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Language Specification**

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standard

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Introduction

This Ecma Standard is based on several originating technologies, the most well known being JavaScript (Netscape) and JScript (Microsoft). The language was invented by Brendan Eich at Netscape and first appeared in that company's Navigator 2.0 browser. It has appeared in all subsequent browsers from Netscape and in all browsers from Microsoft starting with Internet Explorer 3.0.

The development of this Standard started in November 1996. The first edition of this Ecma Standard was adopted by the Ecma General Assembly of June 1997.

That Ecma Standard was submitted to ISO/IEC JTC 1 for adoption under the fast-track procedure, and approved as international standard ISO/IEC 16262, in April 1998. The Ecma General Assembly of June 1998 approved the second edition of ECMA-262 to keep it fully aligned with ISO/IEC 16262. Changes between the first and the second edition are editorial in nature.

The third edition of the Standard introduced powerful regular expressions, better string handling, new control statements, try/catch exception handling, tighter definition of errors, formatting for numeric output and minor changes in anticipation of forthcoming internationalization facilities and future language growth. The third edition of the ECMAScript standard was adopted by the Ecma General Assembly of December 1999 and published as ISO/IEC 16262:2002 in June 2002.

After publication of the third edition, ECMAScript achieved massive adoption in conjunction with the World Wide Web where it has become the programming language that is supported by essentially all web browsers. Significant work was done to develop a fourth edition of ECMAScript. However, that work was not completed and not published¹ as the fourth edition of ECMAScript. The fifth edition of ECMAScript (published as ECMA-262 5th edition) codified de facto interpretations of the language specification that have become common among browser implementations and added support for new features that had emerged since the publication of the third edition. Such features include accessor properties, reflective creation and inspection of objects, program control of property attributes, additional array manipulation functions, support for the JSON object encoding format, and a strict mode that provides enhanced error checking and program security.

The edition 5.1 of the ECMAScript Standard is fully aligned with the third edition of the international standard ISO/IEC 16262:2011.

Goals for the sixth edition include providing better support for large applications, library creation, and for use of ECMAScript as a compilation target for other languages. The sixth edition is the most extensive update to ECMAScript since the publication of the first edition. Some of its major enhancements include modules, class declarations, lexical block scoping, iterators and generators, promises for asynchronous programming, destructuring patterns, and proper tail calls. The ECMAScript library of built-ins has been expanded to support additional data abstractions including maps, sets, and arrays of binary numeric values as well as additional support for the Unicode supplemental characters in strings and regular expressions. The built-ins are now extensible via subclassing.

ECMAScript is now one of the world's most widely used comprehensive general purpose programming languages. It has been adopted not just by browsers but also for servers and embedded applications. New uses and requirements for ECMAScript continue to emerge. The sixth edition provides the foundation for regular, incremental language and library enhancements.

¹ Note: Please note that for ECMAScript Edition 4 the Ecma standard number "ECMA-262 Edition 4" was reserved but not used in the Ecma publication process. Therefore "ECMA-262 Edition 4" as an Ecma International publication does not exist.

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This Ecma Standard has been adopted by the General Assembly of <month> <year>.

"DISCLAIMER"

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ECMAScript 2015 Language Specification

1 Scope

This Standard defines the ECMAScript 2015 general purpose programming language.

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2 Conformance

A conforming implementation of ECMAScript must provide and support all the types, values, objects, properties, functions, and program syntax and semantics described in this specification.

A conforming implementation of ECMAScript must interpret source code input in conformance with the Unicode Standard, Version 5.1.0 or later and ISO/IEC 10646. If the adopted ISO/IEC 10646-1 subset is not otherwise specified, it is presumed to be the Unicode set, collection 10646.

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A conforming implementation of ECMAScript that provides an application programming interface that supports programs that need to adapt to the linguistic and cultural conventions used by different human languages and countries must implement the interface defined by the most recent edition of ECMA-402 that is compatible with this specification.

A conforming implementation of ECMAScript may provide additional types, values, objects, properties, and functions beyond those described in this specification. In particular, a conforming implementation of ECMAScript may provide properties not described in this specification, and values for those properties, for objects that are described in this specification.

A conforming implementation of ECMAScript may support program and regular expression syntax not described in this specification. In particular, a conforming implementation of ECMAScript may support program syntax that makes use of the “future reserved words” listed in subclause 11.6.2.2 of this specification.

A conforming implementation of ECMAScript must not implement any extension that is listed as a Forbidden Extension in subclause 16.1.

3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEEE Std 754-2008: IEEE Standard for Floating-Point Arithmetic. Institute of Electrical and Electronic Engineers, New York (2008)

ISO/IEC 10646:2003: *Information Technology – Universal Multiple-Octet Coded Character Set (UCS) plus Amendment 1:2005, Amendment 2:2006, Amendment 3:2008, and Amendment 4:2008*, plus additional amendments and corrigenda, or successor

The Unicode Standard, Version 5.0, as amended by Unicode 5.1.0, or successor

Unicode Standard Annex #15, Unicode Normalization Forms, version Unicode 5.1.0, or successor

Unicode Standard Annex #31, Unicode Identifiers and Pattern Syntax, version Unicode 5.1.0, or successor.

ECMA-402, ECMAScript Internationalization API Specification.

<http://www.ecma-international.org/publications/standards/Ecma-402.htm>

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ECMA-404, The JSON Data Interchange Format.

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4 Overview

This section contains a non-normative overview of the ECMAScript language.

ECMAScript is an object-oriented programming language for performing computations and manipulating computational objects within a host environment. ECMAScript as defined here is not intended to be computationally self-sufficient; indeed, there are no provisions in this specification for input of external data or output of computed results. Instead, it is expected that the computational environment of an ECMAScript program will provide not only the objects and other facilities described in this specification but also certain environment-specific objects, whose description and behaviour are beyond the scope of this specification except to indicate that they may provide certain properties that can be accessed and certain functions that can be called from an ECMAScript program.

ECMAScript was originally designed to be used as a scripting language, but has become widely used as a general purpose programming language. A **scripting language** is a programming language that is used to manipulate, customize, and automate the facilities of an existing system. In such systems, useful functionality is already available through a user interface, and the scripting language is a mechanism for exposing that functionality to program control. In this way, the existing system is said to provide a host environment of objects and facilities, which completes the capabilities of the scripting language. A scripting language is intended for use by both professional and non-professional programmers.

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ECMAScript was originally designed to be a **Web scripting language**, providing a mechanism to enliven Web pages in browsers and to perform server computation as part of a Web-based client-server architecture. ECMAScript is now used to provide core scripting capabilities for a variety of host environments. Therefore the core language is specified in this document apart from any particular host environment.

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ECMAScript usage has moved beyond simple scripting and it is now used for the full spectrum of programming tasks in many different environments and scales. As the usage of ECMAScript has expanded, so has the features and facilities it provides. ECMAScript is now a fully featured general propose programming language.

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Some of the facilities of ECMAScript are similar to those used in other programming languages; in particular C, Java™, Self, and Scheme as described in:

ISO/IEC 9899:1996, Programming Languages – C.

Gosling, James, Bill Joy and Guy Steele. The Java™ Language Specification. Addison Wesley Publishing Co. 1996.

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Ungar, David, and Smith, Randall B. Self: The Power of Simplicity. OOPSLA '87 Conference Proceedings, pp. 227–241, Orlando, FL, October 1987.

IEEE Standard for the Scheme Programming Language. IEEE Std 1178-1990.

4.1 Web Scripting

A web browser provides an ECMAScript host environment for client-side computation including, for instance, objects that represent windows, menus, pop-ups, dialog boxes, text areas, anchors, frames, history, cookies, and input/output. Further, the host environment provides a means to attach scripting code to events such as change of focus, page and image loading, unloading, error and abort, selection, form submission, and mouse actions. Scripting code appears within the HTML and the displayed page is a combination of user interface elements and fixed and computed text and images. The scripting code is reactive to user interaction and there is no need for a main program.

A web server provides a different host environment for server-side computation including objects representing requests, clients, and files; and mechanisms to lock and share data. By using browser-side and server-side scripting together, it is possible to distribute computation between the client and server while providing a customized user interface for a Web-based application.

Each Web browser and server that supports ECMAScript supplies its own host environment, completing the ECMAScript execution environment.

4.2 ECMAScript Overview

The following is an informal overview of ECMAScript—not all parts of the language are described. This overview is not part of the standard proper.

ECMAScript is object-based: basic language and host facilities are provided by objects, and an ECMAScript program is a cluster of communicating objects. In ECMAScript, an **object** is a collection of **zero or more properties** each with **attributes** that determine how each property can be used—for example, when the Writable attribute for a property is set to **false**, any attempt by executed ECMAScript code to **assign a different value to** the property fails. Properties are containers that hold other objects, **primitive values**, or **functions**. A primitive value is a member of one of the following built-in types: **Undefined**, **Null**, **Boolean**, **Number**, **String**, and **Symbol**; an object is a member of the built-in type **Object**; and a function is a callable object. A function that is associated with an object via a property is **called** a **method**.

ECMAScript defines a collection of **built-in objects** that round out the definition of ECMAScript entities. These built-in objects include the global object; **objects that are fundamental to the runtime semantics of the language including Object, Function, Boolean, Symbol, and various Error objects**; **objects that represent and manipulate numeric values including Math, Number, and Date**; **the text processing objects String and RegExp**; **objects that are indexed collections of values including Array and nine different kinds of Typed Arrays whose elements all have a specific numeric data representation**; **keyed collections including Map and Set objects**; **objects supporting structured data including the JSON object, ArrayBuffer, and DataView**; **objects supporting control abstractions including generator functions and Promise objects**; and **reflection objects including Proxy and Reflect**.

ECMAScript also defines a set of built-in **operators**. ECMAScript operators include various unary operations, multiplicative operators, additive operators, bitwise shift operators, relational operators, equality operators, binary bitwise operators, binary logical operators, assignment operators, and the comma operator.

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Large ECMAScript programs are supported by **modules** which allow a program to be divided into multiple sequences of statements and declarations. Each module explicitly identifies declarations it uses that need to be provided by other modules and which of its declarations are available for use by other modules.

ECMAScript syntax intentionally resembles Java syntax. ECMAScript syntax is relaxed to enable it to serve as an easy-to-use scripting language. For example, a variable is not required to have its type declared nor are types associated with properties, and defined functions are not required to have their declarations appear textually before calls to them.

4.2.1 Objects

ECMAScript objects are not fundamentally class-based such as those in C++, Smalltalk, or Java. Instead objects may be created in various ways including via a literal notation or via **constructors** which create objects and then execute code that initializes all or part of them by assigning initial values to their properties. Each constructor is a function that has a property named “**prototype**” that is used to implement **prototype-based inheritance** and **shared properties**. Objects are created by using constructors in **new** expressions; for example, `new Date(2009, 11)` creates a new Date object. Invoking a constructor without using **new** has consequences that depend on the constructor. For example, `Date()` produces a string representation of the current date and time rather than an object.

Every object created by a constructor has an implicit reference (called the object’s *prototype*) to the value of its constructor’s “**prototype**” property. Furthermore, a prototype may have a non-null implicit reference to its prototype, and so on; this is called the *prototype chain*. When a reference is made to a property in an object, that reference is to the property of that name in the first object in the prototype chain that contains a property of that name. In other words, first the object mentioned directly is examined for such a property; if that object contains the named property, that is the property to which the reference refers; if that object does not contain the named property, the prototype for that object is examined next; and so on.

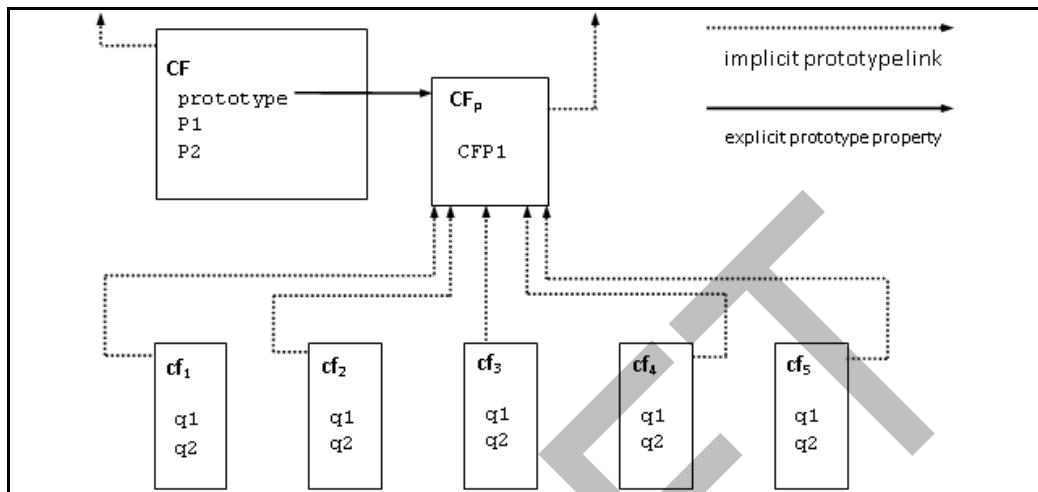


Figure 1 — Object/Prototype Relationships

In a class-based object-oriented language, in general, state is carried by instances, methods are carried by classes, and inheritance is only of structure and behaviour. In ECMAScript, the state and methods are carried by objects, while structure, behaviour, and state are all inherited.

All objects that do not directly contain a particular property that their prototype contains share that property and its value. Figure 1 illustrates this:

CF is a constructor (and also an object). Five objects have been created by using `new` expressions: **cf₁**, **cf₂**, **cf₃**, **cf₄**, and **cf₅**. Each of these objects contains properties named **q1** and **q2**. The dashed lines represent the implicit prototype relationship; so, for example, **cf₃**'s prototype is **CF_p**. The constructor, **CF**, has two properties itself, named **P1** and **P2**, which are not visible to **CF_p**, **cf₁**, **cf₂**, **cf₃**, **cf₄**, or **cf₅**. The property named **CFP1** in **CF_p** is shared by **cf₁**, **cf₂**, **cf₃**, **cf₄**, and **cf₅** (but not by **CF**), as are any properties found in **CF_p**'s implicit prototype chain that are not named **q1**, **q2**, or **CFP1**. Notice that there is no implicit prototype link between **CF** and **CF_p**.

Unlike most class-based object languages, properties can be added to objects dynamically by assigning values to them. That is, constructors are not required to name or assign values to all or any of the constructed object's properties. In the above diagram, one could add a new shared property for **cf₁**, **cf₂**, **cf₃**, **cf₄**, and **cf₅** by assigning a new value to the property in **CF_p**.

Although ECMAScript objects are not inherently class-based, it is often convenient to define class-like abstractions based upon a common pattern of constructor functions, prototype objects, and methods. The ECMAScript built-in objects themselves follow such a class-like pattern. The ECMAScript language includes syntactic class definitions that permit programmers to concisely define objects that conform to the same class-like abstraction pattern used by the built-in objects.

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4.2.2 The Strict Variant of ECMAScript

The ECMAScript Language recognizes the possibility that some users of the language may wish to restrict their usage of some features available in the language. They might do so in the interests of

security, to avoid what they consider to be error-prone features, to get enhanced error checking, or for other reasons of their choosing. In support of this possibility, ECMAScript defines a strict variant of the language. The strict variant of the language excludes some specific syntactic and semantic features of the regular ECMAScript language and modifies the detailed semantics of some features. The strict variant also specifies additional error conditions that must be reported by throwing error exceptions in situations that are not specified as errors by the non-strict form of the language.

The strict variant of ECMAScript is commonly referred to as the *strict mode* of the language. Strict mode selection and use of the strict mode syntax and semantics of ECMAScript is explicitly made at the level of individual ECMAScript code units. Because strict mode is selected at the level of a syntactic code unit, strict mode only imposes restrictions that have local effect within such a code unit. Strict mode does not restrict or modify any aspect of the ECMAScript semantics that must operate consistently across multiple code units. A complete ECMAScript program may be composed for both strict mode and non-strict mode ECMAScript code units. In this case, strict mode only applies when actually executing code that is defined within a strict mode code unit.

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In order to conform to this specification, an ECMAScript implementation must implement both the full unrestricted ECMAScript language and the strict mode variant of the ECMAScript language as defined by this specification. In addition, an implementation must support the combination of unrestricted and strict mode code units into a single composite program.

4.3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

4.3.1 type

set of data values as defined in clause 6 of this specification

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4.3.2 primitive value

member of one of the types Undefined, Null, Boolean, Number, Symbol, or String as defined in clause 6

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NOTE A primitive value is a datum that is represented directly at the lowest level of the language implementation.

4.3.3 object

member of the type Object

NOTE An object is a collection of properties and has a single prototype object. The prototype may be the null value.

4.3.4 constructor

function object that creates and initializes objects

NOTE The value of a constructor's "prototype" property is a prototype object that is used to implement inheritance and shared properties.

4.3.5

prototype

object that provides shared properties for other objects

NOTE When a constructor creates an object, that object implicitly references the constructor's "prototype" property for the purpose of resolving property references. The constructor's "prototype" property can be referenced by the program expression `constructor.prototype`, and properties added to an object's prototype are shared, through inheritance, by all objects sharing the prototype. Alternatively, a new object may be created with an explicitly specified prototype by using the `Object.create` built-in function.

4.3.6

ordinary object

object that has the default behaviour for the essential internal methods that must be supported by all objects.

4.3.7

exotic object

object that does not have the default behaviour for one or more of the essential internal methods that must be supported by all objects.

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NOTE Any object that is not an ordinary object is an exotic object.

4.3.8

standard object

object whose semantics are defined by this specification

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4.3.9

built-in object

object specified and supplied by an ECMAScript implementation

NOTE Standard built-in objects are defined in this specification. An ECMAScript implementation may specify and supply additional kinds of built-in objects. A *built-in constructor* is a built-in object that is also a constructor.

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Deleted: others

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4.3.10

undefined value

primitive value used when a variable has not been assigned a value

4.3.11

Undefined type

type whose sole value is the **undefined** value

4.3.12

null value

primitive value that represents the intentional absence of any object value

4.3.13

Null type

type whose sole value is the null value

4.3.14

Boolean value

member of the Boolean type

NOTE There are only two Boolean values, **true** and **false**.

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4.3.15

Boolean type

type consisting of the primitive values **true** and **false**

4.3.16

Boolean object

member of the Object type that is an instance of the standard built-in **Boolean** constructor

NOTE A Boolean object is created by using the **Boolean** constructor in a **new** expression, supplying a Boolean value as an argument. The resulting object has an internal slot whose value is the Boolean value. A Boolean object can be coerced to a Boolean value.

4.3.17

String value

primitive value that is a finite ordered sequence of zero or more 16-bit unsigned integer

NOTE A String value is a member of the String type. Each integer value in the sequence usually represents a single 16-bit unit of UTF-16 text. However, ECMAScript does not place any restrictions or requirements on the values except that they must be 16-bit unsigned integers.

4.3.18

String type

set of all possible String values

4.3.19

String object

member of the Object type that is an instance of the standard built-in **String** constructor

NOTE A String object is created by using the **String** constructor in a **new** expression, supplying a String value as an argument. The resulting object has an internal slot whose value is the String value. A String object can be coerced to a String value by calling the **String** constructor as a function (21.1.1.1).

4.3.20

Number value

primitive value corresponding to a double-precision 64-bit binary format IEEE 754 value

NOTE A Number value is a member of the Number type and is a direct representation of a number.

4.3.21

Number type

set of all possible Number values including the special “Not-a-Number” (NaN) value, positive infinity, and negative infinity

4.3.22

Number object

member of the Object type that is an instance of the standard built-in **Number** constructor

NOTE A Number object is created by using the **Number** constructor in a **new** expression, supplying a Number value as an argument. The resulting object has an internal slot whose value is the Number value. A Number object can be coerced to a Number value by calling the **Number** constructor as a function (20.1.1.1).

4.3.23

Infinity

number value that is the positive infinite Number value

4.3.24

NaN

number value that is an IEEE 754 “Not-a-Number” value

4.3.25

Symbol value

primitive value that represents a unique, non-String Object property key

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4.3.26

Symbol type

set of all possible Symbol values

4.3.27

Symbol object

member of the Object type that is an instance of the standard built-in **Symbol** constructor

4.3.28

function

member of the Object type that may be invoked as a subroutine

NOTE In addition to its properties, a function contains executable code and state that determine how it behaves when invoked. A function’s code may or may not be written in ECMAScript.

4.3.29

built-in function

built-in object that is a function

NOTE Examples of built-in functions include **parseInt** and **Math.exp**. An implementation may provide implementation-dependent built-in functions that are not described in this specification.

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4.3.30

property

association between a key and a value that is a part of an object. The key be either a String value or a Symbol value.

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NOTE Depending upon the form of the property the value may be represented either directly as a data value (a primitive value, an object, or a function object) or indirectly by a pair of accessor functions.

4.3.31

method

function that is the value of a property

NOTE When a function is called as a method of an object, the object is passed to the function as its **this** value.

4.3.32

built-in method

method that is a built-in function

NOTE Standard built-in methods are defined in this specification, and an ECMAScript implementation may specify and provide other additional built-in methods.

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4.3.33

attribute

internal value that defines some characteristic of a property

4.3.34

own property

property that is directly contained by its object

4.3.35

inherited property

property of an object that is not an own property but is a property (either own or inherited) of the object's prototype

4.4 Organization of This Specification

The remainder of this specification is organized as follows:

Clause 5 defines the notational conventions used throughout the specification.

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Clauses 6–9 define the execution environment within which ECMAScript programs operate.

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Clauses 10–16 define the actual ECMAScript programming language including its syntactic encoding and the execution semantics of all language features.

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Clauses 17–26 define the ECMAScript standard library. It includes the definitions of all of the standard objects that are available for use by ECMAScript programs as they execute.

5 Notational Conventions

5.1 Syntactic and Lexical Grammars

5.1.1 Context-Free Grammars

A *context-free grammar* consists of a number of *productions*. Each production has an abstract symbol called a *nonterminal* as its *left-hand side*, and a sequence of zero or more nonterminal and *terminal* symbols as its *right-hand side*. For each grammar, the terminal symbols are drawn from a specified alphabet.

A *chain production* is a production that has exactly one nonterminal symbol on its right-hand side along with zero or more terminal symbols.

Starting from a sentence consisting of a single distinguished nonterminal, called the *goal symbol*, a given context-free grammar specifies a *language*, namely, the (perhaps infinite) set of possible sequences of terminal symbols that can result from repeatedly replacing any nonterminal in the sequence with a right-hand side of a production for which the nonterminal is the left-hand side.

5.1.2 The Lexical and RegExp Grammars

A *lexical grammar* for ECMAScript is given in clause 11. This grammar has as its terminal symbols Unicode code points that conform to the rules for *SourceCharacter* defined in 10.1. It defines a set of productions, starting from the goal symbol *InputElementDiv* or *InputElementRegExp*, that describe how sequences of such code points are translated into a sequence of input elements.

Input elements other than white space and comments form the terminal symbols for the syntactic grammar for ECMAScript and are called ECMAScript *tokens*. These tokens are the reserved words, identifiers, literals, and punctuators of the ECMAScript language. Moreover, line terminators, although not considered to be tokens, also become part of the stream of input elements and guide the process of automatic semicolon insertion (11.9). Simple white space and single-line comments are discarded and do not appear in the stream of input elements for the syntactic grammar. A *MultiLineComment* (that is, a comment of the form “/*...*/” regardless of whether it spans more than one line) is likewise simply discarded if it contains no line terminator; but if a *MultiLineComment* contains one or more line terminators, then it is replaced by a single line terminator, which becomes part of the stream of input elements for the syntactic grammar.

A *RegExp grammar* for ECMAScript is given in 21.2.1. This grammar also has as its terminal symbols the code points as defined by *SourceCharacter*. It defines a set of productions, starting from the goal symbol *Pattern*, that describe how sequences of code points are translated into regular expression patterns.

Productions of the lexical and RegExp grammars are distinguished by having two colons “::” as separating punctuation. The lexical and RegExp grammars share some productions.

5.1.3 The Numeric String Grammar

Another grammar is used for translating Strings into numeric values. This grammar is similar to the part of the lexical grammar having to do with numeric literals and has as its terminal symbols *SourceCharacter*. This grammar appears in 7.1.3.1.

Productions of the numeric string grammar are distinguished by having three colons “:::” as punctuation.

5.1.4 The Syntactic Grammar

The *syntactic grammar* for ECMAScript is given in clauses 11, 12, 13, 14, and 15. This grammar has ECMAScript tokens defined by the lexical grammar as its terminal symbols (5.1.2). It defines a set of productions, starting from two alternative goal symbols *Script* and *Module*, that describe how sequences of tokens can form syntactically correct independent components of an ECMAScript programs.

When a stream of code points is to be parsed as an ECMAScript *Script* or *Module*, it is first converted to a stream of input elements by repeated application of the lexical grammar; this stream of input elements is then parsed by a single application of the syntactic grammar. The input stream is syntactically in error if the tokens in the stream of input elements cannot be parsed as a single instance of the goal nonterminal (*Script* or *Module*), with no tokens left over.

Productions of the syntactic grammar are distinguished by having just one colon “:” as punctuation.

The syntactic grammar as presented in clauses 12, 13, 14 and 15 is actually not a complete account of which token sequences are accepted as a correct ECMAScript *Script* or *Module*. Certain additional token sequences are also accepted, namely, those that would be described by the grammar if only semicolons were added to the sequence in certain places (such as before line terminator characters). Furthermore,

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certain token sequences that are described by the grammar are not considered acceptable if a [line](#) terminator character appears in certain “awkward” places.

In certain cases in order to avoid ambiguities the syntactic grammar uses generalized productions that permit token sequences that do not form a valid ECMAScript *Script* or *Module*. For example, this technique is used for object literals and object destructuring patterns. In such cases a more restrictive *supplemental grammar* is provided that further restricts the acceptable token sequences. In certain contexts, when explicitly specific, the input elements corresponding to such a production are parsed again using a goal symbol of a supplemental grammar. The input stream is syntactically in error if the tokens in the stream of input elements parsed by a cover grammar cannot be parsed as a single instance of the corresponding supplemental goal symbol, with no tokens left over.

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5.1.5 Grammar Notation

Terminal symbols of the lexical, RegExp, and numeric string grammars, and some of the terminal symbols of the other grammars, are shown in **fixed width** font, both in the productions of the grammars and throughout this specification whenever the text directly refers to such a terminal symbol.

These are to appear in a script exactly as written. All terminal symbol code points specified in this way are to be understood as the appropriate Unicode code points from the Basic Latin range, as opposed to any similar-looking code points from other Unicode ranges.

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Nonterminal symbols are shown in *italic* type. The definition of a nonterminal (also called a “production”) is introduced by the name of the nonterminal being defined followed by one or more colons. (The number of colons indicates to which grammar the production belongs.) One or more alternative right-hand sides for the nonterminal then follow on succeeding lines. For example, the syntactic definition:

```
WhileStatement :
  while ( Expression ) Statement
```

states that the nonterminal *WhileStatement* represents the token **while**, followed by a left parenthesis token, followed by an *Expression*, followed by a right parenthesis token, followed by a *Statement*. The occurrences of *Expression* and *Statement* are themselves nonterminals. As another example, the syntactic definition:

```
ArgumentList :
  AssignmentExpression
  ArgumentList , AssignmentExpression
```

states that an *ArgumentList* may represent either a single *AssignmentExpression* or an *ArgumentList*, followed by a comma, followed by an *AssignmentExpression*. This definition of *ArgumentList* is recursive, that is, it is defined in terms of itself. The result is that an *ArgumentList* may contain any positive number of arguments, separated by commas, where each argument expression is an *AssignmentExpression*. Such recursive definitions of nonterminals are common.

The subscripted suffix “*opt*”, which may appear after a terminal or nonterminal, indicates an optional symbol. The alternative containing the optional symbol actually specifies two right-hand sides, one that omits the optional element and one that includes it. This means that:

```
VariableDeclaration :
  BindingIdentifier Initializeropt
```

is a convenient abbreviation for:

VariableDeclaration :
BindingIdentifier
BindingIdentifier Initializer

and that:

IterationStatement :
for (LexicalDeclaration Expression_{opt} ; Expression_{opt}) Statement

Deleted: ;

is a convenient abbreviation for:

IterationStatement :
for (LexicalDeclaration ; Expression_{opt}) Statement
for (LexicalDeclaration ; Expression) Statement

Deleted: ;

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which in turn is an abbreviation for:

IterationStatement :
for (LexicalDeclaration ;) Statement
for (LexicalDeclaration ; Expression) Statement
for (LexicalDeclaration ; Expression ;) Statement
for (LexicalDeclaration ; Expression ; Expression) Statement

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so, in this example, the nonterminal *IterationStatement* actually has four alternative right-hand sides.

A production may be parameterized by a subscripted annotation of the form “[parameters]”, which may appear as a suffix to the nonterminal symbol defined by the production. “parameters” may be either a single name or a comma separated list of names. A parameterized production is shorthand for a set of productions defining all combinations of the parameter names, preceded by an underscore, appended to the parameterized nonterminal symbol. This means that:

StatementList_[Return] :
ReturnStatement
ExpressionStatement

Deleted: ;

Deleted: ¶

is a convenient abbreviation for:

StatementList :
ReturnStatement
ExpressionStatement

Deleted: ¶

StatementList_{_Return} :
ReturnStatement
ExpressionStatement

Deleted: ¶

and that:

StatementList_[Return, In] :
ReturnStatement
ExpressionStatement

Deleted: ¶

is an abbreviation for:

StatementList :
ReturnStatement
ExpressionStatement

Deleted: 1

StatementList_Return :
ReturnStatement
ExpressionStatement

Deleted: 1

StatementList_In :
ReturnStatement
ExpressionStatement

Deleted: 1

StatementList_Return_In :
ReturnStatement
ExpressionStatement

Deleted: 1

Multiple parameters produce a combinatory number of productions, not all of which are necessarily referenced in a complete grammar.

References to nonterminals on the right-hand side of a production can also be parameterized. For example:

StatementList :
ReturnStatement
ExpressionStatement_[In]

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is equivalent to saying:

StatementList :
ReturnStatement
ExpressionStatement_{_In}

Deleted: 1

A nonterminal reference may have both a parameter list and an “_{opt}” suffix. For example:

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VariableDeclaration :
BindingIdentifier Initializer_{[In]opt}

is an abbreviation for:

VariableDeclaration :
BindingIdentifier
BindingIdentifier Initializer_{_In}

Prefixing a parameter name with “?” on a right-hand side nonterminal reference makes that parameter value dependent upon the occurrence of the parameter name on the reference to the current production’s left-hand side symbol. For example:

VariableDeclaration_[In] :
BindingIdentifier Initializer_[?In]

is an abbreviation for:

VariableDeclaration :
BindingIdentifier Initializer

VariableDeclaration_In :
BindingIdentifier Initializer_In

If a right-hand side alternative is prefixed with “[+parameter]” that alternative is only available if the named parameter was used in referencing the production’s nonterminal symbol. If a right-hand side alternative is prefixed with “[−parameter]” that alternative is only available if the named parameter was *not* used in referencing the production’s nonterminal symbol. This means that:

StatementList_[Return] :
 [+Return] *ReturnStatement*
ExpressionStatement

is an abbreviation for:

StatementList :
ExpressionStatement

StatementList_{_Return} :
ReturnStatement
ExpressionStatement

and that,

StatementList_[Return] :
 [−Return] *ReturnStatement*
ExpressionStatement

is an abbreviation for:

StatementList :
ReturnStatement
ExpressionStatement

StatementList_{_Return} :
ExpressionStatement

When the words “one of” follow the colon(s) in a grammar definition, they signify that each of the terminal symbols on the following line or lines is an alternative definition. For example, the lexical grammar for ECMAScript contains the production:

NonZeroDigit :: one of
 1 2 3 4 5 6 7 8 9

which is merely a convenient abbreviation for:

NonZeroDigit :::

1
2
3
4
5
6
7
8
9

If the phrase “[empty]” appears as the right-hand side of a production, it indicates that the production's right-hand side contains no terminals or nonterminals.

If the phrase “[lookahead \notin set]” appears in the right-hand side of a production, it indicates that the production may not be used if the immediately following input token is a member of the given *set*. The *set* can be written as a list of terminals enclosed in curly brackets. For convenience, the set can also be written as a nonterminal, in which case it represents the set of all terminals to which that nonterminal could expand. If the set consists of a single terminal the phrase “[lookahead \neq terminal]” may be used.

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For example, given the definitions

```
DecimalDigit :: one of
  0 1 2 3 4 5 6 7 8 9

DecimalDigits :::
  DecimalDigit
  DecimalDigits DecimalDigit
```

the definition

```
LookaheadExample :::
  n [lookahead  $\notin$  {1, 3, 5, 7, 9}] DecimalDigits
  DecimalDigit [lookahead  $\notin$  DecimalDigit]
```

matches either the letter *n* followed by one or more decimal digits the first of which is even, or a decimal digit not followed by another decimal digit.

If the phrase “[no LineTerminator here]” appears in the right-hand side of a production of the syntactic grammar, it indicates that the production is a *restricted production*: it may not be used if a *LineTerminator* occurs in the input stream at the indicated position. For example, the production:

```
ThrowStatement :
  throw [no LineTerminator here] Expression ;
```

indicates that the production may not be used if a *LineTerminator* occurs in the script between the *throw* token and the *Expression*.

Unless the presence of a *LineTerminator* is forbidden by a restricted production, any number of occurrences of *LineTerminator* may appear between any two consecutive tokens in the stream of input elements without affecting the syntactic acceptability of the script.

The lexical grammar has multiple goal symbols and the appropriate goal symbol to use depends upon the syntactic grammar context. If a phrase of the form “[Lexical goal LexicalGoalSymbol]” appears on the right-hand-side of a syntactic production then the next token must be lexically recognized using the indicated goal symbol. In the absence of such a phrase the default lexical goal symbol is used.

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When an alternative in a production of the lexical grammar or the numeric string grammar appears to be a multi-code point token, it represents the sequence of code points that would make up such a token.

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The right-hand side of a production may specify that certain expansions are not permitted by using the phrase “**but not**” and then indicating the expansions to be excluded. For example, the production:

Identifier ::
 IdentifierName **but not** *ReservedWord*

means that the nonterminal *Identifier* may be replaced by any sequence of code points that could replace *IdentifierName* provided that the same sequence of code points could not replace *ReservedWord*.

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Deleted: characters

Finally, a few nonterminal symbols are described by a descriptive phrase in sans-serif type in cases where it would be impractical to list all the alternatives:

SourceCharacter ::
 any Unicode code point

5.2 Algorithm Conventions

The specification often uses a numbered list to specify steps in an algorithm. These algorithms are used to precisely specify the required semantics of ECMAScript language constructs. The algorithms are not intended to imply the use of any specific implementation technique. In practice, there may be more efficient algorithms available to implement a given feature.

Algorithms may be explicitly parameterized, in which case the names and usage of the parameters must be provided as part of the algorithm’s definition. In order to facilitate their use in multiple parts of this specification, some algorithms, called *abstract operations*, are named and written in parameterized functional form so that they may be referenced by name from within other algorithms.

Algorithms may be associated with productions of one of the ECMAScript grammars. A production that has multiple alternative definitions will typically have a distinct algorithm for each alternative. When an algorithm is associated with a grammar production, it may reference the terminal and nonterminal symbols of the production alternative as if they were parameters of the algorithm. When used in this manner, nonterminal symbols refer to the actual alternative definition that is matched when parsing the script source code.

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When an algorithm is associated with a production alternative, the alternative is typically shown without any “[]” grammar annotations. Such annotations should only affect the syntactic recognition of the alternative and have no effect on the associated semantics for the alternative.

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Unless explicitly specified otherwise, all chain productions have an implicit definition for every algorithm that might be applied to that production’s left-hand side nonterminal. The implicit definition simply reapplies the same algorithm name with the same parameters, if any, to the chain production’s sole right-hand side nonterminal and then returns the result. For example, assume there is a production:

Deleted: associated
Deleted: is
Deleted:

Block :
{ StatementList }

but there is no corresponding Evaluation algorithm that is explicitly specified for that production. If in some algorithm there is a statement of the form: "Return the result of evaluating *Block*" it is implicit that an Evaluation algorithm exists of the form:

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Deleted: the algorithm has
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Runtime Semantics: Evaluation

Block : { StatementList }

1. Return the result of evaluating *StatementList*.

For clarity of expression, algorithm steps may be subdivided into sequential substeps. Substeps are indented and may themselves be further divided into indented substeps. Outline numbering conventions are used to identify substeps with the first level of substeps labelled with lower case alphabetic characters and the second level of substeps labelled with lower case roman numerals. If more than three levels are required these rules repeat with the fourth level using numeric labels. For example:

1. Top-level step
 - a. Substep.
 - b. Substep.
 - i. Subsubstep.
 1. Subsubsubstep
 - a. Subsubsubsubstep
 - i. Subsubsubsubsubstep

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A step or substep may be written as an "if" predicate that conditions its substeps. In this case, the substeps are only applied if the predicate is true. If a step or substep begins with the word "else", it is a predicate that is the negation of the preceding "if" predicate step at the same level.

A step may specify the iterative application of its substeps.

A step that begins with "Assert." asserts an invariant condition of its algorithm. Such assertions are used to make explicit algorithmic invariants that would otherwise be implicit. Such assertions add no additional semantic requirements and hence need not be checked by an implementation. They are used simply to clarify algorithms.

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Mathematical operations such as addition, subtraction, negation, multiplication, division, and the mathematical functions defined later in this clause should always be understood as computing exact mathematical results on mathematical real numbers, which do not include infinities and do not include a negative zero that is distinguished from positive zero. Algorithms in this standard that model floating-point arithmetic include explicit steps, where necessary, to handle infinities and signed zero and to perform rounding. If a mathematical operation or function is applied to a floating-point number, it should be understood as being applied to the exact mathematical value represented by that floating-point number; such a floating-point number must be finite, and if it is +0 or -0 then the corresponding mathematical value is simply 0.

The mathematical function $\text{abs}(x)$ produces the absolute value of x , which is $-x$ if x is negative (less than zero) and otherwise is x itself.

The mathematical function $\text{sign}(x)$ produces 1 if x is positive and -1 if x is negative. The sign function is not used in this standard for cases when x is zero.

The mathematical function $\min(x_1, x_2, \dots, x_n)$ produces the mathematically smallest of x_1 through x_n . The mathematical function $\max(x_1, x_2, \dots, x_n)$ produces the mathematically largest of x_1 through x_n .

The notation “ x modulo y ” (y must be finite and nonzero) computes a value k of the same sign as y (or zero) such that $\text{abs}(k) < \text{abs}(y)$ and $x - k = q \times y$ for some integer q .

The mathematical function $\text{floor}(x)$ produces the largest integer (closest to positive infinity) that is not larger than x .

NOTE $\text{floor}(x) = x - (x \text{ modulo } 1)$.

5.3 Static Semantic Rules

Context-free grammars are not sufficiently powerful to express all the rules that define whether a stream of input elements form a valid ECMAScript *Script or Module*, that may be evaluated. In some situations additional rules are needed that may be expressed using either ECMAScript algorithm conventions or prose requirements. Such rules are always associated with a production of a grammar and are called the *static semantics* of the production.

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Static Semantic Rules have names and typically are defined using an algorithm. Named Static Semantic Rules are associated with grammar productions and a production that has multiple alternative definitions will typically have for each alternative a distinct algorithm for each applicable named static semantic rule.

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Unless otherwise specified every grammar production alternative in this specification implicitly has a definition for a static semantic rule named *Contains* which takes an argument named *symbol* whose value is a terminal or nonterminal of the grammar that includes the associated production. The default definition of *Contains* is:

1. For each terminal and nonterminal grammar symbol, *sym*, in the definition of this production do
 - a. If *sym* is the same grammar symbol as *symbol*, return **true**.
 - b. If *sym* is a nonterminal, then
 - i. Let *contained* be the result of *sym* *Contains* *symbol*.
 - ii. If *contained* is **true**, return **true**.
2. Return **false**.

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The above definition is explicitly over-ridden for specific productions.

A special kind of static semantic rule is an Early Error Rule. Early error rules define early error conditions (see clause 16) that are associated with specific grammar productions. Evaluation of most early error rules are not explicitly invoked within the algorithms of this specification. A conforming implementation must, prior to the first evaluation of a *Script*, validate all of the early error rules of the productions used to parse that *Script*. If any of the early error rules are violated the *Script* is invalid and cannot be evaluated.

6 ECMAScript Data Types and Values

Algorithms within this specification manipulate values each of which has an associated type. The possible value types are exactly those defined in this clause. Types are further subclassified into ECMAScript language types and specification types.

Within this specification, the notation “*Type*(*x*)” is used as shorthand for “the type of *x*” where “type” refers to the ECMAScript language and specification types defined in this clause. When the term “empty” is used as if it was naming a value, it is equivalent to saying “no value of any type”.

6.1 ECMAScript Language Types

An ECMAScript language type corresponds to values that are directly manipulated by an ECMAScript programmer using the ECMAScript language. The ECMAScript language types are Undefined, Null, Boolean, String, Symbol, Number, and Object. An ECMAScript language value is a value that is characterized by an ECMAScript language type.

6.1.1 The Undefined Type

The Undefined type has exactly one value, called **undefined**. Any variable that has not been assigned a value has the value **undefined**.

6.1.2 The Null Type

The Null type has exactly one value, called **null**.

6.1.3 The Boolean Type

The Boolean type represents a logical entity having two values, called **true** and **false**.

6.1.4 The String Type

The String type is the set of all finite ordered sequences of zero or more 16-bit unsigned integer values ("elements"). The String type is generally used to represent textual data in a running ECMAScript program, in which case each element in the String is treated as a UTF-16 code unit value. Each element is regarded as occupying a position within the sequence. These positions are indexed with nonnegative integers. The first element (if any) is at index 0, the next element (if any) at index 1, and so on. The length of a String is the number of elements (i.e., 16-bit values) within it. The empty String has length zero and therefore contains no elements.

Where ECMAScript operations interpret String values, each element is interpreted as a single UTF-16 code unit. However, ECMAScript does not place any restrictions or requirements on the sequence of code units in a String value, so they may be ill-formed when interpreted as UTF-16 code unit sequences. Operations that do not interpret String contents treat them as sequences of undifferentiated 16-bit unsigned integers. No operations ensure that Strings are in a normalized form. Only operations that are explicitly specified to be language or locale sensitive produce language-sensitive results

NOTE The rationale behind this design was to keep the implementation of Strings as simple and high-performing as possible. If ECMAScript source code is in Normalized Form C, string literals are guaranteed to also be normalized, as long as they do not contain any Unicode escape sequences.

Some operations interpret String contents as UTF-16 encoded Unicode code points. In that case the interpretation is:

- A code unit in the range 0 to 0xD7FF or in the range 0xE000 to 0xFFFF is interpreted as a code point with the same value.
- A sequence of two code units, where the first code unit c_1 is in the range 0xD800 to 0xDBFF and the second code unit c_2 is in the range 0xDC00 to 0xDFFF, is a surrogate pair and is interpreted as a code point with the value $(c_1 - 0xD800) \times 0x400 + (c_2 - 0xDC00) + 0x10000$.
- A code unit that is in the range 0xD800 to 0xDFFF, but is not part of a surrogate pair, is interpreted as a code point with the same value.

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6.1.5 The Symbol Type

The Symbol type is the set of all non-String values that may be used as the key of an Object property
(6.1.7).

Each possible Symbol value is unique and immutable.

Each Symbol value immutably holds an associated value called [[Description]] that is either undefined or a String value.

6.1.5.1 Well-Known Symbols

Well-known symbols are built-in Symbol values that are explicitly referenced by algorithms of this specification. They are typically used as the keys of properties whose values serve as extension points of a specification algorithm. Unless otherwise specified, well-known symbols values are shared by all Code Realms (8.2).

Within this specification a well-known symbol is referred to by using a notation of the form @@name, where "name" is one of the values listed in Table 1.

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Table 1— Well-known Symbols

Specification Name	[[Description]]	Value and Purpose
<code>@@hasInstance</code>	<code>"Symbol.hasInstance"</code>	A method that determines if a constructor object recognizes an object as one of the constructor's instances. Called by the semantics of the <code>instanceof</code> operator.
<code>@@isConcatSpreadable</code>	<code>"Symbol.isConcatSpreadable"</code>	A Boolean valued <u>property</u> that if true indicates that an object should be flattened <u>ed</u> to its array elements by <code>Array.prototype.concat</code> .
<code>@@iterator</code>	<code>"Symbol.iterator"</code>	A method that returns the default iterator for an object. Called by the semantics of the <code>for-of</code> statement.
<code>@@match</code>	<code>"Symbol.match "</code>	<u>A regular expression method that matches the regular expression against a string. Called by the <code>String.prototype.match</code> method.</u>
<code>@@replace</code>	<code>"Symbol.replace "</code>	<u>A regular expression method that replaces matched substrings of a string. Called by the <code>String.prototype.replace</code> method.</u>
<code>@@search</code>	<code>"Symbol.search"</code>	<u>A regular expression method that returns the index within a string that matches the regular expression. Called by the <code>String.prototype.search</code> method.</u>
<code>@@species</code>	<code>"Symbol.species"</code>	<u>A property whose value is the constructor function that is used to create derived objects.</u>
<code>@@split</code>	<code>"Symbol.split"</code>	<u>A regular expression method that splits a string at the indices that match the regular expression. Called by the <code>String.prototype.split</code> method.</u>
<code>@@toPrimitive</code>	<code>"Symbol.toPrimitive"</code>	A method that converts an object to a corresponding primitive value. Called by the <code>ToPrimitive</code> abstract operation.
<code>@@toStringTag</code>	<code>"Symbol.toStringTag"</code>	<u>A property whose <code>String</code> value that is used in the creation of the default string description of an object. Called by the built-in method <code>Object.prototype.toString</code>.</u>
<code>@@unscopables</code>	<code>"Symbol.unscopables"</code>	<u>A property whose value is an <code>Object</code> whose own property names are property names that are excluded from the <code>with</code> environment bindings of the associated object.</u>

6.1.6 The Number Type

The Number type has exactly 18437736874454810627 (that is, $2^{64}-2^{53}+3$) values, representing the double-precision 64-bit format IEEE 754 values as specified in the IEEE Standard for Binary Floating-Point Arithmetic, except that the 9007199254740990 (that is, $2^{53}-2$) distinct “Not-a-Number” values of the IEEE Standard are represented in ECMAScript as a single special **NaN** value. (Note that the **NaN** value is

produced by the program expression `NaN`.) In some implementations, external code might be able to detect a difference between various Not-a-Number values, but such behaviour is implementation-dependent; to ECMAScript code, all `NaN` values are indistinguishable from each other.

NOTE The bit pattern that might be observed in an ArrayBuffer (see 24.1) after a Number value has been stored into it is not necessarily the same as the internal representation of that Number value used by the ECMAScript implementation.

There are two other special values, called **positive Infinity** and **negative Infinity**. For brevity, these values are also referred to for expository purposes by the symbols $+\infty$ and $-\infty$, respectively. (Note that these two infinite Number values are produced by the program expressions `+Infinity` (or simply `Infinity`) and `-Infinity`.)

The other 18437736874454810624 (that is, $2^{64}-2^{53}$) values are called the finite numbers. Half of these are positive numbers and half are negative numbers; for every finite positive Number value there is a corresponding negative value having the same magnitude.

Note that there is both a **positive zero** and a **negative zero**. For brevity, these values are also referred to for expository purposes by the symbols `+0` and `-0`, respectively. (Note that these two different zero Number values are produced by the program expressions `+0` (or simply `0`) and `-0`.)

The 18437736874454810622 (that is, $2^{64}-2^{53}-2$) finite nonzero values are of two kinds:

18428729675200069632 (that is, $2^{64}-2^{54}$) of them are normalized, having the form

$$s \times m \times 2^e$$

where s is $+1$ or -1 , m is a positive integer less than 2^{53} but not less than 2^{52} , and e is an integer ranging from -1074 to 971 , inclusive.

The remaining 9007199254740990 (that is, $2^{53}-2$) values are denormalized, having the form

$$s \times m \times 2^e$$

where s is $+1$ or -1 , m is a positive integer less than 2^{52} , and e is -1074 .

Note that all the positive and negative integers whose magnitude is no greater than 2^{53} are representable in the Number type (indeed, the integer 0 has two representations, `+0` and `-0`).

A finite number has an *odd significand* if it is nonzero and the integer m used to express it (in one of the two forms shown above) is odd. Otherwise, it has an *even significand*.

In this specification, the phrase “the Number value for x ” where x represents an exact nonzero real mathematical quantity (which might even be an irrational number such as π) means a Number value chosen in the following manner. Consider the set of all finite values of the Number type, with `-0` removed and with two additional values added to it that are not representable in the Number type, namely 2^{1024} (which is $+1 \times 2^{53} \times 2^{971}$) and -2^{1024} (which is $-1 \times 2^{53} \times 2^{971}$). Choose the member of this set that is closest in value to x . If two values of the set are equally close, then the one with an even significand is chosen; for this purpose, the two extra values 2^{1024} and -2^{1024} are considered to have even significands. Finally, if 2^{1024} was chosen, replace it with $+\infty$; if -2^{1024} was chosen, replace it with $-\infty$; if `+0` was chosen, replace it with `-0` if and only if x is less than zero; any other chosen value is used unchanged. The result is the

Number value for x . (This procedure corresponds exactly to the behaviour of the IEEE 754 “round to nearest, ties to even” mode.)

Some ECMAScript operators deal only with integers in specific ranges such as -2^{31} through $2^{31}-1$, inclusive, or in the range 0 through $2^{16}-1$, inclusive. These operators accept any value of the Number type but first convert each such value to an integer value in the expected range. See the descriptions of the numeric conversion operations in 7.1.

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6.1.7 The Object Type

An Object is logically a collection of properties. Each property is either a data property, or an accessor property:

- A *data property* associates a key value with an ECMAScript language value and a set of Boolean attributes.
- An *accessor property* associates a key value with one or two accessor functions, and a set of Boolean attributes. The accessor functions are used to store or retrieve an ECMAScript language value that is associated with the property.

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Properties are identified using key values. A key value is either an ECMAScript String value or a Symbol value. All String and Symbol values, including the empty string, are valid as property keys.

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An *integer index* is a String-valued property key that is a canonical numeric String (see 7.1.16) and whose numeric value is either +0 or a positive integer $\leq 2^{53}-1$. An *array index* is an integer index whose numeric value i is in the range $+0 \leq i < 2^{32}-1$.

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Property keys are used to access properties and their values. There are two kinds of access for properties: *get* and *set*, corresponding to value retrieval and assignment, respectively. The properties accessible via get and set access includes both *own properties* that are a direct part of an object and *inherited properties* which are provided by another associated object via a property inheritance relationship. Inherited properties may be either own or inherited properties of the associated object. Each own *property* of an object must each have a key value that is distinct from the key values of the other own properties of that object.

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All objects are logically collections of properties, but there are multiple forms of objects that differ in their semantics for accessing and manipulating their properties. Ordinary objects are the most common form of objects and have the default object semantics. An exotic object is any form of object whose property semantics differ in any way from the default semantics.

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6.1.7.1 Property Attributes

Attributes are used in this specification to define and explain the state of Object properties. A data property associates a key value with the attributes listed in Table 2.

Table 2 — Attributes of a Data Property

Attribute Name	Value Domain	Description
<code>[[Value]]</code>	Any ECMAScript language type	The value retrieved by a get access of the property.
<code>[[Writable]]</code>	Boolean	If false , attempts by ECMAScript code to change the property's <code>[[Value]]</code> attribute using <code>[[Set]]</code> will not succeed.
<code>[[Enumerable]]</code>	Boolean	If true , the property will be enumerated by a for-in enumeration (see 13.6.4). Otherwise, the property is said to be non-enumerable.
<code>[[Configurable]]</code>	Boolean	If false , attempts to delete the property, change the property to be an accessor property, or change its attributes (other than <code>[[Value]]</code> , or changing <code>[[Writable]]</code> to false) will fail.

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An accessor property associates a key value with the attributes listed in Table 3.

Table 3 — Attributes of an Accessor Property

Attribute Name	Value Domain	Description
<code>[[Get]]</code>	Object or Undefined	If the value is an Object it must be a function Object. The function's <code>[[Call]]</code> internal method (Table 6) is called with an empty arguments list to retrieve the property value each time a get access of the property is performed.
<code>[[Set]]</code>	Object or Undefined	If the value is an Object it must be a function Object. The function's <code>[[Call]]</code> internal method (Table 6) is called with an arguments list containing the assigned value as its sole argument each time a set access of the property is performed. The effect of a property's <code>[[Set]]</code> internal method may, but is not required to, have an effect on the value returned by subsequent calls to the property's <code>[[Get]]</code> internal method.
<code>[[Enumerable]]</code>	Boolean	If true , the property is to be enumerated by a for-in enumeration (see 13.6.4). Otherwise, the property is said to be non-enumerable.
<code>[[Configurable]]</code>	Boolean	If false , attempts to delete the property, change the property to be a data property, or change its attributes will fail.

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If the initial values of a property's attributes are not explicitly specified by this specification, the default value defined in Table 4 is used.

Table 4 — Default Attribute Values

Attribute Name	Default Value
<code>[[Value]]</code>	<code>undefined</code>
<code>[[Get]]</code>	<code>undefined</code>
<code>[[Set]]</code>	<code>undefined</code>
<code>[[Writable]]</code>	<code>false</code>
<code>[[Enumerable]]</code>	<code>false</code>
<code>[[Configurable]]</code>	<code>false</code>

6.1.7.2 Object Internal Methods and Internal Slots

The actual semantics of objects, in ECMAScript, are specified via algorithms called *internal methods*. Each object in an ECMAScript engine is associated with a set of internal methods that defines its runtime behaviour. These internal methods are not part of the ECMAScript language. They are defined by this specification purely for expository purposes. However, each object within an implementation of ECMAScript must behave as specified by the internal methods associated with it. The exact manner in which this is accomplished is determined by the implementation.

Internal method names are polymorphic. This means that different object values may perform different algorithms when a common internal method name is invoked upon them. If, at runtime, the implementation of an algorithm attempts to use an internal method of an object that the object does not support, a **TypeError** exception is thrown.

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Internal slots correspond to internal state that is associated with objects and used by various ECMAScript specification algorithms. Internal slots are not object properties and they are not inherited. Depending upon the specific internal slot specification, such state may consist of values of any ECMAScript language type or of specific ECMAScript specification type values. Unless explicitly specified otherwise, internal slots are allocated as part of the process of creating an object and may not be dynamically added to an object. Unless specified otherwise, the initial value of an internal slot is the value `undefined`. Various algorithms within this specification create objects that have internal slots. However, the ECMAScript language provides no direct way to associate internal slots with an object.

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Internal methods and internal slots are identified within this specification using names enclosed in double square brackets `[[]]`.

Table 5 summarizes the *essential internal methods* used by this specification that are applicable to all objects created or manipulated by ECMAScript code. Every object must have algorithms for all of the essential internal methods. However, all objects do not necessarily use the same algorithms for those methods.

The “Signature” column of Table 5 and other similar tables describes the invocation pattern for each internal method. The invocation pattern always includes a parenthesized list of descriptive parameter names. If a parameter name is the same as an ECMAScript type name then the name describes the required type of the parameter value. If an internal method explicitly returns a value, its parameter list is followed by the symbol “ \rightarrow ” and the type name of the returned value. The type names used in signatures refer to the types defined in clause 6 augmented by the following additional names. “any” means the value may be any ECMAScript language type. An internal method implicitly returns a Completion Record as described in 6.2.2. In addition to its parameters, an internal method always has access to the object upon which it is invoked as a method.

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Table 5 — Essential Internal Methods

Internal Method	Signature	Description
<code>[[GetPrototypeOf]]</code>	<code>()→Object or Null</code>	Determine the object that provides inherited properties for this object. A <code>null</code> value indicates that there are no inherited properties.
<code>[[SetPrototypeOf]]</code>	<code>(Object or Null)→Boolean</code>	Associate with <code>this</code> object another object that provides inherited properties. Passing <code>null</code> indicates that there are no inherited properties. Returns <code>true</code> indicating that the operation was completed successfully or <code>false</code> indicating that the operation was not successful.
<code>[[IsExtensible]]</code>	<code>()→Boolean</code>	Determine whether it is permitted to add additional properties to <code>this</code> object.
<code>[[PreventExtensions]]</code>	<code>()→Boolean</code>	Control whether new properties may be added to <code>this</code> object. Returns <code>true</code> if the operation was successful or <code>false</code> if the operation was unsuccessful.
<code>[[GetProperty]]</code>	<code>(propertyKey) → Undefined or Property Descriptor</code>	Returns a Property Descriptor for the own property of this object whose key is <code>propertyKey</code> , or <code>undefined</code> if no such property exists.
<code>[[HasProperty]]</code>	<code>(propertyKey) → Boolean</code>	Returns a Boolean value indicating whether <code>this</code> object already has either an own or inherited property whose key is <code>propertyKey</code> .
<code>[[Get]]</code>	<code>(propertyKey, Receiver) → any</code>	Return the value of the property whose key is <code>propertyKey</code> from <code>this</code> object. If any ECMAScript code must be executed to retrieve the property value, <code>Receiver</code> is used as the <code>this</code> value when evaluating the code.
<code>[[Set]]</code>	<code>(propertyKey,value, Receiver) → Boolean</code>	Set the value of <code>this</code> object property whose key is <code>propertyKey</code> to <code>value</code> . If any ECMAScript code must be executed to set the property value, <code>Receiver</code> is used as the <code>this</code> value when evaluating the code. Returns <code>true</code> if the property value was set or <code>false</code> if that it could not be set.
<code>[[Delete]]</code>	<code>(propertyKey) → Boolean</code>	Removes the own property whose key is <code>propertyKey</code> from <code>this</code> object. Return <code>false</code> if the property was not deleted and is still present. Return <code>true</code> if the property was deleted or is not present.
<code>[[DefineOwnProperty]]</code>	<code>(propertyKey,PropertyDescriptor) → Boolean</code>	Creates or alters the <code>this</code> object own property, whose key is <code>propertyKey</code> , to have the state described by <code>PropertyDescriptor</code> . Returns <code>true</code> if that the property was successfully created/updated or <code>false</code> if that the property could not be created or updated.
<code>[[Enumerate]]</code>	<code>()→Object</code>	Returns an iterator object <code>that produces</code> the keys of the <code>string-keyed</code> enumerable properties of the object.
<code>[[OwnPropertyKeys]]</code>	<code>()→List of propertyKey</code>	Returns a List whose elements are all of the own property keys for the object.

Table 6 summarizes additional essential internal methods that are supported by objects that may be called as functions.

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Table 6 — Additional Essential Internal Methods of Function Objects

Internal Method	Signature	Description
[[Call]]	(any, a List of any) → any	Executes code associated with <code>this</code> object. Invoked via a function call expression. The arguments to the internal method are a <code>this</code> value and a list containing the arguments passed to the function by a call expression. Objects that implement this internal method are <i>callable</i> .
[[Construct]]	(a List of any, Object) → Object	Creates an object. Invoked via the <code>new</code> or <code>super</code> operators. The first arguments to the internal method is a list containing the arguments of the operator. The second argument is the object to which the <code>new</code> operator was initially applied. Objects that implement this internal method are called <i>constructors</i> . A Function object is not necessarily a constructor and such non-constructor Function objects do not have a [[Construct]] internal method.

The semantics of the essential internal methods for ordinary objects and standard exotic objects are specified in clause 8.6. If any specified use of an internal method of an exotic object is not supported by an implementation, that usage must throw a `TypeError` exception when attempted.

6.1.7.3 Invariants of the Essential Internal Methods

The Internal Methods of Objects of an ECMAScript engine must conform to the list of invariants specified below. Ordinary ECMAScript Objects as well as all standard exotic objects in this specification maintain these invariants. ECMAScript Proxy objects maintain these invariants by means of runtime checks on the result of traps invoked on the [[ProxyHandler]] object.

Any implementation provided exotic objects must also maintain these invariants for those objects. Violation of these invariants may cause ECMAScript code to have unpredictable behaviour and create security issues. However, violation of these invariants must never compromise the memory safety of an implementation.

Definitions:

- The *target* of an internal method is the object the internal method is called upon.
- A target is *non-extensible* if it has been observed to return false from its [[IsExtensible]] internal method, or true from its [[PreventExtensions]] internal method.
- A *non-existent* property is a property that does not exist as an own property on a non-extensible target.
- All references to *SameValue* are according to the definition of *SameValue* algorithm specified in 7.2.3.

[[GetPrototypeOf]] ()

- The Type of the return value must be either Object or Null.
- If target is non-extensible, and [[GetPrototypeOf]] returns a value v, then any future calls to [[GetPrototypeOf]] should return the *SameValue* as v.

NOTE An object's prototype chain *should* have finite length (that is, starting from any object, recursively applying the [[GetPrototypeOf]] internal method to its result *should* eventually lead to the value null). However, this requirement is not enforceable as an object level invariant if the prototype chain includes any exotic objects that do not use the ordinary object definition of [[GetPrototypeOf]]. Such a circular prototype chain may result in infinite loops when accessing object properties.

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[[SetPrototypeOf]] (V)

- The Type of the return value must be Boolean.
- If target is non-extensible, [[SetPrototypeOf]] must return false, unless V is the SameValue as the target's observed [[GetPrototypeOf]] value.

[[PreventExtensions]] ()

- The Type of the return value must be Boolean.
- If [[PreventExtensions]] returns true, all future calls to [[IsExtensible]] on the target must return false and the target is now considered non-extensible.

[[GetOwnProperty]] (P)

- The Type of the return value must be either Property Descriptor or Undefined.
- If the Type of the return value is Property Descriptor, the return value must be a complete property descriptor (see 6.2.4.6).
- If a property P is described as a data property with Desc.[[Value]] equal to v and Desc.[[Writable]] and Desc.[[Configurable]] are both false, then the SameValue must be returned for the Desc.[[Value]] attribute of the property on all future calls to [[GetOwnProperty]] (P).
- If P's attributes other than [[Writable]] may change over time or if the property might disappear, then P's [[Configurable]] attribute must be true.
- If the [[Writable]] attribute may change from false to true, then the [[Configurable]] attribute must be true.
- If the target is non-extensible and P is non-existent, then all future calls to [[GetOwnProperty]] (P) on the target must describe P as non-existent (i.e. [[GetOwnProperty]] (P) must return undefined).

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NOTE As a consequence of the third invariant, if a property is described as a data property and it may return different values over time, then either or both of the Desc.[[Writable]] and Desc.[[Configurable]] attributes must be true even if no mechanism to change the value is exposed via the other internal methods.

[[DefineOwnProperty]] (P, Desc)

- The Type of the return value must be Boolean.
- [[DefineOwnProperty]] must return false if P has previously been observed as a non-configurable own property of the target, unless either:
 1. P is a non-configurable writable own data property. A non-configurable writable data property can be changed into a non-configurable non-writable data property.
 2. All attributes in Desc are the SameValue as P's attributes.
- [[DefineOwnProperty]] (P, Desc) must return false if target is non-extensible and P is a non-existent own property. That is, a non-extensible target object cannot be extended with new properties.

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[[HasProperty]] (P)

- The Type of the return value must be Boolean.
- If P was previously observed as a non-configurable data or accessor own property of the target, [[HasProperty]] must return true.

[[Get]] (P, Receiver)

- If P was previously observed as a non-configurable, non-writable own data property of the target with value v, then [[Get]] must return the SameValue.
- If P was previously observed as a non-configurable own accessor property of the target whose [[Get]] attribute is undefined, the [[Get]] operation must return undefined.

[[Set]] (P, V, Receiver)

- The Type of the return value must be Boolean.
- If P was previously observed as a non-configurable, non-writable own data property of the target, then [[Set]] must return false unless V is the SameValue as P's [[Value]] attribute.
- If P was previously observed as a non-configurable own accessor property of the target whose [[Set]] attribute is undefined, the [[Set]] operation must return false.

[[Delete]] (P)

- The Type of the return value must be Boolean.
- If P was previously observed to be a non-configurable own data or accessor property of the target, [[Delete]] must return false.

[[Enumerate]] ()

- The Type of the return value must be Object.

[[OwnPropertyKeys]] ()

- The return value must be a List.
- The Type of each element of the returned List is either String or Symbol.
- The returned List must contain at least the keys of all non-configurable own properties that have previously been observed.
- If the object is non-extensible, the returned List must contain only the keys of all own properties of the object that are observable using [[GetOwnProperty]].

[[Construct]] ()

- The Type of the return value must be Object.

6.1.7.4 Well-Known Intrinsic Objects

Well-known intrinsics are built-in objects that are explicitly referenced by the algorithms of this specification and which usually have Realm specific identities. Unless otherwise specified each intrinsic object actually corresponds to a set of similar objects, one per Realm.

Within this specification a reference such as %name% means the intrinsic object, associated with the current Realm, corresponding to the name. Determination of the current Realm and its intrinsics is described in [8.1.2.5](#). The well-known intrinsics are listed in Table 7.

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Table 7 — Well-known Intrinsic Objects

Intrinsic Name	Global Name	ECMAScript Language Association
%ObjectPrototype%		The initial value of the "prototype" data property of the intrinsic %Object%. (19.1.3)
%ThrowTypeError%		A function object that unconditionally throws a new instance of %TypeError%.
%FunctionPrototype%		The initial value of the "prototype" data property of the intrinsic %Function%.
%Object%	"Object"	The Object constructor (19.1.1)
%ObjProto_toString%		The initial value of the "toString" data property of the intrinsic %ObjectPrototype%. (19.1.3.6)
%eval%	"eval"	The eval function (18.2.1).
%Function%	"Function"	The Function constructor (19.2.1)
%Array%	"Array"	The Array constructor (22.1.1)
%ArrayPrototype%		The initial value of the "prototype" data property of the intrinsic %Array%.
%ArrayProto_values%		The initial value of the "values" data property of the intrinsic %ArrayPrototype%. (22.1.3.29)
%ArrayIteratorPrototype%		The prototype object used for Iterator objects created by the CreateArrayIterator abstract operation.
%String%	"String"	The String constructor (21.1.1)
%StringPrototype%		The initial value of the "prototype" data property of the intrinsic %String%.
%StringIteratorPrototype%		The prototype object used for Iterator objects created by the CreateStringIterator abstract operation
%Boolean%	"Boolean"	The initial value of the global object property named "Boolean".
%BooleanPrototype%		The initial value of the "prototype" data property of the intrinsic %Boolean%.
%Number%	"Number"	The initial value of the global object property named "Number".
%NumberPrototype%		The initial value of the "prototype" data property of the intrinsic %Number%.
%Date%	"Date"	The initial value of the global object property named "Date".
%DatePrototype%		The initial value of the "prototype" data property of the intrinsic %Date%.
%RegExp%	"RegExp"	The initial value of the global object property named "RegExp".

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Deleted: A function that, when called, throws a TypeError exception.

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%RegExpPrototype%		The initial value of the " prototype " data property of the intrinsic %RegExp%.
%Map%	" Map "	The initial value of the global object property named " Map ".
%MapPrototype%		The initial value of the " prototype " data property of the intrinsic %Map%.
%MapIteratorPrototype%		The prototype object used for Iterator objects created by the CreateMapIterator abstract operation
%WeakMap%	" WeakMap "	The initial value of the global object property named " WeakMap ".
%WeakMapPrototype%		The initial value of the " prototype " data property of the intrinsic %WeakMap%.
%Set%	" Set "	The initial value of the global object property named " Set ".
%SetPrototype%		The initial value of the " prototype " data property of the intrinsic %Set%.
%WeakSet%	" WeakSet "	The initial value of the global object property named " WeakSet ".
%WeakSetPrototype%		The initial value of the " prototype " data property of the intrinsic %WeakSet%.
%SetIteratorPrototype%		The prototype object used for Iterator objects created by the CreateSetIterator abstract operation

%GeneratorFunction%		The constructor of generator functions.
%Generator%		The initial value of the <code>prototype</code> property of the %GeneratorFunction% intrinsic
%GeneratorPrototype%		The initial value of the <code>prototype</code> property of the %Generator% intrinsic
%Error%		
%EvalError%		
%RangeError%		
%ReferenceError%		
%SyntaxError%		
%TypeError%		
%URIError%		
%ErrorPrototype%		
%EvalErrorPrototype%		
%RangeErrorPrototype%		
%ReferenceErrorPrototype%		
%SyntaxErrorPrototype%		
%TypeErrorPrototype%		
%URIErrorPrototype%		
%ArrayBuffer%		
%ArrayBufferPrototype%		The initial value of the "prototype" data property of the intrinsic %ArrayBuffer%.
%TypedArray%		
%TypedArrayPrototype%		The initial value of the "prototype" data property of the intrinsic %TypedArray%.
%Int8Array%		
%Int8ArrayPrototype%		
%DataView%		
% DataViewPrototype%		
%Promise%		
%PromisePrototype%		
%Symbol%		
%IteratorPrototype%		An object that all standard built-in iterator objects indirectly inherit from.

6.2 ECMAScript Specification Types

A specification type corresponds to meta-values that are used within algorithms to describe the semantics of ECMAScript language constructs and ECMAScript language types. The specification types are Reference, List, Completion, Property Descriptor, Lexical Environment, Environment Record, and Data Block. Specification type values are specification artefacts that do not necessarily correspond to any specific entity within an ECMAScript implementation. Specification type values may be used to describe intermediate results of ECMAScript expression evaluation but such values cannot be stored as properties of objects or values of ECMAScript language variables.

6.2.1 The List and Record Specification Type

The List type is used to explain the evaluation of argument lists (see 12.3.6) in `new` expressions, in function calls, and in other algorithms where a simple ordered list of values is needed. Values of the List type are simply ordered sequences of list elements containing the individual values. These sequences may be of any length. The elements of a list may be randomly accessed using 0-origin indices. For notational convenience an array-like syntax can be used to access List elements. For example, `arguments[2]` is shorthand for saying the 3rd element of the List `arguments`.

For notational convenience within this specification, a literal syntax can be used to express a new List value. For example, «1, 2» defines a List value that has two elements each of which is initialized to a specific value. A new empty List can be expressed as «».

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The Record type is used to describe data aggregations within the algorithms of this specification. A Record type value consists of one or more named fields. The value of each field is either an ECMAScript value or an abstract value represented by a name associated with the Record type. Field names are always enclosed in double brackets, for example `[[value]]`.

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For notational convenience within this specification, an object literal-like syntax can be used to express a Record value. For example, `{[[field1]]: 42, [[field2]]: false, [[field3]]: empty}` defines a Record value that has three fields, each of which is initialized to a specific value. Field name order is not significant. Any fields that are not explicitly listed are considered to be absent.

In specification text and algorithms, dot notation may be used to refer to a specific field of a Record value. For example, if R is the record shown in the previous paragraph then `R.[[field2]]` is shorthand for “the field of R named `[[field2]]`”.

Schema for commonly used Record field combinations may be named, and that name may be used as a prefix to a literal Record value to identify the specific kind of aggregations that is being described. For example: `PropertyDescriptor{[[Value]]: 42, [[Writable]]: false, [[Configurable]]: true}`.

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6.2.2 The Completion Record Specification Type

The Completion type is a Record used to explain the runtime propagation of values and control flow such as the behaviour of statements (`break`, `continue`, `return` and `throw`) that perform nonlocal transfers of control.

Values of the Completion type are Record values whose fields are defined as by Table 8.

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Table 8 — Completion Record Fields

Field Name	Value	Meaning
<code>[[type]]</code>	One of normal , break , continue , return , or throw	The type of completion that occurred.
<code>[[value]]</code>	any ECMAScript language value or empty	The value that was produced.
<code>[[target]]</code>	any ECMAScript string or empty	The target label for directed control transfers.

The term “abrupt completion” refers to any completion with a `[[type]]` value other than **normal**.

6.2.2.1 NormalCompletion

The abstract operation **NormalCompletion** with a single *argument*, such as:

1. Return **NormalCompletion**(*argument*).

Is a shorthand that is defined as follows:

1. Return **Completion**{`[[type]]`: **normal**, `[[value]]`: *argument*, `[[target]]`:**empty**}.

6.2.2.2 Implicit Completion Values

The algorithms of this specification often implicitly return Completion Records whose `[[type]]` is **normal**. Unless it is otherwise obvious from the context, an algorithm statement that returns a value that is not a Completion Record, such as:

1. Return "Infinity".

Generally means the same thing as:

1. Return **NormalCompletion**("**Infinity**").

A “return” statement without a value in an algorithm step means the same thing as:

1. Return **NormalCompletion**(**undefined**).

Similarly, any reference to a Completion Record value that is in a context that does not explicitly require a complete Completion Record value is equivalent to an explicit reference to the `[[value]]` field of the Completion Record value unless the Completion Record is an abrupt completion.

6.2.2.3 Throw an Exception

Algorithms steps that say to throw an exception, such as:

1. Throw a **TypeError** exception.

mean the same things as:

1. Return **Completion**{`[[type]]`: **throw**, `[[value]]`: a newly created **TypeError** object, `[[target]]`:**empty**}.

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6.2.2.4 ReturnIfAbrupt

Algorithms steps that say

1. ReturnIfAbrupt(*argument*).

mean the same thing, as:

1. If *argument* is an abrupt completion, return *argument*.
2. Else if *argument* is a Completion Record, let *argument* be *argument*.[[value]].

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6.2.3 The Reference Specification Type

NOTE The Reference type is used to explain the behaviour of such operators as delete, typeof, the assignment operators, the super keyword and other language features. For example, the left-hand operand of an assignment is expected to produce a reference.

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A **Reference** is a resolved name or property binding. A Reference consists of three components, the *base* value, the *referenced name* and the Boolean valued *strict reference* flag. The *base* value is either **undefined**, an Object, a Boolean, a String, a Symbol, a Number, or an environment record (8.1.1). A *base* value of **undefined** indicates that the Reference could not be resolved to a binding. The *referenced name* is a String or Symbol value.

A Super Reference is a Reference that is used to represents a name binding that was expressed using the super keyword. A Super Reference has an additional *thisValue* component and its *base* value will never be an environment record.

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The following abstract operations are used in this specification to access the components of references:

- GetBase(*V*). Returns the *base* value component of the reference *V*.
- GetReferencedName(*V*). Returns the *referenced name* component of the reference *V*.
- IsStrictReference(*V*). Returns the *strict reference* flag component of the reference *V*.
- HasPrimitiveBase(*V*). Returns **true** if Type(*base*) is Boolean, String, Symbol, or Number.
- IsPropertyReference(*V*). Returns **true** if either the *base* value is an object or HasPrimitiveBase(*V*) is **true**; otherwise returns **false**.
- IsUnresolvableReference(*V*). Returns **true** if the *base* value is **undefined** and **false** otherwise.
- IsSuperReference(*V*). Returns **true** if this reference has a *thisValue* component.

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The following abstract operations are used in this specification to operate on references:

6.2.3.1 GetValue (*V*)

1. ReturnIfAbrupt(*V*).
2. If Type(*V*) is not Reference, return *V*.
3. Let *base* be GetBase(*V*).
4. If IsUnresolvableReference(*V*), throw a **ReferenceError** exception.
5. If IsPropertyReference(*V*), then
 - a. If HasPrimitiveBase(*V*) is **true**, then
 - i. Assert: In this case, *base* will never be **null** or **undefined**.
 - ii. Let *base* be ToObject(*base*).
 - b. Return the result of calling the [[Get]] internal method of *base* passing GetReferencedName(*V*) and GetThisValue(*V*) as the arguments.
6. Else *base* must be an environment record,
 - a. Return the result of calling the GetBindingValue (see 8.1.1) concrete method of *base* passing GetReferencedName(*V*) and IsStrictReference(*V*) as arguments.

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NOTE The object that may be created in step 5.a.ii is not accessible outside of the above abstract operation and the ordinary object [[Get]] internal method. An implementation might choose to avoid the actual creation of the object.

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6.2.3.2 PutValue (V, W)

1. ReturnIfAbrupt(V).
2. ReturnIfAbrupt(W).
3. If Type(V) is not Reference, throw a **ReferenceError** exception.
4. Let *base* be GetBase(V).
5. If IsUnresolvableReference(V), then
 - a. If IsStrictReference(V) is **true**, then
 - i. Throw **ReferenceError** exception.
 - b. Let *globalObj* be the result of the abstract operation GetGlobalObject.
 - c. Return Put(*globalObj*, GetReferencedName(V), W, **false**).
6. Else if IsPropertyReference(V), then
 - a. If HasPrimitiveBase(V) is **true**, then
 - i. Assert: In this case, *base* will never be **null** or **undefined**.
 - ii. Set *base* to ToObject(*base*).
 - b. Let *succeeded* be the result of calling the **[[Set]]** internal method of *base* passing GetReferencedName(V), W, and GetThisValue(V) as arguments.
 - c. ReturnIfAbrupt(*succeeded*).
 - d. If *succeeded* is **false** and IsStrictReference(V) is **true**, throw a **TypeError** exception.
 - e. Return.
7. Else *base* must be an environment record.
 - a. Return the result of calling the **SetMutableBinding** (8.1.1) concrete method of *base*, passing GetReferencedName(V), W, and IsStrictReference(V) as arguments.

NOTE The object that may be created in step 6.a.ii is not accessible outside of the above algorithm and the ordinary object **[[Set]]** internal method. An implementation might choose to avoid the actual creation of that object.

6.2.3.3 GetThisValue (V)

1. Assert: IsPropertyReference(V) is **true**.
2. If IsSuperReference(V), then
 - a. Return the value of the *thisValue* component of the reference V.
3. Return GetBase(V).

6.2.3.4 InitializeReferencedBinding (V, W)

1. ReturnIfAbrupt(V).
2. ReturnIfAbrupt(W).
3. Assert: Type(V) is Reference.
4. Assert: IsUnresolvableReference(V) is **false**.
5. Let *base* be GetBase(V).
6. Assert: *base* is an Environment Record.
7. Return the result of calling the **InitializeBinding** concrete method of *base* passing GetReferencedName(V) and W as the arguments.

6.2.4 The Property Descriptor Specification Type

The Property Descriptor type is used to explain the manipulation and reification of Object property attributes. Values of the Property Descriptor type are Records. Each field's name is an attribute name and its value is a corresponding attribute value as specified in 6.1.7.1. In addition, any field may be present or absent. The schema name used within this specification to tag literal descriptions of Property Descriptor records is "PropertyDescriptor".

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Property Descriptor values may be further classified as data Property Descriptors and accessor Property Descriptors based upon the existence or use of certain fields. A data Property Descriptor is one that includes any fields named either `[[Value]]` or `[[Writable]]`. An accessor Property Descriptor is one that includes any fields named either `[[Get]]` or `[[Set]]`. Any Property Descriptor may have fields named `[[Enumerable]]` and `[[Configurable]]`. A Property Descriptor value may not be both a data Property Descriptor and an accessor Property Descriptor; however, it may be neither. A generic Property Descriptor is a Property Descriptor value that is neither a data Property Descriptor nor an accessor Property Descriptor. A fully populated Property Descriptor is one that is either an accessor Property Descriptor or a data Property Descriptor and that has all of the fields that correspond to the property attributes defined in either Table 2 or Table 3.

The following abstract operations are used in this specification to operate upon Property Descriptor values:

6.2.4.1 IsAccessorDescriptor (Desc)

When the abstract operation `IsAccessorDescriptor` is called with Property Descriptor `Desc`, the following steps are taken:

1. If `Desc` is `undefined`, **return** `false`.
2. If both `Desc.[[Get]]` and `Desc.[[Set]]` are absent, **return** `false`.
3. Return `true`.

Deleted: A Property Descriptor may be derived from an object that has properties that directly correspond to the fields of a Property Descriptor. Such a derived Property Descriptor has an additional field named `[[Origin]]` whose value is the object from which the Property Descriptor was derived. ¶

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6.2.4.2 IsDataDescriptor (Desc)

When the abstract operation `IsDataDescriptor` is called with Property Descriptor `Desc`, the following steps are taken:

1. If `Desc` is `undefined`, **return** `false`.
2. If both `Desc.[[Value]]` and `Desc.[[Writable]]` are absent, **return** `false`.
3. Return `true`.

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Deleted: <#>If `Desc` has an `[[Origin]]` field, then return `Desc.[[Origin]]`. ¶

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Deleted: and `PropertyDescriptor{[[Value]]}`:
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6.2.4.3 IsGenericDescriptor (Desc)

When the abstract operation `IsGenericDescriptor` is called with Property Descriptor `Desc`, the following steps are taken:

1. If `Desc` is `undefined`, **return** `false`.
2. If `IsAccessorDescriptor(Desc)` and `IsDataDescriptor(Desc)` are both `false`, **return** `true`.
3. Return `false`.

6.2.4.4 FromPropertyDescriptor (Desc)

When the abstract operation `FromPropertyDescriptor` is called with Property Descriptor `Desc`, the following steps are taken:

1. If `Desc` is `undefined`, **return** `undefined`.
2. Let `obj` be `ObjectCreate(%ObjectPrototype%)`.
3. Assert: `obj` is an extensible ordinary object with no own properties.
4. If `Desc` has a `[[Value]]` field, then
 - a. Call `CreateDataProperty(obj, "value", Desc.[[Value]])`
5. If `Desc` has a `[[Writable]]` field, then
 - a. Call `CreateDataProperty(obj, "writable", Desc.[[Writable]])`
6. If `Desc` has a `[[Get]]` field, then

- a. Call `CreateDataProperty(obj, "get", Desc.[[Get]])`.
7. If `Desc` has a `[[Set]]` field, then
 - a. Call `CreateDataProperty(obj, "set", Desc.[[Set]])`
8. If `Desc` has an `[[Enumerable]]` field, then
 - a. Call `CreateDataProperty(obj, "enumerable", Desc.[[Enumerable]])`
9. If `Desc` has a `[[Configurable]]` field, then
 - a. Call `CreateDataProperty(obj, "configurable", Desc.[[Configurable]])`
10. Assert: all of the above `CreateDataProperty` operations return `true`.
11. Return `obj`.

6.2.4.5 ToPropertyDescriptor (Obj)

When the abstract operation `ToPropertyDescriptor` is called with object `Obj`, the following steps are taken:

1. `ReturnIfAbrupt(Obj)`.
2. If `Type(Obj)` is not `Object` throw a `TypeError` exception.
3. Let `desc` be a new Property Descriptor that initially has no fields.
4. If `HasProperty(Obj, "enumerable")` is `true`, then
 - a. Let `enum` be `Get(Obj, "enumerable")`.
 - b. `ReturnIfAbrupt(enum)`.
 - c. Set the `[[Enumerable]]` field of `desc` to `ToBoolean(enum)`.
5. If `HasProperty(Obj, "configurable")` is `true`, then
 - a. Let `conf` be `Get(Obj, "configurable")`.
 - b. `ReturnIfAbrupt(conf)`.
 - c. Set the `[[Configurable]]` field of `desc` to `ToBoolean(conf)`.
6. If `HasProperty(Obj, "value")` is `true`, then
 - a. Let `value` be `Get(Obj, "value")`.
 - b. `ReturnIfAbrupt(value)`.
 - c. Set the `[[Value]]` field of `desc` to `value`.
7. If `HasProperty(Obj, "writable")` is `true`, then
 - a. Let `writable` be `Get(Obj, "writable")`.
 - b. `ReturnIfAbrupt(writable)`.
 - c. Set the `[[Writable]]` field of `desc` to `ToBoolean(writable)`.
8. If `HasProperty(Obj, "get")` is `true`, then
 - a. Let `getter` be `Get(Obj, "get")`.
 - b. `ReturnIfAbrupt(getter)`.
 - c. If `IsCallable(getter)` is `false` and `getter` is not `undefined`, throw a `TypeError` exception.
 - d. Set the `[[Get]]` field of `desc` to `getter`.
9. If `HasProperty(Obj, "set")` is `true`, then
 - a. Let `setter` be `Get(Obj, "set")`.
 - b. `ReturnIfAbrupt(setter)`.
 - c. If `IsCallable(setter)` is `false` and `setter` is not `undefined`, throw a `TypeError` exception.
 - d. Set the `[[Set]]` field of `desc` to `setter`.
10. If either `desc.[[Get]]` or `desc.[[Set]]` are present, then
 - a. If either `desc.[[Value]]` or `desc.[[Writable]]` are present, throw a `TypeError` exception.
11. Return `desc`.

6.2.4.6 CompletePropertyDescriptor (Desc)

When the abstract operation `CompletePropertyDescriptor` is called with Property Descriptor `Desc`, the following steps are taken:

1. `ReturnIfAbrupt(Desc)`.

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2. Assert: *Desc* is a Property Descriptor
3. Let *like* be Record{[[Value]]: **undefined**, [[Writable]]: **false**, [[Get]]: **undefined**, [[Set]]: **undefined**, [[Enumerable]]: **false**, [[Configurable]]: **false**}.
4. If either IsGenericDescriptor(*Desc*) or IsDataDescriptor(*Desc*) is **true**, then
 - a. If *Desc* does not have a [[Value]] field, set *Desc*.[[Value]] to *like*.[[Value]].
 - b. If *Desc* does not have a [[Writable]] field, set *Desc*.[[Writable]] to *like*.[[Writable]].
5. Else,
 - a. If *Desc* does not have a [[Get]] field, set *Desc*.[[Get]] to *like*.[[Get]].
 - b. If *Desc* does not have a [[Set]] field, set *Desc*.[[Set]] to *like*.[[Set]].
6. If *Desc* does not have an [[Enumerable]] field, set *Desc*.[[Enumerable]] to *like*.[[Enumerable]].
7. If *Desc* does not have a [[Configurable]] field, set *Desc*.[[Configurable]] to *like*.[[Configurable]].
8. Return *Desc*.

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 <#>Let *like* be a new Property Descriptor that is a copy of *LikeDesc*. ¶
 <#>Perform CompletePropertyDescriptor(*like*, **undefined**). ¶

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6.2.5 The Lexical Environment and Environment Record Specification Types

The Lexical Environment and Environment Record types are used to explain the behaviour of name resolution in nested functions and blocks. These types and the operations upon them are defined in 8.1.

6.2.6 Data Blocks

The Data Block specification type is used to describe a distinct and mutable sequence of byte-sized (8 bit) numeric values. A Data Block value is created with a fixed number of bytes that each have the initial value 0.

For notational convenience within this specification, an array-like syntax can be used to express to the individual bytes of a Data Block value. This notation presents a Data Block value as a 0-originated integer indexed sequence of bytes. For example, if *db* is a 5 byte Data Block value then *db*[2] can be used to express access to its 3rd byte.

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The following abstract operations are used in this specification to operate upon Data Block values:

6.2.6.1 CreateByteDataBlock(size)

When the abstract operation CreateByteDataBlock is called with integer argument *size*, the following steps are taken:

1. Assert: *size* ≥ 0 .
2. Let *db* be a new Data Block value consisting of *size* bytes. If it is impossible to create such a Data Block, **throw** a RangeError exception.
3. Set all of the bytes of *db* to 0.
4. Return *db*.

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6.2.6.2 CopyDataBlockBytes(toBlock, toIndex, fromBlock, fromIndex, count)

When the abstract operation CopyDataBlockBytes is called the following steps are taken:

1. Assert: *fromBlock* and *toBlock* are distinct Data Block values.
2. Assert: *fromIndex*, *toIndex*, and *count* are positive integer values.
3. Let *fromSize* be the number of bytes in *fromBlock*.
4. Assert: *fromIndex+count* \leq *fromSize*.
5. Let *toSize* be the number of bytes in *toBlock*.
6. Assert: *toIndex+count* \leq *toSize*.
7. Repeat, while *count* > 0
 - a. Set *toBlock*[*toIndex*] to the value of *fromBlock*[*fromIndex*].

7. If *hint* is "default", let *hint* be "number".
 8. Return OrdinaryToPrimitive(*input*, *hint*).

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When the **abstract operation** OrdinaryToPrimitive is called with arguments *O* and *hint*, the following steps are taken:

1. Assert: Type(*O*) is Object
2. Assert: Type(*hint*) is String and its value is either "string" or "number".
3. If *hint* is "string", then
 - a. Let *methodNames* be the List ("toString", "valueOf").
4. Else,
 - a. Let *methodNames* be the List ("valueOf", "toString").
5. For each *name* in *methodNames* in List order, do
 - a. Let *method* be Get(*O*, *name*).
 - b. ReturnIfAbrupt(*method*).
 - c. If IsCallable(*method*) is true, then
 - i. Let *result* be Call(*method*, *O*).
 - ii. ReturnIfAbrupt(*result*).
 - iii. If Type(*result*) is not Object, return *result*.
6. Throw a **TypeError** exception.

NOTE When ToPrimitive is called with no hint, then it generally behaves as if the hint were Number. However, objects may over-ride this behaviour by defining a @@toPrimitive method. Of the objects defined in this specification only Date objects (see 20.3.4.45) and Symbol objects (see 19.4.3.4) over-ride the default ToPrimitive behaviour. Date objects treat no hint as if the hint were String.

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7.1.2 ToBoolean (argument)

The abstract operation ToBoolean converts *argument* to a value of type Boolean according to Table 10:

Table 10 — ToBoolean Conversions

Argument Type	Result
Completion Record	If <i>argument</i> is an abrupt completion, return <i>argument</i> . Otherwise return ToBoolean(<i>argument</i> .[[value]]).
Undefined	Return false.
Null	Return false.
Boolean	Return <i>argument</i> .
Number	Return false if <i>argument</i> is +0, -0, or NaN; otherwise return true.
String	Return false if <i>argument</i> is the empty String (its length is zero); otherwise return true.
Symbol	Return true.
Object	Return true.

Deleted: the

Deleted: the input

Deleted: (no conversion)

Deleted: the

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7.1.3 ToNumber(*argument*)

The abstract operation ToNumber converts *argument* to a value of type Number according to Table 11:

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Table 11 — ToNumber Conversions

Argument Type	Result
Completion Record	If <i>argument</i> is an abrupt completion, return <i>argument</i> . Otherwise return ToNumber(<i>argument</i> .[[value]]).
Undefined	Return NaN .
Null	Return +0 .
Boolean	Return 1 if <i>argument</i> is true . Return +0 if <i>argument</i> is false .
Number	Return <i>argument</i> (no conversion).
String	See grammar and conversion algorithm below.
Symbol	Throw a TypeError exception.
Object	Apply the following steps: <ol style="list-style-type: none"> Let <i>primValue</i> be ToPrimitive(<i>argument</i>, hint Number). Return ToNumber(<i>primValue</i>).

Deleted: Return **NaN**

7.1.3.1 ToNumber Applied to the String Type

ToNumber applied to Strings applies the following grammar to the input String [interpreted as a sequence of UTF-16 encoded code points \(6.1.4\)](#). If the grammar cannot interpret the String as an expansion of *StringNumericLiteral*, then the result of ToNumber is **NaN**.

NOTE The terminal symbols of this grammar are all composed of Unicode BMP code points so the result will be **NaN** if the string contains the UTF-16 encoding of any supplementary code points or any unpaired surrogate code points

Deleted: ¶

Syntax

StringNumericLiteral ::=
*StrWhiteSpace*_{opt}
*StrWhiteSpace*_{opt} *StrNumericLiteral* *StrWhiteSpace*_{opt}

StrWhiteSpace ::=
StrWhiteSpaceChar *StrWhiteSpace*_{opt}

StrWhiteSpaceChar ::=
WhiteSpace
LineTerminator

StrNumericLiteral ::=
StrDecimalLiteral
BinaryIntegerLiteral
OctalIntegerLiteral
HexIntegerLiteral

StrDecimalLiteral :::

- + *StrUnsignedDecimalLiteral*
- *StrSignedDecimalLiteral*

StrUnsignedDecimalLiteral :::

- Infinity**
- DecimalDigits* . *DecimalDigits*_{opt} *ExponentPart*_{opt}
- . *DecimalDigits* *ExponentPart*_{opt}
- DecimalDigits* *ExponentPart*_{opt}

DecimalDigits :::

- DecimalDigit*
- DecimalDigits* *DecimalDigit*

DecimalDigit ::: **one of**

0 1 2 3 4 5 6 7 8 9

ExponentPart :::

- ExponentIndicator* *SignedInteger*

ExponentIndicator ::: **one of**

e E

SignedInteger :::

- DecimalDigits*
- + *DecimalDigits*
- *DecimalDigits*

All grammar symbols not explicitly defined above have the definitions used in the Lexical Grammar for numeric literals (11.8.3).

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NOTE Some differences should be noted between the syntax of a *StringNumericLiteral* and a *NumericLiteral* (see 11.8.3):

- A *StringNumericLiteral* may include leading and/or trailing white space and/or line terminators.
- A *StringNumericLiteral* that is decimal may have any number of leading 0 digits.
- A *StringNumericLiteral* that is decimal may include a + or - to indicate its sign.
- A *StringNumericLiteral* that is empty or contains only white space is converted to +0.
- **Infinity** and **-Infinity** are recognized as a *StringNumericLiteral* but not as a *NumericLiteral*.

7.1.3.1.1 Runtime Semantics: MV's

The conversion of a String to a Number value is similar overall to the determination of the Number value for a numeric literal (see 11.8.3), but some of the details are different, so the process for converting a String numeric literal to a value of Number type is given here. This value is determined in two steps: first, a mathematical value (MV) is derived from the String numeric literal; second, this mathematical value is rounded as described below. The MV on any grammar symbol, not provided below, is the MV for that symbol defined in 11.8.3.1.

- The MV of *StringNumericLiteral* :: [empty] is 0.
- The MV of *StringNumericLiteral* :: *StrWhiteSpace* is 0.

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0x HexDigit

0X HexDigit

HexIntegerLiteral HexDigit

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0 1 2 3 4 5 6 7 8 9 a b

c d e f A B C D E F

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- The MV of $\text{StringNumericLiteral} :: \text{StrWhiteSpace}_{opt} \text{StrNumericLiteral} \text{StrWhiteSpace}_{opt}$ is the MV of StrNumericLiteral , no matter whether white space is present or not.
- The MV of $\text{StrNumericLiteral} :: \text{StrDecimalLiteral}$ is the MV of StrDecimalLiteral .
- The MV of $\text{StrNumericLiteral} :: \text{BinaryIntegerLiteral}$ is the MV of $\text{BinaryIntegerLiteral}$.
- The MV of $\text{StrNumericLiteral} :: \text{OctalIntegerLiteral}$ is the MV of $\text{OctalIntegerLiteral}$.
- The MV of $\text{StrNumericLiteral} :: \text{HexIntegerLiteral}$ is the MV of HexIntegerLiteral .
- The MV of $\text{StrDecimalLiteral} :: \text{StrUnsignedDecimalLiteral}$ is the MV of $\text{StrUnsignedDecimalLiteral}$.
- The MV of $\text{StrDecimalLiteral} :: + \text{StrUnsignedDecimalLiteral}$ is the MV of $\text{StrUnsignedDecimalLiteral}$.
- The MV of $\text{StrDecimalLiteral} :: - \text{StrUnsignedDecimalLiteral}$ is the negative of the MV of $\text{StrUnsignedDecimalLiteral}$. (Note that if the MV of $\text{StrUnsignedDecimalLiteral}$ is 0, the negative of this MV is also 0. The rounding rule described below handles the conversion of this signless mathematical zero to a floating-point $+0$ or -0 as appropriate.)
- The MV of $\text{StrUnsignedDecimalLiteral} :: \text{Infinity}$ is 10^{10000} (a value so large that it will round to $+\infty$).
- The MV of $\text{StrUnsignedDecimalLiteral} :: \text{DecimalDigits}.$ is the MV of DecimalDigits .
- The MV of $\text{StrUnsignedDecimalLiteral} :: \text{DecimalDigits}.$ DecimalDigits is the MV of the first DecimalDigits plus (the MV of the second DecimalDigits times 10^{-n}), where n is the number of code points in the second DecimalDigits .
- The MV of $\text{StrUnsignedDecimalLiteral} :: \text{DecimalDigits}.$ ExponentPart is the MV of DecimalDigits times 10^e , where e is the MV of ExponentPart .
- The MV of $\text{StrUnsignedDecimalLiteral} :: \text{DecimalDigits}.$ DecimalDigits ExponentPart is (the MV of the first DecimalDigits plus (the MV of the second DecimalDigits times 10^{-n})) times 10^e , where n is the number of code points in the second DecimalDigits and e is the MV of ExponentPart .
- The MV of $\text{StrUnsignedDecimalLiteral} :: \text{DecimalDigits}.$ DecimalDigits is the MV of DecimalDigits times 10^{-n} , where n is the number of code points in DecimalDigits .
- The MV of $\text{StrUnsignedDecimalLiteral} :: \text{DecimalDigits}.$ ExponentPart is the MV of DecimalDigits times 10^{e-n} , where n is the number of code points in DecimalDigits and e is the MV of ExponentPart .
- The MV of $\text{StrUnsignedDecimalLiteral} :: \text{DecimalDigits}$ is the MV of DecimalDigits .
- The MV of $\text{StrUnsignedDecimalLiteral} :: \text{DecimalDigits}.$ ExponentPart is the MV of DecimalDigits times 10^e , where e is the MV of ExponentPart .

Once the exact MV for a String numeric literal has been determined, it is then rounded to a value of the Number type. If the MV is 0, then the rounded value is $+0$ unless the first non white space code point in the String numeric literal is ' $-$ ', in which case the rounded value is -0 . Otherwise, the rounded value must be the Number value for the MV (in the sense defined in 6.1.6), unless the literal includes a $\text{StrUnsignedDecimalLiteral}$ and the literal has more than 20 significant digits, in which case the Number value may be either the Number value for the MV of a literal produced by replacing each significant digit after the 20th with a 0 digit or the Number value for the MV of a literal produced by replacing each significant digit after the 20th with a 0 digit and then incrementing the literal at the 20th digit position. A digit is significant if it is not part of an ExponentPart and

- it is not 0 ; or
- there is a nonzero digit to its left and there is a nonzero digit, not in the ExponentPart , to its right.

7.1.4 **Tolnteger(argument)**

The abstract operation **Tolnteger** converts argument to an integral numeric value. This abstract operation functions as follows:

1. Let number be $\text{ToNumber}(\text{argument})$.
2. ReturnIfAbrupt(number).
3. If number is **NaN**, return $+0$.

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Deleted: The MV of $\text{DecimalDigits} :: \text{DecimalDigit}$ is the MV of DecimalDigit . The MV of $\text{DecimalDigits} :: \text{DecimalDigits}$ DecimalDigit is (the MV of DecimalDigits times 10) plus the MV of DecimalDigit . The MV of $\text{ExponentPart} :: \text{ExponentIndicator}$ SignedInteger is the MV of SignedInteger . The MV of $\text{SignedInteger} :: \text{DecimalDigits}$ is the MV of DecimalDigits . The MV of $\text{SignedInteger} :: + \text{DecimalDigits}$ is the MV of DecimalDigits . The MV of $\text{SignedInteger} :: - \text{DecimalDigits}$ is the negative of the MV of DecimalDigits . The MV of $\text{DecimalDigit} :: 0$ or of $\text{HexDigit} :: 0$ is 0. The MV of $\text{DecimalDigit} :: 1$ or of $\text{HexDigit} :: 1$ is 1. The MV of $\text{DecimalDigit} :: 2$ or of $\text{HexDigit} :: 2$ is 2. The MV of $\text{DecimalDigit} :: 3$ or of $\text{HexDigit} :: 3$ is 3. The MV of $\text{DecimalDigit} :: 4$ or of $\text{HexDigit} :: 4$ is 4. The MV of $\text{DecimalDigit} :: 5$ or of $\text{HexDigit} :: 5$ is 5. The MV of $\text{DecimalDigit} :: 6$ or of $\text{HexDigit} :: 6$ is 6. The MV of $\text{DecimalDigit} :: 7$ or of $\text{HexDigit} :: 7$ is 7. The MV of $\text{DecimalDigit} :: 8$ or of $\text{HexDigit} :: 8$ is 8. The MV of $\text{DecimalDigit} :: 9$ or of $\text{HexDigit} :: 9$ is 9. The MV of $\text{HexDigit} :: a$ or of $\text{HexDigit} :: a$ is 10. The MV of $\text{HexDigit} :: b$ or of $\text{HexDigit} :: b$ is 11. The MV of $\text{HexDigit} :: c$ or of $\text{HexDigit} :: c$ is 12. The MV of $\text{HexDigit} :: d$ or of $\text{HexDigit} :: d$ is 13. The MV of $\text{HexDigit} :: e$ or of $\text{HexDigit} :: e$ is 14. The MV of $\text{HexDigit} :: f$ or of $\text{HexDigit} :: f$ is 15. The MV of $\text{HexIntegerLiteral} :: 0x \text{HexDigit}$ is the MV of HexDigit . The MV of $\text{HexIntegerLiteral} :: 0x \text{HexDigit}$ is the MV of HexDigit .
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Deleted: its

4. If *number* is $+0$, -0 , $+\infty$, or $-\infty$, return *number*.
5. Return the number value that is the same sign as *number* and whose magnitude is $\text{floor}(\text{abs}(\text{number}))$.

7.1.5 ToInt32(*argument*) — Signed 32 Bit Integer

The abstract operation *ToInt32* converts *argument* to one of 2^{32} integer values in the range -2^{31} through $2^{31}-1$, inclusive. This abstract operation functions as follows:

1. Let *number* be *ToNumber(argument)*.
2. *ReturnIfAbrupt(number)*.
3. If *number* is NaN , $+0$, -0 , $+\infty$, or $-\infty$, return $+0$.
4. Let *int* be the mathematical value that is the same sign as *number* and whose magnitude is $\text{floor}(\text{abs}(\text{number}))$.
5. Let *int32bit* be *int* modulo 2^{32} .
6. If *int32bit* $\geq 2^{31}$, return *int32bit* $- 2^{32}$, otherwise return *int32bit*.

NOTE Given the above definition of *ToInt32*:

- The *ToInt32* abstract operation is idempotent: if applied to a result that it produced, the second application leaves that value unchanged.
- *ToInt32(ToUint32(x))* is equal to *ToInt32(x)* for all values of *x*. (It is to preserve this latter property that $+\infty$ and $-\infty$ are mapped to $+0$.)
- *ToInt32* maps -0 to $+0$.

7.1.6 ToUint32(*argument*) — Unsigned 32 Bit Integer

The abstract operation *ToUint32* converts *argument* to one of 2^{32} integer values in the range 0 through $2^{32}-1$, inclusive. This abstract operation functions as follows:

1. Let *number* be *ToNumber(argument)*.
2. *ReturnIfAbrupt(number)*.
3. If *number* is NaN , $+0$, -0 , $+\infty$, or $-\infty$, return $+0$.
4. Let *int* be the mathematical value that is the same sign as *number* and whose magnitude is $\text{floor}(\text{abs}(\text{number}))$.
5. Let *int32bit* be *int* modulo 2^{32} .
6. Return *int32bit*.

NOTE Given the above definition of *ToUint32*:

- Step 6 is the only difference between *ToUint32* and *ToInt32*.
- The *ToUint32* abstract operation is idempotent: if applied to a result that it produced, the second application leaves that value unchanged.
- *ToUint32(ToInt32(x))* is equal to *ToUint32(x)* for all values of *x*. (It is to preserve this latter property that $+\infty$ and $-\infty$ are mapped to $+0$.)
- *ToUint32* maps -0 to $+0$.

7.1.7 ToInt16(*argument*) — Signed 16 Bit Integer

The abstract operation *ToInt16* converts *argument* to one of 2^{16} integer values in the range -32768 through 32767 , inclusive. This abstract operation functions as follows:

1. Let *number* be *ToNumber(argument)*.
2. *ReturnIfAbrupt(number)*.

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3. If *number* is NaN, +0, -0, +∞, or -∞, return +0.
4. Let *int* be the mathematical value that is the same sign as *number* and whose magnitude is floor(abs(*number*)).
5. Let *int16bit* be *int* modulo 2^{16} .
6. If *int16bit* $\geq 2^{15}$, return *int16bit* - 2^{16} , otherwise return *int16bit*.

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7.1.8 ToUint16 (*argument*) — Unsigned 16 Bit Integer

The abstract operation ToUint16 converts *argument* to one of 2^{16} integer values in the range 0 through $2^{16}-1$, inclusive. This abstract operation functions as follows:

1. Let *number* be ToNumber(*argument*).
2. ReturnIfAbrupt(*number*).
3. If *number* is NaN, +0, -0, +∞, or -∞, return +0.
4. Let *int* be the mathematical value that is the same sign as *number* and whose magnitude is floor(abs(*number*)).
5. Let *int16bit* be *int* modulo 2^{16} .
6. Return *int16bit*.

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NOTE Given the above definition of ToUint16:

- The substitution of 2^{16} for 2^{32} in step 5 is the only difference between ToUint32 and ToUint16.
- ToUint16 maps -0 to +0.

7.1.9ToInt8 (*argument*) — Signed 8 Bit Integer

The abstract operationToInt8 converts *argument* to one of 2^8 integer values in the range -128 through 127, inclusive. This abstract operation functions as follows:

1. Let *number* be ToNumber(*argument*).
2. ReturnIfAbrupt(*number*).
3. If *number* is NaN, +0, -0, +∞, or -∞, return +0.
4. Let *int* be the mathematical value that is the same sign as *number* and whose magnitude is floor(abs(*number*)).
5. Let *int8bit* be *int* modulo 2^8 .
6. If *int8bit* $\geq 2^7$, return *int8bit* - 2^8 , otherwise return *int8bit*.

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7.1.10 ToUint8 (*argument*) — Unsigned 8 Bit Integer

The abstract operation ToUint8 converts *argument* to one of 2^8 integer values in the range 0 through 255, inclusive. This abstract operation functions as follows:

1. Let *number* be ToNumber(*argument*).
2. ReturnIfAbrupt(*number*).
3. If *number* is NaN, +0, -0, +∞, or -∞, return +0.
4. Let *int* be the mathematical value that is the same sign as *number* and whose magnitude is floor(abs(*number*)).
5. Let *int8bit* be *int* modulo 2^8 .
6. Return *int8bit*.

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7.1.11 ToUint8Clamp (*argument*) — Unsigned 8 Bit Integer, Clamped

The abstract operation ToUint8Clamp converts *argument* to one of 2^8 integer values in the range 0 through 255, inclusive. This abstract operation functions as follows:

1. Let *number* be ToNumber(*argument*).
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2. ReturnIfAbrupt(*number*).
Deleted: >
3. If *number* is NaN, return +0.
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4. If *number* ≤ 0, return +0.
Deleted: >
5. If *number* ≥ 255, return 255.
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6. Let *f* be floor(*number*).
Deleted: , then return
7. If *f* + 0.5 < *number*, return *f* + 1.
Deleted: , then return
8. If *number* < *f* + 0.5, return *f*.
Deleted: ToUnit8Clamp
9. If *f* is odd, return *f* + 1.
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10. Return *f*.

NOTE Note that unlike the other ECMAScript integer conversion abstract operation, `ToUint8Clamp` rounds rather than truncates non-integer values and does not convert $+\infty$ to 0. `ToUint8Clamp` does "round half to even" tie-breaking. This differs from `Math.round` which does "round half up" tie-breaking.

7.1.12 ToString (*argument*)

The abstract operation ToString converts *argument* to a value of type String according to Table 12:

Table 12 — ToString Conversions

Argument Type	Result
Completion Record	If <i>argument</i> is an abrupt completion, return <i>argument</i> . Otherwise return <code>ToString(argument.[[value]])</code> . Deleted: its
Undefined	<u>Return "undefined"</u> . Deleted: , then return
Null	<u>Return "null"</u> . Deleted: , then return
Boolean	If <i>argument</i> is true, return "true". If <i>argument</i> is false, return "false". Deleted: , then return
Number	See 7.1.12.1. Deleted: , then return
String	Return <i>argument</i> . Deleted: (no conversion)
Symbol	Throw a <code>TypeError</code> exception.
Object	Apply the following steps: 1. Let <i>primValue</i> be <code>ToPrimitive(argument, hint String)</code> . 2. Return <code>ToString(primValue)</code> . Deleted: character Deleted: · Deleted: '

7.1.12.1 ToString Applied to the Number Type

The abstract operation ToString converts a Number *m* to String format as follows:

1. If *m* is NaN, return the String "NaN".
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2. If *m* is +0 or -0, return the String "0".
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3. If *m* is less than zero, return the String concatenation of the String "-" and `ToString(-m)`.
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4. If *m* is $+\infty$, return the String "Infinity".
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5. Otherwise, let *n*, *k*, and *s* be integers such that $k \geq 1$, $10^{k-1} \leq s < 10^k$, the Number value for $s \times 10^{n-k}$ is *m*, and *k* is as small as possible. Note that *k* is the number of digits in the decimal representation of *s*, that *s* is not divisible by 10, and that the least significant digit of *s* is not necessarily uniquely determined by these criteria.
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6. If $k \leq n \leq 21$, return the String consisting of the code points of the *k* digits of the decimal representation of *s* (in order, with no leading zeroes), followed by $n-k$ occurrences of the code point U+0030 (DIGIT ZERO).
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7. If $0 < n \leq 21$, return the String consisting of the code points of the most significant n digits of the decimal representation of s , followed by the code point U+002E (FULL STOP), followed by the code points of the remaining $k-n$ digits of the decimal representation of s .
8. If $-6 < n \leq 0$, return the String consisting of the code point U+0030 (DIGIT ZERO), followed by a the code point U+002E (FULL STOP), followed by $-n$ occurrences of the code point U+0030 (DIGIT ZERO), followed by the code points of the k digits of the decimal representation of s .
9. Otherwise, if $k = 1$, return the String consisting of the code point of the single digit of s , followed by code point U+0065 (LATIN SMALL LETTER E), followed by the code point U+002B (PLUS SIGN), or the code point U+002D (HYPHEN-MINUS), according to whether $n-1$ is positive or negative, followed by the code points of the decimal representation of the integer $\text{abs}(n-1)$ (with no leading zeroes).
10. Return the String consisting of the code point of the most significant digit of the decimal representation of s , followed by code point U+002E (FULL STOP), followed by the code points of the remaining $k-1$ digits of the decimal representation of s , followed by code point U+0065 (LATIN SMALL LETTER E), followed by code point U+002B (PLUS SIGN) or the code point U+002D (HYPHEN-MINUS), according to whether $n-1$ is positive or negative, followed by the code points of the decimal representation of the integer $\text{abs}(n-1)$ (with no leading zeroes).

NOTE 1 The following observations may be useful as guidelines for implementations, but are not part of the normative requirements of this Standard:

- If x is any Number value other than **-0**, then $\text{ToNumber}(\text{ToString}(x))$ is exactly the same Number value as x .
- The least significant digit of s is not always uniquely determined by the requirements listed in step 5.

NOTE 2 For implementations that provide more accurate conversions than required by the rules above, it is recommended that the following alternative version of step 5 be used as a guideline:

Otherwise, let n , k , and s be integers such that $k \geq 1$, $10^{k-1} \leq s < 10^k$, the Number value for $s \times 10^{n-k}$ is m , and k is as small as possible. If there are multiple possibilities for s , choose the value of s for which $s \times 10^{n-k}$ is closest in value to m . If there are two such possible values of s , choose the one that is even. Note that k is the number of digits in the decimal representation of s and that s is not divisible by 10.

NOTE 3 Implementers of ECMAScript may find useful the paper and code written by David M. Gay for binary-to-decimal conversion of floating-point numbers:

Gay, David M. Correctly Rounded Binary-Decimal and Decimal-Binary Conversions. Numerical Analysis, Manuscript 90-10. AT&T Bell Laboratories (Murray Hill, New Jersey). November 30, 1990. Available as <http://cm.bell-labs.com/cm/cs/doc/90/4-10.ps.gz>. Associated code available as <http://netlib.sandia.gov/fp/dtoa.c> and as http://netlib.sandia.gov/fp/g_fmt.c and may also be found at the various **netlib** mirror sites.

7.1.13 ToObject (argument)

The abstract operation **ToObject** converts argument to a value of type Object according to Table 13:

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Deleted: character ‘e’
Deleted: a plus sign ‘+’
Deleted: minus sign ‘-’
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Deleted:
Deleted: a decimal point ‘.’
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Deleted: the lowercase character ‘e’
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Table 13 — ToObject Conversions

Argument Type	Result
Completion Record	If <i>argument</i> is an abrupt completion, return <i>argument</i> . Otherwise return <code>ToObject(argument.[[value]])</code> .
Undefined	Throw a TypeError exception.
Null	Throw a TypeError exception.
Boolean	Return a new Boolean object whose <code>[[BooleanData]]</code> internal slot is set to the value of <i>argument</i> . See 19.3 for a description of Boolean objects.
Number	Return a new Number object whose <code>[[NumberData]]</code> internal slot is set to the value of <i>argument</i> . See 20.1 for a description of Number objects.
String	Return a new String object whose <code>[[StringData]]</code> internal slot is set to the value of <i>argument</i> . See 21.1 for a description of String objects.
Symbol	Return a new Symbol object whose <code>[[SymbolData]]</code> internal slot is set to the value of <i>argument</i> . See 19.4 for a description of Symbol objects.
Object	Return <i>argument</i> .

Deleted: (no conversion)

7.1.14 ToPropertyKey (*argument*)

The abstract operation `ToPropertyKey` converts *argument* to a value that can be used as a property key by performing the following steps:

1. Let *key* be `ToPrimitive(argument, hint String)`.
2. ReturnIfAbrupt(*key*).
3. If `Type(key)` is Symbol, then
 - a. Return *key*.
4. Return `ToString(key)`.

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7.1.15 ToLength (*argument*)

The abstract operation `ToLength` converts *argument* to an integer suitable for use as the length of an array-like object. It performs the following steps:

1. `ReturnIfAbrupt(argument)`.
2. Let *len* be `ToInteger(argument)`.
3. `ReturnIfAbrupt(len)`.
4. If *len* ≤ +0, return +0.
5. Return `min(len, 253-1)`.

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7.1.16 CanonicalNumericIndexString (*argument*)

The abstract operation `CanonicalNumericIndexString` returns *argument* converted to a numeric value if it is a String representation of a Number that would be produced by `ToString`, or the string "-0". Otherwise, it returns `undefined`. This abstract operation functions as follows:

1. Assert: `Type(argument)` is String.
2. If *argument* is "-0", return -0.
3. Let *n* be `ToNumber(argument)`.
4. If `SameValue(ToString(n), argument)` is false, return `undefined`.
5. Return *n*.

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A canonical numeric string is any String value for which the CanonicalNumericIndexString abstraction operation does not return undefined.

7.2 Testing and Comparison Operations

7.2.1 RequireObjectCoercible (argument)

The abstract operation RequireObjectCoercible throws an error if argument is a value that cannot be converted to an Object using ToObject. It is defined by Table 14:

Table 14 — RequireObjectCoercible Results

Argument Type	Result
Completion Record	If <u>argument</u> is an abrupt completion, return <u>argument</u> . Otherwise return <u>RequireObjectCoercible(argument.[[value]])</u> .
Undefined	Throw a TypeError exception.
Null	Throw a TypeError exception.
Boolean	Return <u>argument</u> .
Number	Return <u>argument</u> .
String	Return <u>argument</u> .
Symbol	Return <u>argument</u> .
Object	Return <u>argument</u> .

7.2.2 IsArray (argument)

The abstract operation IsArray takes one argument argument, and performs the following steps:

1. If Type(argument) is not Object, return false.
2. If argument is an Array exotic object, return true.
3. If argument is a Proxy exotic object, then
 - a. Let target be the value of the [[ProxyTarget]] internal slot of argument.
 - b. Return IsArray(target).
4. Return false.

7.2.3 IsCallable (argument)

The abstract operation IsCallable determines if argument, which must be an ECMAScript language value or a Completion Record, is a callable function with a [[Call]] internal method:

1. ReturnIfAbrupt(argument).
2. If Type(argument) is not Object, return false.
3. If argument has a [[Call]] internal method, return true.
4. Return false.

7.2.4 IsConstructor (argument)

The abstract operation IsConstructor determines if argument, which must be an ECMAScript language value or a Completion Record, is a function object with a [[Construct]] internal method.

1. ReturnIfAbrupt(argument).

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Deleted: <#>If target is null, then throw a TypeException exception.

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Argument Type

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2. If Type(argument) is not Object, return **false**.
3. If argument has a [[Construct]] internal method, return **true**.
4. Return **false**.

7.2.5 IsExtensible (*O*)

The abstract operation IsExtensible is used to determine whether additional properties can be added to the object that is *O*. A Boolean value is returned. This abstract operation performs the following steps:

1. Assert: Type(*O*) is Object.
2. Return the result of calling the [[IsExtensible]] internal method of *O*.

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7.2.6 IsInteger (*argument*)

The abstract operation IsInteger determines if *argument* is a finite integer numeric value.

1. ReturnIfAbrupt(*argument*).
2. If Type(*argument*) is not Number, return **false**.
3. If *argument* is NaN, +∞, or -∞, return **false**.
4. If floor(abs(*argument*)) ≠ abs(*argument*), **return false**.
5. Return **true**.

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7.2.7 IsPropertyKey (*argument*)

The abstract operation IsPropertyKey determines if *argument*, which must be an ECMAScript language value or a Completion Record, is a value that may be used as a property key.

1. ReturnIfAbrupt(*argument*).
2. If Type(*argument*) is String, return **true**.
3. If Type(*argument*) is Symbol, return **true**.
4. Return **false**.

7.2.8 IsRegExp (*argument*)

The abstract operation IsRegExp with argument *argument* performs the following steps:

1. If Type(*argument*) is not Object, **return false**.
2. Let *isRegExp* be Get(*argument*, @@match).
3. ReturnIfAbrupt(*isRegExp*).
4. If *isRegExp* is not undefined, **return ToBoolean(*isRegExp*)**.
5. If *argument* has a [[RegExpMatcher]] internal slot, **return true**.
6. **Return false**.

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7.2.9 SameValue(x, y)

The internal comparison abstract operation SameValue(*x*, *y*), where *x* and *y* are ECMAScript language values, produces **true** or **false**. Such a comparison is performed as follows:

1. ReturnIfAbrupt(*x*).
2. ReturnIfAbrupt(*y*).
3. If Type(*x*) is different from Type(*y*), **return false**.
4. If Type(*x*) is Undefined, **return true**.
5. If Type(*x*) is Null, **return true**.
6. If Type(*x*) is Number, then

- a. If x is `Nan` and y is `Nan`, return `true`.
 - b. If x is `+0` and y is `-0`, return `false`.
 - c. If x is `-0` and y is `+0`, return `false`.
 - d. If x is the same Number value as y , return `true`.
 - e. Return `false`.
7. If $\text{Type}(x)$ is String, then
- a. If x and y are exactly the same sequence of code units (same length and same code units ~~at~~ corresponding indices) return `true`; otherwise, return `false`.
8. If $\text{Type}(x)$ is Boolean, then
- a. If x and y are both `true` or both `false`, ~~return true~~; otherwise, return `false`.
9. If $\text{Type}(x)$ is Symbol, then
- a. If x and y are both the same Symbol value, ~~return true~~; otherwise, return `false`.
10. Return `true` if x and y are the same Object value. Otherwise, return `false`.

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7.2.10 SameValueZero(x, y)

The internal comparison abstract operation `SameValueZero(x, y)`, where x and y are ECMAScript language values, produces `true` or `false`. Such a comparison is performed as follows:

- 1. `ReturnIfAbrupt(x)`.
- 2. `ReturnIfAbrupt(y)`.
- 3. If $\text{Type}(x)$ is different from $\text{Type}(y)$, return `false`.
- 4. If $\text{Type}(x)$ is `Undefined`, return `true`.
- 5. If $\text{Type}(x)$ is `Null`, return `true`.
- 6. If $\text{Type}(x)$ is Number, then
 - a. If x is `Nan` and y is `Nan`, return `true`.
 - b. If x is `+0` and y is `-0`, return `true`.
 - c. If x is `-0` and y is `+0`, return `true`.
 - d. If x is the same Number value as y , return `true`.
 - e. Return `false`.
- 7. If $\text{Type}(x)$ is String, then
 - a. If x and y are exactly the same sequence of code units (same length and same code units ~~at~~ corresponding indices) return `true`; otherwise, return `false`.
- 8. If $\text{Type}(x)$ is Boolean, then
 - a. If x and y are both `true` or both `false`, ~~return true~~; otherwise, return `false`.
- 9. If $\text{Type}(x)$ is Symbol, then
 - a. If x and y are both the same Symbol value, ~~return true~~; otherwise, return `false`.
- 10. Return `true` if x and y are the same Object value. Otherwise, return `false`.

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NOTE `SameValueZero` differs from `SameValue` only in its treatment of `+0` and `-0`.

7.2.11 Abstract Relational Comparison

The comparison $x < y$, where x and y are values, produces `true`, `false`, or `undefined` (which indicates that at least one operand is `Nan`). In addition to x and y the algorithm takes a Boolean flag named `LeftFirst` as a parameter. The flag is used to control the order in which operations with potentially visible side-effects are performed upon x and y . It is necessary because ECMAScript specifies left to right evaluation of expressions. The default value of `LeftFirst` is `true` and indicates that the x parameter corresponds to an expression that occurs to the left of the y parameter's corresponding expression. If `LeftFirst` is `false`, the reverse is the case and operations must be performed upon y before x . Such a comparison is performed as follows:

1. `ReturnIfAbrupt(x)`.
2. `ReturnIfAbrupt(y)`.

3. If the *LeftFirst* flag is **true**, then
 - a. Let px be $\text{ToPrimitive}(x, \text{hint Number})$.
 - b. $\text{ReturnIfAbrupt}(px)$.
 - c. Let py be $\text{ToPrimitive}(y, \text{hint Number})$.
 - d. $\text{ReturnIfAbrupt}(py)$.
4. Else the order of evaluation needs to be reversed to preserve left to right evaluation
 - a. Let py be $\text{ToPrimitive}(y, \text{hint Number})$.
 - b. $\text{ReturnIfAbrupt}(py)$.
 - c. Let px be $\text{ToPrimitive}(x, \text{hint Number})$.
 - d. $\text{ReturnIfAbrupt}(px)$.
5. If both px and py are Strings, then
 - a. If py is a prefix of px , return **false**. (A String value p is a prefix of String value q if q can be the result of concatenating p and some other String r . Note that any String is a prefix of itself, because r may be the empty String.)
 - b. If px is a prefix of py , return **true**.
 - c. Let k be the smallest nonnegative integer such that the code unit at index k within px is different from the code unit at index k within py . (There must be such a k , for neither String is a prefix of the other.)
 - d. Let m be the integer that is the code unit value at index k within px .
 - e. Let n be the integer that is the code unit value at index k within py .
 - f. If $m < n$, return **true**. Otherwise, return **false**.
6. Else
 - a. Let nx be $\text{ToNumber}(px)$. Because px and py are primitive values evaluation order is not important.
 - b. $\text{ReturnIfAbrupt}(nx)$.
 - c. Let ny be $\text{ToNumber}(py)$.
 - d. $\text{ReturnIfAbrupt}(ny)$.
 - e. If nx is NaN , return **undefined**.
 - f. If ny is NaN , return **undefined**.
 - g. If nx and ny are the same Number value, return **false**.
 - h. If nx is $+0$ and ny is -0 , return **false**.
 - i. If nx is -0 and ny is $+0$, return **false**.
 - j. If nx is $+\infty$, return **false**.
 - k. If ny is $+\infty$, return **true**.
 - l. If ny is $-\infty$, return **false**.
 - m. If nx is $-\infty$, return **true**.
 - n. If the mathematical value of nx is less than the mathematical value of ny —note that these mathematical values are both finite and not both zero—return **true**. Otherwise, return **false**.

NOTE 1 Step 5 differs from step 11 in the algorithm for the addition operator `+` (12.7.3) in using “and” instead of “or”.

NOTE 2 The comparison of Strings uses a simple lexicographic ordering on sequences of code unit values. There is no attempt to use the more complex, semantically oriented definitions of character or string equality and collating order defined in the Unicode specification. Therefore String values that are canonically equal according to the Unicode standard could test as unequal. In effect this algorithm assumes that both Strings are already in normalized form. Also, note that for strings containing supplementary characters, lexicographic ordering on sequences of UTF-16 code unit values differs from that on sequences of code point values.

7.2.12 Abstract Equality Comparison

The comparison $x == y$, where x and y are values, produces **true** or **false**. Such a comparison is performed as follows:

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1. `ReturnIfAbrupt(x)`.
2. `ReturnIfAbrupt(y)`.
3. If `Type(x)` is the same as `Type(y)`, then
 - a. Return the result of performing Strict Equality Comparison $x === y$.
4. If `x` is `null` and `y` is `undefined`, return `true`.
5. If `x` is `undefined` and `y` is `null`, return `true`.
6. If `Type(x)` is Number and `Type(y)` is String, return the result of the comparison $x == \text{ToNumber}(y)$.
7. If `Type(x)` is String and `Type(y)` is Number, return the result of the comparison $\text{ToNumber}(x) == y$.
8. If `Type(x)` is Boolean, return the result of the comparison $\text{ToNumber}(x) == y$.
9. If `Type(y)` is Boolean, return the result of the comparison $x == \text{ToNumber}(y)$.
10. If `Type(x)` is either String, Number, or Symbol and `Type(y)` is Object, then
 - return the result of the comparison $x == \text{ToPrimitive}(y)$.
11. If `Type(x)` is Object and `Type(y)` is either String, Number, or Symbol, then
 - return the result of the comparison $\text{ToPrimitive}(x) == y$.
12. Return `false`.

Deleted: <#>If `Type(x)` is Symbol or `Type(y)` is Symbol, return `false`.¶

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7.2.13 Strict Equality Comparison

The comparison $x === y$, where `x` and `y` are values, produces `true` or `false`. Such a comparison is performed as follows:

1. If `Type(x)` is different from `Type(y)`, return `false`.
2. If `Type(x)` is Undefined, return `true`.
3. If `Type(x)` is Null, return `true`.
4. If `Type(x)` is Number, then
 - a. If `x` is `NaN`, return `false`.
 - b. If `y` is `NaN`, return `false`.
 - c. If `x` is the same Number value as `y`, return `true`.
 - d. If `x` is `+0` and `y` is `-0`, return `true`.
 - e. If `x` is `-0` and `y` is `+0`, return `true`.
 - f. Return `false`.
5. If `Type(x)` is String, then
 - a. If `x` and `y` are exactly the same sequence of code units (same length and same code units at corresponding indices), return `true`.
 - b. Else, return `false`.
6. If `Type(x)` is Boolean, then
 - a. If `x` and `y` are both `true` or both `false`, return `true`.
 - b. Else, return `false`.
7. If `x` and `y` are the same Symbol value, return `true`.
8. If `x` and `y` are the same Object value, return `true`.
9. Return `false`.

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NOTE This algorithm differs from the SameValue Algorithm (7.2.3) in its treatment of signed zeroes and NaNs.

7.3 Operations on Objects

7.3.1 Get (O, P)

The abstract operation Get is used to retrieve the value of a specific property of an object. The operation is called with arguments `O` and `P` where `O` is the object and `P` is the property key. This abstract operation performs the following steps:

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1. Assert: Type(O) is Object.
- ~~2. Assert: IsPropertyKey(P) is true.~~
3. Return the result of calling the [[Get]] internal method of O passing P and O as the arguments.

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7.3.2 GetV (V, P)

The abstract operation `GetV` is used to retrieve the value of a specific property of an ECMAScript language value. If the value is not an object, the property lookup is performed using a wrapper object appropriate for the type of the value. The operation is called with arguments V and P where V is the value and P is the property key. This abstract operation performs the following steps:

1. ~~Assert: IsPropertyKey(P) is true.~~
2. Let Q be `ToObject`(V).
3. ~~ReturnIfAbrupt(Q).~~
4. Return the result of calling the [[Get]] internal method of Q passing P and V as the arguments.

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7.3.3 Put ($O, P, V, Throw$)

The abstract operation `Put` is used to set the value of a specific property of an object. The operation is called with arguments O , P , V , and $Throw$ where O is the object, P is the property key, V is the new value for the property and $Throw$ is a Boolean flag. This abstract operation performs the following steps:

1. Assert: Type(O) is Object.
2. Assert: IsPropertyKey(P) is true.
3. Assert: Type($Throw$) is Boolean.
4. Let $success$ be the result of calling the [[Set]] internal method of O passing P , V , and O as the arguments.
5. ~~ReturnIfAbrupt($success$).~~
6. If $success$ is false and $Throw$ is true, ~~throw~~ a `TypeError` exception.
7. Return $success$.

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7.3.4 CreateDataProperty (O, P, V)

The abstract operation `CreateDataProperty` is used to create a new own property of an object. The operation is called with arguments O , P , and V where O is the object, P is the property key, and V is the value for the property. This abstract operation performs the following steps:

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1. Assert: Type(O) is Object.
2. Assert: IsPropertyKey(P) is true.
3. Let $newDesc$ be the `PropertyDescriptor`{[[Value]]: V , [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}.
4. Return the result of calling the [[DefineOwnProperty]] internal method of O passing P and $newDesc$ as arguments.

NOTE This abstract operation creates a property whose attributes are set to the same defaults used for properties created by the ECMAScript language assignment operator. Normally, the property will not already exist. If it does exist and is not configurable or if O is not extensible, [[DefineOwnProperty]] will return false.

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7.3.5 CreateDataPropertyOrThrow (O, P, V)

The abstract operation `CreateDataPropertyOrThrow` is used to create a new own property of an object. It throws a `TypeError` exception if the requested property update cannot be performed. The operation is called with arguments O , P , and V where O is the object, P is the property key, and V is the value for the property. This abstract operation performs the following steps:

1. Assert: Type(O) is Object.
2. Assert: IsPropertyKey(P) is true.
3. Let $success$ be CreateDataProperty(O , P , V).
4. ReturnIfAbrupt($success$).
5. If $success$ is false, throw a **TypeError** exception.
6. Return $success$.

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NOTE This abstract operation creates a property whose attributes are set to the same defaults used for properties created by the ECMAScript language assignment operator. Normally, the property will not already exist. If it does exist and is not configurable or if O is not extensible, [[DefineOwnProperty]] will return false causing this operation to throw a **TypeError** exception.

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7.3.6 DefinePropertyOrThrow (O , P , $desc$)

The abstract operation DefinePropertyOrThrow is used to call the [[DefineOwnProperty]] internal method of an object in a manner that will throw a **TypeError** exception if the requested property update cannot be performed. The operation is called with arguments O , P , and $desc$ where O is the object, P is the property key, and $desc$ is the Property Descriptor for the property. This abstract operation performs the following steps:

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1. Assert: Type(O) is Object.
2. Assert: IsPropertyKey(P) is true.
3. Let $success$ be the result of calling the [[DefineOwnProperty]] internal method of O passing P and $desc$ as arguments.
4. ReturnIfAbrupt($success$).
5. If $success$ is false, throw a **TypeError** exception.
6. Return $success$.

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7.3.7 DeletePropertyOrThrow (O , P)

The abstract operation DeletePropertyOrThrow is used to remove a specific own property of an object. It throws an exception if the property is not configurable. The operation is called with arguments O and P where O is the object and P is the property key. This abstract operation performs the following steps:

1. Assert: Type(O) is Object.
2. Assert: IsPropertyKey(P) is true.
3. Let $success$ be the result of calling the [[Delete]] internal method of O passing P as the argument.
4. ReturnIfAbrupt($success$).
5. If $success$ is false, throw a **TypeError** exception.
6. Return $success$.

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7.3.8 GetMethod (O , P)

The abstract operation GetMethod is used to get the value of a specific property of an object when the value of the property is expected to be a function. The operation is called with arguments O and P where O is the object, P is the property key. This abstract operation performs the following steps:

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1. Assert: IsPropertyKey(P) is true.
2. Let $func$ be GetV(O , P).
3. ReturnIfAbrupt($func$).
4. If $func$ is either undefined or null, return undefined.
5. If IsCallable($func$) is false, throw a **TypeError** exception.
6. Return $func$.

7.3.9 HasProperty (O, P)

The abstract operation HasProperty is used to determine whether an object has a property with the specified property key. The property may be either an own or inherited. A Boolean value is returned. The operation is called with arguments O and P where O is the object and P is the property key. This abstract operation performs the following steps:

1. Assert: Type(O) is Object.
2. Assert: IsPropertyKey(P) is true.
3. Return the result of calling the [[HasProperty]] internal method of O with argument P .

7.3.10 HasOwnProperty (O, P)

The abstract operation HasOwnProperty is used to determine whether an object has an own property with the specified property key. A Boolean value is returned. The operation is called with arguments O and P where O is the object and P is the property key. This abstract operation performs the following steps:

1. Assert: Type(O) is Object.
2. Assert: IsPropertyKey(P) is true.
3. Let $desc$ be the result of calling the [[GetOwnProperty]] internal method of O passing P as the argument.
4. ReturnIfAbrupt($desc$).
5. If $desc$ is undefined, return false.
6. Return true.

7.3.11 Call(F, V, [argumentsList])

The abstract operation Call is used to call the [[Call]] internal method of a function object. The operation is called with arguments F , V , and optionally $argumentsList$ where F is the function object, V is an ECMAScript language value that is the this value of the [[Call]], and $argumentsList$ is the value passed to the corresponding argument of the internal method. If $argumentsList$ is not present, an empty List is used as its value. This abstract operation performs the following steps:

1. ReturnIfAbrupt(F).
2. If $argumentsList$ was not passed, let $argumentsList$ be a new empty List.
3. If IsCallable(F) is false, throw a TypeError exception.
4. Return the result of calling the [[Call]] internal method of F with arguments V and $argumentsList$.

7.3.12 Invoke(O,P, [argumentsList])

The abstract operation Invoke is used to call a method property of an object. The operation is called with arguments O , P , and optionally $argumentsList$ where O serves as both the lookup point for the property and the this value of the call, P is the property key, and $argumentsList$ is the list of arguments values passed to the method. If $argumentsList$ is not present, an empty List is used as its value. This abstract operation performs the following steps:

1. Assert: P is a valid property key.
2. If $argumentsList$ was not passed, let $argumentsList$ be a new empty List.
3. Let $func$ be GetV(O , P).
4. Return Call($func$, O , $argumentsList$).

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7.3.13 Construct (*F*, [*argumentsList*], [*newTarget*])

The abstract operation `Construct` is used to call the `[[Construct]]` internal method of a function object. The operation is called with arguments *F*, and optionally *argumentsList*, and *newTarget* where *F* is the function object. *argumentsList* and *newTarget* are the values to be passed as the corresponding arguments of the internal method. If *argumentsList* is not present, an empty List is used as its value. If *newTarget* is not present, *F* is used as its value. This abstract operation performs the following steps:

1. If *newTarget* was not passed, let *newTarget* be *F*.
2. If *argumentsList* was not passed, let *argumentsList* be a new empty List.
3. Assert: `IsConstructor` (*F*) is **true**.
4. Assert: `IsConstructor` (*newTarget*) is **true**.
5. Return the result of calling the `[[Construct]]` internal method of *F* passing *argumentsList* and *newTarget* as the arguments.

NOTE If *newTarget* is not passed, this operation is equivalent to: `new F(...argumentsList)`

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7.3.14 SetIntegrityLevel (*O*, *level*)

The abstract operation `SetIntegrityLevel` is used to fix the set of own properties of an object. This abstract operation performs the following steps:

1. Assert: `Type`(*O*) is Object.
2. Assert: *level* is either "**sealed**" or "**frozen**".
3. Let *status* be the result of calling the `[[PreventExtensions]]` internal method of *O*.
4. `ReturnIfAbrupt`(*status*).
5. If *status* is **false**, **return false**.
6. Let *keys* be the result of calling the `[[OwnPropertyKeys]]` internal method of *O*.
7. `ReturnIfAbrupt`(*keys*).
8. If *level* is "**sealed**", then
 - a. Repeat for each element *k* of *keys*,
 - i. Let *status* be `DefinePropertyOrThrow`(*O*, *k*, `PropertyDescriptor`{ `[[Configurable]]`: **false** }).
 - ii. `ReturnIfAbrupt`(*status*).
9. Else *level* is "**frozen**", then
 - a. Repeat for each element *k* of *keys*,
 - i. Let *currentDesc* be the result of calling the `[[GetOwnProperty]]` internal method of *O* with argument *k*.
 - ii. `ReturnIfAbrupt`(*currentDesc*).
 - iii. If *currentDesc* is not **undefined**, then
 1. If `IsAccessorDescriptor`(*currentDesc*) is **true**, then
 - a. Let *desc* be the `PropertyDescriptor`{ `[[Configurable]]`: **false** }.
 2. Else,
 - a. Let *desc* be the `PropertyDescriptor` { `[[Configurable]]`: **false**, `[[Writable]]`: **false** }.
 3. Let *status* be `DefinePropertyOrThrow`(*O*, *k*, *desc*).
 4. `ReturnIfAbrupt`(*status*).
 10. `Return true`.

7.3.15 TestIntegrityLevel (*O*, *level*)

The abstract operation `TestIntegrityLevel` is used to determine if the set of own properties of an object are fixed. This abstract operation performs the following steps:

1. Assert: `Type`(*O*) is Object.

Deleted: , then return

Deleted: *Array*

Deleted: <#>Let *keys* be `CreateListFromArrayLike`(*keysArray*).¶

Deleted: <#>Let *pendingException* be `undefinedempty`.¶

Deleted: If *status* is an abrupt completion, then

Deleted: <#>If *pendingException* is empty**undefined**, then set *pendingException* to *status*.¶

Deleted: *status*

Deleted: If *status* is an abrupt completion, then

Deleted: <#>If *pendingException* is empty**undefined**, then set *pendingException* to *status*.¶

Deleted: <#>Else,¶

<#>Let *currentDesc* be `status`.`[[value]]`.¶

Deleted: <#>**1**

Deleted: If *status* is an abrupt completion, then

Deleted: <#>If *pendingException* is empty**undefined**, then set *pendingException* to *status*.¶

<#>If *pendingException* is not empty**undefined**, then return *pendingException*.¶

Deleted: the result of calling the `[[PreventExtensions]]` internal method of *O*

Deleted: .

2. Assert: *level* is either "sealed" or "frozen".
3. Let *status* be IsExtensible(*O*).
4. ReturnIfAbrupt(*status*).
5. If *status* is true, return false
6. NOTE If the object is extensible, none of its properties are examined.
7. Let *keys* be the result of calling the [[OwnPropertyKeys]] internal method of *O*.
8. ReturnIfAbrupt(*keys*).
9. Let *configurable* be false.
10. Let *writable* be false.
11. Repeat for each element *k* of *keys*,
 - a. Let *currentDesc* be the result of calling the [[GetOwnProperty]] internal method of *O* with *k*.
 - b. ReturnIfAbrupt(*currentDesc*).
 - c. If *currentDesc* is not undefined, then
 - i. If *currentDesc*.[[Configurable]] is true, return false.
 - ii. If IsDataDescriptor(*currentDesc*) is true, then
 1. If *currentDesc*.[[Writable]] is true, return false.
12. Return true.

7.3.16 CreateArrayFromList (*elements*)

The abstract operation CreateArrayFromList is used to create an Array object whose elements are provided by a List. This abstract operation performs the following steps:

1. Assert: *elements* is a List whose elements are all ECMAScript language values.
2. Let *array* be ArrayCreate(0) (see 9.4.2.2).
3. Let *n* be 0.
4. For each element *e* of *elements*
 - a. Let *status* be the result of CreateDataProperty(*array*, ToString(*n*), *e*).
 - b. Assert: *status* is true.
 - c. Increment *n* by 1.
5. Return *array*.

7.3.17 CreateListFromArrayLike (*obj* [*elementType*])

The abstract operation CreateListFromArrayLike is used to create a List value whose elements are provided by the indexed properties of an array-like object. The optional argument *elementType* is a List containing the names of ECMAScript Language Types that are allowed for element values of the List that is created. This abstract operation performs the following steps:

1. ReturnIfAbrupt(*obj*).
2. If *elementType* was not passed, let *elementType* be (Undefined, Null, Boolean, String, Symbol, Number, Object).
3. If Type(*obj*) is not Object, throw a **TypeError** exception.
4. Let *len* be ToLength(Get(*obj*, "length")).
5. ReturnIfAbrupt(*len*).
6. Let *list* be an empty List.
7. Let *index* be 0.
8. Repeat while *index* < *len*
 - a. Let *indexName* be ToString(*index*).
 - b. Let *next* be Get(*obj*, *indexName*).
 - c. ReturnIfAbrupt(*next*).
 - d. If Type(*next*) is not an element of *elementType*, throw a **TypeError** exception.
 - e. Append *next* as the last element of *list*.

Deleted: , then return

Deleted: *Array*

Deleted: <#>Let *keys* be CreateListFromArrayLike(*keysArray*).¶

Deleted: <#>Let pendingException be emptyundefined.¶

Deleted: *status*

Deleted: If *status* is an abrupt completion, then

Deleted: <#>If pendingException is emptyundefined, then set pendingException to status.¶
<#>Let configurable be true.¶
<#>Else.¶
<#>Let currentDesc be status.[[value]].¶

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Deleted: <#>Set writable to writable logically ored with *currentDesc*.[[Writable]].¶

Deleted: <#>If pendingException is not emptyundefined, then return pendingException.¶

Deleted: <#>If level is "frozen" and writable is true, then return, return false. ¶
<#>¶
<#>If configurable is true, then return, return false. ¶
<#>¶

- f. Set *index* to *index* + 1.
9. Return *list*.

7.3.18 OrdinaryHasInstance (C, O)

The abstract operation `OrdinaryHasInstance` implements the default algorithm for determining if an object *O* inherits from the instance object inheritance path provided by constructor *C*. This abstract operation performs the following steps:

1. If `IsCallable(C)` is **false**, return **false**.
2. If *C* has a `[[BoundTargetFunction]]` internal slot, then
 - a. Let *BC* be the value of *C*'s `[[BoundTargetFunction]]` internal slot.
 - b. Return `InstanceOfOperator(O, BC)` (see 12.9.4).
3. If `Type(O)` is not `Object`, return **false**.
4. Let *P* be `Get(C, "prototype")`.
5. `ReturnIfAbrupt(P)`.
6. If `Type(P)` is not `Object`, throw a **TypeError** exception.
7. Repeat
 - a. Set *O* to the result of calling the `[[GetPrototypeOf]]` internal method of *O* with no arguments.
 - b. `ReturnIfAbrupt(O)`.
 - c. If *O* is `null`, return **false**.
 - d. If `SameValue(P, O)` is **true**, return **true**.

7.3.19 SpeciesConstructor (O, defaultConstructor)

The abstract operation `SpeciesConstructor` is used to retrieve the constructor that should be used to create new objects that are derived from the argument object *O*. The `defaultConstructor` argument is the constructor to use if *O* does not have a `@@species` property. This abstract operation performs the following steps:

1. **Assert:** `Type(O)` is `Object`.
2. Let *C* be `Get(O, "constructor")`.
3. `ReturnIfAbrupt(C)`.
4. If *C* is `undefined`, return `defaultConstructor`.
5. If `Type(C)` is not `Object`, throw a **TypeError** exception.
6. Let *S* be `Get(C, @@species)`.
7. `ReturnIfAbrupt(S)`.
8. If *S* is either `undefined` or `null`, return `defaultConstructor`.
9. If `IsConstructor(S)` is **true**, return *S*.
10. Throw a **TypeError** exception.

7.3.20 EnumerableOwnPropertyNames (O)

When the abstract operation `EnumerableOwnPropertyNames` is called with Object *O* the following steps are taken:

1. **Assert:** `Type(O)` is `Object`.
2. Let *ownKeys* be the result of calling the `[[OwnPropertyKeys]]` internal method of *O* with no arguments.
3. `ReturnIfAbrupt(ownKeys)`.
4. Let *names* be a new empty List.
5. Repeat, for each element *key* of *ownKeys* in List order
 - a. If `Type(key)` is `String`, then

Deleted: <#>`GetPrototypeFromConstructor (constructor, intrinsicDefaultProto)`

The abstract operation `GetPrototypeFromConstructor` determines the `[[Prototype]]` value that should be used to create an object corresponding to a specific constructor. The value is retrieved from the constructor's `prototype` property, if it exists. Otherwise the supplied default is used for `[[Prototype]]`. This abstract operation performs the following steps:
 ¶

<#>**Assert:** `intrinsicDefaultProto` is a string value that is this specification's name of an intrinsic object. The corresponding object must be an intrinsic that is intended to be used as the `[[Prototype]]` value of an object.
 ¶**If** `Assert: IsConstructor(constructor)` is **false****then** throw a **TypeError** exception.
 ¶**Let** `proto` be `Get(constructor, "prototype")`.
 ¶**ReturnIfAbrupt(proto)**.
 ¶**If** `Type(proto)` is not `Object`, then
 ¶**If** `constructor` has a `[[Realm]]` internal slot, let `realm` be `GetFunctionRealm(constructor)``constructor`'s `[[Realm]]` internal slot.
 ¶**Else**,
 ¶**Let** `ctx` be the running execution context.
 ¶**Let** `realm` be `ctx`'s `Realm`.
 ¶**Let** `proto` be `realm`'s intrinsic object named `intrinsicDefaultProto`.
 ¶**Return** `proto`.

NOTE If `constructor` does not supply a `[[Prototype]]` value, the default value that is used is `intrinsicDefaultProto`.

Deleted: **NOTE** .. This operation is equivalent to: `F[Symbol.create]()` followed by an error check.
 ¶

Deleted: <#>`Construct (F, argumentsList)`
 When the abstract operation `Construct` is called with Object *F* and List *argumentsList* the following steps are taken:
 ¶

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Deleted: <#>`GetOption (options, P)`
 The abstract operation `GetOption` is used to retrieve the value of a specific property of an object in situation where the object may not be

Deleted: <#>**Let** `length` be `ToLength(Get(ownKeys, "length"))`.
 ¶**ReturnIfAbrupt(length)**.
 ¶

Deleted: <#>**Let** `k` be `0`.
 ¶

Deleted: while `k < length`

Deleted: <#>**Let** `key` be `Get(ownKeys, ToString(k))`.
 ¶**ReturnIfAbrupt(key)**.
 ¶

- i. Let *desc* be the resulting of calling the `[[GetOwnProperty]]` internal method of *O* with argument *key*.
- ii. `ReturnIfAbrupt(desc)`.
- iii. If *desc* is not `undefined`, then
 1. If *desc*.`[[Enumerable]]` is `true`, append *key* to *names*.

6. Order the elements of *names* so they are in the same relative order as would be produced by the Iterator that would be returned if the `[[Enumerate]]` internal method was invoked on *O*.

7. `Return names`.

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Deleted: <#>Let *k* be *k* + 1.¶

NOTE The order of elements is returned list is the same as the enumeration order that used by a for-in statement.

7.3.21 `GetFunctionRealm (obj)` Abstract Operation

The abstract operation `GetFunctionRealm` with argument *obj* performs the following steps:

1. Assert: *obj* is a callable object.
2. If *obj* has a `[[Realm]]` internal slot, then
 - a. Return *obj*'s `[[Realm]]` internal slot.
3. If *obj* is a Bound Function exotic object, then
 - a. Let *target* be *obj*'s `[[BoundTargetFunction]]` internal slot.
 - b. Return `GetFunctionRealm(target)`.
4. If *obj* is a Proxy exotic object, then
 - a. Let *proxyTarget* be the value of *obj*'s `[[ProxyTarget]]` internal slot.
 - b. If *proxyTarget* is not null, return `GetFunctionRealm(proxyTarget)`.
5. Return the running execution context's Realm.

NOTE Step 5 will only be reached if *target* is a revoked proxy function or a non-standard exotic function object that does not have a `[[Realm]]` internal slot.

7.4 Operations on Iterator Objects

See Common Iteration Interfaces (25.1).

7.4.1 `GetIterator (obj, method)`

The abstract operation `GetIterator` with argument *obj* and optional argument *method* performs the following steps:

1. `ReturnIfAbrupt(obj)`.
2. If *method* was not passed, then
 - a. Let *method* be `GetMethod(obj, @@iterator)`.
 - b. `ReturnIfAbrupt(method)`.
3. Let *iterator* be `Call(method, obj)`.
4. `ReturnIfAbrupt(iterator)`.
5. If `Type(iterator)` is not Object, throw a `TypeError` exception.
6. Return *iterator*.

7.4.2 `IteratorNext (iterator, value)`

The abstract operation `IteratorNext` with argument *iterator* and optional argument *value* performs the following steps:

1. If *value* was not passed, then

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Deleted: <#>CheckIterable (*obj*)¶
 The abstract operation `CheckIterable` with argument *obj* performs the following steps:¶
 <#>If `Type(obj)` is not `Object``undefined` or `null`, then return `undefined`.¶
 <#>If `Type(obj)` is `Object`, then Return `Get(obj, @@iterator)`.¶
 <#>Let *box* be `ToObject(obj)`.¶
 <#>`ReturnIfAbrupt(box)`.¶
 <#>Return the result of calling the `[[Get]]` internal method of *box* passing `@@iterator` and *obj* as the arguments.¶

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Deleted: <#>Return *iteratorGetter*.¶

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Deleted: <#>If `IsCallable(method)` is `false`, then throw a `TypeError` exception.¶

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Deleted: <#>IsIterable (*obj*)¶

The abstract operation `IsIterable` with argument *obj* performs the following steps:¶
 <#>If `Type(obj)` is not `Object`, then return `undefined`.¶

<#>Let *iteratorGetter* be `Get(obj, @@Iterator)`.¶
 <#>`Return iteratorGetter`.¶

Deleted: let *value* be `undefined`.

- a. Let *result* be *Invoke(iterator, "next", «»)*.
2. Else,
 - a. Let *result* be *Invoke(iterator, "next", «value»)*.
3. *ReturnIfAbrupt(result)*.
4. If *Type(result)* is not Object, *throw* a **TypeError** exception.
5. Return *result*.

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7.4.3 IteratorComplete (*iterResult*)

The abstract operation *IteratorComplete* with argument *iterResult* performs the following steps:

1. Assert: *Type(iterResult)* is Object.
2. *Return ToBoolean(Get(iterResult, "done"))*.

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Deleted: <#>*Return ToBoolean(done)*.

7.4.4 IteratorValue (*iterResult*)

The abstract operation *IteratorValue* with argument *iterResult* performs the following steps:

1. Assert: *Type(iterResult)* is Object.
2. Return *Get(iterResult, "value")*.

7.4.5 IteratorStep (*iterator*)

The abstract operation *IteratorStep* with argument *iterator* requests the next value from *iterator* and returns either **false** indicating that the iterator has reached its end or the *IteratorResult* object if a next value is available. *IteratorStep* performs the following steps:

1. Let *result* be *IteratorNext(iterator)*.
2. *ReturnIfAbrupt(result)*.
3. Let *done* be *IteratorComplete(result)*.
4. *ReturnIfAbrupt(done)*.
5. If *done* is true, *return* **false**.
6. Return *result*.

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7.4.6 IteratorClose(*iterator*, *completion*)

The abstract operation *IteratorClose* with arguments *iterator* and *completion* is used to notify an iterator that should perform any actions it would normally perform when it has reached its completed state:

1. Assert: *Type(iterator)* is Object.
2. Assert: *completion* is a Completion Record.
3. Let *return* be *GetMethod(iterator, "return")*.
4. *ReturnIfAbrupt(return)*.
5. If *return* is **undefined**, *return completion*.
6. Let *innerResult* be *Call(return, iterator, «»)*.
7. If *completion.[[type]]* is **throw**, *return completion*.
8. If *innerResult.[[type]]* is **throw**, *return innerResult*.
9. If *Type(innerResult.[[value]])* is not Object, *throw* a **TypeError** exception.
10. *Return completion*.

7.4.7 CreateIteratorResultObject (*value*, *done*)

The abstract operation *CreateIteratorResultObject* with arguments *value* and *done* creates an object that supports the *IteratorResult* interface by performing the following steps:

1. Assert: Type(*done*) is Boolean.
2. Let *obj* be ObjectCreate(%ObjectPrototype%).
3. Perform CreateDataProperty(*obj*, "value", *value*).
4. Perform CreateDataProperty(*obj*, "done", *done*).
5. Return *obj*.

7.4.8 CreateListIterator (*list*)

The abstract operation CreateListIterator with argument *list* creates an Iterator (25.1.1.2) object whose next method returns the successive elements of *list*. It performs the following steps:

1. Let *iterator* be ObjectCreate(%IteratorPrototype%, *[[IteratorNext]]*, *[[IteratedList]]*, *[[ListIteratorNextIndex]]*).
2. Set *iterator*'s *[[IteratedList]]* internal slot to *list*.
3. Set *iterator*'s *[[ListIteratorNextIndex]]* internal slot to 0.
4. Let *next* be a new built-in function object as defined in ListIterator *next* (7.4.8.1).
5. Set *iterator*'s *[[IteratorNext]]* internal slot to *next*.
6. Let *status* be the result of CreateDataProperty(*iterator*, "next", *next*).
7. Return *iterator*.

7.4.8.1 ListIterator *next()*

The ListIterator *next* method is a standard built-in function object (clause 17) that performs the following steps:

1. Let *O* be the **this** value.
2. Let *f* be the active function object.
3. If *O* does not have a *[[IteratorNext]]* internal slot, throw a **TypeError** exception.
4. Let *next* be the value of the *[[IteratorNext]]* internal slot of *O*.
5. If SameValue(*f*, *next*) is **false**, throw a **TypeError** exception.
6. If *O* does not have a *[[IteratedList]]* internal slot, throw a **TypeError** exception.
7. Let *list* be the value of the *[[IteratedList]]* internal slot of *O*.
8. Let *index* be the value of the *[[ListIteratorNextIndex]]* internal slot of *O*.
9. Let *len* be the number of elements of *list*.
10. If *index* \geq *len*, then
 - a. Return CreateIterResultObject(**undefined**, **true**).
11. Set the value of the *[[ListIteratorNextIndex]]* internal slot of *O* to *index*+1.
12. Return CreateIterResultObject(*list*[*index*], **false**).

NOTE A ListIterator *next* method will throw an exception if applied to any object other than the one with which it was originally associated.

7.4.9 CreateCompoundIterator (*iterator1*, *iterator2*)

The abstract operation CreateCompoundIterator with arguments *iterator1* and *iterator2* creates an Iterator (25.1.1.2) object whose *next* method returns the successive elements of *iterator1* followed by the successive elements of *iterator2*. It performs the following steps:

1. Let *iterator* be ObjectCreate(%IteratorPrototype%, *[[Iterator1]]*, *[[Iterator2]]*, *[[State]]*, *[[IteratorNext]]*).
2. Set *iterator*'s *[[Iterator1]]* internal slot to *iterator1*.
3. Set *iterator*'s *[[Iterator2]]* internal slot to *iterator2*.
4. Set *iterator*'s *[[State]]* internal slot to 1.

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The abstract operation CreateEmptyIterator with no arguments creates an Iterator object whose next method always reports that the iterator is done. It performs the following steps:

<#>Let *empty* be a List with no elements.¶

<#>Return CreateListIterator(*empty*).¶

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5. Let `next` be a new built-in function object as defined in [CompoundIterator `next`](#) (7.4.9.1).
6. Set `iterator`'s `[[IteratorNext]]` internal slot to `next`.
7. Let `status` be the result of `CreateDataProperty(iterator, "next", next)`.
8. Return `iterator`.

[7.4.9.1 CompoundIterator `next\(\)`](#)

The CompoundIterator `next` method is a standard built-in function object that performs the following steps:

1. Let `O` be the `this` value.
2. Let `f` be the active function object.
3. If `O` does not have a `[[IteratorOrNext]]` internal slot, throw a `TypeError` exception.
4. Let `next` be the value of the `[[IteratorOrNext]]` internal slot of `O`.
5. If `SameValue(f, next)` is `false`, throw a `TypeError` exception.
6. If `O` does not have a `[[Iterator1]]` internal slot, throw a `TypeError` exception.
7. Assert: `O` is an object created and initialized by `CreateCompoundIterator`.
8. Let `state` be the value of `O`'s `[[State]]` internal slot.
9. If `state = 1`, then
 - a. Let `iterator1` be the value of `O`'s `[[Iterator1]]` internal slot.
 - b. Let `result1` be `IteratorStep(iterator1)`.
 - c. If `result1` is not `false`, then
 - i. Return `result1`.
 - d. Set `O`'s `[[State]]` internal slot to `2`.
10. Let `iterator2` be the value of `O`'s `[[Iterator2]]` internal slot.
11. Return `IteratorNext(iterator2)`.

NOTE A CompoundIterator `next` method will throw an exception if applied to any object other than the one with which it was originally associated.

8 Executable Code and Execution Contexts

8.1 Lexical Environments

A *Lexical Environment* is a specification type used to define the association of *Identifiers* to specific variables and functions based upon the lexical nesting structure of ECMAScript code. A Lexical Environment consists of an Environment Record and a possibly null reference to an outer Lexical Environment. Usually a Lexical Environment is associated with some specific syntactic structure of ECMAScript code such as a *FunctionDeclaration*, a *BlockStatement*, or a *Catch* clause of a *TryStatement* and a new Lexical Environment is created each time such code is evaluated.

An *Environment Record* records the identifier bindings that are created within the scope of its associated Lexical Environment.

The outer environment reference is used to model the logical nesting of Lexical Environment values. The outer reference of a (inner) Lexical Environment is a reference to the Lexical Environment that logically surrounds the inner Lexical Environment. An outer Lexical Environment may, of course, have its own outer Lexical Environment. A Lexical Environment may serve as the outer environment for multiple inner Lexical Environments. For example, if a *FunctionDeclaration* contains two nested *FunctionDeclarations* then the Lexical Environments of each of the nested functions will have as their outer Lexical Environment the Lexical Environment of the current evaluation of the surrounding function.

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Deleted: <#>Operations on Promise Objects

Promise Objects (25.4) serve as a place holder for the eventual result of a deferred (and possibly asynchronous) computation. Within this specification the adjective "eventual" mean a value or a Promise object that will ultimately resolves to the value. For example, "Returns an eventual String" is equivalent to "Returns either a String or a Promise object that will eventually resolves to a String". A "resolved value" is the final value of an "eventual value".
NOTE The Promise related abstract operations defined in this subclause are used by specification algorithms when they perform or respond to asynchronous operations. They ensure that the actual built-in Promise operations are used by the algorithms, even if ECMAScript code has modified the properties of %Promise% or %PromisePrototype%.
<#>PromiseNew (executor) Abstraction Operation

The abstract operation PromiseNew allocates and initializes a new built-in `promise` object for use by specification algorithm. The `executor` argument initiates the deferred computation.

<#>Let `promise` be
 AllocatePromise(%Promise%).
 <#>Return InitializePromise(`promise`, `executor`).
<#>PromiseBuiltInCapability () Abstraction Operation

The abstract operation PromiseNewCapability PromiseBuiltInCapability allocates a PromiseCapability record (25.4.1.1) for a builtin `promise` object for use by specification algorithm.

<#>Let `promise` be
 AllocatePromise(%Promise%).
 <#>Return
 CreatePromiseCapabilityRecord(`promise`, %Promise%).

NOTE This abstract operation is the same as the default built-in behaviour of

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<#>PromiseCatch (promise, rejectedAction) Abstraction Operation

A *global environment* is a Lexical Environment which does not have an outer environment. The global environment's outer environment reference is `null`. A global environment's environment record may be prepopulated with identifier bindings and includes an associated *global object* whose properties provide some of the global environment's identifier bindings. This global object is the value of a global environment's `this` binding. As ECMAScript code is executed, additional properties may be added to the global object and the initial properties may be modified.

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A *module environment* is a Lexical Environment that contains the bindings for the top level declarations of a *Module*. It also contains the bindings that are explicitly imported by the *Module*. The outer environment of a module environment is a global environment.

A *function environment* is a Lexical Environment that corresponds to the invocation of an ECMAScript function object. A *function environment* may establish a new `this` binding. A *function environment* also captures the state necessary to support `super` method invocations.

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Lexical Environments and Environment Record values are purely specification mechanisms and need not correspond to any specific artefact of an ECMAScript implementation. It is impossible for an ECMAScript program to directly access or manipulate such values.

8.1.1 Environment Records

There are two primary kinds of Environment Record values used in this specification: *declarative environment records* and *object environment records*. Declarative environment records are used to define the effect of ECMAScript language syntactic elements such as *FunctionDeclarations*, *VariableDeclarations*, and *Catch* clauses that directly associate identifier bindings with ECMAScript language values. Object environment records are used to define the effect of ECMAScript elements such as *WithStatement* that associate identifier bindings with the properties of some object. Global Environment Records and Function Environment Records are specializations that are used for specifically for *Script* global declarations and for top-level declarations within functions.

For specification purposes Environment Record values can be thought of as existing in a simple object-oriented hierarchy where Environment Record is an abstract class with three concrete subclasses, declarative environment record, object environment record, and global environment record. Function environment records and module environment records are subclasses of declarative environment record. The abstract class includes the abstract specification methods defined in Table 16. These abstract methods have distinct concrete algorithms for each of the concrete subclasses.

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Table 16 — Abstract Methods of Environment Records

Method	Purpose	Formatted Table
HasBinding(N)	Determine if an environment record has a binding for <u>the String value N</u> . Return true if it does and false if it does not.	Deleted: an identifier
CreateMutableBinding(N, D)	Create a new but uninitialized mutable binding in an environment record. The String value <u>N</u> is the text of the bound name. If the optional Boolean argument <u>D</u> is true the binding is may be subsequently deleted.	Deleted: . The String value <u>N</u> is the text of the identifier.
CreateImmutableBinding(N, S)	Create a new but uninitialized immutable binding in an environment record. The String value <u>N</u> is the text of the bound name. <u>If S is true then attempts to access the value of the binding before it is initialized or set it after it has been initialized will always throw an exception, regardless of the strict mode setting of operations that reference that binding. S is an optional parameter that defaults to false.</u>	Deleted: Formatted: Font: Bold
InitializeBinding(N,V)	Set the value of an already existing but uninitialized binding in an environment record. The String value <u>N</u> is the text of the bound name. <u>V</u> is the value for the binding and is a value of any ECMAScript language type.	
SetMutableBinding(N,V, S)	Set the value of an already existing mutable binding in an environment record. The String value <u>N</u> is the text of the bound name. <u>V</u> is the value for the binding and may be a value of any ECMAScript language type. <u>S</u> is a Boolean flag. If <u>S</u> is true and the binding cannot be set throw a TypeError exception.	
GetBindingValue(N,S)	Returns the value of an already existing binding from an environment record. The String value <u>N</u> is the text of the bound name. <u>S</u> is used to identify strict mode references. If <u>S</u> is true and the binding does not exist throw a ReferenceError exception. <u>If the binding exists but is uninitialized a ReferenceError is thrown, regardless of the value of S</u>	Deleted: <u>S</u> is used to identify strict mode references. Deleted: or is uninitialized Comment [AWB243]: Note that this isn't a breaking change from ES5 because in ES5 all immutable bindings were immediately initialized.
DeleteBinding(N)	Delete a binding from an environment record. The String value <u>N</u> is the text of the bound name. If a binding for <u>N</u> exists, remove the binding and return true . If the binding exists but cannot be removed return false . If the binding does not exist return true .	
HasThisBinding()	Determine if an environment record establishes a this binding. Return true if it does and false if it does not.	
HasSuperBinding()	Determine if an environment record establishes a super method binding. Return true if it does and false if it does not.	
WithBaseObject ()	If this environment record is associated with a with statement, return the with object. Otherwise, return undefined .	

8.1.1.1 Declarative Environment Records

Each declarative environment record is associated with an ECMAScript program scope containing variable, constant, let, class, module, import, and/or function declarations. A declarative environment record binds the set of identifiers defined by the declarations contained within its scope.

The behaviour of the concrete specification methods for Declarative Environment Records is defined by the following algorithms.

8.1.1.1.1 HasBinding(N)

The concrete environment record method `HasBinding` for declarative environment records simply determines if the argument identifier is one of the identifiers bound by the record:

1. Let `envRec` be the declarative environment record for which the method was invoked.
2. If `envRec` has a binding for the name that is the value of `N`, return `true`.
3. Return `false`.

8.1.1.1.2 CreateMutableBinding (N, D)

The concrete Environment Record method `CreateMutableBinding` for declarative environment records creates a new mutable binding for the name `N` that is uninitialized. A binding must not already exist in this Environment Record for `N`. If Boolean argument `D` is provided and has the value `true` the new binding is marked as being subject to deletion.

1. Let `envRec` be the declarative environment record for which the method was invoked.
2. Assert: `envRec` does not already have a binding for `N`.
3. Create a mutable binding in `envRec` for `N` and record that it is uninitialized. If `D` is `true` record that the newly created binding may be deleted by a subsequent `DeleteBinding` call.
4. Return `NormalCompletion(empty)`.

8.1.1.1.3 CreateImmutableBinding (N, S)

The concrete Environment Record method `CreateImmutableBinding` for declarative environment records creates a new immutable binding for the name `N` that is uninitialized. A binding must not already exist in this environment record for `N`. If Boolean argument `S` is provided and has the value `true` the new binding is marked as a strict binding.

1. Let `envRec` be the declarative environment record for which the method was invoked.
2. Assert: `envRec` does not already have a binding for `N`.
3. Create an immutable binding in `envRec` for `N` and record that it is uninitialized. If `S` is `true` record that the newly created binding is a strict binding.
4. Return `NormalCompletion(empty)`.

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8.1.1.1.4 InitializeBinding (N,V)

The concrete Environment Record method `InitializeBinding` for declarative environment records is used to set the bound value of the current binding of the identifier whose name is the value of the argument `N` to the value of argument `V`. An uninitialized binding for `N` must already exist.

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1. Let `envRec` be the declarative environment record for which the method was invoked.
2. Assert: `envRec` must have an uninitialized binding for `N`.
3. Set the bound value for `N` in `envRec` to `V`.
4. Record that the binding for `N` in `envRec` has been initialized.
5. Return `NormalCompletion(empty)`.

8.1.1.1.5 SetMutableBinding (N,V,S)

The concrete Environment Record method SetMutableBinding for declarative environment records attempts to change the bound value of the current binding of the identifier whose name is the value of the argument *N* to the value of argument *V*. A binding for *N* normally already exist, but in rare cases it may not. If the binding is an immutable binding, a **TypeError** is thrown if *S* is **true**.

1. Let *envRec* be the declarative environment record for which the method was invoked.
2. If *envRec* does not have a binding for *N*, then
 - a. If *S* is **true** throw a **ReferenceError** exception.
 - b. Call the CreateMutableBinding concrete method of *envRec* with arguments *N* and **true**.
 - c. Call the InitializeBinding concrete method of *envRec* with arguments *N* and *V*.
 - d. Return NormalCompletion(empty).
3. If the binding for *N* in *envRec* is a strict binding, let *S* be **true**.
4. If the binding for *N* in *envRec* has not yet been initialized throw a **ReferenceError** exception.
5. Else if the binding for *N* in *envRec* is a mutable binding, change its bound value to *V*.
6. Else this must be an attempt to change the value of an immutable binding so if *S* is **true** throw a **TypeError** exception.
7. Return NormalCompletion(empty).

NOTE An example of ECMAScript code that results in a missing binding at step 2 is:

```
function f() {eval("var x; x = (delete x, 0);")}
```

8.1.1.1.6 GetBindingValue(N,S)

The concrete Environment Record method GetBindingValue for declarative environment records simply returns the value of its bound identifier whose name is the value of the argument *N*. If the binding exists but is uninitialized a **ReferenceError** is thrown, regardless of the value of *S*.

1. Let *envRec* be the declarative environment record for which the method was invoked.
2. Assert: *envRec* has a binding for *N*.
3. If the binding for *N* in *envRec* is an uninitialized binding, throw a **ReferenceError** exception.
4. Return the value currently bound to *N* in *envRec*.

8.1.1.1.7 DeleteBinding (N)

The concrete Environment Record method DeleteBinding for declarative environment records can only delete bindings that have been explicitly designated as being subject to deletion.

1. Let *envRec* be the declarative environment record for which the method was invoked.
2. If *envRec* does not have a binding for the name that is the value of *N*, return **true**.
3. If the binding for *N* in *envRec* cannot be deleted, return **false**.
4. Remove the binding for *N* from *envRec*.
5. Return **true**.

8.1.1.1.8 HasThisBinding ()

Regular Declarative Environment Records do not provide a **this** binding.

1. Return **false**.

8.1.1.1.9 HasSuperBinding ()

Regular Declarative Environment Records do not provide a **super** binding.

1. Return **false**.

8.1.1.1.10 WithBaseObject()

Declarative Environment Records always return **undefined** as their WithBaseObject.

1. Return **undefined**.

8.1.1.2 Object Environment Records

Each object environment record is associated with an object called its *binding object*. An object environment record binds the set of string identifier names that directly correspond to the property names of its binding object. Property keys that are not strings in the form of an *IdentifierName* are not included in the set of bound identifiers. Both own and inherited properties are included in the set regardless of the setting of their **[[Enumerable]]** attribute. Because properties can be dynamically added and deleted from objects, the set of identifiers bound by an object environment record may potentially change as a side-effect of any operation that adds or deletes properties. Any bindings that are created as a result of such a side-effect are considered to be a mutable binding even if the **Writable** attribute of the corresponding property has the value **false**. Immutable bindings do not exist for object environment records.

Object environment records created for **with** statements (13.10) can provide their binding object as an implicit this value for use in function calls. The capability is controlled by a **withEnvironment** Boolean value that is associated with each object environment record. By default, the value of **withEnvironment** is **false** for any object environment record.

The behaviour of the concrete specification methods for Object Environment Records is defined by the following algorithms.

8.1.1.2.1 HasBinding(N)

The concrete Environment Record method **HasBinding** for object environment records determines if its associated binding object has a property whose name is the value of the argument **N**:

1. Let **envRec** be the object environment record for which the method was invoked.
2. Let **bindings** be the binding object for **envRec**.
3. Let **foundBinding** be **HasProperty(bindings, N)**.
4. **ReturnIfAbrupt(foundBinding)**.
5. If **foundBinding** is **false**, return **false**.
6. If the **withEnvironment** flag of **envRec** is **false**, return **true**.
7. Let **unscopables** be **Get(bindings, @@unscopables)**.
8. **ReturnIfAbrupt(unscopables)**.
9. If **Type(unscopables)** is **Object**, then
 - a. Let **blocked** be **Get(unscopables, N)**.
 - b. **ReturnIfAbrupt(blocked)**.
 - c. If **ToBoolean(blocked)** is **true**, return **false**.
10. Return **true**.

8.1.1.2.2 CreateMutableBinding (N, D)

The concrete Environment Record method **CreateMutableBinding** for object environment records creates in an environment record's associated binding object a property whose name is the String value and initializes it to the value **undefined**. If Boolean argument **D** is provided and has the value **true** the new property's **[[Configurable]]** attribute is set to **true**, otherwise it is set to **false**.

Deleted: Object environment records also have a possibly empty List of strings called **unscopables**. The strings in this List are excluded from the environment records set of bound names, regardless of whether or not they exist as property keys of its binding object.¶

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Deleted: **blocked** is not **undefined**

Deleted: , then return

Deleted: <#> Repeat, while **bindings** is not **null**.¶
 <#> Let **hasOwn** be **HasOwnProperty(bindings, N)**.¶

<#> **ReturnIfAbrupt(hasOwn)**.¶
 <#> If **hasOwn** is **true**, then
 <#> Let **hasUnscopables** be **HasOwnProperty(bindings, @@unscopables)**.¶
 <#> **ReturnIfAbrupt(hasUnscopables)**.¶
 <#> If **hasUnscopables** is **false**, then return **true**.¶

<#> Let **unscopables** be **Get(bindings, @@unscopables)**.¶
 <#> **ReturnIfAbrupt(unscopables)**.¶
 <#> If **Type(unscopables)** is not **Object**, then return **true**.¶

<#> Let **isBlocked** be **HasOwnProperty(unscopables, N)**.¶
 <#> **ReturnIfAbrupt(isBlocked)**.¶
 <#> If **isBlocked** is **false**, then return **true**.¶
 <#> Let **bindings** be the result of calling the **[[GetPrototypeOf]]** internal method of **bindings** with no arguments.¶
 <#> **ReturnIfAbrupt(bindings)**.¶

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Deleted: **false**

Deleted: the result of **HasProperty(bindings, N)**

1. Let *envRec* be the object environment record for which the method was invoked.
2. Let *bindings* be the binding object for *envRec*.
3. If *D* is **true** then let *configValue* be **true** otherwise let *configValue* be **false**.
4. Return *DefinePropertyOrThrow(bindings, N, PropertyDescriptor{[[Value]]:**undefined**, [[Writable]]:**true**, [[Enumerable]]: **true**, [[Configurable]]: *configValue*})*.

NOTE Normally *envRec* will not have a binding for *N* but if it does, the semantics of *DefinePropertyOrThrow* may result in an existing binding being replaced or shadowed or cause an abrupt completion to be returned.

8.1.1.2.3 **CreateImmutableBinding (N, S)**

The concrete Environment Record method *CreateImmutableBinding* is never used within this specification in association with Object environment records.

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8.1.1.2.4 **InitializeBinding (N,V)**

The concrete Environment Record method *InitializeBinding* for object environment records is used to set the bound value of the current binding of the identifier whose name is the value of the argument *N* to the value of argument *V*. An uninitialized binding for *N* must already exist.

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1. Let *envRec* be the object environment record for which the method was invoked.
2. Assert: *envRec* must have an uninitialized binding for *N*.
3. Record that the binding for *N* in *envRec* has been initialized.
4. Return the result of calling the *SetMutableBinding* concrete method of *envRec* with *N*, *V*, and **false** as arguments.

8.1.1.2.5 **SetMutableBinding (N,V,S)**

The concrete Environment Record method *SetMutableBinding* for object environment records attempts to set the value of the environment record's associated binding object's property whose name is the value of the argument *N* to the value of argument *V*. A property named *N* normally already exists but if it does not or is not currently writable, error handling is determined by the value of the Boolean argument *S*.

1. Let *envRec* be the object environment record for which the method was invoked.
2. Let *bindings* be the binding object for *envRec*.
3. Return *Put(bindings, N, V, and S)*.

8.1.1.2.6 **GetBindingValue(N,S)**

The concrete Environment Record method *GetBindingValue* for object environment records returns the value of its associated binding object's property whose name is the String value of the argument identifier *N*. The property should already exist but if it does not the result depends upon the value of the *S* argument:

1. Let *envRec* be the object environment record for which the method was invoked.
2. Let *bindings* be the binding object for *envRec*.
3. Let *value* be *HasProperty(bindings, N)*.
4. ReturnIfAbrupt(*value*).
5. If *value* is **false**, then
 - a. If *S* is **false**, return the value **undefined**, otherwise throw a **ReferenceError** exception.
6. Return *Get(bindings, N)*.

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Deleted: <#>Let *bindings* be *bindingThis*.¶
 <#>Repeat, while *bindings* is not **null**.¶
 <#>Let *hasOwn* be *HasOwnProperty(bindings, N)*.¶
 <#>ReturnIfAbrupt(*hasOwn*).¶
 <#>If *hasOwn* is **true**, then¶
 <#>Let *hasUnscopables* be *HasOwnProperty(bindings, @@unscopables)*.¶
 <#>ReturnIfAbrupt(*hasUnscopables*).¶
 <#>Let *isBlocked* be **false**.¶
 <#>If *hasUnscopables* is **true**, then¶
 <#>Let *unscopables* be *Get(bindings, @@unscopables)*.¶
 <#>ReturnIfAbrupt(*unscopables*).¶
 <#>If *Type(unscopables)* is **Object**, then¶
 <#>Let *isBlocked* be
HasOwnProperty(unscopables, N).¶
 <#>ReturnIfAbrupt(*isBlocked*).¶
 <#>If *isBlocked* is **false**, then¶
 <#>Return the result of calling the **[[Get]]** internal method of *bindings* with arguments,
N and *bindingThis*).¶
 <#>Let *bindings* be the result of calling the
[[GetPrototypeOf]] internal method of *bindings* with no arguments.¶
 <#>ReturnIfAbrupt(*bindings*).¶

Deleted: Let *value* be *HasProperty(bindings, N)*.¶
 <#>ReturnIfAbrupt(*value*).¶
 <#>If *value* is **false**, then¶

8.1.1.2.7 DeleteBinding (N)

The concrete Environment Record method `DeleteBinding` for object environment records can only delete bindings that correspond to properties of the environment object whose `[[Configurable]]` attribute have the value `true`.

1. Let `envRec` be the object environment record for which the method was invoked.
2. Let `bindings` be the binding object for `envRec`.
3. Return the result of calling the `[[Delete]]` internal method of `bindings` passing `N` as the argument.

8.1.1.2.8 HasThisBinding ()

Regular Object Environment Records do not provide a `this` binding.

1. Return `false`.

8.1.1.2.9 HasSuperBinding ()

Regular Object Environment Records do not provide a `super` binding.

1. Return `false`.

8.1.1.2.10 WithBaseObject()

Object Environment Records return `undefined` as their `WithBaseObject` unless their `withEnvironment` flag is `true`.

1. Let `envRec` be the object environment record for which the method was invoked.
2. If the `withEnvironment` flag of `envRec` is `true`, return the binding object for `envRec`.
3. Otherwise, return `undefined`.

8.1.1.3 Function Environment Records

A function environment record is a declarative environment record that is used to represent the `top-level` scope of a function and, if the function is not an `ArrowFunction`, provides a `this` binding. If a function is not an `ArrowFunction` function and references `super`, its function environment record also contains the state that is used to perform `super` method invocations from within the function.

Function-environment records have the additional state `fields` listed in Table 17.

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Table 17 — Additional **Fields** of Function Environment Records

<u>Component</u>	<u>Purpose</u>
<code>[[thisValue]]</code>	If the value is empty , this is an <i>ArrowFunction</i> and does not have a local <code>this</code> value. Otherwise, this is the <code>this</code> value used for this invocation of the function.
<code>[[thisInitializationState]]</code>	If false , the <code>[[thisValue]]</code> field has not yet been initialized, otherwise true .
<code>[[FunctionObject]]</code>	The Function Object whose invocation caused this environment record to be created.
<code>[[HomeObject]]</code>	If the associated function <u>has super property accesses</u> and is not an <i>ArrowFunction</i> , <code>[[HomeObject]]</code> is the object that the function is bound to as a <u>method</u> . The default value for <code>[[HomeObject]]</code> is undefined .
<code>[[NewTarget]]</code>	If this environment record was created by the <code>[[Construct]]</code> internal method, <code>[[NewTarget]]</code> is the value of the <code>[[Construct]] newTarget</code> parameter. Otherwise, its value is undefined .
<code>[[topLex]]</code>	The lexical environment record that contains the <u>bindings for lexical declarations</u> that occur <u>at the top-level</u> of the function. For strict mode functions, this is the same as current function environment record.

Function environment records support all of Declarative Environment Record methods listed in Table 16 and share the same specifications for all of those methods except for `HasThisBinding` and `HasSuperBinding`. In addition, **Function Environment Records** support the methods listed in Table 18:

Table 18.— Additional Methods of Function Environment Records

<u>Method</u>	<u>Purpose</u>
<code>BindThisValue(V)</code>	Set the <code>[[thisValue]]</code> and record that it has been initialized.
<code>GetThisBinding()</code>	Return the value of this environment record's <code>this</code> binding.
<code>GetSuperBase()</code>	Return the object that is the base for <code>super</code> property accesses bound in this environment record. The object is derived from this environment record's <code>[[HomeObject]]</code> field. The value undefined indicates that <code>super</code> property accesses will produce runtime errors.

The behaviour of the additional concrete specification methods for Function Environment Records is defined by the following algorithms:

8.1.1.3.1 `BindThisValue(V)`

1. Let `envRec` be the function environment record for which the method was invoked.
2. Assert: `envRec.[[thisInitializationState]]` is **false**.
3. Set `envRec.[[thisValue]]` to `V`.
4. If `envRec.[[thisInitializationState]]` is **true**, throw a **ReferenceError** exception.
5. Set `envRec.[[thisInitializationState]]` to **true**.
6. Return `V`.

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Deleted: Function environment records store their `this` binding as the value of their `thisValue`. If the associated function references `super`, the environment record stores in `HomeObject` the object that the function is bound to as a method and in `MethodName` the property key used for unqualified `super` invocations from within the function. The default value for `HomeObject` and `MethodName` is **undefined**.¶

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8.1.1.3.2 HasThisBinding ()

1. Let `envRec` be the function environment record for which the method was invoked.
2. If `envRec.[[thisValue]]` has the value empty, return false; otherwise, return true.

8.1.1.3.3 HasSuperBinding ()

1. Let `envRec` be the function environment record for which the method was invoked.
2. If `envRec.[[thisValue]]` has the value empty, return false.
3. If `envRec.[[HomeObject]]` has the value `undefined`, return false; otherwise, return true.

8.1.1.3.4 GetThisBinding ()

1. Let `envRec` be the function environment record for which the method was invoked.
2. If `envRec.[[thisInitializationState]]` is false, throw a `ReferenceError` exception.
3. Return `envRec.[[thisValue]]`.

8.1.1.3.5 GetSuperBase ()

1. Let `envRec` be the function environment record for which the method was invoked.
2. Let `home` be the value of `envRec.[[HomeObject]]`.
3. If `home` has the value `undefined`, return `undefined`.
4. Assert: `Type(home)` is Object.
5. Return the result of calling `home`'s `[[GetPrototypeOf]]` internal method.

8.1.1.4 Global Environment Records

A global environment record is used to represent the outer most scope that is shared by all of the ECMAScript *Script* elements that are processed in a common Realm (8.2). A global environment record provides the bindings for built-in globals (clause 18), properties of the global object, and for all declarations that are not function code and that occur within *Script* productions.

A global environment record is logically a single record but it is specified as a composite encapsulating an object environment record and a declarative environment record. The object environment record has as its base object the global object of the associated Realm. This global object is also the value of the global environment record's `GetThisBinding` concrete method. The object environment record component of a global environment record contains the bindings for all built-in globals (clause 18) and all bindings introduced by a *FunctionDeclaration*, *GeneratorDeclaration*, or *VariableStatement* contained in global code. The bindings for all other ECMAScript declarations in global code are contained in the declarative environment record component of the global environment record.

Properties may be created directly on a global object. Hence, the object environment record component of a global environment record may contain both bindings created explicitly by *FunctionDeclaration*, *GeneratorDeclaration*, or *VariableDeclaration* declarations and binding created implicitly as properties of the global object. In order to identify which bindings were explicitly created using declarations, a global environment record maintains a list of the names bound using its `CreateGlobalVarBindings` and `CreateGlobalFunctionBindings` concrete methods.

Global environment records have the additional `fields` listed in Table 19, and the additional methods listed in Table 20.

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Table 19.—Fields of Global Environment Records

Component	Purpose
<code>[[ObjectRecord]]</code>	An Object Environment Record whose base object is the global object. It contains global built-in bindings as well as <i>FunctionDeclaration</i> , <i>GeneratorDeclaration</i> , and <i>VariableDeclaration</i> bindings in global code for the associated Realm.
<code>[[DeclarativeRecord]]</code>	A Declarative Environment Record that contains bindings for all declarations in global code for the associated Realm code except for <i>FunctionDeclaration</i> , <i>GeneratorDeclaration</i> , and <i>VariableDeclaration</i> bindings.
<code>[[VarNames]]</code>	A List containing the string names bound by <i>FunctionDeclaration</i> , <i>GeneratorDeclaration</i> , and <i>VariableDeclaration</i> declarations in global code for the associated Realm.

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Table 20.—Additional Methods of Global Environment Records

Method	Purpose
<code>GetThisBinding()</code>	Return the value of this environment record's <code>this</code> binding.
<code>HasVarDeclaration(N)</code>	Determines if the argument identifier has a binding in this environment record that was created using a <i>VariableDeclaration</i> , <i>FunctionDeclaration</i> , or <i>GeneratorDeclaration</i> .
<code>HasLexicalDeclaration(N)</code>	Determines if the argument identifier has a binding in this environment record that was created using a lexical declaration such as a <i>LexicalDeclaration</i> or a <i>ClassDeclaration</i> .
<code>HasRestrictedGlobalProperty(N)</code>	Determines if the argument is the name of a global object property that may not be shadowed by a global lexically binding.
<code>CanDeclareGlobalVar(N)</code>	Determines if a corresponding <code>CreateGlobalVarBinding</code> call would succeed if called for the same argument <i>N</i> .
<code>CanDeclareGlobalFunction(N)</code>	Determines if a corresponding <code>CreateGlobalFunctionBinding</code> call would succeed if called for the same argument <i>N</i> .
<code>CreateGlobalVarBinding(N, D)</code>	Used to create global <code>var</code> bindings in the <code>[[ObjectRecord]]</code> component of a global environment record. The binding will be a mutable binding. The corresponding global object property will have attribute values appropriate for a <code>var</code> . The String value <i>N</i> is bound name. If <i>D</i> is true the binding may be subsequently deleted. This is logically equivalent to <code>CreateMutableBinding</code> but it allows var declarations to receive special treatment.
<code>CreateGlobalFunctionBinding(N, V, D)</code>	Used to create and initialize global <code>function</code> bindings in the <code>[[ObjectRecord]]</code> component of a global environment record. The binding will be a mutable binding. The corresponding global object property will have attribute values appropriate for a <code>function</code> . The String value <i>N</i> is the text of the bound name. <i>V</i> is the initial value of the binding. If the optional Boolean argument <i>D</i> is true the binding is may be subsequently deleted. This is logically equivalent to <code>CreateMutableBinding</code> followed by a <code>SetMutableBinding</code> but it allows function declarations to receive special treatment.

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The behaviour of the concrete specification methods for Global Environment Records is defined by the following algorithms.

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8.1.1.4.1 HasBinding(N)

The concrete environment record method HasBinding for global environment records simply determines if the argument identifier is one of the identifiers bound by the record:

1. Let *envRec* be the global environment record for which the method was invoked.
2. Let *DclRec* be *envRec*.[[DeclarativeRecord]].
3. If the result of calling *DclRec*'s HasBinding concrete method with argument *N* is **true**, return **true**.
4. Let *ObjRec* be *envRec*.[[ObjectRecord]].
5. Return the result of calling *ObjRec*'s HasBinding concrete method with argument *N*.

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8.1.1.4.2 CreateMutableBinding (N, D)

The concrete environment record method CreateMutableBinding for global environment records creates a new mutable binding for the name *N* that is uninitialized. The binding is created in the associated DeclarativeRecord. A binding for *N* must not already exist in the DeclarativeRecord. If Boolean argument *D* is provided and has the value **true** the new binding is marked as being subject to deletion.

1. Let *envRec* be the global environment record for which the method was invoked.
2. Let *DclRec* be *envRec*.[[DeclarativeRecord]].
3. Let *alreadyThere* be the result of calling the HasBinding concrete method of *DclRec* with argument *N*.
4. ReturnIfAbrupt(*alreadyThere*).
5. If *alreadyThere* is **true**, throw a **TypeError** exception.
6. Return the result of calling the CreateMutableBinding concrete method of *DclRec* with arguments *N* and *D*.

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8.1.1.4.3 CreateImmutableBinding (N, S)

The concrete Environment Record method CreateImmutableBinding for global environment records creates a new immutable binding for the name *N* that is uninitialized. A binding must not already exist in this environment record for *N*. If Boolean argument *S* is provided and has the value **true** the new binding is marked as a strict binding.

1. Let *envRec* be the global environment record for which the method was invoked.
2. Let *DclRec* be *envRec*.[[DeclarativeRecord]].
3. Let *alreadyThere* be the result of calling the HasBinding concrete method of *DclRec* with argument *N*.
4. ReturnIfAbrupt(*alreadyThere*).
5. If *alreadyThere* is **true**, throw a **TypeError** exception.
6. Return the result of calling the CreateImmutableBinding concrete method of *DclRec* with argument *N* and *S*.

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8.1.1.4.4 InitializeBinding (N,V)

The concrete Environment Record method InitializeBinding for global environment records is used to set the bound value of the current binding of the identifier whose name is the value of the argument *N* to the value of argument *V*. An uninitialized binding for *N* must already exist.

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3. If the result of calling *DclRec*'s HasBinding concrete method with argument *N* is **true**, then
 - a. Return the result of calling *DclRec*'s InitializeBinding concrete method with arguments *N* and *V*.
4. Assert: If the binding exists it must be in the object environment record.
5. Let *ObjRec* be *envRec*.[\[\[ObjectRecord\]\]](#).
6. Return the result of calling *ObjRec*'s InitializeBinding concrete method with arguments *N* and *V*.

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8.1.1.4.5 SetMutableBinding (N,V,S)

The concrete Environment Record method SetMutableBinding for global environment records attempts to change the bound value of the current binding of the identifier whose name is the value of the argument *N* to the value of argument *V*. If the binding is an immutable binding, a **TypeError** is thrown if *S* is **true**. A property named *N* normally already exists but if it does not or is not currently writable, error handling is determined by the value of the Boolean argument *S*.

1. Let *envRec* be the [global](#) environment record for which the method was invoked.
2. Let *DclRec* be *envRec*.[\[\[DeclarativeRecord\]\]](#).
3. If the result of calling *DclRec*'s HasBinding concrete method with argument *N* is **true**, then
 - a. Return the result of calling the SetMutableBinding concrete method of *DclRec* with arguments *N*, *V*, and *S*.
4. Let *ObjRec* be *envRec*.[\[\[ObjectRecord\]\]](#).
5. Return the result of calling the SetMutableBinding concrete method of *ObjRec* with arguments *N*, *V*, and *S*.

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8.1.1.4.6 GetBindingValue(N,S)

The concrete Environment Record method GetBindingValue for global environment records returns the value of its bound identifier whose name is the value of the argument *N*. If the binding is an uninitialized binding throw a **ReferenceError** exception. A property named *N* normally already exists but if it does not or is not currently writable, error handling is determined by the value of the Boolean argument *S*.

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1. Let *envRec* be the [global](#) environment record for which the method was invoked.
2. Let *DclRec* be *envRec*.[\[\[DeclarativeRecord\]\]](#).
3. If the result of calling *DclRec*'s HasBinding concrete method with argument *N* is **true**, then
 - a. Return the result of calling the GetBindingValue concrete method of *DclRec* with arguments *N* and *S*.
4. Let *ObjRec* be *envRec*.[\[\[ObjectRecord\]\]](#).
5. Return the result of calling the GetBindingValue concrete method of *ObjRec* with arguments *N*, and *S*.

8.1.1.4.7 DeleteBinding (N)

The concrete Environment Record method DeleteBinding for global environment records can only delete bindings that have been explicitly designated as being subject to deletion.

1. Let *envRec* be the [global](#) environment record for which the method was invoked.
2. Let *DclRec* be *envRec*.[\[\[DeclarativeRecord\]\]](#).
3. If the result of calling *DclRec*'s HasBinding concrete method with argument *N* is **true**, then
 - a. Return the result of calling the DeleteBinding concrete method of *DclRec* with argument *N*.
4. Let *ObjRec* be *envRec*.[\[\[ObjectRecord\]\]](#).
5. If the result of calling *ObjRec*'s HasBinding concrete method with argument *N* is **true**, then
 - a. Let *status* be the result of calling the DeleteBinding concrete method of *ObjRec* with argument *N*.
 - b. ReturnIfAbrupt(*status*).

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- c. If *status* is **true**, then
 - i. Let *varNames* be *envRec.[[VarNames]]* List.
 - ii. If *N* is an element of *varNames*, remove that element from the *varNames*.
 - d. Return *status*.
- 6. Return **true**.

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8.1.1.4.8 **HasThisBinding ()**

Global Environment Records always provide a **this** binding whose value is the associated global object.

1. Return **true**.

8.1.1.4.9 **HasSuperBinding ()**

1. Return **false**.

8.1.1.4.10 **WithBaseObject()**

Global Environment Records always return **undefined** as their WithBaseObject.

1. Return **undefined**.

8.1.1.4.11 **GetThisBinding ()**

1. Let *envRec* be the global environment record for which the method was invoked.
2. Let *ObjRec* be *envRec.[[ObjectRecord]]*.
3. Let *bindings* be the binding object for *ObjRec*.
4. Return *bindings*.

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8.1.1.4.12 **HasVarDeclaration (N)**

The concrete environment record method HasVarDeclaration for global environment records determines if the argument identifier has a binding in this record that was created using a *VariableStatement* or a *FunctionDeclaration*:

1. Let *envRec* be the global environment record for which the method was invoked.
2. Let *varDeclaredNames* be *envRec.[[VarNames]]*.
3. If *varDeclaredNames* contains the value of *N*, return **true**.
4. Return **false**.

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8.1.1.4.13 **HasLexicalDeclaration (N)**

The concrete environment record method HasLexicalDeclaration for global environment records determines if the argument identifier has a binding in this record that was created using a lexical declaration such as a *LexicalDeclaration* or a *ClassDeclaration*:

1. Let *envRec* be the global environment record for which the method was invoked.
2. Let *DclRec* be *envRec.[[DeclarativeRecord]]*.
3. Return the result of calling *DclRec*'s HasBinding concrete method with argument *N*.

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8.1.1.4.14 HasRestrictedGlobalProperty (N)

The concrete environment record method `HasRestrictedGlobalProperty` for global environment records determines if the argument identifier is the name of a property of the global object that must not be shadowed by a global lexically binding:

1. Let `envRec` be the global environment record for which the method was invoked.
2. Let `ObjRec` be `envRec.[[ObjectRecord]]`.
3. Let `globalObject` be the binding object for `ObjRec`.
4. Let `existingProp` be the result of calling the `[[GetOwnProperty]]` internal method of `globalObject` with argument `N`.
5. `ReturnIfAbrupt(existingProp)`.
6. If `existingProp` is `undefined`, return `false`.
7. If `existingProp.[[Configurable]]` is `true`, return `false`.
8. Return `true`.

NOTE Properties may exist upon a global object that were directly created rather than being declared using a `var` or function declaration. A global lexical binding may not be created that has the same name as a non-configurable property of the global object. The global property `undefined` is an example of such a property.

8.1.1.4.15 CanDeclareGlobalVar (N)

The concrete environment record method `CanDeclareGlobalVar` for global environment records determines if a corresponding `CreateGlobalVarBinding` call would succeed if called for the same argument `N`. Redundant var declarations and var declarations for pre-existing global object properties are allowed.

1. Let `envRec` be the global environment record for which the method was invoked.
2. Let `ObjRec` be `envRec.[[ObjectRecord]]`.
3. If the result of calling `ObjRec`'s `HasBinding` concrete method with argument `N` is `true`, return `true`.
4. Let `bindings` be the binding object for `ObjRec`.
5. Let `extensible` be `IsExtensible(bindings)`.
6. Return `extensible`.

8.1.1.4.16 CanDeclareGlobalFunction (N)

The concrete environment record method `CanDeclareGlobalFunction` for global environment records determines if a corresponding `CreateGlobalFunctionBinding` call would succeed if called for the same argument `N`.

1. Let `envRec` be the global environment record for which the method was invoked.
2. Let `ObjRec` be `envRec.[[ObjectRecord]]`.
3. Let `globalObject` be the binding object for `ObjRec`.
4. Let `extensible` be `IsExtensible(globalObject)`.
5. `ReturnIfAbrupt(extensible)`.
6. If the result of calling `ObjRec`'s `HasBinding` concrete method with argument `N` is `false`, return `extensible`.
7. Let `existingProp` be the result of calling the `[[GetOwnProperty]]` internal method of `globalObject` with argument `N`.
8. `ReturnIfAbrupt(existingProp)`.
9. If `existingProp` is `undefined`, return `extensible`.
10. If `existingProp.[[Configurable]]` is `true`, return `true`.
11. If `IsDataDescriptor(existingProp)` is `true` and `existingProp` has attribute values `[[Writable]]: true, [[Enumerable]]: true`, return `true`.

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12. Return **false**.

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8.1.1.4.17 CreateGlobalVarBinding (N, D)

The concrete Environment Record method CreateGlobalVarBinding for global environment records creates a mutable binding in the associated object environment record and records the bound name in the associated [[VarNames]] List. If a binding already exists, it is reused.

1. Let *envRec* be the global environment record for which the method was invoked.
2. Let *ObjRec* be *envRec*.[[ObjectRecord]].
3. If the result of calling *ObjRec*'s HasBinding concrete method with argument *N* is **false**, then
 - a. Let *status* be the result of calling the CreateMutableBinding concrete method of *ObjRec* with arguments *N* and *D*.
 - b. ReturnIfAbrupt(*status*).
4. Let *varDeclaredNames* be *envRec*.[[VarNames]].
5. If *varDeclaredNames* does not contain the value of *N*, then
 - a. Append *N* to *varDeclaredNames*.
6. Return NormalCompletion(empty).

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8.1.1.4.18 CreateGlobalFunctionBinding (N, V, D)

The concrete Environment Record method CreateGlobalFunctionBinding for global environment records creates a mutable binding in the associated object environment record and records the bound name in the associated [[VarNames]] List. If a binding already exists, it is replaced.

1. Let *envRec* be the global environment record for which the method was invoked.
2. Let *ObjRec* be *envRec*.[[ObjectRecord]].
3. Let *globalObject* be the binding object for *ObjRec*.
4. Let *existingProp* be the result of calling the [[GetOwnProperty]] internal method of *globalObject* with argument *N*.
5. ReturnIfAbrupt(existingProp).
6. If *existingProp* is undefined or *existingProp*.[[Configurable]] is **true**, then
 - a. Let *desc* be the PropertyDescriptor{[[Value]]:*V*, [[Writable]]: **true**, [[Enumerable]]: **true**, [[Configurable]]: *D*}.
7. Else,
 - a. Let *desc* be the PropertyDescriptor{[[Value]]:*V* }.
8. Let *status* be DefinePropertyOrThrow(*globalObject*, *N*, *desc*).
9. ReturnIfAbrupt(*status*).
10. Let *varDeclaredNames* be *envRec*.[[VarNames]].
11. If *varDeclaredNames* does not contain the value of *N*, then
 - a. Append *N* to *varDeclaredNames*.
12. Return NormalCompletion(empty).

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NOTE Global function declarations are always represented as own properties of the global object. If possible, an existing own property is reconfigured to have a standard set of attribute values.

8.1.1.5 Module Environment Records

A module environment record is a declarative environment record that is used to represent the outer scope of an ECMAScript Module. In addition to normal mutable and immutable bindings, module environment records also provide immutable import bindings which are bindings that provide indirect access to a target binding that exists in another environment record.

Module environment records support all of the Declarative Environment Record methods listed in Table 16 and share the same specifications for all of those methods except for GetBindingValue, DeleteBinding, HasThisBinding and GetThisBinding. In addition, module environment records support the methods listed in Table 21:

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Table 21 — Additional Methods of Module Environment Records

<u>Method</u>	<u>Purpose</u>
<u>CreateImportBinding(N, M, N2)</u>	Create an <u>immutable</u> , indirect binding in a module environment record. The String value <u>N</u> is the text of the bound name. <u>M</u> is a Module Record (see 15.2.1.15), and <u>N2</u> is a binding that exists in <u>M</u> 's module environment record.
<u>GetThisBinding()</u>	Return the value of this environment record's <u>this</u> binding.

The behaviour of the additional concrete specification methods for Module Environment Records is defined by the following algorithms:

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8.1.1.5.1 GetBindingValue(N,S)

The concrete Environment Record method GetBindingValue for module environment records returns the value of its bound identifier whose name is the value of the argument N. However, if the binding is an indirect binding the value of the target binding is returned. If the binding exists but is uninitialized a ReferenceError is thrown, regardless of the value of S.

1. Let envRec be the module environment record for which the method was invoked.
2. Assert: envRec has a binding for N.
3. If the binding for N is an indirect binding, then
 - a. Assert: M and N2 are the indirection values provided when this binding for N was created.
 - b. Let targetER be M.[[Environment]]'s environment record.
 - c. Return the result of calling the GetBindingValue concrete method of targetER with arguments N2 and S.
4. If the binding for N in envRec is an uninitialized binding, throw a ReferenceError exception.
5. Return the value currently bound to N in envRec.

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NOTE Because a Module is always strict mode code, calls to GetBindingValue should always pass true as the value of S.

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8.1.1.5.2 DeleteBinding (N)

The concrete Environment Record method DeleteBinding for module environment records refuses to delete bindings.

1. Let envRec be the module environment record for which the method was invoked.
2. If envRec does not have a binding for the name that is the value of N, return true.
3. Return false.

NOTE Because the bindings of a module environment record are not deletable.

8.1.1.5.3 HasThisBinding ()

Module Environment Records provide a this binding.

1. Return true.

8.1.1.5.4 GetThisBinding()

1. Return **undefined**.

8.1.1.5.5 CreateImportBinding (N, M, N2)

The concrete Environment Record method `CreateImportBinding` for module environment records creates a new initialized immutable indirect binding for the name *N*. A binding must not already exist in this environment record for *N*. *M* is a Module Record (see 15.2.1.15), and *N2* is the name of a binding that exists in *M*'s module environment record. Accesses to the value of the new binding will indirectly access the bound value of value of the target binding.

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1. Let *envRec* be the module environment record for which the method was invoked.
2. Assert: *envRec* does not already have a binding for *N*.
3. Assert: *M* is a Module Record.
4. Assert: **When *M*.[[Environment]] is instantiated it will have a direct binding for *N2*.**
5. Create an immutable indirect binding in *envRec* for *N* that references *M* and *N2* as its target binding and record that the binding is initialized.
6. Return NormalCompletion(empty).

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8.1.2 Lexical Environment Operations

The following abstract operations are used in this specification to operate upon lexical environments:

8.1.2.1 GetIdentifierReference (lex, name, strict) **Abstract Operation**

The abstract operation `GetIdentifierReference` is called with a Lexical Environment *lex*, a String *name*, and a Boolean flag *strict*. The value of *lex* may be **null**. When called, the following steps are performed:

1. If *lex* is the value **null**, then
 - a. Return a value of type Reference whose base value is **undefined**, whose referenced name is *name*, and whose strict reference flag is *strict*.
2. Let *envRec* be *lex*'s environment record.
3. Let *exists* be the result of calling the `HasBinding` concrete method of *envRec* passing *name* as the argument.
4. **ReturnIfAbrupt(exists).**
5. If *exists* is **true**, then
 - a. Return a value of type Reference whose base value is *envRec*, whose referenced name is *name*, and whose strict reference flag is *strict*.
6. Else
 - a. Let *outer* be the value of *lex*'s outer environment reference.
 - b. Return `GetIdentifierReference(outer, name, strict)`.

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8.1.2.2 NewDeclarativeEnvironment (E) **Abstract Operation**

When the abstract operation `NewDeclarativeEnvironment` is called with either a Lexical Environment or **null** as argument *E* the following steps are performed:

1. Let *env* be a new Lexical Environment.
2. Let *envRec* be a new declarative environment record containing no bindings.
3. Set *env*'s environment record to be *envRec*.
4. Set the outer lexical environment reference of *env* to *E*.
5. Return *env*.

8.1.2.3 NewObjectEnvironment (O, E) Abstract Operation

When the abstract operation `NewObjectEnvironment` is called with an Object O and a Lexical Environment E (or `null`) as arguments, the following steps are performed:

1. Let env be a new Lexical Environment.
2. Let $envRec$ be a new object environment record containing O as the binding object.
3. Set env 's environment record to $envRec$.
4. Set the outer lexical environment reference of env to E .
5. Return env .

Deleted: <#>Set $envRec$'s `unscopables` to an empty List.¶

8.1.2.4 NewFunctionEnvironment (F) Abstract Operation

When the abstract operation `NewFunctionEnvironment` is called with an ECMAScript function Object F as its argument, the following steps are performed:

1. Let env be a new Lexical Environment.
2. Let $envRec$ be a new Function environment record containing no bindings.
3. Set $envRec.[[FunctionObject]]$ to F .
4. Set $envRec.[[thisInitializationState]]$ to `false`.
5. If F 's `[[ThisMode]]` internal slot is lexical, set $envRec.[[thisValue]]$ to empty.
6. If F 's `[[NeedsSuper]]` internal slot is `true`, then
 - a. Let $home$ be the value of F 's `[[HomeObject]]` internal slot.
 - b. If $home$ is `undefined`, throw a **ReferenceError** exception.
 - c. Set $envRec.[[HomeObject]]$ to $home$.
7. Else,
 - a. Set $envRec.[[HomeObject]]$ to `undefined`.
8. Set $envRec.[[NewTarget]]$ to `undefined`.
9. Set env 's environment record to be $envRec$.
10. Set the outer lexical environment reference of env to the value of F 's `[[Environment]]` internal slot.
11. Return env .

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8.1.2.5 NewGlobalEnvironment (G) Abstract Operation

When the abstract operation `NewGlobalEnvironment` is called with an ECMAScript Object G as its argument, the following steps are performed:

1. Let env be a new Lexical Environment.
2. Let $objRec$ be a new object environment record containing G as the binding object.
3. Set $objRec$'s `unscopables` to an empty List.
4. Let $dclRec$ be a new declarative environment record containing no bindings.
5. Let $globalRec$ be a new global environment record.
6. Set $globalRec.[[ObjectRecord]]$ to $objRec$.
7. Set $globalRec.[[DeclarativeRecord]]$ to $dclRec$.
8. Set $globalRec.[[VarNames]]$ to a new empty List.
9. Set env 's environment record to $globalRec$.
10. Set the outer lexical environment reference of env to `null`.
11. Return env .

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8.1.2.6 NewModuleEnvironment (E) Abstract Operation

When the abstract operation `NewModuleEnvironment` is called with a Lexical Environment argument E the following steps are performed:

1. Let *env* be a new Lexical Environment.
2. Let *envRec* be a new module environment record containing no bindings.
3. Set *env*'s environment record to be *envRec*.
4. Set the outer lexical environment reference of *env* to *E*.
5. Return *env*.

8.2 Code Realms

Before it is evaluated, all ECMAScript code must be associated with a *Realm*. Conceptually, a realm consists of a set of intrinsic objects, an ECMAScript global environment, all of the ECMAScript code that is loaded within the scope of that global environment, and other associated state and resources.

A Realm is specified as a Record with the fields specified in [Table 22](#):

Table 22 — Realm Record Fields

Field Name	Value	Meaning
<code>[[intrinsics]]</code>	A record whose field names are intrinsic keys and whose values are objects	These are the intrinsic values used by code associated with this Realm
<code>[[globalThis]]</code>	An object	The global object for this Realm
<code>[[globalEnv]]</code>	An ECMAScript environment	The global environment for this Realm
<code>[[templateMap]]</code>	A List of Record([strings]: List, [array]: Object)	Template objects are canonicalized separately for each Realm using its [[TemplateMap]]. Each [[strings]] value is a List containing in source code order the raw string values of a TemplateLiteral that has been evaluated. The associated [[array]] value is the corresponding template object that is passed to a tag function.
<code>[[modules]]</code>	A List of ModuleRecords.	An initially empty List containing the ModuleRecord for each module that has been loaded by this Realm.

8.2.1 CreateRealm () Abstract Operation

The abstract operation `CreateRealm` with no arguments performs the following steps:

1. Let *realmRec* be a new Record.
2. Let *intrinsics* be `CreateIntrinsics(realmRec)`.
3. Set *realmRec.[[globalThis]]* to [undefined](#).
4. Set *realmRec.[[globalEnv]]* to [undefined](#).
5. Set *realmRec.[[templateMap]]* to a new empty List.
6. Set *realmRec.[[modules]]* to a new empty List.
7. Return *realmRec*.

8.2.2 CreateIntrinsics (realmRec) Abstract Operation

When the abstract operation `CreateIntrinsics` with argument *realmRec* performs the following steps:

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1. Let *intrinsics* be a new Record.
2. Set *realmRec*.*[[intrinsics]]* to *intrinsics*.
3. Let *objProto* be ObjectCreate(**null**).
4. Set *intrinsics*.*[[%ObjectPrototype%]]* to *objProto*.
5. Let *throwerSteps* be the algorithm steps of the *%ThrowTypeError%* function (9.2.8.1).
6. Let *thrower* be CreateBuiltinFunction(*realmRec*, *throwerSteps*, **null**).
7. Set *intrinsics*.*[[%ThrowTypeError%]]* to *thrower*.
8. Let *noSteps* be an empty sequence of algorithm steps.
9. Let *funcProto* be the CreateBuiltinFunction(*realmRec*, *noSteps*, *objProto*).
10. Set *intrinsics*.*[[%FunctionPrototype%]]* to *funcProto*.
11. Call the *[[SetPrototypeOf]]* internal method of *thrower* with argument *funcProto*.
12. Perform AddRestrictedFunctionProperties(*funcProto*, *realmRec*).
13. Set fields of *intrinsics* with the values listed in Table 7 that have not already been handled above.
The field names are the names listed in column one of the table. The value of each field is a new object value fully and recursively populated with property values as defined by the specification of each object in clauses 18-26. All object property values are newly created object values. All values that are built-in function objects are created by performing CreateBuiltinFunction(*realmRec*, <steps>, <prototype>, <slots>) where <steps> is the definition of that function provided by this specification, <prototype> is the specified value of the function's *[[Prototype]]* internal slot and <slots> is a list of the names, if any, of the functions specified internal slots. The creation of the *intrinsics* and their properties must be ordered to avoid any dependencies upon objects that have not yet been created.
14. Return *intrinsics*.

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<#>Set the *[[Realm]]* internal slot of *thrower* to *realmRec*.
<#>Perform DefinePropertyOrThrow(*thrower*, "caller", PropertyDescriptor {*[[Get]]*: *thrower*, *[[Set]]*: *thrower*, *[[Enumerable]]*: **false**, *[[Configurable]]*: **false**}).
<#>Perform DefinePropertyOrThrow(*thrower*, "arguments", PropertyDescriptor {*[[Get]]*: *thrower*, *[[Set]]*: *thrower*, *[[Enumerable]]*: **false**, *[[Configurable]]*: **false**}).
<#>Assert: Defining the above two properties will not result in an abrupt completion.

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8.2.3 SetRealmGlobalObj (*realmRec*, *globalObj*) Abstract Operation

The abstract operation *SetRealmGlobalObj* with arguments *realmRec* and *globalObj* performs the following steps:

1. If *globalObj* is **undefined**, then
 - a. Let *intrinsics* be *realmRec*.*[[intrinsics]]*.
 - b. Let *globalObj* be ObjectCreate(*intrinsics*, *[[%ObjectPrototype%]]*).
2. Assert: Type(*globalObj*) is Object.
3. Set *realmRec*.*[[globalThis]]* to *newGlobal*.
4. Let *newGlobalEnv* be NewGlobalEnvironment(*newGlobal*).
5. Set *realmRec*.*[[globalEnv]]* to *newGlobalEnv*.
6. Return *realmRec*.

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8.2.4 SetDefaultGlobalBindings (*realmRec*) Abstract Operation

The abstract operation *SetDefaultGlobalBindings* with argument *realmRec* performs the following steps:

1. Let *global* be *realmRec*.*[[globalThis]]*.
2. For each property of the Global Object specified in clause 18, do
 - a. Let *name* be the string value of the property name.
 - b. Let *desc* be the fully populated data property descriptor for the property containing the specified attributes for the property. For properties whose values are functions, the value of the *[[Value]]* attribute is the corresponding intrinsic function object from *realmRec*.
 - c. Let *status* be DefinePropertyOrThrow(*global*, *name*, *desc*).
 - d. ReturnIfAbrupt(*status*).
3. Return *global*.

8.3 Execution Contexts

An *execution context* is a specification device that is used to track the runtime evaluation of code by an ECMAScript implementation. At any point in time, there is at most one execution context that is actually executing code. This is known as the *running* execution context. A stack is used to track execution contexts. The running execution context is always the top element of this stack. A new execution context is created whenever control is transferred from the executable code associated with the currently running execution context to executable code that is not associated with that execution context. The newly created execution context is pushed onto the stack and becomes the running execution context.

An execution context contains whatever implementation specific state is necessary to track the execution progress of its associated code. Each execution context has at least the state components listed in [Table 23](#).

Table 23.—State Components for All Execution Contexts

Component	Purpose
code evaluation state	Any state needed to perform, suspend, and resume evaluation of the code associated with this execution context.
Function	If this execution context is evaluating the code of a function object, then the value of this component is that function object. If the context is evaluating the code of a Script or Module, the value is null.
Realm	The Realm from which associated code accesses ECMAScript resources.

Evaluation of code by the running execution context may be suspended at various points defined within this specification. Once the running execution context has been suspended a different execution context may become the running execution context and commence evaluating its code. At some later time a suspended execution context may again become the running execution context and continue evaluating its code at the point where it had previously been suspended. Transition of the running execution context status among execution contexts usually occurs in stack-like last-in/first-out manner. However, some ECMAScript features require non-LIFO transitions of the running execution context.

The value of the Realm component of the running execution context is also called the *current Realm*. The value of the Function component of the running execution context is also called the *active function object*.

Execution contexts for ECMAScript code have the additional state components listed in [Table 24](#).

Table 24.—Additional State Components for ECMAScript Code Execution Contexts

Component	Purpose
LexicalEnvironment	Identifies the Lexical Environment used to resolve identifier references made by code within this execution context.
VariableEnvironment	Identifies the Lexical Environment whose environment record holds bindings created by <i>VariableStatements</i> within this execution context.

The LexicalEnvironment and VariableEnvironment components of an execution context are always Lexical Environments. When an execution context is created its LexicalEnvironment and VariableEnvironment components initially have the same value.

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Execution contexts representing the evaluation of generator objects have the additional state components listed in [Table 25](#).

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Table 25.— Additional State Components for Generator Execution Contexts

Component	Purpose
Generator	The GeneratorObject that this execution context is evaluating.

In most situations only the running execution context (the top of the execution context stack) is directly manipulated by algorithms within this specification. Hence when the terms “LexicalEnvironment”, and “VariableEnvironment” are used without qualification they are in reference to those components of the running execution context.

An execution context is purely a specification mechanism and need not correspond to any particular artefact of an ECMAScript implementation. It is impossible for ECMAScript code to directly access or observe an execution context.

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8.3.1 ResolveBinding (*name*) Abstract Operation

The `ResolveBinding` abstract operation is used to determine the binding of *name* passed as a string value using the `LexicalEnvironment` of the running execution context. During execution of ECMAScript code, `ResolveBinding` is performed using the following algorithm:

1. Let *env* be the running execution context’s `LexicalEnvironment`.
2. If the syntactic production that is being evaluated is contained in strict mode code, let *strict* be **true**, else let *strict* be **false**.
3. Return `GetIdentifierReference(env, name, strict)`.

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NOTE The result of `ResolveBinding` is always a `Reference` value with its referenced name component equal to the *name* argument.

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8.3.2 GetThisEnvironment () Abstract Operation

The abstract operation `GetThisEnvironment` finds the `environment record` that currently supplies the binding of the keyword `this`. `GetThisEnvironment` performs the following steps:

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1. Let *lex* be the running execution context’s `LexicalEnvironment`.
2. Repeat
 - a. Let *envRec* be *lex*’s environment record.
 - b. Let *exists* be the result of calling the `HasThisBinding` concrete method of *envRec*.
 - c. If *exists* is **true**, return *envRec*.
 - d. Let *outer* be the value of *lex*’s outer environment reference.
 - e. Let *lex* be *outer*.

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NOTE The loop in step 2 will always terminate because the list of environments always ends with the global environment which has a `this` binding.

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8.3.3 ResolveThisBinding () Abstract Operation

The abstract operation `ResolveThisBinding` determines the binding of the keyword `this` using the `LexicalEnvironment` of the running execution context. `ResolveThisBinding` performs the following steps:

1. Let *envRec* be `GetThisEnvironment()`.
2. Return the result of calling the `GetThisBinding` concrete method of *envRec*.

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8.3.4 GetNewTarget () Abstract Operation

The abstract operation `GetNewTarget` determines the `NewTarget` value using the `LexicalEnvironment` of the running execution context. `GetNewTarget` performs the following steps:

1. Let `envRec` be `GetThisEnvironment()`.
2. Assert: `envRec` has a `[[NewTarget]]` field.
3. Return `envRec.[[NewTarget]]`.

8.3.5 GetGlobalObject () Abstract Operation

The abstract operation `GetGlobalObject` returns the global object used by the currently running execution context. `GetGlobalObject` performs the following steps:

1. Let `ctx` be the running execution context.
2. Let `currentRealm` be `ctx`'s Realm.
3. Return `currentRealm.[[globalThis]]`.

8.4 Jobs and Job Queues

A `Job` is an abstract operation that initiates an `ECMAScript` computation when no other `ECMAScript` computation is currently in progress. A `Job` abstract operation may be defined to accept an arbitrary set of `job` parameters.

Execution of a `Job` can be initiated only when there is no running execution context and the execution context stack is empty. A `PendingJob` is a request for the future execution of a `Job`. A `PendingJob` is an internal Record whose fields are specified in Table 26. Once execution of a `Job` is initiated, the `Job` always executes to completion. No other `Job` may be initiated until the currently running `Job` completes. However, the currently running `Job` or external events may cause the enqueueing of additional `PendingJobs` that may be initiated sometime after completion of the currently running `Job`.

Table 26 – PendingJob Record Fields

Field Name	Value	Meaning
<code>[[Job]]</code>	The name of a <code>Job</code> abstract operation	This is the abstract operation that is performed when execution of this <code>PendingJob</code> is initiated. <code>Jobs</code> are abstract operations that use <code>NextJob</code> rather than <code>Return</code> to indicate that they have completed.
<code>[[Arguments]]</code>	A List	The List of argument values that are to be passed to <code>[[Job]]</code> when it is activated.
<code>[[Realm]]</code>	A Realm Record	The Realm for the initial execution context when this Pending <code>Job</code> is initiated.
<code>[[HostDefined]]</code>	Any, default value is <code>undefined</code> .	Field reserved for use by host environments that need to associate additional information with a pending <code>Job</code> .

A `Job` Queue is a FIFO queue of `PendingJob` records. Each `Job` Queue has a name and the full set of available `Job` Queues are defined by an `ECMAScript` implementation. Every `ECMAScript` implementation has at least the `Job Queues` defined in Table 27.

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The abstract operation <code>IsThisInitialized</code> determines whether the visible binding of <code>this</code> has been initialized.¶
<#>Let <code>envRec</code> be <code>GetThisEnvironment()</code> .¶
<#>If <code>envRec</code> is not a Function Environment Record, return <code>true</code> .¶
<#>Return the value of <code>envRec.[[thisInitializationState]]</code> .¶
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Table 27—Required Job Queues

Name	Purpose
ScriptJobs	Jobs that validate and evaluate ECMAScript Script and Module code units. See clauses 10 and 15.
PromiseJobs	Jobs that are responses to the settlement of a Promise (see 25.4).

A request for the future execution of a *Job* is made by enqueueing, on a *Job Queue*, a *PendingJob* record that includes a *Job* abstract operation name and any necessary argument values. When there is no running execution context and the execution context stack is empty, the ECMAScript implementation removes the first *PendingJob* from a *Job Queue* and uses the information contained in it to create an execution context and starts execution of the associated *Job* abstract operation.

The *PendingJob* records from a single *Job Queue* are always initiated in FIFO order. This specification does not define the order in which multiple *Job Queues* are serviced. An ECMAScript implementation may interweave the FIFO evaluation of the *PendingJob* records of a *Job Queue* with the evaluation of the *PendingJob* records of one or more other *Job Queues*. An implementation must define what occurs when there are no running execution context and all *Job Queues* are empty.

NOTE Typically an ECMAScript implementation will have its *Job Queues* pre-initialized with at least one *PendingJob* and one of those *Jobs* will be the first to be executed. An implementation might choose to free all resources and terminate if the current *Job* completes and all *Job Queues* are empty. Alternatively, it might choose to wait for a some implementation specific agent or mechanism to enqueue new *PendingJob* requests.

The following abstract operations are used to create and manage *Jobs* and *Job Queues*:

8.4.1 EnqueueJob (queueName, job, arguments) Abstract Operation

The *EnqueueJob* abstract operation requires three arguments: *queueName*, *job*, and *arguments*. It performs the following steps:

1. Assert: Type(*queueName*) is String and its value is the name of a *Job Queue* recognized by this implementation.
2. Assert: *job* is the name of a *Job*.
3. Assert: *arguments* is a List that has the same number of elements as the number of parameters required by *job*.
4. Let *callerContext* be the running execution context.
5. Let *callerRealm* be *callerContext*'s Realm.
6. Let *pending* be PendingJob{ [[Job]]: *job*, [[Arguments]]: *arguments*, [[Realm]]: *callerRealm*, [[HostDefined]]: undefined }.
7. Perform any implementation or host environment defined processing of *pending*. This may including modify the [[HostDefined]] field or any other field of *pending*.
8. Add *pending* at the back of the *Job Queue* named by *queueName*.
9. Return NormalCompletion(empty).

8.4.2 NextJobResult

An algorithm step such as:

1. NextJobResult.

is used in *Job abstract operations* in place of:

1. Return *result*.

Job abstract operations must not contain a Return step or a ReturnIfAbrupt step. The NextJob result operation is equivalent to the following steps:

1. If *result* is an abrupt completion, perform implementation defined unhandled exception processing.
2. Suspend the running execution context and remove it from the execution context stack.
3. Assert: The execution context stack is now empty.
4. Let *nextQueue* be a non-empty Job Queue chosen in an implementation defined manner. If all Job Queues are empty, the result is implementation defined.
5. Let *nextPending* be the Pending Job record at the front of *nextQueue*. Remove that record from *nextQueue*.
6. Let *newContext* be a new execution context.
7. Set *newContext*'s Realm to *nextPending*.[[Realm]].
8. Push *newContext* onto the execution context stack; *newContext* is now the running execution context.
9. Perform any implementation or host environment defined job initialization using *nextPending*.
10. Perform the abstract operation named by *nextPending*.[[Job]] using the elements of *nextPending*.[[Arguments]] as its arguments.

8.5 Initialization

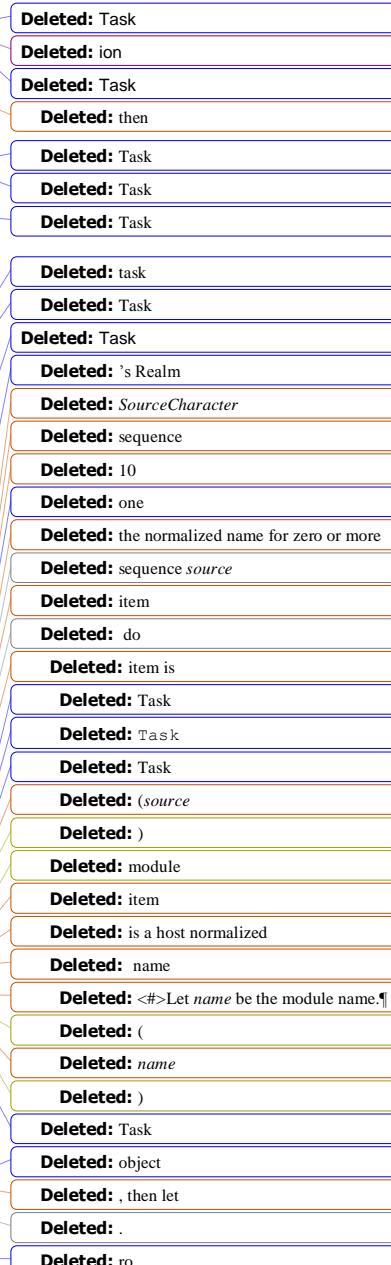
An ECMAScript implementation performs the following steps prior to the execution of any Jobs or the evaluation of any ECMAScript code:

1. Let *realm* be CreateRealm().
2. Let *newContext* be a new execution context.
3. Set the Function of *newContext* to null.
4. Set the Realm of *newContext* to *realm*.
5. Push *newContext* onto the execution context stack; *newContext* is now the running execution context.
6. Let *status* be InitializeFirstRealm(*realm*).
7. If *status* is an abrupt completion, then
 - a. Assert: The first realm could not be created.
 - b. Terminate ECMAScript execution.
8. In an implementation dependent manner, obtain the *sourceCodeId* strings (see 8.6.1) for zero or more ECMAScript scripts and/or ECMAScript modules. For each such *sourceCodeId* do
 - a. If the *sourceCodeId* identifies the source code of a script, then
 - i. Let *source* be the SourceCharacter sequence of the script.
 - ii. EnqueueJob("ScriptJobs", ScriptEvaluationJob, «*sourceCodeId*»).
 - b. Else the *sourceCodeId* identifies the source code of a module.
 - i. EnqueueJob("ScriptJobs", ModuleEvaluationJob, «*sourceCodeId*»).
9. NextJob NormalCompletion(undefined).

8.5.1 InitializeFirstRealm (*realm*) Abstract Operation

The abstract operation InitializeFirstRealm with parameter *realm* performs the following steps:

1. Let *intrinsic*s be CreateIntrinsics(*realm*).
2. If this implementation requires use of an exotic object to serve as *realm*'s global object, let *global* be such an object created in an implementation defined manner. Otherwise, let *global* be undefined indicating that an ordinary object should be created as the global object.
3. Perform SetRealmGlobalObject(*realm*, *global*).



4. Let *globalObj* be *SetDefaultGlobalBindings(realm)*.
5. ReturnIfAbrupt(*globalObj*).
6. Create any implementation defined global object properties on *globalObj*.
7. Return NormalCompletion(**undefined**).

8.6 Host Provided Services

Host provided services are abstract operations used by this specification to access resources of the host environment within which an ECMAScript implementation is operating. The specific semantics must be defined by the ECMAScript implementation.

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8.6.1 HostGetSource (*sourceCodeId*) Abstract Operation

A *sourceCodeId* is a host defined string value that identifies a specific source code resource. The abstract operation HostGetSource retrieves the *SourceCharacter* sequence (see clause 10) that is identified by the String *sourceCodeId*. The returned value is the *SourceCharacter* sequence. If *sourceCodeId* does not identify a *SourceCharacter* sequence or if the *SourceCharacter* sequence cannot be retrieved an abrupt completion value is returned.

The argument value passed to this operation is a *sourceCodeId* that was previously either directly provided by the host or returned from the HostNormalizeModuleName abstract operation.

8.6.2 HostNormalizeModuleName (*unnormalizedName*, *referrerId*) Abstract Operation

The abstract operation HostNormalizeModuleName translates an unnormalized module name string to a host defined *sourceCodeId* that can be used to retrieve the source code for the named module. *unnormalizedName* is a String and is the name to be normalized. *referrerId* is a String and is the host supplied *sourceCodeId* of the module that referenced *unnormalizedName*. The returned value is either a String or undefined. If undefined is returned, the name cannot be normalized to a *sourceCodeId* that is usable to retrieve source code.

A host must supply a stable mapping of unnormalized names to *sourceCodeId*s. Multiple successive calls to HostNormalizeModuleName, with the same arguments, must return the same String value.

Many different unnormalized names may be mapped to the same *sourceCodeId*. The actual normalization mapping is implementation defined but typically includes processes such as alphabetic case normalization and expansion of relative and abbreviated file system paths.

NOTE The *referrerId* argument is intended to support relative naming syntax that might be used within an unnormalized name. The actual relative naming semantic, if any, are host defined.

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(*normalizedNamemoduleId*) Abstract
Operation¶

The abstract operation HostGetSource retrieves the *SourceCharacter* sequence (see clause 10) that is identified by the String *normalizedNamemoduleId*. The returned value is the *SourceCharacter* sequence. If *normalizedNamemoduleId* does not identify a *SourceCharacter* sequence or if the *SourceCharacter* sequence cannot be retrieved an abrupt completion value is returned.¶ The argument value passed to this operation is typically a value that has been returned from the HostNormalizeModuleName abstract operation.¶

9 Ordinary and Exotic Objects Behaviours

9.1 Ordinary Object Internal Methods and Internal Slots

All ordinary objects have an internal slot called **[[Prototype]]**. The value of this internal slot is either **null** or an object and is used for implementing inheritance. Data properties of the **[[Prototype]]** object are inherited (are visible as properties of the child object) for the purposes of get access, but not for set access. Accessor properties are inherited for both get access and set access.

Every ordinary object has a Boolean-valued **[[Extensible]]** internal slot that controls whether or not properties may be added to the object. If the value of the **[[Extensible]]** internal slot is **false** then additional properties may not be added to the object. In addition, if **[[Extensible]]** is **false** the value of the

[[Prototype]] internal slot of the object may not be modified. Once the value of an object's **[[Extensible]]** internal slot has been set to **false** it may not be subsequently changed to **true**.

In the following algorithm descriptions, assume O is an ordinary object, P is a property key value, V is any ECMAScript language value, and $Desc$ is a Property Descriptor record.

9.1.1 **[[GetPrototypeOf]] ()**

When the **[[GetPrototypeOf]]** internal method of O is called the following steps are taken:

1. Return the value of the **[[Prototype]]** internal slot of O .

9.1.2 **[[SetPrototypeOf]] (V)**

When the **[[SetPrototypeOf]]** internal method of O is called with argument V the following steps are taken:

1. Assert: Either $\text{Type}(V)$ is **Object** or $\text{Type}(V)$ is **Null**.
2. Let $extensible$ be the value of the **[[Extensible]]** internal slot of O .
3. Let $current$ be the value of the **[[Prototype]]** internal slot of O .
4. If $\text{SameValue}(V, current)$, **return true**.
5. If $extensible$ is **false**, **return false**.
6. If V is not **null**, then
 - a. Let p be V .
 - b. Repeat, while p is not **null**
 - i. If $\text{SameValue}(p, O)$ is **true**, **return false**.
 - ii. Let $nextp$ be the result of calling the **[[GetPrototypeOf]]** internal method of p with no arguments.
 - iii. **ReturnIfAbrupt(nextp)**.
 - iv. Let p be $nextp$.
7. Let $extensible$ be the value of the **[[Extensible]]** internal slot of O .
8. If $extensible$ is **false**, then
 - a. Let $current2$ be the value of the **[[Prototype]]** internal slot of O .
 - b. If $\text{SameValue}(V, current2)$ is **true**, **return true**.
 - c. **Return false**.
9. Set the value of the **[[Prototype]]** internal slot of O to V .
10. **Return true**.

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9.1.3 **[[IsExtensible]] ()**

When the **[[IsExtensible]]** internal method of O is called the following steps are taken:

1. Return the value of the **[[Extensible]]** internal slot of O .

9.1.4 **[[PreventExtensions]] ()**

When the **[[PreventExtensions]]** internal method of O is called the following steps are taken:

1. Set the value of the **[[Extensible]]** internal slot of O to **false**.
2. **Return true**.

9.1.5 [[GetOwnProperty]] (P)

When the [[GetOwnProperty]] internal method of O is called with property key P , the following steps are taken:

1. Return OrdinaryGetOwnProperty(O, P).

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9.1.5.1 OrdinaryGetOwnProperty (O, P)

When the abstract operation OrdinaryGetOwnProperty is called with Object O and with property key P , the following steps are taken:

1. Assert: IsPropertyKey(P) is **true**.
2. If O does not have an own property with key P , return **undefined**.
3. Let D be a newly created Property Descriptor with no fields.
4. Let X be O 's own property whose key is P .
5. If X is a data property, then
 - a. Set $D.[[Value]]$ to the value of X 's [[Value]] attribute.
 - b. Set $D.[[Writable]]$ to the value of X 's [[Writable]] attribute
6. Else X is an accessor property, so
 - a. Set $D.[[Get]]$ to the value of X 's [[Get]] attribute.
 - b. Set $D.[[Set]]$ to the value of X 's [[Set]] attribute.
7. Set $D.[[Enumerable]]$ to the value of X 's [[Enumerable]] attribute.
8. Set $D.[[Configurable]]$ to the value of X 's [[Configurable]] attribute.
9. Return D .

9.1.6 [[DefineOwnProperty]] (P, Desc)

When the [[DefineOwnProperty]] internal method of O is called with property key P and Property Descriptor $Desc$, the following steps are taken:

1. Return OrdinaryDefineOwnProperty($O, P, Desc$).

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9.1.6.1 OrdinaryDefineOwnProperty (O, P, Desc)

When the abstract operation OrdinaryDefineOwnProperty is called with Object O , property key P , and Property Descriptor $Desc$ the following steps are taken:

1. Let $current$ be the result of calling the [[GetOwnProperty]] internal method of O with argument P .
2. ReturnIfAbrupt($current$).
3. Let $extensible$ be the value of the [[Extensible]] internal slot of O .
4. Return ValidateAndApplyPropertyDescriptor($O, P, extensible, Desc, current$).

9.1.6.2 IsCompatiblePropertyDescriptor (Extensible, Desc, Current)

When the abstract operation IsCompatiblePropertyDescriptor is called with Boolean value $Extensible$, and Property Descriptors $Desc$, and $Current$ the following steps are taken:

1. Return ValidateAndApplyPropertyDescriptor(**undefined**, **undefined**, $Extensible, Desc, Current$).

9.1.6.3 ValidateAndApplyPropertyDescriptor (O, P, extensible, Desc, current)

When the abstract operation ValidateAndApplyPropertyDescriptor is called with Object O , property key P , Boolean value $extensible$, and Property Descriptors $Desc$, and $current$ the following steps are taken:

This algorithm contains steps that test various fields of the Property Descriptor *Desc* for specific values. The fields that are tested in this manner need not actually exist in *Desc*. If a field is absent then its value is considered to be **false**.

NOTE If **undefined** is passed as the *O* argument only validation is performed and no object updates are performed.

1. Assert: If *O* is not **undefined** then *P* is a valid property key.
2. If *current* is **undefined**, then
 - a. If *extensible* is **false**, **return false**.
 - b. Assert: *extensible* is **true**.
 - c. If *IsGenericDescriptor(Desc)* or *IsDataDescriptor(Desc)* is **true**, then
 - i. If *O* is not **undefined**, create an own data property named *P* of object *O* whose *[[Value]]*, *[[Writable]]*, *[[Enumerable]]* and *[[Configurable]]* attribute values are described by *Desc*. If the value of an attribute field of *Desc* is absent, the attribute of the newly created property is set to its default value.
 - d. Else *Desc* must be an accessor Property Descriptor,
 - i. If *O* is not **undefined**, create an own accessor property named *P* of object *O* whose *[[Get]]*, *[[Set]]*, *[[Enumerable]]* and *[[Configurable]]* attribute values are described by *Desc*. If the value of an attribute field of *Desc* is absent, the attribute of the newly created property is set to its default value.
 - e. Return **true**.
3. Return **true**, if every field in *Desc* is absent.
4. Return **true**, if every field in *Desc* also occurs in *current* and the value of every field in *Desc* is the same value as the corresponding field in *current* when compared using the *SameValue* algorithm.
5. If the *[[Configurable]]* field of *current* is **false**, then
 - a. Return **false**, if the *[[Configurable]]* field of *Desc* is **true**.
 - b. Return **false**, if the *[[Enumerable]]* field of *Desc* is present and the *[[Enumerable]]* fields of *current* and *Desc* are the Boolean negation of each other.
6. If *IsGenericDescriptor(Desc)* is **true**, no further validation is required.
7. Else if *IsDataDescriptor(current)* and *IsDataDescriptor(Desc)* have different results, then
 - a. Return **false**, if the *[[Configurable]]* field of *current* is **false**.
 - b. If *IsDataDescriptor(current)* is **true**, then
 - i. If *O* is not **undefined**, convert the property named *P* of object *O* from a data property to an accessor property. Preserve the existing values of the converted property's *[[Configurable]]* and *[[Enumerable]]* attributes and set the rest of the property's attributes to their default values.
 - c. Else,
 - i. If *O* is not **undefined**, convert the property named *P* of object *O* from an accessor property to a data property. Preserve the existing values of the converted property's *[[Configurable]]* and *[[Enumerable]]* attributes and set the rest of the property's attributes to their default values.
8. Else if *IsDataDescriptor(current)* and *IsDataDescriptor(Desc)* are both **true**, then
 - a. If the *[[Configurable]]* field of *current* is **false**, then
 - i. Return **false**, if the *[[Writable]]* field of *current* is **false** and the *[[Writable]]* field of *Desc* is **true**.
 - ii. If the *[[Writable]]* field of *current* is **false**, then
 1. Return **false**, if the *[[Value]]* field of *Desc* is present and *SameValue(Desc.[[Value]], current.[[Value]])* is **false**.
 - b. Else the *[[Configurable]]* field of *current* is **true**, so any change is acceptable.
9. Else *IsAccessorDescriptor(current)* and *IsAccessorDescriptor(Desc)* are both **true**,
 - a. If the *[[Configurable]]* field of *current* is **false**, then

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- i. Return **false**, if the `[[Set]]` field of `Desc` is present and `SameValue(Desc.[[Set]], current.[[Set]])` is **false**.
 - ii. Return **false**, if the `[[Get]]` field of `Desc` is present and `SameValue(Desc.[[Get]], current.[[Get]])` is **false**.
10. If `O` is not **undefined**, then
- a. For each field of `Desc` that is present, set the corresponding attribute of the property named `P` of object `O` to the value of the field.
11. Return **true**.

NOTE Step 8.b allows any field of `Desc` to be different from the corresponding field of `current` if `current`'s `[[Configurable]]` field is **true**. This even permits changing the `[[Value]]` of a property whose `[[Writable]]` attribute is **false**. This is allowed because a **true** `[[Configurable]]` attribute would permit an equivalent sequence of calls where `[[Writable]]` is first set to **true**, a new `[[Value]]` is set, and then `[[Writable]]` is set to **false**.

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9.1.7 `[[HasProperty]](P)`

When the `[[HasProperty]]` internal method of `O` is called with property key `P`, the following steps are taken:

1. [Return OrdinaryHasProperty\(`O, P`\).](#)

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9.1.7.1 `OrdinaryHasProperty (O, P)`

When the abstract operation `OrdinaryHasProperty` is called with Object `O` and with property key `P`, the following steps are taken:

1. Assert: `IsPropertyKey(P)` is **true**.
2. Let `hasOwn` be [OrdinaryGetOwnProperty\(`O, P`\)](#).
3. ReturnIfAbrupt(`hasOwn`).
4. If `hasOwn` is not **undefined**, [return true](#).
5. Let `parent` be the result of calling the `[[GetPrototypeOf]]` internal method of `O`.
6. ReturnIfAbrupt(`parent`).
7. If `parent` is not **null**, then
 - a. Return the result of calling the `[[HasProperty]]` internal method of `parent` with argument `P`.
8. Return **false**.

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9.1.8 `[[Get]] (P, Receiver)`

When the `[[Get]]` internal method of `O` is called with property key `P` and ECMAScript language value `Receiver` the following steps are taken:

1. Assert: `IsPropertyKey(P)` is **true**.
2. Let `desc` be the result of calling the `[[GetOwnProperty]]` internal method of `O` with argument `P`.
3. ReturnIfAbrupt(`desc`).
4. If `desc` is **undefined**, then
 - a. Let `parent` be the result of calling the `[[GetPrototypeOf]]` internal method of `O`.
 - b. ReturnIfAbrupt(`parent`).
 - c. If `parent` is **null**, [return undefined](#).
 - d. Return the result of calling the `[[Get]]` internal method of `parent` with arguments `P` and `Receiver`.
5. If `IsDataDescriptor(desc)` is **true**, return `desc.[[Value]]`.
6. Otherwise, `IsAccessorDescriptor(desc)` must be **true** so, let `getter` be `desc.[[Get]]`.
7. If `getter` is **undefined**, return **undefined**.
8. Return [Call\(`getter, Receiver`\)](#).

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9.1.9 [[Set]] (P, V, Receiver)

When the [[Set]] internal method of O is called with property key P , value V , and ECMAScript language value $Receiver$, the following steps are taken:

1. Assert: IsPropertyKey(P) is **true**.
2. Let $ownDesc$ be the result of calling the [[GetOwnProperty]] internal method of O with argument P .
3. ReturnIfAbrupt($ownDesc$).
4. If $ownDesc$ is **undefined**, then
 - a. Let $parent$ be the result of calling the [[GetPrototypeOf]] internal method of O .
 - b. ReturnIfAbrupt($parent$).
 - c. If $parent$ is not **null**, then
 - i. Return the result of calling the [[Set]] internal method of $parent$ with arguments P , V , and $Receiver$.
 - d. Else,
 - i. Let $ownDesc$ be the PropertyDescriptor{[[Value]]: **undefined**, [[Writable]]: **true**, [[Enumerable]]: **true**, [[Configurable]]: **true**}.
5. If IsDataDescriptor($ownDesc$) is **true**, then
 - a. If $ownDesc$.[[Writable]] is **false**, return **false**.
 - b. If Type($Receiver$) is not Object, return **false**.
 - c. Let $existingDescriptor$ be the result of calling the [[GetOwnProperty]] internal method of $Receiver$ with argument P .
 - d. ReturnIfAbrupt($existingDescriptor$).
 - e. If $existingDescriptor$ is not **undefined**, then
 - i. Let $valueDesc$ be the PropertyDescriptor{[[Value]]: V }.
 - ii. Return the result of calling the [[DefineOwnProperty]] internal method of $Receiver$ with arguments P and $valueDesc$.
 - f. Else $Receiver$ does not currently have a property P .
 - i. Return CreateDataProperty($Receiver$, P , V).
6. Assert: IsAccessorDescriptor($ownDesc$) is **true**.
7. Let $setter$ be $ownDesc$.[[Set]].
8. If $setter$ is **undefined**, return **false**.
9. Let $setterResult$ be Call($setter$, $Receiver$, $\langle V \rangle$).
10. ReturnIfAbrupt($setterResult$).
11. Return **true**.

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9.1.10 [[Delete]] (P)

When the [[Delete]] internal method of O is called with property key P the following steps are taken:

1. Assert: IsPropertyKey(P) is **true**.
2. Let $desc$ be the result of calling the [[GetOwnProperty]] internal method of O with argument P .
3. ReturnIfAbrupt($desc$).
4. If $desc$ is **undefined**, return true.
5. If $desc$.[[Configurable]] is **true**, then
 - a. Remove the own property with name P from O .
 - b. Return **true**.
6. Return **false**.

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9.1.11 [[Enumerate]] ()

When the [[Enumerate]] internal method of O is called the following steps are taken:

1. Return an Iterator object (25.1.1.2) whose `next` method iterates over all the String-valued keys of enumerable properties of O . The Iterator object must inherit from `%IteratorPrototype%` (25.1.2). The mechanics and order of enumerating the properties is not specified but must conform to the rules specified below.

The iterator's `next` method processes object properties to determine whether the property key should be returned as an iterator value. Processed properties do not include properties whose property key is a Symbol. Properties of the object being enumerated may be deleted during enumeration. A property that is deleted before it is processed by the iterator's `next` method is ignored. If new properties are added to the object being enumerated during enumeration, the newly added properties are not guaranteed to be processed in the active enumeration. A property name will be returned by the iterator's `next` method at most once in any enumeration.

Enumerating the properties of an object includes processing properties of its prototype, and the prototype of the prototype, and so on, recursively; but a property of a prototype is not processed if it has the same name as a property that has already been processed by the iterator's `next` method. The values of `[[Enumerable]]` attributes are not considered when determining if a property of a prototype object has already been processed.

The following is an informative definition of an ECMAScript generator function that conforms to these rules:

```
function* enumerate(obj) {
  if (Object(obj) !== obj) return undefined;
  let visited = new Set();
  while (obj !== null) {
    for (let name of Object.getOwnPropertyNames(obj)) {
      //any new properties added to obj by visitor are ignored.
      if (!visited.has(name)) {
        let desc = Object.getOwnPropertyDescriptor(obj, name);
        if (desc) {
          visited.add(name);
          if (desc.enumerable) yield name;
        }
      }
    }
    obj = Object.getPrototypeOf(obj);
  }
}
```

9.1.12 `[[OwnPropertyKeys]]()`

When the `[[OwnPropertyKeys]]` internal method of O is called the following steps are taken:

1. Let $keys$ be a new empty List.
2. For each own property key P of O that is an integer index, in ascending numeric index order
 - a. Add P as the last element of $keys$.
3. For each own property key P of O that is a String but is not an integer index, in property creation order
 - a. Add P as the last element of $keys$.
4. For each own property key P of O that is a Symbol, in property creation order
 - a. Add P as the last element of $keys$.
5. Return $keys$.

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Deleted: <#>Let $proto$ be the result of calling the <code>[[GetPrototypeOf]]</code> internal method of O with no arguments. <#>ReturnIfAbrupt($proto$). <#>If $proto$ is the value <code>null</code> , then <#>Let $propList$ be a new empty List. <#>Else <#>Let $propList$ be the result of calling the <code>[[Enumerate]]</code> internal method of $proto$. <#>ReturnIfAbrupt($propList$). <#>For each $name$ that is the property key of an own property of O <#>If <code>Type($name$)</code> is <code>String</code> , then <#>Let $desc$ be the result of calling the <code>[[GetProperty]]</code> internal method of O with argument $name$. <#>ReturnIfAbrupt($desc$). <#>If $name$ is an element of $propList$, then remove $name$ as an element of $propList$. <#>If $desc.[[Enumerable]]$ is <code>true</code> , then add $name$ as an element of $propList$. <#>Order the elements of $propList$ in an implementation defined order. <#>Return $propList$.
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9.1.13 ObjectCreate(proto, internalSlotsList) Abstract Operation

The abstract operation ObjectCreate with argument *proto* (an object or null) is used to specify the runtime creation of new ordinary objects. The optional argument *internalSlotsList* is a List of the names of additional internal slots that must be defined as part of the object. If the list is not provided, an empty List is used. This abstract operation performs the following steps:

1. If *internalSlotsList* was not provided, let *internalSlotsList* be an empty List.
2. Let *obj* be a newly created object with an internal slot for each name in *internalSlotsList*.
3. Set *obj*'s essential internal methods to the default ordinary object definitions specified in 9.1.
4. Set the ***[[Prototype]]*** internal slot of *obj* to *proto*.
5. Set the ***[[Extensible]]*** internal slot of *obj* to **true**.
6. Return *obj*.

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9.1.14 OrdinaryCreateFromConstructor (constructor, *intrinsicDefaultProto*, *internalSlotsList*)

The abstract operation OrdinaryCreateFromConstructor creates an ordinary object whose ***[[Prototype]]*** value is retrieved from a constructor's ***prototype*** property, if it exists. Otherwise the *intrinsic named by intrinsicDefaultProto* is used for ***[[Prototype]]***. The optional *internalSlotsList* is a List of the names of additional internal slots that must be defined as part of the object. If the list is not provided, an empty List is used. This abstract operation performs the following steps:

1. Assert: *intrinsicDefaultProto* is a string value that is this specification's name of an intrinsic object. The corresponding object must be an intrinsic that is intended to be used as the ***[[Prototype]]*** value of an object.
2. Let *proto* be GetPrototypeFromConstructor(*constructor*, *intrinsicDefaultProto*).
3. ReturnIfAbrupt(*proto*).
4. Return ObjectCreate(*proto*, *internalSlotsList*).

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9.1.15 GetPrototypeFromConstructor (constructor, *intrinsicDefaultProto*)

The abstract operation GetPrototypeFromConstructor determines the ***[[Prototype]]*** value that should be used to create an object corresponding to a specific constructor. The value is retrieved from the constructor's ***prototype*** property, if it exists. Otherwise the *intrinsic named by intrinsicDefaultProto* is used for ***[[Prototype]]***. This abstract operation performs the following steps:

1. Assert: *intrinsicDefaultProto* is a string value that is this specification's name of an intrinsic object. The corresponding object must be an intrinsic that is intended to be used as the ***[[Prototype]]*** value of an object.
2. Assert: IsConstructor(*constructor*) is **true**.
3. Let *proto* be Get(*constructor*, "prototype").
4. ReturnIfAbrupt(*proto*).
5. If Type(*proto*) is not Object, then
 - a. Let *realm* be GetFunctionRealm(*constructor*).
 - b. Let *proto* be *realm*'s intrinsic object named *intrinsicDefaultProto*.
6. Return *proto*.

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NOTE If *constructor* does not supply a ***[[Prototype]]*** value, the default value that is used is obtained from the Code Realm of the *constructor* function rather than from the running execution context.

9.2 ECMAScript Function Objects

ECMAScript function objects encapsulate *parameterized* ECMAScript code closed over a lexical environment and support the dynamic evaluation of that code. An ECMAScript function object is an

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ordinary object and has the same internal slots and (except as noted below) and the same internal methods as other ordinary objects. The code of an ECMAScript function object may be either strict mode code (10.2.1) or non-strict mode code.

ECMAScript function objects have the additional internal slots listed in [Table 28](#).

ECMAScript function objects whose code is not strict mode code (10.2.1) provide an alternative definition for the `[[GetOwnProperty]]` internal method. This alternative prevents the value of strict mode function from being revealed as the value of a function object property named `"caller"`. The alternative definition exist solely to preclude a non-standard legacy feature of some ECMAScript implementations from revealing information about strict mode callers. If an implementation does not provide such a feature, it need not implement this alternative internal method for ECMAScript function objects. ECMAScript function objects are considered to be ordinary objects even though they may use the alternative definition of `[[GetOwnProperty]]`.

[Table 28](#) Internal Slots of ECMAScript Function Objects

Internal Slot	Type	Description
<code>[[Environment]]</code>	Lexical Environment	The Lexical Environment that the function was closed over. Used as the outer environment when evaluating the code of the function.
<code>[[FormalParameters]]</code>	Parse Node	The root parse node of the source code that defines the function's formal parameter list.
<code>[[FunctionKind]]</code>	String	Either <code>"normal"</code> , <code>"classConstructor"</code> or <code>"generator"</code> .
<code>[[ECMAScriptCode]]</code>	Parse Node	The root parse node of the source code that defines the function's body.
<code>[[ConstructorKind]]</code>	String	Either <code>"base"</code> or <code>"derived"</code> .
<code>[[Realm]]</code>	Realm Record	The Code Realm in which the function was created and which provides any intrinsic objects that are accessed when evaluating the function.
<code>[[ThisMode]]</code>	(lexical, strict, global)	Defines how <code>this</code> references are interpreted within the formal parameters and code body of the function. lexical means that <code>this</code> refers to the <code>this</code> value of a lexically enclosing function. strict means that the <code>this</code> value is used exactly as provided by an invocation of the function. global means that a <code>this</code> value of <code>undefined</code> is interpreted as a reference to the global object.
<code>[[Strict]]</code>	Boolean	<code>true</code> if this is a strict mode function, <code>false</code> if this is not a strict mode function.
<code>[[NeedsSuper]]</code>	Boolean	<code>true</code> if this function uses <code>super</code> .
<code>[[HomeObject]]</code>	Object	If the function uses <code>super</code> , this is the object whose <code>[[GetPrototypeOf]]</code> provides the object where <code>super</code> property lookups begin.

All ECMAScript function objects have the `[[Call]]` internal method defined here. ECMAScript functions that are also constructors in addition have the `[[Construct]]` internal method. ECMAScript function objects whose code is not strict mode code have the `[[GetOwnProperty]]` internal method defined here.

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9.2.1 [[GetOwnProperty]] (P)

When the [[GetOwnProperty]] internal method of a non-strict ECMAScript function object F is called with property key P , the following steps are taken:

1. Let v be OrdinaryGetOwnProperty(F, P).
2. If IsDataDescriptor(v) is true, then
 - a. If P is "caller", then
 - i. Let $callerValue$ be $v.[[Value]]$.
 - ii. If $callerValue$ is an ECMAScript Function object, then
 1. If $callerValue$'s [[Strict]] internal slot is true, set $v.[[Value]]$ to null.
3. Return v .

If an implementation extends non-strict ECMAScript function objects with a built-in `caller` own property then it must use this definition of [[GetOwnProperty]]. If an implementation does not provide such an extension, the ordinary object [[GetOwnProperty]] internal method must be used.

9.2.2 [[Call]] (thisArgument, argumentsList)

The [[Call]] internal method for an ECMAScript function object F is called with parameters $thisArgument$ and $argumentsList$, a List of ECMAScript language values. The following steps are taken:

1. Assert: F is an ECMAScript function object.
2. If F 's [[FunctionKind]] internal slot is "classConstructor", throw a **TypeError** exception.
3. Let $callerContext$ be the running execution context.
4. Let $calleeContext$ be PrepareForOrdinaryCall(F, null).
5. ReturnIfAbrupt($calleeContext$).
6. Let $status$ be OrdinaryCallBindThis($F, calleeContext, thisArgument$).
7. If $status$ is an abrupt completion, then
 - a. Remove $calleeContext$ from the execution context stack and restore $callerContext$ as the running execution context.
 - b. Return $status$.
8. Let $result$ be OrdinaryCallEvaluateBody($F, calleeContext, argumentsList$).
9. Remove $calleeContext$ from the execution context stack and restore $callerContext$ as the running execution context.
10. If $result.[[type]]$ is return, return NormalCompletion($result.[[value]]$).
11. ReturnIfAbrupt($result$).
12. Return NormalCompletion(**undefined**).

NOTE When $calleeContext$ is removed from the execution context stack in step 8 it must not be destroyed if it is suspended and retained for later resumption by an accessible generator object.

9.2.2.1 PrepareForOrdinaryCall($F, newTarget$)

When the abstract operation PrepareForOrdinaryCall is called with function object F and ECMAScript language value $newTarget$, the following steps are taken:

1. Assert: Type($newTarget$) is **Undefined** or **Object**.
2. Let $callerContext$ be the running execution context.
3. If $callerContext$ is not already suspended, Suspend $callerContext$.
4. Let $calleeContext$ be a new ECMAScript Code execution context.
5. Set the Function of $calleeContext$ to F .
6. Let $calleeRealm$ be the value of F 's [[Realm]] internal slot.
7. Set the Realm of $calleeContext$ to $calleeRealm$.

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Deleted: <#>FunctionAllocate Abstract Operation¶

The abstract operation FunctionAllocate requires the two arguments `functionPrototype` and `strict`. It also accepts one optional argument, `functionKind`. FunctionAllocate performs the following steps:¶

<#>Assert: Type(`functionPrototype`) is Object.¶
<#>Assert: If `functionKind` is present, its value is either "normal" or "generator".¶
<#>If `functionKind` is not present, then let `functionKind` be "normal".¶

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8. Let `localEnv` be `NewFunctionEnvironment(F)`.
9. `ReturnIfAbrupt(localEnv)`.
10. Let `localER` be `localEnv`'s environment record.
11. Set `localER.[[NewTarget]]` to `newTarget`.
12. NOTE Any exception objects produced by `NewFunctionEnvironment` are associated with `callerRealm`.
13. Set the `LexicalEnvironment` of `calleeContext` to `localEnv`.
14. Set the `VariableEnvironment` of `calleeContext` to `localEnv`.
15. Push `calleeContext` onto the execution context stack; `calleeContext` is now the running execution context.
16. Return `calleeContext`.

9.2.2.2 OrdinaryCallBindThis (*F*, *calleeContext*, *thisArgument*)

When the abstract operation `OrdinaryCallBindThis` is called with function object *F*, execution context *calleeContext*, and ECMAScript value *thisArgument* the following steps are taken:

1. Let `thisMode` be the value of *F*'s `[[ThisMode]]` internal slot.
2. If `thisMode` is `Lexical`, return `NormalCompletion(undefined)`.
3. Let `calleeRealm` be the value of *F*'s `[[Realm]]` internal slot.
4. Let `localEnv` to be the `LexicalEnvironment` of *calleeContext*.
5. If `thisMode` is `strict`, let `thisValue` be *thisArgument*.
6. Else
 - a. if *thisArgument* is `null` or `undefined`, then
 - i. Let `thisValue` be `calleeRealm.[[globalThis]]`.
 - b. Else
 - i. Let `thisValue` be `ToObject(thisArgument)`.
 - ii. Assert: `thisValue` is not an abrupt completion.
 - iii. NOTE `ToObject` produces `wrapper` objects using `calleeRealm`.
7. Let `envRec` be `localEnv`'s environment record.
8. Return the result of calling the `BindThisValue` concrete method of `envRec` with argument `thisValue`.

9.2.2.3 OrdinaryCallEvaluateBody (*F*, *calleeContext*, *argumentsList*)

When the abstract operation `OrdinaryCallEvaluateBody` is called with function object *F*, execution context *calleeContext*, and List *argumentsList* the following steps are taken:

1. Let `localEnv` be the `LexicalEnvironment` of *calleeContext*.
2. Let `status` be the result of performing `FunctionDeclarationInstantiation` using the function *F*, *argumentsList*, and *localEnv* as described in 9.2.13.
3. `ReturnIfAbrupt(status)`.
4. Return the result of `EvaluateBody` of the production that is the value of *F*'s `[[ECMAScriptCode]]` internal slot passing *F* as the argument.

9.2.3 `[[Construct]]` (*argumentsList*, *newTarget*)

The `[[Construct]]` internal method for an ECMAScript Function object *F* is called with parameters *argumentsList* and *newTarget*. *argumentsList* is a possibly empty List of ECMAScript language values. The following steps are taken:

1. Assert: *F* is an ECMAScript function object.
2. Assert: `Type(newTarget)` is `Object`.
3. Let `callerContext` be the running execution context.
4. Let `kind` be *F*'s `[[ConstructorKind]]` internal slot.
5. If `kind` is `"base"`, then

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- a. Let *thisArgument* be *OrdinaryCreateFromConstructor(newTarget, "%ObjectPrototype%")*.
- b. *ReturnIfAbrupt(thisArgument)*.
6. Let *calleeContext* be *PrepareForOrdinaryCall(F, newTarget)*.
7. *ReturnIfAbrupt(calleeContext)*.
8. *Assert: calleeContext is now the active execution context*.
9. If *kind* is "base", then
 - a. Let *status* be *OrdinaryCallBindThis(F, calleeContext, thisArgument)*.
 - b. If *status* is an abrupt completion, then
 - i. Remove *calleeContext* from the execution context stack and restore *callerContext* as the running execution context.
 - ii. *Return status*.
10. Let *constructorEnv* be the LexicalEnvironment of *calleeContext*.
11. Let *envRec* be *constructorEnv*'s environment record.
12. Let *result* be *OrdinaryCallEvaluateBody(F, calleeContext, argumentsList)*.
13. Remove *calleeContext* from the execution context stack and restore *callerContext* as the running execution context.
14. If *result.[[type]]* is return, then
 - a. If *Type(result.[[value]])* is Object, return *NormalCompletion(result.[[value]])*.
 - b. If *kind* is "base", return *NormalCompletion(thisArgument)*.
 - c. Throw a *TypeError* exception.
15. *ReturnIfAbrupt(result)*.
16. *Return the result of calling the GetThisBinding concrete method of envRec's with no arguments*

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9.2.4 FunctionAllocate (*functionPrototype*, *strict* [, *functionKind*]) Abstract Operation

Deleted: <#>*Return Construct(F, argumentsList)*.¶

The abstract operation *FunctionAllocate* requires the two arguments *functionPrototype* and *strict*. It also accepts one optional argument, *functionKind*. *FunctionAllocate* performs the following steps:

1. *Assert: Type(functionPrototype) is Object*.
2. *Assert: If functionKind is present, its value is either "normal", "non-constructor" or "generator".*
3. If *functionKind* is not present, let *functionKind* be "normal".
4. If *functionKind* is "non-constructor", then
 - a. Let *functionKind* be "normal".
 - b. Let *needsConstruct* be false.
5. Else let *needsConstruct* be true.
6. Let *F* be a newly created ECMAScript function object with the internal slots listed in [Table 28](#), All of those internal slots are initialized to **undefined**.
7. Set *F*'s essential internal methods except for *[[GetOwnProperty]]* to the default ordinary object definitions specified in [9.1](#).
8. If *strict* is true, set *F*'s *[[GetOwnProperty]]* internal method to the default ordinary object definition specified in [9.1.5](#).
9. Else, set *F*'s *[[GetOwnProperty]]* internal method as specified in [9.2.1](#).
10. Set *F*'s *[[Call]]* internal method to the definition specified in [9.2.2](#).
11. If *needsConstruct* is true, then
 - a. Set *F*'s *[[Construct]]* internal method to the definition specified in [9.2.3](#).
 - b. If *functionKind* is "generator", set the *[[ConstructorKind]]* internal slot of *F* to "derived".
 - c. Else, set the *[[ConstructorKind]]* internal slot of *F* to "base".
 - d. NOTE Generator functions are tagged as "derived" constructors to prevent *[[Construct]]* from preallocating a generator instance. Generator instance objects are allocated when *EvaluateBody* is applied to the *GeneratorBody* of a generator function.
12. Set the *[[Strict]]* internal slot of *F* to *strict*.

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13. Set the `[[FunctionKind]]` internal slot of F to $functionKind$.
14. Set the `[[Prototype]]` internal slot of F to $functionPrototype$.
15. Set the `[[Extensible]]` internal slot of F to `true`.
16. Set the `[[Realm]]` internal slot of F to the running execution context's Realm.
17. Return F .

9.2.5 FunctionInitialize (F , $kind$, $Strict$, $ParameterList$, $Body$, $Scope$) Abstract Operation

The abstract operation `FunctionInitialize` requires the arguments: a function object F , $kind$ which is one of (Normal, Method, Arrow), a Boolean $Strict$, a parameter list production specified by $ParameterList$, a body production specified by $Body$, a Lexical Environment specified by $Scope$. `FunctionInitialize` performs the following steps:

1. Assert: F is an extensible object that does not have a `length` own property.
2. Let len be the `ExpectedArgumentCount` of $ParameterList$.
3. Let $realm$ be the value of F 's `[[Realm]]` internal slot.
4. Let $status$ be `DefinePropertyOrThrow`(F , `"length"`, `PropertyDescriptor`{`[[Value]]: len , [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true}).`
5. Assert: $status$ is not an abrupt completion.
6. Set the `[[Strict]]` internal slot of F to $Strict$.
7. Set the `[[Environment]]` internal slot of F to the value of $Scope$.
8. Set the `[[FormalParameters]]` internal slot of F to $ParameterList$.
9. Set the `[[ECMAScriptCode]]` internal slot of F to $Body$.
10. If $kind$ is Arrow, set the `[[ThisMode]]` internal slot of F to lexical.
11. Else if $Strict$ is `true`, set the `[[ThisMode]]` internal slot of F to strict.
12. Else set the `[[ThisMode]]` internal slot of F to global.
13. Return F .

Deleted: <#>Let $strict$ be the value of F 's `[[Strict]]` internal slot.
Deleted: ReturnIfAbrupt($status$).
Deleted: <#>If $strict$ $Strict$ is `true`, then
 <#>Let $status$ be AddRestrictedFunctionProperties(F , $realm$). ¶
 <#>ReturnIfAbrupt($status$). ¶
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Deleted: $strict$
Deleted: then

9.2.6 FunctionCreate ($kind$, $ParameterList$, $Body$, $Scope$, $Strict$) Abstract Operation

The abstract operation `FunctionCreate` requires the arguments: $kind$ which is one of (Normal, Method, Arrow), a parameter list production specified by $ParameterList$, a body production specified by $Body$, a Lexical Environment specified by $Scope$, a Boolean flag $Strict$, and optionally, an object $functionPrototype$. `FunctionCreate` performs the following steps:

1. If the `functionPrototype` argument was not passed, then,
 - a. Let $functionPrototype$ be the intrinsic object `%FunctionPrototype%`.
2. If $kind$ is not Normal, let $allocKind$ be "non-constructor".
3. Else let $allocKind$ be "normal".
4. Let F be `FunctionAllocate`($functionPrototype$, $Strict$, $allocKind$).
5. Return `FunctionInitialize`(F , $kind$, $Strict$, $ParameterList$, $Body$, $Scope$).

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9.2.7 GeneratorFunctionCreate ($kind$, $ParameterList$, $Body$, $Scope$, $Strict$) Abstract Operation

The abstract operation `GeneratorFunctionCreate` requires the arguments: $kind$ which is one of (Normal, Method), a parameter list production specified by $ParameterList$, a body production specified by $Body$, a Lexical Environment specified by $Scope$, and a Boolean flag $Strict$. `GeneratorFunctionCreate` performs the following steps:

1. Let `functionPrototype` be the intrinsic object `%Generator%`.
2. Let F be `FunctionAllocate`($functionPrototype$, $Strict$, "generator").
3. Return `FunctionInitialize`(F , $kind$, $Strict$, $ParameterList$, $Body$, $Scope$).

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Deleted: , and optionally, an object `functionPrototype`
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9.2.8 AddRestrictedFunctionProperties(*F, realm*) Abstract Operation

The abstract operation AddRestrictedFunctionProperties is called with a function object *F* and Realm Record *realm* as its argument. It performs the following steps:

1. Assert: *realm*.[[intrinsic]].[[%ThrowTypeError%]] exists and has been initialized.
2. Let *thrower* be *realm*.[[intrinsic]].[%ThrowTypeError%].
3. Let *status* be DefinePropertyOrThrow(*F*, "caller", PropertyDescriptor {[[Get]]: *thrower*, [[Set]]: *thrower*, [[Enumerable]]: false, [[Configurable]]: true}).
4. Assert: *status* is not an abrupt completion.
5. Return DefinePropertyOrThrow(*F*, "arguments", PropertyDescriptor {[[Get]]: *thrower*, [[Set]]: *thrower*, [[Enumerable]]: false, [[Configurable]]: true}).
6. Assert: The above returned value is not an abrupt completion.

9.2.8.1 %ThrowTypeError%()

The %ThrowTypeError% intrinsic is an anonymous built-in function object that is defined once for each Realm. When %ThrowTypeError% is called it performs the following steps:

1. Throw a **TypeError** exception.

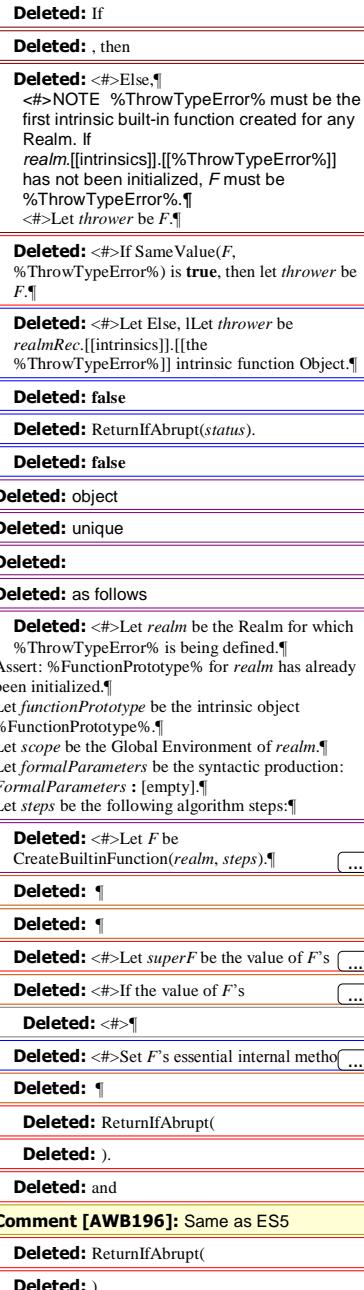
The value of the [[Extensible]] internal slot of a %ThrowTypeError% function is **false**.

The **length** property of a %ThrowTypeError% function has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }.

9.2.9 MakeConstructor(*F, writablePrototype, prototype*) Abstract Operation

The abstract operation MakeConstructor requires a Function argument *F* and optionally, a Boolean *writablePrototype* and an object *prototype*. If *prototype* is provided it is assumed to already contain, if needed, a "constructor" property whose value is *F*. This operation converts *F* into a constructor by performing the following steps:

1. Assert: *F* is an ECMAScript function object.
2. Assert: *F* has a [[Constructor]] internal method.
3. Assert: *F* is an extensible object that does not have a **prototype** own property.
4. Assert: If the **prototype** argument was provided it is an extensible object that does not have a **constructor** own property.
5. Let *installNeeded* be **false**.
6. If the *prototype* argument was not provided, then
 - a. Let *installNeeded* be **true**.
 - b. Let *prototype* be ObjectCreate(%ObjectPrototype%).
7. If the *writablePrototype* argument was not provided, then
 - a. Let *writablePrototype* be **true**.
8. If *installNeeded*, then
 - a. Let *status* be DefinePropertyOrThrow(*prototype*, "constructor", PropertyDescriptor {[[Value]]: *F*, [[Writable]]: *writablePrototype*, [[Enumerable]]: false, [[Configurable]]: *writablePrototype* }).
 - b. Assert: *status* is not an abrupt completion.
9. Let *status* be DefinePropertyOrThrow(*F*, "prototype", PropertyDescriptor {[[Value]]: *prototype*, [[Writable]]: *writablePrototype*, [[Enumerable]]: false, [[Configurable]]: false}).
10. Assert: *status* is not an abrupt completion.
11. Return NormalCompletion(**undefined**).



9.2.10 MakeClassConstructor (F) Abstract Operation

The abstract operation MakeClassConstructor with argument *F* performs the following steps:

1. Assert: *F* is an ECMAScript function object.
2. Assert: *F*'s [[FunctionKind]] internal slot is "normal".
3. Set *F*'s [[FunctionKind]] internal slot to "classConstructor".
4. Return NormalCompletion(**undefined**).

9.2.11 MakeMethod (F, homeObject) Abstract Operation

The abstract operation MakeMethod with arguments *F* and *homeObject* configures *F* as a method by performing the following steps:

1. Assert: *F* is an ECMAScript function object.
2. Assert: Type(*homeObject*) is either Undefined or Object.
3. Set the [[NeedsSuper]] internal slot of *F* to **true**.
4. Set the [[HomeObject]] internal slot of *F* to *homeObject*.
5. Return NormalCompletion(**undefined**).

9.2.12 SetFunctionName (F, name, prefix) Abstract Operation

The abstract operation SetFunctionName requires a Function argument *F*, a String or Symbol argument *name* and optionally a String argument *prefix*. This operation adds a **name** property to *F* by performing the following steps:

1. Assert: *F* is an extensible object that does not have a **name** own property.
2. Assert: Type(*name*) is either Symbol or String.
3. Assert: If *prefix* was passed, then Type(*prefix*) is String.
4. If Type(*name*) is Symbol, then
 - a. Let *description* be *name*'s [[Description]] value.
 - b. If *description* is **undefined**, let *name* be the empty String.
 - c. Else, let *name* be the concatenation of "[", *description*, and "]".
5. If *prefix* was passed, then
 - a. Let *name* be the concatenation of *prefix*, Unicode code point U+0020 (Space), and *name*.
6. Return DefinePropertyOrThrow(*F*, "name", PropertyDescriptor{[[Value]]: *name*, [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **true**}).
7. Assert: the result is never an abrupt completion.

9.2.13 FunctionDeclarationInstantiation(func, argumentsList, env) Abstract Operation

NOTE When an execution context is established for evaluating an ECMAScript function a new Function Environment Record is created and bindings for each formal parameter are instantiated in that environment record. Each declaration in the function body is also instantiated. If the function's formal parameters do not include any default value initializers then the body declarations are instantiated in the same environment record as the parameters. If default value parameter initializers exist, a second environment record is created for the body declarations. Formal parameters and functions are initialized as part of FunctionDeclarationInstantiation. All other bindings are initialized during evaluation of the function body.

FunctionDeclarationInstantiation is performed as follows using arguments *func*, *argumentsList*, and *env*. *func* is the function object that for which the execution context is being established. *env* is the Lexical environment in which formal parameter bindings are to be created.

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Deleted: <#>Assert: <i>methodName</i> is either undefined or a property key.
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Deleted: <#>Assert: Defining the name property will always succeed.
<#>Return NormalCompletion(undefined).
Deleted: <#>GetSuperBinding(<i>obj</i>)
Abstract Operation¶
The abstract operation GetSuperBinding is called with <i>obj</i> as its argument. It performs the following steps: ¶
<#>If Type(<i>obj</i>) is not Object, then return undefined .
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1. Let `envRec` be `env`'s environment record.
2. Let `calleeContext` be the running execution context.
3. Let `code` be the value of the `[[ECMAScriptCode]]` internal slot of `func`.
4. Let `strict` be the value of the `[[Strict]]` internal slot of `func`.
5. Let `formals` be the value of the `[[FormalParameters]]` internal slot of `func`.
6. Let `parameterNames` be the `BoundNames` of `formals`.
7. If `parameterNames` has any duplicate entries, let `hasDuplicates` be `true`. Otherwise, let `hasDuplicates` be `false`.
8. Let `simpleParameterList` be `IsSimpleParameterList` of `formals`.
9. Let `hasParameterExpressions` be `ContainsExpression` of `formals`.
10. Let `varNames` be the `VarDeclaredNames` of `code`.
11. Let `varDeclarations` be the `VarScopedDeclarations` of `code`.
12. Let `lexicalNames` be the `LexicallyDeclaredNames` of `code`.
13. Let `functionNames` be an empty List.
14. Let `functionsToInitialize` be an empty List.
15. For each `d` in `varDeclarations`, in reverse list order do
 - a. If `d` is neither a `VariableDeclaration` or a `ForBinding`, then
 - i. Assert: `d` is either a `FunctionDeclaration` or a `GeneratorDeclaration`.
 - ii. Let `fn` be the sole element of the `BoundNames` of `d`.
 - iii. If `fn` is not an element of `functionNames`, then
 1. Insert `fn` as the first element of `functionNames`.
 2. NOTE If there are multiple `FunctionDeclarations` or `GeneratorDeclarations` for the same name, the last declaration is used.
 3. Insert `d` as the first element of `functionsToInitialize`.
16. Let `argumentsObjectNeeded` be `true`.
17. If the value of the `[[ThisMode]]` internal slot of `func` is `lexical`, then
 - a. NOTE Arrow functions never have an `arguments` objects.
 - b. Let `argumentsObjectNeeded` be `false`.
18. Else if "`arguments`" is an element of `parameterNames`, then
 - a. Let `argumentsObjectNeeded` be `false`.
19. Else if `hasParameterExpressions` is `false`, then
 - a. If "`arguments`" is an element of `functionNames` or if "`arguments`" is an element of `lexicalNames`, then
 - i. Let `argumentsObjectNeeded` be `false`.
20. For each String `paramName` in `parameterNames`, do
 - a. Let `alreadyDeclared` be the result of calling `envRec`'s `HasBinding` concrete method passing `paramName` as the argument.
 - b. NOTE Early errors ensure that duplicate parameter names can only occur in non-strict functions that do not have parameter default values or rest parameters.
 - c. If `alreadyDeclared` is `false`, then
 - i. Let `status` be the result of calling `envRec`'s `CreateMutableBinding` concrete method passing `paramName` as the argument.
 - ii. If `hasDuplicates` is `true`, then
 1. Let `status` be the result of calling `envRec`'s `InitializeBinding` concrete method passing `paramName` and `undefined` as the argument.
 - iii. Assert: `status` is never an abrupt completion for either of the above operations.
21. If `argumentsObjectNeeded` is `true`, then
 - a. If `strict` is `true` or if `simpleParameterList` is `false`, then
 - i. Let `ao` be `CreateUnmappedArgumentsObject(argumentsList)`.
 - b. Else,
 - i. NOTE mapped argument object is only provided for non-strict functions that don't have a rest parameter, any parameter default value initializers, or any destructured parameters.
 - ii. Let `ao` be `CreateMappedArgumentsObject(func, formals, argumentsList, env)`.

- c. `ReturnIfAbrupt(ao).`
- d. If `strict` is `true`, then
- i. Let `status` be the result of calling `envRec`'s `CreateImmutableBinding` concrete method passing `"arguments"` as the argument.
 - e. Else,
 - i. Let `status` be the result of calling `envRec`'s `CreateMutableBinding` concrete method passing `"arguments"` as the argument.
- f. Assert: `status` is never an abrupt completion.
- g. Call `envRec`'s `InitializeBinding` concrete method passing `"arguments"` and `ao` as arguments.
- h. Append `"arguments"` to `parameterNames`.
22. If `hasDuplicates` is `true`, then
- a. Let `formalStatus` be the result of performing `IteratorBindingInitialization` for `formals` with `CreateListIterator(argumentsList)` and `undefined` as arguments.
23. Else,
- a. Let `formalStatus` be the result of performing `IteratorBindingInitialization` for `formals` with `CreateListIterator(argumentsList)` and `envRec` as arguments.
24. `ReturnIfAbrupt(formalStatus).`
25. If `hasParameterExpressions` is `false`, then
- a. NOTE Only a single lexical environment is needed for the parameters and top-level vars.
 - b. Let `instantiatedVarNames` be a copy of the List `parameterNames`.
 - c. For each `n` in `varNames`, do
 - i. If `n` is not an element of `instantiatedVarNames`, then
 1. Append `n` to `instantiatedVarNames`.
 2. Let `status` be the result of calling `envRec`'s `CreateMutableBinding` concrete method passing `n` as the argument.
 3. Assert: `status` is never an abrupt completion.
 4. Call `envRec`'s `InitializeBinding` concrete method passing `n` and `undefined` as arguments.
 - d. Let `varEnv` be `env`.
 - e. Let `varEnvRec` be `envRec`.
26. Else.
- a. NOTE A separate environment record is needed to ensure that closures created by expressions in the formal parameter list do not have visibility of declarations in the function body.
 - b. Let `varEnv` be `NewDeclarativeEnvironment(env)`.
 - c. Let `varEnvRec` be `varEnv`'s environment record.
 - d. Set the VariableEnvironment of `calleeContext` to `varEnv`.
 - e. Let `instantiatedVarNames` be a new emptyList.
 - f. For each `n` in `varNames`, do
 - i. If `n` is not an element of `instantiatedVarNames`, then
 1. Append `n` to `instantiatedVarNames`.
 2. Let `status` be the result of calling `varEnvRec`'s `CreateMutableBinding` concrete method passing `n` as the argument.
 3. Assert: `status` is never an abrupt completion.
 4. If `n` is not an element of `parameterNames` or if `n` is an element of `functionNames`, let `initialValue` be `undefined`.
 5. else,
 - a. Let `initialValue` be the result of calling `envRec`'s `GetBindingValue` concrete method passing `n` and `false` as the arguments.
 - b. `ReturnIfAbrupt(initialValue)`.
 6. Call `varEnvRec`'s `InitializeBinding` concrete method passing `n` and `initialValue` as arguments.
 7. NOTE vars whose names are the same as a formal parameter, initially have the same value as the corresponding initialized parameter.

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Deleted: <#>If `strict` is true, then, then
Deleted: <#>Let `status` be the result of calling `env`'s `CreateImmutableBinding` concrete method passing `"arguments"` as the argument.
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Deleted: <#>Let `status` be the result of calling `env`'s `CreateMutableBinding` concrete method passing `"arguments"` as the argument.
Deleted: <#>Assert: `status` is never an abrupt completion
Deleted: <#>if `argumentsObjectNeeded` is false, then let `ao` be `undefined`.
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Deleted: <#>If `needsSpecialArgumentsBinding` is true, then
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27. If *strict* is **false**, then
- Let *lexEnv* be *NewDeclarativeEnvironment*(*varEnv*).
 - NOTE:** Non-strict functions use a separate lexical environment record for top-level lexical declarations so that a direct *eval* (see 12.3.4.1) can determine whether any *var* scoped declarations introduced by the *eval* code conflict with pre-existing top-level lexically scoped declarations. This is not needed for strict functions because a strict direct *eval* always places all declarations into a new environment record.
28. Else, let *lexEnv* be *varEnv*.
29. Let *lexEnvRec* be *lexEnv*'s environment record.
30. Set *envRec*[[*topLex*]] to *lexEnvRec*.
31. Set the LexicalEnvironment of *calleeContext* to *lexEnv*.
32. Let *lexDeclarations* be the LexicallyScopedDeclarations of *code*.
33. For each element *d* in *lexDeclarations* do
- NOTE:** A lexically declared name cannot be the same as a function/generator declaration, formal parameter, or a *var* name. Lexically declared names are only instantiated here but not initialized.
 - For each element *dn* of the *BoundNames* of *d* do
 - If *IsConstantDeclaration* of *d* is **true**, then
 - Let *status* be the result of calling *lexEnvRec*'s *CreateImmutableBinding* concrete method passing *dn* and **true** as the arguments.
 - Else,
 - Let *status* be the result of calling *lexEnvRec*'s *CreateMutableBinding* concrete method passing *dn* and **false** as the arguments.
 - Assert: *status* is never an abrupt completion.
34. For each production *f* in *functionsToInitialize*, do
- Let *fn* be the sole element of the *BoundNames* of *f*.
 - Let *fo* be the result of performing *InstantiateFunctionObject* for *f* with argument *lexEnv*.
 - Let *status* be the result of calling *varEnvRec*'s *SetMutableBinding* concrete method passing *fn*, *fo* and **false** as the arguments.
 - Assert: *status* is never an abrupt completion.
35. Return *NormalCompletion*(empty).

NOTE B.3.2 provides an extension to the above algorithm that is necessary for backwards compatibility with web browser implementations of ECMAScript that predate the sixth edition of ECMA-262.

9.3 Built-in Function Objects

The built-in function objects defined in this specification may be implemented as either ECMAScript function objects (9.2) whose behaviour is provided using ECMAScript code or as implementation provided exotic function objects whose behaviour is provided in some other manner. In either case, the effect of calling such functions must conform to their specifications. An implementation may also provide additional built-in function objects that are not defined in this specification.

If a built-in function object is implemented as an exotic object it must have the ordinary object behaviour specified in 9.1 except [[GetOwnProperty]] which must be as specified in 9.2.1. All such exotic function objects also have [[Prototype]], [[Extensible]], and [[Realm]] internal slots.

Unless otherwise specified every built-in function object initially has the %FunctionPrototype% object (19.2.3) as the initial value of its [[Prototype]] internal slot.

The behaviour specified for each built-in function via algorithm steps or other means is the specification of the function body behaviour for both [[Call]] and [[Construct]] invocations of the function. For each built-in function, when invoked with [[Call]], the [[Call]] thisArgument provides the this value, the [[Call]]

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Deleted: If such an exotic function object has a [[Construct]] internal method it must also have a [[CreateAction]] internal slot.

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argumentsList provides the named parameters, and the *NewTarget* value is *undefined*. When invoked with *[[Construct]]*, the *this* value is uninitialized, the *[[Construct]] argumentsList* provides the named parameters, and the *[[Construct]] newTarget* parameter provides the *NewTarget* value. If the built-in function is implemented as an ECMAScript function object then this specified behaviour must be implemented by the ECMAScript code that is the body of the function. Built-in functions that are ECMAScript function objects must be strict mode functions. If a built-in constructor has any *[[Call]]* behaviour other than throwing a *TypeError* exception, an ECMAScript implementation of the function must be done in a manner that does not cause the function's *[[FunctionKind]]* internal slot to have the value "classConstructor".

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Built-in function objects that are not identified as constructors do not implement the *[[Construct]]* internal method unless otherwise specified in the description of a particular function. When a built-in constructor is called as part of a *new* expression the *argumentsList* parameter of the invoked *[[Construct]]* internal method provides the values for the built-in constructor's named parameters.

Built-in functions that are not constructors do not have a *prototype* property unless otherwise specified in the description of a particular function.

If a built-in function object is not implemented as an ECMAScript function it must provide *[[Call]]* and *[[Construct]]* internal methods that conforms to the following definitions:

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9.3.1 *[[Call]]* (*thisArgument*, *argumentsList*)

The *[[Call]]* internal method for a built-in function object *F* is called with parameters *thisArgument* and *argumentsList*, a List of ECMAScript language values. The following steps are taken:

1. Let *callerContext* be the running execution context.
2. If *callerContext* is not already suspended, Suspend *callerContext*.
3. Let *calleeContext* be a new execution context.
4. Set the Function of *calleeContext* to *F*.
5. Let *calleeRealm* be the value of *F*'s *[[Realm]]* internal slot.
6. Set the Realm of *calleeContext* to *calleeRealm*.
7. Perform any necessary implementation defined initialization of *calleeContext*.
8. Push *calleeContext* onto the execution context stack; *calleeContext* is now the running execution context.
9. Let *result* be the Completion Record that is the result of evaluating *F* in an implementation defined manner that conforms to the specification of *F*. *thisArgument* is the *this* value, *argumentsList* provides the named parameters, and the *NewTarget* value is *undefined*.
10. Remove *calleeContext* from the execution context stack and restore *callerContext* as the running execution context.
11. Return *result*.

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NOTE 1 When *calleeContext* is removed from the execution context stack it must not be destroyed if it has been suspended and retained by an accessible generator object for later resumption.

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9.3.2 *[[Construct]]* (*argumentsList*, *newTarget*)

The *[[Construct]]* internal method for built-in function object *F* is called with parameters *argumentsList* and *newTarget*. The steps performed as the same as *[[Call]]* (see 9.3.1) except that step 9 is replaced by:

9. Let *result* be the Completion Record that is the result of evaluating *F* in an implementation defined manner that conforms to the specification of *F*. The *this* value is uninitialized, *argumentsList* provides the named parameters, and *newTarget* provides the *NewTarget* value.

9.3.3 CreateBuiltinFunction(*realm*, *steps*, *prototype*, *internalSlotsList*) Abstract Operation

The abstract operation `CreateBuiltinFunction` takes arguments *realm*, *prototype*, and *steps*. The optional argument *internalSlotsList* is a List of the names of additional internal slot that must be defined as part of the object. If the list is not provided, an empty List is used. `CreateBuiltinFunction` returns a built-in function object created by the following steps:

1. Assert: *realm* is a Realm Record.
2. Assert: *steps* is either a set of algorithm steps or other definition of a functions behaviour provided in this specification.
3. Let *func* be a new built-in function object that when called performs the action described by *steps*. The new function object has internal slots whose names are the elements of *internalSlotsList*. The initial value of each of those internal slots is **undefined**.
4. Set the `[[Realm]]` internal slot of *func* to *realm*.
5. Set the `[[Prototype]]` internal slot of *func* to *prototype*.
6. Return *func*.

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Table 29 — Internal Slots of Exotic Bound Function Objects

Internal Slot	Type	Description
<code>[[BoundTargetFunction]]</code>	Callable Object	The wrapped function object.
<code>[[BoundThis]]</code>	Any	The value that is always passed as the <code>this</code> value when calling the wrapped function.
<code>[[BoundArguments]]</code>	List of Any	A list of values whose elements are used as the first arguments to any call to the wrapped function.

Unlike ECMAScript function objects, bound function objects do not use **an** alternative definition of the `[[GetProperty]]` internal methods. Bound function objects provide all of the essential internal methods as specified in 9.1. However, they use the following definitions for the essential internal methods of function objects.

9.4.1.1 `[[Call]]` (*thisArgument*, *argumentsList*)

When the `[[Call]]` internal method of an exotic bound function object, *F*, which was created using the bind function is called with parameters *thisArgument* and *argumentsList*, a List of ECMAScript language values, the following steps are taken:

1. Let *target* be the value of *F*'s `[[BoundTargetFunction]]` internal slot.

Deleted: <#>Let *boundArgs* be the value of *F*'s `[[BoundArguments]]` internal slot.¶

2. Let *boundThis* be the value of *F*'s [[BoundThis]] internal slot.
- 3. Let *boundArgs* be the value of *F*'s [[BoundArguments]] internal slot.**
4. Let *args* be a new list containing the same values as the list *boundArgs* in the same order followed by the same values as the list *argumentsList* in the same order.
5. Return Call(*target*, *boundThis*, *args*).

9.4.1.2 [[Construct]] (*argumentsList*, *newTarget*)

When the [[Construct]] internal method of an exotic bound function object, *F* that was created using the bind function is called with a list of arguments *argumentsList* and *newTarget*, the following steps are taken:

1. Let *target* be the value of *F*'s [[BoundTargetFunction]] internal slot.
2. Assert: *target* has a [[Construct]] internal method.
3. Let *boundArgs* be the value of *F*'s [[BoundArguments]] internal slot.
4. Let *args* be a new list containing the same values as the list *boundArgs* in the same order followed by the same values as the list *argumentsList* in the same order.
- 5. If SameValue(*F*, *newTarget*) is true, let *newTarget* be *target*.**
6. Return Construct(*target*, *args*, *newTarget*).

9.4.1.3 BoundFunctionCreate (*targetFunction*, *boundThis*, *boundArgs*) Abstract Operation

The abstract operation BoundFunctionCreate with arguments *targetFunction*, *boundThis* and *boundArgs* is used to specify the creation of new Bound Function exotic objects. It performs the following steps:

1. Let *proto* be the intrinsic %FunctionPrototype%.
2. Let *obj* be a newly created object.
3. Set *obj*'s essential internal methods to the default ordinary object definitions specified in 9.1.
4. Set the [[Call]] internal method of *obj* as described in 9.4.1.1.
5. If *targetFunction* has a [[Construct]] internal method, then
 - a. Set the [[Construct]] internal method of *obj* as described in 9.4.1.2.
6. Set the [[Prototype]] internal slot of *obj* to *proto*.
7. Set the [[Extensible]] internal slot of *obj* to **true**.
8. Set the [[BoundTargetFunction]] internal slot of *obj* to *targetFunction*.
9. Set the [[BoundThis]] internal slot of *obj* to the value of *boundThis*.
10. Set the [[BoundArguments]] internal slot of *obj* to *boundArgs*.
11. Return *obj*.

9.4.1.4 BoundFunctionClone (*function*) Abstract Operation

The abstract operation BoundFunctionClone is called with argument *function* it performs the following steps:

1. **Assert: *function* is a Bound Function exotic object.**
2. **Let *new* be a new Bound Function exotic object that has all of the same internal methods and internal slots as *function*.**
3. **Set the value of each of *new*'s internal slots, except for [[Extensible]] to the value of *function*'s corresponding internal slot.**
4. **Set *new*'s [[Extensible]] internal slot to **true**.**
5. **Return *new*.**

9.4.2 Array Exotic Objects

An Array object is an exotic object that gives special treatment to array index property keys (see 6.1.7). A property whose property name is an array index is also called an element. Every Array object has a

Deleted: <#>Let <i>target</i> be the value of <i>F</i> 's [[BoundTargetFunction]] internal slot.¶
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Deleted: <i>ExtraArgs</i>
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Deleted: <#>Assert: Type(<i>newHome</i>) is Object.¶
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Deleted: <#>Let <i>realm</i> be GetFunctionRealmBoundFunctionTargetRealm(<i>new</i>).¶
<#>Let <i>status</i> be AddRestrictedFunctionProperties(<i>new</i> , <i>realm</i>).¶
<#>ReturnIfAbrupt(<i>status</i>).¶
Deleted: <#>BoundFunctionTargetRealm (<i>bound</i>) Abstract Operation¶
The abstract operation BoundFunctionTargetRealm with argument <i>bound</i> performs the following steps:¶
<#>Assert: <i>bound</i> is a Bound Function exotic object.¶
<#>Let <i>target</i> be <i>bound</i> 's [[BoundTargetFunction]] internal slot.¶
<#>If <i>target</i> is a Bound Function exotic object, then¶
<#>Return BoundFunctionTargetRealm(<i>target</i>).¶
<#>If <i>target</i> has a [[Realm]] internal slot, then¶
<#>Return <i>target</i> 's [[Realm]] internal slot.¶
<#>Return the running execution context's Realm.¶
NOTE Step 5 will only be reached if <i>target</i> is a non-standard exotic function object that does not have a [[Realm]] internal slot.¶
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length property whose value is always a nonnegative integer less than 2^{32} . The value of the **length** property is numerically greater than the name of every own property whose name is an array index; whenever an own property of an Array object is created or changed, other properties are adjusted as necessary to maintain this invariant. Specifically, whenever an own property is added whose name is an array index, the value of the length property is changed, if necessary, to be one more than the numeric value of that array index; and whenever the value of the length property is changed, every own property whose name is an array index whose value is not smaller than the new length is deleted. This constraint applies only to own properties of an Array object and is unaffected by **length** or array index properties that may be inherited from its prototypes.

NOTE A String property name *P* is an *array index* if and only if $\text{ToString}(\text{ToUint32}(P))$ is equal to *P* and $\text{ToUint32}(P)$ is not equal to $2^{32}-1$.

Array exotic objects always have a non-configurable property named "**length**".

Array exotic objects provide an alternative definition for the **[[DefineOwnProperty]]** internal method. Except for that internal method, Array exotic objects provide all of the other essential internal methods as specified in 9.1.

9.4.2.1 **[[DefineOwnProperty]] (*P*, *Desc*)**

When the **[[DefineOwnProperty]]** internal method of an Array exotic object *A* is called with property key *P*, and Property Descriptor *Desc* the following steps are taken:

1. Assert: **IsPropertyKey(*P*)** is **true**.
2. If *P* is "**length**", then
 - a. Return **ArraySetLength(*A*, *Desc*)**.
3. Else if *P* is an array index, then
 - a. Let *oldLenDesc* be **OrdinaryGetOwnProperty(*A*, "length")**.
 - b. **Assert: *oldLenDesc* will never be undefined or an accessor descriptor because Array objects are created with a length data property that cannot be deleted or reconfigured.**
 - c. Let *oldLen* be *oldLenDesc*.**[[Value]]**.
 - d. Let *index* be **ToUint32(*P*)**.
 - e. **Assert: *index* will never be an abrupt completion.**
 - f. If *index* \geq *oldLen* and *oldLenDesc*.**[[Writable]]** is **false**, **return false**.
 - g. Let *succeeded* be **OrdinaryDefineOwnProperty(*A*, *P*, *Desc*)**.
 - h. **Assert: *succeeded* is not an abrupt completion.**
 - i. If *succeeded* is **false**, **return false**.
 - j. If *index* \geq *oldLen*
 - i. Set *oldLenDesc*.**[[Value]]** to *index* + 1.
 - ii. Let *succeeded* be **OrdinaryDefineOwnProperty(*A*, "length", *oldLenDesc*)**.
 - iii. **Assert: *succeeded* is true.**
 - k. Return **true**.
4. Return **OrdinaryDefineOwnProperty(*A*, *P*, *Desc*)**.

9.4.2.2 **ArrayCreate(*length*, *proto*) Abstract Operation**

The abstract operation **ArrayCreate** with argument *length* (a positive integer) and optional argument *proto* is used to specify the creation of new Array exotic objects. It performs the following steps:

1. **Assert: *length* is an integer Number ≥ 0 .**
2. If *length* is -0 , let *length* be $+0$.
3. If *length* $> 2^{32}-1$, throw a **RangeError** exception.

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Deleted: <#>Let *oldLenDesc* be the result of calling the **[[GetOwnProperty]]** internal method of *A* passing "**length**" as the argument. The result will never be undefined or an accessor descriptor because Array objects are created with a length data property that cannot be deleted or reconfigured. ¶

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4. If the `proto` argument was not passed, let `proto` be the intrinsic object `%ArrayPrototype%`.
5. Let `A` be a newly created Array exotic object.
6. Set `A`'s essential internal methods except for `[[DefineOwnProperty]]` to the default ordinary object definitions specified in 9.1.
7. Set the `[[DefineOwnProperty]]` internal method of `A` as specified in 9.4.2.1.
8. Set the `[[Prototype]]` internal slot of `A` to `proto`.
9. Set the `[[Extensible]]` internal slot of `A` to `true`.
10. Call `OrdinaryDefineOwnProperty` with arguments `A`, `"length"` and `PropertyDescriptor{[[Value]]: length, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: false}`.
11. Return `A`.

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Deleted: <#>If `length` is not `undefined`, then
 <#>Set the `[[ArrayInitialisatnInitializationState]]` internal slot of `A` to `true`.
 <#>Else
 <#>Set the `[[ArrayInitialisatnInitializationState]]` internal slot of `A` to `false`.
 <#>Let `length` be `+0`.
 <#>If `length`> $2^{32}-1$, then throw a `RangeError` exception. ¶

9.4.2.3 `ArraySpeciesCreate(originalArray, length)` Abstract Operation

The abstract operation `ArraySpeciesCreate` with arguments `originalArray` and `length` is used to specify the creation of a new Array object using a constructor function that is derived from `originalArray`. It performs the following steps:

1. Assert: `length` is an integer Number ≥ 0 .
2. If `length` is -0 , let `length` be $+0$.
3. Let `C` be `undefined`.
4. If `IsArray(originalArray)` is `true`, then
 - a. Let `C` be `Get(originalArray, "constructor")`.
 - b. `ReturnIfAbrupt(C)`.
 - c. If `IsConstructor(C)` is `true`, then
 - i. Let `thisRealm` be the running execution context's Realm.
 - ii. Let `realmC` be `GetFunctionRealm(C)`.
 - iii. If `thisRealm` and `realmC` are not the same Realm Record, then
 1. If `SameValue(C, realmC.[[intrinsic]].[[%Array%]])` is `true`, let `C` be `undefined`.
 - d. If `Type(C)` is `Object`, then
 - i. Let `C` be `Get(C, @@species)`.
 - ii. `ReturnIfAbrupt(C)`.
5. If `C` is `undefined`, return `ArrayCreate(length)`.
6. If `IsConstructor(C)` is `false`, throw a `TypeError` exception.
7. Return `Construct(C, <length>)`.

Deleted: NOTE Passing `undefined` as the first argument to `ArrayCreate` causes the `[[ArrayInitialisatnInitializationState]]` internal slot of the array to be initially assigned set to the value `false`. This is a flag is used to indicate that the instance has not yet been initialized by the `Array` constructor. This flag value is never directly exposed to ECMAScript code; hence implementations may choose to encode the flag in any unobservable manner. ¶

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 <#>ReturnIfAbrupt(isArray).¶

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NOTE If `originalArray` was created using the standard built-in `Array` constructor for a Realm that is not the Realm of the running execution context, then a new `Array` is created using the Realm of the running execution context. This maintains compatibility with Web browsers that have historically had that behaviour for the `Array.prototype` methods that now are defined using `ArraySpeciesCreate`.

9.4.2.4 `ArraySetLength(A, Desc)` Abstract Operation

When the abstract operation `ArraySetLength` is called with an `Array` exotic object `A`, and Property Descriptor `Desc` the following steps are taken:

1. If the `[[Value]]` field of `Desc` is absent, then
 - a. Return `OrdinaryDefineOwnProperty(A, "length", Desc)`.
2. Let `newLenDesc` be a copy of `Desc`.
3. Let `newLen` be `ToInt32(Desc.[[Value]])`.
4. `ReturnIfAbrupt(newLen)`.
5. Let `numberLen` be `ToNumber(Desc.[[Value]])`.
6. `ReturnIfAbrupt(numberLen)`.
7. If `newLen` ≠ `numberLen`, throw a `RangeError` exception.

8. Set `newLenDesc.[[Value]]` to `newLen`.
- ~~9. Let `oldLenDesc` be `OrdinaryGetOwnProperty(A, "length")`.~~
- ~~10. Assert: `oldLenDesc` is not an abrupt completion.~~
11. ~~Assert: `oldLenDesc` will never be **undefined** or an accessor descriptor because Array objects are created with a length data property that cannot be deleted or reconfigured.~~
12. Let `oldLen` be `oldLenDesc.[[Value]]`.
13. If `newLen ≥ oldLen`, then
 - a. Return `OrdinaryDefineOwnProperty(A, "length", newLenDesc)`.
14. If `oldLenDesc.[[Writable]]` is **false**, return **false**.
15. If `newLenDesc.[[Writable]]` is absent or has the value **true**, let `newWritable` be **true**.
16. Else,
 - a. Need to defer setting the `[[Writable]]` attribute to **false** in case any elements cannot be deleted.
 - b. Let `newWritable` be **false**.
 - c. Set `newLenDesc.[[Writable]]` to **true**.
17. Let `succeeded` be `OrdinaryDefineOwnProperty(A, "length", newLenDesc)`.
- ~~18. Assert:`succeeded` is not an abrupt completion.~~
19. If `succeeded` is **false**, return **false**.
20. While `newLen < oldLen` repeat,
 - a. Set `oldLen` to `oldLen - 1`.
 - b. Let `deleteSucceeded` be the result of calling the `[Delete]` internal method of `A` passing `ToString(oldLen)`.
 - c. ~~Assert: `deleteSucceeded` is not an abrupt completion.~~
 - d. If `deleteSucceeded` is **false**, then
 - i. Set `newLenDesc.[[Value]]` to `oldLen + 1`.
 - ii. If `newWritable` is **false**, set `newLenDesc.[[Writable]]` to **false**.
 - iii. Let `succeeded` be `OrdinaryDefineOwnProperty(A, "length", newLenDesc)`.
 - iv. ~~Assert:`succeeded` is not an abrupt completion.~~
 - v. Return **false**.
21. If `newWritable` is **false**, then
 - a. ~~Return `OrdinaryDefineOwnProperty(A, "length", PropertyDescriptor{[[Writable]]: false})`.~~

This call will always return **true**.
22. Return **true**.

NOTE In steps 3 and 4, if `Desc.[[Value]]` is an object then its `valueOf` method is called twice. This is legacy behaviour that was specified with this effect starting with the 2nd Edition of this specification.

9.4.3 String Exotic Objects

A `String` object is an exotic object that encapsulates a `String` value and exposes virtual integer indexed data properties corresponding to the individual code unit elements of the string value. Exotic `String` objects always have a data property named `"length"` whose value is the number of code unit elements in the encapsulated `String` value. Both the code unit data properties and the `"length"` property are non-writable and non-configurable.

Exotic `String` objects have the same internal slots as ordinary objects. They also have a `[[StringData]]` internal slot.

Exotic `String` objects provide alternative definitions for the following internal methods. All of the other exotic `String` object essential internal methods that are not defined below are as specified in 9.1.

- Deleted:** the result of calling the `[GetOwnProperty]` internal method of `A` passing `"length"` as the argument
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9.4.3.1 [[GetOwnProperty]] (P)

When the [[GetOwnProperty]] internal method of an exotic String object S is called with property key P the following steps are taken:

1. Assert: IsPropertyKey(P) is **true**.
2. Let $desc$ be OrdinaryGetOwnProperty(S, P).
3. If $desc$ is not **undefined** return $desc$.
4. Return StringGetIndexProperty(S, P).

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9.4.3.1.1 StringGetIndexProperty (S, P)

When the abstract operation StringGetIndexProperty is called with an exotic String object S and with property key P , the following steps are taken:

1. If Type(P) is not String, **return undefined**.
2. Let $index$ be CanonicalNumericIndexString (P).
3. Assert: $index$ is not an abrupt completion.
4. If $index$ is **undefined**, **return undefined**.
5. If IsInteger($index$) is **false**, **return undefined**.
6. If $index = -0$, **return undefined**.
7. Let str be the String value of the [[StringData]] internal slot of S .
8. Let len be the number of elements in str .
9. If $index < 0$ or $len \leq index$, **return undefined**.
10. Let $resultStr$ be a String value of length 1, containing one code unit from str , specifically the code unit at index.
11. Return a PropertyDescriptor{ [[Value]]: $resultStr$, [[Enumerable]]: **true**, [[Writable]]: **false**, [[Configurable]]: **false** }.

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Deleted: <#>If SameValue($absIntIndex, P$) is false return **undefined**.¶
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Deleted: , where the first (leftmost) element in str is considered to be at position 0, the next one at position 1, and so on

9.4.3.2 [[HasProperty]](P)

When the [[HasProperty]] internal method of an exotic String object S is called with property key P , the following steps are taken:

1. Let $hasOrdinary$ be OrdinaryHasProperty(S, P).
2. If $hasOrdinary$ is **true**, **return true**.
3. Let $desc$ be StringGetIndexProperty(S, P).
4. If $desc$ is **undefined**, **return false**; otherwise, **return true**.

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9.4.3.3 [[Enumerate]] ()

When the [[Enumerate]] internal method of an exotic String object O is called the following steps are taken:

1. Let $indexKeys$ be a new empty List.
2. Let str be the String value of the [[StringData]] internal slot of O .
3. Let len be the number of elements in str .
4. For each integer i starting with 0 such that $i < len$, in ascending order,
 - a. Add ToString(i) as the last element of $indexKeys$.
5. Let $ordinary$ be the result of calling the default ordinary object [[Enumerate]] internal method (9.1.11) on O .
6. ReturnIfAbrupt($ordinary$).
7. Return CreateCompoundIterator(CreateListIterator($indexKeys$), $ordinary$).

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9.4.3.4 `[[OwnPropertyKeys]]()`

When the `[[OwnPropertyKeys]]` internal method of a String exotic object O is called the following steps are taken:

1. Let $keys$ be a new empty List.
2. Let str be the String value of the `[[StringData]]` internal slot of O .
3. Let len be the number of elements in str .
4. For each integer i starting with 0 such that $i < len$, in ascending order
 - a. Add $\text{ToString}(i)$ as the last element of $keys$.
5. For each own property key P of O such that P is an integer index and $\text{ToInteger}(P) \geq len$, in ascending numeric index order,
 - a. Add P as the last element of $keys$.
6. For each own property key P of O such that $\text{Type}(P)$ is `String` and P is not an integer index, in property creation order,
 - a. Add P as the last element of $keys$.
7. For each own property key P of O such that $\text{Type}(P)$ is `Symbol`, in property creation order,
 - a. Add P as the last element of $keys$.
8. Return $keys$.

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9.4.3.5 `StringCreate(value, prototype)` Abstract Operation

The abstract operation `StringCreate` with arguments s value and prototype is used to specify the creation of new exotic String objects. It performs the following steps:

1. ReturnIfAbrupt(prototype).
2. Assert: Type(value) is String.
3. Let S be a newly created String exotic object.
4. Set the `[[StringData]]` internal slot of S to value.
5. Set S 's essential internal methods to the default ordinary object definitions specified in 9.1.
6. Set the `[[GetOwnProperty]]` internal method of S as specified in 9.4.3.1.
7. Set the `[[Enumerate]]` internal method of S as specified in 9.4.3.2.
8. Set the `[[OwnPropertyKeys]]` internal method of S as specified in 9.4.3.3.
9. Set the `[[Prototype]]` internal slot of S to `prototype`.
10. Set the `[[Extensible]]` internal slot of S to `true`.
11. Let $length$ be the number of code unit elements in $value$.
12. Let $status$ be `DefinePropertyOrThrow(S, "length", PropertyDescriptor{[[Value]]: length, [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false })`.
13. Assert: status is not an abrupt completion.
14. Return S .

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9.4.4 Arguments Exotic Objects

Most ECMAScript functions make an arguments objects available to their code. Depending upon the characteristics of the function definition, its argument object is either an ordinary object or an arguments exotic object. An arguments exotic object is an exotic object whose array index properties map to the formal parameters bindings of an invocation of its associated ECMAScript function.

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Arguments exotic objects have the same internal slots as ordinary objects. They also have a `[[ParameterMap]]` internal slot. Ordinary arguments objects also have a `[[ParameterMap]]` internal slot whose value is always undefined. For ordinary argument objects the `[[ParameterMap]]` internal slot is only used by `Object.prototype.toString` (19.1.3.6) to identify them as such.

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Arguments exotic objects provide alternative definitions for the following internal methods. All of the other exotic arguments object essential internal methods that are not defined below are as specified in 9.1.

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NOTE 1 For non-strict mode functions the integer indexed data properties of an arguments object whose numeric name values are less than the number of formal parameters of the corresponding function object initially share their values with the corresponding argument bindings in the function's execution context. This means that changing the property changes the corresponding value of the argument binding and vice-versa. This correspondence is broken if such a property is deleted and then redefined or if the property is changed into an accessor property. For strict mode functions, the values of the arguments object's properties are simply a copy of the arguments passed to the function and there is no dynamic linkage between the property values and the formal parameter values.

NOTE 2 The ParameterMap object and its property values are used as a device for specifying the arguments object correspondence to argument bindings. The ParameterMap object and the objects that are the values of its properties are not directly observable from ECMAScript code. An ECMAScript implementation does not need to actually create or use such objects to implement the specified semantics.

NOTE 3 Arguments objects for strict mode functions define non-configurable accessor properties named "`caller`" and "`callee`" which throw a **TypeError** exception on access. The "`callee`" property has a more specific meaning for non-strict mode functions and a "`caller`" property has historically been provided as an implementation-defined extension by some ECMAScript implementations. The strict mode definition of these properties exists to ensure that neither of them is defined in any other manner by conforming ECMAScript implementations.

9.4.4.1 **[[GetOwnProperty]] (P)**

The **[[GetOwnProperty]]** internal method of an arguments exotic object when called with a property name *P* performs the following steps:

1. Let *args* be the arguments object.
2. Let *desc* be *OrdinaryGetOwnProperty(args, P)*.
3. If *desc* is **undefined**, return *desc*.
4. Let *map* be the value of the **[[ParameterMap]]** internal slot of the arguments object.
5. Let *isMapped* be *HasOwnProperty(map, P)*.
6. Assert: *isMapped* is never an abrupt completion.
7. If the value of *isMapped* is **true**, then
 - a. Set *desc.[[Value]]* to *Get(map, P)*.
8. If *IsDataDescriptor(desc)* is **true** and *P* is "`caller`" and *desc.[[Value]]* is a strict mode Function object, throw a **TypeError** exception.
9. Return *desc*.

If an implementation does not provide a built-in `caller` property for argument exotic objects then step 8 of this algorithm is must be skipped.

9.4.4.2 **[[DefineOwnProperty]] (P, Desc)**

The **[[DefineOwnProperty]]** internal method of an arguments exotic object when called with a property name *P* and Property Descriptor *Desc* performs the following steps:

1. Let *args* be the arguments object.
2. Let *map* be the value of the **[[ParameterMap]]** internal slot of the arguments object.
3. Let *isMapped* be *HasOwnProperty(map, P)*.
4. Let *allowed* be *OrdinaryDefineOwnProperty(args, P, Desc)*.
5. ReturnIfAbrupt(allowed).
6. If *allowed* is **false**, return false.

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7. If the value of *isMapped* is **true**, then
 - a. If *IsAccessorDescriptor*(*Desc*) is **true**, then
 - i. Call the **[[Delete]]** internal method of *map* passing *P* as the argument.
 - b. Else
 - i. If *Desc*.**[[Value]]** is present, then
 1. Let *putStatus* be *Put*(*map*, *P*, *Desc*.**[[Value]]**, **false**).
 2. **Assert: *putStatus* is **true**** because formal parameters mapped by argument objects are always writable.
 - ii. If *Desc*.**[[Writable]]** is present and its value is **false**, then
 1. Call the **[[Delete]]** internal method of *map* passing *P* as the argument.
8. Return **true**.

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2. **Assert: *putStatus* is **true**** because formal parameters mapped by argument objects are always writable.

9.4.4.3 **[[Get]] (P, Receiver)**

The **[[Get]]** internal method of an arguments exotic object when called with a property name *P* and ECMA Script language value *Receiver* performs the following steps:

1. Let *args* be the arguments object.
2. Let *map* be the value of the **[[ParameterMap]]** internal slot of the arguments object.
3. Let *isMapped* be *HasOwnProperty*(*map*, *P*).
4. **Assert: *isMapped* is not an abrupt completion.**
5. If the value of *isMapped* is **false**, then
 - a. Let *v* be the result of calling the default ordinary object **[[Get]]** internal method (9.1.8) on *args* passing *P* and *Receiver* as the arguments.
6. Else *map* contains a formal parameter mapping for *P*.
 - a. Let *v* be *Get*(*map*, *P*).
7. **ReturnIfAbrupt**(*v*).
8. Return *v*.

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9.4.4.4 **[[Set]] (P, V, Receiver)**

The **[[Set]]** internal method of an arguments exotic object when called with property key *P*, value *V*, and ECMA Script language value *Receiver* performs the following steps:

1. Let *args* be the arguments object.
2. **If *SameValue*(*args*, *Receiver*) is **false**, then**
 - a. Let *isMapped* be **undefined**.
3. **Else**
 - a. Let *map* be the value of the **[[ParameterMap]]** internal slot of the arguments object.
 - b. Let *isMapped* be *HasOwnProperty*(*map*, *P*).
 - c. **Assert: *isMapped* is not an abrupt completion.**
4. If the value of *isMapped* is **false**, then
 - a. Return the result of calling the default ordinary object **[[Set]]** internal method (9.1.9) on *args* passing *P*, *V* and *Receiver* as the arguments.
5. Else *map* contains a formal parameter mapping for *P*.
 - a. Return *Put*(*map*, *P*, *V*, **false**).

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9.4.4.5 **[[Delete]] (P)**

The **[[Delete]]** internal method of an arguments exotic object when called with a property key *P* performs the following steps:

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1. Let *map* be the value of the **[[ParameterMap]]** internal slot of the arguments object.

2. Let *isMapped* be HasOwnProperty(*map*, *P*).
3. Assert: *isMapped* is not an abrupt completion.
4. Let *result* be the result of calling the default [[Delete]] internal method for ordinary objects (9.1.10) on the arguments object passing *P* as the argument.
5. ReturnIfAbrupt(*result*).
6. If *result* is true and the value of *isMapped* is true, then
 - a. Call the [[Delete]] internal method of *map* passing *P* as the argument.
7. Return *result*.

9.4.4.6 CreateUnmappedArgumentsObject(argumentsList) Abstract Operation

The abstract operation CreateUnmappedArgumentsObject called with an argument *argumentsList* performs the following steps:

1. Let *len* be the number of elements in *argumentsList*.
2. Let *obj* be ObjectCreate(%ObjectPrototype%, [[ParameterMap]]).
3. Set *obj*'s [[ParameterMap]] internal slot to undefined.
4. Perform DefinePropertyOrThrow(*obj*, "length", PropertyDescriptor{[[Value]]: *len*, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true}).
5. Let *index* be 0.
6. Repeat while *index* < *len*,
 - a. Let *val* be the element of *argumentsList*[*index*].
 - b. Perform CreateDataProperty(*obj*, ToString(*index*), *val*).
 - c. Let *index* be *index* + 1
7. Perform DefinePropertyOrThrow(*obj*, @@iterator, PropertyDescriptor{[[Value]]: %ArrayProto_values%, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true}).
8. Perform DefinePropertyOrThrow(*obj*, "caller", PropertyDescriptor{[[Get]]: %ThrowTypeError%, [[Set]]: %ThrowTypeError%, [[Enumerable]]: false, [[Configurable]]: false}).
9. Perform DefinePropertyOrThrow(*obj*, "callee", PropertyDescriptor{[[Get]]: %ThrowTypeError%, [[Set]]: %ThrowTypeError%, [[Enumerable]]: false, [[Configurable]]: false}).
10. Assert: the above property definitions will not produce an abrupt completion.
11. Return *obj*

9.4.4.7 CreateMappedArgumentsObject (func, formals, argumentsList, env) Abstract Operation

The abstract operation CreateMappedArgumentsObject is called with object *func*, grammar production *formals*, List *argumentsList*, and environment record *env*. The following steps are performed:

1. Assert: *formals* does not contain a rest parameter, any binding patterns, or any initializers. It may contain duplicate identifiers.
2. Let *len* be the number of elements in *argumentsList*.
3. Let *obj* be a newly created arguments exotic object with a [[ParameterMap]] internal slot.
4. Set the [[GetOwnProperty]] internal method of *obj* as specified in 9.4.4.1.
5. Set the [[DefineOwnProperty]] internal method of *obj* as specified in 9.4.4.2.
6. Set the [[Get]] internal method of *obj* as specified in 9.4.4.3.
7. Set the [[Set]] internal method of *obj* as specified in 9.4.4.4.
8. Set the [[Delete]] internal method of *obj* as specified in 9.4.4.5.
9. Set the remainder of *obj*'s essential internal methods to the default ordinary object definitions specified in 9.1.
10. Set the [[Prototype]] internal slot of *obj* to %ObjectPrototype%.
11. Set the [[Extensible]] internal slot of *obj* to true.

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Deleted: NOTE 1 For non-strict mode functions with simple parameter lists, those integer indexed data properties of an arguments object whose numeric name values are less than the number of formal parameters of the function initially share their values with the corresponding argument bindings in the function's execution context. This means that changing the property changes the corresponding value of the argument binding and vice-versa. This correspondence is broken if such a property is deleted and then redefined or if the property is changed into an accessor property. For strict mode functions, the values of the arguments object's properties are simply a copy of the arguments passed to the function and there is no dynamic linkage between the property values and the formal parameter values.¶

NOTE 2. The ParameterMap object and its property values are used as a device for specifying the arguments object correspondence to argument bindings. The ParameterMap object and the objects that are the values of its properties are not directly accessible from ECMAScript code. An ECMAScript implementation does not need to actually create or use such objects to implement the specified semantics.¶

NOTE 3 Arguments objects for strict mode functions define non-configurable accessor properties named "caller" and "callee" which throw a **TypeError** exception on access...¶

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12. Let *parameterNames* be the BoundNames of *formals*.
13. Let *numberOfParameters* be the number of elements in *parameterNames*
14. Let *index* be 0.
15. Repeat while *index* < *len*.
 - a. Let *val* be the element of *argumentsList*[*index*].
 - b. Perform *CreateDataProperty*(*obj*, *ToString*(*index*), *val*).
 - c. Let *index* be *index* + 1
16. Perform *DefinePropertyOrThrow*(*obj*, "length", *PropertyDescriptor*{[[Value]]: *len*, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true}).
17. Let *map* be *ObjectCreate*(null).
18. Let *mappedNames* be an empty List.
19. Let *index* be *numberOfParameters* - 1.
20. Repeat while *index* ≥ 0.
 - a. Let *name* be the element of *parameterNames*[*index*].
 - b. If *name* is not an element of *mappedNames*, then
 - i. Add *name* as an element of the list *mappedNames*.
 - ii. If *index* < *len*, then
 1. Let *g* be *MakeArgGetter*(*name*, *env*).
 2. Let *p* be *MakeArgSetter*(*name*, *env*).
 3. Call the [[DefineOwnProperty]] internal method of *map* passing *ToString*(*index*) and the *PropertyDescriptor*{[[Set]]: *p*, [[Get]]: *g*, [[Enumerable]]: false, [[Configurable]]: true} as arguments.
 - c. Let *index* be *index* - 1
21. Set the [[ParameterMap]] internal slot of *obj* to *map*.
22. Perform *DefinePropertyOrThrow*(*obj*, @@iterator, *PropertyDescriptor*{[[Value]]: %ArrayProto_values%, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true}).
23. Perform *DefinePropertyOrThrow*(*obj*, "callee", *PropertyDescriptor* {[[Value]]: *func*, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true}).
24. Assert: the above property definitions will not produce an abrupt completion.
25. Return *obj*

9.4.4.7.1 MakeArgGetter (name, env) Abstract Operation

The abstract operation *MakeArgGetter* called with String *name* and environment record *env* creates a built-in function object that when executed returns the value bound for *name* in *env*. It performs the following steps:

1. Let *realm* be the current Realm.
2. Let *steps* be the steps of an ArgGetter function as specified below.
3. Let *getter* be *CreateBuiltInFunction*(*realm*, *steps*, %FunctionPrototype%, [[name]], [[env]]).
4. Set *getter*'s [[name]] internal slot to *name*.
5. Set *getter*'s [[env]] internal slot to *env*.
6. Return *getter*.

An ArgGetter function is an anonymous built-in function with [[name]] and [[env]] internal slots. When an ArgGetter function *f* that expects no arguments is called it performs the following steps:

1. Let *name* be the value of *f*'s [[name]] internal slot.
2. Let *env* be the value of *f*'s [[env]] internal slot.
3. Return the result of calling the *GetBindingValue* concrete method of *env* with arguments *name* and *false*.

NOTE ArgGetter functions are never directly accessible to ECMAScript code.

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9.4.4.7.2 MakeArgSetter (name, env) Abstract Operation

The abstract operation `MakeArgSetter` called with String `name` and environment record `env` creates a built-in function object that when executed sets the value bound for `name` in `env`. It performs the following steps:

1. Let `realm` be the current Realm.
2. Let `steps` be the steps of an `ArgSetter` function as specified below.
3. Let `setter` be `CreateBuiltInFunction(realm, steps, %FunctionPrototype%, «[[name]], [[env]]»).`
4. Set `setter`'s `[[name]]` internal slot to `name`.
5. Set `setter`'s `[[env]]` internal slot to `env`.
6. Return `setter`.

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An `ArgSetter` function is an anonymous built-in function with `[[name]]` and `[[env]]` internal slots. When an `ArgSetter` function `f` is called with argument `value`, it performs the following steps:

1. Let `name` be the value of `f`'s `[[name]]` internal slot.
2. Let `env` be the value of `f`'s `[[env]]` internal slot.
3. Return the result of calling the `SetMutableBinding` concrete method of `env` with arguments `name`, `value`, and `false`.

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NOTE ArgSetter functions are never directly accessible to ECMAScript code.

9.4.5 Integer Indexed Exotic Objects

An `Integer Indexed object` is an exotic object that performs special handling of integer `index` property keys.

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Integer Indexed exotic objects have the same internal slots as ordinary objects additionally `[[ViewedArrayBuffer]]`, `[[ArrayLength]]`, `[[ByteOffset]]`, and `[[TypedArrayName]]` internal slots.

Integer Indexed Exotic objects provide alternative definitions for the following internal methods. All of the other Integer Indexed exotic object essential internal methods that are not defined below are as specified in 9.1.

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9.4.5.1 `[[GetOwnProperty]](P)`

When the `[[GetOwnProperty]]` internal method of an Integer Indexed exotic object `O` is called with property key `P` the following steps are taken:

1. Assert: `IsPropertyKey(P)` is `true`.
2. Assert: `O` is an Object that has a `[[ViewedArrayBuffer]]` internal slot.
3. If `Type(P)` is String, then
 - a. Let `numericIndex` be `CanonicalNumericIndexString(P)`.
 - b. Assert: `numericIndex` is not an abrupt completion.
 - c. If `numericIndex` is not `undefined`, then
 - i. Let `value` be `IntegerIndexedElementGet(O, numericIndex)`.
 - ii. `ReturnIfAbrupt(value)`.
 - iii. If `value` is `undefined`, **return** `undefined`.
 - iv. Return a `PropertyDescriptor` { `[[Value]]: value, [[Enumerable]]: true, [[Writable]]: true, [[Configurable]]: false` }.
4. Return `OrdinaryGetOwnProperty(O, P)`.

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9.4.5.2 [[HasProperty]](P)

When the [[HasProperty]] internal method of an Integer Indexed exotic object O is called with property key P , the following steps are taken:

1. Assert: IsPropertyKey(P) is true.
2. Assert: O is an Object that has a [[ViewedArrayBuffer]] internal slot.
3. If Type(P) is String, then
 - a. Let $numericIndex$ be CanonicalNumericIndexString(P).
 - b. Assert: $numericIndex$ is not an abrupt completion.
 - c. If $numericIndex$ is not undefined, then
 - i. Let $buffer$ be the value of O 's [[ViewedArrayBuffer]] internal slot.
 - ii. If IsDetachedBuffer($buffer$) is true, throw a **TypeError** exception.
 - iii. If IsInteger($index$) is false, return false.
 - iv. If $index = -0$, return false.
 - v. Return true.
4. Return OrdinaryHasProperty(O, P).

9.4.5.3 [[DefineOwnProperty]] (P , Desc)

When the [[DefineOwnProperty]] internal method of an Integer Indexed exotic object O is called with property key P , and Property Descriptor $Desc$ the following steps are taken:

1. Assert: IsPropertyKey(P) is true.
2. Assert: O is an Object that has a [[ViewedArrayBuffer]] internal slot.
3. If Type(P) is String, then
 - a. Let $numericIndex$ be CanonicalNumericIndexString (P).
 - b. Assert: $numericIndex$ is not an abrupt completion.
 - c. If $numericIndex$ is not undefined, then
 - i. If IsInteger($numericIndex$) is false, return false.
 - ii. Let $intIndex$ be $numericIndex$.
 - iii. If $intIndex = -0$, return false.
 - iv. If $intIndex < 0$, return false.
 - v. Let $length$ be the value of O 's [[ArrayLength]] internal slot.
 - vi. If $intIndex \geq length$, return false.
 - vii. If IsAccessorDescriptor($Desc$) is true, return false.
 - viii. If $Desc$ has a [[Configurable]] field and if $Desc.[[Configurable]]$ is true, return false.
 - ix. If $Desc$ has an [[Enumerable]] field and if $Desc.[[Enumerable]]$ is false, return false.
 - x. If $Desc$ has a [[Writable]] field and if $Desc.[[Writable]]$ is false, return false.
 - xi. If $Desc$ has a [[Value]] field, then
 1. Let $value$ be $Desc.[[Value]]$.
 2. Let $status$ be IntegerIndexedElementSet ($O, intIndex, value$).
 3. ReturnIfAbrupt($status$).
 - xii. Return true.
4. Return OrdinaryDefineOwnProperty($O, P, Desc$).

9.4.5.4 [[Get]] (P , Receiver)

When the [[Get]] internal method of an Integer Indexed exotic object O is called with property key P and ECMAScript language value $Receiver$ the following steps are taken:

1. Assert: IsPropertyKey(P) is true.
2. If Type(P) is String and if SameValue($O, Receiver$) is true, then
 - a. Let $numericIndex$ be CanonicalNumericIndexString (P).

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- b. Assert: *numericIndex* is not an abrupt completion.
 - c. If *numericIndex* is not **undefined**, then
 - i. Return *IntegerIndexedElementGet* (*O*, *numericIndex*).
3. Return the result of calling the default ordinary object **[[Get]]** internal method (9.1.8) on *O* passing *P* and *Receiver* as arguments.

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9.4.5.5 **[[Set]]** (*P*, *V*, *Receiver*)

When the **[[Set]]** internal method of an Integer Indexed exotic object *O* is called with property key *P*, value *V*, and ECMAScript language value *Receiver*, the following steps are taken:

- 1. Assert: *IsPropertyKey*(*P*) is **true**.
- 2. If *Type*(*P*) is String and if *SameValue*(*O*, *Receiver*) is **true**, then
 - a. Let *numericIndex* be *CanonicalNumericIndexString* (*P*).
 - b. Assert: *numericIndex* is not an abrupt completion.
 - c. If *numericIndex* is not **undefined**, then
 - i. Return *IntegerIndexedElementSet* (*O*, *numericIndex*, *V*).
- 3. Return the result of calling the default ordinary object **[[Set]]** internal method (9.1.8) on *O* passing *P*, *V*, and *Receiver* as arguments.

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Deleted: <#>For each own property key *P* of *O* such that *P* is that is an integer index and *ToInteger*(*P*) \geq *len*, in ascending numeric index order¶

<#>Add *P* as the last element of *keys*.¶

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9.4.5.6 **[[Enumerate]]** ()

When the **[[Enumerate]]** internal method of an Integer Indexed exotic object *O* is called the following steps are taken:

- 1. Let *indexKeys* be a new empty List.
- 2. Assert: *O* is an Object that has **[[ViewedArrayBuffer]]**, **[[ArrayLength]]**, **[[ByteOffset]]**, and **[[TypedArrayName]]** internal slots.
- 3. Let *len* be the value of *O*'s **[[ArrayLength]]** internal slot.
- 4. For each integer *i* starting with 0 such that *i* $<$ *len*, in ascending order,
 - a. Add *ToString*(*i*) as the last element of *indexKeys*.
- 5. Let *ordinary* be the result of calling the default ordinary object **[[Enumerate]]** internal method (9.1.11) on *O*.
- 6. ReturnIfAbrupt(*ordinary*).
- 7. Return *CreateCompoundIterator*(*CreateListIterator*(*indexKeys*), *ordinary*).

9.4.5.7 **[[OwnPropertyKeys]]** ()

When the **[[OwnPropertyKeys]]** internal method of an Integer Indexed exotic object *O* is called the following steps are taken:

- 1. Let *keys* be a new empty List.
- 2. Assert: *O* is an Object that has **[[ViewedArrayBuffer]]**, **[[ArrayLength]]**, **[[ByteOffset]]**, and **[[TypedArrayName]]** internal slots.
- 3. Let *len* be the value of *O*'s **[[ArrayLength]]** internal slot.
- 4. For each integer *i* starting with 0 such that *i* $<$ *len*, in ascending order,
 - a. Add *ToString*(*i*) as the last element of *keys*.
- 5. For each own property key *P* of *O* such that *Type*(*P*) is String and *P* is not an integer index, in property creation order
 - a. Add *P* as the last element of *keys*.
- 6. For each own property key *P* of *O* such that *Type*(*P*) is Symbol, in property creation order
 - a. Add *P* as the last element of *keys*.

7. Return keys

9.4.5.8 IntegerIndexedObjectCreate (prototype, internalSlotsList) Abstract Operation

The abstract operation `IntegerIndexedObjectCreate` with arguments `prototype` and `internalSlotsList` is used to specify the creation of new Integer Indexed exotic objects. The argument `internalSlotsList` is a List of the names of additional internal slots that must be defined as part of the object. `IntegerIndexedObjectCreate` performs the following steps:

1. Let `A` be a newly created object with an internal slot for each name in `internalSlotsList`.
2. Set `A`'s essential internal methods to the default ordinary object definitions specified in 9.1.
3. Set the `[[GetOwnProperty]]` internal method of `A` as specified in 9.4.5.1.
4. Set the `[[DefineOwnProperty]]` internal method of `A` as specified in 9.4.5.2.
5. Set the `[[Get]]` internal method of `A` as specified in 9.4.5.3.
6. Set the `[[Set]]` internal method of `A` as specified in 9.4.5.4.
7. Set the `[[Enumerate]]` internal method of `A` as specified in 9.4.5.5.
8. Set the `[[OwnPropertyKeys]]` internal method of `A` as specified in 9.4.5.6.
9. Set the `[[Prototype]]` internal slot of `A` to `prototype`.
10. Set the `[[Extensible]]` internal slot of `A` to `true`.
11. Return `A`.

9.4.5.9 IntegerIndexedElementGet (`O`, `index`) Abstract Operation

The abstract operation `IntegerIndexedElementGet` with arguments `O` and `index` performs the following steps:

1. Assert: `Type(index)` is Number.
2. Assert: `O` is an Object that has `[[ViewedArrayBuffer]]`, `[[ArrayLength]]`, `[[ByteOffset]]`, and `[[TypedArrayName]]` internal slots.
3. Let `buffer` be the value of `O`'s `[[ViewedArrayBuffer]]` internal slot.
4. If `IsDetachedBuffer(buffer)` is true, throw a `TypeError` exception.
5. If `IsInteger(index)` is false, return `undefined`.
6. If `index = -0`, return `undefined`.
7. Let `length` be the value of `O`'s `[[ArrayLength]]` internal slot.
8. If `index < 0` or `index ≥ length`, return `undefined`.
9. Let `offset` be the value of `O`'s `[[ByteOffset]]` internal slot.
10. Let `arrayTypeName` be the string value of `O`'s `[[TypedArrayName]]` internal slot.
11. Let `elementSize` be the Number value of the Element Size value specified in Table 46 for `arrayTypeName`.
12. Let `indexedPosition = (index × elementSize) + offset`.
13. Let `elementType` be the string value of the Element Type value in Table 46 for `arrayTypeName`.
14. Return `GetValueFromBuffer(buffer, indexedPosition, elementType)`.

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9.4.5.10 IntegerIndexedElementSet (`O`, `index`, `value`) Abstract Operation

The abstract operation `IntegerIndexedElementSet` with arguments `O`, `index`, and `value` performs the following steps:

1. Assert: `Type(index)` is Number.
2. Assert: `O` is an Object that has `[[ViewedArrayBuffer]]`, `[[ArrayLength]]`, `[[ByteOffset]]`, and `[[TypedArrayName]]` internal slots.
3. Let `numValue` be `ToNumber(value)`.
4. ReturnIfAbrupt(numValue).
5. Let `buffer` be the value of `O`'s `[[ViewedArrayBuffer]]` internal slot.

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6. If `IsDetachedBuffer(buffer)` is `true`, throw a `TypeError` exception.
1. If `IsInteger(index)` is `false`, return `false`.
2. If `index = -0`, return `false`.
3. Let `length` be the value of `O`'s `[[ArrayLength]]` internal slot.
4. If `index < 0` or `index ≥ length`, return `false`.
5. Let `offset` be the value of `O`'s `[[ByteOffset]]` internal slot.
6. Let `arrayTypeName` be the string value `of` `O`'s `[[TypedArrayName]]` internal slot.
7. Let `elementSize` be the Number value of the Element Size value specified in [Table 46](#) for `arrayTypeName`.
8. Let `indexedPosition` = $(index \times elementSize) + offset$.
9. Let `elementType` be the string value of the Element Type value in [Table 46](#) for `arrayTypeName`.
10. Let `status` be `SetValueInBuffer(buffer, indexedPosition, elementType, numValue)`.
11. ReturnIfAbrupt(`status`).
12. Return `true`.

9.4.6 Module Namespace Exotic Objects

A `module namespace object` is an exotic object that exposes the bindings exported from an ECMAScript Module (See 15.2.3). There is a one-to-one correspondence between the `String-keyed` own properties of a module `namespace exotic object` and the `binding names` `exported by the Module`. The exported bindings include any bindings that are indirectly exported using `export * export items`. Each `String-valued` own property `key` is the `StringValue` of the corresponding exported binding `name`. These are the only `String-keyed` properties of a `module namespace exotic object`. Each such property `has` the attributes `{[[Configurable]]: false, [[Enumerable]]: true}`. Module `namespace objects` are not extensible.

`Module namespace objects` have the internal slots defined in [Table 30](#).

Table 30 — Internal Slots of Module Namespace Exotic Objects

Internal Slot	Type	Description
<code>[[Module]]</code>	Module Record	The <code>Module Record</code> whose exports this namespace exposes.
<code>[[Exports]]</code>	List of String	A List containing the <code>String values of the exported names</code> exposed as own properties of this object. The list is ordered as if an Array of those <code>string</code> values had been sorted using <code>Array.prototype.sort</code> using <code>SortCompare as comparefn</code> .

Module `namespace exotic objects` provide alternative definitions for all of the internal methods.

9.4.6.1 `[[GetPrototypeOf]] ()`

When the `[[GetPrototypeOf]]` internal method of a module `namespace exotic object O` is called the following steps are taken:

1. Return `null`.

9.4.6.2 `[[SetPrototypeOf]] (V)`

When the `[[SetPrototypeOf]]` internal method of a module `namespace exotic object O` is called with argument `V` the following steps are taken:

1. Assert: Either `Type(V)` is `Object` or `Type(V)` is `Null`.
2. Return `false`.

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Deleted: <#>If <code>index = -0</code> , then return <code>undefined</code> .
Deleted: <#>Let <code>numValue</code> be <code>ToNumber(value)</code> . ¶ <#>ReturnIfAbrupt(<code>numValue</code>).
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9.4.6.3 [[IsExtensible]] ()

| When the [[IsExtensible]] internal method of a module namespace exotic object O is called the following steps are taken:

1. Return **false**.

9.4.6.4 [[PreventExtensions]] ()

| When the [[PreventExtensions]] internal method of a module namespace exotic object O is called the following steps are taken:

1. Return **true**.

9.4.6.5 [[GetOwnProperty]] (P)

| When the [[GetOwnProperty]] internal method of a module namespace exotic object O is called with property key P , the following steps are taken:

1. If Type(P) is **Symbol**, return OrdinaryGetOwnProperty(O, P).
2. Throw a **TypeError** exception.

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9.4.6.6 [[DefineOwnProperty]] ($P, Desc$)

| When the [[DefineOwnProperty]] internal method of a module namespace exotic object O is called with property key P and Property Descriptor $Desc$, the following steps are taken:

1. Return **false**.

9.4.6.7 [[HasProperty]] (P)

| When the [[HasProperty]] internal method of a module namespace exotic object O is called with property key P , the following steps are taken:

1. If Type(P) is **Symbol**, return OrdinaryHasProperty(O, P).
2. Let $exports$ be the value of O 's [[Exports]] internal slot.
3. If P is an element of $exports$, return **true**.
4. Return **false**.

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9.4.6.8 [[Get]] ($P, Receiver$)

| When the [[Get]] internal method of a module namespace exotic object O is called with property key P and ECMAScript language value $Receiver$ the following steps are taken:

1. Assert: IsPropertyKey(P) is **true**.
2. If Type(P) is **Symbol**, then
 - a. Return the result of calling the default ordinary object [[Get]] internal method (9.1.8) on O passing P and $Receiver$ as arguments.
3. Let $exports$ be the value of O 's [[Exports]] internal slot.
4. If P is not an element of $exports$, return **undefined**.
5. Let m be the value of O 's [[Module]] internal slot.
6. Let $binding$ be $\text{ResolveExport}(m, P, \ll\gg)$.
7. If binding is an abrupt completion, then
 - a. Assert: The binding for P exported by the module is ambiguous.
 - b. Throw a **ReferenceError** exception.

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Deleted: <#>Let **realm** be value of O 's [[Realm]] internal slot.**¶**

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8. Let *binding* be *binding*.*[[value]]*.
9. Assert: *binding* is not **null**.
10. Let *targetModule* be *binding*.*[[module]]*.
11. Assert: *targetModule* is not **undefined**.
12. Let *targetEnvRec* be *targetModule*.*[[Environment]]*'s environment record.
13. Return the result of calling the *GetBindingValue* concrete method of *targetEnvRec*, with arguments *binding*.*[[bindingName]]* and **true**.

NOTE *ResolveExport* is idempotent and side-effect free. An implementation might choose to pre-compute or cache the *ResolveExport* results for the *[[Exports]]* of each module namespace exotic object.

9.4.6.9 **[[Set]] (P, V, Receiver)**

When the *[[Set]]* internal method of a module *namespace* exotic object *O* is called with property key *P*, value *V*, and ECMAScript language value *Receiver*, the following steps are taken:

1. Return **false**.

9.4.6.10 **[[Delete]] (P)**

When the *[[Delete]]* internal method of a module *namespace* exotic object *O* is called with property key *P*, the following steps are taken:

1. Assert: *IsPropertyKey(P)* is **true**.
2. Let *exports* be the value of *O*'s *[[Exports]]* internal slot.
3. If *P* is an element of *exports*, **return false**.
4. Return **true**.



9.4.6.11 **[[Enumerate]] ()**

When the *[[Enumerate]]* internal method of a module *namespace* exotic object *O* is called the following steps are taken:

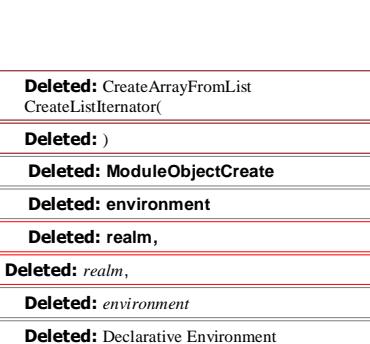
1. Let *exports* be the value of *O*'s *[[Exports]]* internal slot.
2. Return *CreateListIterator(exports)*.



9.4.6.12 **[[OwnPropertyKeys]] ()**

When the *[[OwnPropertyKeys]]* internal method of a *namespace* module exotic object *O* is called the following steps are taken:

1. Let *exports* be *a copy of* the value of *O*'s *[[Exports]]* internal slot.
2. Let *symbolKeys* the result of calling the default ordinary object *[[OwnPropertyKeys]]* internal method (9.1.12) on *O* passing *no arguments*.
3. Append all the entries of *symbolKeys* to the end of *exports*.
4. Return *exports*.



9.4.6.13 **ModuleNamespaceCreate (module, exports)**

The abstract operation *ModuleNamespaceCreate* with arguments *module*, and *exports* is used to specify the creation of new module namespace exotic objects. It performs the following steps:

1. Assert: *module* is a *Module Record* (see 15.2.1.15).
2. Assert: *module*.*[[Namespace]]* is **undefined**.
3. Assert: *realm* is a *Realm Record*.

4. Assert: *exports* is a List of string values.
5. Let *M* be a newly created object.
6. Set *M*'s essential internal methods to the definitions specified in 9.4.6.
7. Set *M*'s **[[Module]]** internal slot to *module*.
8. Set *M*'s **[[Exports]]** internal slot to *exports*.
9. Create own properties of *M* corresponding to the definitions in 26.3.
10. Set *module*.**[[Namespace]]** to *M*.
11. Return *M*.

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9.5 Proxy Object Internal Methods and Internal Slots

A proxy object is an exotic object whose essential internal methods are partially implemented using ECMAScript code. Every proxy objects has an internal slot called **[[ProxyHandler]]**. The value of **[[ProxyHandler]]** is an object, called the proxy's *handler object*, or **null**. Methods (see Table 31) of a handler object may be used to augment the implementation for one or more of the proxy object's internal methods. Every proxy object also has an internal slot called **[[ProxyTarget]]** whose value is either an object or the **null** value. This object is called the proxy's *target object*.

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Table 31 — Proxy Handler Methods

<u>Internal Method</u>	<u>Handler Method</u>
<u>[[GetPrototypeOf]]</u>	<u>getPrototypeOf</u>
<u>[[SetPrototypeOf]]</u>	<u>setPrototypeOf</u>
<u>[[IsExtensible]]</u>	<u>isExtensible</u>
<u>[[PreventExtensions]]</u>	<u>preventExtensions</u>
<u>[[GetOwnProperty]]</u>	<u>getOwnPropertyDescriptor</u>
<u>[[HasProperty]]</u>	<u>has</u>
<u>[[Get]]</u>	<u>get</u>
<u>[[Set]]</u>	<u>set</u>
<u>[[Delete]]</u>	<u>deleteProperty</u>
<u>[[DefineOwnProperty]]</u>	<u>defineProperty</u>
<u>[[Enumerate]]</u>	<u>enumerate</u>
<u>[[OwnPropertyKeys]]</u>	<u>ownKeys</u>
<u>[[Call]]</u>	<u>apply</u>
<u>[[Construct]]</u>	<u>construct</u>

When a handler method is called to provide the implementation of a proxy object internal method, the handler method is passed the proxy's target object as a parameter. A proxy's handler object does not necessarily have a method corresponding to every essential internal method. Invoking an internal method on the proxy results in the invocation of the corresponding internal method on the proxy's target object if the handler object does not have a method corresponding to the internal trap.

The **[[ProxyHandler]]** and **[[ProxyTarget]]** internal slots of a proxy object are always initialized when the object is created and typically may not be modified. Some proxy objects are created in a manner that permits them to be subsequently *revoked*. When a proxy is revoked, its **[[ProxyHander]]** and **[[ProxyTarget]]** internal slots are set to **null** causing subsequent invocations of internal methods on that proxy object to throw a **TypeError** exception.

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Because proxy **objects** permit the implementation of internal methods to be provided by arbitrary **ECMAScript code**, it is possible to define a proxy object whose handler methods violates the invariants defined in 6.1.7.3. Some of the internal method invariants defined in 6.1.7.3 are essential integrity

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invariants. These invariants are explicitly enforced by the proxy `object` internal methods specified in this section. An ECMAScript implementation must be robust in the presence of all possible invariant violations.

In the following algorithm descriptions, assume O is an ECMAScript proxy object, P is a property key value, V is any ECMAScript language value, and Desc is a Property Descriptor record.

9.5.1 [[GetPrototypeOf]] ()

When the [[GetPrototypeOf]] internal method of an exotic Proxy object O is called the following steps are taken:

1. Let handler be the value of the [[ProxyHandler]] internal slot of O .
2. If handler is `null`, throw a `TypeError` exception.
3. Assert: `Type(handler)` is `Object`.
4. Let target be the value of the [[ProxyTarget]] internal slot of O .
5. Let trap be `GetMethod(handler, "getPrototypeOf")`.
6. `ReturnIfAbrupt(trap)`.
7. If trap is `undefined`, then
 - a. Return the result of calling the [[GetPrototypeOf]] internal method of target .
8. Let handlerProto be `Call(trap, handler, «target»)`.
9. `ReturnIfAbrupt(handlerProto)`.
10. If `Type(handlerProto)` is neither `Object` nor `Null`, throw a `TypeError` exception.
11. Let extensibleTarget be `IsExtensible(target)`.
12. `ReturnIfAbrupt(extensibleTarget)`.
13. If extensibleTarget is `true`, return handlerProto .
14. Let targetProto be the result of calling the [[GetPrototypeOf]] internal method of target .
15. `ReturnIfAbrupt(targetProto)`.
16. If `SameValue(handlerProto, targetProto)` is `false`, throw a `TypeError` exception.
17. Return handlerProto .

NOTE [[GetPrototypeOf]] for proxy objects enforces the following invariant:

- The result of [[GetPrototypeOf]] must be either an `Object` or `null`.
- If the target object is not extensible, [[GetPrototypeOf]] applied to the proxy object must return the same value as [[GetPrototypeOf]] applied to the proxy object's target object.

9.5.2 [[SetPrototypeOf]] (V)

When the [[SetPrototypeOf]] internal method of an exotic Proxy object O is called with argument V the following steps are taken:

1. Assert: Either `Type(V)` is `Object` or `Type(V)` is `Null`.
2. Let handler be the value of the [[ProxyHandler]] internal slot of O .
3. If handler is `null`, throw a `TypeError` exception.
4. Assert: `Type(handler)` is `Object`.
5. Let target be the value of the [[ProxyTarget]] internal slot of O .
6. Let trap be `GetMethod(handler, "setPrototypeOf")`.
7. `ReturnIfAbrupt(trap)`.
8. If trap is `undefined`, then
 - a. Return the result of calling the [[SetPrototypeOf]] internal method of target with argument V .
9. Let booleanTrapResult be `ToBoolean(Call(trap, handler, «target, V»))`.
10. `ReturnIfAbrupt(booleanTrapResult)`.
11. Let extensibleTarget be `IsExtensible(target)`.

12. ReturnIfAbrupt(*extensibleTarget*).
13. If *extensibleTarget* is **true**, **return** *booleanTrapResult*.
14. Let *targetProto* be the result of calling the **[[GetPrototypeOf]]** internal method of *target*.
15. ReturnIfAbrupt(*targetProto*).
16. If *booleanTrapResult* is **true** and **SameValue(V, targetProto)** is **false**, **throw** a **TypeError** exception.
17. Return *booleanTrapResult*.

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NOTE **[[SetPrototypeOf]]** for proxy objects enforces the following invariant:
 • If the target object is not extensible, the argument value must be the same as the result of **[[GetPrototypeOf]]** applied to target object.

9.5.3 **[[IsExtensible]] ()**

When the **[[IsExtensible]]** internal method of an exotic Proxy object *O* is called the following steps are taken:

1. Let *handler* be the value of the **[[ProxyHandler]]** internal slot of *O*.
2. If *handler* is **null**, **throw** a **TypeError** exception.
3. **Assert: Type(handler) is Object.**
4. Let *target* be the value of the **[[ProxyTarget]]** internal slot of *O*.
5. Let *trap* be **GetMethod(handler, "isExtensible")**.
6. ReturnIfAbrupt(*trap*).
7. If *trap* is **undefined**, then
 - a. Return the result of calling the **[[IsExtensible]]** internal method of *target*.
8. Let *booleanTrapResult* be **ToBoolean(Call(*trap, handler, <target>*)**.
9. ReturnIfAbrupt(*booleanTrapResult*).
10. Let *targetResult* be the result of calling the **[[IsExtensible]]** internal method of *target*.
11. ReturnIfAbrupt(*targetResult*).
12. If **SameValue(booleanTrapResult, targetResult)** is **false**, **throw** a **TypeError** exception.
13. Return *booleanTrapResult*.

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NOTE **[[IsExtensible]]** for proxy objects enforces the following invariant:
 • **[[IsExtensible]]** applied to the proxy object must return the same value as **[[IsExtensible]]** applied to the proxy object's target object with the same argument.

9.5.4 **[[PreventExtensions]] ()**

When the **[[PreventExtensions]]** internal method of an exotic Proxy object *O* is called the following steps are taken:

1. Let *handler* be the value of the **[[ProxyHandler]]** internal slot of *O*.
2. If *handler* is **null**, **throw** a **TypeError** exception.
3. **Assert: Type(handler) is Object.**
4. Let *target* be the value of the **[[ProxyTarget]]** internal slot of *O*.
5. Let *trap* be **GetMethod(handler, "preventExtensions")**.
6. ReturnIfAbrupt(*trap*).
7. If *trap* is **undefined**, then
 - a. Return the result of calling the **[[PreventExtensions]]** internal method of *target*.
8. Let *booleanTrapResult* be **ToBoolean(Call(*trap, handler, <target>*)**.
9. ReturnIfAbrupt(*booleanTrapResult*).
10. If *booleanTrapResult* is **true**, then
 - a. Let *targetIsExtensible* be the result of calling the **[[IsExtensible]]** internal method of *target*.
 - b. ReturnIfAbrupt(*targetIsExtensible*).

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- c. If `targetIsExtensible` is `true`, throw a **TypeError** exception.
 11. Return `booleanTrapResult`.

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NOTE [[PreventExtensions]] for proxy objects enforces the following invariant:

- [[PreventExtensions]] applied to the proxy object only returns `true` if [[IsExtensible]] applied to the proxy object's target object is `false`.

9.5.5 [[GetOwnProperty]] (P)

When the [[GetOwnProperty]] internal method of an exotic Proxy object O is called with property key P , the following steps are taken:

1. Assert: IsPropertyKey(P) is `true`.
2. Let $handler$ be the value of the [[ProxyHandler]] internal slot of O .
3. If $handler$ is `null`, throw a **TypeError** exception.
4. Assert: Type($handler$) is Object.
5. Let $target$ be the value of the [[ProxyTarget]] internal slot of O .
6. Let $trap$ be GetMethod($handler$, "getOwnPropertyDescriptor").
7. ReturnIfAbrupt($trap$).
8. If $trap$ is `undefined`, then
 - a. Return the result of calling the [[GetOwnProperty]] internal method of $target$ with argument P .
9. Let $trapResultObj$ be Call($trap$, $handler$, $\langle target, P \rangle$).
10. ReturnIfAbrupt($trapResultObj$).
11. If Type($trapResultObj$) is neither Object nor Undefined, throw a **TypeError** exception.
12. Let $targetDesc$ be the result of calling the [[GetOwnProperty]] internal method of $target$ with argument P .
13. ReturnIfAbrupt($targetDesc$).
14. If $trapResultObj$ is `undefined`, then
 - a. If $targetDesc$ is `undefined`, return `undefined`.
 - b. If $targetDesc$.[[Configurable]] is `false`, throw a **TypeError** exception.
 - c. Let $extensibleTarget$ be IsExtensible($target$).
 - d. ReturnIfAbrupt($extensibleTarget$).
 - e. If ToBoolean($extensibleTarget$) is `false`, throw a **TypeError** exception.
 - f. Return `undefined`.
15. Let $extensibleTarget$ be IsExtensible($target$).
16. ReturnIfAbrupt($extensibleTarget$).
17. Let $resultDesc$ be ToPropertyDescriptor($trapResultObj$).
18. ReturnIfAbrupt($resultDesc$).
19. Call CompletePropertyDescriptor($resultDesc$).
20. Let $valid$ be IsCompatiblePropertyDescriptor($extensibleTarget$, $resultDesc$, $targetDesc$).
21. If $valid$ is `false`, throw a **TypeError** exception.
22. If $resultDesc$.[[Configurable]] is `false`, then
 - a. If $targetDesc$ is `undefined` or $targetDesc$.[[Configurable]] is `true`, then
 - i. Throw a **TypeError** exception.
23. Return $resultDesc$.

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NOTE [[GetOwnProperty]] for proxy objects enforces the following invariants:

- The result of [[GetOwnProperty]] must be either an Object or `undefined`.
- A property cannot be reported as non-existent, if it exists as a non-configurable own property of the target object.
- A property cannot be reported as non-existent, if it exists as an own property of the target object and the target object is not extensible.
- A property cannot be reported as existent, if it does not exist as an own property of the target object and the target object is not extensible.

- A property cannot be reported as non-configurable, if it does not exists as an own property of the target object or if it exists as a configurable own property of the target object.
- The result of [[GetOwnProperty]] can be applied to the target object using [[DefineOwnProperty]] and will not throw an exception.

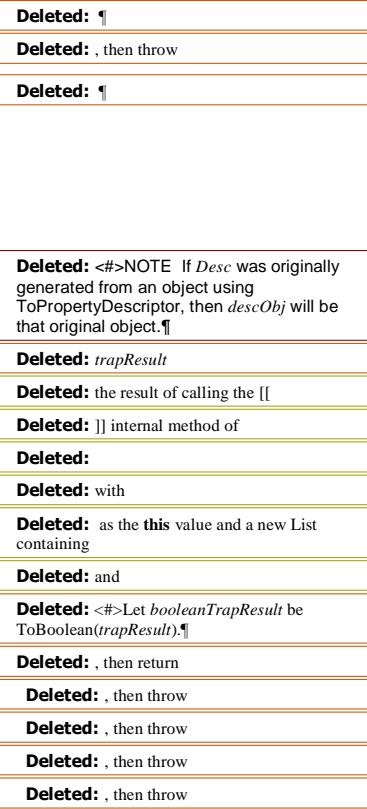
9.5.6 [[DefineOwnProperty]] (P, Desc)

When the [[DefineOwnProperty]] internal method of an exotic Proxy object O is called with property key P and Property Descriptor $Desc$, the following steps are taken:

1. Assert: IsPropertyKey(P) is true.
2. Let $handler$ be the value of the [[ProxyHandler]] internal slot of O .
3. If $handler$ is null, throw a **TypeError** exception.
4. Assert: Type($handler$) is Object.
5. Let $target$ be the value of the [[ProxyTarget]] internal slot of O .
6. Let $trap$ be GetMethod($handler$, "defineProperty").
7. ReturnIfAbrupt($trap$).
8. If $trap$ is undefined, then
 - a. Return the result of calling the [[DefineOwnProperty]] internal method of $target$ with arguments P and $Desc$.
9. Let $descObj$ be FromPropertyDescriptor($Desc$).
10. Let $booleanTrapResult$ be ToBoolean(Call($trap$, $handler$, « $target$, P , $descObj$ »)).
11. ReturnIfAbrupt($booleanTrapResult$).
12. If $booleanTrapResult$ is false, return false.
13. Let $targetDesc$ be the result of calling the [[GetOwnProperty]] internal method of $target$ with argument P .
14. ReturnIfAbrupt($targetDesc$).
15. Let $extensibleTarget$ be IsExtensible($target$).
16. ReturnIfAbrupt($extensibleTarget$).
17. If $Desc$ has a [[Configurable]] field and if $Desc$.[[Configurable]] is false, then
 - a. Let $settingConfigFalse$ be true.
18. Else let $settingConfigFalse$ be false.
19. If $targetDesc$ is undefined, then
 - a. If $extensibleTarget$ is false, throw a **TypeError** exception.
 - b. If $settingConfigFalse$ is true, throw a **TypeError** exception.
20. Else $targetDesc$ is not undefined,
 - a. If IsComitablePropertyDescriptor($extensibleTarget$, $Desc$, $targetDesc$) is false, throw a **TypeError** exception.
 - b. If $settingConfigFalse$ is true and $targetDesc$.[[Configurable]] is true, throw a **TypeError** exception.
21. Return true.

NOTE [[DefineOwnProperty]] for proxy objects enforces the following invariants:

- A property cannot be added, if the target object is not extensible.
- A property cannot be added as or modified to be non-configurable, if it does not exists as a non-configurable own property of the target object.
- A property may not be non-configurable, if a corresponding configurable property of the target object exists.
- If a property has a corresponding target object property then apply the Property Descriptor of the property to the target object using [[DefineOwnProperty]] will not throw an exception.



9.5.7 [[HasProperty]] (P)

When the [[HasProperty]] internal method of an exotic Proxy object O is called with property key P , the following steps are taken:

1. Assert: IsPropertyKey(P) is **true**.
2. Let $handler$ be the value of the [[ProxyHandler]] internal slot of O .
3. If $handler$ is **null**, throw a **TypeError** exception.
4. Assert: Type($handler$) is **Object**.
5. Let $target$ be the value of the [[ProxyTarget]] internal slot of O .
6. Let $trap$ be GetMethod($handler$, "has").
7. ReturnIfAbrupt($trap$).
8. If $trap$ is **undefined**, then
 - a. Return the result of calling the [[HasProperty]] internal method of $target$ with argument P .
9. Let $booleanTrapResult$ be ToBoolean(Call($trap$, $handler$, $\langle target, P \rangle$)).
10. ReturnIfAbrupt($booleanTrapResult$).
11. If $booleanTrapResult$ is **false**, then
 - a. Let $targetDesc$ be the result of calling the [[GetOwnProperty]] internal method of $target$ with argument P .
 - b. ReturnIfAbrupt($targetDesc$).
 - c. If $targetDesc$ is not **undefined**, then
 - i. If $targetDesc.[[Configurable]]$ is **false**, throw a **TypeError** exception.
 - ii. Let $extensibleTarget$ be IsExtensible($target$).
 - iii. ReturnIfAbrupt($extensibleTarget$).
 - iv. If $extensibleTarget$ is **false**, throw a **TypeError** exception.
12. Return $booleanTrapResult$.

NOTE [[HasProperty]] for proxy objects enforces the following invariants:

- A property cannot be reported as non-existent, if it exists as a non-configurable own property of the target object.
- A property cannot be reported as non-existent, if it exists as an own property of the target object and the target object is not extensible.

9.5.8 [[Get]] (P, Receiver)

When the [[Get]] internal method of an exotic Proxy object O is called with property key P and ECMAScript language value $Receiver$ the following steps are taken:

1. Assert: IsPropertyKey(P) is **true**.
2. Let $handler$ be the value of the [[ProxyHandler]] internal slot of O .
3. If $handler$ is **null**, throw a **TypeError** exception.
4. Assert: Type($handler$) is **Object**.
5. Let $target$ be the value of the [[ProxyTarget]] internal slot of O .
6. Let $trap$ be GetMethod($handler$, "get").
7. ReturnIfAbrupt($trap$).
8. If $trap$ is **undefined**, then
 - a. Return the result of calling the [[Get]] internal method of $target$ with arguments P and $Receiver$.
9. Let $trapResult$ be Call($trap$, $handler$, $\langle target, P, Receiver \rangle$).
10. ReturnIfAbrupt($trapResult$).
11. Let $targetDesc$ be the result of calling the [[GetOwnProperty]] internal method of $target$ with argument P .
12. ReturnIfAbrupt($targetDesc$).
13. If $targetDesc$ is not **undefined**, then

- a. If `IsDataDescriptor(targetDesc)` and `targetDesc.[[Configurable]]` is **false** and `targetDesc.[[Writable]]` is **false**, then
 - i. If `SameValue(trapResult, targetDesc.[[Value]])` is **false**, throw a `TypeError` exception.
 - b. If `IsAccessorDescriptor(targetDesc)` and `targetDesc.[[Configurable]]` is **false** and `targetDesc.[[Get]]` is **undefined**, then
 - i. If `trapResult` is not **undefined**, throw a `TypeError` exception.
14. Return `trapResult`.

Deleted: , then throw**Deleted:** , then throwNOTE `[[Get]]` for proxy objects enforces the following invariants:

- The value reported for a property must be the same as the value of the corresponding target object property if the target object property is a non-writable, non-configurable data property.
- The value reported for a property must be **undefined** if the corresponding target object property is non-configurable accessor property that has **undefined** as its `[[Get]]` attribute.

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9.5.9 `[[Set]] (P, V, Receiver)`

When the `[[Set]]` internal method of an exotic Proxy object O is called with property key P , value V , and ECMAScript language value $Receiver$, the following steps are taken:

1. Assert: `IsPropertyKey(P)` is **true**.
2. Let `handler` be the value of the `[[ProxyHandler]]` internal slot of O .
3. If `handler` is **null**, throw a `TypeError` exception.
4. Assert: `Type(handler)` is `Object`.
5. Let `target` be the value of the `[[ProxyTarget]]` internal slot of O .
6. Let `trap` be `GetMethod(handler, "set")`.
7. `ReturnIfAbrupt(trap)`.
8. If `trap` is **undefined**, then
 - a. Return the result of calling the `[[Set]]` internal method of `target` with arguments P , V , and $Receiver$.
9. Let `booleanTrapResult` be `ToBoolean(Call(trap, handler, «target, P, V, Receiver»))`.
10. `ReturnIfAbrupt(booleanTrapResult)`.
11. If `booleanTrapResult` is **false**, return **false**.
12. Let `targetDesc` be the result of calling the `[[GetOwnProperty]]` internal method of `target` with argument P .
13. `ReturnIfAbrupt(targetDesc)`.
14. If `targetDesc` is not **undefined**, then
 - a. If `IsDataDescriptor(targetDesc)` and `targetDesc.[[Configurable]]` is **false** and `targetDesc.[[Writable]]` is **false**, then
 - i. If `SameValue(V, targetDesc.[[Value]])` is **false**, throw a `TypeError` exception.
 - b. If `IsAccessorDescriptor(targetDesc)` and `targetDesc.[[Configurable]]` is **false**, then
 - i. If `targetDesc.[[Set]]` is **undefined**, throw a `TypeError` exception.
15. Return **true**.

Deleted: ¶**Deleted:** , then throw**Deleted:** ¶**Deleted:** trapResult**Deleted:** the result of calling the [[**Deleted:**]] internal method of**Deleted:****Deleted:** with**Deleted:** as the `this` value and a new List containing**Deleted:** and**Deleted:** <#>Let `booleanTrapResult` be `ToBoolean(trapResult)`.¶**Deleted:** , then return**Deleted:** , then throw**Deleted:** , then throw**Deleted:** n**Deleted:** correspondingNOTE `[[Set]]` for proxy objects enforces the following invariants:

- Cannot change the value of a property to be different from the value of the corresponding target object property if the corresponding target object property is a non-writable, non-configurable data property.
- Cannot set the value of a property if the corresponding target object property is a non-configurable accessor property that has **undefined** as its `[[Set]]` attribute.

9.5.10 `[[Delete]] (P)`

When the `[[Delete]]` internal method of an exotic Proxy object O is called with property name P the following steps are taken:

1. Assert: IsPropertyKey(P) is **true**.
2. Let $handler$ be the value of the [[ProxyHandler]] internal slot of O .
3. If $handler$ is **null**, **throw** a **TypeError** exception.
4. **Assert: Type(handler) is Object**.
5. Let $target$ be the value of the [[ProxyTarget]] internal slot of O .
6. Let $trap$ be $\text{GetMethod}(handler, \text{"deleteProperty"})$.
7. $\text{ReturnIfAbrupt}(trap)$.
8. If $trap$ is **undefined**, then
 - a. Return the result of calling the [[Delete]] internal method of $target$ with argument P .
9. Let booleanTrapResult be $\text{ToBoolean}(\text{Call}(trap, handler, \langle target, P \rangle))$.
10. $\text{ReturnIfAbrupt}(\text{booleanTrapResult})$.
11. If booleanTrapResult is **false**, **return** **false**.
12. Let $targetDesc$ be the result of calling the $\text{[[GetOwnProperty]]}$ internal method of $target$ with argument P .
13. $\text{ReturnIfAbrupt}(targetDesc)$.
14. If $targetDesc$ is **undefined**, **return** **true**.
15. If $targetDesc.\text{[[Configurable]]}$ is **false**, **throw** a **TypeError** exception.
16. **Return true**.

NOTE [[Delete]] for proxy objects enforces the following invariant:

- A property cannot be deleted, if it exists as a non-configurable own property of the target object.

9.5.11 $\text{[[Enumerate]]}()$

When the [[Enumerate]] internal method of an exotic Proxy object O is called the following steps are taken:

1. Let $handler$ be the value of the [[ProxyHandler]] internal slot of O .
2. If $handler$ is **null**, **throw** a **TypeError** exception.
3. **Assert: Type(handler) is Object**.
4. Let $target$ be the value of the [[ProxyTarget]] internal slot of O .
5. Let $trap$ be $\text{GetMethod}(handler, \text{"enumerate"})$.
6. $\text{ReturnIfAbrupt}(trap)$.
7. If $trap$ is **undefined**, then
 - a. Return the result of calling the [[Enumerate]] internal method of $target$.
8. Let trapResult be $\text{Call}(trap, handler, \langle target \rangle)$.
9. $\text{ReturnIfAbrupt}(\text{trapResult})$.
10. If $\text{Type}(\text{trapResult})$ is not **Object**, **throw** a **TypeError** exception.
11. **Return trapResult**.

NOTE [[Enumerate]] for proxy objects enforces the following invariants:

- The result of [[Enumerate]] must be an **Object**.

9.5.12 $\text{[[OwnPropertyKeys]]}()$

When the $\text{[[OwnPropertyKeys]]}$ internal method of an exotic Proxy object O is called the following steps are taken:

1. Let $handler$ be the value of the [[ProxyHandler]] internal slot of O .
2. If $handler$ is **null**, **throw** a **TypeError** exception.
3. **Assert: Type(handler) is Object**.
4. Let $target$ be the value of the [[ProxyTarget]] internal slot of O .
5. Let $trap$ be $\text{GetMethod}(handler, \text{"ownKeys"})$.

6. ReturnIfAbrupt(*trap*).
7. If *trap* is **undefined**, then
 - a. Return the result of calling the **[[OwnPropertyKeys]]** internal method of *target*.
8. Let *trapResultArray* be *Call*(*trap.handler*, *target*).
9. Let *trapResult* be *CreateListFromArrayLike*(*trapResultArray*, «String, Symbol»).
10. ReturnIfAbrupt(*trapResult*).
11. Let *extensibleTarget* be *IsExtensible*(*target*).
12. ReturnIfAbrupt(*extensibleTarget*).
13. Let *targetKeys* be the result of calling the **[[OwnPropertyKeys]]** internal method of *target*.
14. ReturnIfAbrupt(*targetKeys*).
15. Assert: *targetKeys* is a List containing only String and Symbol values.
16. Let *targetConfigurableKeys* be an empty List.
17. Let *targetNonconfigurableKeys* be an empty List.
18. Repeat, for each element *key* of *targetKeys*,
 - a. Let *desc* the result of calling the **[[GetOwnProperty]]** internal method of *target* with argument *key*.
 - b. ReturnIfAbrupt(*desc*).
 - c. If *desc* is not **undefined** and *desc.[[Configurable]]* is **false**, then
 - i. Append *key* as an element of *targetNonconfigurableKeys*.
 - d. Else,
 - i. Append *key* as an element of *targetConfigurableKeys*.
19. If *extensibleTarget* is **true** and *targetNonconfigurableKeys* is empty, then
 - a. Return *trapResult*.
20. Let *uncheckedResultKeys* be a new List which is a copy of *trapResult*.
21. Repeat, for each *key* that is an element of *targetNonconfigurableKeys*,
 - a. If *key* is not an element of *uncheckedResultKeys*, throw a **TypeError** exception.
 - b. Remove *key* from *uncheckedResultKeys*.
22. If *extensibleTarget* is **true**, return *trapResult*.
23. Repeat, for each *key* that is an element of *targetConfigurableKeys*,
 - a. If *key* is not an element of *uncheckedResultKeys*, throw a **TypeError** exception.
 - b. Remove *key* from *uncheckedResultKeys*.
24. If *uncheckedResultKeys* is not empty, throw a **TypeError** exception.
25. Return *trapResult*.

NOTE **[[OwnPropertyKeys]]** for proxy objects enforces the following invariants:

- The result of **[[OwnPropertyKeys]]** is a List.
- The Type of each result List element is either String or Symbol.
- The result List must contain the keys of all non-configurable own properties of the target object.
- If the target object is not extensible, then the result List must contain all the keys of the own properties of the target object and no other values.

9.5.13 [[Call]] (*thisArgument*, *argumentsList*)

The **[[Call]]** internal method of an exotic Proxy object *O* is called with parameters *thisArgument* and *argumentsList*, a List of ECMAScript language values. The following steps are taken:

1. Let *handler* be the value of the **[[ProxyHandler]]** internal slot of *O*.
2. If *handler* is **null**, throw a **TypeError** exception.
3. Assert: **Type(handler)** is Object.
4. Let *target* be the value of the **[[ProxyTarget]]** internal slot of *O*.
5. Let *trap* be *GetMethod*(*handler*, "apply").
6. ReturnIfAbrupt(*trap*).
7. If *trap* is **undefined**, then

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- Deleted:** <#>If **Type(trapResult)** is not Object, then throw a **TypeError** exception.¶ If *trapResult* is not an Array exotic object, then throw a **TypeError** exception.¶
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- Deleted:** <#>Let *targetLength* be *ToLength*(*Get(targetKeys, "length")*) the number of elements in *targetKeys*.¶
- Deleted:** <#>ReturnIfAbrupt(*targetLength*).¶
- Deleted:** <#>Let *n* be 0.¶
- Deleted:** while *n*<*targetLength*
- Deleted:** <#>Let *key* be *Get(targetKeys, ToString(*n*))*.¶ <#>ReturnIfAbrupt(*key*).¶
- Deleted:** <#>Let *n* be *n* + 1.¶
- Deleted:** <#>Let *resultLength* be *ToLength*(*Get(trapResult, "length")*).¶ <#>ReturnIfAbrupt(*resultLength*).¶
- Deleted:** *n*
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- Deleted:** <#>Let *n* be 0.¶ <#>Repeat, while *n*<*resultLength*,¶ <#>Let *key* be *Get(trapResult, ToString(*n*))*.¶ <#>ReturnIfAbrupt(*key*).¶ ...
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- a. Return `Call(target, thisArgument, argumentsList)`.
8. Let `argArray` be `CreateArrayFromList(argumentsList)`.
9. Return `Call(trap, handler, target, thisArgument, argArray)`.

NOTE A Proxy exotic object only has a `[[Call]]` internal method if the initial value of its `[[ProxyTarget]]` internal slot is an object that has a `[[Call]]` internal method.

9.5.14 `[[Construct]](argumentsList, newTarget)`

The `[[Construct]]` internal method of an exotic Proxy object O is called with parameters $argumentsList$ which is a possibly empty List of ECMAScript language values and $newTarget$. The following steps are taken:

1. Let `handler` be the value of the `[[ProxyHandler]]` internal slot of O .
2. If `handler` is `null`, throw a `TypeError` exception.
3. **Assert: `Type(handler) is Object`.**
4. Let `target` be the value of the `[[ProxyTarget]]` internal slot of O .
5. Let `trap` be `GetMethod(handler, "construct")`.
6. ReturnIfAbrupt(`trap`).
7. If `trap` is `undefined`, then
 - a. **Assert: `target` has a `[[Construct]]` internal method.**
 - b. Return `Construct(target, argumentsList, newTarget)`.
8. Let `argArray` be `CreateArrayFromList(argumentsList)`.
9. Let `newObj` be `Call(trap, handler, target, argArray, newTarget)`.
10. ReturnIfAbrupt(`newObj`).
11. If `Type(newObj)` is not `Object`, throw a `TypeError` exception.
12. Return `newObj`.

NOTE 1 A Proxy exotic object only has a `[[Construct]]` internal method if the initial value of its `[[ProxyTarget]]` internal slot is an object that has a `[[Construct]]` internal method.

NOTE 2 `[[Construct]]` for proxy objects enforces the following invariants:

- The result of `[[Construct]]` must be an `Object`.

9.5.15 `ProxyCreate(target, handler)` Abstract Operation

The abstract operation `ProxyCreate` with arguments `target` and `handler` is used to specify the creation of new Proxy exotic objects. It performs the following steps:

1. If `Type(target)` is not `Object`, throw a `TypeError` Exception.
2. If `Type(handler)` is not `Object`, throw a `TypeError` Exception.
3. Let P be a newly created object.
4. Set P 's essential internal methods (except for `[[Call]]` and `[[Construct]]`) to the definitions specified in 9.5.
5. If `IsCallable(target)` is `true`, then
 - a. Set the `[[Call]]` internal method of P as specified in 9.5.13.
 - b. If `target` has a `[[Construct]]` internal method, then
 - i. Set the `[[Construct]]` internal method of P as specified in 9.5.14.
6. Set the `[[ProxyTarget]]` internal slot of P to `target`.
7. Set the `[[ProxyHandler]]` internal slot of P to `handler`.
8. Return P .

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10 ECMAScript Language: Source Code

10.1 Source Text

Syntax

SourceCharacter ::
any Unicode code point

The ECMAScript code is expressed using Unicode, version 5.1 or later. ECMAScript source text is a sequence of code points. All Unicode code point values from U+0000 to U+10FFFF, including surrogate code points, may occur in source text where permitted by the ECMAScript grammars. The actual encodings used to store and interchange ECMAScript source text is not relevant to this specification. Regardless of the external source text encoding, a conforming ECMAScript implementation processes the source text as if it was an equivalent sequence of *SourceCharacter* values. Each *SourceCharacter* being a Unicode code point. Conforming ECMAScript implementations are not required to perform any normalization of text, or behave as though they were performing normalization of text.

The components of a combining character sequence are treated as individual Unicode code points even though a user might think of the whole sequence as a single character.

NOTE In string literals, regular expression literals, template literals and identifiers, any Unicode code point may also be expressed using Unicode escape sequences that explicitly express a code point's numeric value. Within a comment, such an escape sequence is effectively ignored as part of the comment.

ECMAScript differs from the Java programming language in the behaviour of Unicode escape sequences. In a Java program, if the Unicode escape sequence \u000A, for example, occurs within a single-line comment, it is interpreted as a line terminator (Unicode code point U+000A is LINE FEED (LF)) and therefore the next code point is not part of the comment. Similarly, if the Unicode escape sequence \u000A occurs within a string literal in a Java program, it is likewise interpreted as a line terminator, which is not allowed within a string literal—one must write \n instead of \u000A to cause a LINE FEED (LF) to be part of the string value of a string literal. In an ECMAScript program, a Unicode escape sequence occurring within a comment is never interpreted and therefore cannot contribute to termination of the comment. Similarly, a Unicode escape sequence occurring within a string literal in an ECMAScript program always contributes to the literal and is never interpreted as a line terminator or as a code point that might terminate the string literal.

10.1.1 Static Semantics: UTF-16Encoding

The UTF-16Encoding of a numeric code point value, *cp*, is determined as follows:

1. Assert: $0 \leq cp \leq 0x10FFFF$.
2. If $cp \leq 65535$, return *cp*.
3. Let *cu1* be $\text{floor}((cp - 65536) / 1024) + 0xD800$.
4. Let *cu2* be $((cp - 65536) \bmod 1024) + 0xDC00$.
5. Return the code unit sequence consisting of *cu1* followed by *cu2*.

10.1.2 Static Semantics: UTF16Decode(*lead*, *trail*)

Two code units, *lead* and *trail*, that form a UTF-16 surrogate pair are converted to a code point by performing the following steps:

1. Assert: $0xD800 \leq lead \leq 0xDBFF$ and $0xDC00 \leq trail \leq 0xDFFF$.
2. Let *cp* be $(lead - 0xD800) \times 1024 + (trail - 0xDC00) + 0x10000$.

3. Return the code point *cp*.

10.2 Types of Source Code

There are four types of ECMAScript code:

- *Global code* is source text that is treated as an ECMAScript *Script*. The global code of a particular *Script* does not include any source text that is parsed as part of a [FunctionDeclaration](#), [FunctionExpression](#), [GeneratorDeclaration](#), [GeneratorExpression](#), [MethodDefinition](#), [ArrowFunction](#), [ClassDeclaration](#), or [ClassExpression](#).
- *Eval code* is the source text supplied to the built-in `eval` function. More precisely, if the parameter to the built-in `eval` function is a String, it is treated as an ECMAScript *Script*. The eval code for a particular invocation of `eval` is the global code portion of that *Script*.
- *Function code* is source text that is parsed to supply the value of the `[[ECMAScriptCode]]` internal slot (see 9.1.14) of function and generator objects. It also includes the code that defines and initializes the formal parameters of the function. The *function code* of a particular function or generator does not include any source text that is parsed as the function code of a nested [FunctionDeclaration](#), [FunctionExpression](#), [GeneratorDeclaration](#), [GeneratorExpression](#), [MethodDefinition](#), [ArrowFunction](#), [ClassDeclaration](#), or [ClassExpression](#).
- *Module code* is source text that is code that is provided as a *ModuleBody*. It is the code that is directly evaluated when a module is initialized. The module code of a particular module does not include any source text that is parsed as part of a nested [FunctionDeclaration](#), [FunctionExpression](#), [GeneratorDeclaration](#), [GeneratorExpression](#), [MethodDefinition](#), [ArrowFunction](#), [ClassDeclaration](#), or [ClassExpression](#).

NOTE Function code is generally provided as the bodies of Function Definitions (14.1), Arrow Function Definitions (14.2), Method Definitions (14.3) and Generator Definitions (14.4). Function code is also derived from the last argument to the Function constructor (19.2.1.1) and the GeneratorFunction constructor (25.2.1.1).

10.2.1 Strict Mode Code

An ECMAScript *Script* syntactic unit may be processed using either unrestricted or strict mode syntax and semantics. When processed using strict mode the four types of ECMAScript code are referred to as module code, strict global code, strict eval code, and strict function code. Code is interpreted as strict mode code in the following situations:

- Global code is strict global code if it begins with a Directive Prologue that contains a Use Strict Directive (see 14.1.1).
- Module code is always strict code.
- All parts of a *ClassDeclaration* or a *ClassExpression* are strict code.
- Eval code is strict eval code if it begins with a Directive Prologue that contains a Use Strict Directive or if the call to eval is a direct call (see 12.3.4.1) to the eval function that is contained in strict mode code.
- Function code is strict function code if its [FunctionDeclaration](#), [FunctionExpression](#), [GeneratorDeclaration](#), [GeneratorExpression](#), [MethodDefinition](#), or [ArrowFunction](#) is contained in strict mode code.

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mode code or if it is within a *FunctionBody* that begins with a Directive Prologue that contains a Use Strict Directive.

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- Function code that is supplied as the last argument to the built-in Function constructor is strict function code if the last argument is a String that when processed as a *FunctionBody* begins with a Directive Prologue that contains a Use Strict Directive.

10.2.2 Non-ECMAScript Functions

An ECMAScript implementation may support the evaluation of exotic function objects whose evaluative behaviour is expressed in some implementation defined form of executable code other than via ECMAScript code. Whether a function object is an ECMAScript code function or a non-ECMAScript function is not semantically observable from the perspective of an ECMAScript code function that calls or is called by such a non-ECMAScript function.

11 ECMAScript Language: Lexical Grammar

The source text of an ECMAScript Script or Module is first converted into a sequence of input elements, which are tokens, line terminators, comments, or white space. The source text is scanned from left to right, repeatedly taking the longest possible sequence of code units as the next input element.

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There are several situations where the identification of lexical input elements is sensitive to the syntactic grammar context that is consuming the input elements. This requires multiple goal symbols for the lexical grammar. The *InputElementDiv* goal symbol is the default goal symbol and is used in those syntactic grammar contexts where a leading division (/) or division-assignment (/=) operator is permitted. The *InputElementRegExp* goal symbol is used in all syntactic grammar contexts where a *RegularExpressionLiteral* is permitted. The *InputElementTemplateTail* goal is used in syntactic grammar contexts where a *TemplateLiteral* logically continues after a substitution element.

NOTE There are no syntactic grammar contexts where both a leading division or division-assignment, and a leading *RegularExpressionLiteral* are permitted. This is not affected by semicolon insertion (see 11.9); in examples such as the following:

```
a = b
/hi/g.exec(c).map(d);
```

Comment [AWB97]: May need to also say something about TemplateSubstitution tail. Also need to consider with there are any ASI issues concerning it.

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where the first non-whitespace, non-comment code point after a *LineTerminator* is SOLIDUS (/) and the syntactic context allows division or division-assignment; no semicolon is inserted at the *LineTerminator*. That is, the above example is interpreted in the same way as:

```
a = b / hi / g.exec(c).map(d);
```

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Syntax

InputElementDiv ::
 WhiteSpace
LineTerminator
Comment
Token
DivPunctuator
RightBracePunctuator

```
InputElementRegExp ::
 WhiteSpace
  LineTerminator
  Comment
  Token
  RightBracePunctuator
  RegularExpressionLiteral
```

```
InputElementTemplateTail ::
 WhiteSpace
  LineTerminator
  Comment
  Token
  DivPunctuator
  TemplateSubstitutionTail
```

11.1 Unicode Format-Control Characters

The Unicode format-control characters (i.e., the characters in category “Cf” in the Unicode Character Database such as LEFT-TO-RIGHT MARK or RIGHT-TO-LEFT MARK) are control codes used to control the formatting of a range of text in the absence of higher-level protocols for this (such as mark-up languages).

It is useful to allow format-control characters in source text to facilitate editing and display. All format control characters may be used within comments, and within string literals, template literals, and regular expression literals.

U+200C (ZERO WIDTH NON-JOINER) and U+200D (ZERO WIDTH JOINER) are format-control characters that are used to make necessary distinctions when forming words or phrases in certain languages. In ECMAScript source text, [these code points](#) may also be used in an [IdentifierName](#) (see [11.6.1](#)) after the first character.

U+FEFF ([ZERO WIDTH NO-BREAK SPACE](#)) is a format-control character used primarily at the start of a text to mark it as Unicode and to allow detection of the text's encoding and byte order. [`<ZWNBSP>`](#) characters intended for this purpose can sometimes also appear after the start of a text, for example as a result of concatenating files. In ECMAScript source text [`<ZWNBSP>`](#) [code points](#) are treated as white space characters (see [11.2](#)).

The special treatment of certain format-control characters outside of comments, string literals, and regular expression literals is [summarized](#) in [Table 32](#).

Table 32 — Format-Control [Code Point Usage](#)

Code Point	Name	Abbreviation	Usage
U+200C	ZERO WIDTH NON-JOINER	<code><ZWNJ></code>	IdentifierPart
U+200D	ZERO WIDTH JOINER	<code><ZWJ></code>	IdentifierPart
U+FEFF	ZERO WIDTH NO-BREAK SPACE	<code><ZWNBSP></code>	Whitespace

11.2 White Space

White space [code points](#) are used to improve source text readability and to separate tokens (indivisible lexical units) from each other, but are otherwise insignificant. White space [code points](#) may occur

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between any two tokens and at the start or end of input. White space [code points](#) may occur within a *StringLiteral*, a *RegularExpressionLiteral*, a *Template*, or a *TemplateSubstitutionTail* where they are considered significant [code points](#) forming part of a literal value. They may also occur within a *Comment*, but cannot appear within any other kind of token.

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The ECMAScript white space [code points](#) are listed in [Table 33](#).

Table 33 — Whitespace [Code Point](#)

Code Point	Name	Abbreviation
U+0009	CHARACTER TABULATION	<TAB>
U+000B	LINE TABULATION	<VT>
U+000C	FORM FEED (FF)	<FF>
U+0020	SPACE	<SP>
U+00A0	NO-BREAK SPACE	<NBSP>
U+FEFF	ZERO WIDTH NO-BREAK SPACE	<ZWNBSP>
Other category "Zs"	Any other Unicode "Separator, space " code point	<USP>

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ECMAScript implementations must recognize as *Whitespace* code points listed in the "Separator, [space](#)" (Zs) category by Unicode 5.1. ECMAScript implementations may also recognize as *Whitespace* additional category Zs code points from subsequent editions of the Unicode Standard.

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NOTE Other than for the code points listed in [Table 33](#), ECMAScript *Whitespace* intentionally excludes all code points that have the Unicode "White_Space" property but which are not classified in category "Zs".

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Syntax

```
WhiteSpace :::  
    <TAB>  
    <VT>  
    <FF>  
    <SP>  
    <NBSP>  
    <ZWNBSP>  
    <USP>
```

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Comment [AWB98]: Need to talk about line terminators in Templates

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11.3 Line Terminators

Like white space [code points](#), line terminator [code points](#) are used to improve source text readability and to separate tokens (indivisible lexical units) from each other. However, unlike white space [code points](#), line terminators have some influence over the behaviour of the syntactic grammar. In general, line terminators may occur between any two tokens, but there are a few places where they are forbidden by the syntactic grammar. Line terminators also affect the process of automatic semicolon insertion (11.9). A line terminator cannot occur within any token except a *StringLiteral*, *Template*, or *TemplateSubstitutionTail*. Line terminators may only occur within a *StringLiteral* token as part of a *LineContinuation*.

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A line terminator can occur within a *MultiLineComment* (11.4) but cannot occur within a *SingleLineComment*.

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Line terminators are included in the set of white space [code points](#) that are matched by the \s class in regular expressions.

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The ECMAScript line terminator [code points](#) are listed in [Table 34](#).

Table 34 — Line Terminator Code Points

Code Point	Unicode Name	Abbreviation
U+000A	LINE FEED (LF)	<LF>
U+000D	CARRIAGE RETURN (CR)	<CR>
U+2028	LINE SEPARATOR	<LS>
U+2029	PARAGRAPH SEPARATOR	<PS>

Only the Unicode code points in [Table 34](#) are treated as line terminators. Other new line or line breaking Unicode code points [are not treated as line terminators but](#) are treated as white space [if they meet the requirements listed in Table 33](#). The sequence <CR><LF> is commonly used as a line terminator. It should be considered a single *SourceCharacter* for the purpose of reporting line numbers.

Syntax

LineTerminator ::

<LF>
<CR>
<LS>
<PS>

LineTerminatorSequence ::

<LF>
<CR> [lookahead ~~not~~ <LF>]
<LS>
<PS>
<CR> <LF>

11.4 Comments

Comments can be either single or multi-line. Multi-line comments cannot nest.

Because a single-line comment can contain any Unicode code point except a *LineTerminator* [code point](#), and because of the general rule that a token is always as long as possible, a single-line comment always consists of all [code points](#) from the // marker to the end of the line. However, the *LineTerminator* at the end of the line is not considered to be part of the single-line comment; it is [recognized](#) separately by the lexical grammar and becomes part of the stream of input elements for the syntactic grammar. This point is very important, because it implies that the presence or absence of single-line comments does not affect the process of automatic semicolon insertion (see 11.9).

Comments behave like white space and are discarded except that, if a *MultiLineComment* contains a line terminator [code point](#), then the entire comment is considered to be a *LineTerminator* for purposes of parsing by the syntactic grammar.

Syntax

Comment ::

MultiLineComment
SingleLineComment

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Deleted: but not as line terminators.

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```

MultiLineComment ::=
  /* MultiLineCommentCharsopt */

MultiLineCommentChars ::=
  MultiLineNotAsteriskChar MultiLineCommentCharsopt
  * PostAsteriskCommentCharsopt

PostAsteriskCommentChars ::=
  MultiLineNotForwardSlashOrAsteriskChar MultiLineCommentCharsopt
  * PostAsteriskCommentCharsopt

MultiLineNotAsteriskChar ::=
  SourceCharacter but not *

MultiLineNotForwardSlashOrAsteriskChar ::=
  SourceCharacter but not one of / or *

SingleLineComment ::=
  // SingleLineCommentCharsopt

SingleLineCommentChars ::=
  SingleLineCommentChar SingleLineCommentCharsopt

SingleLineCommentChar ::=
  SourceCharacter but not LineTerminator

```

11.5 Tokens

Syntax

```

Token ::=
  IdentifierName
  Punctuator
  NumericLiteral
  StringLiteral
  Template

```

NOTE The *DivPunctuator*, *RegularExpressionLiteral*, *RightBracePunctuator*, and *TemplateSubstitutionTail* productions define tokens, but are not included in the *Token* production.

11.6 Names and Keywords

IdentifierName and *ReservedWord* are tokens that are interpreted according to the Default Identifier Syntax given in Unicode Standard Annex #31, Identifier and Pattern Syntax, with some small modifications.

ReservedWord is an enumerated subset of *IdentifierName*. The syntactic grammar defines *Identifier* as an *IdentifierName* that is not a *ReservedWord* (see 11.6.2). The Unicode identifier grammar is based on character properties specified by the Unicode Standard. The Unicode code points in the specified categories in version 5.1.0 of the Unicode standard must be treated as in those categories by all conforming ECMAScript implementations. ECMAScript implementations may recognize identifier code points defined in later editions of the Unicode Standard.

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NOTE 1 This standard specifies specific code point additions: U+0024 (DOLLAR SIGN) and U+005F (LOW LINE) are permitted anywhere in an *IdentifierName*, and the characters U+200C (ZERO-WIDTH NON-JOINER) and U+200D (ZERO-WIDTH JOINER) are permitted anywhere after the first code unit of an *IdentifierName*.

Unicode escape sequences are permitted in an *IdentifierName*, where they contribute a single Unicode code point to the *IdentifierName*. The code point is expressed by the *HexDigits* of the *UnicodeEscapeSequence* (see 11.8.4). The \ preceding the *UnicodeEscapeSequence* and the u and { } code units, if they appear, do not contribute code points to the *IdentifierName*. A *UnicodeEscapeSequence* cannot be used to put a code point into an *IdentifierName* that would otherwise be illegal. In other words, if a \ *UnicodeEscapeSequence* sequence were replaced by the *SourceCharacter* it contributes, the result must still be a valid *IdentifierName* that has the exact same sequence of *SourceCharacter* elements as the original *IdentifierName*. All interpretations of *IdentifierName* within this specification are based upon their actual code points regardless of whether or not an escape sequence was used to contribute any particular code point.

Two *IdentifierName* that are canonically equivalent according to the Unicode standard are *not* equal unless they are represented by the exact same sequence of code points (in other words, conforming ECMAScript implementations are only required to do bitwise comparison on *IdentifierName* values).

Syntax

IdentifierName ::
 IdentifierStart
 IdentifierName IdentifierPart

IdentifierStart ::
 UnicodeIDStart
 \$
 \ *UnicodeEscapeSequence*

IdentifierPart ::
 UnicodeIDContinue
 \$
 \ *UnicodeEscapeSequence*
 <ZWNJ>
 <ZWJ>

UnicodeIDStart ::
 any Unicode code point with the Unicode property “ID_Start” or “Other_ID_Start”

UnicodeIDContinue ::
 any Unicode code point with the Unicode property “ID_Continue” “Other_ID_Continue”, or
“Other_ID_Start”

The definitions of the nonterminal *UnicodeEscapeSequence* is given in 11.8.4.

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Deleted: U+0024
Deleted: the underscore
Deleted: U+005f
Deleted: zero width non-joiner
Deleted: U+200C
Deleted: zero width joiner
Deleted: U+200D
Deleted: character
Deleted: characters
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Deleted: or
Deleted:

11.6.1 Identifier Names

11.6.1.1 Static Semantics: Early Errors

IdentifierStart :: \ *UnicodeEscapeSequence*

- It is a Syntax Error if SV(*UnicodeEscapeSequence*) is neither the UTF-16 Encoding (10.1.1) of a single Unicode code point with the Unicode property "ID_Start" nor "\$" or "_"

Deleted: n
Deleted: e
Deleted: "
Deleted: "
Deleted: n
Deleted: e
Deleted: "
Deleted: "
Deleted: e
Deleted: ZAJ
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IdentifierPart :: \ *UnicodeEscapeSequence*

- It is a Syntax Error if SV(*UnicodeEscapeSequence*) is neither the UTF-16 Encoding (10.1.1) of a single Unicode code point with the Unicode property "ID_Continue" nor "\$" or "_" nor the UTF-16 Encoding of either <ZWNJ> or <ZWJ>.

11.6.1.2 Static Semantics: StringValue

See also: 11.8.4.2, [12.1.4](#)

IdentifierName ::

IdentifierStart
IdentifierName IdentifierPart

1. Return the String value consisting of the sequence of code units corresponding to *IdentifierName*. In determining the sequence any occurrences of \ *UnicodeEscapeSequence* are first replaced with the code point represented by the *UnicodeEscapeSequence* and then the code points of the entire *IdentifierName* are converted to code units by UTF-16 Encoding (10.1.1) each code point.

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11.6.2 Reserved Words

A reserved word is an *IdentifierName* that cannot be used as an *Identifier*.

Syntax

ReservedWord ::

Keyword
FutureReservedWord
NullLiteral
BooleanLiteral

NOTE The *ReservedWord* definitions are specified as literal sequences of specific *SourceCharacter* elements. A code point in a *ReservedWord* cannot be expressed by a \ *UnicodeEscapeSequence*.

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11.6.2.1 Keywords

The following tokens are ECMAScript keywords and may not be used as *Identifiers* in ECMAScript programs.

Syntax

Keyword :: one of

break	do	in	<u>typeof</u>
case	else	instanceof	<u>var</u>
catch	export	new	<u>void</u>
class	extends	return	<u>while</u>
const	finally	super	<u>with</u>
continue	for	switch	<u>yield</u>
debugger	function	this	
default	if	throw	
delete	import	try	

typeof,
var,
void,
while,
with,
yield

Deleted: typeof
Deleted: var
Deleted: void
Deleted: while
Deleted: with
Deleted: yield

NOTE In some contexts yield is given the semantics of an *Identifier*. See 12.1.1. In strict mode code, let and static are treated as reserved keywords through static semantic restrictions (see 12.1.1, 13.2.1.1, 13.6.4.1, and 14.5.1) rather than the lexical grammar.

11.6.2.2 Future Reserved Words

The following tokens are reserved for used as keywords in future language extensions.

Syntax

FutureReservedWord ::

enum
await

await is only treated as a *FutureReservedWord* when *Module* is the goal symbol of the syntactic grammar.

NOTE Use of the following tokens within strict mode code (see 10.2.1) is also reserved. That usage is restricted using static semantic restrictions (see 12.1.1) rather than the lexical grammar:

implements
interface
package
private
protected
public

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Deleted: proposed
Deleted: and are therefore reserved to allow for the possibility of future adoption of those extensions
Deleted: enum

11.7 Punctuators

Syntax

Punctuator :: one of

11.7 {	()	[]	.
11.7 ...	;	,	<	>	<=
11.7 >=	==	!=	====	!==	
11.7 +	-	*	%	++	--
11.7 <<	>>	>>>	&		^
11.7 !	~	&&		?	:
11.7 =	+=	-=	*=	%=	<<=
11.7 >>=	>>>=	&=	=	^=	=>

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DivPunctuator :: one of

/ /=

RightBracePunctuator ::

}

11.8 Literals

11.8.1 Null Literals

Syntax

NullLiteral ::

null

11.8.2 Boolean Literals

Syntax

BooleanLiteral ::

true

false

11.8.3 Numeric Literals

Syntax

NumericLiteral ::

DecimalLiteral
 BinaryIntegerLiteral
 OctalIntegerLiteral
 HexIntegerLiteral

DecimalLiteral ::

DecimalIntegerLiteral . *DecimalDigits_{opt}* *ExponentPart_{opt}*
 . *DecimalDigits* *ExponentPart_{opt}*
 DecimalIntegerLiteral *ExponentPart_{opt}*

DecimalIntegerLiteral ::

 0
 NonZeroDigit *DecimalDigits_{opt}*

DecimalDigits ::

DecimalDigit
 DecimalDigits *DecimalDigit*

DecimalDigit :: one of

0 1 2 3 4 5 6 7 8 9

NonZeroDigit :: one of

1 2 3 4 5 6 7 8 9

ExponentPart ::

ExponentIndicator *SignedInteger*

Comment [AWB79]: From March 29 meeting notes: Hex floating point literals:
 Waldemar: Other languages include these things. They're rarely used but when you want one, you really want one. Use cases are similar to that of hex literals.
 Will explore adding them.
 MarkM: 0x3.p1 currently evaluates to undefined. This would be a breaking change.
 Waldemar: Not clear anyone would notice. How did other languages deal with this?

Comment [AWB710]: The various Digit productions could be refactored to have less redundancy

ExponentIndicator :: one of

e **E**

SignedInteger ::

DecimalDigits
+ *DecimalDigits*
- *DecimalDigits*

BinaryIntegerLiteral ::

0b *BinaryDigits*
0B *BinaryDigits*

BinaryDigits ::

BinaryDigit
BinaryDigits BinaryDigit

BinaryDigit :: one of

0 **1**

OctalIntegerLiteral ::

0o *OctalDigits*
0O *OctalDigits*

OctalDigits ::

OctalDigit
OctalDigits OctalDigit

OctalDigit :: one of

0 **1** **2** **3** **4** **5** **6** **7**

HexIntegerLiteral ::

0x *HexDigits*
0X *HexDigits*

HexDigits ::

HexDigit
HexDigits HexDigit

HexDigit :: one of

0 **1** **2** **3** **4** **5** **6** **7** **8** **9** **a** **b** **c** **d** **e** **f** **A** **B** **C** **D** **E** **F**

The *SourceCharacter* immediately following a *NumericLiteral* must not be an *IdentifierStart* or *DecimalDigit*.

NOTE For example:

3in

is an error and not the two input elements **3** and **in**.

A conforming implementation, when processing strict mode code (see 10.2.1), must not extend, as described in B.1.1, the syntax of *NumericLiteral* to include *LegacyOctalIntegerLiteral*, nor extend the syntax of *DecimalIntegerLiteral* to include *NonOctalDecimalIntegerLiteral*.

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11.8.3.1 Static Semantics: MV's

A numeric literal stands for a value of the Number type. This value is determined in two steps: first, a mathematical value (MV) is derived from the literal; second, this mathematical value is rounded as described below.

- The MV of *NumericLiteral :: DecimalLiteral* is the MV of *DecimalLiteral*.
- The MV of *NumericLiteral :: BinaryIntegerLiteral* is the MV of *BinaryIntegerLiteral*.
- The MV of *NumericLiteral :: OctalIntegerLiteral* is the MV of *OctalIntegerLiteral*.
- The MV of *NumericLiteral :: HexIntegerLiteral* is the MV of *HexIntegerLiteral*.
- The MV of *DecimalLiteral :: DecimalIntegerLiteral .* is the MV of *DecimalIntegerLiteral*.
- The MV of *DecimalLiteral :: DecimalIntegerLiteral . DecimalDigits* is the MV of *DecimalIntegerLiteral* plus (the MV of *DecimalDigits* $\times 10^n$), where *n* is the number of code points in *DecimalDigits*. Deleted: characters
- The MV of *DecimalLiteral :: DecimalIntegerLiteral . ExponentPart* is the MV of *DecimalIntegerLiteral* $\times 10^e$, where *e* is the MV of *ExponentPart*.
- The MV of *DecimalLiteral :: DecimalIntegerLiteral . DecimalDigits ExponentPart* is (the MV of *DecimalIntegerLiteral* plus (the MV of *DecimalDigits* $\times 10^n$)) $\times 10^e$, where *n* is the number of code points in *DecimalDigits* and *e* is the MV of *ExponentPart*. Deleted: characters
- The MV of *DecimalLiteral :: DecimalDigits* is the MV of *DecimalDigits* $\times 10^{-n}$, where *n* is the number of code points in *DecimalDigits*. Deleted: characters
- The MV of *DecimalLiteral :: DecimalDigits ExponentPart* is (the MV of *DecimalDigits* $\times 10^{-n}$) $\times 10^e$, where *n* is the number of code points in *DecimalDigits* and *e* is the MV of *ExponentPart*. Deleted: characters
- The MV of *DecimalLiteral :: DecimalIntegerLiteral* is the MV of *DecimalIntegerLiteral*.
- The MV of *DecimalLiteral :: DecimalIntegerLiteral ExponentPart* is the MV of *DecimalIntegerLiteral* $\times 10^e$, where *e* is the MV of *ExponentPart*.
- The MV of *DecimalIntegerLiteral :: 0* is 0.
- The MV of *DecimalIntegerLiteral :: NonZeroDigit* is the MV of *NonZeroDigit*.
- The MV of *DecimalIntegerLiteral :: NonZeroDigit DecimalDigits* is (the MV of *NonZeroDigit* $\times 10^n$) plus the MV of *DecimalDigits*, where *n* is the number of code points in *DecimalDigits*. Deleted: characters
- The MV of *DecimalDigits :: DecimalDigit* is the MV of *DecimalDigit*.
- The MV of *DecimalDigits :: DecimalDigits DecimalDigit* is (the MV of *DecimalDigits* $\times 10$) plus the MV of *DecimalDigit*.
- The MV of *ExponentPart :: ExponentIndicator SignedInteger* is the MV of *SignedInteger*.
- The MV of *SignedInteger :: DecimalDigits* is the MV of *DecimalDigits*.
- The MV of *SignedInteger :: + DecimalDigits* is the MV of *DecimalDigits*.
- The MV of *SignedInteger :: - DecimalDigits* is the negative of the MV of *DecimalDigits*.
- The MV of *DecimalDigit :: 0* or of *HexDigit :: 0* or of *OctalDigit :: 0* or of *BinaryDigit :: 0* is 0.
- The MV of *DecimalDigit :: 1* or of *NonZeroDigit :: 1* or of *HexDigit :: 1* or of *OctalDigit :: 1* or of *BinaryDigit :: 1* is 1.
- The MV of *DecimalDigit :: 2* or of *NonZeroDigit :: 2* or of *HexDigit :: 2* or of *OctalDigit :: 2* is 2.
- The MV of *DecimalDigit :: 3* or of *NonZeroDigit :: 3* or of *HexDigit :: 3* or of *OctalDigit :: 3* is 3.
- The MV of *DecimalDigit :: 4* or of *NonZeroDigit :: 4* or of *HexDigit :: 4* or of *OctalDigit :: 4* is 4.
- The MV of *DecimalDigit :: 5* or of *NonZeroDigit :: 5* or of *HexDigit :: 5* or of *OctalDigit :: 5* is 5.
- The MV of *DecimalDigit :: 6* or of *NonZeroDigit :: 6* or of *HexDigit :: 6* or of *OctalDigit :: 6* is 6.
- The MV of *DecimalDigit :: 7* or of *NonZeroDigit :: 7* or of *HexDigit :: 7* or of *OctalDigit :: 7* is 7.
- The MV of *DecimalDigit :: 8* or of *NonZeroDigit :: 8* or of *HexDigit :: 8* is 8.

- The MV of *DecimalDigit* :: **9** or of *NonZeroDigit* :: **9** or of *HexDigit* :: **9** is 9.
- The MV of *HexDigit* :: **a** or of *HexDigit* :: **A** is 10.
- The MV of *HexDigit* :: **b** or of *HexDigit* :: **B** is 11.
- The MV of *HexDigit* :: **c** or of *HexDigit* :: **C** is 12.
- The MV of *HexDigit* :: **d** or of *HexDigit* :: **D** is 13.
- The MV of *HexDigit* :: **e** or of *HexDigit* :: **E** is 14.
- The MV of *HexDigit* :: **f** or of *HexDigit* :: **F** is 15.
- The MV of *BinaryIntegerLiteral* :: **0b** *BinaryDigits* is the MV of *BinaryDigits*.
- The MV of *BinaryIntegerLiteral* :: **0B** *BinaryDigits* is the MV of *BinaryDigits*.
- The MV of *BinaryDigits* :: *BinaryDigit* is the MV of *BinaryDigit*.
- The MV of *BinaryDigits* :: *BinaryDigits* *BinaryDigit* is (the MV of *BinaryDigits* × 2) plus the MV of *BinaryDigit*.
- The MV of *OctalIntegerLiteral* :: **0o** *OctalDigits* is the MV of *OctalDigits*.
- The MV of *OctalIntegerLiteral* :: **0O** *OctalDigits* is the MV of *OctalDigits*.
- The MV of *OctalDigits* :: *OctalDigit* is the MV of *OctalDigit*.
- The MV of *OctalDigits* :: *OctalDigits* *OctalDigit* is (the MV of *OctalDigits* × 8) plus the MV of *OctalDigit*.
- The MV of *HexIntegerLiteral* :: **0x** *HexDigits* is the MV of *HexDigits*.
- The MV of *HexIntegerLiteral* :: **0X** *HexDigits* is the MV of *HexDigits*.
- The MV of *HexDigits* :: *HexDigit* is the MV of *HexDigit*.
- The MV of *HexDigits* :: *HexDigits* *HexDigit* is (the MV of *HexDigits* × 16) plus the MV of *HexDigit*.

Once the exact MV for a numeric literal has been determined, it is then rounded to a value of the Number type. If the MV is 0, then the rounded value is +0; otherwise, the rounded value must be the Number value for the MV (as specified in 6.1.6), unless the literal is a *DecimalLiteral* and the literal has more than 20 significant digits, in which case the Number value may be either the Number value for the MV of a literal produced by replacing each significant digit after the 20th with a 0 digit or the Number value for the MV of a literal produced by replacing each significant digit after the 20th with a 0 digit and then incrementing the literal at the 20th significant digit position. A digit is *significant* if it is not part of an *ExponentPart* and

- it is not 0; or
- there is a nonzero digit to its left and there is a nonzero digit, not in the *ExponentPart*, to its right.

11.8.4 String Literals

NOTE A string literal is zero or more Unicode code points enclosed in single or double quotes. Unicode code points may also be represented by an escape sequence. All [code points](#) may appear literally in a string literal except for the closing quote [code points](#), [REVERSE SOLIDUS](#) (\), [CARRIAGE RETURN](#) (CR), [LINE SEPARATOR](#), [PARAGRAPH SEPARATOR](#), and [LINE FEED](#) (LF). Any [code points](#) may appear in the form of an escape sequence. String literals evaluate to [ECMAScript](#) String values. When generating these string values Unicode code points are UTF-16 encoded as defined in 10.1.1. Code points belonging to Basic Multilingual Plane are encoded as a single code unit element of the string. All other code points are encoded as two code unit elements of the string.

Syntax

```
StringLiteral ::  
    " DoubleStringCharactersopt "  
    ' SingleStringCharactersopt '
```

Deleted: characters
Deleted: character
Deleted: backslash
Formatted: All caps
Formatted: All caps
Deleted: character
Formatted: All caps
Formatted: All caps
Deleted: ECAMScript
Deleted: .
Deleted: .

DoubleStringCharacters ::
DoubleStringCharacter DoubleStringCharacters_{opt}

SingleStringCharacters ::
SingleStringCharacter SingleStringCharacters_{opt}

DoubleStringCharacter ::
*SourceCharacter **but not one of** " or \ or LineTerminator*
\ EscapeSequence
LineContinuation

SingleStringCharacter ::
*SourceCharacter **but not one of** ' or \ or LineTerminator*
\ EscapeSequence
LineContinuation

LineContinuation ::
\ LineTerminatorSequence

EscapeSequence ::
CharacterEscapeSequence
0 [lookahead \notin DecimalDigit]
HexEscapeSequence
UnicodeEscapeSequence

A conforming implementation, when processing strict mode code (see 10.2.1), must not extend the syntax of *EscapeSequence* to include *LegacyOctalEscapeSequence* as described in [B.1.2](#).

CharacterEscapeSequence ::
SingleEscapeCharacter
NonEscapeCharacter

SingleEscapeCharacter :: one of
' " \ b f n r t v

NonEscapeCharacter ::
*SourceCharacter **but not one of** EscapeCharacter or LineTerminator*

EscapeCharacter ::
SingleEscapeCharacter
DecimalDigit
x
u

HexEscapeSequence ::
x HexDigit HexDigit

UnicodeEscapeSequence ::
u Hex4Digits
u{ HexDigits }

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Deleted: B.1.1

Hex4Digits ::
HexDigit HexDigit HexDigit HexDigit

The definition of the nonterminal *HexDigit* is given in 11.8.3. *SourceCharacter* is defined in 10.1.

NOTE A line terminator *code point* cannot appear in a string literal, except as part of a *LineContinuation* to produce the empty *code points* sequence. The *proper* way to cause a line terminator *code point* to be part of the String value of a string literal is to use an escape sequence such as `\n` or `\u000A`.

11.8.4.1 Static Semantics: Early Errors

UnicodeEscapeSequence :: \u{ HexDigits }

- It is a Syntax Error if the MV of *HexDigits* > 1114111.

11.8.4.2 Static Semantics: StringValue

See also: 11.6.1.2, [12.1.4](#).

StringLiteral ::
" DoubleStringCharacters_{opt} "
' SingleStringCharacters_{opt} '

- Return the String value whose elements are the SV of this *StringLiteral*.

11.8.4.3 Static Semantics: SV's

A string literal stands for a value of the String type. The String value (SV) of the literal is described in terms of code unit values contributed by the various parts of the string literal. As part of this process, some Unicode code points within the string literal are interpreted as having a mathematical value (MV), as described below or in 11.8.3.

- The SV of *StringLiteral :: " "* is the empty code unit sequence.
- The SV of *StringLiteral :: ' '* is the empty code unit sequence.
- The SV of *StringLiteral :: " DoubleStringCharacters "* is the SV of *DoubleStringCharacters*.
- The SV of *StringLiteral :: ' SingleStringCharacters '* is the SV of *SingleStringCharacters*.
- The SV of *DoubleStringCharacters :: DoubleStringCharacter* is a sequence of one or two code units that is the *SV* of *DoubleStringCharacter*.
- The SV of *DoubleStringCharacters :: DoubleStringCharacter DoubleStringCharacters* is a sequence of one or two code units that is the *SV* of *DoubleStringCharacter* followed by all the code units in the SV of *DoubleStringCharacters* in order.
- The SV of *SingleStringCharacters :: SingleStringCharacter* is a sequence of one or two code units that is the *SV* of *SingleStringCharacter*.
- The SV of *SingleStringCharacters :: SingleStringCharacter SingleStringCharacters* is a sequence of one or two code units that is the *SV* of *SingleStringCharacter* followed by all the code units in the SV of *SingleStringCharacters* in order.
- The *SV* of *DoubleStringCharacter :: SourceCharacter but not one of " or \ or LineTerminator* is the UTF-16Encoding (10.1.1) of the code point value of *SourceCharacter*.
- The *SV* of *DoubleStringCharacter :: \ EscapeSequence* is the *SV* of the *EscapeSequence*.
- The *SV* of *DoubleStringCharacter :: LineContinuation* is the empty *code unit* sequence.

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- The SV of *SingleStringCharacter :: SourceCharacter but not one of ' or \ or LineTerminator* is the UTF-16Encoding (10.1.1) of the code point value of *SourceCharacter*.
- The SV of *SingleStringCharacter :: \ EscapeSequence* is the SV of the *EscapeSequence*.
- The SV of *SingleStringCharacter :: LineContinuation* is the empty code unit sequence.
- The SV of *EscapeSequence :: CharacterEscapeSequence* is the SV of the *CharacterEscapeSequence*.
- The SV of *EscapeSequence :: 0* is the code unit value 0.
- The SV of *EscapeSequence :: HexEscapeSequence* is the SV of the *HexEscapeSequence*.
- The SV of *EscapeSequence :: UnicodeEscapeSequence* is the SV of the *UnicodeEscapeSequence*.
- The SV of *CharacterEscapeSequence :: SingleEscapeCharacter* is the code unit whose value is determined by the *SingleEscapeCharacter* according to Table 35.

Table 35—String Single Character Escape Sequences

<u>Escape Sequence</u>	<u>Code Unit Value</u>	<u>Unicode Character Name</u>	<u>Symbol</u>
\b	0x0008	BACKSPACE	<BS>
\t	0x0009	CHARACTER TABULATION	<HT>
\n	0x000A	LINE FEED (LF)	<LF>
\v	0x000B	LINE TABULATION	<VT>
\f	0x000C	FORM FEED (FF)	<FF>
\r	0x000D	CARRIAGE RETURN (CR)	<CR>
\"	0x0022	QUOTATION MARK	"
\'	0x0027	APOSTROPHE	'
\\\	0x005C	REVERSE SOLIDUS	\

- The SV of *CharacterEscapeSequence :: NonEscapeCharacter* is the SV of the *NonEscapeCharacter*.
- The SV of *NonEscapeCharacter :: SourceCharacter but not one of EscapeCharacter or LineTerminator* is the UTF-16Encoding (10.1.1) of the code point value of *SourceCharacter*.
- The SV of *HexEscapeSequence :: x HexDigit HexDigit* is the code unit value that is (16 times the MV of the first *HexDigit*) plus the MV of the second *HexDigit*.
- The SV of *UnicodeEscapeSequence :: u Hex4Digits* is the SV of *Hex4Digits*.
- The SV of *Hex4Digits :: HexDigit HexDigit HexDigit HexDigit* is the code unit value that is (4096 times the MV of the first *HexDigit*) plus (256 times the MV of the second *HexDigit*) plus (16 times the MV of the third *HexDigit*) plus the MV of the fourth *HexDigit*.
- The SV of *UnicodeEscapeSequence :: u{ HexDigits }* is the UTF-16Encoding (10.1.1) of the MV of *HexDigits*.

11.8.5 Regular Expression Literals

NOTE A regular expression literal is an input element that is converted to a `RegExp` object (see 21.2) each time the literal is evaluated. Two regular expression literals in a program evaluate to regular expression objects that never compare as `==` to each other even if the two literals' contents are identical. A `RegExp` object may also be created at runtime by `new RegExp` (see 21.2.3.2) or calling the `RegExp` constructor as a function (21.2.3.1).

The productions below describe the syntax for a regular expression literal and are used by the input element scanner to find the end of the regular expression literal. The source code comprising the *RegularExpressionBody* and the *RegularExpressionFlags* are subsequently parsed using the more stringent ECMAScript Regular Expression grammar (21.2.1).

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Deleted: HORIZONTAL TAB
Deleted: (NEW LINE)
Deleted: VERTICAL TAB
Deleted: DOUBLE
Deleted: E
Deleted: SINGLE QUOTE
Deleted: BACKSLASH
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An implementation may extend the ECMAScript Regular Expression grammar defined in 21.2.1, but it must not extend the *RegularExpressionBody* and *RegularExpressionFlags* productions defined below or the productions used by these productions.

Syntax

RegularExpressionLiteral ::
 / *RegularExpressionBody* / *RegularExpressionFlags*

RegularExpressionBody ::
 RegularExpressionFirstChar *RegularExpressionChars*

RegularExpressionChars ::
 [empty]
 RegularExpressionChars *RegularExpressionChar*

RegularExpressionFirstChar ::
 RegularExpressionNonTerminator **but not one of * or \ or / or [**
 RegularExpressionBackslashSequence
 RegularExpressionClass

RegularExpressionChar ::
 RegularExpressionNonTerminator **but not one of \ or / or [**
 RegularExpressionBackslashSequence
 RegularExpressionClass

RegularExpressionBackslashSequence ::
 \ *RegularExpressionNonTerminator*

RegularExpressionNonTerminator ::
 SourceCharacter **but not LineTerminator**

RegularExpressionClass ::
 [*RegularExpressionClassChars*]

RegularExpressionClassChars ::
 [empty]
 RegularExpressionClassChars *RegularExpressionClassChar*

RegularExpressionClassChar ::
 RegularExpressionNonTerminator **but not one of] or **
 RegularExpressionBackslashSequence

RegularExpressionFlags ::
 [empty]
 RegularExpressionFlags *IdentifierPart*

NOTE Regular expression literals may not be empty; instead of representing an empty regular expression literal, the code unit sequence // starts a single-line comment. To specify an empty regular expression, use: /(?:)/.

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11.8.5.1 Static Semantics: Early Errors

RegularExpressionFlags :: RegularExpressionFlags IdentifierPart

- It is a Syntax Error if *IdentifierPart* contains a Unicode escape sequence.

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11.8.5.2 Static Semantics: BodyText

RegularExpressionLiteral :: / RegularExpressionBody / RegularExpressionFlags

1. Return the source code that was recognized as *RegularExpressionBody*.

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11.8.5.3 Static Semantics: FlagText

RegularExpressionLiteral :: / RegularExpressionBody / RegularExpressionFlags

1. Return the source code that was recognized as *RegularExpressionFlags*.

Deleted: recognised

11.8.6 Template Literal Lexical Components

Syntax

Template ::
NoSubstitutionTemplate
TemplateHead

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NoSubstitutionTemplate ::
` *TemplateCharacters_{opt}*

Deleted: ¶

TemplateHead ::
` *TemplateCharacters_{opt}* \${

Deleted: ¶

TemplateSubstitutionTail ::
TemplateMiddle
TemplateTail

Deleted: ¶

TemplateMiddle ::
` *TemplateCharacters_{opt}* \${

Deleted: ¶

TemplateTail ::
` *TemplateCharacters_{opt}* `

Deleted: ¶

TemplateCharacters ::
TemplateCharacter *TemplateCharacters_{opt}*

Deleted: *SourceCharacter but not one of ` or \ or \$ or LineTerminatorSequence*

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TemplateCharacter ::
\$ [lookahead $\neq t$]
\ *EscapeSequence*
LineContinuation
LineTerminatorSequence
SourceCharacter but not one of ` or \ or \$ or LineTerminator

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A conforming implementation must not use the extended definition of *EscapeSequence* described in B.1.2 when parsing a *TemplateCharacter*.

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NOTE *TemplateSubstitutionTail* is used by the *InputElementTemplateTail* alternative lexical goal.

11.8.6.1 Static Semantics: TV's and TRV's

A template literal component is interpreted as a sequence of Unicode code points. The Template Value (TV) of a literal component is described in terms of code unit values (*SV*, 11.8.4) contributed by the various parts of the template literal component. As part of this process, some Unicode code points within the template component are interpreted as having a mathematical value (MV, 11.8.3). In determining a TV, escape sequences are replaced by the UTF-16 code unit(s) of the Unicode code point represented by the escape sequence. The Template Raw Value (TRV) is similar to a Template Value with the difference that in TRVs escape sequences are interpreted literally.

- The TV and TRV of *NoSubstitutionTemplate* :: `` is the empty code unit sequence.
- The TV and TRV of *TemplateHead* :: ` \${ } is the empty code unit sequence.
- The TV and TRV of *TemplateMiddle* :: } \${ } is the empty code unit sequence.
- The TV and TRV of *TemplateTail* :: } ` is the empty code unit sequence.
- The TV of *NoSubstitutionTemplate* :: ` *TemplateCharacters* ` is the TV of *TemplateCharacters*.
- The TV of *TemplateHead* :: ` *TemplateCharacters* \${ } is the TV of *TemplateCharacters*.
- The TV of *TemplateMiddle* :: } *TemplateCharacters* \${ } is the TV of *TemplateCharacters*.
- The TV of *TemplateTail* :: } *TemplateCharacters* ` is the TV of *TemplateCharacters*.
- The TV of *TemplateCharacters* :: *TemplateCharacter* is the TV of *TemplateCharacter*.
- The TV of *TemplateCharacters* :: *TemplateCharacter TemplateCharacters* is a sequence consisting of the code units in the TV of *TemplateCharacter* followed by all the code units in the TV of *TemplateCharacters* in order.
- The TV of *TemplateCharacter* :: *SourceCharacter but not one of ` or \ or \$ or LineTerminator* is the UTF-16 Encoding (10.1.1) of the code point value of *SourceCharacter*.
- The TV of *TemplateCharacter* :: \$ is the code unit value 0x0024.
- The TV of *TemplateCharacter* :: \ *EscapeSequence* is the *SV* of *EscapeSequence*.
- The TV of *TemplateCharacter* :: LineContinuation is the TV of *LineContinuation*.
- The TV of *TemplateCharacter* :: LineTerminatorSequence is the TRV of *LineTerminatorSequence*.
- The TV of *LineContinuation* :: \ *LineTerminatorSequence* is the empty code unit sequence.
- The TRV of *NoSubstitutionTemplate* :: ` *TemplateCharacters* ` is the TRV of *TemplateCharacters*.
- The TRV of *TemplateHead* :: ` *TemplateCharacters* \${ } is the TRV of *TemplateCharacters*.
- The TRV of *TemplateMiddle* :: } *TemplateCharacters* \${ } is the TRV of *TemplateCharacters*.
- The TRV of *TemplateTail* :: } *TemplateCharacters* ` is the TRV of *TemplateCharacters*.
- The TRV of *TemplateCharacters* :: *TemplateCharacter* is the TRV of *TemplateCharacter*.
- The TRV of *TemplateCharacters* :: *TemplateCharacter TemplateCharacters* is a sequence consisting of the code units in the TRV of *TemplateCharacter* followed by all the code units in the TRV of *TemplateCharacters*, in order.
- The TRV of *TemplateCharacter* :: *SourceCharacter but not one of ` or \ or \$ or LineTerminator* is the UTF-16 Encoding (10.1.1) of the code point value of *SourceCharacter*.
- The TRV of *TemplateCharacter* :: \$ is the code unit value 0x0024.
- The TRV of *TemplateCharacter* :: \ *EscapeSequence* is the sequence consisting of the code unit value 0x005C followed by the code units of TRV of *EscapeSequence*.
- The TRV of *TemplateCharacter* :: LineContinuation is the TRV of *LineContinuation*.
- The TRV of *TemplateCharacter* :: LineTerminatorSequence is the TRV of *LineTerminatorSequence*.
- The TRV of *EscapeSequence* :: *CharacterEscapeSequence* is the TRV of the *CharacterEscapeSequence*.

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- The TRV of *EscapeSequence* :: 0 is the code unit value 0x0030.
- The TRV of *EscapeSequence* :: *HexEscapeSequence* is the TRV of the *HexEscapeSequence*.
- The TRV of *EscapeSequence* :: *UnicodeEscapeSequence* is the TRV of the *UnicodeEscapeSequence*.
- The TRV of *CharacterEscapeSequence* :: *SingleEscapeCharacter* is the TRV of the *SingleEscapeCharacter*.
- The TRV of *CharacterEscapeSequence* :: *NonEscapeCharacter* is the *SV* of the *NonEscapeCharacter*.
- The TRV of *SingleEscapeCharacter* :: one of ' " \ b f n r t v' is the *SV* of the *SourceCharacter* that is that single *code point*.
- The TRV of *HexEscapeSequence* :: *x HexDigit HexDigit* is the sequence consisting of code unit value 0x0078 followed by TRV of the first *HexDigit* followed by the TRV of the second *HexDigit*.
- The TRV of *UnicodeEscapeSequence* :: u*Hex4Digits* is the sequence consisting of code unit value 0x0075 followed by TRV of *Hex4Digits*.
- The TRV of *UnicodeEscapeSequence* :: u{ *HexDigits* } is the sequence consisting of code unit value 0x0075 followed by code unit value 0x007B followed by TRV of *HexDigits* followed by code unit value 0x007D.
- The TRV of *Hex4Digits* :: *HexDigit HexDigit HexDigit HexDigit* is the sequence consisting of the TRV of the first *HexDigit* followed by the TRV of the second *HexDigit* followed by the TRV of the third *HexDigit* followed by the TRV of the fourth *HexDigit*.
- The TRV of *HexDigits* :: *HexDigit* is the TRV of *HexDigit*.
- The TRV of *HexDigits* :: *HexDigits HexDigit* is the sequence consisting of TRV of *HexDigits* followed by TRV of *HexDigit*.
- The TRV of a *HexDigit* is the *SV* of the *SourceCharacter* that is that *HexDigit*.
- The TRV of *LineContinuation* :: \ *LineTerminatorSequence* is the sequence consisting of the code unit value 0x005C followed by the code units of TRV of *LineTerminatorSequence*.
- The TRV of *LineTerminatorSequence* :: <LF> is the code unit value 0x000A.
- The TRV of *LineTerminatorSequence* :: <CR> is the code unit value 0x000A.
- The TRV of *LineTerminatorSequence* :: <LS> is the code unit value 0x2028.
- The TRV of *LineTerminatorSequence* :: <PS> is the code unit value 0x2029.
- The TRV of *LineTerminatorSequence* :: <CR><LF> is the sequence consisting of the code unit value 0x000A.

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NOTE TV excludes the code units of *LineContinuation* while TRV includes them. <CR><LF> and <CR>*LineTerminatorSequences* are normalized to <LF> for both TV and TRV. An explicit *EscapeSequence* is needed to include a <CR> or <CR><LF> sequence.

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11.9 Automatic Semicolon Insertion

Certain ECMAScript statements (empty statement, **let**, **const**, **import**, and **export** declarations, variable statement, expression statement, **debugger** statement, **continue** statement, **break** statement, **return** statement, and **throw** statement) must be terminated with semicolons. Such semicolons may always appear explicitly in the source text. For convenience, however, such semicolons may be omitted from the source text in certain situations. These situations are described by saying that semicolons are automatically inserted into the source code token stream in those situations.

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11.9.1 Rules of Automatic Semicolon Insertion

There are three basic rules of semicolon insertion:

1. When, as a Script or Module is parsed from left to right, a token (called the *offending token*) is encountered that is not allowed by any production of the grammar, then a semicolon is automatically inserted before the offending token if one or more of the following conditions is true:

- The offending token is separated from the previous token by at least one *LineTerminator*.
- The offending token is `}`.

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2. When, as the Script or Module is parsed from left to right, the end of the input stream of tokens is encountered and the parser is unable to parse the input token stream as a single complete ECMAScript Script or Module, then a semicolon is automatically inserted at the end of the input stream.

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3. When, as the Script or Module is parsed from left to right, a token is encountered that is allowed by some production of the grammar, but the production is a *restricted production* and the token would be the first token for a terminal or nonterminal immediately following the annotation “[no LineTerminator here]” within the restricted production (and therefore such a token is called a *restricted token*), and the restricted token is separated from the previous token by at least one *LineTerminator*, then a semicolon is automatically inserted before the restricted token.

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However, there is an additional overriding condition on the preceding rules: a semicolon is never inserted automatically if the semicolon would then be parsed as an empty statement or if that semicolon would become one of the two semicolons in the header of a `for` statement (see 13.6.3).

NOTE The following are the only restricted productions in the grammar:

```

PostfixExpression[Yield] :
  LeftHandSideExpression[?Yield] [no LineTerminator here] ++
  LeftHandSideExpression[?Yield] [no LineTerminator here] --

ContinueStatement[Yield] :
  continue ;
  continue [no LineTerminator here] LabelIdentifier[?Yield] ;

BreakStatement[Yield] :
  break ;
  break [no LineTerminator here] LabelIdentifier[?Yield] ;

ReturnStatement[Yield] :
  return [no LineTerminator here] Expression ;
  return [no LineTerminator here] Expression[In, ?Yield] ;

ThrowStatement[Yield] :
  throw [no LineTerminator here] Expression[In, ?Yield] ;

ArrowFunction[In, Yield] :
  ArrowParameters[?Yield] [no LineTerminator here] => ConciseBody[?In]

YieldExpression[In] :
  yield [no LineTerminator here] * [Lexical goal InputElementRegExp] AssignmentExpression[?In, Yield]
  yield [no LineTerminator here] [Lexical goal InputElementRegExp] AssignmentExpression[?In, Yield]

```

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Deleted: ModuleImport :¶
module [no LineTerminator here]
ImportedBinding FromClause ;¶

The practical effect of these restricted productions is as follows:

When a `++` or `--` token is encountered where the parser would treat it as a postfix operator, and at least one *LineTerminator* occurred between the preceding token and the `++` or `--` token, then a semicolon is automatically inserted before the `++` or `--` token.

When a `continue`, `break`, `return`, `throw`, or `yield` token is encountered and a *LineTerminator* is encountered before the next token, a semicolon is automatically inserted after the `continue`, `break`, `return`, `throw`, or `yield` token.

The resulting practical advice to ECMAScript programmers is:

A postfix `++` or `--` operator should appear on the same line as its operand.

An *Expression* in a `return` or `throw` statement or an *AssignmentExpression* in a `yield` expression should start on the same line as the `return`, `throw`, or `yield` token.

An *IdentifierReference* in a `break` or `continue` statement should be on the same line as the `break` or `continue` token.

11.9.2 Examples of Automatic Semicolon Insertion

The source

```
{ 1 2 } 3
```

is not a valid sentence in the ECMAScript grammar, even with the automatic semicolon insertion rules. In contrast, the source

```
{ 1  
2 } 3
```

is also not a valid ECMAScript sentence, but is transformed by automatic semicolon insertion into the following:

```
{ 1  
;2 ;} 3;
```

which is a valid ECMAScript sentence.

The source

```
for (a; b  
)
```

is not a valid ECMAScript sentence and is not altered by automatic semicolon insertion because the semicolon is needed for the header of a `for` statement. Automatic semicolon insertion never inserts one of the two semicolons in the header of a `for` statement.

The source

```
return  
a + b
```

is transformed by automatic semicolon insertion into the following:

```
return;  
a + b;
```

NOTE The expression `a + b` is not treated as a value to be returned by the `return` statement, because a *LineTerminator* separates it from the token `return`.

The source

```
a = b
++c
```

is transformed by automatic semicolon insertion into the following:

```
a = b;
++c;
```

NOTE The token `++` is not treated as a postfix operator applying to the variable `b`, because a *LineTerminator* occurs between `b` and `++`.

The source

```
if (a > b)
else c = d
```

is not a valid ECMAScript sentence and is not altered by automatic semicolon insertion before the `else` token, even though no production of the grammar applies at that point, because an automatically inserted semicolon would then be parsed as an empty statement.

The source

```
a = b + c
(d + e).print()
```

is *not* transformed by automatic semicolon insertion, because the parenthesized expression that begins | the second line can be interpreted as an argument list for a function call:

```
a = b + c(d + e).print()
```

In the circumstance that an assignment statement must begin with a left parenthesis, it is a good idea for the programmer to provide an explicit semicolon at the end of the preceding statement rather than to rely on automatic semicolon insertion.

12 ECMAScript Language: Expressions

12.1 Identifiers

Syntax

IdentifierReference_[Yield] :
Identifier
`[~Yield] yield`

BindingIdentifier_[Yield] :
Identifier
`[~Yield] yield`

LabelIdentifier_[Yield] :
Identifier
`[~Yield] yield`

Identifier :
IdentifierName **but not ReservedWord**

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`[~Yield] yield` .

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12.1.1 Static Semantics: Early Errors

BindingIdentifier : *Identifier*

- It is a Syntax Error if this production is contained in strict code and the StringValue of *Identifier* is "arguments" or "eval".

IdentifierReference [Yield] : *yield*

BindingIdentifier [Yield] : *yield*

LabelIdentifier [Yield] : *yield*

It is a Syntax Error if this production has a [Yield] parameter.

- It is a Syntax Error if this production is contained in strict code.
- It is a Syntax Error if this production is within the *GeneratorBody* of a *GeneratorMethod*, *GeneratorDeclaration*, or *GeneratorExpression*.

IdentifierReference [Yield] : *Identifier*

BindingIdentifier [Yield] : *Identifier*

LabelIdentifier [Yield] : *Identifier*

- It is a Syntax Error if this production has a [Yield] parameter and StringValue of *Identifier* is "yield".

Identifier :: *IdentifierName* but not *ReservedWord*

- It is a Syntax Error if this phrase is contained in strict code and the StringValue of *IdentifierName* is: "implements", "interface", "let", "package", "private", "protected", "public", "static", or "yield".
- It is a Syntax Error if StringValue of *IdentifierName* is the same string value as the StringValue of any *ReservedWord* except for *yield*.

NOTE StringValue of *IdentifierName* normalizes any Unicode escape sequences in *IdentifierName* hence such escapes cannot be used to write an *Identifier* whose code point sequence is the same as a *ReservedWord*.

Deleted: *IdentifierReference* : *Identifier*
 <#> It is a Syntax Error if StringValue of *Identifier* does not statically resolve to a declarative environment record binding.
 NOTE Unlike a *BindingIdentifier*, an *IdentifierReference* in strict code may be the *Identifier eval* or *arguments*.¶

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Deleted: *IdentifierReference* [Yield] : *Identifier*
BindingIdentifier [Default Yield] : *Identifier*
LabelIdentifier [Yield] : *Identifier*
 <#> It is a Syntax Error if this production has a [Yield] parameter and the StringValue of *Identifier* is "yield".¶

Deleted: *Default*,

Deleted: *FunctionBody*

Deleted: *production*

Deleted: *IdentifierName*

Deleted: or

Deleted: <#> It is a Syntax Error if this production/*IdentifierName* is contained in strict code and the StringValue of *IdentifierName* is "yield".¶

12.1.2 Static Semantics: BoundNames

See also: 13.2.1.2, 13.2.2.1, [13.6.4.2](#), 14.1.3, 14.2.2, 14.4.2, 14.5.2, [15.2.2.2](#), [15.2.3.1](#)

BindingIdentifier : *Identifier*

1. Return a new List containing the StringValue of *Identifier*.

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Deleted: 15.2.2.215.2.1.2

Deleted: 15.2.3.115.2.2.1

Deleted: *Name*

BindingIdentifier : *yield*

1. Return a new List containing "yield".

12.1.3 Static Semantics: IsValidSimpleAssignmentTarget

See also: 12.2.0.4, 12.2.9.3, 12.3.1.3, 12.4.3, 12.5.3, 12.6.2, 12.7.2, 12.8.2, 12.9.2, 12.10.2, 12.11.2, 12.12.2, 12.13.2, 12.14.3, 12.15.2.

IdentifierReference : Identifier

1. If this *IdentifierReference* is contained in strict code and StringValue of *Identifier* is "eval" or "arguments", return false.
2. Return true.

Deleted: , then return

IdentifierReference : yield

1. Return true.

12.1.4 Static Semantics: StringValue

See also: 11.6.1.2, 11.8.4.2.

IdentifierReference : yield

BindingIdentifier : yield

LabelIdentifier : yield

1. Return "yield".

Identifier : IdentifierName but not ReservedWord

1. Return the StringValue of *IdentifierName*.

Deleted: *BindingIdentifier : default*
 <#>Return a new List containing "default".¶

Deleted: *BindingIdentifier : default*
 <#>Return "default".¶

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12.1.5 Runtime Semantics: BindingInitialization

With arguments *value* and *environment*.

See also: 13.2.3.5, 13.6.4.8

NOTE **undefined** is passed for *environment* to indicate that a PutValue operation should be used to assign the initialization value. This is the case for **var** statements and formal parameter lists of some non-strict functions (See 9.2.13). In those cases a lexical binding is hoisted and preinitialized prior to evaluation of its initializer.

BindingIdentifier : Identifier

1. Let *name* be StringValue of *Identifier*.
2. Return InitializeBoundName(*name*, *value*, *environment*).

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Deleted: 13.14.3

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BindingIdentifier : yield

1. Return InitializeBoundName("yield", *value*, *environment*).

Deleted: *BindingIdentifier : default*
 <#>Return InitializeBoundName("default",
value, *environment*).¶

12.1.5.1 Runtime Semantics: InitializeBoundName(*name*, *value*, *environment*)

1. Assert: Type(*name*) is String.
2. If *environment* is not **undefined**, then
 - a. Let *env* be the environment record component of *environment*.
 - b. Call the InitializeBinding concrete method of *env* passing *name* and *value* as the arguments.
 - c. Return NormalCompletion(**undefined**).
3. Else
 - a. Let *lhs* be ResolveBinding(*name*).
 - b. Return PutValue(*lhs*, *value*).

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12.1.6 Runtime Semantics: Evaluation

IdentifierReference : *Identifier*

1. Return *ResolveBinding(StringValue* of *Identifier*).


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IdentifierReference : **yield**

1. Return *ResolveBinding("yield")*.


Deleted: "

Deleted: "

NOTE 1: The result of evaluating an *IdentifierReference* is always a value of type Reference.

NOTE 2: In non-strict code, the keyword **yield** may be used as an identifier. Evaluating the *IdentifierReference* production resolves the binding of **yield** as if it was an *Identifier*. Early Error restriction ensures that such an evaluation only can occur for non-strict code. See 13.2.1 for the handling of **yield** in binding creation contexts.

12.2 Primary Expression

Syntax

PrimaryExpression_[?Yield] :

this
IdentifierReference_[?Yield]
Literal
ArrayLiteral_[?Yield]
ObjectLiteral_[?Yield]
FunctionExpression
ClassExpression
GeneratorExpression
RegularExpressionLiteral
TemplateLiteral_[?Yield]
CoverParenthesizedExpressionAndArrowParameterList_[?Yield]

CoverParenthesizedExpressionAndArrowParameterList_[?Yield] :

(*Expression_[In, ?Yield]*)
()
(. . . *BindingIdentifier_[?Yield]*)
(*Expression_[In, ?Yield]* , . . . *BindingIdentifier_[?Yield]*)

Supplemental Syntax

When processing the production

PrimaryExpression_[?Yield] : *CoverParenthesizedExpressionAndArrowParameterList_[?Yield]*
the interpretation of *CoverParenthesizedExpressionAndArrowParameterList* is refined using the following grammar:

ParenthesizedExpression_[Yield] :
 (*Expression_[In, ?Yield]*)

Deleted:
Deleted: :

12.2.0 Semantics

12.2.0.1 Static Semantics: CoveredParenthesizedExpression

CoverParenthesizedExpressionAndArrowParameterList_[Yield] : (*Expression_[In, ?Yield]*)

1. Return the result of parsing the lexical token stream matched by *CoverParenthesizedExpressionAndArrowParameterList_[Yield]* using either *ParenthesizedExpression* or *ParenthesizedExpression_[Yield]* as the goal symbol depending upon whether the *[Yield]* grammar parameter was present when *CoverParenthesizedExpressionAndArrowParameterList* was matched.

Deleted: .

12.2.0.2 Static Semantics: IsFunctionDefinition

See also: 12.2.9.2, 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, 14.1.12, [14.4.9](#), 14.5.8.

Deleted: 14.4.8

PrimaryExpression :

this
IdentifierReference
Literal
ArrayLiteral
ObjectLiteral
RegularExpressionLiteral
TemplateLiteral

Deleted: *Initializer*

Deleted: *GeneratorComprehension* ↴

1. Return **false**.

PrimaryExpression : *CoverParenthesizedExpressionAndArrowParameterList*

1. Let *expr* be *CoveredParenthesizedExpression* of *CoverParenthesizedExpressionAndArrowParameterList*.
2. Return *IsFunctionDefinition* of *expr*.

12.2.0.3 Static Semantics: IsIdentifierRef

See also: 12.3.1.3.

PrimaryExpression :
IdentifierReference

1. Return **true**.

PrimaryExpression :

- this*
- Literal*
- ArrayLiteral*
- ObjectLiteral*
- FunctionExpression*
- ClassExpression*
- GeneratorExpression*
- RegularExpressionLiteral*
- TemplateLiteral*
- CoverParenthesizedExpressionAndArrowParameterList*

1. Return **false**.

12.2.0.4 Static Semantics: IsValidSimpleAssignmentTarget

See also: 12.1.3, 12.2.9.3, 12.3.1.3, 12.4.3, 12.5.3, 12.6.2, 12.7.2, 12.8.2, 12.9.2, 12.10.2, 12.11.2, 12.12.2, 12.13.2, 12.14.3, 12.15.2.

PrimaryExpression :

- this*
- Literal*
- ArrayLiteral*
- ObjectLiteral*
- FunctionExpression*
- ClassExpression*
- GeneratorExpression*
- RegularExpressionLiteral*
- TemplateLiteral*

1. Return **false**.

PrimaryExpression : CoverParenthesizedExpressionAndArrowParameterList

1. Let *expr* be *CoveredParenthesizedExpression* of *CoverParenthesizedExpressionAndArrowParameterList*.
2. Return *IsValidSimpleAssignmentTarget* of *expr*.

Deleted: *Initializer*

Deleted: *GeneratorComprehension*

Deleted: *Initializer*

Deleted: *GeneratorComprehension*

Deleted: *PrimaryExpression : IdentifierReference*

<#> If this *PrimaryExpression* is contained in strict code and StringValue of *IdentifierReference* is "eval" or "arguments", then return **false**.
<#> Return **true**.¶

12.2.1 The **this** Keyword

12.2.1.1 Runtime Semantics: Evaluation

PrimaryExpression : this

1. Return *ResolveThisBinding()*.

Deleted: ¶

12.2.2 Identifier Reference

See 12.1 for *IdentifierReference*.

Deleted: *PrimaryExpression :*

12.2.3 Literals

Syntax

Literal :

- NullLiteral*
- BooleanLiteral*
- NumericLiteral*
- StringLiteral*

12.2.3.1 Runtime Semantics: Evaluation

Literal : *NullLiteral*

1. Return **null**.

Literal : *BooleanLiteral*

1. Return **false** if *BooleanLiteral* is the token **false**.
2. Return **true** if *BooleanLiteral* is the token **true**.

Literal : *NumericLiteral*

1. Return the number whose value is MV of *NumericLiteral* as defined in 11.8.3.

Literal : *StringLiteral*

1. Return the StringValue of *StringLiteral* as defined in 11.8.4.2.

12.2.4 Array Initializer

NOTE An *ArrayLiteral* is an expression describing the initialization of an Array object, using a list, of zero or more expressions each of which represents an array element, enclosed in square brackets. The elements need not be literals; they are evaluated each time the array initializer is evaluated.

Array elements may be elided at the beginning, middle or end of the element list. Whenever a comma in the element list is not preceded by an *AssignmentExpression* (i.e., a comma at the beginning or after another comma), the missing array element contributes to the length of the Array and increases the index of subsequent elements. Elided array elements are not defined. If an element is elided at the end of an array, that element does not contribute to the length of the Array.

Syntax

*ArrayLiteral*_[Yield] :

- [*Elision*_{opt}]
- [*ElementList*_[?Yield]]
- [*ElementList*_[?Yield] , *Elision*_{opt}]

*ElementList*_[Yield] :

- Elision*_{opt} *AssignmentExpression*_[In, ?Yield]
- Elision*_{opt} *SpreadElement*_[?Yield]
- ElementList*_[?Yield] , *Elision*_{opt} *AssignmentExpression*_[In, ?Yield]
- ElementList*_[?Yield] , *Elision*_{opt} *SpreadElement*_[?Yield]

Deleted: <#>Runtime Semantics: Evaluation

PrimaryExpression : *IdentifierReference*_[¶]
 <#>Return
 ResolveBinding(StringValue(*IdentifierReference*)
).¶

NOTE 1: The result of evaluating an *IdentifierReference* is always a value of type Reference.¶
 NOTE 2: In non-strict code, the keyword **yield** may be used as an identifier. Evaluating the *IdentifierReference* production resolves the binding of **yield** as if it was an *Identifier*. Early Error restriction ensures that such an evaluation only can occur for non-strict code. See 13.2.1 for the handling of **yield** in binding creation contexts.¶

Deleted: *ValueLiteral*_[¶]
ValueLiteral : ¶

Deleted: ¶

Deleted: ¶

Deleted: *Value*

Deleted: ¶

Deleted: Syntax¶

*ArrayInitializer*_[Yield] : ¶

*ArrayLiteral*_[?Yield]

*ArrayComprehension*_[?Yield]

<#>Array Literal¶

Elision :

'*Elision* ,

SpreadElement[?yield] :

... *AssignmentExpression*[In, ?Yield]

12.2.4.1 Static Semantics: ElisionWidth

Elision : ,

1. Return the numeric value 1.

Elision : *Elision* ,

1. Let *preceding* be the *ElisionWidth* of *Elision*.
2. Return *preceding*+1.

12.2.4.2 Runtime Semantics: Array Accumulation

With parameters *array* and *nextIndex*.

ElementList : *Elision*_{opt} *AssignmentExpression*

1. Let *padding* be the *ElisionWidth* of *Elision*; if *Elision* is not present, use the numeric value zero.
2. Let *initResult* be the result of evaluating *AssignmentExpression*.
3. Let *initValue* be *GetValue*(*initResult*).
4. ReturnIfAbrupt(*initValue*).
5. Let *created* be *CreateDataProperty*(*array*, *ToString*(*ToUint32*(*nextIndex*+*padding*)), *initValue*).
6. Assert: *created* is **true**.
7. Return *nextIndex*+*padding*+1.

ElementList : *Elision*_{opt} *SpreadElement*

1. Let *padding* be the *ElisionWidth* of *Elision*; if *Elision* is not present, use the numeric value zero.
2. Return the result of performing *ArrayAccumulation* for *SpreadElement* with arguments *array* and *nextIndex*+*padding*.

ElementList : *ElementList* , *Elision*_{opt} *AssignmentExpression*

1. Let *postIndex* be the result of performing *ArrayAccumulation* for *ElementList* with arguments *array* and *nextIndex*.
2. ReturnIfAbrupt(*postIndex*).
3. Let *padding* be the *ElisionWidth* of *Elision*; if *Elision* is not present, use the numeric value zero.
4. Let *initResult* be the result of evaluating *AssignmentExpression*.
5. Let *initValue* be *GetValue*(*initResult*).
6. ReturnIfAbrupt(*initValue*).
7. Let *created* be *CreateDataProperty*(*array*, *ToString*(*ToUint32*(*postIndex*+*padding*)), *initValue*).
8. Assert: *created* is **true**.
9. Return *postIndex*+*padding*+1.

ElementList : *ElementList* , *Elision*_{opt} *SpreadElement*

1. Let *postIndex* be the result of performing *ArrayAccumulation* for *ElementList* with arguments *array* and *nextIndex*.

Deleted:

Deleted: ¶

Deleted: ¶

Deleted:

Deleted:

Deleted:

Deleted: the result of calling the
[[DefineOwnProperty]] internal method of

Deleted:

Deleted:

Deleted: with arguments

Deleted: and the PropertyDescriptor{ [[Value]]:
true, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}

Deleted:

Deleted:

Deleted:

Deleted: the result of calling the
[[DefineOwnProperty]] internal method of

Deleted:

Deleted:

Deleted: with arguments

Deleted: and the PropertyDescriptor{ [[Value]]:
true, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}

Deleted:

2. ReturnIfAbrupt(*postIndex*).
3. Let *padding* be the *ElisionWidth* of *Elision*; if *Elision* is not present, use the numeric value zero.
4. Return the result of performing *ArrayAccumulation* for *SpreadElement* with arguments *array* and *postIndex+padding*.

Deleted:

SpreadElement : ... *AssignmentExpression*

1. Let *spreadRef* be the result of evaluating *AssignmentExpression*.
2. Let *spreadObj* be GetValue(*spreadRef*).
3. Let *iterator* be GetIterator(*spreadObj*).
4. ReturnIfAbrupt(*iterator*).
5. Repeat
 - a. Let *next* be IteratorStep(*iterator*).
 - b. ReturnIfAbrupt(*next*).
 - c. If *next* is false, return *nextIndex*.
 - d. Let *nextValue* be IteratorValue(*next*).
 - e. ReturnIfAbrupt(*nextValue*).
 - f. Let *status* be CreateDataProperty(*array*, ToString(ToUint32(*nextIndex*)), *nextValue*).
 - g. Assert: *status* is true.
 - h. Let *nextIndex* be *nextIndex* + 1.

Deleted: ToObject()

Deleted:)

Deleted: <#>ReturnIfAbrupt(*spreadObj*).
<#>If Type(*spreadObj*) is not Object, then throw a TypeError exception.
¶

Deleted: , then return

Comment [AW11]: Note that indices wrap.
For example consider:

[..... { 4294967293: "x", length:
Math.pow(2,32)-2}]

Deleted: defineStatus

Deleted: OrThrow

Deleted: A

Deleted: ReturnIfAbrupt(defineStatus)

Deleted: =

Deleted: [[DefineOwnProperty]]

Deleted: ¶

Deleted:

Deleted: t

Deleted:

Deleted: ¶

NOTE *CreateDataProperty* is used to ensure that own properties are defined for the array even if the standard built-in Array prototype object has been modified in a manner that would preclude the creation of new own properties using *[[Set]]*.

12.2.4.3 Runtime Semantics: Evaluation

ArrayLiteral : [*Elision*_{opt}]

1. Let *array* be *ArrayCreate*(0).
2. Let *pad* be the *ElisionWidth* of *Elision*; if *Elision* is not present, use the numeric value zero.
3. Perform Put(*array*, "length", *pad*, false).
4. **NOTE:** The above Put cannot fail because of the nature of the object returned by *ArrayCreate*.
5. Return *array*.

Deleted: defineStatus

Deleted: OrThrow

Deleted: A

Deleted: ReturnIfAbrupt(defineStatus)

Deleted: =

Deleted: [[DefineOwnProperty]]

Deleted: ¶

Deleted:

Deleted: t

Deleted:

Deleted: ¶

ArrayLiteral : [*ElementList*]

1. Let *array* be *ArrayCreate*(0).
2. Let *len* be the result of performing *ArrayAccumulation* for *ElementList* with arguments *array* and 0.
3. ReturnIfAbrupt(*len*).
4. Perform Put(*array*, "length", *len*, false).
5. **NOTE:** The above Put cannot fail because of the nature of the object returned by *ArrayCreate*.
6. Return *array*.

Deleted: t

Deleted:

Deleted: ¶

ArrayLiteral : [*ElementList* , *Elision*_{opt}]

1. Let *array* be *ArrayCreate*(0).
2. Let *len* be the result of performing *ArrayAccumulation* for *ElementList* with arguments *array* and 0.
3. ReturnIfAbrupt(*len*).
4. Let *padding* be the *ElisionWidth* of *Elision*; if *Elision* is not present, use the numeric value zero.
5. Perform Put(*array*, "length", ToUint32(*padding*+*len*), false).
6. **NOTE:** The above Put cannot fail because of the nature of the object returned by *ArrayCreate*.
7. Return *array*.

Deleted:

Deleted:

Deleted: ¶

12.2.5 Object Initializer

NOTE 1 An object initializer is an expression describing the initialization of an Object, written in a form resembling a literal. It is a list of zero or more pairs of property names and associated values, enclosed in curly brackets. The values need not be literals; they are evaluated each time the object initializer is evaluated.

Syntax

```
ObjectLiteral[?yield] :
  { }
  { PropertyDefinitionList[?yield] }
  { PropertyDefinitionList[?yield] , }
```

```
PropertyDefinitionList[?yield] :
  PropertyDefinition[?yield]
  PropertyDefinitionList[?yield] , PropertyDefinition[?yield]
```

```
PropertyDefinition[?yield] :
  IdentifierReference[?yield]
  CoverInitializedName[?yield]
  PropertyName[?yield] : AssignmentExpression[?in, ?yield]
  MethodDefinition[?yield]
```

```
PropertyName[?yield,GeneratorParameter] :
  LiteralPropertyName
  [+GeneratorParameter] ComputedPropertyName
  [-GeneratorParameter] ComputedPropertyName[?yield]
```

```
LiteralPropertyName :
  IdentifierName
  StringLiteral
  NumericLiteral
```

```
ComputedPropertyName[?yield] :
  [ AssignmentExpression[?in, ?yield] ]
```

```
CoverInitializedName[?yield] :
  IdentifierReference[?yield] Initializer[?in, ?yield]
```

```
Initializer[?in, ?yield] :
  = AssignmentExpression[?in, ?yield]
```

NOTE 2 *MethodDefinition* is defined in 14.3.

NOTE 3 In certain contexts, *ObjectLiteral* is used as a cover grammar for a more restricted secondary grammar. The *CoverInitializedName* production is necessary to fully cover these secondary grammars. However, use of this production results in an early Syntax Error in normal contexts where an actual *ObjectLiteral* is expected.

12.2.5.1 Static Semantics: Early Errors

PropertyDefinition : *MethodDefinition*

- It is a Syntax Error if *HasDirectSuper*(*MethodDefinition*) is true.

Deleted: <#>Array Comprehension

Syntax

```
ArrayComprehension[?yield] :
  [ Comprehension[?yield] ] |
  Comprehension[?yield] :
    ComprehensionFor[?yield]
    ComprehensionTail[?yield] |
    ComprehensionTail[?yield] :
      AssignmentExpression[?in, ?yield]
      ComprehensionFor[?yield]
      ComprehensionTail[?yield] ~
      ComprehensionIf[?yield] ComprehensionTail[?yield]
      ComprehensionFor[?yield] :
        for (ForBinding[?yield] of
          AssignmentExpression[?in, ?yield] ) |
      ComprehensionIf[?yield] :
        if (AssignmentExpression[?in, ?yield] ) |
      ForBinding[?yield] :
        BindingIdentifier[?yield]
        BindingPattern[?yield] |
      <#> Static Semantics: Early Errors
```

ComprehensionFor : for (ForBinding of AssignmentExpression) |

<#> It is a Syntax Error if the BoundNames of ForBinding contains "let". |

ForBinding : BindingPattern |

<#> It is a Syntax Error if the BoundNames of ForBindingPattern contains any duplicate entries. |

<#> Runtime Semantics: BindingInitialization |

With arguments value and environment. |

See also: , , , Error! Reference source not found. 12.1.2, 13.2.2.2, 13.2.3.4, 13.14.3. - |

NOTE undefined is passed for environment to indicate that a PutValue operation should be used to assign the initialization value. This is the case for var statements and the formal parameter lists of some non-strict functions (see). In those cases a lexical binding is hoisted and preinitialized prior to evaluation of its initializer. |

ForBinding : BindingPattern |

<#> If Type(value) is not Object, then throw a TypeError exception. |

<#> Return the result of performing BindingInitialization for BindingPattern passing value and environment as the arguments. |

Deleted: braces

Deleted: Yield

Deleted: Yield

Deleted: Yield

Deleted: ¶

Deleted: .

Deleted: ¶

Deleted: contains

Deleted: NewSuper

In addition to describing an actual object initializer the *ObjectLiteral* productions are also used as a cover grammar for *ObjectAssignmentPattern* (12.14.5), and may be recognized as part of a *CoverParenthesizedExpressionAndArrowParameterList*. When *ObjectLiteral* appears in a context where *ObjectAssignmentPattern* is required the following Early Error rules are **not** applied. In addition, they are not applied when initially parsing a *CoverParenthesizedExpressionAndArrowParameterList*.

PropertyDefinition : *CoverInitializedName*

- Always throw a Syntax Error if this production is present

NOTE This production exists so that *ObjectLiteral* can serve as a cover grammar for *ObjectAssignmentPattern* (12.14.5). It cannot occur in an actual object initializer.

12.2.5.2 Static Semantics: *ComputedPropertyContains*

With parameter *symbol*.

See also: 14.3.2, [14.4.3](#), 14.5.5.

PropertyName : *LiteralPropertyName*

1. Return **false**.

PropertyName : *ComputedPropertyName*

1. Return the result of *ComputedPropertyName* *Contains* *symbol*.

12.2.5.3 Static Semantics: *Contains*

With parameter *symbol*.

See also: 5.3, 12.3.1.1, 14.1.4, 14.2.3, [14.4.4](#), 14.5.4.

PropertyDefinition : *MethodDefinition*

1. If *symbol* is *MethodDefinition*, return **true**.
2. Return the result of *ComputedPropertyContains* for *MethodDefinition* with argument *symbol*.

NOTE Static semantic rules that depend upon substructure generally do not look into function definitions.

LiteralPropertyName : *IdentifierName*

1. If *symbol* is a *ReservedWord*, return **false**.
2. If *symbol* is an *Identifier* and *StringValue* of *symbol* is the same value as the *StringValue* of *IdentifierName*, return **true**;
3. Return **false**.

12.2.5.4 Static Semantics: *HasComputedPropertyKey*

See also: 14.3.4, 14.4.5

PropertyDefinitionList : *PropertyDefinitionList* , *PropertyDefinition*

1. If *HasComputedPropertyKey* of *PropertyDefinitionList* is **true**, **return true**.
2. Return *HasComputedPropertyKey* of *PropertyDefinition*.

Deleted: *ObjectLiteral* : {
PropertyDefinitionList } ¶
 and ¶
ObjectLiteral : { *PropertyDefinitionList* , } ¶
 <#>It is a Syntax Error if *PropertyNameList* of
PropertyDefinitionList contains any duplicate
 entries, unless one of the following conditions
 are true for each duplicate entry: ¶
 <#>The source code corresponding to
PropertyDefinitionList is not strict code and
 all occurrences in the list of the duplicated
 entry were obtained from productions of
 the form *PropertyDefinition* : *PropertyName*
 : *AssignmentExpression*. ¶
 <#>The duplicated entry occurs exactly
 twice in the list and one occurrence was
 obtained from a *get* accessor
MethodDefinition and the other occurrence
 was obtained from a *set* accessor
MethodDefinition. ¶

Deleted: 014.4.3

Deleted: Contains for

Deleted: with argument

Deleted: 014.4.3

Deleted: ¶

Deleted: ..

Deleted: ¶

PropertyDefinition : *IdentifierReference*

1. Return **false**.

Deleted: ¶

PropertyDefinition : *PropertyName* : *AssignmentExpression*

1. Return *IsComputedPropertyKey* of *PropertyName*.

Deleted: ¶

12.2.5.5 Static Semantics: *IsComputedPropertyKey*

Deleted: NOTE An alternative semantics for this production is given in B.3.1.¶

PropertyName : *LiteralPropertyName*

1. Return **false**.

PropertyName : *ComputedPropertyName*

1. Return **true**.

12.2.5.6 Static Semantics: *PropName*

See also: 14.3.5, 14.4.9, 14.5.12

Deleted: 14.4.914.4.914.4.10

Deleted: 14.5.1214.5.1214.5.13

Deleted: ¶

PropertyDefinition : *IdentifierReference*

1. Return *StringValue* of *IdentifierReference*.

Deleted: ¶

PropertyDefinition : *PropertyName* : *AssignmentExpression*

1. Return *PropName* of *PropertyName*.

Deleted: ¶

LiteralPropertyName : *IdentifierName*

1. Return *StringValue* of *IdentifierName*.

Deleted: ¶

LiteralPropertyName : *StringLiteral*

1. Return a String value whose code units are the *SV* of the *StringLiteral*.

Deleted: ¶

Deleted: characters

LiteralPropertyName : *NumericLiteral*

Deleted: ¶

1. Let *nbr* be the result of forming the value of the *NumericLiteral*.
2. Return *ToString*(*nbr*).

Comment [AWB1012]: Issue: static semantic rules probably should call *ToString* (a runtime operation).

Deleted: ¶

ComputedPropertyName : [*AssignmentExpression*]

1. Return empty.

Deleted: ¶

12.2.5.7 Static Semantics: *PropertyNameList*

PropertyNameList : *PropertyDefinition*

Deleted: ¶

1. If *PropName* of *PropertyDefinition* is empty, return a new empty List.
2. Return a new List containing *PropName* of *PropertyDefinition*.

PropertyNameList : *PropertyNameList* , *PropertyDefinition*

1. Let *list* be *PropertyNameList* of *PropertyNameList*.

2. If PropName of *PropertyDefinition* is empty, return *list*.
3. Append PropName of *PropertyDefinition* to the end of *list*.
4. Return *list*.

12.2.5.8 Runtime Semantics: Evaluation

ObjectLiteral : { }

1. Return ObjectCreate(%ObjectPrototype%).

Deleted: ¶

ObjectLiteral :
 { *PropertyDefinitionList* }
 { *PropertyDefinitionList* , }

1. Let *obj* be ObjectCreate(%ObjectPrototype%).
2. Let *status* be the result of performing PropertyDefinitionEvaluation of *PropertyDefinitionList* with arguments *obj* and **true**.
3. ReturnIfAbrupt(*status*).
4. Return *obj*.

Deleted: ¶

Deleted:

Deleted: the result of the abstract operation

Deleted: with the intrinsic object

Deleted: as its argument

LiteralPropertyName : *IdentifierName*

1. Return StringValue of *IdentifierName*.

Deleted: *PropertyDefinition* : *IdentifierReference* ¶
 <#>Return StringValue of *IdentifierReference*. ¶
PropertyDefinition : *PropertyName* :
AssignmentExpression ¶
 <#>Return the result of evaluating *PropertyName*. ¶

Deleted: ¶

Deleted: ¶

Deleted: characters

Deleted: ¶

LiteralPropertyName : *StringLiteral*

1. Return a String value whose code units are the SV of the *StringLiteral*.

LiteralPropertyName : *NumericLiteral*

1. Let *nbr* be the result of forming the value of the *NumericLiteral*.
2. Return ToString(*nbr*).

ComputedPropertyName : [*AssignmentExpression*]

Deleted: ¶

1. Let *exprValue* be the result of evaluating *AssignmentExpression*.
2. Let *propName* be GetValue(*exprValue*).
3. ReturnIfAbrupt(*propName*).
4. Return ToPropertyKey(*propName*).

12.2.5.9 Runtime Semantics: PropertyDefinitionEvaluation

With parameter *object* and enumerable.

See also: [14.3.10](#), [14.4.14](#), [B.3.1](#)

Deleted: 14.3.9

Deleted: 14.4.13

Deleted: 014.4.1314.4.1314.4.1614.4.1614.4.1
5

PropertyDefinitionList : *PropertyDefinitionList* , *PropertyDefinition*

1. Let *status* be the result of performing PropertyDefinitionEvaluation of *PropertyDefinitionList* with arguments *object* and enumerable.
2. ReturnIfAbrupt(*status*).
3. Return the result of performing PropertyDefinitionEvaluation of *PropertyDefinition* with arguments *object* and enumerable.

Deleted: Let *propDef* be

Deleted: ¶

PropertyDefinition : IdentifierReference

1. Let *propName* be StringValue of *IdentifierReference*.
2. Let *exprValue* be the result of evaluating *IdentifierReference*.
3. ReturnIfAbrupt(*exprValue*).
4. Let *propValue* be GetValue(*exprValue*).
5. ReturnIfAbrupt(*propValue*).
6. **Assert: enumerable is true.**
7. Return *CreateDataPropertyOrThrow*(*object*, *propName*, *propValue*).

PropertyDefinition : PropertyName : AssignmentExpression

1. Let *propKey* be the result of evaluating *PropertyName*.
2. ReturnIfAbrupt(*propKey*).
3. Let *exprValueRef* be the result of evaluating *AssignmentExpression*.
4. Let *propValue* be GetValue(*exprValueRef*).
5. ReturnIfAbrupt(*propValue*).
6. If IsFunctionDefinition of *AssignmentExpression* is **true**, then
 - a. Assert: *propValue* is an ECMAScript function object.
 - b. Let *referencesSuper* be the value of *propValue*'s **[[NeedsSuper]]** internal slot.
 - c. Let *thisMode* be the value of *propValue*'s **[[ThisMode]]** internal slot.
 - d. If *thisMode* is not lexical and *referencesSuper* is **true**, then
 - i. If *propValue*'s **[[HomeObject]]** internal slot is **undefined**, then
 1. Assert: *AssignmentExpression* is not a class definition whose constructor references **super**.
 2. Set *propValue*'s **[[HomeObject]]** internal slot to *object*.
- e. If IsAnonymousFunctionDefinition(*AssignmentExpression*) is **true**, then
 - i. Let *hasNameProperty* be HasOwnProperty(*propValue*, "name").
 - ii. ReturnIfAbrupt(*hasNameProperty*).
 - iii. If *hasNameProperty* is **false**, perform *SetFunctionName*(*propValue*, *propKey*).
7. **Assert: enumerable is true.**
8. Return *CreateDataPropertyOrThrow*(*object*, *propKey*, *propValue*).

NOTE An alternative semantics for this production is given in [B.3.1](#).

12.2.6 Function Defining Expressions

See 14.1 for *PrimaryExpression : FunctionExpression*.

See 14.4 for *PrimaryExpression : GeneratorExpression*.

See 14.5 for *PrimaryExpression : ClassExpression*.

12.2.7 Regular Expression Literals

Syntax

See 11.8.4.

Deleted: <#>ReturnIfAbrupt(*propDef*).
 <#>If *propDef* is empty, then return *propDef*.
 <#>Let *status* be DefinePropertyOrThrow(*object*, *propDef*[**[[key]]**], *propDef*[**[[descriptor]]**]).
 <#>Return *status*.
Deleted: ¶

Deleted: <#>Let *desc* be the Property Descriptor{**[[Value]]**: *propValue*, **[[Writable]]**: **true**, **[[Enumerable]]**: **true**, **[[Configurable]]**: **true**}
Deleted: DefinePropertyOrThrow
Deleted: *desc*
Deleted: ¶

Deleted: <#>Set *propValue*'s **[[MethodName]]** internal slot to *propKey*.
Deleted: ¶

Deleted: <#>Set *propValue*'s **[[MethodObject]]** internal slot to *object*.
Deleted: ¶

Deleted: <#>Assert: *SetFunctionName* will not return an abrupt completion.
Deleted: ¶

Deleted: <#>Let *desc* be the Property Descriptor{**[[Value]]**: *propValue*, **[[Writable]]**: **true**, **[[Enumerable]]**: **true**, **[[Configurable]]**: **true**}
Deleted: DefinePropertyOrThrow
Deleted: *desc*
Deleted: ¶

Deleted: <#>Generator Comprehensions¶

Syntax
GeneratorComprehension[*yield*] ¶
 (*Comprehension*[*yield*]) ¶
 NOTE The keyword **yield** may be used in *IdentifierReference* contexts within a *GeneratorComprehension* contained in non-strict code. The following early error rule ensures that a *GeneratorComprehension* never contains a *YieldExpression*.¶

<#>**Static Semantics: Early Errors**
GeneratorComprehension : (*Comprehension*) ¶
 <#>It is a Syntax Error if *Comprehension* Contains *YieldExpression* is **true**.¶
 <#>**Runtime Semantics: Evaluation**
GeneratorComprehension : (*Comprehension*) ¶
 <#>If *GeneratorComprehension* is contained in strict mode code, then let *strict* be **true**; otherwise let *strict* be **false**.¶
 <#>Let *scope* be the LexicalEnvironment of the running execution context.¶
 <#>Let *parameters* be the production: *FormalParameters* : [empty].¶
 <#>Using *Comprehension* from the production that is being evaluated, let *body* be the ...
Deleted: ¶

12.2.7.1 Static Semantics: Early Errors

PrimaryExpression : *RegularExpressionLiteral*

- It is a Syntax Error if BodyText of *RegularExpressionLiteral* cannot be recognized using the goal symbol *Pattern* of the ECMAScript RegExp grammar specified in 21.2.1.
- It is a Syntax Error if FlagText of *RegularExpressionLiteral* contains any code points other than "g", "i", "m", "u", or "y", or if it contains the same code point more than once.

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12.2.7.2 Runtime Semantics: Evaluation

PrimaryExpression : *RegularExpressionLiteral*

1. Let *pattern* be the string value consisting of the UTF-16Encoding of each code point of BodyText of *RegularExpressionLiteral*.
2. Let *flags* be the string value consisting of the UTF-16Encoding of each code point of FlagText of *RegularExpressionLiteral*.
3. Return *RegExpCreate*(*pattern*, *flags*).

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12.2.8 Template Literals

Syntax

*TemplateLiteral*_[?yield] :
NoSubstitutionTemplate

TemplateHead *Expression*_[in, ?yield] [Lexical goal *InputElementTemplateTail*] *TemplateSpans*_[?yield]

Deleted:

*TemplateSpans*_[?yield] :
TemplateTail
*TemplateMiddleList*_[?yield] [Lexical goal *InputElementTemplateTail*] *TemplateTail*

*TemplateMiddleList*_[?yield] :
TemplateMiddle *Expression*_[in, ?yield]

*TemplateMiddleList*_[?yield] [Lexical goal *InputElementTemplateTail*] *TemplateMiddle* *Expression*_[in, ?yield]

12.2.8.1 Static Semantics

12.2.8.1.1 Static Semantics: TemplateStrings

With parameter *raw*.

TemplateLiteral : *NoSubstitutionTemplate*

Deleted: ¶

1. If *raw* is **false**, then
 - a. Let *string* be the TV of *NoSubstitutionTemplate*.
2. Else,
 - a. Let *string* be the TRV of *NoSubstitutionTemplate*.
3. Return a List containing the single element, *string*.

TemplateLiteral : *TemplateHead* *Expression* *TemplateSpans*

1. If *raw* is **false**, then
 - a. Let *head* be the TV of *TemplateHead*.
2. Else,

- a. Let *head* be the TRV of *TemplateHead*.
- 3. Let *tail* be TemplateStrings of *TemplateSpans* with argument *raw*.
- 4. Return a List containing *head* followed by the element, in order of *tail*.

TemplateSpans : *TemplateTail*

- 1. If *raw* is **false**, then
 - a. Let *tail* be the TV of *TemplateTail*.
- 2. Else,
 - a. Let *tail* be the TRV of *TemplateTail*.
- 3. Return a List containing the single element, *tail*.

TemplateSpans : *TemplateMiddleList* *TemplateTail*

- 1. Let *middle* be TemplateStrings of *TemplateMiddleList* with argument *raw*.
- 2. If *raw* is **false**, then
 - a. Let *tail* be the TV of *TemplateTail*.
- 3. Else,
 - a. Let *tail* be the TRV of *TemplateTail*.
- 4. Return a List containing the elements, in order, of *middle* followed by *tail*.

TemplateMiddleList : *TemplateMiddle Expression*

- 1. If *raw* is **false**, then
 - a. Let *string* be the TV of *TemplateMiddle*.
- 2. Else,
 - a. Let *string* be the TRV of *TemplateMiddle*.
- 3. Return a List containing the single element, *string*.

Deleted: ¶

TemplateMiddleList : *TemplateMiddleList* *TemplateMiddle Expression*

- 1. Let *front* be TemplateStrings of *TemplateMiddleList* with argument *raw*.
- 2. If *raw* is **false**, then
 - a. Let *last* be the TV of *TemplateMiddle*.
- 3. Else,
 - a. Let *last* be the TRV of *TemplateMiddle*.
- 4. Append *last* as the last element of the List *front*.
- 5. Return *front*.

Deleted: ¶

12.2.8.2 Runtime Semantics

12.2.8.2.1 Runtime Semantics: ArgumentListEvaluation

See also: 12.3.6.1

TemplateLiteral : *NoSubstitutionTemplate*

- 1. Let *siteObj* be the result of the abstract operation [GetTemplateObject](#) passing this *TemplateLiteral* production as the argument.
- 2. Return a List containing the one element which is *siteObj*.

Deleted: ¶

Deleted: GetTemplateCallSite

TemplateLiteral : *TemplateHead Expression* *TemplateSpans*

- 1. Let *siteObj* be the result of the abstract operation [GetTemplateObject](#) passing this *TemplateLiteral* production as the argument.

Deleted: GetTemplateCallSite

2. Let *firstSub* be the result of evaluating *Expression*.
3. ReturnIfAbrupt(*firstSub*).
4. Let *restSub* be SubstitutionEvaluation of *TemplateSpans*.
5. ReturnIfAbrupt(*restSub*).
6. Assert: *restSub* is a List.
7. Return a List whose first element is *siteObj*, whose second elements is *firstSub*, and whose subsequent elements are the elements of *restSub*, in order. *restSub* may contain no elements.

Deleted: ¶

12.2.8.2.2 Runtime Semantics: GetTemplateObject (templateLiteral)

The abstract operation GetTemplateObject is called with a grammar production, *templateLiteral*, as an argument. It performs the following steps:

1. Let *rawStrings* be TemplateStrings of *templateLiteral* with argument **true**.
2. Let *ctx* be the running execution context.
3. Let *realm* be the *ctx*'s Realm.
4. Let *templateRegistry* be *realm*.[[templateMap]].
5. For each element *e* of *templateRegistry*, do
 - a. If *e*.[[strings]] and *rawStrings* contain the same values in the same order, then
 - i. Return *e*.[[array]].
6. Let *cookedStrings* be TemplateStrings of *templateLiteral* with argument **false**.
7. Let *count* be the number of elements in the List *cookedStrings*.
8. Let *template* be ArrayCreate(*count*).
9. Let *rawObj* be ArrayCreate(*count*).
10. Let *index* be 0.
11. Repeat while *index* < *count*
 - a. Let *prop* be ToString(*index*).
 - b. Let *cookedValue* be the string value *List* *cookedStrings*.[[index]].
 - c. Call the [[DefineOwnProperty]] internal method of *template* with arguments *prop* and PropertyDescriptor{[[Value]]: *cookedValue*, [[Enumerable]]: **true**, [[Writable]]: **false**, [[Configurable]]: **false**}.
 - d. Let *rawValue* be the string value *rawStrings*.[[index]].
 - e. Call the [[DefineOwnProperty]] internal method of *rawObj* with arguments *prop* and PropertyDescriptor{[[Value]]: *rawValue*, [[Enumerable]]: **true**, [[Writable]]: **false**, [[Configurable]]: **false**}.
 - f. Let *index* be *index*+1.
12. Perform SetIntegrityLevel(*rawObj*, "frozen").
13. Call the [[DefineOwnProperty]] internal method of *template* with arguments "raw" and PropertyDescriptor{[[Value]]: *rawObj*, [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false**}.
14. Perform SetIntegrityLevel(*template*, "frozen").
15. Append the Record{[[strings]]: *rawStrings*, [[array]]: *template*} to *templateRegistry*.
16. Return *template*.

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Deleted: GetTemplateCallSite

Deleted: GetTemplateCallSite

Deleted: <#>If a call site object for the source code corresponding to *templateLiteral* has already been created (see step 12 below) by a previous call to this abstract operation, then<#>Return that call site object.¶

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Deleted: ¶

Deleted: *siteObj*

Deleted: at 0-based position *index* of the

Deleted: *siteObj*

Deleted: at 0-based position *index* of the List

Deleted: *siteObj*

Deleted: *siteObj*

Deleted: Remember an association between the source code corresponding to *templateLiteral* and *siteObj* such that *siteObj* can be retrieved in subsequent calls to this abstract operation

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Deleted: *siteObj*

Deleted: call site

Deleted: Template

Deleted: call site

Deleted: 12.2.9.2.4

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NOTE 1 The creation of a *template* object cannot result in an abrupt completion.

NOTE 2 Each *TemplateLiteral* in the program code of a Realm is associated with a unique *template* object that is used in the evaluation of tagged Templates (12.2.8.2.4). The *template* objects are frozen and the same *template* object is used each time a specific tagged Template is evaluated. Whether *template* objects are created lazily upon first evaluation of the *TemplateLiteral* or eagerly prior to first evaluation is an implementation choice that is not observable to ECMAScript code.

NOTE 3 Future editions of this specification may define additional non-enumerable properties of *template* objects.

12.2.8.2.3 Runtime Semantics: SubstitutionEvaluation

TemplateSpans : *TemplateTail*

1. Return an empty List.

Deleted: ¶

TemplateSpans : *TemplateMiddleList* *TemplateTail*

1. Return the result of SubstitutionEvaluation of *TemplateMiddleList*.

Deleted: ¶

TemplateMiddleList : *TemplateMiddle Expression*

1. Let *sub* be the result of evaluating *Expression*.
2. ReturnIfAbrupt(*sub*).
3. Return a List containing only *sub*.

Deleted: ¶

TemplateMiddleList : *TemplateMiddleList* *TemplateMiddle Expression*

1. Let *preceding* be the result of SubstitutionEvaluation of *TemplateMiddleList*.
2. ReturnIfAbrupt(*preceding*).
3. Let *next* be the result of evaluating *Expression*.
4. ReturnIfAbrupt(*next*).
5. Append *next* as the last element of the List *preceding*.
6. Return *preceding*.

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12.2.8.2.4 Runtime Semantics: Evaluation

TemplateLiteral : *NoSubstitutionTemplate*

1. Return the string value whose code units are the elements of the TV of *NoSubstitutionTemplate* as defined in 11.8.6.

Deleted: ¶

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TemplateLiteral : *TemplateHead* *Expression* *TemplateSpans*

1. Let *head* be the TV of *TemplateHead* as defined in 11.8.6.
2. Let *sub* be the result of evaluating *Expression*.
3. Let *middle* be *ToString*(*sub*).
4. ReturnIfAbrupt(*middle*).
5. Let *tail* be the result of evaluating *TemplateSpans*.
6. ReturnIfAbrupt(*tail*).
7. Return the string value whose code units are the elements of *head* followed by the elements of *middle* followed by the elements of *tail*.

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NOTE The string conversion semantics applied to the *Expression* value are like *String.prototype.concat* rather than the + operator.

TemplateSpans : *TemplateTail*

1. Let *tail* be the TV of *TemplateTail* as defined in 11.8.6.
2. Return the string consisting of the code units of *tail*.

Deleted: whose elements are

TemplateSpans : *TemplateMiddleList* *TemplateTail*

1. Let *head* be the result of evaluating *TemplateMiddleList*.
2. ReturnIfAbrupt(*head*).

3. Let *tail* be the TV of *TemplateTail* as defined in 11.8.6.
 4. Return the string whose code units are the elements of *head* followed by the elements of *tail*.

Deleted: elements

TemplateMiddleList : *TemplateMiddle Expression*

1. Let *head* be the TV of *TemplateMiddle* as defined in 11.8.6.
2. Let *sub* be the result of evaluating *Expression*.
3. Let *middle* be *ToString*(*sub*).
4. ReturnIfAbrupt(*middle*).
5. Return the sequence of code units consisting of the code units of *head* followed by the elements of *middle*.

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NOTE The string conversion semantics applied to the *Expression* value are like *String.prototype.concat* rather than the + operator.

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TemplateMiddleList : *TemplateMiddleList* *TemplateMiddle Expression*

1. Let *rest* be the result of evaluating *TemplateMiddleList*.
2. ReturnIfAbrupt(*rest*).
3. Let *middle* be the TV of *TemplateMiddle* as defined in 11.8.6.
4. Let *sub* be the result of evaluating *Expression*.
5. Let *last* be *ToString*(*sub*).
6. ReturnIfAbrupt(*last*).
7. Return the sequence of code units consisting of the elements of *rest* followed by the code units of *middle* followed by the elements of *last*.

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NOTE The string conversion semantics applied to the *Expression* value are like *String.prototype.concat* rather than the + operator.

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12.2.9 The Grouping Operator

12.2.9.1 Static Semantics: Early Errors

PrimaryExpression : *CoverParenthesizedExpressionAndArrowParameterList*

Deleted: ¶

- It is a Syntax Error if the lexical token sequence matched by *CoverParenthesizedExpressionAndArrowParameterList* cannot be parsed with no tokens left over using *ParenthesizedExpression* as the goal symbol.
- All Early Errors rules for *ParenthesizedExpression* and its derived productions also apply to *CoveredParenthesizedExpression* of *CoverParenthesizedExpressionAndArrowParameterList*.

Deleted: the

12.2.9.2 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, [14.1.12](#), [14.4.9](#), 14.5.8.

Deleted: 14.1.1214.1.11

Deleted: 14.4.8

ParenthesizedExpression : (*Expression*)

1. Return IsFunctionDefinition of *Expression*.

12.2.9.3 Static Semantics: IsValidSimpleAssignmentTarget

See also: 12.1.3, 12.2.0.3, 12.3.1.3, 12.4.3, 12.5.3, 12.6.2, 12.7.2, 12.8.2, 12.9.2, 12.10.2, 12.11.2, 12.12.2, 12.13.2, 12.14.3, 12.15.2.

ParenthesizedExpression : (*Expression*)

1. Return IsValidSimpleAssignmentTarget of *Expression*.

12.2.9.4 Runtime Semantics: Evaluation

PrimaryExpression : *CoverParenthesizedExpressionAndArrowParameterList*

1. Let *expr* be *CoveredParenthesizedExpression* of *CoverParenthesizedExpressionAndArrowParameterList*.
2. Return the result of evaluating *expr*.

ParenthesizedExpression : (*Expression*)

1. Return the result of evaluating *Expression*. This may be of type Reference.

NOTE This algorithm does not apply GetValue to the result of evaluating *Expression*. The principal motivation for this is so that operators such as `delete` and `typeof` may be applied to parenthesized expressions.

12.3 Left-Hand-Side Expressions

Syntax

MemberExpression_[Yield] :

[Lexical goal *InputElementRegExp*] *PrimaryExpression_[?Yield]*
MemberExpression_[?Yield] [*Expression_[In, ?Yield]*]
MemberExpression_[?Yield] . *IdentifierName*
MemberExpression_[?Yield] *TemplateLiteral_[?Yield]*
SuperProperty_[?Yield]
MetaProperty
new MemberExpression_[?Yield] *Arguments_[?Yield]*

SuperProperty_[Yield] :

super [*Expression_[In, ?Yield]*]
super . *IdentifierName*

NewExpression_[Yield] :

MemberExpression_[?Yield]
new NewExpression_[?Yield]

MetaProperty :

NewTarget

NewTarget :

new . target

NewExpression_[Yield] :

MemberExpression_[?Yield]
new NewExpression_[?Yield]

Deleted: ¶

Deleted: *super* [*Expression*]

Deleted: *in*

Deleted:]

Deleted: *NewSuper* . *IdentifierName*
upernew super *Arguments_[?Yield]* .

Deleted: opt

Deleted: [lookahead $\notin \{ \text{super} \}$]

Deleted: *NewSuper* :¶
new super ¶

Deleted: *NewSuper*

Deleted: *new super*

Deleted: *new . target*

Deleted: .
NewSuper

CallExpression_[?Yield] :

- MemberExpression_[?Yield] Arguments_[?Yield]*
- SuperCall_[?Yield]*
- CallExpression_[?Yield] Arguments_[?Yield]*
- CallExpression_[?Yield] [Expression_[In, ?Yield]]*
- CallExpression_[?Yield] . IdentifierName*
- CallExpression_[?Yield] TemplateLiteral_[?Yield]*

Deleted: *super Arguments*

SuperCall_[?Yield] :

- super Arguments_[?Yield]*

Deleted: *¶*

Arguments_[?Yield] :

- ()*
- (ArgumentList_[?Yield])*

ArgumentList_[?Yield] :

- AssignmentExpression_[In, ?Yield]*
- ... *AssignmentExpression_[In, ?Yield]*
- ArgumentList_[?Yield] , AssignmentExpression_[In, ?Yield]*
- ArgumentList_[?Yield] , ... AssignmentExpression_[In, ?Yield]*

LeftHandSideExpression_[?Yield] :

- NewExpression_[?Yield]*
- CallExpression_[?Yield]*

12.3.1 Static Semantics

12.3.1.1 Static Semantics: Contains

With parameter *symbol*.

See also: 5.3, 12.2.5.2, 14.1.4, 14.2.3, [14.4.4](#), 14.5.4

MemberExpression : *MemberExpression* . *IdentifierName*

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Deleted: *MemberExpression*

Deleted:

Deleted: *¶*

Deleted: *MemberExpression : new super Arguments*

```
<#>If symbol is the ReservedWord super, return true.  
<#>If symbol is the ReservedWord new, return true.  
<#>Return the result of Arguments Contains symbol.
```

Deleted: *: new super ¶*

```
<#>If symbol is the ReservedWord super, return true.  
<#>If symbol is the ReservedWord new, return true.  
<#>Return false.
```

Deleted: *¶*

SuperProperty : *super* . *IdentifierName*

1. If *symbol* is the ReservedWord **super**, return **true**.
2. If *symbol* is a *ReservedWord*, return **false**.
3. If *symbol* is an *Identifier* and *StringValue* of *symbol* is the same value as the *StringValue* of *IdentifierName*, return **true**;
4. Return **false**.

CallExpression : *CallExpression* . *IdentifierName*

1. If *CallExpression* Contains *symbol* is **true**, return **true**.
2. If *symbol* is a *ReservedWord*, return **false**.

3. If *symbol* is an *Identifier* and *StringValue* of *symbol* is the same value as the *StringValue* of *IdentifierName*, return **true**;
4. Return **false**.

12.3.1.2 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, [12.2.9.2](#), 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, [14.1.12](#), 14.4.8, 14.5.8.

Deleted: 12.2.9.2 12.2.10.2

Deleted: 14.1.11

MemberExpression:

MemberExpression [*Expression*]
MemberExpression . *IdentifierName*
MemberExpression *TemplateLiteral*
SuperProperty
MetaProperty
new MemberExpression Arguments

Deleted: *super* [*Expression*]

Deleted: []

Deleted: *super* . *IdentifierName*

Deleted: *NewSuper* **new super** *Arguments* *opt*

Deleted: *NewSuper*

Deleted: **new super**

Deleted: *super Arguments*

Deleted: ¶

1. Return **false**.

12.3.1.3 Static Semantics: IsDestructuring

See also: 13.6.4.5.

Deleted: ¶

Deleted: , then return

MemberExpression : *PrimaryExpression*

1. If *PrimaryExpression* is either an *ObjectLiteral* or an *ArrayLiteral*, return **true**.
2. Return **false**.

Deleted: *NewSuper Arguments* ¶

MemberExpression:

MemberExpression [*Expression*]
MemberExpression . *IdentifierName*
MemberExpression *TemplateLiteral*
SuperProperty
MetaProperty
new MemberExpression Arguments

NewExpression:

new NewExpression

Deleted:
NewSuper

CallExpression :

- MemberExpression Arguments*
- SuperCall*
- CallExpression Arguments*
- CallExpression [Expression]*
- CallExpression . IdentifierName*
- CallExpression TemplateLiteral*

1. Return **false**.

12.3.1.4 Static Semantics: IsIdentifierRef

See also: 12.2.0.3.

LeftHandSideExpression :

- CallExpression*

MemberExpression :

- MemberExpression [Expression]*
- MemberExpression . IdentifierName*
- MemberExpression TemplateLiteral*
- SuperProperty*
- MetaProperty*
- new MemberExpression Arguments*

NewExpression :

- new NewExpression*

1. Return **false**.

12.3.1.5 Static Semantics: IsValidSimpleAssignmentTarget

See also: 12.1.3, 12.2.0.3, 12.2.9.3, 12.4.3, 12.5.3, 12.6.2, 12.7.2, 12.8.2, 12.9.2, 12.10.2, 12.11.2, 12.12.2, 12.13.2, 12.14.3, 12.15.2.

CallExpression :

- CallExpression [Expression]*
- CallExpression . IdentifierName*

MemberExpression :

- MemberExpression [Expression]*
- MemberExpression . IdentifierName*
- SuperProperty*

1. Return **true**.

CallExpression :

- MemberExpression Arguments*
- SuperCall*
- CallExpression Arguments*
- CallExpression TemplateLiteral*

NewExpression :

- new NewExpression*

Deleted: ↗

Deleted: super [Expression]

Deleted: ↗

Deleted: super . IdentifierName

Deleted: NewSuper new super ArgumentsOpt ↗

Deleted: ↗

Deleted: NewSuper

Deleted: ↗

Deleted: ↗

Deleted: super [Expression]

Deleted: ↗

Deleted: super . IdentifierName

Deleted: ↗

Deleted: ↗

Deleted: ↗

Deleted: ↗

Deleted: ↗

Deleted: ↗

MemberExpression :

MemberExpression TemplateLiteral
new MemberExpression Arguments

NewTarget:

new . target

1. Return **false**.

12.3.2 Property Accessors

NOTE Properties are accessed by name, using either the dot notation:

MemberExpression . IdentifierName
CallExpression . IdentifierName

or the bracket notation:

MemberExpression [Expression]
CallExpression [Expression]

The dot notation is explained by the following syntactic conversion:

MemberExpression . IdentifierName

is identical in its behaviour to

MemberExpression [<identifier-name-string>]

and similarly

CallExpression . IdentifierName

is identical in its behaviour to

CallExpression [<identifier-name-string>]

where *<identifier-name-string>* is the result of evaluating *StringValue* of *IdentifierName*.

12.3.2.1 Runtime Semantics: Evaluation

MemberExpression : MemberExpression [Expression]

1. Let *baseReference* be the result of evaluating *MemberExpression*.
2. Let *baseValue* be *GetValue(baseReference)*.
3. ReturnIfAbrupt(*baseValue*).
4. Let *propertyNameReference* be the result of evaluating *Expression*.
5. Let *propertyNameValue* be *GetValue(propertyNameReference)*.
6. ReturnIfAbrupt(*propertyNameValue*).
7. Let *bv* be *RequireObjectCoercible(baseValue)*.
8. ReturnIfAbrupt(*bv*).
9. Let *propertyKey* be *ToPropertyKey(propertyNameValue)*.
10. ReturnIfAbrupt(*propertyKey*).
11. If the code matched by the syntactic production that is being evaluated is strict mode code, let *strict* be **true**, else let *strict* be **false**.
12. Return a value of type Reference whose base value is *bv* and whose referenced name is *propertyKey*, and whose strict reference flag is *strict*.

Deleted: *NewSuper* *new super* *Arguments* *opt MetaProperty* ↴

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Deleted: a string literal containing the same sequence of characters code units after processing of Unicode escape sequences as the

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Deleted: *CheckObjectCoercible*

Deleted: *propertyNameString*

Deleted: *ToString*

Deleted: *propertyNameString*

MemberExpression : MemberExpression . IdentifierName

1. Let *baseReference* be the result of evaluating *MemberExpression*.
2. Let *baseValue* be *GetValue(baseReference)*.
3. ReturnIfAbrupt(*baseValue*).
4. Let *bv* be *RequireObjectCoercible(baseValue)*.
5. ReturnIfAbrupt(*bv*).
6. Let *propertyNameString* be *StringValue* of *IdentifierName*.
7. If the code matched by the syntactic production that is being evaluated is strict mode code, let *strict* be **true**, else let *strict* be **false**.
8. Return a value of type Reference whose base value is *bv* and whose referenced name is *propertyNameString*, and whose strict reference flag is *strict*.

Deleted: ¶

CallExpression : CallExpression [Expression]

Is evaluated in exactly the same manner as *MemberExpression : MemberExpression [Expression]* except that the contained *CallExpression* is evaluated in step 1.

CallExpression : CallExpression . IdentifierName

Is evaluated in exactly the same manner as *MemberExpression : MemberExpression . IdentifierName* except that the contained *CallExpression* is evaluated in step 1.

12.3.3 The new Operator

12.3.3.1 Runtime Semantics: Evaluation

NewExpression : new NewExpression

1. Let *thisNewExpression* be *this NewExpression*.
2. Return *EvaluateNew(thisNewExpression, NewExpression, empty)*.

MemberExpression : new MemberExpression Arguments

1. Let *thisMemberExpression* be *this MemberExpression*.
2. Return *EvaluateNew(thisMemberExpression, MemberExpression, Arguments)*.

12.3.3.1.1 Runtime Semantics: EvaluateNew(thisCall, constructProduction, arguments)

The abstract operation *EvaluateNew* with arguments *production* and *arguments* performs the following steps:

1. Assert: *thisCall* is either a *NewExpression* or a *MemberExpression*.
2. Assert: *constructProduction* is either a *NewExpression* or a *MemberExpression*.
3. Assert: *arguments* is either empty or an *Arguments* production.
4. Let *ref* be the result of evaluating *constructProduction*.
5. Let *constructor* be *GetValue(ref)*.
6. ReturnIfAbrupt(*constructor*).
7. If *arguments* is empty, let *argList* be an empty List.
8. Else,
 - a. Let *argList* be *ArgumentListEvaluation* of *arguments*.
 - b. ReturnIfAbrupt(*argList*).
9. If *IsConstructor(constructor)* is false, throw a **TypeError** exception.
10. Let *tailCall* be *IsInTailPosition(thisCall)*. (See 14.6.1.)
11. If *tailCall* is true, perform the *PrepareForTailCall* abstract operation.

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Deleted: <#>Let *ref* be the result of evaluating *NewExpression*.¶
<#>Let *constructor* be *GetValue(ref)*.¶
<#>ReturnIfAbrupt(*constructor*).¶
<#>If *IsConstructor(constructor)* is false, throw a **TypeError** exception.¶

Deleted: *Call*

Deleted: <#>Let *tailCall* be *IsInTailPosition(thisCall)*. (See) ¶
<#>If *tailCall* is true, then perform the *PrepareForTailCall* abstract operation.¶
<#>Let *result* be the result of calling the *[[Construct]]* internal method on *constructor* with an empty List as the argument.¶
<#>Assert: If *tailCall* is true, the above call of *[[Construct]]* will not return here, but instead evaluation will continue as if the following return has already occurred.¶

Deleted: *result*

Deleted: the result of calling the *[[Construct]]* internal method on *constructor* with an empty List as the argument

Deleted: ¶

Deleted: *MemberExpression*

Deleted: , then let

Deleted: the result of evaluating

Deleted: *s*

Deleted: *Arguments*

Deleted: , producing a List of argument values (12.3.6)

Deleted: <#>Let *thisCall* be this *MemberExpression*.¶

Deleted: ¶

Deleted: then

12. Let *result* be *Construct*(*constructor*, *argList*)
13. Assert: If *tailCall* is **true**, the above call of *Construct* will not return here, but instead evaluation will continue as if the following return has already occurred.
14. Return *result*.

Deleted: the result of calling the [[
Deleted:]] internal method on of
Deleted: , passing
Deleted: with argument
Deleted: as the argument
Deleted: [[
Deleted:]]
Deleted: ¶

12.3.4 Function Calls

12.3.4.1 Runtime Semantics: Evaluation

CallExpression : MemberExpression Arguments

1. Let *ref* be the result of evaluating *MemberExpression*.
2. Let *func* be *GetValue*(*ref*).
3. *ReturnIfAbrupt*(*func*).
4. If *Type*(*ref*) is Reference and *IsPropertyReference*(*ref*) is **false** and *GetReferencedName*(*ref*) is "**eval**", then
 - a. If *SameValue*(*func*, %*eval*%) is **true**, then
 - i. Let *argList* be *ArgumentListEvaluation*(*Arguments*).
 - ii. *ReturnIfAbrupt*(*argList*).
 - iii. If *argList* has no elements, **return undefined**.
 - iv. Let *evalText* be the first element of *argList*.
 - v. If the source code matching this *CallExpression* is strict code, let *strictCaller* be **true**. Otherwise let *strictCaller* be **false**.
 - vi. Let *evalRealm* be the running execution context's Realm.
 - vii. *Return PerformEval*(*evalText*, *evalRealm*, *strictCaller*, **true**).
5. If *Type*(*ref*) is Reference, then
 - a. If *IsPropertyReference*(*ref*) is **true**, then
 - i. Let *thisValue* be *GetThisValue*(*ref*).
 - b. Else, the base of *ref* is an Environment Record
 - i. Let *thisValue* be the result of calling the *WithBaseObject* concrete method of *GetBase*(*ref*).
6. Else *Type*(*ref*) is not Reference.
 - a. Let *thisValue* be **undefined**.
7. Let *thisCall* be this *CallExpression*.
8. Let *tailCall* be *IsInTailPosition*(*thisCall*). (See 14.6.1)
9. *Return EvaluateDirectCall*(*func*, *thisValue*, *Arguments*, *tailCall*).

Deleted: If *MemberExpression* consists solely of the an *IdentifierName IdentifierReference* whose StringValue
Deleted: <#>check if direct eval
Deleted: a
Deleted: , then return
Deleted: , then let

Deleted: EvaluateCall
Deleted: (*ref*, *Arguments*, **false**)

Deleted: *ref*

Deleted: that

Deleted: ¶

A *CallExpression* whose evaluation executes step 4.a.vii is a *direct eval*.

CallExpression : CallExpression Arguments

1. Let *ref* be the result of evaluating *CallExpression*.
2. Let *thisCall* be this *CallExpression*.
3. Let *tailCall* be *IsInTailPosition*(*thisCall*). (See 14.6.1)
4. *Return EvaluateCall*(*ref*, *Arguments*, *tailCall*).

Deleted: ¶

Deleted:

Deleted: and

Deleted: .

Deleted: <#>Let *argList* be *ArgumentListEvaluation*(*arguments*).¶
<#>*ReturnIfAbrupt*(*argList*).¶
<#>If *Type*(*func*) is not Object, throw a
TypeError exception.¶
<#>If *IsCallable*(*func*) is **false**, throw a
TypeError exception.¶

12.3.4.2 Runtime Semantics: EvaluateCall(*ref*, *arguments*, *tailPosition*)

The abstract operation *EvaluateCall* takes as arguments a value *ref*, a syntactic grammar production *arguments*, and a Boolean argument *tailPosition*. It performs the following steps:

1. Let *func* be *GetValue*(*ref*).
2. *ReturnIfAbrupt*(*func*).
3. If *Type*(*ref*) is Reference, then
 - a. If *IsPropertyReference*(*ref*) is **true**, then

- i. Let *thisValue* be *GetThisValue(ref)*.
- b. Else, the base of *ref* is an Environment Record
 - i. Let *thisValue* be the result of calling the *WithBaseObject* concrete method of *GetBase(ref)*.
4. Else *Type(ref)* is not Reference,
 - a. Let *thisValue* be ***undefined***.
5. **Return** *EvaluateDirectCall(func, thisValue, arguments, tailPosition)*.

12.3.4.3 Runtime Semantics: *EvaluateDirectCall(func, thisValue, arguments, tailPosition)*

The abstract operation *EvaluateDirectCall* takes as arguments a value *func*, a value *thisValue*, a syntactic grammar production *arguments*, and a Boolean argument *tailPosition*. It performs the following steps:

1. Let *argList* be *ArgumentListEvaluation(arguments)*.
2. **ReturnIfAbrupt(argList)**.
3. If *Type(func)* is not Object, throw a **TypeError** exception.
4. If *IsCallable(func)* is false, throw a **TypeError** exception.
5. If *tailPosition* is true, perform the *PrepareForTailCall* abstract operation.
6. Let *result* be *Call(func, thisValue, argList)*.
7. Assert: If *tailPosition* is true, the above call will not return here, but instead evaluation will continue as if the following return has already occurred.
8. Assert: If *result* is not an abrupt completion then *Type(result)* is an ECMAScript language type.
9. **Return** *result*.

12.3.5 The super Keyword

12.3.5.1 Runtime Semantics: Evaluation

SuperProperty: **super** [*Expression*]

1. Let *propertyNameReference* be the result of evaluating *Expression*.
2. Let *propertyNameValue* be *GetValue(propertyNameReference)*.
3. Let *propertyKey* be *ToPropertyKey(propertyNameValue)*.
4. **ReturnIfAbrupt(propertyKey)**.
5. If the code matched by the syntactic production that is being evaluated is strict mode code, let *strict* be true, else let *strict* be false.
6. **Return** *MakeSuperPropertyReference(propertyKey, strict)*.

SuperProperty: **super** . *IdentifierName*

1. Let *propertyKey* be String Value of *IdentifierName*.
2. If the code matched by the syntactic production that is being evaluated is strict mode code, let *strict* be true, else let *strict* be false.
3. **Return** *MakeSuperPropertyReference(propertyKey, strict)*.

SuperCall: **super** *Arguments*

1. Let *newTarget* be *GetNewTarget()*.
2. If *newTarget* is ***undefined***, throw a **ReferenceError** exception.
3. Let *func* be *GetSuperConstructor()*.
4. **ReturnIfAbrupt(func)**.
5. Let *argList* be *ArgumentListEvaluation of Arguments*.
6. **ReturnIfAbrupt(argList)**.
7. Let *result* be *Construct(func, argList, newTarget)*.
8. **ReturnIfAbrupt(result)**.

Deleted: <#> If *tailPosition* is true, then perform the *PrepareForTailCall* abstract operation.
 <#> Let *result* be the result of calling the [[Call]] internal method on *func*, passing *thisValue* as the *thisArgument* and *argList* as the *argumentsList*.
 <#> Assert: If *tailPosition* is true, the above call will not return here, but instead evaluation will continue as if the following return has already occurred.
 <#> Assert: If *result* is not an abrupt completion then *Type(result)* is an ECMAScript language type.

Deleted: *result*

Deleted: *then*

Deleted: the result of calling the [[

Deleted:]] internal method on

Deleted: passing

Deleted: as the *thisArgument* and

Deleted: as the *argumentsList*

Deleted: <#> Static Semantics: Early Errors

MemberExpression :
SuperProperty **super** [*Expression*]
super . *IdentifierName* +
NewSuper new **super** *Arguments*_{opt} ¶
NewExpression : *NewSuper* new **super** ¶
CallExpression : **super** *Arguments* ¶
 <#> It is a Syntax Error if the source code parsed with this production is global code that is not eval code.¶
 <#> It is a Syntax Error if the source code parsed with this production is module code ...

Deleted: *MemberExpression*

Deleted: ¶

Deleted: *MemberExpression*

Deleted: ¶

Deleted: ¶

Deleted: *MemberExpression* : *NewSuper* new **super** *Arguments*_{opt} ¶

Deleted: *CallExpression*

Deleted: ¶

Deleted: <#> If *IsThisInitialized()* is false, throw a **ReferenceError** exception.¶

Deleted: null

Deleted: <#> If the code matched by the syntactic production that is being evaluated is ...

Deleted: Let *thisValue* be *ResolveThisBinding()*.

Deleted: *func*

Deleted: Let *thisCall* be this *CallExpression*.

9. Let *thisER* be *GetThisEnvironment()*.
 10. Return the result of calling the *BindThisValue* concrete method of *thisER* with argument *result*.

Deleted: <#>Let *tailCall* be *IsInTailPosition(thisCall)*. (See 14.6.1)
 Return *EvaluateDirectCall(reffunc, thisValue, Arguments, tailCall)*

Deleted: .

12.3.5.2 Runtime Semantics: *GetSuperConstructor()*

The abstract operation *GetSuperConstructor* performs the following steps:

1. Let *envRec* be *GetThisEnvironment()*.
2. Assert: *envRec* is a Function environment record.
3. Let *activeFunction* be *envRec*'s *[[FunctionObject]]*.
4. Let *superConstructor* be the result of calling *activeFunction*'s *[[GetPrototypeOf]]* internal method.
5. ReturnIfAbrupt(*superConstructor*).
6. If *IsConstructor*(*superConstructor*) is false, throw a **TypeError** exception.
7. Return *superConstructor*.

Deleted: 's

Deleted: home

Deleted: Callable

Deleted: , then throw

Deleted: Reference

Deleted: ¶

12.3.5.3 Runtime Semantics: *MakeSuperPropertyReference*(*propertyKey*, *strict*)

The abstract operation *MakeSuperPropertyReference* with arguments *propertyKey* and *strict* performs the following steps:

1. Let *env* be *GetThisEnvironment()*.
2. If the result of calling the *HasSuperBinding* concrete method of *env* is false, throw a **ReferenceError** exception.
3. Let *actualThis* be the result of calling the *GetThisBinding* concrete method of *env*.
4. ReturnIfAbrupt(actualThis).
5. Let *baseValue* be the result of calling the *GetSuperBase* concrete method of *env*.
6. Let *bv* be *RequireObjectCoercible(baseValue)*.
7. ReturnIfAbrupt(*bv*).
8. Return a value of type Reference that is a Super Reference whose base value is *bv*, whose referenced name is *propertyKey*, whose *thisValue* is *actualThis*, and whose strict reference flag is *strict*.

Deleted: , then throw

Deleted: CheckObjectCoercible

Deleted: <#>If *propertyKey* is undefined, then
 <#>Let *propertyKey* be the result of calling the *GetMethodNames* concrete method of *env*.
 <#>If *propertyKey* is undefined, then then throw a **ReferenceError** exception.

Deleted: ¶

12.3.6 Argument Lists

NOTE The evaluation of an argument list produces a List of values (see 6.2.1).

12.3.6.1 Runtime Semantics: *ArgumentListEvaluation*

See also: 12.2.8.2.1.

Deleted: 12.2.9.2.1

Arguments : ()

Deleted: ¶

1. Return an empty List.

ArgumentList : AssignmentExpression

Deleted: ¶

1. Let *ref* be the result of evaluating *AssignmentExpression*.
2. Let *arg* be *GetValue(ref)*.
3. ReturnIfAbrupt(*arg*).
4. Return a List whose sole item is *arg*.

ArgumentList : . . . AssignmentExpression

Deleted: ¶

1. Let *list* be an empty List.

2. Let *spreadRef* be the result of evaluating *AssignmentExpression*.
3. Let *spreadObj* be *GetValue(spreadRef)*.
4. Let *iterator* be *GetIterator(spreadObj)*.
5. ReturnIfAbrupt(*iterator*).
6. Repeat
 - a. Let *next* be *IteratorStep(iterator)*.
 - b. ReturnIfAbrupt(*next*).
 - c. If *next* is **false**, return *list*.
 - d. Let *nextArg* be *IteratorValue(next)*.
 - e. ReturnIfAbrupt(*nextArg*).
 - f. Append *nextArg* as the last element of *list*.

Deleted: ToObject()
Deleted:)
Deleted: <#>ReturnIfAbrupt(spreadObj).
 <#>If Type(spreadObj) is not Object, then throw a **TypeError** exception.
Deleted: , then return

ArgumentList : *ArgumentList* , *AssignmentExpression*

1. Let *precedingArgs* be the result of evaluating *ArgumentList*.
2. ReturnIfAbrupt(*precedingArgs*).
3. Let *ref* be the result of evaluating *AssignmentExpression*.
4. Let *arg* be *GetValue(ref)*.
5. ReturnIfAbrupt(*arg*).
6. Append *arg* to the end of *precedingArgs*.
7. Return *precedingArgs*.

Deleted: ¶

ArgumentList : *ArgumentList* , ... *AssignmentExpression*

1. Let *precedingArgs* be the result of evaluating *ArgumentList*.
2. Let *spreadRef* be the result of evaluating *AssignmentExpression*.
3. Let *iterator* be *GetIterator(GetValue(spreadRef))*.
4. ReturnIfAbrupt(*iterator*).
5. Repeat
 - a. Let *next* be *IteratorStep(iterator)*.
 - b. ReturnIfAbrupt(*next*).
 - c. If *next* is **false**, return *precedingArgs*.
 - d. Let *nextArg* be *IteratorValue(next)*.
 - e. ReturnIfAbrupt(*nextArg*).
 - f. Append *nextArg* as the last element of *precedingArgs*.

Deleted: a List whose length is one greater than the length of *precedingArgs* and whose items are the items of

Deleted: , in order, followed at the end by *arg* which is the last item of the new list

Deleted: ¶

Deleted: be

Deleted: <#>Let *spreadObj* be
GetValue(spreadRef).
 <#>ReturnIfAbrupt(spreadObj).
 <#>If Type(spreadObj) is not Object, then throw a **TypeError** exception.

Deleted: ToObject()

Deleted:)

Deleted: *spreadObj*

Deleted: , then return

Deleted: call site

12.3.7 Tagged Templates

NOTE A tagged template is a function call where the arguments of the call are derived from a *TemplateLiteral* (12.2.8). The actual arguments include a *Template* object (12.2.8.2.2) and the values produced by evaluating the expressions embedded within the *TemplateLiteral*.

12.3.7.1 Runtime Semantics: Evaluation

MemberExpression : *MemberExpression* *TemplateLiteral*

1. Let *tagRef* be the result of evaluating *MemberExpression*.
2. Let *thisCall* be this *MemberExpression*.
3. Let *tailCall* be *IsInTailPosition(thisCall)*. (See 14.6.1)
4. Return *EvaluateCall(tagRef, TemplateLiteral, tailCall)*.

Deleted: ¶

Deleted: *func*

CallExpression : *CallExpression* *TemplateLiteral*

1. Let *tagRef* be the result of evaluating *CallExpression*.

Deleted: ¶

2. Let *thisCall* be this *CallExpression*.
3. Let *tailCall* be *IsInTailPosition(thisCall)*. (See 14.6.1).
4. Return *EvaluateCall(tagRef, TemplateLiteral, tailCall)*.

12.3.8 Meta Properties

Formatted: Not Highlight

12.3.8.1 Runtime Semantics: Evaluation

NewTarget: new . target

1. Return *GetNewTarget()*.

Deleted: MemberExpression

Formatted: Not Highlight

12.4 Postfix Expressions

Syntax

PostfixExpression_[?yield] :

LeftHandSideExpression_[?yield]
LeftHandSideExpression_[?yield] [no LineTerminator here] **++**
LeftHandSideExpression_[?yield] [no LineTerminator here] **--**

12.4.1 Static Semantics: Early Errors

PostfixExpression :

LeftHandSideExpression **++**
LeftHandSideExpression **--**

- It is an early Reference Error if *IsValidSimpleAssignmentTarget* of *LeftHandSideExpression* is **false**.

12.4.2 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, 12.2.9.2, 12.3.1.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, 14.1.12, 14.4.8, 14.5.8

Deleted: 12.2.9.212.2.10.2

Deleted: 14.1.11

PostfixExpression :

LeftHandSideExpression **++**
LeftHandSideExpression **--**

1. Return **false**.

12.4.3 Static Semantics: IsValidSimpleAssignmentTarget

See also: 12.1.3, 12.2.0.3, 12.2.9.3, 12.3.1.3, 12.5.3, 12.6.2, 12.7.2, 12.8.2, 12.9.2, 12.10.2, 12.11.2, 12.12.2, 12.13.2, 12.14.3, 12.15.2.

Deleted: 12.2.10.3

PostfixExpression :

LeftHandSideExpression **++**
LeftHandSideExpression **--**

1. Return **false**.

12.4.4 Postfix Increment Operator

12.4.4.1 Runtime Semantics: Evaluation

*PostfixExpression : LeftHandSideExpression **++***

1. Let *lhs* be the result of evaluating *LeftHandSideExpression*.
2. Let *oldValue* be *ToNumber*(*GetValue*(*lhs*)).
3. ReturnIfAbrupt(*oldValue*).
4. Let *newValue* be the result of adding the value **1** to *oldValue*, using the same rules as for the **+** operator (see 12.7.5).
5. Let *status* be *PutValue*(*lhs*, *newValue*).
6. ReturnIfAbrupt(*status*).
7. Return *oldValue*.

Deleted: **¶**

12.4.5 Postfix Decrement Operator

12.4.5.1 Runtime Semantics: Evaluation

*PostfixExpression : LeftHandSideExpression **--***

1. Let *lhs* be the result of evaluating *LeftHandSideExpression*.
2. Let *oldValue* be *ToNumber*(*GetValue*(*lhs*)).
3. ReturnIfAbrupt(*oldValue*).
4. Let *newValue* be the result of subtracting the value **1** from *oldValue*, using the same rules as for the **-** operator (12.7.5).
5. Let *status* be *PutValue*(*lhs*, *newValue*).
6. ReturnIfAbrupt(*status*).
7. Return *oldValue*.

Deleted: **¶**

12.5 Unary Operators

Syntax

UnaryExpression_[Yield] :

- PostfixExpression_[?Yield]*
- delete** *UnaryExpression_[?Yield]*
- void** *UnaryExpression_[?Yield]*
- typeof** *UnaryExpression_[?Yield]*
- ++** *UnaryExpression_[?Yield]*
- *UnaryExpression_[?Yield]*
- +** *UnaryExpression_[?Yield]*
- *UnaryExpression_[?Yield]*
- ~** *UnaryExpression_[?Yield]*
- !** *UnaryExpression_[?Yield]*

12.5.1 Static Semantics: Early Errors

UnaryExpression :

- ++** *UnaryExpression*
- *UnaryExpression*

- It is an early Reference Error if *IsValidSimpleAssignmentTarget* of *UnaryExpression* is **false**.

12.5.2 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, [12.2.9.2](#), 12.3.1.2, 12.4.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, [14.1.12](#), 14.4.8, 14.5.8.

Deleted: 12.2.9.212.2.10.2

Deleted: 14.1.11

UnaryExpression :

- `delete UnaryExpression`
- `void UnaryExpression`
- `typeof UnaryExpression`
- `++ UnaryExpression`
- `-- UnaryExpression`
- `+ UnaryExpression`
- `- UnaryExpression`
- `~ UnaryExpression`
- `! UnaryExpression`

1. Return `false`.

12.5.3 Static Semantics: IsValidSimpleAssignmentTarget

See also: [12.1.3](#), 12.2.0.3, [12.2.9.3](#), 12.3.1.3, 12.4.3, 12.6.2, 12.7.2, 12.8.2, 12.9.2, 12.10.2, 12.11.2, 12.12.2, 12.13.2, 12.14.3, 12.15.2.

Deleted: 12.2.10.3

UnaryExpression :

- `delete UnaryExpression`
- `void UnaryExpression`
- `typeof UnaryExpression`
- `++ UnaryExpression`
- `-- UnaryExpression`
- `+ UnaryExpression`
- `- UnaryExpression`
- `~ UnaryExpression`
- `! UnaryExpression`

1. Return `false`.

12.5.4 The delete Operator

12.5.4.1 Static Semantics: Early Errors

UnaryExpression : delete UnaryExpression

Deleted: ¶

- It is a Syntax Error if the *UnaryExpression* is contained in strict code and the derived *UnaryExpression* is *PrimaryExpression : IdentifierReference*.
- It is a Syntax Error if the derived *UnaryExpression* is

$$\begin{aligned} \text{PrimaryExpression} : & \text{CoverParenthesizedExpressionAndArrowParameterList} \\ \text{and } & \text{CoverParenthesizedExpressionAndArrowParameterList} \end{aligned}$$
ultimately derives a *phrase* that, if used in place of *UnaryExpression*, would produce a Syntax Error according to these rules. This rule is recursively applied.

Deleted: production

NOTE The last rule means that expressions such as
`delete (((foo)))`
produce early errors because of recursive application of the first rule.

12.5.4.2 Runtime Semantics: Evaluation

UnaryExpression : `delete UnaryExpression`

1. Let *ref* be the result of evaluating *UnaryExpression*.
2. ReturnIfAbrupt(*ref*).
3. If Type(*ref*) is not Reference, return **true**.
4. If IsUnresolvableReference(*ref*) is **true**, then
 - a. Assert: IsStrictReference(*ref*) is **false**.
 - b. Return **true**.
5. If IsPropertyReference(*ref*) is **true**, then
 - a. If IsSuperReference(*ref*), **throw** a **ReferenceError** exception.
 - b. Let *deleteStatus* be the result of calling the **[[Delete]]** internal method on *ToObject*(*GetBase*(*ref*)), providing *GetReferencedName*(*ref*) as the argument.
 - c. ReturnIfAbrupt(*deleteStatus*).
 - d. If *deleteStatus* is **false** and IsStrictReference(*ref*) is **true**, **throw** a **TypeError** exception.
 - e. Return *deleteStatus*.
6. Else *ref* is a Reference to an Environment Record binding,
 - a. Let *bindings* be *GetBase*(*ref*).
 - b. Return the result of calling the **DeleteBinding** concrete method of *bindings*, providing *GetReferencedName*(*ref*) as the argument.

NOTE When a **delete** operator occurs within strict mode code, a **SyntaxError** exception is thrown if its *UnaryExpression* is a direct reference to a variable, function argument, or function name. In addition, if a **delete** operator occurs within strict mode code and the property to be deleted has the attribute { **[[Configurable]]: false** }, a **TypeError** exception is thrown.

12.5.5 The `void` Operator

12.5.5.1 Runtime Semantics: Evaluation

UnaryExpression : `void UnaryExpression`

1. Let *expr* be the result of evaluating *UnaryExpression*.
2. Let *status* be *GetValue*(*expr*).
3. ReturnIfAbrupt(*status*).
4. Return **undefined**.

NOTE *GetValue* must be called even though its value is not used because it may have observable side-effects.

12.5.6 The `typeof` Operator

12.5.6.1 Runtime Semantics: Evaluation

UnaryExpression : `typeof UnaryExpression`

1. Let *val* be the result of evaluating *UnaryExpression*.
2. If Type(*val*) is Reference, then
 - a. If IsUnresolvableReference(*val*) is **true**, return "**undefined**".

3. Let *val* be GetValue(*val*).
4. ReturnIfAbrupt(*val*).
5. Return a String according to [Table 36](#).

Deleted: Table 34Table 34Table 33Table 33Table 33

Deleted: 343433

Table 36 — typeof Operator Results

Type of <i>val</i>	Result
Undefined	" <code>undefined</code> "
Null	" <code>object</code> "
Boolean	" <code>boolean</code> "
Number	" <code>number</code> "
String	" <code>string</code> "
Symbol	" <code>symbol</code> "
Object (ordinary and does not implement [[Call]])	" <code>object</code> "
Object (standard exotic and does not implement [[Call]])	" <code>object</code> "
Object (implements [[Call]])	" <code>function</code> "
Object (non-standard exotic and does not implement [[Call]])	Implementation-defined. Must not be " <code>undefined</code> ", " <code>boolean</code> ", " <code>function</code> ", " <code>number</code> ", " <code>symbol</code> ", or " <code>string</code> ".

NOTE Implementations are discouraged from defining new `typeof` result values for non-standard exotic objects. If possible "`object`" should be used for such objects.

12.5.7 Prefix Increment Operator

12.5.7.1 Runtime Semantics: Evaluation

UnaryExpression : `++ UnaryExpression`

Deleted: ¶

1. Let *expr* be the result of evaluating *UnaryExpression*.
2. Let *oldValue* be ToNumber(GetValue(*expr*)).
3. ReturnIfAbrupt(*oldValue*).
4. Let *newValue* be the result of adding the value 1 to *oldValue*, using the same rules as for the `+` operator (see 12.7.5).
5. Let *status* be PutValue(*expr*, *newValue*).
6. ReturnIfAbrupt(*status*).
7. Return *newValue*.

12.5.8 Prefix Decrement Operator

12.5.8.1 Runtime Semantics: Evaluation

UnaryExpression : `-- UnaryExpression`

Deleted: ¶

1. Let *expr* be the result of evaluating *UnaryExpression*.
2. Let *oldValue* be ToNumber(GetValue(*expr*)).

3. ReturnIfAbrupt(*oldValue*).
4. Let *newValue* be the result of subtracting the value **1** from *oldValue*, using the same rules as for the **-** operator (see 12.7.5).
5. Let *status* be PutValue(*expr*, *newValue*).
6. ReturnIfAbrupt(*status*).
7. Return *newValue*.

12.5.9 Unary + Operator

NOTE The unary **+** operator converts its operand to Number type.

12.5.9.1 Runtime Semantics: Evaluation

UnaryExpression : + UnaryExpression

1. Let *expr* be the result of evaluating *UnaryExpression*.
2. Return ToNumber(GetValue(*expr*)).

12.5.10 Unary - Operator

NOTE The unary **-** operator converts its operand to Number type and then negates it. Negating **+0** produces **-0**, and negating **-0** produces **+0**.

12.5.10.1 Runtime Semantics: Evaluation

UnaryExpression : - UnaryExpression

1. Let *expr* be the result of evaluating *UnaryExpression*.
2. Let *oldValue* be ToNumber(GetValue(*expr*)).
3. ReturnIfAbrupt(*oldValue*).
4. If *oldValue* is **NaN**, return **NaN**.
5. Return the result of negating *oldValue*; that is, compute a Number with the same magnitude but opposite sign.

12.5.11 Bitwise NOT Operator (**~**)

12.5.11.1 Runtime Semantics: Evaluation

UnaryExpression : ~ UnaryExpression

1. Let *expr* be the result of evaluating *UnaryExpression*.
2. Let *oldValue* beToInt32(GetValue(*expr*)).
3. ReturnIfAbrupt(*oldValue*).
4. Return the result of applying bitwise complement to *oldValue*. The result is a signed 32-bit integer.

12.5.12 Logical NOT Operator (**!**)

12.5.12.1 Runtime Semantics: Evaluation

UnaryExpression : ! UnaryExpression

1. Let *expr* be the result of evaluating *UnaryExpression*.
2. Let *oldValue* be ToBoolean(GetValue(*expr*)).

3. ReturnIfAbrupt(*oldValue*).
4. If *oldValue* is **true**, return **false**.
5. Return **true**.

12.6 Multiplicative Operators

Syntax

MultiplicativeExpression_[?yield] :
UnaryExpression_[?yield]
MultiplicativeExpression_[?yield] MultiplicativeOperator_[?yield] UnaryExpression_[?yield]

MultiplicativeOperator : one of
*** / %

12.6.1 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, [12.2.9.2](#), 12.3.1.2, 12.4.2, 12.5.2, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, [14.1.12](#), 14.4.8, 14.5.8.

Deleted: *MultiplicativeExpression_[?yield] **
UnaryExpression_[?yield]
MultiplicativeExpression_[?yield] / UnaryExpression_[?yield]
UnaryExpression_[?yield] ~

Deleted: %

MultiplicativeExpression : *MultiplicativeExpression MultiplicativeOperator UnaryExpression*

1. Return **false**.

12.6.2 Static Semantics: IsValidSimpleAssignmentTarget

See also: [12.1.3](#), 12.2.0.3, [12.2.9.3](#), 12.3.1.3, 12.4.3, 12.5.3, 12.7.2, 12.8.2, 12.9.2, 12.10.2, 12.11.2, 12.12.2, 12.13.2, 12.14.3, 12.15.2.

Deleted: 12.2.9.212.2.10.2

Deleted: 14.1.11

Deleted: ¶
*MultiplicativeExpression * UnaryExpression*
MultiplicativeExpression / UnaryExpression
MultiplicativeExpression % UnaryExpression

MultiplicativeExpression : *MultiplicativeExpression MultiplicativeOperator UnaryExpression*

1. Return **false**.

12.6.3 Runtime Semantics: Evaluation

MultiplicativeExpression : *MultiplicativeExpression MultiplicativeOperator UnaryExpression*

1. Let *left* be the result of evaluating *MultiplicativeExpression*.
2. Let *leftValue* be *GetValue(left)*.
3. ReturnIfAbrupt(*leftValue*).
4. Let *right* be the result of evaluating *UnaryExpression*.
5. Let *rightValue* be *GetValue(right)*.
6. Let *lnum* be *ToNumber(leftValue)*.
7. ReturnIfAbrupt(*lnum*).
8. Let *rnum* be *ToNumber(rightValue)*.
9. ReturnIfAbrupt(*rnum*).
10. Return the result of applying the *MultiplicativeOperator* (*, /, or %) to *lnum* and *rnum* as specified in 12.6.3.1, 12.6.3.2, or 12.6.3.3.

Deleted: *MultiplicativeExpression* : ¶

Deleted: *MultiplicativeExpression * UnaryExpression*
MultiplicativeExpression / UnaryExpression
MultiplicativeExpression % UnaryExpression

Deleted: The production
MultiplicativeExpression : *MultiplicativeExpression @ UnaryExpression*, where @ stands for one of the operators in the above definitions, is evaluated as follows: ¶

12.6.3.1 Applying the * Operator

The * *MultiplicativeOperator* performs multiplication, producing the product of its operands. Multiplication is commutative. Multiplication is not always associative in ECMAScript, because of finite precision.

Deleted: specified operation

Deleted: . See the Notes below

Deleted: and

Deleted: operator

The result of a floating-point multiplication is governed by the rules of IEEE 754 binary double-precision arithmetic:

- If either operand is **NaN**, the result is **NaN**.
- The sign of the result is positive if both operands have the same sign, negative if the operands have different signs.
- Multiplication of an infinity by a zero results in **NaN**.
- Multiplication of an infinity by an infinity results in an infinity. The sign is determined by the rule already stated above.
- Multiplication of an infinity by a finite nonzero value results in a signed infinity. The sign is determined by the rule already stated above.
- In the remaining cases, where neither an infinity nor NaN is involved, the product is computed and rounded to the nearest representable value using IEEE 754 round-to-nearest mode. If the magnitude is too large to represent, the result is then an infinity of appropriate sign. If the magnitude is too small to represent, the result is then a zero of appropriate sign. The ECMAScript language requires support of gradual underflow as defined by IEEE 754.

12.6.3.2 Applying the / Operator

The `/` *MultiplicativeOperator* performs division, producing the quotient of its operands. The left operand is the dividend and the right operand is the divisor. ECMAScript does not perform integer division. The operands and result of all division operations are double-precision floating-point numbers. The result of division is determined by the specification of IEEE 754 arithmetic:

Deleted: operator

- If either operand is **NaN**, the result is **NaN**.
- The sign of the result is positive if both operands have the same sign, negative if the operands have different signs.
- Division of an infinity by an infinity results in **NaN**.
- Division of an infinity by a zero results in an infinity. The sign is determined by the rule already stated above.
- Division of an infinity by a nonzero finite value results in a signed infinity. The sign is determined by the rule already stated above.
- Division of a finite value by an infinity results in zero. The sign is determined by the rule already stated above.
- Division of a zero by a zero results in **NaN**; division of zero by any other finite value results in zero, with the sign determined by the rule already stated above.
- Division of a nonzero finite value by a zero results in a signed infinity. The sign is determined by the rule already stated above.
- In the remaining cases, where neither an infinity, nor a zero, nor **NaN** is involved, the quotient is computed and rounded to the nearest representable value using IEEE 754 round-to-nearest mode. If the magnitude is too large to represent, the operation overflows; the result is then an infinity of appropriate sign. If the magnitude is too small to represent, the operation underflows and the result is a zero of the appropriate sign. The ECMAScript language requires support of gradual underflow as defined by IEEE 754.

12.6.3.3 Applying the % Operator

The `%` *MultiplicativeOperator* yields the remainder of its operands from an implied division; the left operand is the dividend and the right operand is the divisor.

Deleted: operator

NOTE In C and C++, the remainder operator accepts only integral operands; in ECMAScript, it also accepts floating-point operands.

The result of a floating-point remainder operation as computed by the % operator is not the same as the “remainder” operation defined by IEEE 754. The IEEE 754 “remainder” operation computes the remainder from a rounding division, not a truncating division, and so its behaviour is not analogous to that of the usual integer remainder operator. Instead the ECMAScript language defines % on floating-point operations to behave in a manner analogous to that of the Java integer remainder operator; this may be compared with the C library function fmod.

The result of an ECMAScript floating-point remainder operation is determined by the rules of IEEE arithmetic:

- If either operand is **NaN**, the result is **NaN**.
- The sign of the result equals the sign of the dividend.
- If the dividend is an infinity, or the divisor is a zero, or both, the result is **NaN**.
- If the dividend is finite and the divisor is an infinity, the result equals the dividend.
- If the dividend is a zero and the divisor is nonzero and finite, the result is the same as the dividend.
- In the remaining cases, where neither an infinity, nor a zero, nor **NaN** is involved, the floating-point remainder r from a dividend n and a divisor d is defined by the mathematical relation $r = n - (d \times q)$ where q is an integer that is negative only if n/d is negative and positive only if n/d is positive, and whose magnitude is as large as possible without exceeding the magnitude of the true mathematical quotient of n and d. r is computed and rounded to the nearest representable value using IEEE 754 round-to-nearest mode.

12.7 Additive Operators

Syntax

```
AdditiveExpression[?Yield] :
  MultiplicativeExpression[?Yield]
  AdditiveExpression[?Yield] + MultiplicativeExpression[?Yield]
  AdditiveExpression[?Yield] - MultiplicativeExpression[?Yield]
```

12.7.1 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, 12.2.9.2, 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, 14.1.12, 14.4.8, 14.5.8.

Deleted: 12.2.10.2

Deleted: 14.1.11

AdditiveExpression :

```
AdditiveExpression + MultiplicativeExpression
AdditiveExpression - MultiplicativeExpression
```

1. Return **false**.

12.7.2 Static Semantics: IsValidSimpleAssignmentTarget

See also: 12.1.3, 12.2.0.3, 12.2.9.3, 12.3.1.3, 12.4.3, 12.5.3, 12.6.2, 12.8.2, 12.9.2, 12.10.2, 12.11.2, 12.12.2, 12.13.2, 12.14.3, 12.15.2.

Deleted: 12.2.10.3

AdditiveExpression :

AdditiveExpression + MultiplicativeExpression
AdditiveExpression - MultiplicativeExpression

1. Return **false**.

12.7.3 The Addition operator (+)

NOTE The addition operator either performs string concatenation or numeric addition.

12.7.3.1 Runtime Semantics: Evaluation

AdditiveExpression : AdditiveExpression + MultiplicativeExpression

1. Let *lref* be the result of evaluating *AdditiveExpression*.
2. Let *lval* be *GetValue(lref)*.
3. *ReturnIfAbrupt(lval)*.
4. Let *rref* be the result of evaluating *MultiplicativeExpression*.
5. Let *rval* be *GetValue(rref)*.
6. *ReturnIfAbrupt(rval)*.
7. Let *lprim* be *ToPrimitive(lval)*.
8. *ReturnIfAbrupt(lprim)*.
9. Let *rprim* be *ToPrimitive(rval)*.
10. *ReturnIfAbrupt(rprim)*.
11. If *Type(lprim)* is String or *Type(rprim)* is String, then
 - a. Let *lstr* be *ToString(lprim)*.
 - b. *ReturnIfAbrupt(lstr)*.
 - c. Let *rstr* be *ToString(rprim)*.
 - d. *ReturnIfAbrupt(rstr)*.
 - e. Return the String that is the result of concatenating *lstr* and *rstr*.
12. Let *lnum* be *ToNumber(lprim)*.
13. *ReturnIfAbrupt(lnum)*.
14. Let *rnum* be *ToNumber(rprim)*.
15. *ReturnIfAbrupt(rnum)*.
16. Return the result of applying the addition operation to *lnum* and *rnum*. See the Note below 12.7.5.

NOTE 1 No hint is provided in the calls to *ToPrimitive* in steps 7 and 9. All standard objects except Date objects handle the absence of a hint as if the hint Number were given; Date objects handle the absence of a hint as if the hint String were given. Exotic objects may handle the absence of a hint in some other manner.

NOTE 2 Step 11 differs from step 5 of the Abstract Relational Comparison algorithm (7.2.9), by using the logical-**-** or operation instead of the logical-and operation.

Deleted: ¶

Deleted: ¶

Deleted: If

Deleted: *Type(lprim)* is Symbol or *Type(rprim)* is Symbol, then throw a *TypeError* exception.

Deleted: *ToString(lprim)*

Deleted: followed by

Deleted: *ToString(rprim)*

Deleted: *ToNumber(lprim)*

Deleted: *ToNumber(rprim)*

Deleted: 7.2.8

12.7.4 The Subtraction Operator (-)

12.7.4.1 Runtime Semantics: Evaluation

AdditiveExpression : AdditiveExpression - MultiplicativeExpression

Deleted: ¶

1. Let *lref* be the result of evaluating *AdditiveExpression*.
2. Let *lval* be *GetValue(lref)*.
3. *ReturnIfAbrupt(lval)*.
4. Let *rref* be the result of evaluating *MultiplicativeExpression*.
5. Let *rval* be *GetValue(rref)*.

6. ReturnIfAbrupt(*rval*).
7. Let *lnum* be ToNumber(*lval*).
8. ReturnIfAbrupt(*lnum*).
9. Let *rnum* be ToNumber(*rval*).
10. ReturnIfAbrupt(*rnum*).
11. Return the result of applying the subtraction operation to *lnum* and *rnum*. See the note below 12.7.5.

12.7.5 Applying the Additive Operators to Numbers

The `+` operator performs addition when applied to two operands of numeric type, producing the sum of the operands. The `-` operator performs subtraction, producing the difference of two numeric operands.

Addition is a commutative operation, but not always associative.

The result of an addition is determined using the rules of IEEE 754 binary double-precision arithmetic:

- If either operand is **NaN**, the result is **NaN**.
- The sum of two infinities of opposite sign is **NaN**.
- The sum of two infinities of the same sign is the infinity of that sign.
- The sum of an infinity and a finite value is equal to the infinite operand.
- The sum of two negative zeroes is **-0**. The sum of two positive zeroes, or of two zeroes of opposite sign, is **+0**.
- The sum of a zero and a nonzero finite value is equal to the nonzero operand.
- The sum of two nonzero finite values of the same magnitude and opposite sign is **+0**.
- In the remaining cases, where neither an infinity, nor a zero, nor NaN is involved, and the operands have the same sign or have different magnitudes, the sum is computed and rounded to the nearest representable value using IEEE 754 round-to-nearest mode. If the magnitude is too large to represent, the operation overflows and the result is then an infinity of appropriate sign. The ECMAScript language requires support of gradual underflow as defined by IEEE 754.

NOTE The `-` operator performs subtraction when applied to two operands of numeric type, producing the difference of its operands; the left operand is the minuend and the right operand is the subtrahend. Given numeric operands *a* and *b*, it is always the case that *a* $-$ *b* produces the same result as *a* $+$ $(-b)$.

12.8 Bitwise Shift Operators

Syntax

```
ShiftExpression[?Yield] :
  AdditiveExpression[?Yield]
  ShiftExpression[?Yield] << AdditiveExpression[?Yield]
  ShiftExpression[?Yield] >> AdditiveExpression[?Yield]
  ShiftExpression[?Yield] >>> AdditiveExpression[?Yield]
```

12.8.1 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, 12.2.9.2, 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, 14.1.12, 14.4.8, 14.5.8.

Deleted: 12.2.10.2

Deleted: 14.1.11

ShiftExpression :

- ShiftExpression << AdditiveExpression*
- ShiftExpression >> AdditiveExpression*
- ShiftExpression >>> AdditiveExpression*

1. Return **false**.

12.8.2 Static Semantics: IsValidSimpleAssignmentTarget

See also: [12.1.3](#), [12.2.0.3](#), [12.2.9.3](#), [12.3.1.3](#), [12.4.3](#), [12.5.3](#), [12.6.2](#), [12.7.2](#), [12.9.2](#), [12.10.2](#), [12.11.2](#), [12.12.2](#), [12.13.2](#), [12.14.3](#), [12.15.2](#).

Deleted: [12.2.10.3](#)

ShiftExpression :

- ShiftExpression << AdditiveExpression*
- ShiftExpression >> AdditiveExpression*
- ShiftExpression >>> AdditiveExpression*

1. Return **false**.

12.8.3 The Left Shift Operator (<<)

NOTE Performs a bitwise left shift operation on the left operand by the amount specified by the right operand.

12.8.3.1 Runtime Semantics: Evaluation

ShiftExpression : ShiftExpression << AdditiveExpression

Deleted: [1](#)

1. Let *lref* be the result of evaluating *ShiftExpression*.
2. Let *lval* be *GetValue(lref)*.
3. ReturnIfAbrupt(*lval*).
4. Let *rref* be the result of evaluating *AdditiveExpression*.
5. Let *rval* be *GetValue(rref)*.
6. ReturnIfAbrupt(*rval*).
7. Let *lnum* be *ToInt32(lval)*.
8. ReturnIfAbrupt(*lnum*).
9. Let *rnum* be *ToUint32(rval)*.
10. ReturnIfAbrupt(*rnum*).
11. Let *shiftCount* be the result of masking out all but the least significant 5 bits of *rnum*, that is, compute *rnum* & *0x1F*.
12. Return the result of left shifting *lnum* by *shiftCount* bits. The result is a signed 32-bit integer.

12.8.4 The Signed Right Shift Operator (>>)

NOTE Performs a sign-filling bitwise right shift operation on the left operand by the amount specified by the right operand.

12.8.4.1 Runtime Semantics: Evaluation

ShiftExpression : ShiftExpression >> AdditiveExpression

Deleted: [1](#)

1. Let *lref* be the result of evaluating *ShiftExpression*.
2. Let *lval* be *GetValue(lref)*.
3. ReturnIfAbrupt(*lval*).
4. Let *rref* be the result of evaluating *AdditiveExpression*.

5. Let *rval* be GetValue(*rref*).
6. ReturnIfAbrupt(*rval*).
7. Let *lnum* be ToInt32(*lval*).
8. ReturnIfAbrupt(*lnum*).
9. Let *rnum* be ToUint32(*rval*).
10. ReturnIfAbrupt(*rnum*).
11. Let *shiftCount* be the result of masking out all but the least significant 5 bits of *rnum*, that is, compute *rnum* & 0x1F.
12. Return the result of performing a sign-extending right shift of *lnum* by *shiftCount* bits. The most significant bit is propagated. The result is a signed 32-bit integer.

12.8.5 The Unsigned Right Shift Operator (`>>>`)

NOTE Performs a zero-filling bitwise right shift operation on the left operand by the amount specified by the right operand.

12.8.5.1 Runtime Semantics: Evaluation

ShiftExpression : *ShiftExpression* `>>>` *AdditiveExpression*

Deleted: 1

1. Let *lref* be the result of evaluating *ShiftExpression*.
2. Let *lval* be GetValue(*lref*).
3. ReturnIfAbrupt(*lval*).
4. Let *rref* be the result of evaluating *AdditiveExpression*.
5. Let *rval* be GetValue(*rref*).
6. ReturnIfAbrupt(*rval*).
7. Let *lnum* be ToUint32(*lval*).
8. ReturnIfAbrupt(*lnum*).
9. Let *rnum* be ToUint32(*rval*).
10. ReturnIfAbrupt(*rnum*).
11. Let *shiftCount* be the result of masking out all but the least significant 5 bits of *rnum*, that is, compute *rnum* & 0x1F.
12. Return the result of performing a zero-filling right shift of *lnum* by *shiftCount* bits. Vacated bits are filled with zero. The result is an unsigned 32-bit integer.

12.9 Relational Operators

NOTE The result of evaluating a relational operator is always of type Boolean, reflecting whether the relationship named by the operator holds between its two operands.

Syntax

RelationalExpression[*in*, *Yield*] :

- ShiftExpression*[?*Yield*]
- RelationalExpression*[?*in*, ?*Yield*] `<` *ShiftExpression*[?*Yield*]
- RelationalExpression*[?*in*, ?*Yield*] `>` *ShiftExpression*[?*Yield*]
- RelationalExpression*[?*in*, ?*Yield*] `<=` *ShiftExpression*[?*Yield*]
- RelationalExpression*[?*in*, ?*Yield*] `>=` *ShiftExpression*[?*Yield*]
- RelationalExpression*[?*in*, ?*Yield*] `instanceof` *ShiftExpression*[?*Yield*]
- [+*In*] *RelationalExpression*[?*in*, ?*Yield*] `in` *ShiftExpression*[?*Yield*]

Deleted: in

NOTE The `[+In]` grammar parameter is needed to avoid confusing the `in` operator in a relational expression with the `in` operator in a `for` statement.

12.9.1 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, 12.2.9.2, 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, 14.1.12, 14.4.8, 14.5.8.

Deleted: 12.2.10.2

Deleted: 14.1.11

RelationalExpression :

RelationalExpression < ShiftExpression
RelationalExpression > ShiftExpression
RelationalExpression <= ShiftExpression
RelationalExpression >= ShiftExpression
RelationalExpression instanceof ShiftExpression
RelationalExpression in ShiftExpression

1. Return **false**.

12.9.2 Static Semantics: IsValidSimpleAssignmentTarget

See also: 12.1.3, 12.2.0.3, 12.2.9.3, 12.3.1.3, 12.4.3, 12.5.3, 12.6.2, 12.7.2, 12.8.2, 12.10.2, 12.11.2, 12.12.2, 12.13.2, 12.14.3, 12.15.2.

Deleted: 12.2.10.3

RelationalExpression :

RelationalExpression < ShiftExpression
RelationalExpression > ShiftExpression
RelationalExpression <= ShiftExpression
RelationalExpression >= ShiftExpression
RelationalExpression instanceof ShiftExpression
RelationalExpression in ShiftExpression

1. Return **false**.

12.9.3 Runtime Semantics: Evaluation

RelationalExpression : RelationalExpression < ShiftExpression

Deleted: ¶

1. Let *lref* be the result of evaluating *RelationalExpression*.
2. Let *lval* be *GetValue(lref)*.
3. ReturnIfAbrupt(*lval*).
4. Let *rref* be the result of evaluating *ShiftExpression*.
5. Let *rval* be *GetValue(rref)*.
6. Let *r* be the result of performing Abstract Relational Comparison *lval < rval*. (see 7.2.9)
7. ReturnIfAbrupt(*r*).
8. If *r* is **undefined**, return **false**. Otherwise, return *r*.

Deleted: 7.2.87.2.8

RelationalExpression : RelationalExpression > ShiftExpression

Deleted: ¶

1. Let *lref* be the result of evaluating *RelationalExpression*.
2. Let *lval* be *GetValue(lref)*.
3. ReturnIfAbrupt(*lval*).
4. Let *rref* be the result of evaluating *ShiftExpression*.
5. Let *rval* be *GetValue(rref)*.
6. Let *r* be the result of performing Abstract Relational Comparison *rval < lval* with *LeftFirst* equal to **false**.
7. ReturnIfAbrupt(*r*).

8. If r is **undefined**, return **false**. Otherwise, return r .

RelationalExpression : RelationalExpression <= ShiftExpression

Deleted: 1

1. Let $lref$ be the result of evaluating *RelationalExpression*.
2. Let $lval$ be $\text{GetValue}(lref)$.
3. $\text{ReturnIfAbrupt}(lval)$.
4. Let $rref$ be the result of evaluating *ShiftExpression*.
5. Let $rval$ be $\text{GetValue}(rref)$.
6. Let r be the result of performing Abstract Relational Comparison $rval < lval$ with *LeftFirst* equal to **false**.
7. $\text{ReturnIfAbrupt}(r)$.
8. If r is **true** or **undefined**, return **false**. Otherwise, return **true**.

RelationalExpression : RelationalExpression >= ShiftExpression

Deleted: 1

1. Let $lref$ be the result of evaluating *RelationalExpression*.
2. Let $lval$ be $\text{GetValue}(lref)$.
3. $\text{ReturnIfAbrupt}(lval)$.
4. Let $rref$ be the result of evaluating *ShiftExpression*.
5. Let $rval$ be $\text{GetValue}(rref)$.
6. Let r be the result of performing Abstract Relational Comparison $lval < rval$.
7. $\text{ReturnIfAbrupt}(r)$.
8. If r is **true** or **undefined**, return **false**. Otherwise, return **true**.

RelationalExpression : RelationalExpression instanceof ShiftExpression

Deleted: 1

1. Let $lref$ be the result of evaluating *RelationalExpression*.
2. Let $lval$ be $\text{GetValue}(lref)$.
3. $\text{ReturnIfAbrupt}(lval)$.
4. Let $rref$ be the result of evaluating *ShiftExpression*.
5. Let $rval$ be $\text{GetValue}(rref)$.
6. $\text{ReturnIfAbrupt}(rval)$.
7. Return *InstanceofOperator*($lval, rval$).

RelationalExpression : RelationalExpression in ShiftExpression

Deleted: 1

1. Let $lref$ be the result of evaluating *RelationalExpression*.
2. Let $lval$ be $\text{GetValue}(lref)$.
3. $\text{ReturnIfAbrupt}(lval)$.
4. Let $rref$ be the result of evaluating *ShiftExpression*.
5. Let $rval$ be $\text{GetValue}(rref)$.
6. $\text{ReturnIfAbrupt}(rval)$.
7. If $\text{Type}(rval)$ is not **Object**, throw a **TypeError** exception.
8. Return *HasProperty*($rval, \text{ToPropertyKey}(lval)$).

12.9.4 Runtime Semantics: InstanceofOperator(O, C)

The abstract operation *InstanceofOperator*(O, C) implements the generic algorithm for determining if an object O inherits from the inheritance path defined by constructor C . This abstract operation performs the following steps:

1. If $\text{Type}(C)$ is not **Object**, throw a **TypeError** exception.
2. Let instOfHandler be $\text{GetMethod}(C, @@\text{hasInstance})$.

3. ReturnIfAbrupt(*instOfHandler*).
4. If *instOfHandler* is not **undefined**, then
 - a. [Return ToBoolean\(Call\(*instOfHandler*, *C*, *O*\)\)](#).
5. If **IsCallable(C)** is **false**, throw a **TypeError** exception.
6. Return **OrdinaryHasInstance(C, O)**.

NOTE Steps 5 and 6 provide compatibility with previous editions of ECMAScript that did not use a `@@hasInstance` method to define the `instanceof` operator semantics. If a function object does not define or inherit `@@hasInstance` it uses the default `instanceof` semantics.

Deleted: Let *result* be
Deleted: the result of calling the `[[]`
Deleted: `]]` internal method of
Deleted:
Deleted: passing
Deleted: as *thisArgument* and a new List containing
Deleted: as *argumentsList*
Deleted: `<#>Return ToBoolean(result)`.¶
Deleted: , then throw

12.10 Equality Operators

NOTE The result of evaluating an equality operator is always of type Boolean, reflecting whether the relationship named by the operator holds between its two operands.

Syntax

*EqualityExpression*_[?In, ?Yield] :

```

RelationalExpression[?In, ?Yield]
EqualityExpression[?In, ?Yield] == RelationalExpression[?In, ?Yield]
EqualityExpression[?In, ?Yield] != RelationalExpression[?In, ?Yield]
EqualityExpression[?In, ?Yield] ==== RelationalExpression[?In, ?Yield]
EqualityExpression[?In, ?Yield] !== RelationalExpression[?In, ?Yield]

```

12.10.1 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, [12.2.9.2](#), 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, [14.1.12](#), 14.4.8, 14.5.8.

Deleted: 12.2.9.212.2.10.2
Deleted: 14.1.11

EqualityExpression :

```

EqualityExpression == RelationalExpression
EqualityExpression != RelationalExpression
EqualityExpression ==== RelationalExpression
EqualityExpression !== RelationalExpression

```

1. Return **false**.

12.10.2 Static Semantics: IsValidSimpleAssignmentTarget

See also: [12.1.3](#), 12.2.0.3, [12.2.9.3](#), 12.3.1.3, 12.4.3, 12.5.3, 12.6.2, 12.7.2, 12.8.2, 12.9.2, 12.11.2, 12.12.2, 12.13.2, 12.14.3, 12.15.2.

Deleted: 12.2.10.3

EqualityExpression :

```

EqualityExpression == RelationalExpression
EqualityExpression != RelationalExpression
EqualityExpression ==== RelationalExpression
EqualityExpression !== RelationalExpression

```

1. Return **false**.

12.10.3 Runtime Semantics: Evaluation

EqualityExpression : *EqualityExpression* $\equiv\equiv$ *RelationalExpression*

1. Let *lref* be the result of evaluating *EqualityExpression*.
2. Let *lval* be *GetValue(lref)*.
3. ReturnIfAbrupt(*lval*).
4. Let *rref* be the result of evaluating *RelationalExpression*.
5. Let *rval* be *GetValue(rref)*.
6. ReturnIfAbrupt(*rval*).
7. Return the result of performing Abstract Equality Comparison *rval* $\equiv\equiv$ *lval*.

Deleted: 1

EqualityExpression : *EqualityExpression* $\neq\neq$ *RelationalExpression*

1. Let *lref* be the result of evaluating *EqualityExpression*.
2. Let *lval* be *GetValue(lref)*.
3. ReturnIfAbrupt(*lval*).
4. Let *rref* be the result of evaluating *RelationalExpression*.
5. Let *rval* be *GetValue(rref)*.
6. ReturnIfAbrupt(*rval*).
7. Let *r* be the result of performing Abstract Equality Comparison *rval* $\equiv\equiv$ *lval*.
8. If *r* is **true**, return **false**. Otherwise, return **true**.

Deleted: 1

EqualityExpression : *EqualityExpression* $\equiv\equiv\equiv\equiv$ *RelationalExpression*

1. Let *lref* be the result of evaluating *EqualityExpression*.
2. Let *lval* be *GetValue(lref)*.
3. ReturnIfAbrupt(*lval*).
4. Let *rref* be the result of evaluating *RelationalExpression*.
5. Let *rval* be *GetValue(rref)*.
6. ReturnIfAbrupt(*rval*).
7. Return the result of performing Strict Equality Comparison *rval* $\equiv\equiv\equiv\equiv$ *lval*.

Deleted: 1

EqualityExpression : *EqualityExpression* $\neq\neq\neq\neq$ *RelationalExpression*

1. Let *lref* be the result of evaluating *EqualityExpression*.
2. Let *lval* be *GetValue(lref)*.
3. ReturnIfAbrupt(*lval*).
4. Let *rref* be the result of evaluating *RelationalExpression*.
5. Let *rval* be *GetValue(rref)*.
6. ReturnIfAbrupt(*rval*).
7. Let *r* be the result of performing Strict Equality Comparison *rval* $\equiv\equiv\equiv\equiv$ *lval*.
8. If *r* is **true**, return **false**. Otherwise, return **true**.

Deleted: 1

NOTE 1 Given the above definition of equality:

- String comparison can be forced by: `"" + a == "" + b`.
- Numeric comparison can be forced by: `+a == +b`.
- Boolean comparison can be forced by: `!a == !b`.

NOTE 2 The equality operators maintain the following invariants:

- `A != B` is equivalent to `!(A == B)`.
- `A == B` is equivalent to `B == A`, except in the order of evaluation of `A` and `B`.

NOTE 3 The equality operator is not always transitive. For example, there might be two distinct String objects, each representing the same String value; each String object would be considered equal to the String value by the `==` operator, but the two String objects would not be equal to each other. For Example:

- `new String("a") == "a"` and `"a" == new String("a")` are both true.
- `new String("a") == new String("a")` is false.

Deleted: 1

NOTE 4 Comparison of Strings uses a simple equality test on sequences of code unit values. There is no attempt to use the more complex, semantically oriented definitions of character or string equality and collating order defined in the Unicode specification. Therefore Strings values that are canonically equal according to the Unicode standard could test as unequal. In effect this algorithm assumes that both Strings are already in normalized form.

12.11 Binary Bitwise Operators

Syntax

*BitwiseANDExpression*_[?In, ?Yield] :

*EqualityExpression*_[?In, ?Yield]

*BitwiseANDExpression*_[?In, ?Yield] & *EqualityExpression*_[?In, ?Yield]

*BitwiseXORExpression*_[?In, ?Yield] :

*BitwiseANDExpression*_[?In, ?Yield]

*BitwiseXORExpression*_[?In, ?Yield] ^ *BitwiseANDExpression*_[?In, ?Yield]

*BitwiseORExpression*_[?In, ?Yield] :

*BitwiseXORExpression*_[?In, ?Yield]

*BitwiseORExpression*_[?In, ?Yield] | *BitwiseXORExpression*_[?In, ?Yield]

12.11.1 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, 12.2.9.2, 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, 14.1.12, 14.4.8, 14.5.8.

Deleted: 12.2.10.2

Deleted: 14.1.11

BitwiseANDExpression : *BitwiseANDExpression* & *EqualityExpression*

BitwiseXORExpression : *BitwiseXORExpression* ^ *BitwiseANDExpression*

BitwiseORExpression : *BitwiseORExpression* | *BitwiseXORExpression*

1. Return `false`.

12.11.2 Static Semantics: IsValidSimpleAssignmentTarget

See also: 12.1.3, 12.2.0.3, 12.2.9.3, 12.3.1.3, 12.4.3, 12.5.3, 12.6.2, 12.7.2, 12.8.2, 12.9.2, 12.10.2, 12.12.2, 12.13.2, 12.14.3, 12.15.2.

Deleted: 12.2.10.3

BitwiseANDExpression : *BitwiseANDExpression* & *EqualityExpression*

BitwiseXORExpression : *BitwiseXORExpression* ^ *BitwiseANDExpression*

BitwiseORExpression : *BitwiseORExpression* | *BitwiseXORExpression*

1. Return `false`.

12.11.3 Runtime Semantics: Evaluation

The production $A : A @ B$, where $@$ is one of the bitwise operators in the productions above, is evaluated as follows:

1. Let *lref* be the result of evaluating *A*.
2. Let *lval* be GetValue(*lref*).
3. ReturnIfAbrupt(*lval*).
4. Let *rref* be the result of evaluating *B*.
5. Let *rval* be GetValue(*rref*).
6. ReturnIfAbrupt(*rval*).
7. Let *lnum* beToInt32(*lval*).
8. ReturnIfAbrupt(*lnum*).
9. Let *rnum* beToInt32(*rval*).
10. ReturnIfAbrupt(*rnum*).
11. Return the result of applying the bitwise operator @ to *lnum* and *rnum*. The result is a signed 32 bit integer.

12.12 Binary Logical Operators

Syntax

*LogicalANDExpression*_[in, Yield] :

*BitwiseORExpression*_[?in, ?Yield]

*LogicalANDExpression*_[?in, ?Yield] && *BitwiseORExpression*_[?in, ?Yield]

*LogicalORExpression*_[in, Yield] :

*LogicalANDExpression*_[?in, ?Yield]

*LogicalORExpression*_[?in, ?Yield] || *LogicalANDExpression*_[?in, ?Yield]

NOTE The value produced by a && or || operator is not necessarily of type Boolean. The value produced will always be the value of one of the two operand expressions.

12.12.1 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, ~~12.2.9.2~~, 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.13.1, 12.14.2, 12.15.1, ~~14.1.12~~, 14.4.8, 14.5.8.

Deleted: 12.2.10.2

Deleted: 14.1.11

LogicalANDExpression : *LogicalANDExpression* && *BitwiseORExpression*
LogicalORExpression : *LogicalORExpression* || *LogicalANDExpression*

1. Return **false**.

12.12.2 Static Semantics: IsValidSimpleAssignmentTarget

See also: ~~12.1.3~~, 12.2.0.3, ~~12.2.9.3~~, 12.3.1.3, 12.4.3, 12.5.3, 12.6.2, 12.7.2, 12.8.2, 12.9.2, 12.10.2, 12.11.2, 12.13.2, 12.14.3, 12.15.2.

Deleted: 12.2.10.3

LogicalANDExpression : *LogicalANDExpression* && *BitwiseORExpression*
LogicalORExpression : *LogicalORExpression* || *LogicalANDExpression*

1. Return **false**.

12.12.3 Runtime Semantics: Evaluation

LogicalANDExpression : *LogicalANDExpression* && *BitwiseORExpression*

Deleted: ¶

1. Let *lref* be the result of evaluating *LogicalANDExpression*.

2. Let *lval* be GetValue(*lref*).
3. Let *lbool* be ToBoolean(*lval*).
4. ReturnIfAbrupt(*lbool*).
5. If *lbool* is **false**, return *lval*.
6. Let *rref* be the result of evaluating *BitwiseORExpression*.
7. Return GetValue(*rref*).

LogicalORExpression : *LogicalORExpression* || *LogicalANDExpression*

Deleted: ¶

1. Let *lref* be the result of evaluating *LogicalORExpression*.
2. Let *lval* be GetValue(*lref*).
3. Let *lbool* be ToBoolean(*lval*).
4. ReturnIfAbrupt(*lbool*).
5. If *lbool* is **true**, return *lval*.
6. Let *rref* be the result of evaluating *LogicalANDExpression*.
7. Return GetValue(*rref*).

12.13 Conditional Operator (?:)

Syntax

*ConditionalExpression*_[In, Yield] :
*LogicalORExpression*_[?In, ?Yield]
*LogicalORExpression*_[?In, ?Yield] ? *AssignmentExpression*_[In, ?Yield] : *AssignmentExpression*_[?In, ?Yield]

NOTE The grammar for a *ConditionalExpression* in ECMAScript is slightly different from that in C and Java, which each allow the second subexpression to be an *Expression* but restrict the third expression to be a *ConditionalExpression*. The motivation for this difference in ECMAScript is to allow an assignment expression to be governed by either arm of a conditional and to eliminate the confusing and fairly useless case of a comma expression as the centre expression.

12.13.1 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, ~~12.2.9.2~~, 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.14.2, 12.15.1, ~~14.1.12~~, 14.4.8, 14.5.8.

Deleted: 12.2.10.2

Deleted: 14.1.11

ConditionalExpression : *LogicalORExpression* ? *AssignmentExpression* : *AssignmentExpression*

1. Return **false**.

12.13.2 Static Semantics: IsValidSimpleAssignmentTarget

See also: ~~12.1.3~~, 12.2.0.3, ~~12.2.9.3~~, 12.3.1.3, 12.4.3, 12.5.3, 12.6.2, 12.7.2, 12.8.2, 12.9.2, 12.10.2, 12.11.2, 12.12.2, 12.14.3, 12.15.2.

Deleted: 12.2.10.3

ConditionalExpression : *LogicalORExpression* ? *AssignmentExpression* : *AssignmentExpression*

1. Return **false**.

12.13.3 Runtime Semantics: Evaluation

ConditionalExpression : *LogicalORExpression* ? *AssignmentExpression* : *AssignmentExpression*

1. Let *lref* be the result of evaluating *LogicalORExpression*.

2. Let *lval* be ToBoolean(GetValue(*lref*)).
3. ReturnIfAbrupt(*lval*).
4. If *lval* is **true**, then
 - a. Let *trueRef* be the result of evaluating the first *AssignmentExpression*.
 - b. Return GetValue(*trueRef*).
5. Else
 - a. Let *falseRef* be the result of evaluating the second *AssignmentExpression*.
 - b. Return GetValue(*falseRef*).

12.14 Assignment Operators

Syntax

*AssignmentExpression*_[?In, ?Yield] :
 *ConditionalExpression*_[?In, ?Yield]
 [+Yield] *YieldExpression*_[?In]
 *ArrowFunction*_[?In, ?Yield]
 *LeftHandSideExpression*_[?Yield] = *AssignmentExpression*_[?In, ?Yield]
 *LeftHandSideExpression*_[?Yield] *AssignmentOperator* *AssignmentExpression*_[?In, ?Yield]

AssignmentOperator : one of
 *= /= %= += -= <<= >>= >>>= &= ^= |=

12.14.1 Static Semantics: Early Errors

AssignmentExpression : *LeftHandSideExpression* = *AssignmentExpression*

Deleted: ¶

- It is a Syntax Error if *LeftHandSideExpression* is either an *ObjectLiteral* or an *ArrayLiteral* and the lexical token sequence matched by *LeftHandSideExpression* cannot be parsed with no tokens left over using *AssignmentPattern* as the goal symbol.
- It is an early Reference Error if *LeftHandSideExpression* is neither an *ObjectLiteral* nor an *ArrayLiteral* and *IsValidSimpleAssignmentTarget* of *LeftHandSideExpression* is **false**.

AssignmentExpression : *LeftHandSideExpression* *AssignmentOperator* *AssignmentExpression*

- It is an early Reference Error if *IsValidSimpleAssignmentTarget* of *LeftHandSideExpression* is **false**.

12.14.2 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, 12.2.9.2, 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.15.1, 14.1.12, 14.4.8, 14.5.8.

AssignmentExpression : *ArrowFunction*

1. Return **true**.

AssignmentExpression :
 YieldExpression
 LeftHandSideExpression = *AssignmentExpression*
 LeftHandSideExpression *AssignmentOperator* *AssignmentExpression*

1. Return **false**.

Deleted: <#>If *LeftHandSideExpression* is either an *ObjectLiteral* or an *ArrayLiteral* and if the lexical token sequence matched by *LeftHandSideExpression* can be parsed with no tokens left over using *AssignmentPattern* as the goal symbol then the following rules are not applied. Instead, the Early Error rules for *AssignmentPattern* are used.¶

Deleted: <#>It is a Syntax Error if *LeftHandSideExpression* is an *IdentifierReference* that can be statically determined to always resolve to a declarative environment record binding and the resolved binding is an immutable binding.¶

Deleted: ¶

Deleted: <#>It is a Syntax Error if the *LeftHandSideExpression* is an *IdentifierReference* that can be statically determined to always resolve to a declarative environment record binding and the resolved binding is an immutable binding.¶

Deleted: 12.2.10.2

Deleted: 14.1.11

12.14.3 Static Semantics: IsValidSimpleAssignmentTarget

See also: [12.1.3](#), [12.2.0.3](#), [12.2.9.3](#), [12.3.1.3](#), [12.4.3](#), [12.5.3](#), [12.6.2](#), [12.7.2](#), [12.8.2](#), [12.9.2](#), [12.10.2](#), [12.11.2](#), [12.12.2](#), [12.13.2](#), [12.15.2](#).

Deleted: 12.2.10.3

AssignmentExpression :

YieldExpression

ArrowFunction

LeftHandSideExpression = AssignmentExpression

LeftHandSideExpression AssignmentOperator AssignmentExpression

1. Return **false**.

12.14.4 Runtime Semantics: Evaluation

AssignmentExpression_[In, Yield] : LeftHandSideExpression_[?Yield] = AssignmentExpression_[?In, ?Yield]

Deleted: ¶

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1. If *LeftHandSideExpression* is neither an *ObjectLiteral* nor an *ArrayLiteral*, then
 - a. Let *lref* be the result of evaluating *LeftHandSideExpression*.
 - b. ReturnIfAbrupt(*lref*).
 - c. Let *rref* be the result of evaluating *AssignmentExpression*.
 - d. Let *rval* be GetValue(*rref*).
 - e. If *IsAnonymousFunctionDefinition(AssignmentExpression)* and *IsIdentifierRef* of *LeftHandSideExpression* are **both true**, then
 - i. Let *hasNameProperty* be HasOwnProperty(*rval*, "name").
 - ii. ReturnIfAbrupt(*hasNameProperty*).
 - iii. If *hasNameProperty* is **false**, *perform SetFunctionName(rval, GetReferenceName(lref))*.
 - f. Let *status* be PutValue(*lref*, *rval*).
 - g. ReturnIfAbrupt(*status*).
 - h. Return *rval*.
2. Let *assignmentPattern* be the parse of the source code corresponding to *LeftHandSideExpression* using *AssignmentPattern_[?Yield]* as the goal symbol.
3. Let *rref* be the result of evaluating *AssignmentExpression*.
4. Let *rval* be GetValue(*rref*).
5. ReturnIfAbrupt(*rval*).
6. Let *status* be the result of performing *DestructuringAssignmentEvaluation* of *assignmentPattern* using *rval* as the argument.
7. ReturnIfAbrupt(*status*).
8. Return *rval*.

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Assert: SetFunctionName will not return an abrupt completion.

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Deleted: <#>If Type(*rval*) is not Object, then throw a *TypeError* exception.¶

Deleted: AssignmentPattern

AssignmentExpression : LeftHandSideExpression AssignmentOperator AssignmentExpression

1. Let *lref* be the result of evaluating *LeftHandSideExpression*.
2. Let *lval* be GetValue(*lref*).
3. ReturnIfAbrupt(*lval*).
4. Let *rref* be the result of evaluating *AssignmentExpression*.
5. Let *rval* be GetValue(*rref*).
6. ReturnIfAbrupt(*rval*).
7. Let *op* be the @ where *AssignmentOperator* is @=
8. Let *r* be the result of applying *op* to *lval* and *rval* as if evaluating the expression *lval op rval*.
9. Let *status* be PutValue(*lref*, *r*).
10. ReturnIfAbrupt(*status*).
11. Return *r*.

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NOTE When an assignment occurs within strict mode code, it is a runtime error if *lref* in step 1.f.of the first algorithm or step 9 of the second algorithm is an unresolvable reference. If it is, a **ReferenceError** exception is thrown. The *LeftHandSide* also may not be a reference to a data property with the attribute value `{[[Writable]]:false}`, to an accessor property with the attribute value `{[[Set]]:undefined}`, nor to a non-existent property of an object for which the `IsExtensible` predicate returns the value `false`. In these cases a **TypeError** exception is thrown.

12.14.5 Destructuring Assignment

Supplemental Syntax

In certain circumstances when processing the production *AssignmentExpression* : *LeftHandSideExpression* = *AssignmentExpression* the following grammar is used to refine the interpretation of *LeftHandSideExpression*.

```

AssignmentPattern[Yield] :
  ObjectAssignmentPattern[?Yield]
  ArrayAssignmentPattern[?Yield]

ObjectAssignmentPattern[Yield] :
  { }
  { AssignmentPropertyList[?Yield] }
  { AssignmentPropertyList[?Yield] , }

ArrayAssignmentPattern[Yield] :
  [ Elisionopt AssignmentRestElement[?Yield]opt ]
  [ AssignmentElementList[?Yield] ]
  [ AssignmentElementList[?Yield] , Elisionopt AssignmentRestElement[?Yield]opt ]

AssignmentPropertyList[Yield] :
  AssignmentProperty[?Yield]
  AssignmentPropertyList[?Yield] , AssignmentProperty[?Yield]

AssignmentElementList[Yield] :
  AssignmentElisionElement[?Yield]
  AssignmentElementList[?Yield] , AssignmentElisionElement[?Yield]

AssignmentElisionElement[Yield] :
  Elisionopt AssignmentElement[?Yield]

AssignmentProperty[Yield] :
  IdentifierReference[?Yield] Initializer[In,?Yield]opt
  PropertyName : AssignmentElement[?Yield]

AssignmentElement[Yield] :
  DestructuringAssignmentTarget[?Yield] Initializer[In,?Yield]opt

AssignmentRestElement[Yield] :
  ... DestructuringAssignmentTarget[?Yield]

DestructuringAssignmentTarget[Yield] :
  LeftHandSideExpression[?Yield]

```

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12.14.5.1 Static Semantics: Early Errors

AssignmentProperty : *IdentifierReference* *Initializer*_{opt}

- It is a Syntax Error if *IsValidSimpleAssignment* of *IdentifierReference* is false.

DestructuringAssignmentTarget : *LeftHandSideExpression*

- It is a Syntax Error if *LeftHandSideExpression* is either an *ObjectLiteral* or an *ArrayLiteral* and if the lexical token sequence matched by *LeftHandSideExpression* cannot be parsed with no tokens left over using *AssignmentPattern* as the goal symbol.
- It is a Syntax Error if *LeftHandSideExpression* is neither an *ObjectLiteral* nor an *ArrayLiteral* and *IsValidSimpleAssignmentTarget*(*LeftHandSideExpression*) is false.

12.14.5.2 Runtime Semantics: DestructuringAssignmentEvaluation

with parameter *value*

ObjectAssignmentPattern : { }

1. Let *valid* be *RequireObjectCoercible*(*value*).
2. ReturnIfAbrupt(*valid*).
3. Return NormalCompletion(empty).

ArrayAssignmentPattern : []

1. Let *iterator* be *GetIterator*(*value*).
2. ReturnIfAbrupt(*iterator*).
3. Return *IteratorClose*(*iterator*, NormalCompletion(empty)).

ArrayAssignmentPattern : [*Elision*]

1. Let *iterator* be *GetIterator*(*value*).
2. ReturnIfAbrupt(*iterator*).
3. Let *result* be the result of performing *IteratorDestructuringAssignmentEvaluation* of *Elision* with *iterator* as the argument.
4. Return *IteratorClose*(*iterator*, *result*).

ArrayAssignmentPattern : [*Elision*_{opt} *AssignmentRestElement*]

1. Let *iterator* be *GetIterator*(*value*).
2. ReturnIfAbrupt(*iterator*).
3. If *Elision* is present, then
 - a. Let *status* be the result of performing *IteratorDestructuringAssignmentEvaluation* of *Elision* with *iterator* as the argument.
 - b. If *status* is an abrupt completion, return *IteratorClose*(*iterator*, *status*).
4. Let *result* be the result of performing *IteratorDestructuringAssignmentEvaluation* of *AssignmentRestElement* with *iterator* as the argument.
5. Return *IteratorClose*(*iterator*, *result*).

ArrayAssignmentPattern : [*AssignmentElementList*]

1. Let *iterator* be *GetIterator*(*value*).
2. ReturnIfAbrupt(*iterator*).
3. Let *result* be the result of performing *IteratorDestructuringAssignmentEvaluation* of *AssignmentElementList* using *iterator* as the argument.

Deleted: <#>It is a Syntax Error if *IdentifierReference* statically resolves to a immutable binding.¶

Deleted: *AssignmentRestElement* : . . .

DestructuringAssignmentTarget¶
 <#>It is a Syntax Error if *IsValidSimpleAssignmentTarget* of *DestructuringAssignmentTarget* is false.¶

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Deleted: <#>It is a Syntax Error if *LeftHandSideExpression* is an *IdentifierReference* that can be statically determined to always resolve to a declarative environment record binding and the resolved binding is an immutable binding.¶

Deleted: <#>It is a Syntax Error if *LeftHandSideExpression* is *CoverParenthesizedExpressionAndArrowParameterList* : (*Expression*) and *Expression* derives a production that would produce a Syntax Error according to these rules if that production is substituted for *LeftHandSideExpression*. This rule is recursively applied.¶
 NOTE . The last rule means that the other rules are applied even if multiple levels of nested parenthesizes parentheses surround *Expression*.¶

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Deleted: Return

Deleted: *obj*

Deleted: *ReturnIfAbrupt*(*status*)

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Deleted: *obj*

Deleted: Return

4. [Return IteratorClose\(iterator, result\)](#)

ArrayAssignmentPattern : [*AssignmentElementList* , *Elision_{opt}* *AssignmentRestElement_{opt}*]

1. Let *iterator* be GetIterator([value](#)).
2. ReturnIfAbrupt(*iterator*).
3. Let *status* be the result of performing IteratorDestructuringAssignmentEvaluation of *AssignmentElementList* using *iterator* as the argument.
4. If *status* is an abrupt completion, return IteratorClose(*iterator*, *status*).
5. If *Elision* is present, then
 - a. Let *status* be the result of performing IteratorDestructuringAssignmentEvaluation of *Elision* with *iterator* as the argument.
 - b. If *status* is an abrupt completion, return IteratorClose(*iterator*, *status*).
6. If *AssignmentRestElement* is present, then
 - a. Let *status* be the result of performing IteratorDestructuringAssignmentEvaluation of *AssignmentRestElement* with *iterator* as the argument.
7. Return IteratorClose(*iterator*, *status*).

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Deleted: ReturnIfAbrupt(*status*)

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Deleted: return *status*.

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Deleted: <#>Return *lastIndex*.¶

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AssignmentPropertyList : *AssignmentPropertyList* , *AssignmentProperty*

1. Let *status* be the result of performing DestructuringAssignmentEvaluation for *AssignmentPropertyList* using [value](#) as the argument.
2. ReturnIfAbrupt(*status*).
3. Return the result of performing DestructuringAssignmentEvaluation for *AssignmentProperty* using [value](#) as the argument.

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Deleted: <#>Return *lastIndex*.¶

Deleted: *obj*

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Deleted: <#>Return *lastIndex*.¶

Deleted: *obj*

Deleted: ¶

AssignmentProperty : *IdentifierReference* *Initializer_{opt}*

1. Let *P* be StringValue of *IdentifierReference*.
2. Let *lref* be ResolveBinding(*P*).
3. ReturnIfAbrupt(*P*).
4. Let *v* be GetV([value](#), *P*).
5. ReturnIfAbrupt(*v*).
6. If *Initializer_{opt}* is present and *v* is **undefined**, then
 - a. Let *defaultValue* be the result of evaluating *Initializer*.
 - b. Let *v* be GetValue(*defaultValue*).
 - c. ReturnIfAbrupt(*v*).
- d. If IsAnonymousFunctionDefinition(*Initializer*) is true, then
 - i. Let *hasNameProperty* be HasOwnProperty(*v*, "name").
 - ii. ReturnIfAbrupt(*hasNameProperty*).
 - iii. If *hasNameProperty* is false, perform SetFunctionName(*v*, *P*).

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Deleted: <#>Assert: SetFunctionName will not return an abrupt completion..¶

Deleted: <#>Let *lref* be ResolveBinding(*P*).¶

Deleted: *obj*

AssignmentProperty : *PropertyName* : *AssignmentElement*

1. Let *name* be the result of evaluating *PropertyName*.
2. ReturnIfAbrupt(*name*).
3. Return the result of performing KeyedDestructuringAssignmentEvaluation of *AssignmentElement* with [value](#) and *name* as the arguments.

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12.14.5.3 Runtime Semantics: IteratorDestructuringAssignmentEvaluation

with parameters *iterator*

Deleted: ¶

AssignmentElementList : *AssignmentElisionElement*

1. Return the result of performing IteratorDestructuringAssignmentEvaluation of *AssignmentElisionElement* using *iterator* as the argument.

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AssignmentElementList : *AssignmentElementList* , *AssignmentElisionElement*

1. Let *status* be the result of performing IteratorDestructuringAssignmentEvaluation of *AssignmentElementList* using *iterator* as the argument.
2. ReturnIfAbrupt(*status*).
3. Return the result of performing IteratorDestructuringAssignmentEvaluation of *AssignmentElisionElement* using *iterator* as the argument.

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AssignmentElisionElement : *AssignmentElement*

1. Return the result of performing IteratorDestructuringAssignmentEvaluation of *AssignmentElement* with *iterator* as the argument.

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AssignmentElisionElement : *Elision AssignmentElement*

1. Let *status* be the result of performing IteratorDestructuringAssignmentEvaluation of *Elision* with *iterator* as the argument.
2. ReturnIfAbrupt(*status*).
3. Return the result of performing IteratorDestructuringAssignmentEvaluation of *AssignmentElement* with *iterator* as the argument.

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Elision :

1. Return IteratorStep(*iterator*).

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Elision : *Elision* ,

1. Let *status* be the result of performing IteratorDestructuringAssignmentEvaluation of *Elision* with *iterator* as the argument.
2. ReturnIfAbrupt(*status*).
3. Return IteratorStep(*iterator*).

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*AssignmentElement*_[yield] : *DestructuringAssignmentTarget Initializer*_{opt}

1. If *DestructuringAssignmentTarget* is neither an *ObjectLiteral* nor an *ArrayLiteral*, then
 - a. Let *lref* be the result of evaluating *DestructuringAssignmentTarget*.
 - b. ReturnIfAbrupt(*lref*).
2. Let *next* be IteratorStep(*iterator*).
3. ReturnIfAbrupt(*next*).
4. If *next* is *false*, let *value* be *undefined*,
5. Else
 - a. Let *value* be IteratorValue(*next*).
 - b. ReturnIfAbrupt(*value*).
6. If *Initializer* is present and *value* is *undefined*, then
 - a. Let *defaultValue* be the result of evaluating *Initializer*.
 - b. Let *v* be GetValue(*defaultValue*)
 - c. ReturnIfAbrupt(*v*).
7. Else, let *v* be *value*.
8. If *DestructuringAssignmentTarget* is an *ObjectLiteral* or an *ArrayLiteral*, then

Deleted: , then let

Deleted: *v*

Deleted: ¶

Deleted: *v*

Deleted: *v*

Deleted: *v*

- a. Let *nestedAssignmentPattern* be the parse of the source code corresponding to *DestructuringAssignmentTarget* using either *AssignmentPattern* or *AssignmentPattern_[Yield]* as the goal symbol depending upon whether this *AssignmentElement* has the *Yield* parameter.
 - b. Return the result of performing *DestructuringAssignmentEvaluation* of *nestedAssignmentPattern* with *v* as the argument.
9. If *Initializer* is present and *value* is *undefined* and *IsAnonymousFunctionDefinition(Initializer)* and *IsIdentifierRef of DestructuringAssignmentTarget* are both *true*, then
- a. Let *hasNameProperty* be *HasOwnProperty(v, "name")*.
 - b. *ReturnIfAbrupt(hasNameProperty)*.
 - c. If *hasNameProperty* is *false*, perform *SetFunctionName(v, GetReferencedName(lref))*.
10. *Return PutValue(lref, v)*.

NOTE Left to right evaluation order is maintained by evaluating a *DestructuringAssignmentTarget* that is not a *destructuring pattern* prior to accessing the iterator or evaluating the *Initializer*.

AssignmentRestElement_[Yield] : . . . *DestructuringAssignmentTarget*

1. If *DestructuringAssignmentTarget* is neither an *ObjectLiteral* nor an *ArrayLiteral*, then
 - a. Let *lref* be the result of evaluating *DestructuringAssignmentTarget*.
 - b. *ReturnIfAbrupt(lref)*.
2. Let *A* be *ArrayCreate(0)*.
3. Let *n=0*;
4. Let *accumulationFinished* be *false*.
5. Repeat until *accumulationFinished* is *true*.
 - a. Let *next* be *IteratorStep(iterator)*.
 - b. *ReturnIfAbrupt(next)*.
 - c. If *next* is *false*, then
 - i. Let *accumulationFinished* be *true*.
 - d. else,
 - i. Let *nextValue* be *IteratorValue(next)*.
 - ii. *ReturnIfAbrupt(nextValue)*.
 - iii. Let *status* be *CreateDataProperty(A, ToString(ToUint32(n)), nextValue)*.
 - iv. Assert: *status* is *true*.
 - v. Increment *n* by 1.
6. If *DestructuringAssignmentTarget* is neither an *ObjectLiteral* nor an *ArrayLiteral*, then
 - a. *Return PutValue(lref, A)*.
7. Let *nestedAssignmentPattern* be the parse of the source code corresponding to *DestructuringAssignmentTarget* using either *AssignmentPattern* or *AssignmentPattern_[Yield]* as the goal symbol depending upon whether this *AssignmentElement* has the *Yield* parameter.
8. Return the result of performing *DestructuringAssignmentEvaluation* of *nestedAssignmentPattern* with *A* as the argument.

12.14.5.4 Runtime Semantics: KeyedDestructuringAssignmentEvaluation

with parameters *value* and *propertyName*

AssignmentElement_[Yield] : *DestructuringAssignmentTarget* *Initializer_{opt}*

1. If *DestructuringAssignmentTarget* is neither an *ObjectLiteral* nor an *ArrayLiteral*, then
 - a. Let *lref* be the result of evaluating *DestructuringAssignmentTarget*.
 - b. *ReturnIfAbrupt(lref)*.
2. Let *v* be *GetV(value, propertyName)*.
3. *ReturnIfAbrupt(v)*.

Deleted: <#>If *Type(v)* is not *Object*, then throw a *TypeError* exception. Let *v* be *ToObject(v)*. ¶ <#>*ReturnIfAbrupt(v)*. ¶

Deleted: then

Deleted: ¶

Deleted: <#>Assert: *SetFunctionName* will not return an abrupt completion. ¶

Deleted:

Deleted: <#>If *DestructuringAssignmentTarget* is neither an *ObjectLiteral* nor an *ArrayLiteral* then ¶ <#>Let *lref* be the result of evaluating *DestructuringAssignmentTarget*. ¶ <#>*ReturnIfAbrupt(lref)*. ¶

Deleted: *Return PutValue(lref, A)*

Deleted: *ammumumulationFinished*

Comment [AW13]: Note that indices wrap. For example consider:

[..... . . . { 4294967293: "x", length: Math.pow(2,32)-2}]

Deleted: *defineStatus*

Deleted: *OrThrow*

Deleted: *ReturnIfAbrupt(defineStatus)*

Deleted: <#>Let *lref* be the result of evaluating *DestructuringAssignmentTarget*. ¶ <#>*ReturnIfAbrupt(lref)*. ¶

Deleted: <#>If *DestructuringAssignmentTarget* is an *ObjectLiteral* or an *ArrayLiteral* then ¶ <#>Let *nestedAssignmentPattern* be the parse of the source code corresponding to *DestructuringAssignmentTarget* using either *AssignmentPattern* or *AssignmentPattern_[Yield]* as the goal symbol depending upon whether this *AssignmentRestElement* has the *Yield* parameter. ¶ <#>Return the result of performing *DestructuringAssignmentEvaluation* of *nestedAssignmentPattern* with *A* as the argument. ¶

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Deleted: *obj*

Deleted: *name*

4. If *Initializer* is present and *v* is **undefined**, then
 - a. Let *defaultValue* be the result of evaluating *Initializer*.
 - b. Let *rhsValue* be *GetValue(defaultValue)*
 - c. ReturnIfAbrupt(*rhsValue*).
5. Else, let *rhsValue* be *v*.
6. If *DestructuringAssignmentTarget* is an *ObjectLiteral* or an *ArrayLiteral*, then
 - a. Let *AssignmentPattern* be the parse of the source code corresponding to *DestructuringAssignmentTarget* using either *AssignmentPattern* or *AssignmentPattern[Yield]* as the goal symbol depending upon whether this *AssignmentElement* has the *Yield* parameter.
 - b. Return the result of performing *DestructuringAssignmentEvaluation* of *AssignmentPattern* with *rhsValue* as the argument.
7. If *Initializer* is present and *v* is **undefined** and *IsAnonymousFunctionDefinition(Initializer)* and *IsIdentifierRef* of *DestructuringAssignmentTarget* are both **true**, then
 - a. Let *hasNameProperty* be *HasOwnProperty(rhsValue, "name")*.
 - b. ReturnIfAbrupt(*hasNameProperty*).
 - c. If *hasNameProperty* is **false**, perform *SetFunctionName(rhsValue, GetReferencedName(lref))*.
8. Return *PutValue(lref, rhsValue)*.

12.15 Comma Operator (,)

Syntax

*Expression*_[In, Yield] :

 *AssignmentExpression*_[?In, ?Yield]

*Expression*_[?In, ?Yield] , *AssignmentExpression*_[?In, ?Yield]

12.15.1 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, 12.2.9.2, 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 14.1.12, 14.4.8, 14.5.8.

Expression : *Expression* , *AssignmentExpression*

1. Return **false**.

12.15.2 Static Semantics: IsValidSimpleAssignmentTarget

See also: 12.1.3, 12.2.0.3, 12.2.9.3, 12.3.1.3, 12.4.3, 12.5.3, 12.6.2, 12.7.2, 12.8.2, 12.9.2, 12.10.2, 12.11.2, 12.12.2, 12.13.2, 12.14.3.

Expression : *Expression* , *AssignmentExpression*

1. Return **false**.

12.15.3 Runtime Semantics: Evaluation

Expression : *Expression* , *AssignmentExpression*

1. Let *lref* be the result of evaluating *Expression*.
2. ReturnIfAbrupt(*GetValue(lref)*)
3. Let *rref* be the result of evaluating *AssignmentExpression*.
4. Return *GetValue(rref)*.

NOTE *GetValue* must be called even though its value is not used because it may have observable side-effects.

Deleted: *v*

Deleted: *v*

Deleted: <#> If *Type(v)* is not *Object*, then throw a *TypeError* exceptionLet *v* be *ToObject(v)*.
<#>ReturnIfAbrupt(*v*).
¶

Deleted: *v*

Deleted: <#>Let *lref* be the result of evaluating *DestructuringAssignmentTarget*.
¶

Deleted: *v*

Deleted: *then*

Deleted: ¶

Deleted: <#>Assert: *SetFunctionName* will not return an abrupt completion.
¶

Deleted: *v*

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Deleted: 14.1.11

Deleted: 12.2.10.3

Deleted: ¶

13 ECMAScript Language: Statements and Declarations

Syntax

Deleted: ¶

Statement[?Yield, ?Return] :

- BlockStatement*[?Yield, ?Return]
- VariableStatement*[?Yield]
- EmptyStatement*
- ExpressionStatement*[?Yield]
- IfStatement*[?Yield, ?Return]
- BreakableStatement*[?Yield, ?Return]
- ContinueStatement*[?Yield]
- BreakStatement*[?Yield]
- [+Return] *ReturnStatement*[?Yield]
- WithStatement*[?Yield, ?Return]
- LabelledStatement*[?Yield, ?Return]
- ThrowStatement*[?Yield]
- TryStatement*[?Yield, ?Return]
- DebuggerStatement*

Declaration[?Yield] :

HoistableDeclaration[?Yield]

- ClassDeclaration*[?Yield]
- LexicalDeclaration*[In, ?Yield]

Deleted: , Default

Deleted: *FunctionDeclaration*[?Yield, ?Default]
Generator

Deleted: *Declaration*

Deleted: , ?Default

Deleted: , ?Default

BreakableStatement[?Yield, ?Return] :

IterationStatement[?Yield, ?Return]

SwitchStatement[?Yield, ?Return]

13.0 Statement Semantics

13.0.1 Static Semantics: ContainsDuplicateLabels

With argument *labelSet*.

See also: 13.1.2, 13.5.2, 13.6.1.1, 13.6.2.1, 13.6.3.2, 13.6.4.3, 13.10.2, 13.11.2, 13.12.2, 13.14.2,
15.2.1.2.

Statement :

VariableStatement
EmptyStatement
ExpressionStatement
ContinueStatement
BreakStatement
ReturnStatement
ThrowStatement
DebuggerStatement

1. Return false.

13.0.2 Static Semantics: ContainsUndefinedBreakTarget

With argument *labelSet*.

See also: 13.1.3, 13.5.3, 13.6.1.2, 13.6.2.2, 13.6.3.3, 13.6.4.4, 13.8.2, 13.10.3, 13.11.3, 13.12.3, 13.14.3, 15.2.1.3.

Statement :

VariableStatement
EmptyStatement
ExpressionStatement
ContinueStatement
ReturnStatement
ThrowStatement
DebuggerStatement

1. Return **false**.

13.0.3 Static Semantics: ContainsUndefinedContinueTarget

With arguments *iterationSet* and *labelSet*.

See also: 13.1.4, 13.5.4, 13.6.1.3, 13.6.2.3, 13.6.3.4, 13.6.4.5, 13.7.2, 13.10.4, 13.11.4, 13.12.4, 13.14.4, 15.2.1.4.

Statement :

VariableStatement
EmptyStatement
ExpressionStatement
BreakStatement
ReturnStatement
ThrowStatement
DebuggerStatement

1. Return **false**.

BreakableStatement : IterationStatement

1. Let *newIterationSet* be a copy of *iterationSet* with all the elements of *labelSet* appended.
2. Return ContainsUndefinedContinueTarget of *IterationStatementList* with arguments *newIterationSet* and « ».

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13.0.4 Static Semantics: DeclarationPart

HoistableDeclaration : FunctionDeclaration

1. Return *FunctionDeclaration*.

Deleted: ¶

Deleted: .

Deleted: ¶

HoistableDeclaration : GeneratorDeclaration

1. Return *GeneratorDeclaration*.

Deleted: ¶

Declaration : ClassDeclaration

1. Return *ClassDeclaration*.

Deleted: ¶

Declaration : LexicalDeclaration

1. Return *LexicalDeclaration*.

Deleted: ¶

13.0.5 Static Semantics: VarDeclaredNames

See also: [13.1.11](#), [13.2.2.2](#), [13.5.5](#), [13.6.1.4](#), [13.6.2.4](#), [13.6.3.5](#), [13.6.4.7](#), [13.10.5](#), [13.11.7](#), [13.12.12](#), [13.14.5](#), 14.1.18, 14.2.13, 15.1.5, 15.2.1.13.

Statement :

EmptyStatement
ExpressionStatement
ContinueStatement
BreakStatement
ReturnStatement
ThrowStatement
DebuggerStatement

1. Return a new empty List.

Deleted: 13.1.8

Deleted: 13.5.2

Deleted: 13.6.1.1

Deleted: 13.6.2.1,

Deleted: 13.6.3.2

Deleted: 13.6.4.3

Deleted: 13.10.2

Deleted: 13.11.4

Deleted: 13.12.10

Deleted: 13.14.2

13.0.6 Static Semantics: VarScopedDeclarations

See also: [13.1.12](#), [13.2.2.3](#), [13.5.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.6.4.8](#), [13.10.6](#), [13.11.8](#), [13.12.13](#), [13.14.6](#), 14.1.19, 14.2.14, 15.1.6, [15.2.1.14](#).

Statement :

EmptyStatement
ExpressionStatement
ContinueStatement
BreakStatement
ReturnStatement
ThrowStatement
DebuggerStatement

1. Return a new empty List.

Deleted: 13.1.11

Deleted: 13.5.3

Deleted: 13.6.1.2

Deleted: 13.6.2.2

Deleted: 13.6.3.3

Deleted: 13.6.4.4

Deleted: 13.10.3

Deleted: 13.11.5

Deleted: 13.12.11

Deleted: 13.14.3

Deleted: 15.2.1.1315.2.1.14

13.0.7 Runtime Semantics: LabelledEvaluation

With argument *labelSet*.

See also: [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.6.4.11](#), [13.12.14](#).

BreakableStatement : IterationStatement

1. Let *stmtResult* be the result of performing *LabelledEvaluation* of *IterationStatement* with argument *labelSet*.
2. If *stmtResult*.[[type]] is **break** and *stmtResult*.[[target]] is empty, then
 - a. If *stmtResult*.[[value]] is empty, let *stmtResult* be *NormalCompletion*(**undefined**).
 - b. Else, let *stmtResult* be *NormalCompletion*(*stmtResult*.[[value]])
3. Return *stmtResult*.

Deleted: 13.6.1.2

Deleted: 13.6.2.2

Deleted: ¶

Deleted: , then let

BreakableStatement : SwitchStatement

1. Let *stmtResult* be the result of evaluating *SwitchStatement*.
2. If *stmtResult*.[[type]] is **break** and *stmtResult*.[[target]] is empty, then

- a. If *stmtResult*.[[value]] is empty, let *stmtResult* be NormalCompletion(**undefined**).
 b. Else, let *stmtResult* be NormalCompletion(*stmtResult*.[[value]])
 3. Return *stmtResult*.

NOTE A *BreakableStatement* is one that can be exited via an unlabelled *BreakStatement*.

13.0.8 Runtime Semantics: Evaluation

HoistableDeclaration :
FunctionDeclaration
GeneratorDeclaration
 1. Return NormalCompletion(empty).

BreakableStatement :
IterationStatement
SwitchStatement

1. Let *newLabelSet* be a new empty List.
 2. Return the result of performing LabelledEvaluation of this *BreakableStatement* with argument *newLabelSet*.

13.1 Block

Syntax

BlockStatement[?Yield, ?Return] :
Block[?Yield, ?Return]

Block[?Yield, ?Return] :
 { *StatementList*[?Yield, ?Return]opt }

StatementList[?Yield, ?Return] :
StatementListItem[?Yield, ?Return]
StatementList[?Yield, ?Return] *StatementListItem*[?Yield, ?Return]

StatementListItem[?Yield, ?Return] :
Statement[?Yield, ?Return]
Declaration[?Yield]

13.1.1 Static Semantics: Early Errors

Block : { *StatementList* } ▾

- It is a Syntax Error if the LexicallyDeclaredNames of *StatementList* contains any duplicate entries.
- It is a Syntax Error if any element of the LexicallyDeclaredNames of *StatementList* also occurs in the VarDeclaredNames of *StatementList*.

13.1.2 Static Semantics: ContainsDuplicateLabels

With argument *labelSet*.

See also: 13.0.1, 13.5.2, 13.6.1.1, 13.6.2.1, 13.6.3.2, 13.6.4.3, 13.10.2, 13.11.2, 13.12.2, 13.14.2, 15.2.1.2.

Block : { }

1. Return false.

Deleted: ¶

StatementList : StatementList StatementListItem

1. Let *hasDuplicates* be ContainsDuplicateLabels of *StatementList* with argument *labelSet*.
2. If *hasDuplicates* is true, return true.
3. Return ContainsDuplicateLabels of *StatementListItem* with argument *labelSet*.

Deleted: ¶

Deleted: , then return

StatementListItem : Declaration

1. Return false.

Deleted: ¶

13.1.3 Static Semantics: ContainsUndefinedBreakTarget

With argument *labelSet*.

See also: 13.0.2, 13.5.3, 13.6.1.2, 13.6.2.2, 13.6.3.3, 13.6.4.4, 13.8.2, 13.10.3, 13.11.3, 13.12.3, 13.14.3, 15.2.1.3.

Block : { }

1. Return false.

Deleted: ¶

StatementList : StatementList StatementListItem

1. Let *hasUndefinedLabels* be ContainsUndefinedBreakTarget of *StatementList* with argument *labelSet*.
2. If *hasUndefinedLabels* is true, return true.
3. Return ContainsUndefinedBreakTarget of *StatementListItem* with argument *labelSet*.

Deleted: ¶

Deleted: , then return

StatementListItem : Declaration

1. Return false.

Deleted: ¶

13.1.4 Static Semantics: ContainsUndefinedContinueTarget

With arguments *iterationSet* and *labelSet*.

See also: 13.0.3, 13.5.4, 13.6.1.3, 13.6.2.3, 13.6.3.4, 13.6.4.5, 13.7.2, 13.10.4, 13.11.4, 13.12.4, 13.14.4, 15.2.1.4.

Block : { }

1. Return false.

Deleted: ¶

StatementList : StatementList StatementListItem

1. Let *hasUndefinedLabels* be ContainsUndefinedContinueTarget of *StatementList* with arguments *iterationSet* and « ».
2. If *hasUndefinedLabels* is true, return true.
3. Return ContainsUndefinedContinueTarget of *StatementListItem* with arguments *iterationSet* and « ».

Deleted: ¶

Deleted: , then return

StatementListItem : Declaration

1. Return `false`.

Deleted: ¶

13.1.5 Static Semantics: LexicallyDeclaredNames

See also: 13.11.2, [13.12.6](#), 14.1.15, 14.2.10, 15.1.3, [15.2.1.11](#),

Deleted: 15.2.1.10

Block : { }

1. Return a new empty List.

Deleted: ¶

StatementList : StatementList StatementListItem

1. Let *names* be LexicallyDeclaredNames of *StatementList*.
2. Append to *names* the elements of the LexicallyDeclaredNames of *StatementListItem*.
3. Return *names*.

Deleted: ¶

StatementListItem : Statement

1. If *Statement* is *Statement : LabelledStatement*, return LexicallyDeclaredNames of *Statement*.
2. Return a new empty List.

Deleted: ¶
Deleted: , then return

StatementListItem : Declaration

1. Return the BoundNames of *Declaration*.

Deleted: ¶

13.1.6 Static Semantics: LexicallyScopedDeclarations

See also: [13.11.5](#), [13.12.6](#), 14.1.16, 14.2.11, 15.1.4, [15.2.1.12](#), [15.2.3.8](#),

Deleted: 15.2.1.11
Deleted: 15.2.3.7
Deleted: ¶

StatementList : StatementList StatementListItem

1. Let *declarations* be LexicallyScopedDeclarations of *StatementList*.
2. Append to *declarations* the elements of the LexicallyScopedDeclarations of *StatementListItem*.
3. Return *declarations*.

StatementListItem : Statement

1. If *Statement* is *Statement : LabelledStatement*, return LexicallyScopedDeclarations of *Statement*.
2. Return a new empty List.

Deleted: ¶
Deleted: , then return

StatementListItem : Declaration

1. Return a new List containing *DeclarationPart of Declaration*.

Deleted: ¶
Deleted:

13.1.7 Static Semantics: TopLevelLexicallyDeclaredNames

See also: [13.12.8](#),

Deleted: 13.12.6

StatementList : StatementList StatementListItem

Deleted: ¶

1. Let *names* be TopLevelLexicallyDeclaredNames of *StatementList*.
2. Append to *names* the elements of the TopLevelLexicallyDeclaredNames of *StatementListItem*.
3. Return *names*.

StatementListItem : *Statement*

1. Return a new empty List.

Deleted: ¶

StatementListItem : *Declaration*

1. If *Declaration* is *Declaration* : *FunctionDeclaration*, *return* a new empty List.
2. If *Declaration* is *Declaration* : *GeneratorDeclaration*, *return* a new empty List.
3. Return the *BoundNames* of *Declaration*.

Deleted: ¶

Deleted: , then return

Deleted: , then return

NOTE At the top level of a function, or script, function declarations are treated like var declarations rather than like lexical declarations.

Deleted: ¶

13.1.8 Static Semantics: TopLevelLexicallyScopedDeclarations

See also: [13.12.9](#)

Deleted: 13.12.7

Block : { }

Deleted: ¶

1. *Return* a new empty List.

StatementList : *StatementList StatementListItem*

Deleted: ¶

1. Let *declarations* be *TopLevelLexicallyScopedDeclarations* of *StatementList*.
2. Append to *declarations* the elements of the *TopLevelLexicallyScopedDeclarations* of *StatementListItem*.
3. *Return* *declarations*.

StatementListItem : *Statement*

Deleted: ¶

1. Return a new empty List.

StatementListItem : *Declaration*

Deleted: ¶

Deleted: , then return

Deleted: , then return

13.1.9 Static Semantics: TopLevelVarDeclaredNames

See also: [13.12.10](#)

Deleted: 13.12.8

Block : { }

Deleted: ¶

1. *Return* a new empty List.

StatementList : *StatementList StatementListItem*

Deleted: ¶

1. Let *names* be *TopLevelVarDeclaredNames* of *StatementList*.
2. Append to *names* the elements of the *TopLevelVarDeclaredNames* of *StatementListItem*.
3. *Return* *names*.

StatementListItem : *Declaration*

Deleted: ¶

Deleted: , then return

Deleted: LexicallyDeclaredNames

Deleted: , then return

Deleted: LexicallyDeclaredNames

StatementListItem : Statement

1. If Statement is Statement : LabelledStatement, return TopLevelVarDeclaredNames of Statement.
2. Return VarDeclaredNames of Statement.

Deleted: ¶

Deleted: , then return

NOTE At the top level of a function or script, inner function declarations are treated like var declarations.

Deleted: ¶

13.1.10 Static Semantics: TopLevelVarScopedDeclarations

See also: [13.12.11](#)

Block : { }

1. Return a new empty List.

Deleted: 13.12.9

Deleted: ¶

StatementList : StatementList StatementListItem

1. Let declarations be TopLevelVarScopedDeclarations of StatementList.
2. Append to declarations the elements of the TopLevelVarScopedDeclarations of StatementListItem.
3. Return declarations.

Deleted: ¶

StatementListItem : Statement

1. If Statement is Statement : LabelledStatement, return TopLevelVarScopedDeclarations of Statement.
2. Return VarScopedDeclarations of Statement.

Deleted: ¶

Deleted: then

Deleted: If Statement is Statement : VariableStatement, then return

Deleted: a new List containing

Deleted: Variable

Deleted: <#>Return a new empty List.¶

Deleted: ¶

Deleted: then

Deleted: then

StatementListItem : Declaration

1. If Declaration is Declaration : FunctionDeclaration, return a new List containing FunctionDeclaration.
2. If Declaration is Declaration : GeneratorDeclaration, return a new List containing GeneratorDeclaration.
3. Return a new empty List.

13.1.11 Static Semantics: VarDeclaredNames

See also: [13.0.5](#), [13.2.2.2](#), [13.5.5](#), [13.6.1.4](#), [13.6.2.4](#), [13.6.3.5](#), [13.6.4.7](#), [13.10.5](#), [13.11.7](#), [13.12.12](#), [13.14.5](#), [14.1.18](#), [14.2.13](#), [15.1.5](#), [15.2.1.13](#).

Block : { }

1. Return a new empty List.

Deleted: See also: 13.0.1, 13.2.2.2, 13.5.2, 13.6.1.1, 13.6.2.1, 13.6.3.213.6.3.1, 13.6.4.3, 13.10.2| , 13.11.4, 13.12.10, 13.14.2, 14.1.1814.1.17, 14.2.13, 15.1.5, 15.2.1.1313.0.1, , 13.5.1, 13.6.1.1, 13.6.2.1, 13.6.3.1, 13.6.4.3, 13.10.2, 13.11.4, 13.12.2, 0013.14.2, 14.1.16, 14.4.12, 14.5.1514.5.16, 15.1.5, 15.2.0.13.¶

Deleted: ¶

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Deleted: ¶

StatementList : StatementList StatementListItem

1. Let names be VarDeclaredNames of StatementList.
2. Append to names the elements of the VarDeclaredNames of StatementListItem.
3. Return names.

StatementListItem : Declaration

1. Return a new empty List.

13.1.12 Static Semantics: VarScopedDeclarations

See also: [13.0.6](#), [13.2.2.3](#), [13.5.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.6.4.8](#), [13.10.6](#), [13.11.8](#), [13.12.13](#), [13.14.6](#), [14.1.19](#), [14.2.14](#), [15.1.6](#), [15.2.1.14](#).

Block : { }

1. Return a new empty List.

StatementList : StatementList StatementListItem

1. Let *declarations* be VarScopedDeclarations of *StatementList*.
2. Append to *declarations* the elements of the VarScopedDeclarations of *StatementListItem*.
3. Return *declarations*.

StatementListItem : Declaration

1. Return a new empty List.

13.1.13 Runtime Semantics: Evaluation

Block : { }

1. Return NormalCompletion(**undefined**).

Block : { StatementList }

1. Let *oldEnv* be the running execution context's LexicalEnvironment.
2. Let *blockEnv* be NewDeclarativeEnvironment(*oldEnv*).
3. Perform BlockDeclarationInstantiation(*StatementList*, *blockEnv*).
4. Set the running execution context's LexicalEnvironment to *blockEnv*.
5. Let *blockValue* be the result of evaluating *StatementList*.
6. Set the running execution context's LexicalEnvironment to *oldEnv*.
7. If *blockValue*.[[type]] is normal and *blockValue*.[[value]] is empty, then
 - a. Return NormalCompletion(**undefined**).
8. Return *blockValue*.

NOTE No matter how control leaves the *Block* the LexicalEnvironment is always restored to its former state.

StatementList : StatementList StatementListItem

1. Let *sl* be the result of evaluating *StatementList*.
2. ReturnIfAbrupt(*sl*).
3. Let *s* be the result of evaluating *StatementListItem*.
4. If *s*.[[type]] is throw, return *s*.
5. If *s*.[[value]] is empty, let *V* = *sl*.[[value]], otherwise let *V* = *s*.[[value]].
6. Return Completion{[[type]]: *s*.[[type]], [[value]]: *V*, [[target]]: *s*.[[target]]}.

NOTE Steps 5 and 6 of the above algorithm ensure that the value of a *StatementList* is the value of the last value producing item in the *StatementList*. For example, the following calls to the **eval** function all return the value 1:

```
eval("1;;;;")
eval("1;{}")
eval("1;var a;")
```

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Deleted: StatementItem : Statement ¶ <#>If Statement is Statement : VariableStatement, then return a new List containing VariableStatement.¶ <#>Return VarScopedDeclarations of Statement a new empty List.¶
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Comment [AWB1314]: Breaking change: completion reform
Comment [AWB1315]: TODO, need to verify that under completion reform empty blocks evaluate to undefined.
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Comment [AWB1316]: Breaking change: completion reform
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Comment [AWB1317]: ISSUE: above changes to completion reform will means this evaluates to undefined rather than 1 is

13.1.14 Runtime Semantics: BlockDeclarationInstantiation(`, env)`

NOTE When a *Block* or *CaseBlock* production is evaluated a new Declarative Environment Record is created and bindings for each block scoped variable, constant, function, generator function, or class declared in the block are instantiated in the environment record.

BlockDeclarationInstantiation is performed as follows using arguments *code* and *env*. *code* is the grammar production corresponding to the body of the block. *env* is the declarative environment record in which bindings are to be created.

1. Let *declarations* be the LexicallyScopedDeclarations of *code*.
2. For each element *d* in *declarations* do
 - a. For each element *dn* of the BoundNames of *d* do
 - i. If IsConstantDeclaration of *d* is true, then
 1. Call *env*'s CreateImmutableBinding concrete method passing *dn* and true as the arguments.
 - ii. Else,
 1. Let *status* be the result of calling *env*'s CreateMutableBinding concrete method passing *dn* and false as the arguments.
 2. Assert: *status* is never an abrupt completion.
 - b. If *d* is a GeneratorDeclaration production or a FunctionDeclaration production, then
 - i. Let *fn* be the sole element of the BoundNames of *d*.
 - ii. Let *fo* be the result of performing InstantiateFunctionObject for *d* with argument *env*.
 - iii. Call *env*'s InitializeBinding concrete method passing *fn*, and *fo* as the arguments.

13.2 Declarations and the Variable Statement

13.2.1 Let and Const Declarations

NOTE *let* and *const* declarations define variables that are scoped to the running execution context's LexicalEnvironment. The variables are created when their containing Lexical Environment is instantiated but may not be accessed in any way until the variable's *LexicalBinding* is evaluated. A variable defined by a *LexicalBinding* with an *Initializer* is assigned the value of its *Initializer*'s *AssignmentExpression* when the *LexicalBinding* is evaluated, not when the variable is created. If a *LexicalBinding* in a *let* declaration does not have an *Initializer* the variable is assigned the value *undefined* when the *LexicalBinding* is evaluated.

Syntax

LexicalDeclaration[?In, Yield] :
LetOrConst BindingList[?In, ?Yield] ;

LetOrConst :
let
const,

BindingList[In, Yield] :
LexicalBinding[?In, ?Yield]
BindingList[?In, ?Yield], *LexicalBinding*[?In, ?Yield]

LexicalBinding[In, Yield] :
BindingIdentifier[?Yield] *Initializer*[?In, ?Yield]opt
BindingPattern[?Yield] *Initializer*[?In, ?Yield]

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Deleted: <#>Let *functionsToInitialize* be an empty List.¶
Deleted: <#>If *d* is a GeneratorDeclaration production or a FunctionDeclaration production, then¶
 <#>Let *fn* be the sole element of the BoundNames of *d*¶
 <#>Let *fo* be the result of performing InstantiateFunctionObject for *d* with argument *env*.¶
 <#>Call *env*'s InitializeBinding concrete method passing *fn*, and *fo* as the arguments.¶
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Deleted: <#>If *d* is a GeneratorDeclaration production or a FunctionDeclaration production, then¶
 <#>Append *d* to *functionsToInitialize*.¶
 <#>For each production *f* in *functionsToInitialize*, in list order do¶
 <#>Let *fn* be the sole element of the BoundNames of *f*.¶
 <#>Let *fo* be the result of performing InstantiateFunctionObject for *f* with argument *env*.¶
 <#>Call *env*'s InitializeBinding concrete method passing *fn*, and *fo* as the arguments.¶
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13.2.1.1 Static Semantics: Early Errors

LexicalDeclaration : *LetOrConst BindingList ;*

- It is a Syntax Error if the *BoundNames* of *BindingList* contains "let".
- It is a Syntax Error if the *BoundNames* of *BindingList* contains any duplicate entries.

Deleted: ¶

LexicalBinding : *BindingIdentifier Initializer_{opt}*

- It is a Syntax Error if *Initializer* is not present and *IsConstantDeclaration* of the *LexicalDeclaration* containing this production is true.

13.2.1.2 Static Semantics: BoundNames

See also: 12.1.2, [13.6.4.2](#), 14.1.3, 14.2.2, 14.4.2, 14.5.2, 15.2.2.2, 15.2.3.1

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Deleted: 15.2.2.1
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LexicalDeclaration : *LetOrConst BindingList ;*

1. Return the *BoundNames* of *BindingList*.

BindingList : *BindingList , LexicalBinding*

1. Let *names* be the *BoundNames* of *BindingList*.
2. Append to *names* the elements of the *BoundNames* of *LexicalBinding*.
3. Return *names*.

Deleted: ¶

LexicalBinding : *BindingIdentifier Initializer_{opt}*

1. Return the *BoundNames* of *BindingIdentifier*.

Deleted: ¶

LexicalBinding : *BindingPattern Initializer*

1. Return the *BoundNames* of *Binding Pattern*.

13.2.1.3 Static Semantics: IsConstantDeclaration

See also: 14.1.11, [14.4.8](#), 14.5.7, [15.2.3.7](#)

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LexicalDeclaration : *LetOrConst BindingList ;*

1. Return *IsConstantDeclaration* of *LetOrConst*.

LetOrConst : **let**

1. Return false.

LetOrConst : **const**

1. Return true.

13.2.1.4 Runtime Semantics: Evaluation

LexicalDeclaration : *LetOrConst BindingList ;*

Deleted: ¶

1. Let *next* be the result of evaluating *BindingList*.
2. ReturnIfAbrupt(*next*).

3. Return NormalCompletion(empty).

BindingList : BindingList , LexicalBinding

1. Let *next* be the result of evaluating *BindingList*.
2. ReturnIfAbrupt(*next*).
3. Return the result of evaluating *LexicalBinding*.

Deleted: ¶

LexicalBinding : BindingIdentifier

1. Let *lhs* be ResolveBinding(StringValue of *BindingIdentifier*).
2. Return InitializeReferencedBinding(*lhs*, undefined).

Deleted: ¶

Deleted: Let *env* be the running execution context's LexicalEnvironment.

Deleted: the result of performing BindingInitialization for *BindingIdentifier* passing *undefined* and *env* as the arguments

NOTE A static semantics rule ensures that this form of *LexicalBinding* never occurs in a **const** declaration.

LexicalBinding : BindingIdentifier Initializer

1. Let *bindingId* be StringValue of *BindingIdentifier*.
2. Let *lhs* be ResolveBinding(*bindingId*).
3. Let *rhs* be the result of evaluating *Initializer*.
4. Let *value* be GetValue(*rhs*).
5. ReturnIfAbrupt(*value*).
6. If IsAnonymousFunctionDefinition(*Initializer*) is **true**, then
 - a. Let *hasNameProperty* be HasOwnProperty(*value*, "name").
 - b. ReturnIfAbrupt(*hasNameProperty*).
 - c. If *hasNameProperty* is **false**, perform SetFunctionName(*value*, *bindingId*).
7. Return InitializeReferencedBinding(*lhs*, *value*).

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Deleted: <#>Assert: SetFunctionName will not return an abrupt completion.¶

Deleted: <#>Let *env* be the running execution context's LexicalEnvironment.¶

Deleted: the result of performing BindingInitialization for *BindingIdentifier* passing *value* and *env* as the arguments

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Deleted: <#>If Type(*value*) is not Object, then throw a **TypeError** exception.¶

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LexicalBinding : BindingPattern Initializer

1. Let *rhs* be the result of evaluating *Initializer*.
2. Let *value* be GetValue(*rhs*).
3. ReturnIfAbrupt(*value*).
4. Let *env* be the running execution context's LexicalEnvironment.
5. Return the result of performing BindingInitialization for *BindingPattern* using *value* and *env* as the arguments.

13.2.2 Variable Statement

NOTE A **var** statement declares variables that are scoped to the running execution context's **VariableEnvironment**. Var variables are created when their containing Lexical Environment is instantiated and are initialized to **undefined** when created. Within the scope of any **VariableEnvironment** a common *BindingIdentifier* may appear in more than one *VariableDeclaration* but those declarations collective define only one variable. A variable defined by a *VariableDeclaration* with an *Initializer* is assigned the value of its *Initializer*'s *AssignmentExpression* when the *VariableDeclaration* is executed, not when the variable is created.

Syntax

*VariableStatement*_[Yield] :

 var *VariableDeclarationList*_[In, ?Yield] ;

*VariableDeclarationList*_[In, Yield] :

 *VariableDeclaration*_[?In, ?Yield]

 *VariableDeclarationList*_[?In, ?Yield] , *VariableDeclaration*_[?In, ?Yield]



VariableDeclaration[`In`, `Yield`] :

*BindingIdentifier*_[?Yield] *Initializer*_{[?In, ?Yield]opt}
*BindingPattern*_[?Yield] *Initializer*_[?In, ?Yield]

13.2.2.1 Static Semantics: BoundNames

See also: 13.2.1.2, 12.1.2, [13.6.4.2](#), 14.1.3, 14.2.2, 14.4.2, 14.5.2, [15.2.2.2](#), [15.2.3.1](#).

VariableDeclarationList : *VariableDeclarationList* , *VariableDeclaration*

1. Let $names$ be BoundNames of *VariableDeclarationList*.
 2. Append to $names$ the elements of BoundNames of *VariableDeclaration*.
 3. Return $names$.

VariableDeclaration : *BindingIdentifier* *Initializer*_{opt}

1. Return the `BoundNames` of *BindingIdentifier*.

VariableDeclaration : *BindingPattern* *Initializer*

1. Return the `BoundNames` of *BindingPattern*.

13.2.2.2 Static Semantics: VarDeclaredNames

See also: [13.0.5](#), [13.1.11](#), [13.5.5](#), [13.6.1.4](#), [13.6.2.4](#), [13.6.3.5](#), [13.6.4.7](#), [13.10.5](#), [13.11.7](#), [13.12.12](#), [13.14.5](#), [14.1.18](#), [14.2.13](#), [15.1.5](#), [15.2.1.13](#).

VariableStatement : var VariableDeclarationList

- ## 1. Return BoundNames of *VariableDeclarationList*.

13.2.2.3 Static Semantics: VarScopedDeclarations

See also: [13.0.6](#), [13.1.12](#), [13.5.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.6.4.8](#), [13.10.6](#), [13.11.8](#), [13.12.13](#), [13.14.6](#), [14.1.19](#), [14.2.14](#), [15.1.6](#), [15.2.1.14](#).

VariableDeclarationList : *VariableDeclaration* *VariableDeclarationList* | *VariableDeclaration*

1. Return a new List containing *VariableDeclaration*.

VariableDeclarationList · *VariableDeclarationList* · *VariableDeclaration*

1. Let *declarations* be `VarScopedDeclarations` of *VariableDeclarationList*.
 2. Append *VariableDeclaration* to *declarations*.
 3. Return *declarations*.

13.2.2.4 Runtime Semantics: Evaluation

VariableStatement :: var VariableDeclarationList ;

1. Let *next* be the result of evaluating *VariableDeclarationList*.
 2. ReturnIfAbrupt(*next*).
 3. Return NormalCompletion(*empty*)

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Deleted: 13.14.3

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Deleted: <#>**Runtime Semantics:**
BindingInitialization¶

With arguments *value* and *environment*. ¶

See also: 12.1.4. , 13.2.3.5, 13.6.4.5, 13.14.412.2.4.2.2, **Error! Reference source not found.** 12.1.2, 13.2.3.4, 13.14.3. ¶

NOTE . **undefined** is passed for *environment* to indicate that a PutValue operation should be used to assign the initialization value. . This is the case for **vax** statements and the formal parameter lists of some non-strict functions (see 9.2.13). In those cases a lexical binding is hoisted and preinitialized prior to evaluation of its initializer. ¶

VariableDeclaration : *BindingIdentifier* ¶

<#>Return the result of performing BindingInitialization for *BindingIdentifier* passing *value* and **undefined** as the arguments. ¶

VariableDeclaration : *BindingIdentifier* *Initializer* ¶

<#>Return the result of performing BindingInitialization for *BindingIdentifier* passing *value* and **undefined** as the arguments. ¶

VariableDeclarationList : *VariableDeclarationList* , *VariableDeclaration*

1. Let *next* be the result of evaluating *VariableDeclarationList*.
2. ReturnIfAbrupt(*next*).
3. Return the result of evaluating *VariableDeclaration*.

Deleted: ¶

VariableDeclaration : *BindingIdentifier*

1. Return NormalCompletion(empty).

Deleted: ¶

VariableDeclaration : *BindingIdentifier Initializer*

1. Let *bindingId* be *StringValue* of *BindingIdentifier*.
2. Let *lhs* be *ResolveBinding*(*bindingId*).
3. ReturnIfAbrupt(*lhs*).
4. Let *rhs* be the result of evaluating *Initializer*.
5. Let *value* be *GetValue*(*rhs*).
6. ReturnIfAbrupt(*value*).
7. If *IsAnonymousFunctionDefinition*(*Initializer*) is **true**, then
 - a. Let *hasNameProperty* be *HasOwnProperty*(*value*, "name").
 - b. ReturnIfAbrupt(*hasNameProperty*).
 - c. If *hasNameProperty* is **false**, perform *SetFunctionName*(*value*, *bindingId*).
8. Return *PutValue*(*lhs*, *value*).

Deleted: ¶

NOTE If a *VariableDeclaration* is nested within a *with* statement and the *BindingIdentifier* in the *VariableDeclaration* is the same as a property name of the binding object of the *with* statement's object environment record, then step 7 will assign *value* to the property instead of *assigning* to the VariableEnvironment binding of the *Identifier*.

Formatted

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Deleted: *StringValue* of *BindingIdentifier*

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Deleted: <#>Assert: *SetFunctionName* will not return an abrupt completion.¶

Deleted: the result of performing *BindingInitialization* for *BindingIdentifier* passing *value* and *undefined* as the arguments

Deleted: *Identifier*

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Deleted: <#>If *Type(rval)* is not Object, then throw a *TypeError* exception.¶

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VariableDeclaration : *BindingPattern Initializer*

1. Let *rhs* be the result of evaluating *Initializer*.
2. Let *rval* be *GetValue*(*rhs*).
3. ReturnIfAbrupt(*rval*).
4. Return the result of performing *BindingInitialization* for *BindingPattern* passing *rval* and *undefined* as arguments.

13.2.3 Destructuring Binding Patterns

Syntax

BindingPattern[?Yield,?GeneratorParameter] :

ObjectBindingPattern[?Yield,?GeneratorParameter]
 ArrayBindingPattern[?Yield,?GeneratorParameter]

ObjectBindingPattern[?Yield,?GeneratorParameter] :

 { }
 { *BindingPropertyList*[?Yield,?GeneratorParameter] }
 { *BindingPropertyList*[?Yield,?GeneratorParameter] , }

ArrayBindingPattern[?Yield,?GeneratorParameter] :

 [*Elision*? *BindingRestElement*[?Yield,?GeneratorParameter]?]
 [*BindingElementList*[?Yield,?GeneratorParameter]]
 [*BindingElementList*[?Yield,?GeneratorParameter] , *Elision*? *BindingRestElement*[?Yield,?GeneratorParameter]?]

*BindingPropertyList*_[Yield,GeneratorParameter] :
*BindingProperty*_[?Yield, ?GeneratorParameter]
*BindingPropertyList*_[?Yield, ?GeneratorParameter] , *BindingProperty*_[?Yield, ?GeneratorParameter]

*BindingElementList*_[Yield,GeneratorParameter] :
*BindingElisionElement*_[?Yield, ?GeneratorParameter]
*BindingElementList*_[?Yield, ?GeneratorParameter] , *BindingElisionElement*_[?Yield, ?GeneratorParameter]

*BindingElisionElement*_[Yield,GeneratorParameter] :
 $\text{Elision}_{\text{opt}}$ *BindingElement*_[?Yield, ?GeneratorParameter]

*BindingProperty*_[Yield,GeneratorParameter] :
*SingleNameBinding*_[?Yield, ?GeneratorParameter]
*PropertyName*_[?Yield, ?GeneratorParameter] : *BindingElement*_[?Yield, ?GeneratorParameter]

Deleted:

| *BindingElement*_[Yield,GeneratorParameter] :
*SingleNameBinding*_[?Yield, ?GeneratorParameter]
[+GeneratorParameter] *BindingPattern*_[?Yield,GeneratorParameter] *Initializer*_{[In]opt}
[-GeneratorParameter] *BindingPattern*_[?Yield] *Initializer*_{[In, ?Yield]opt}

| *SingleNameBinding*_[Yield,GeneratorParameter] :
[+GeneratorParameter] *BindingIdentifier*_[Yield] *Initializer*_{[In]opt}
[-GeneratorParameter] *BindingIdentifier*_[?Yield] *Initializer*_{[In, ?Yield]opt}

*BindingRestElement*_[Yield, GeneratorParameter] :
[+GeneratorParameter] . . . *BindingIdentifier*_[Yield]
[-GeneratorParameter] . . . *BindingIdentifier*_[?Yield]

Deleted: ¶

13.2.3.1 Static Semantics: BoundNames

See also: 13.2.1.2, 13.2.2.1, [13.6.4.2](#), 14.1.3, 14.2.2, 14.4.2, 14.5.2, [15.2.2.2](#), [15.2.3.1](#),

Deleted: ¶ 13.6.4.2

ObjectBindingPattern : { }

Deleted: ¶ 15.2.1.2

Deleted: ¶ 15.2.2.1

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1. Return an empty List.

ArrayBindingPattern : [*Elision*_{opt}]

Deleted: ¶

ArrayBindingPattern : [*Elision*_{opt} *BindingRestElement*]

Deleted: ¶

1. Return the BoundNames of *BindingRestElement*.

ArrayBindingPattern : [*BindingElementList* , *Elision*_{opt}]

Deleted: ¶

1. Return the BoundNames of *BindingElementList*.

ArrayBindingPattern : [*BindingElementList* , *Elision*_{opt} *BindingRestElement*]

Deleted: ¶

1. Let *names* be BoundNames of *BindingElementList*.

2. Append to *names* the elements of BoundNames of *BindingRestElement*.

3. Return *names*.

BindingPropertyList : *BindingPropertyList* , *BindingProperty*

1. Let *names* be *BoundNames* of *BindingPropertyList*.
2. Append to *names* the elements of *BoundNames* of *BindingProperty*.
3. Return *names*.

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BindingElementList : *BindingElementList* , *BindingElisionElement*

1. Let *names* be *BoundNames* of *BindingElementList*.
2. Append to *names* the elements of *BoundNames* of *BindingElisionElement*.
3. Return *names*.

Deleted: ¶

BindingElisionElement : *Elision*_{opt} *BindingElement*

1. Return *BoundNames* of *BindingElement*.

Deleted: ¶

BindingProperty : *PropertyName* : *BindingElement*

1. Return the *BoundNames* of *BindingElement*.

Deleted: ¶

SingleNameBinding : *BindingIdentifier* *Initializer*_{opt}

1. Return the *BoundNames* of *BindingIdentifier*.

Deleted: ¶

BindingElement : *BindingPattern* *Initializer*_{opt}

1. Return the *BoundNames* of *BindingPattern*.

Deleted: ¶

13.2.3.2 Static Semantics: ContainsExpression

See also: 14.1.5, 14.2.4.

ObjectBindingPattern : { }

1. Return **false**.

Deleted: ¶

ArrayBindingPattern : []

1. Return **false**.

Deleted: ¶

ArrayBindingPattern : []

1. Return **false**.

Deleted: ¶

ArrayBindingPattern : []

1. Return *ContainsExpression* of *BindingElementList*.

Deleted: ¶

ArrayBindingPattern : []

1. Return *ContainsExpression* of *BindingElementList*.

Deleted: ¶

BindingPropertyList : *BindingPropertyList* , *BindingProperty*

1. Let *has* be *ContainsExpression* of *BindingPropertyList*.
2. If *has* is **true**, return **true**.
3. Return *ContainsExpression* of *BindingProperty*.

Deleted: ¶

BindingElementList : *BindingElementList* , *BindingElisionElement*

1. Let *has* be *ContainsExpression* of *BindingElementList*.
2. If *has* is **true**, return **true**.
3. Return *ContainsExpression* of *BindingElisionElement*.

Deleted: ¶

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BindingElisionElement : *Elision*_{opt} *BindingElement*

1. Return *ContainsExpression* of *BindingElement*.

Deleted: ¶

BindingProperty : *PropertyName* : *BindingElement*

1. Let *has* be *IsComputedPropertyKey* of *PropertyName*.
2. If *has* is **true**, return **true**.
3. Return the *ContainsExpression* of *BindingElement*.

Deleted: ¶

BindingElement : *BindingPattern* *Initializer*

1. Return **true**.

Deleted: ¶

SingleNameBinding : *BindingIdentifier*

1. Return **false**.

Deleted: ¶

SingleNameBinding : *BindingIdentifier* *Initializer*

1. Return **true**.

Deleted: ¶

13.2.3.3 Static Semantics: HasInitializer

See also: 13.2.3.3, 14.1.7, 14.2.7.

BindingElement : *BindingPattern*

1. Return **false**.

Deleted: ¶

BindingElement : *BindingPattern* *Initializer*

1. Return **true**.

Deleted: ¶

SingleNameBinding : *BindingIdentifier*

1. Return **false**.

Deleted: ¶

SingleNameBinding : *BindingIdentifier* *Initializer*

1. Return **true**.

Deleted: ¶

13.2.3.4 Static Semantics: IsSimpleParameterList

See also: [14.1.12](#), 14.2.8.

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BindingElement : *BindingPattern*

1. Return **false**.

Deleted: ¶

BindingElement : *BindingPattern Initializer*

1. Return **false**.

Deleted: ¶

SingleNameBinding : *BindingIdentifier*

1. Return **true**.

Deleted: ¶

SingleNameBinding : *BindingIdentifier Initializer*

1. Return **false**.

Deleted: ¶

13.2.3.5 Runtime Semantics: BindingInitialization

With parameters *value* and *environment*.

See also: [12.1.5](#), [13.6.4.8](#)

NOTE When **undefined** is passed for *environment* it indicates that a PutValue operation should be used to assign the initialization value. This is the case for formal parameter lists of non-strict functions. In that case the formal parameter bindings are preinitialized in order to deal with the possibility of multiple parameters with the same name.

BindingPattern : *ObjectBindingPattern*

1. Let *valid* be RequireObjectCoercible(*value*).
2. ReturnIfAbrupt(*valid*).
3. Return the result of performing BindingInitialization for *ObjectBindingPattern* using *value* and *environment* as arguments.

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BindingPattern : *ArrayBindingPattern*

1. Let *iterator* be GetIterator(*value*).
2. ReturnIfAbrupt(*iterator*).
3. Let *result* be the result of performing IteratorBindingInitialization for *ArrayBindingPattern* using *iterator*, and *environment* as arguments.
4. Return IteratorClose(*iterator*, *result*).

Deleted: ¶
Deleted: <#>Assert: Type(*value*) is Object¶
Deleted: *obj*
Deleted: Return

ObjectBindingPattern : { }

1. Return NormalCompletion(empty).

Deleted: ¶
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BindingPropertyList : *BindingPropertyList* , *BindingProperty*

1. Let *status* be the result of performing BindingInitialization for *BindingPropertyList* using *value* and *environment* as arguments.
2. ReturnIfAbrupt(*status*).
3. Return the result of performing BindingInitialization for *BindingProperty* using *value* and *environment* as arguments.

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BindingProperty : *SingleNameBinding*

1. Let *name* be the string that is the only element of BoundNames of *SingleNameBinding*.
2. Return the result of performing KeyedBindingInitialization for *SingleNameBinding* using *value*, *environment*, and *name* as the arguments.

Deleted: ¶

BindingProperty : *PropertyName* : *BindingElement*

Deleted: ¶

1. Let *P* be the result of evaluating *PropertyName*
2. ReturnIfAbrupt(*P*).
3. Return the result of performing KeyedBindingInitialization for *BindingElement* using *value*, *environment*, and *P* as arguments.

13.2.3.6 Runtime Semantics: IteratorBindingInitialization

With parameters *iterator*, and *environment*.

See also: [14.1.21](#), [14.2.15](#).

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NOTE When **undefined** is passed for *environment* it indicates that a PutValue operation should be used to assign the initialization value. This is the case for formal parameter lists of non-strict functions. In that case the formal parameter bindings are preinitialized in order to deal with the possibility of multiple parameters with the same name.

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ArrayBindingPattern : []

Deleted: ¶

1. Return NormalCompletion(empty).

ArrayBindingPattern : [*Elision*]

1. Return the result of performing IteratorDestructuringAssignmentEvaluation of *Elision* with *iterator* as the argument.

ArrayBindingPattern : [*Elision*_{opt} *BindingRestElement*]

Deleted: ¶

1. If *Elision* is present, then
 - a. Let *status* be the result of performing IteratorDestructuringAssignmentEvaluation of *Elision* with *iterator* as the argument.
 - b. ReturnIfAbrupt(*status*).
2. Return the result of performing IteratorBindingInitialization for *BindingRestElement* using *iterator* and *environment* as arguments.

ArrayBindingPattern : [*BindingElementList*]

Deleted: ¶

1. Return the result of performing IteratorBindingInitialization for *BindingElementList* using *iterator* and *environment* as arguments.

ArrayBindingPattern : [*BindingElementList* , 1]

Deleted: ¶

1. Return the result of performing IteratorBindingInitialization for *BindingElementList* using *iterator* and *environment* as arguments.

ArrayBindingPattern : [*BindingElementList* , *Elision*]

Deleted: ¶

1. Let *status* be the result of performing IteratorBindingInitialization for *BindingElementList* using *iterator* and *environment* as arguments.
2. ReturnIfAbrupt(*status*).
3. Return the result of performing IteratorDestructuringAssignmentEvaluation of *Elision* with *iterator* as the argument.

ArrayBindingPattern : [BindingElementList , Elision_{opt} BindingRestElement]

Deleted: ¶

1. Let *status* be the result of performing IteratorBindingInitialization for *BindingElementList* using *iterator* and *environment* as arguments.
2. ReturnIfAbrupt(*status*).
3. If *Elision* is present, then
 - a. Let *status* be the result of performing IteratorDestructuringAssignmentEvaluation of *Elision* with *iterator* as the argument.
 - b. ReturnIfAbrupt(*status*).
4. Return the result of performing IteratorBindingInitialization for *BindingRestElement* using *iterator* and *environment* as arguments.

BindingElementList : BindingElisionElement

Deleted: ¶

1. Return the result of performing IteratorBindingInitialization for *BindingElisionElement* using *iterator* and *environment* as arguments.

BindingElementList : BindingElementList , BindingElisionElement

Deleted: ¶

1. Let *status* be the result of performing IteratorBindingInitialization for *BindingElementList* using *iterator* and *environment* as arguments.
2. ReturnIfAbrupt(*status*).
3. Return the result of performing IteratorBindingInitialization for *BindingElisionElement* using *iterator* and *environment* as arguments.

BindingElisionElement : BindingElement

Deleted: ¶

1. Return the result of performing IteratorBindingInitialization of *BindingElement* with *iterator* and *environment* as the arguments.

BindingElisionElement : Elision BindingElement

Deleted: ¶

1. Let *status* be the result of performing IteratorDestructuringAssignmentEvaluation of *Elision* with *iterator* as the argument.
2. ReturnIfAbrupt(*status*).
3. Return the result of performing IteratorBindingInitialization of *BindingElement* with *iterator* and *environment* as the arguments.

BindingElement : SingleNameBinding

Deleted: ¶

1. Return the result of performing IteratorBindingInitialization for *SingleNameBinding* using *iterator* and *environment* as the arguments.

SingleNameBinding : BindingIdentifier Initializer_{opt}

Deleted: ¶

1. Let *bindingId* be StringValue of *BindingIdentifier*.
2. Let *lhs* be ResolveBinding(*bindingId*).
3. ReturnIfAbrupt(*lhs*).
4. Let *next* be IteratorStep(*iterator*).
5. ReturnIfAbrupt(*next*).
6. If *next* is false, let *v* be undefined.
7. Else
 - a. Let *v* be IteratorValue(*next*).
 - b. ReturnIfAbrupt(*v*).
8. If *Initializer* is present and *v* is undefined, then

Deleted: , then let

Deleted: ¶

- a. Let *defaultValue* be the result of evaluating *Initializer*.
- b. Let *v* be *GetValue(defaultValue)*.
- c. *ReturnIfAbrupt(v)*.
- d. If *IsAnonymousFunctionDefinition(Initializer)* is **true**, then
 - i. Let *hasNameProperty* be *HasOwnProperty(v, "name")*.
 - ii. *ReturnIfAbrupt(hasNameProperty)*.
 - iii. If *hasNameProperty* is **false**, *perform SetFunctionName(v, bindingId)*.

9. If environment is undefined, return PutValue(lhs, v).

10. Return *InitializeReferencedBinding(lhs, v)*.

BindingElement : BindingPattern Initializer_{opt}

1. Let *next* be *IteratorStep(iterator)*.
2. *ReturnIfAbrupt(next)*.
3. If *next* is **false**, let *v* be **undefined**.
4. Else
 - a. Let *v* be *IteratorValue(next)*.
 - b. *ReturnIfAbrupt(v)*.
5. If *Initializer* is present and *v* is **undefined**, then
 - a. Let *defaultValue* be the result of evaluating *Initializer*.
 - b. Let *v* be *GetValue(defaultValue)*.
 - c. *ReturnIfAbrupt(v)*.
6. Return the result of performing *BindingInitialization* of *BindingPattern* with *v* and *environment* as the arguments.

BindingRestElement : ... BindingIdentifier

1. Let *lhs* be *ResolveBinding(String Value of BindingIdentifier)*.
2. *ReturnIfAbrupt(lhs)*.
3. Let *A* be *ArrayCreate(0)*.
4. Let *n=0*.
5. Repeat
 - a. Let *next* be *IteratorStep(iterator)*.
 - b. *ReturnIfAbrupt(next)*.
 - c. If *next* is **false**, then
 - i. If *environment* is **undefined**, then *PutValue(lhs, A)*.
 - ii. Return *InitializeReferencedBinding(lhs, A)*.
 - d. Let *nextValue* be *IteratorValue(next)*.
 - e. *ReturnIfAbrupt(nextValue)*.
 - f. Let *status* be *CreateDataProperty(A, ToString(ToUint32(n)), nextValue)*.
 - g. *Assert: status is true*.
 - h. Increment *n* by 1.

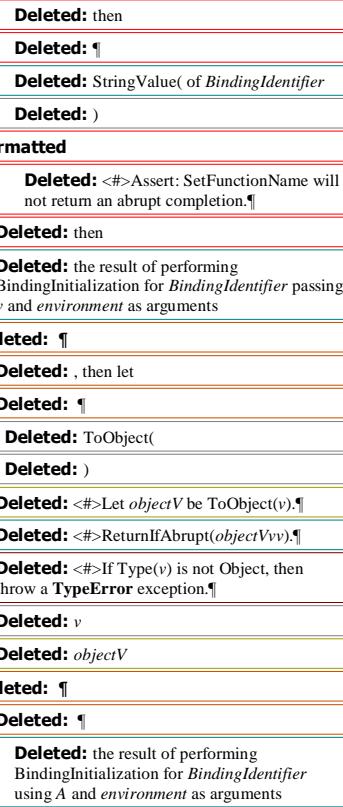
13.2.3.7 Runtime Semantics: KeyedBindingInitialization

With parameters *value*, *environment*, and *propertyName*.

NOTE When **undefined** is passed for *environment* it indicates that a *PutValue* operation should be used to assign the initialization value. This is the case for formal parameter lists of non-strict functions. In that case the formal parameter bindings are preinitialized in order to deal with the possibility of multiple parameters with the same name.

BindingElement : BindingPattern Initializer_{opt}

1. Let *v* be *GetV(value, propertyName)*.



2. ReturnIfAbrupt(*v*).
 3. If *Initializer* is present and *v* is **undefined**, then
 a. Let *defaultValue* be the result of evaluating *Initializer*.
 b. Let *v* be GetValue(*defaultValue*).
 c. [ReturnIfAbrupt\(*v*\)](#).
 4. [Return the result of performing BindingInitialization for *BindingPattern* passing *v* and *environment* as arguments.](#)
- SingleNameBinding : BindingIdentifier Initializer_{opt}*
1. [Let *bindingId* be StringValue of *BindingIdentifier*.](#)
 2. [Let *lhs* be ResolveBinding\(*bindingId*\).](#)
 3. [ReturnIfAbrupt\(*lhs*\).](#)
 4. Let *v* be GetV(*value*, *propertyName*).
 5. ReturnIfAbrupt(*v*).
 6. If *Initializer* is present and *v* is **undefined**, then
 a. Let *defaultValue* be the result of evaluating *Initializer*.
 b. Let *v* be GetValue(*defaultValue*).
 c. ReturnIfAbrupt(*v*).
 d. If IsAnonymousFunctionDefinition(*Initializer*) is **true**, then
 i. Let *hasNameProperty* be HasOwnProperty(*v*, "name").
 ii. ReturnIfAbrupt(*hasNameProperty*).
 iii. If *hasNameProperty* is **false**, [perform SetFunctionName\(*v*, *bindingId*\)](#).
 7. [If *environment* is **undefined**, return PutValue\(*lhs*, *v*\).](#)
 8. Return [InitializeReferencedBinding\(*lhs*, *v*\)](#).

13.3 Empty Statement

Syntax

EmptyStatement :
 ;

13.3.1 Runtime Semantics: Evaluation

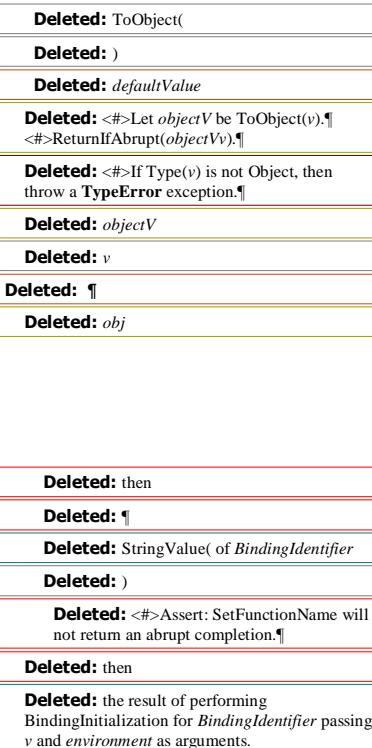
- EmptyStatement : ;*
1. Return NormalCompletion(empty).

13.4 Expression Statement

Syntax

ExpressionStatement_[Yield] :
 [lookahead \notin {}, function, class, let [,]] *Expression_[In, ?Yield]* ;

NOTE An *ExpressionStatement* cannot start with a **LEFT CURLY BRACKET** because that might make it ambiguous with a *Block*. Also, an *ExpressionStatement* cannot start with the **function** or **class** keywords because that would make it ambiguous with a *FunctionDeclaration*, a *GeneratorDeclaration*, or a *ClassDeclaration*. An *ExpressionStatement* cannot start with the two token sequence **let [** because that would make it ambiguous with a **let LexicalDeclaration** whose first *LexicalBinding* was an *ArrayBindingPattern*.



13.4.1 Runtime Semantics: Evaluation

ExpressionStatement : Expression ;

1. Let *exprRef* be the result of evaluating *Expression*.
2. Return GetValue(*exprRef*).

Deleted: ¶

Deleted: Let *value* be

Deleted: <#>ReturnIfAbrupt(*value*).¶
<#>Return NormalCompletion(*value*).¶

13.5 The if Statement

Syntax

IfStatement[Yield, Return] :

```
if ( Expression[In, ?Yield] ) Statement[?Yield, ?Return] else Statement[?Yield, ?Return]
if ( Expression[In, ?Yield] ) Statement[?Yield, ?Return]
```

Each *else* for which the choice of associated *if* is ambiguous shall be associated with the nearest possible *if* that would otherwise have no corresponding *else*.

13.5.1 Static Semantics: Early Errors

IfStatement :

```
if ( Expression ) Statement else Statement
if ( Expression ) Statement
```

Deleted: ¶

- It is a Syntax Error if IsLabelledFunction(*Statement*) is true for any occurrence of *Statement* in these rules.

NOTE It is only necessary to apply this rule if the extension specified in B.3.2 is implemented.

Deleted: n

Deleted: ¶

13.5.2 Static Semantics: ContainsDuplicateLabels

With argument *labelSet*.

See also: 13.0.1, 13.1.2, 13.6.1.1, 13.6.2.1, 13.6.3.2, 13.6.4.3, 13.10.2, 13.11.2, 13.12.2, 13.14.2, 15.2.1.2.

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IfStatement : if (Expression) Statement else Statement

Deleted: ¶

1. Let *hasUndefinedLabels* be ContainsDuplicateLabels of the first *statement* with argument *labelSet*.
2. If *hasUndefinedLabels* is true, return true.
3. Return ContainsDuplicateLabels of the second *statement* with argument *labelSet*.

Deleted: , then return

IfStatement : if (Expression) Statement

Deleted: ¶

1. Return ContainsDuplicateLabels of *statement* with argument *labelSet*.

13.5.3 Static Semantics: ContainsUndefinedBreakTarget

With argument *labelSet*.

See also: 13.0.2, 13.1.3, 13.6.1.2, 13.6.2.2, 13.6.3.3, 13.6.4.4, 13.8.2, 13.10.3, 13.11.3, 13.12.3, 13.14.3, 15.2.1.3.

IfStatement : if (Expression) Statement **else** Statement

1. Let *hasUndefinedLabels* be ContainsUndefinedBreakTarget of the first *Statement* with argument *labelSet*.
2. If *hasUndefinedLabels* is true, return true.
3. Return ContainsUndefinedBreakTarget of the second *Statement* with argument *labelSet*.

Deleted: ¶

Deleted: , then return

IfStatement : if (Expression) Statement

1. Return ContainsUndefinedBreakTarget of *Statement* with argument *labelSet*.

Deleted: ¶

13.5.4 Static Semantics: ContainsUndefinedContinueTarget

With arguments *iterationSet* and *labelSet*.

See also: 13.0.3, 13.1.4, 13.6.1.3, 13.6.2.3, 13.6.3.4, 13.6.4.5, 13.7.2, 13.10.4, 13.11.4, 13.12.4, 13.14.4, 15.2.1.4.

IfStatement : if (Expression) Statement **else** Statement

1. Let *hasUndefinedLabels* be ContainsUndefinedContinueTarget of the first *Statement* with arguments *iterationSet* and « ».
2. If *hasUndefinedLabels* is true, return true.
3. Return ContainsUndefinedContinueTarget of the second *Statement* with arguments *iterationSet* and « ».

Deleted: ¶

Deleted: , then return

IfStatement : if (Expression) Statement

1. Return ContainsUndefinedContinueTarget of *Statement* with arguments *iterationSet* and « ».

Deleted: ¶

13.5.5 Static Semantics: VarDeclaredNames

See also: 13.0.5, 13.1.11, 13.2.2.2, 13.6.1.4, 13.6.2.4, 13.6.3.5, 13.6.4.7, 13.10.5, 13.11.7, 13.12.12, 13.14.5, 14.1.18, 14.2.13, 15.1.5, 15.2.1.13.

IfStatement : if (Expression) Statement **else** Statement

1. Let *names* be VarDeclaredNames of the first *Statement*.
2. Append to *names* the elements of the VarDeclaredNames of the second *Statement*.
3. Return *names*.

Deleted: See also: 13.0.1, , 13.2.2.2, 13.6.1.1, 13.6.2.1, 13.6.3.2, 13.6.4.3, 13.10.2, , , 13.14.2, 14.1.18, 14.2.13, 15.1.5, ¶

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Deleted: 13.12.11

Deleted: 13.14.3

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IfStatement : if (Expression) Statement

1. Return the VarDeclaredNames of *Statement*.

13.5.6 Static Semantics: VarScopedDeclarations

See also: 13.0.6, 13.1.12, 13.2.2.3, 13.6.1.5, 13.6.2.5, 13.6.3.6, 13.6.4.8, 13.10.6, 13.11.8, 13.12.13, 13.14.6, 14.1.19, 14.2.14, 15.1.6, 15.2.1.14.

IfStatement : if (Expression) Statement **else** Statement

1. Let *declarations* be VarScopedDeclarations of the first *Statement*.
2. Append to *declarations* the elements of the VarScopedDeclarations of the second *Statement*.
3. Return *declarations*.

IfStatement : if (Expression) Statement

1. Return the VarDeclaredNames of *Statement*.

Deleted: ¶

13.5.7 Runtime Semantics: Evaluation

IfStatement : if (Expression) Statement else Statement

Deleted: ¶

1. Let *exprRef* be the result of evaluating *Expression*.
2. Let *exprValue* be ToBoolean(GetValue(*exprRef*)).
3. ReturnIfAbrupt(*exprValue*).
4. If *exprValue* is **true**, then
 - a. Let *stmtValue* be the result of evaluating the first *Statement*.
5. Else,
 - a. Let *stmtValue* be the result of evaluating the second *Statement*.
6. If *stmtValue.[[type]]* is normal and *stmtValue.[[value]]* is empty, then
 - a. Return NormalCompletion(**undefined**).
7. Return *stmtValue*.

Comment [AWB1319]: Breaking change from ES5: completion reform

IfStatement : if (Expression) Statement

Deleted: ¶

1. Let *exprRef* be the result of evaluating *Expression*.
2. Let *exprValue* be ToBoolean(GetValue(*exprRef*)).
3. ReturnIfAbrupt(*exprValue*).
4. If *exprValue* is **false**, then
 - a. Return NormalCompletion(**undefined**).
5. Else,
 - a. Let *stmtValue* be the result of evaluating *Statement*.
6. If *stmtValue.[[type]]* is normal and *stmtValue.[[value]]* is empty, then
 - a. Return NormalCompletion(**undefined**).
7. Return *stmtValue*.

Comment [AWB620]: Breaking change from ES5: completion reform

Deleted: ¶

Comment [AWB1321]: Breaking change from ES5: completion reform

Deleted: ¶

13.6 Iteration Statements

Syntax

```
IterationStatement[?Yield, ?Return] :
  do Statement[?Yield, ?Return] while ( Expression[In, ?Yield] ) ;opt
  while ( Expression[In, ?Yield] ) Statement[?Yield, ?Return]
  for ( [!lookahead ∈ {let, !}] Expression[?Yield]opt ; Expression[In, ?Yield]opt ; Expression[In, ?Yield]opt )
    Statement[?Yield, ?Return]
  for ( var VariableDeclarationList[?Yield] ; Expression[In, ?Yield]opt ; Expression[In, ?Yield]opt )
    Statement[?Yield, ?Return]
  for ( LexicalDeclaration[?Yield] Expression[In, ?Yield]opt ; Expression[In, ?Yield]opt ) Statement[?Yield, ?Return]
  for ( [!lookahead ∈ {let, !}] LeftHandSideExpression[?Yield] in Expression[In, ?Yield] ) Statement[?Yield, ?Return]
  for ( var ForBinding[?Yield] in Expression[In, ?Yield] ) Statement[?Yield, ?Return]
  for ( ForDeclaration[?Yield] in Expression[In, ?Yield] ) Statement[?Yield, ?Return]
  for ( [!lookahead ≠ let] LeftHandSideExpression[?Yield] of AssignmentExpression[In, ?Yield] )
    Statement[?Yield, ?Return]
  for ( var ForBinding[?Yield] of AssignmentExpression[In, ?Yield] ) Statement[?Yield, ?Return]
  for ( ForDeclaration[?Yield] of AssignmentExpression[In, ?Yield] ) Statement[?Yield, ?Return]
```

Comment [AWB622]: This is breaking change from ES5 which allowed a *VariableDeclarationNoIn* to appear here. See es-discuss thread "lexical for-in/for-of loose end"

Deleted: ¶

ForDeclaration_[yield] :
LetOrConst ForBinding_[?yield]

Deleted: 1

ForBinding_[yield] :
BindingIdentifier_[?yield]
BindingPattern_[?yield]

Deleted: 1

NOTE 1 A semicolon is not required after a `do-while` statement.

Comment [AWB623]: Note that this is technically a breaking change from ES5, however it is made to match web reality.

Deleted: NOTE 1 *ForBinding* is defined in 12.2.4.2.¶

Deleted: 2

13.6.0 Semantics

13.6.0.1 Static Semantics: Early Errors

IterationStatement :
`do Statement while (Expression) iopt`
`while (Expression) Statement`
`for ([lookahead \notin {let, let*}] Expressionopt ; Expressionopt ; Expressionopt) Statement`
`for (var VariableDeclarationList ; Expressionopt ; Expressionopt) Statement`
`for (LexicalDeclaration Expressionopt ; Expressionopt) Statement`
`for ([lookahead \notin {let, let*}] LeftHandSideExpression in Expression) Statement`
`for (var ForBinding in Expression) Statement`
`for (ForDeclaration in Expression) Statement`
`for ([lookahead # let] LeftHandSideExpression of AssignmentExpression) Statement`
`for (var ForBinding of AssignmentExpression) Statement`
`for (ForDeclaration of AssignmentExpression[in, ?yield]) Statement`

Comment [AWB624]: This is a breaking change from ES5 which allowed a `VariableDeclarationNoIn` to appear here. See es-discuss thread "lexical for-in/for-of loose end"

Deleted: 1

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- It is a Syntax Error if `IsLabelledFunction(Statement)` is true for any occurrence of `Statement` in these rules.

NOTE It is only necessary to apply this rule if the extension specified in B.3.2 is implemented.

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13.6.0.2 Runtime Semantics: LoopContinues(completion, labelSet)

The abstract operation `LoopContinues` with arguments `completion` and `labelSet` is defined by the following step:

1. If `completion.[[type]]` is normal, return true.
2. If `completion.[[type]]` is not continue, return false.
3. If `completion.[[target]]` is empty, return true.
4. If `completion.[[target]]` is an element of `labelSet`, return true.
5. Return false.

Deleted: , then return

Deleted: , then return

Deleted: , then return

Deleted: , then return

NOTE Within the `Statement` part of an `IterationStatement` a `ContinueStatement` may be used to begin a new iteration.

13.6.1 The do-while Statement

13.6.1.1 Static Semantics: ContainsDuplicateLabels

With argument `labelSet`.

See also: 13.0.1, 13.1.2, 13.5.2, 13.6.2.1, 13.6.3.2, 13.6.4.3, 13.10.2, 13.11.2, 13.12.2, 13.14.2, 15.2.1.2.

IterationStatement : do Statement while (Expression) ;_{opt}

Deleted: ¶

1. Return ContainsDuplicateLabels of Statement with argument *labelSet*.

13.6.1.2 Static Semantics: ContainsUndefinedBreakTarget

With argument *labelSet*.

See also: 13.0.2, 13.1.3, 13.5.3, 13.6.2.2, 13.6.3.3, 13.6.4.4, 13.8.2, 13.10.3, 13.11.3, 13.12.3, 13.14.3, 15.2.1.3.

IterationStatement : do Statement while (Expression) ;_{opt}

Deleted: ¶

1. Return ContainsUndefinedBreakTarget of Statement with argument *labelSet*.

13.6.1.3 Static Semantics: ContainsUndefinedContinueTarget

With arguments *iterationSet* and *labelSet*.

See also: 13.0.3, 13.1.4, 13.5.4, 13.6.2.3, 13.6.3.4, 13.6.4.5, 13.7.2, 13.10.4, 13.11.4, 13.12.4, 13.14.4, 15.2.1.4.

IterationStatement : do Statement while (Expression) ;_{opt}

Deleted: ¶

1. Return ContainsUndefinedContinueTarget of Statement with arguments *iterationSet* and « ».

13.6.1.4 Static Semantics: VarDeclaredNames

See also: 13.0.5, 13.1.11, 13.2.2.2, 13.5.5, 13.6.2.4, 13.6.3.5, 13.6.4.7, 13.10.5, 13.11.7, 13.12.12, 13.14.5, 14.1.18, 14.2.13, 15.1.5, 15.2.1.13.

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Deleted: 13.10.3

Deleted: 13.11.5

Deleted: 13.12.11

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Deleted: 13.12.413.12.3

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Comment [AWB625]: Breaking change:
completion reform

Deleted: ¶

IterationStatement : do Statement while (Expression) ;_{opt}

1. Return the VarDeclaredNames of Statement.

13.6.1.5 Static Semantics: VarScopedDeclarations

See also: 13.0.6, 13.1.12, 13.2.2.3, 13.5.6, 13.6.2.5, 13.6.3.6, 13.6.4.8, 13.10.6, 13.11.8, 13.12.13, 13.14.6, 14.1.19, 14.2.14, 15.1.6, 15.2.1.14.

IterationStatement : do Statement while (Expression) ;_{opt}

Deleted: ¶

1. Return the VarScopedDeclarations of Statement.

13.6.1.6 Runtime Semantics: LabelledEvaluation

With argument *labelSet*.

See also: 13.0.6, 13.6.2.5, 13.6.3.6, 13.6.4.11, 13.12.12

IterationStatement : do Statement while (Expression) ;_{opt}

Deleted: ¶

1. Let *V* = undefined.

2. Repeat

- a. Let *stmt* be the result of evaluating Statement.

- b. If `LoopContinues(stmt,labelSet)` is `false`, return `stmt`.
- c. If `stmt.[[value]]` is not `empty`, let `V = stmt.[[value]]`.
- d. Let `exprRef` be the result of evaluating `Expression`.
- e. Let `exprValue` be `GetValue(exprRef)`.
- f. If `exprValue.[[type]]` is `normal`, then
 - i. If `ToBoolean(exprValue)` is `false`, return `NormalCompletion(V)`.
- g. Else
 - i. Assert: `exprValue` is an abrupt completion.
 - ii. If `LoopContinues(exprValue,labelSet)` is `false`, return `exprValue`.

13.6.2 The `while` Statement

13.6.2.1 Static Semantics: `ContainsDuplicateLabels`

With argument `labelSet`.

See also: 13.0.1, 13.1.2, 13.5.2, 13.6.1.1, 13.6.3.2, 13.6.4.3, 13.10.2, 13.11.2, 13.12.2, 13.14.2, 15.2.1.2.

IterationStatement : `while (Expression) Statement`

1. Return `ContainsDuplicateLabels` of `Statement` with argument `labelSet`.

13.6.2.2 Static Semantics: `ContainsUndefinedBreakTarget`

With argument `labelSet`.

See also: 13.0.2, 13.1.3, 13.5.3, 13.6.1.2, 13.6.3.3, 13.6.4.4, 13.8.2, 13.10.3, 13.11.3, 13.12.3, 13.14.3, 15.2.1.3.

IterationStatement : `while (Expression) Statement`

1. Return `ContainsUndefinedBreakTarget` of `Statement` with argument `labelSet`.

13.6.2.3 Static Semantics: `ContainsUndefinedContinueTarget`

With arguments `iterationSet` and `labelSet`.

Deleted: <#>If `stmt` is an abrupt completion and `LoopContinues(stmt,labelSet)` is `false`, return `stmt`.¶

Deleted: `ToBoolean(`

Deleted: `)`

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Deleted: `Return`

Comment [AWB626]: Break/continue/return in the expression works normally (future for do {} or block lambda expressions)

Deleted: if `exprValue` is not `true`, then

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See also: 13.0.3, 13.1.4, 13.5.4, 13.6.1.3, 13.6.3.4, 13.6.4.5, 13.7.2, 13.10.4, 13.11.4, 13.12.4, 13.14.4, 15.2.1.4.

IterationStatement : `while (Expression) Statement`

1. Return `ContainsUndefinedContinueTarget` of `Statement` with arguments `iterationSet` and « ».

13.6.2.4 Static Semantics: `VarDeclaredNames`

See also: 13.0.5, 13.1.11, 13.2.2.2, 13.5.5, 13.6.1.4, 13.6.3.5, 13.6.4.7, 13.10.5, 13.11.7, 13.12.12, 13.14.5, 14.1.18, 14.2.13, 15.1.5, 15.2.1.13.

IterationStatement : `while (Expression) Statement`

1. Return the `VarDeclaredNames` of `Statement`.

Deleted: See also: 13.0.1, 13.1.8, 13.2.2.2, 13.5.2, 13.6.1.1, 13.6.3.213.6.3.1, 13.6.4.3, 13.10.2, 13.11.4, 13.12.10, 13.14.2, 14.1.1814.1.17, 14.2.13, 15.1.5, 15.2.1.1313.0.1, 13.1.8, 13.5.1, 13.6.1.1, 13.6.3.1, 13.6.4.3, 13.10.2, 13.11.4, 13.12.2, 013.14.2, 14.1.16, 14.4.12, 14.5.1514.5.16, 15.1.5, 15.2.0.13.¶

Deleted: `¶`

13.6.2.5 Static Semantics: VarScopedeclarations

See also: [13.0.6](#), [13.1.12](#), [13.2.2.3](#), [13.5.6](#), [13.6.1.5](#), [13.6.3.6](#), [13.6.4.8](#), [13.10.6](#), [13.11.8](#), [13.12.13](#), [13.14.6](#), 14.1.19, 14.2.14, 15.1.6, 15.2.1.14.

IterationStatement : while (Expression) Statement

1. Return the VarScopedeclarations of Statement.

13.6.2.6 Runtime Semantics: LabelledEvaluation

With argument *labelSet*.

See also: [13.0.6](#), [13.6.1.5](#), [13.6.3.6](#), [13.6.4.11](#), [13.12.12](#).

IterationStatement : while (Expression) Statement

1. Let *V* = **undefined**.
2. Repeat
 - a. Let *exprRef* be the result of evaluating *Expression*.
 - b. Let *exprValue* be *GetValue(exprRef)*.
 - c. If *exprValue.[[type]]* is **normal**, then
 - i. If *ToBoolean(exprValue)* is **false**, return *NormalCompletion(V)*.
 - d. Else,
 - i. Assert: *exprValue* is an abrupt completion.
 - ii. If *LoopContinues(exprValue,labelSet)* is **false**, return *exprValue*.
 - e. Let *stmt* be the result of evaluating *Statement*.
 - f. If *LoopContinues(stmt,labelSet)* is **false**, return *stmt*.
 - g. If *stmt.[[value]]* is not empty, let *V* = *stmt.[[value]]*.

13.6.3 The for Statement

13.6.3.1 Static Semantics: Early Errors

IterationStatement : for (LexicalDeclaration Expression_{opt} ; Expression_{opt}) Statement

- It is a Syntax Error if any element of the BoundNames of *LexicalDeclaration* also occurs in the VarDeclaredNames of *Statement*.

13.6.3.2 Static Semantics: ContainsDuplicateLabels

With argument *labelSet*.

See also: [13.0.1](#), [13.1.2](#), [13.5.2](#), [13.6.1.1](#), [13.6.2.1](#), [13.6.4.3](#), [13.10.2](#), [13.11.2](#), [13.14.2](#), [15.2.1.2](#).

IterationStatement :

```
for ([lookahead ≠ {let | }]) Expressionopt ; Expressionopt ; Expressionopt) Statement
for (var VariableDeclarationList ; Expressionopt ; Expressionopt) Statement
for (LexicalDeclaration Expressionopt ; Expressionopt) Statement
```

1. Return ContainsDuplicateLabels of *Statement* with argument *labelSet*.

Deleted: 13.0.3
Deleted: 13.1.9
Deleted: 13.5.3
Deleted: 13.6.1.2
Deleted: 13.6.3.3
Deleted: 13.6.4.4
Deleted: 13.10.3
Deleted: 13.11.5
Deleted: 13.12.11
Deleted: 13.14.3
Deleted: ¶
Deleted: 13.0.313.0.313.0.2
Deleted: 13.6.1.2
Deleted: 13.6.3.313.6.3.313.6.3.313.6.3.2
Deleted: 13.6.4.7
Deleted: 13.6.4.1113.6.4.613.6.4.613.6.4.613.6.4.5
Deleted: 13.12.413.12.3
Deleted: ¶
Comment [AWB627]: ES5 breaking change: completion reform
Deleted: <i>ToBoolean(</i>
Deleted: <i>)</i>
Comment [AWB628]: Break/continue/return in the expression works normally (future for <i>for</i> <i>{}</i> or block lambda expressions)
Deleted: If <i>exprValue</i> is not true , then
Deleted: <#> If <i>LoopContinues(stmt,labelSet)</i> is false , return <i>stmt</i> .¶
Deleted: ¶

13.6.3.3 Static Semantics: ContainsUndefinedBreakTarget

With argument *labelSet*.

See also: 13.0.2, 13.1.3, 13.5.3, 13.6.1.2, 13.6.2.2, 13.6.4.4, 13.8.2, 13.10.3, 13.11.3, 13.12.3, 13.14.3, 15.2.1.3.

IterationStatement :

```
for ( [lookahead ≠ {let | } ] Expressionopt ; Expressionopt ; Expressionopt ) Statement
for ( var VariableDeclarationList ; Expressionopt ; Expressionopt ) Statement
for ( LexicalDeclaration Expressionopt ; Expressionopt ) Statement
```

1. Return ContainsUndefinedBreakTarget of *Statement* with argument *labelSet*.

13.6.3.4 Static Semantics: ContainsUndefinedContinueTarget

With arguments *iterationSet* and *labelSet*.

See also: 13.0.3, 13.1.4, 13.5.4, 13.6.1.3, 13.6.2.3, 13.6.4.5, 13.7.2, 13.10.4, 13.11.4, 13.12.4, 13.14.4, 15.2.1.4.

Deleted: 115.2.1.4

IterationStatement :

```
for ( [lookahead ≠ {let | } ] Expressionopt ; Expressionopt ; Expressionopt ) Statement
for ( var VariableDeclarationList ; Expressionopt ; Expressionopt ) Statement
for ( LexicalDeclaration Expressionopt ; Expressionopt ) Statement
```

1. Return ContainsUndefinedContinueTarget of *Statement* with arguments *iterationSet* and « ».

13.6.3.5 Static Semantics: VarDeclaredNames

See also: 13.0.5, 13.1.11, 13.2.2.2, 13.5.5, 13.6.1.4, 13.6.2.4, 13.6.4.7, 13.10.5, 13.11.7, 13.12.12, 13.14.5, 14.1.18, 14.2.13, 15.1.5, 15.2.1.13.

Deleted: See also: 13.0.1, 13.1.8, 13.2.2.2, 13.5.2, 13.6.1.1, 13.6.3.213.6.2.1, 13.6.4.3, 13.10.2, , 13.11.4, 13.12.10, 13.14.2, 14.1.1814.1.17, 14.2.13, 15.1.5, 15.2.1.1313.0.1, 13.1.8, , 13.5.1, 13.6.1.1, 13.6.2.1, 13.6.4.3, 13.10.2, 13.11.4, 13.12.2, 013.14.2, 14.1.16, 14.4.12, 14.5.1514.5.16, 15.1.5, 15.2.0.13.¶

IterationStatement : ~~for (Expression_{opt} ; Expression_{opt} ; Expression_{opt}) Statement~~

1. Return the VarDeclaredNames of *Statement*.

IterationStatement : ~~for (var VariableDeclarationList ; Expression_{opt} ; Expression_{opt}) Statement~~

1. Let *names* be BoundNames of *VariableDeclarationList*.
2. Append to *names* the elements of the VarDeclaredNames of *Statement*.
3. Return *names*.

IterationStatement : ~~for (LexicalDeclaration Expression_{opt} ; Expression_{opt}) Statement~~

1. Return the VarDeclaredNames of *Statement*.

13.6.3.6 Static Semantics: VarScopedDeclarations

See also: 13.0.6, 13.1.12, 13.2.2.3, 13.5.6, 13.6.1.5, 13.6.2.5, 13.6.4.8, 13.10.6, 13.11.8, 13.12.13, 13.14.6, 14.1.19, 14.2.14, 15.1.6, 15.2.1.14.

Deleted: [lookahead ≠ {let | }]

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Deleted: 13.6.4.4

Deleted: 13.10.3

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Deleted: 13.12.11

Deleted: 13.14.3

IterationStatement : for (Expression_{opt} ; Expression_{opt} ; Expression_{opt}) Statement

1. Return the VarScopedDeclarations of *Statement*.

Deleted: [lookahead \notin {let, t}]

Deleted: ¶

IterationStatement : for (var VariableDeclarationList ; Expression_{opt} ; Expression_{opt}) Statement

1. Let *declarations* be VarScopedDeclarations of *VariableDeclarationList*.
2. Append to *declarations* the elements of the VarScopedDeclarations of *Statement*.
3. Return *declarations*.

Deleted: ¶

IterationStatement : for (LexicalDeclaration Expression_{opt} ; Expression_{opt}) Statement

1. Return the VarScopedDeclarations of *Statement*.

Deleted: ¶

13.6.3.7 Runtime Semantics: LabelledEvaluation

With argument *labelSet*.

See also: [13.0.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.4.11](#), [13.12.12](#)

IterationStatement : for (Expression_{opt} ; Expression_{opt} ; Expression_{opt}) Statement

1. If the first *Expression* is present, then
 - a. Let *exprRef* be the result of evaluating the first *Expression*.
 - b. Let *exprValue* be *GetValue(exprRef)*.
 - c. If *LoopContinues(exprValue,labelSet)* is **false**, return *exprValue*.
2. Return the result of performing *ForBodyEvaluation* with the *second Expression* as the *testExpr* argument, the *third Expression* as the *incrementExpr* argument, *Statement* as the *stmt* argument, *«»* as the *perIterationBindings*, and with *labelSet*.

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Deleted: 13.6.1.2

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Deleted: 13.12.413.12.3

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IterationStatement : for (var VariableDeclarationList ; Expression_{opt} ; Expression_{opt}) Statement

1. Let *varDcl* be the result of evaluating *VariableDeclarationList*.
2. If *LoopContinues(varDcl,labelSet)* is **false**, return *varDcl*.
3. Return the result of performing *ForBodyEvaluation* with the first *Expression* as the *testExpr* argument, the second *Expression* as the *incrementExpr* argument, *Statement* as the *stmt* argument, *«»* as the *perIterationBindings*, and with *labelSet*.

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IterationStatement : for (LexicalDeclaration Expression_{opt} ; Expression_{opt}) Statement

1. Let *oldEnv* be the running execution context's *LexicalEnvironment*.
2. Let *loopEnv* be *NewDeclarativeEnvironment(oldEnv)*.
3. Let *isConst* be the result of performing *IsConstantDeclaration* of *LexicalDeclaration*.
4. Let *boundNames* be the *BoundNames* of *LexicalDeclaration*.
5. For each element *dn* of *boundNames* do
 - a. If *isConst* is **true**, then
 - i. Call *loopEnv*'s *CreateImmutableBinding* concrete method passing *dn* and **true** as the arguments.
 - b. Else,
 - i. Call *loopEnv*'s *CreateMutableBinding* concrete method passing *dn* and **false** as the arguments.
 - ii. Assert: The above call to *CreateMutableBinding* will never return an abrupt completion.
6. Set the running execution context's *LexicalEnvironment* to *loopEnv*.
7. Let *forDcl* be the result of evaluating *LexicalDeclaration*.
8. If *LoopContinues(forDcl,labelSet)* is **false**, then

Deleted: ¶

- a. Set the running execution context's LexicalEnvironment to *oldEnv*.
- b. Return *forDcl*.
9. If *isConst* is **false**, let *perIterationLets* be *boundNames* otherwise let *perIterationLets* be ~~*labelSet*~~.
10. Let *bodyResult* be the result of performing ForBodyEvaluation with the first *Expression* as the *testExpr* argument, the second *Expression* as the *incrementExpr* argument, *Statement* as the *stmt* argument, *perIterationLets* as the *perIterationBindings*, and with *labelSet*.
11. Set the running execution context's LexicalEnvironment to *oldEnv*.
12. Return *bodyResult*.

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Deleted: (
Deleted:)

13.6.3.8 Runtime Semantics: ForBodyEvaluation

The abstract operation ForBodyEvaluation with arguments *testExpr*, *incrementExpr*, *stmt*, *perIterationBindings*, and *labelSet* is performed as follows:

1. Let *V* = **undefined**.
2. Let *status* be CreatePerIterationEnvironment(*perIterationBindings*).
3. ReturnIfAbrupt(*status*).
4. Repeat
 - a. If *testExpr* is not [empty], then
 - i. Let *testExprRef* be the result of evaluating *testExpr*.
 - ii. Let *testExprValue* be GetValue(*testExprRef*).
 - iii. If *testExprValue*.[[type]] is normal, then
 1. If ToBoolean(*testExprValue*) is **false**, return NormalCompletion(*V*).
 - iv. Else₂
 1. Assert: *testExprValue* is an abrupt completion.
 2. If LoopContinues(*testExprValue,labelSet*) is **false**, return *testExprValue*.
 - b. Let *result* be the result of evaluating *stmt*.
 - c. If LoopContinues(*result,labelSet*) is **false**, return *result*
 - d. If *result*.[[value]] is not empty, let *V* = *result*.[[value]].
 - e. Let *status* be CreatePerIterationEnvironment(*perIterationBindings*).
 - f. ReturnIfAbrupt(*status*).
 - g. If *incrementExpr* is not [empty], then
 - i. Let *incExprRef* be the result of evaluating *incrementExpr*.
 - ii. Let *incExprValue* be GetValue(*incExprRef*).
 - iii. If LoopContinues(*incExprValue,labelSet*) is **false**, return *incExprValue*.

Comment [AWB629]: ES5 breaking change:
 Completion reform

Deleted: ToBoolean(
Deleted:)

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Deleted: <#>If LoopContinues
 (*result,labelSet*) is **false**, return *result*.¶

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13.6.3.9 Runtime Semantics: CreatePerIterationEnvironment

The abstract operation CreatePerIterationEnvironment with argument *perIterationBindings* is performed as follows:

1. If *perIterationBindings* has any elements, then
 - a. Let *lastIterationEnv* be the running execution context's LexicalEnvironment.
 - b. Let *outer* be *lastIterationEnv*'s outer environment reference.
 - c. Assert: *outer* is not **null**.
 - d. Let *thisIterationEnv* be NewDeclarativeEnvironment(*outer*).
 - e. For each element *bn* of *perIterationBindings* do,
 - i. Let *status* be the result of calling *thisIterationEnv*'s CreateMutableBinding concrete method passing *bn* and **false** as the arguments.
 - ii. Assert: *status* is never an abrupt completion.
 - iii. Let *lastValue* be the result of calling *lastIterationEnv*'s GetBindingValue concrete method passing *bn* and **true** as the arguments.
 - iv. ReturnIfAbrupt(*lastValue*).

Deleted: lexical

- v. Call the InitializeBinding concrete method of *thisIterationEnv* passing *bn* and *lastValue* as the arguments.
- f. Set the running execution context's LexicalEnvironment to *thisIterationEnv*.
- 2. Return **undefined**

13.6.4 The **for-in** and **for-of** Statements

13.6.4.1 Static Semantics: Early Errors

IterationStatement :

for (*LeftHandSideExpression* **in** *Expression*) *Statement*
for (*LeftHandSideExpression* **of** *AssignmentExpression*) *Statement*

- It is a Syntax Error if *LeftHandSideExpression* is either an *ObjectLiteral* or an *ArrayLiteral* and if the lexical token sequence matched by *LeftHandSideExpression* cannot be parsed with no tokens left over using *AssignmentPattern* as the goal symbol.

If *LeftHandSideExpression* is either an *ObjectLiteral* or an *ArrayLiteral* and if the lexical token sequence matched by *LeftHandSideExpression* can be parsed with no tokens left over using *AssignmentPattern* as the goal symbol then the following rules are not applied. Instead, the Early Error rules for *AssignmentPattern* are used.

- It is a Syntax Error if *IsValidSimpleAssignmentTarget* of *LeftHandSideExpression* is **false**.
- It is a Syntax Error if the *LeftHandSideExpression* is *CoverParenthesizedExpressionAndArrowParameterList* : (*Expression*) and *Expression* derives a production that would produce a Syntax Error according to these rules if that production is substituted for *LeftHandSideExpression*. This rule is recursively applied.

NOTE The last rule means that the other rules are applied even if parentheses surround *Expression*.

IterationStatement :

for (*ForDeclaration* **in** *Expression*) *Statement*
for (*ForDeclaration* **of** *AssignmentExpression*) *Statement*

- It is a Syntax Error if the *BoundNames* of *ForDeclaration* contains "let".
- It is a Syntax Error if any element of the *BoundNames* of *ForDeclaration* also occurs in the *VarDeclaredNames* of *Statement*.
- **It is a Syntax Error if the *BoundNames* of *ForDeclaration* contains any duplicate entries.**

13.6.4.2 Static Semantics: BoundNames

See also: 13.2.1.2, 13.2.2.1, 12.1.2, 14.1.3, 14.2.2, 14.4.2, 14.5.2, [15.2.2.2](#), [15.2.3.1](#)

ForDeclaration : *LetOrConst* *ForBinding*

1. Return the *BoundNames* of *ForBinding*.

13.6.4.3 Static Semantics: ContainsDuplicateLabels

With argument *labelSet*.

See also: 13.0.1, 13.1.2, 13.5.2, 13.6.1.1, 13.6.2.1, 13.6.3.2, 13.10.2, 13.11.2, 13.12.2, 13.14.2, 15.2.1.2

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Deleted: <#>It is a Syntax Error if *LeftHandSideExpression* is a *IdentifierReference* that can be statically determined to always resolve to a declarative environment record binding and the resolved binding is an immutable binding.¶

Deleted: *LeftHandSideExpression* is neither an *ObjectLiteral* nor an *ArrayLiteral* and

Deleted: multiple levels of nested

Deleted: parenthesizes

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Deleted: *ForBinding* : *BindingPattern*¶

Deleted: *BindingPattern*

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Deleted: 15.2.3.115.2.2.1

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IterationStatement :

```

for (lookahead ≠ {let, [ }) LeftHandSideExpression in Expression ) Statement
for ( var ForBinding in Expression ) Statement
for ( ForDeclaration in Expression ) Statement
for (lookahead ≠ let) LeftHandSideExpression of AssignmentExpression ) Statement
for ( var ForBinding of AssignmentExpression ) Statement
for ( ForDeclaration of AssignmentExpression[In, ?Yield] ) Statement

```

Deleted: ¶

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1. Return ContainsDuplicateLabels of Statement with argument *labelSet*.

13.6.4.4 Static Semantics: ContainsUndefinedBreakTarget

With argument *labelSet*.

See also: 13.0.2, 13.1.3, 13.5.3, 13.6.1.2, 13.6.2.2, 13.6.3.3, 13.8.2, 13.10.3, 13.11.3, 13.12.3, 13.14.3, 15.2.1.3.

IterationStatement :

```

for (lookahead ≠ {let, [ }) LeftHandSideExpression in Expression ) Statement
for ( var ForBinding in Expression ) Statement
for ( ForDeclaration in Expression ) Statement
for (lookahead ≠ let) LeftHandSideExpression of AssignmentExpression ) Statement
for ( var ForBinding of AssignmentExpression ) Statement
for ( ForDeclaration of AssignmentExpression[In, ?Yield] ) Statement

```

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1. Return ContainsUndefinedBreakTarget of Statement with argument *labelSet*.

13.6.4.5 Static Semantics: ContainsUndefinedContinueTarget

With arguments *iterationSet* and *labelSet*.

See also: 13.0.3, 13.1.4, 13.5.4, 13.6.1.3, 13.6.2.3, 13.6.3.4, 13.7.2, 13.10.4, 13.11.4, 13.12.4, 13.14.4, 15.2.1.4.

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IterationStatement :

```

for (lookahead ≠ {let, [ }) LeftHandSideExpression in Expression ) Statement
for ( var ForBinding in Expression ) Statement
for ( ForDeclaration in Expression ) Statement
for (lookahead ≠ let) LeftHandSideExpression of AssignmentExpression ) Statement
for ( var ForBinding of AssignmentExpression ) Statement
for ( ForDeclaration of AssignmentExpression[In, ?Yield] ) Statement

```

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1. Return ContainsUndefinedContinueTarget of Statement with arguments *iterationSet* and « ».

13.6.4.6 Static Semantics: IsDestructuring

See also: 12.3.1.3.

ForDeclaration : LetOrConst ForBinding

Deleted: ¶

1. Return IsDestructuring of *ForBinding*.

ForBinding : BindingIdentifier

1. Return **false**.

ForBinding : BindingPattern

1. Return **true**.

13.6.4.7 Static Semantics: VarDeclaredNames

See also: [13.0.5](#), [13.1.11](#), [13.2.2.2](#), [13.5.5](#), [13.6.1.4](#), [13.6.2.4](#), [13.6.3.5](#), [13.10.5](#), [13.11.7](#), [13.12.12](#), [13.14.5](#), [14.1.18](#), [14.2.13](#), [15.1.5](#), [15.2.1.13](#).

IterationStatement : for (LeftHandSideExpression in Expression) Statement

1. Return the VarDeclaredNames of *Statement*.

IterationStatement : for (var ForBinding in Expression) Statement

1. Let *names* be the BoundNames of *ForBinding*.
2. Append to *names* the elements of the VarDeclaredNames of *Statement*.
3. Return *names*.

Deleted: See also: [13.0.1](#), [13.1.8](#), [13.2.2.2](#), [13.5.2](#), [13.6.1.1](#), [13.6.3.2](#)[13.6.2.1](#), [13.6.3.1](#), [13.10.2](#), [13.11.4](#), [13.12.10](#), [13.14.2](#), [14.1.18](#)[14.1.17](#), [14.2.13](#), [15.1.5](#), [15.2.1.13](#)[13.0.1](#), [13.1.8](#), [13.5.1](#), [13.6.1.2](#), [13.6.2.1](#), [13.6.3.1](#), [13.10.2](#), [13.11.4](#), [13.12.2](#), [013.14.2](#), [14.1.16](#), [14.4.12](#), [14.5.15](#)[14.5.16](#), [15.1.5](#), [15.2.0.13](#).

Deleted: ¶

IterationStatement : for (ForDeclaration in Expression) Statement

1. Return the VarDeclaredNames of *Statement*.

Deleted: ¶

IterationStatement : for (LeftHandSideExpression of AssignmentExpression) Statement

1. Return the VarDeclaredNames of *Statement*.

Deleted: ¶

IterationStatement : for (var ForBinding of AssignmentExpression) Statement

1. Let *names* be the BoundNames of *ForBinding*.
2. Append to *names* the elements of the VarDeclaredNames of *Statement*.
3. Return *names*.

IterationStatement : for (ForDeclaration of AssignmentExpression) Statement

1. Return the VarDeclaredNames of *Statement*.

Deleted: ¶

13.6.4.8 Static Semantics: VarScopedDeclarations

See also: [13.0.6](#), [13.1.12](#), [13.2.2.3](#), [13.5.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.10.6](#), [13.11.8](#), [13.12.13](#), [13.14.6](#), [14.1.19](#), [14.2.14](#), [15.1.6](#), [15.2.1.14](#).

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IterationStatement : for (ForDeclaration in Expression) Statement

1. Return the VarScopedDeclarations of Statement.

Deleted: ¶

IterationStatement : for (LeftHandSideExpression of AssignmentExpression) Statement

1. Return the VarScopedDeclarations of Statement.

Deleted: ¶

IterationStatement : for (var ForBinding of AssignmentExpression) Statement

1. Let declarations be a List containing ForBinding.
2. Append to declarations the elements of the VarScopedDeclarations of Statement.
3. Return declarations.

Deleted: the BoundNames of VarScopedDeclarations

IterationStatement : for (ForDeclaration of AssignmentExpression) Statement

1. Return the VarScopedDeclarations of Statement.

Deleted: ¶

13.6.4.9 Runtime Semantics: BindingInitialization

With arguments value and environment.

See also: [12.1.5](#), [13.2.3.5](#).

Deleted: 12.1.4, 13.2.2.4, 13.2.3.5, 13.14.4

NOTE undefined is passed for environment to indicate that a PutValue operation should be used to assign the initialization value. This is the case for var statements and the formal parameter lists of some non-strict functions (see 9.2.13). In those cases a lexical binding is hoisted and preinitialized prior to evaluation of its initializer.

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ForDeclaration : LetOrConst ForBinding

1. Return the result of performing BindingInitialization for ForBinding passing value and environment as the arguments.

Deleted: ForBinding : BindingPattern¶
 <#>If Type(value) is not Object, then throw a TypeError exception.
 Let obj be ToObject(obj).¶
 <#>ReturnIfAbrupt(obj).¶
 <#>Return the result of performing BindingInitialization for BindingPattern passing valueobjvalue and environment as the arguments.¶

13.6.4.10 Runtime Semantics: BindingInstantiation

With argument environment.

ForDeclaration : LetOrConst ForBinding

1. For each element name of the BoundNames of ForBinding do
 - a. If IsConstantDeclaration of LetOrConst is true, then
 - i. Call environment's CreateImmutableBinding concrete method with arguments name and true.
 - b. Else,
 - i. Call environment's CreateMutableBinding concrete method with argument name.
 - ii. Assert: The above call to CreateMutableBinding will never return an abrupt completion.

Deleted: s value and

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See also: [13.0.313.0.313.0.2](#), [13.6.1.2](#), [13.6.2.2](#), [13.6.3.313.6.3.313.6.3.2](#), [13.12.1213.12.413.12.3](#).

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Deleted: <#>Return the result of performing BindingInitialization for ForBinding passing value and environment as the arguments.¶

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13.6.4.11 Runtime Semantics: LabelledEvaluation

With argument labelSet.

See also: [13.0.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.12.14](#).

IterationStatement : for (LeftHandSideExpression in Expression) Statement

1. Let *keyResult* be *ForIn/OfExpressionEvaluation(«», Expression, enumerate, labelSet)*.
2. ReturnIfAbrupt(*keyResult*).
3. Return *ForIn/OfBodyEvaluation(LeftHandSideExpression, Statement, keyResult, assignment, labelSet)*.

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IterationStatement : for (var ForBinding in Expression) Statement

1. Let *keyResult* be *ForIn/OfExpressionEvaluation(«», Expression, enumerate, labelSet)*.
2. ReturnIfAbrupt(*keyResult*).
3. Return *ForIn/OfBodyEvaluation(ForBinding, Statement, keyResult, varBinding, labelSet)*.

Deleted: the result of performing ...

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IterationStatement : for (ForDeclaration in Expression) Statement

1. Let *keyResult* be the result of performing *ForIn/OfExpressionEvaluation(BoundNames of ForDeclaration, Expression, enumerate, labelSet)*.
2. ReturnIfAbrupt(*keyResult*).
3. Return *ForIn/OfBodyEvaluation(ForDeclaration, Statement, keyResult, lexicalBinding, labelSet)*.

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IterationStatement : for (LeftHandSideExpression of AssignmentExpression) Statement

1. Let *keyResult* be the result of performing *ForIn/OfExpressionEvaluation(«», AssignmentExpression, iterate, labelSet)*.
2. ReturnIfAbrupt(*keyResult*).
3. Return *ForIn/OfBodyEvaluation(LeftHandSideExpression, Statement, keyResult, assignment, labelSet)*.

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IterationStatement : for (var ForBinding of AssignmentExpression) Statement

1. Let *keyResult* be the result of performing *ForIn/OfExpressionEvaluation(«», AssignmentExpression, iterate, labelSet)*.
2. ReturnIfAbrupt(*keyResult*).
3. Return *ForIn/OfBodyEvaluation(ForBinding, Statement, keyResult, varBinding, labelSet)*.

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Deleted: the result of performing ...

IterationStatement : for (ForDeclaration of AssignmentExpression) Statement

1. Let *keyResult* be the result of performing *ForIn/OfExpressionEvaluation(BoundNames of ForDeclaration, AssignmentExpression, iterate, labelSet)*.
2. ReturnIfAbrupt(*keyResult*).
3. Return *ForIn/OfBodyEvaluation(ForDeclaration, Statement, keyResult, lexicalBinding, labelSet)*.

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Deleted: the result of performing ...

13.6.4.12 Runtime Semantics: ForIn/OfExpressionEvaluation Abstract Operation

The abstract operation *ForIn/OfExpressionEvaluation* is called with arguments *TDZnames*, *expr*, *iterationKind*, and *labelSet*. The value of *iterationKind* is either **enumerate** or **iterate**.

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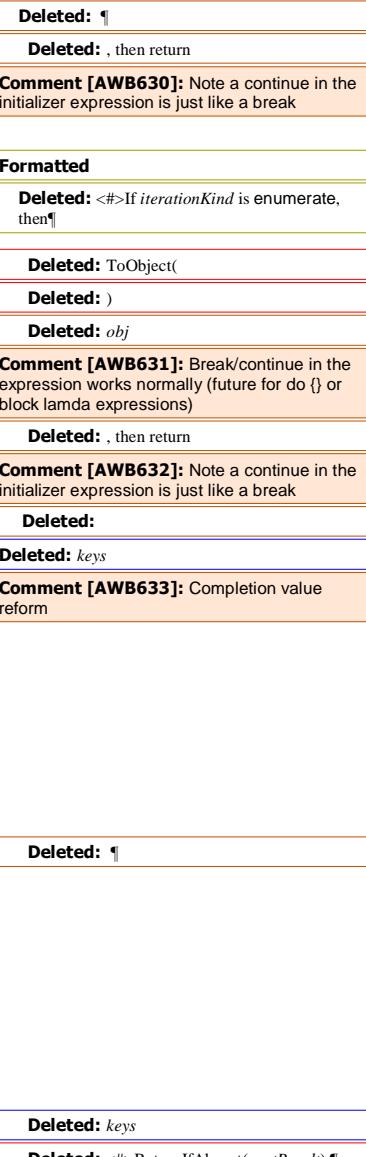
1. Let *oldEnv* be the running execution context's *LexicalEnvironment*.
2. If *TDZnames* is not an empty List, then
 - a. Assert: *TDZnames* has no duplicate entries.
 - b. Let *TDZ* be *NewDeclarativeEnvironment(oldEnv)*.
 - c. For each string *name* in *TDZnames*, do
 - i. Let *status* be the result of calling *TDZ*'s *CreateMutableBinding* concrete method passing *name* and **false** as the arguments.
 - ii. Assert: *status* is never an abrupt completion.

- d. Set the running execution context's LexicalEnvironment to *TDZ*.
- 3. Let *exprRef* be the result of evaluating the production that is *expr*.
- 4. Set the running execution context's LexicalEnvironment to *oldEnv*.
- 5. Let *exprValue* be GetValue(*exprRef*).
- 6. If *exprValue* is an abrupt completion,
 - a. If LoopContinues(*exprValue*,*labelSet*) is false, return *exprValue*.
 - b. Else, return Completion{[[type]]: break, [[value]]: empty, [[target]]: empty}.
- 7. If *iterationKind* is enumerate, then
 - a. If *exprValue*.[[value]] is null or undefined, then
 - i. Return Completion{[[type]]: break, [[value]]: empty, [[target]]: empty}.
 - b. Let *obj* be ToObject(*exprValue*).
 - c. Let *keys* be the result of calling the [[Enumerate]] internal method of *obj* with no arguments.
 - 8. Else,
 - a. Assert: *iterationKind* is iterate.
 - b. Let *keys* be GetIterator(*exprValue*).
 - 9. If *keys* is an abrupt completion, then
 - a. If LoopContinues(*keys*,*labelSet*) is false, return *keys*.
 - b. Assert: *keys*.[[type]] is continue
 - c. Return Completion{[[type]]: break, [[value]]: empty, [[target]]: empty}.
 - 10. Return *keys*.

13.6.4.13 Runtime Semantics: ForIn/OfBodyEvaluation

The abstract operation ForIn/OfBodyEvaluation is called with arguments *lhs*, *stmt*, *iterator*, *lhsKind*, and *labelSet*. The value of *lhsKind* is either **assignment**, **varBinding** or **lexicalBinding**.

- 1. Let *oldEnv* be the running execution context's LexicalEnvironment.
- 2. Let *V* = undefined.
- 3. Let *destructuring* be IsDestructuring of *lhs*.
- 4. If *destructuring* is true and if *lhsKind* is assignment, then
 - a. Assert: *lhs* is a LeftHandSideExpression.
 - b. Let *AssignmentPattern* be the parse of the source code corresponding to *lhs* using AssignmentPattern as the goal symbol.
- 5. Repeat
 - a. If *lhsKind* is either assignment or varBinding, then
 - i. If *destructuring* is false, then
 - 1. Let *lhsRef* be the result of evaluating *lhs* (it may be evaluated repeatedly).
 - 2. ReturnIfAbrupt(*lhsRef*).
 - b. Else
 - i. Assert: *lhsKind* is lexicalBinding.
 - ii. Assert: *lhs* is a ForDeclaration.
 - iii. Let *iterationEnv* be NewDeclarativeEnvironment(*oldEnv*).
 - iv. Set the running execution context's LexicalEnvironment to *iterationEnv*.
 - v. Perform BindingInstantiation for *lhs* passing *iterationEnv* as the argument.
 - vi. If *destructuring* is false, then
 - 1. Assert: *lhs* binds a single name.
 - 2. Let *lhsName* be the sole element of BoundNames of *lhs*.
 - 3. Let *lhsRef* be ResolveBinding(the sole element of *lhs*).
 - 4. Assert: *lhsRef* is not an abrupt completion.
 - c. Let *nextResult* be IteratorStep(*iterator*).
 - d. If *nextResult* is an abrupt completion, then
 - i. Set the running execution context's LexicalEnvironment to *oldEnv*.
 - ii. Return *nextResult*.



- e. If *nextResult* is **false**, then
 - i. Set the running execution context's LexicalEnvironment to *oldEnv*.
 - ii. Return NormalCompletion(*V*).
- f. Let *nextValue* be IteratorValue(*nextResult*).
- g. If *nextValue* is an abrupt completion, then
 - i. Set the running execution context's LexicalEnvironment to *oldEnv*.
 - ii. Return *nextValue*.
- h. If *destructuring* is **false**, then
 - i. If *lhsKind* is **lexicalBinding**, then
 - 1. Let *status* be InitializeReferencedBinding(*lhsRef*, *nextValue*).
 - ii. Else
 - 1. Let *status* be PutValue(*lhsRef*, *nextValue*).
 - iii. Else
 - 1. If *lhsKind* is **assignment**, then
 - 1. Let *status* be the result of performing **DestructuringAssignmentEvaluation** of *assignmentPattern* using *nextValue* as the argument.
 - ii. Else if *lhsKind* is **varBinding**, then
 - 1. Assert: *lhs* is a **ForBinding**.
 - 2. Let *status* be the result of performing **BindingInitialization** for *lhs* passing *nextValue* and **undefined** as the arguments.
 - iii. Else
 - 1. Assert: *lhsKind* is **lexicalBinding**.
 - 2. Assert: *lhs* is a **ForDeclaration**.
 - 3. Let *status* be the result of performing **BindingInitialization** for *lhs* passing *nextValue* and *iterationEnv* as arguments.
- j. If *status* is an abrupt completion, then
 - i. Set the running execution context's LexicalEnvironment to *oldEnv*.
 - ii. Return IteratorClose(*iterator*, *status*).
- k. Let *status* be the result of evaluating *stmt*.
- l. If *status*.[[type]] is normal and *status*.[[value]] is not empty, then
 - i. Let *V* = *status*.[[value]].
- m. Set the running execution context's LexicalEnvironment to *oldEnv*.
- n. If *LoopContinues(status,labelSet)* is **false**, then
 - i. Return IteratorClose(*iterator*, *status*).

13.6.4.14 Runtime Semantics: Evaluation

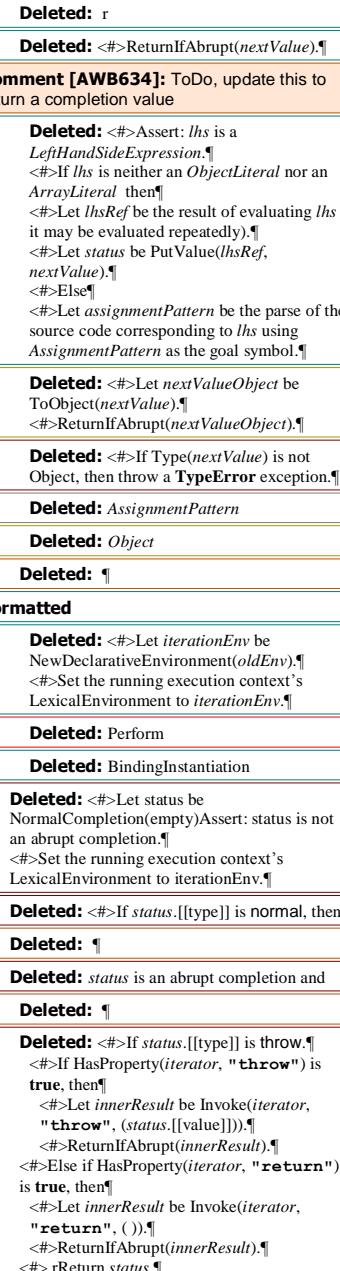
ForBinding : *BindingIdentifier*

1. Let *bindingId* be **StringValue** of *BindingIdentifier*.
2. Return **ResolveBinding**(*bindingId*)

13.7 The continue Statement

Syntax

```
ContinueStatement[Yield] :
  continue ;
  continue [no LineTerminator here] LabelIdentifier[?Yield] ;
```



13.7.1 Static Semantics: Early Errors

ContinueStatement : `continue` ;
ContinueStatement : `continue` *LabelIdentifier* ;

- It is a Syntax Error if this production is not nested, directly or indirectly (but not crossing function boundaries), within an *IterationStatement*.

13.7.2 Static Semantics: ContainsUndefinedContinueTarget

With arguments *iterationSet* and *labelSet*.

See also: 13.0.3, 13.1.4, 13.5.4, 13.6.1.3, 13.6.2.3, 13.6.3.4, 13.6.4.5, 13.10.4, 13.11.4, 13.12.4, 13.14.4, 15.2.1.4.

ContinueStatement : `continue` *i* ;

1. Return `false`.

ContinueStatement : `continue` *LabelIdentifier* ;

1. If the StringValue of *LabelIdentifier* is not an element of *iterationSet*, return `true`.
2. Return `false`.

13.7.3 Runtime Semantics: Evaluation

ContinueStatement : `continue` ;

1. Return Completion{[[type]]: `continue`, [[value]]: empty, [[target]]: empty}.

ContinueStatement : `continue` *LabelIdentifier* ;

1. Let *label* be the StringValue of *LabelIdentifier*.
2. Return Completion{[[type]]: `continue`, [[value]]: empty, [[target]]: *label*}.

13.8 The `break` Statement

Syntax

*BreakStatement*_[Yield] :
 `break` ;
 `break` [no LineTerminator here] *LabelIdentifier*_[?Yield] ;

13.8.1 Static Semantics: Early Errors

BreakStatement : `break` ;

- It is a Syntax Error if this production is not nested, directly or indirectly (but not crossing function boundaries), within an *IterationStatement* or a *SwitchStatement*.

13.8.2 Static Semantics: ContainsUndefinedBreakTarget

With argument *labelSet*.

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Deleted: <#>It is a Syntax Error if this production is not nested, directly or indirectly (but not crossing function boundaries), within an *IterationStatement*.¶
<#>It is a Syntax Error if StringValue(of *LabelIdentifier*) does not appear in the enclosing *CurrentLabelSet IterationLabelSet* of an enclosing (but not crossing function boundaries) *this ContinueStatementIterationStatement*.¶

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Deleted: *BreakStatement* : `break`
LabelIdentifier : ¶
<#>It is a Syntax Error if StringValue(of *LabelIdentifier*) does not appear in the enclosing *CurrentLabelSet* of an enclosing (but not crossing function boundaries) *this BreakStatementStatement*.¶

See also: [13.0.2](#), [13.1.3](#), [13.5.3](#), [13.6.1.2](#), [13.6.2.2](#), [13.6.3.3](#), [13.6.4.4](#), [13.10.3](#), [13.11.3](#), [13.12.3](#), [13.14.3](#), [15.2.1.3](#).

BreakStatement : break ;

1. Return **false**.

Deleted: ¶

BreakStatement : break LabelIdentifier ;

1. If the StringValue of *LabelIdentifier* is not an element of *labelSet*, return **true**.
2. Return **false**.

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13.8.3 Runtime Semantics: Evaluation

BreakStatement : break ;

1. Return Completion{[[type]]: break, [[value]]: empty, [[target]]: empty}.

Deleted: ¶

BreakStatement : break LabelIdentifier ;

1. Let *label* be the StringValue of *LabelIdentifier*.
2. Return Completion{[[type]]: break, [[value]]: empty, [[target]]: *label*}.

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13.9 The **return** Statement

Syntax

```
ReturnStatement[Yield] :
  return ;
  return [no LineTerminator here] Expression[In, ?Yield] ;
```

NOTE A **return** statement causes a function to cease execution and return a value to the caller. If *Expression* is omitted, the return value is **undefined**. Otherwise, the return value is the value of *Expression*.

13.9.1 Runtime Semantics: Evaluation

ReturnStatement : return ;

1. Return Completion{[[type]]: return, [[value]]: **undefined**, [[target]]: empty}.

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ReturnStatement : return Expression ;

1. Let *exprRef* be the result of evaluating *Expression*.
2. Let *exprValue* be *GetValue(exprRef)*.
3. ReturnIfAbrupt(*exprValue*).
4. Return Completion{[[type]]: return, [[value]]: *exprValue*, [[target]]: empty}.

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13.10 The **with** Statement

Syntax

```
WithStatement[Yield, Return] :
  with ( Expression[In, ?Yield] ) Statement[?Yield, ?Return]
```

NOTE The `with` statement adds an object environment record for a computed object to the lexical environment of the running execution context. It then executes a statement using this augmented lexical environment. Finally, it restores the original lexical environment.

13.10.1 Static Semantics: Early Errors

WithStatement : `with` (Expression) Statement

- It is a Syntax Error if the code that matches this production is contained in strict code.
- It is a Syntax Error if IsLabelledFunction(Statement) is true.

NOTE It is only necessary to apply the second rule if the extension specified in [B.3.2 is implemented](#).

13.10.2 Static Semantics: ContainsDuplicateLabels

With argument `labelSet`.

See also: [13.0.1](#), [13.1.2](#), [13.5.2](#), [13.6.1.1](#), [13.6.2.1](#), [13.6.3.2](#), [13.6.4.3](#), [13.11.2](#), [13.12.2](#), [13.14.2](#), [15.2.1.2](#).

WithStatement : `with` (Expression) Statement

1. Return `ContainsDuplicateLabels` of `Statement` with argument `labelSet`.

13.10.3 Static Semantics: ContainsUndefinedBreakTarget

With argument `labelSet`.

See also: [13.0.2](#), [13.1.3](#), [13.5.3](#), [13.6.1.2](#), [13.6.2.2](#), [13.6.3.3](#), [13.6.4.4](#), [13.8.2](#), [13.11.3](#), [13.12.3](#), [13.14.3](#), [15.2.1.3](#).

WithStatement : `with` (Expression) Statement

1. Return `ContainsUndefinedBreakTarget` of `Statement` with argument `labelSet`.

13.10.4 Static Semantics: ContainsUndefinedContinueTarget

With arguments `iterationSet` and `labelSet`.

See also: [13.0.3](#), [13.1.4](#), [13.5.4](#), [13.6.1.3](#), [13.6.2.3](#), [13.6.3.4](#), [13.6.4.5](#), [13.7.2](#), [13.11.4](#), [13.12.4](#), [13.14.4](#), [15.2.1.4](#).

WithStatement : `with` (Expression) Statement

1. Return `ContainsUndefinedContinueTarget` of `Statement` with arguments `iterationSet` and « ».

13.10.5 Static Semantics: VarDeclaredNames

See also: [13.0.5](#), [13.1.11](#), [13.2.2.2](#), [13.5.5](#), [13.6.1.4](#), [13.6.2.4](#), [13.6.3.5](#), [13.6.4.7](#), [13.11.7](#), [13.12.12](#), [13.14.5](#), [14.1.18](#), [14.2.13](#), [15.1.5](#), [15.2.1.13](#).

WithStatement : `with` (Expression) Statement

1. Return the `VarDeclaredNames` of `Statement`.

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13.10.6 Static Semantics: VarScopedDeclarations

See also: [13.0.6](#), [13.1.12](#), [13.2.2.3](#), [13.5.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.6.4.8](#), [13.11.8](#), [13.12.13](#), [13.14.6](#), [14.1.19](#), [14.2.14](#), [15.1.6](#), [15.2.1.14](#).

WithStatement : with (Expression) Statement

1. Return the VarScopedDeclarations of *Statement*.

13.10.7 Runtime Semantics: Evaluation

WithStatement : with (Expression) Statement

1. Let *val* be the result of evaluating *Expression*.
2. Let *obj* be *ToObject*(*GetValue*(*val*)).
3. ReturnIfAbrupt(*obj*).
4. Let *oldEnv* be the running execution context's *LexicalEnvironment*.
5. Let *newEnv* be *NewObjectEnvironment*(*obj*, *oldEnv*).
6. Set the *withEnvironment* flag of *newEnv*'s environment record to **true**.
7. Set the running execution context's *LexicalEnvironment* to *newEnv*.
8. Let *C* be the result of evaluating *Statement*.
9. Set the running execution context's *Lexical Environment* to *oldEnv*.
10. Return *C*.

NOTE No matter how control leaves the embedded *Statement*, whether normally or by some form of abrupt completion or exception, the *LexicalEnvironment* is always restored to its former state.

13.11 The switch Statement

Syntax

SwitchStatement[Yield, Return] :
switch (*Expression*[In, ?Yield]) *CaseBlock*[?Yield, ?Return]

CaseBlock[Yield, Return] :
{ *CaseClauses*[?Yield, ?Return]opt }
{ *CaseClauses*[?Yield, ?Return]opt *DefaultClause*[?Yield, ?Return] *CaseClauses*[?Yield, ?Return]opt }

CaseClauses[Yield, Return] :
CaseClause[?Yield, ?Return]
CaseClauses[?Yield, ?Return] *CaseClause*[?Yield, ?Return]

CaseClause[Yield, Return] :
case *Expression*[In, ?Yield] : *StatementList*[?Yield, ?Return]opt

DefaultClause[Yield, Return] :
default : *StatementList*[?Yield, ?Return]opt

13.11.1 Static Semantics: Early Errors

CaseBlock : { *CaseClauses* } ▾

- It is a Syntax Error if the LexicallyDeclaredNames of *CaseClauses* contains any duplicate entries.

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Deleted: 13.6.3.3

Deleted: 13.6.4.4

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Deleted: 13.12.11

Deleted: 13.14.3

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- It is a Syntax Error if any element of the LexicallyDeclaredNames of *CaseClauses* also occurs in the VarDeclaredNames of *CaseClauses*.

13.11.2 Static Semantics: ContainsDuplicateLabels

With argument *labelSet*.

See also: 13.0.1, 13.1.2, 13.5.2, 13.6.1.1, 13.6.2.1, 13.6.3.2, 13.6.4.3, 13.10.2, 13.12.2, 13.14.2, 15.2.1.2.

SwitchStatement : switch (Expression) CaseBlock

- Return ContainsDuplicateLabels of *CaseBlock* with argument *labelSet*.

CaseBlock : { }

- Return false.

CaseBlock : { CaseClauses_{opt} DefaultClause CaseClauses_{opt} }

- If the first *CaseClauses* is present, then
 - Let *hasDuplicates* be ContainsDuplicateLabels of the first *CaseClauses* with argument *labelSet*.
 - If *hasDuplicates* is true, return true.
- Let *hasDuplicates* be ContainsDuplicateLabels of *DefaultClause* with argument *labelSet*.
- If *hasDuplicates* is true, return true.
- If the second *CaseClauses* is not present, return false.
- Return ContainsDuplicateLabels of the second *CaseClauses* with argument *labelSet*.

CaseClauses : CaseClauses CaseClause

- Let *hasDuplicates* be ContainsDuplicateLabels of *CaseClauses* with argument *labelSet*.
- If *hasDuplicates* is true, return true.
- Return ContainsDuplicateLabels of *CaseClause* with argument *labelSet*.

CaseClause : case Expression : StatementList_{opt}

- If the *StatementList* is present, return ContainsDuplicateLabels of *StatementList*.
- Else return false.

DefaultClause : default : StatementList_{opt}

- If the *StatementList* is present, return ContainsDuplicateLabels of *StatementList* with argument *labelSet*.
- Else return false.

13.11.3 Static Semantics: ContainsUndefinedBreakTarget

With argument *labelSet*.

See also: 13.0.2, 13.1.3, 13.5.3, 13.6.1.2, 13.6.2.2, 13.6.3.3, 13.6.4.4, 13.8.2, 13.10.3, 13.12.3, 13.14.3, 15.2.1.3.

SwitchStatement : switch (Expression) CaseBlock

- Return ContainsUndefinedBreakTarget of *CaseBlock* with argument *labelSet*.

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CaseBlock : { }

1. Return **false**.

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CaseBlock : { CaseClauses_{opt} DefaultClause CaseClauses_{opt} }

1. If the first *CaseClauses* is present, then
 - a. Let *hasUndefinedLabels* be ContainsUndefinedBreakTarget of the first *CaseClauses* with argument *labelSet*.
 - b. If *hasUndefinedLabels* is true, return true.
2. Let *hasUndefinedLabels* be ContainsUndefinedBreakTarget of *DefaultClause* with argument *labelSet*.
3. If *hasUndefinedLabels* is true, return true.
4. If the second *CaseClauses* is not present, return false.
5. Return ContainsUndefinedBreakTarget of the second *CaseClauses* with argument *labelSet*.

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CaseClauses : CaseClauses CaseClause

1. Let *hasUndefinedLabels* be ContainsUndefinedBreakTarget of *CaseClauses* with argument *labelSet*.
2. If *hasUndefinedLabels* is true, return true.
3. Return ContainsUndefinedBreakTarget of *CaseClause* with argument *labelSet*.

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CaseClause : case Expression : StatementList_{opt}

1. If the *StatementList* is present, return ContainsUndefinedBreakTarget of *StatementList* with argument *labelSet*.
2. Else return false.

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DefaultClause : default : StatementList_{opt}

1. If the *StatementList* is present, return ContainsUndefinedBreakTarget of *StatementList* with argument *labelSet*.
2. Else return false.

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13.11.4 Static Semantics: ContainsUndefinedContinueTarget

With arguments *iterationSet* and *labelSet*.

See also: 13.0.3, 13.1.4, 13.5.4, 13.6.1.3, 13.6.2.3, 13.6.3.4, 13.6.4.5, 13.7.2, 13.10.4, 13.12.4, 13.14.4, 15.2.1.4.

SwitchStatement : switch (Expression) CaseBlock

1. Return ContainsUndefinedContinueTarget of *CaseBlock* with arguments *iterationSet* and « ».

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CaseBlock : { }

1. Return **false**.

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CaseBlock : { CaseClauses_{opt} DefaultClause CaseClauses_{opt} }

1. If the first *CaseClauses* is present, then
 - a. Let *hasUndefinedLabels* be ContainsUndefinedContinueTarget of the first *CaseClauses* with arguments *iterationSet* and « ».
 - b. If *hasUndefinedLabels* is true, return true.

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2. Let `hasUndefinedLabels` be `ContainsUndefinedContinueTarget` of `DefaultClause` with arguments `iterationSet` and `<>`.
3. If `hasUndefinedLabels` is `true`, return `true`.
4. If the second `CaseClauses` is not present, return `false`.
5. Return `ContainsUndefinedContinueTarget` of the second `CaseClauses` with arguments `iterationSet` and `<>`.

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`CaseClauses : CaseClauses CaseClause`

1. Let `hasUndefinedLabels` be `ContainsUndefinedContinueTarget` of `CaseClauses` with arguments `iterationSet` and `<>`.
2. If `hasUndefinedLabels` is `true`, return `true`.
3. Return `ContainsUndefinedContinueTarget` of `CaseClause` with arguments `iterationSet` and `<>`.

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`CaseClause : case Expression : StatementListopt`

1. If the `StatementList` is present, return `ContainsUndefinedContinueTarget` of `StatementList` with arguments `iterationSet` and `<>`.
2. Else return `false`.

Deleted: ¶

`DefaultClause : default : StatementListopt`

1. If the `StatementList` is present, return `ContainsUndefinedContinueTarget` of `StatementList` with arguments `iterationSet` and `<>`.
2. Else return `false`.

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13.11.5 Static Semantics: LexicallyDeclaredNames

See also: 13.1.2, [13.12.6](#), [14.1.15](#), 14.2.10, 15.1.3, [15.2.1.11](#),

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`CaseBlock : { }`

1. Return a new empty List.

`CaseBlock : { CaseClausesopt DefaultClause CaseClausesopt }`

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1. If the first `CaseClauses` is present, let `names` be the `LexicallyDeclaredNames` of the first `CaseClauses`.
2. Else let `names` be a new empty List.
3. Append to `names` the elements of the `LexicallyDeclaredNames` of the `DefaultClause`.
4. If the second `CaseClauses` is not present, return `names`.
5. Else return the result of appending to `names` the elements of the `LexicallyDeclaredNames` of the second `CaseClauses`.

`CaseClauses : CaseClauses CaseClause`

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1. Let `names` be `LexicallyDeclaredNames` of `CaseClauses`.
2. Append to `names` the elements of the `LexicallyDeclaredNames` of `CaseClause`.
3. Return `names`.

`CaseClause : case Expression : StatementListopt`

Deleted: ¶

1. If the `StatementList` is present, return the `LexicallyDeclaredNames` of `StatementList`.
2. Else return a new empty List.

DefaultClause : default : StatementList_{opt}

1. If the *StatementList* is present, return the LexicallyDeclaredNames of *StatementList*.
2. Else return a new empty List.

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13.11.6 Static Semantics: LexicallyScopedDeclarations

See also: [13.1.6](#), [13.12.7](#), [14.1.16](#), [14.2.11](#), [15.1.4](#), [15.2.1.12](#), [15.2.3.8](#)

CaseBlock : { }_v

1. Return a new empty List.

CaseBlock : { CaseClauses_{opt} DefaultClause CaseClauses_{opt} }_v

1. If the first *CaseClauses* is present, let *declarations* be the LexicallyScopedDeclarations of the first *CaseClauses*.
2. Else let *declarations* be a new empty List.
3. Append to *declarations* the elements of the LexicallyScopedDeclarations of the *DefaultClause*.
4. If the second *CaseClauses* is not present, return *declarations*.
5. Else return the result of appending to *declarations* the elements of the LexicallyScopedDeclarations of the second *CaseClauses*.

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Deleted: 15.2.1.11

Deleted: 15.2.3.7

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CaseClauses : CaseClauses CaseClause_v

1. Let *declarations* be LexicallyScopedDeclarations of *CaseClauses*.
2. Append to *declarations* the elements of the LexicallyScopedDeclarations of *CaseClause*.
3. Return *declarations*.

Deleted: ¶

CaseClause : case Expression : StatementList_{opt}

1. If the *StatementList* is present, return the LexicallyScopedDeclarations of *StatementList*.
2. Else return a new empty List.

Deleted: ¶

DefaultClause : default : StatementList_{opt}

1. If the *StatementList* is present, return the LexicallyScopedDeclarations of *StatementList*.
2. Else return a new empty List.

Deleted: ¶

13.11.7 Static Semantics: VarDeclaredNames

See also: [13.0.5](#), [13.1.11](#), [13.2.2.2](#), [13.5.5](#), [13.6.1.4](#), [13.6.2.4](#), [13.6.3.5](#), [13.6.4.7](#), [13.10.5](#), [13.12.12](#), [13.14.5](#), [14.1.18](#), [14.2.13](#), [15.1.5](#), [15.2.1.13](#)

SwitchStatement : switch (Expression) CaseBlock_v

1. Return the VarDeclaredNames of *CaseBlock*.

Deleted: See also: 13.0.1, 13.1.8, 13.2.2.2, 13.5.2, 13.6.1.1, 13.6.3.213.6.2.1, 13.6.3.1, 13.6.4.3, 13.10.2, , 13.12.10, 13.14.2, 14.1.1814.1.17, 14.2.13, 15.1.5, 15.2.1.1313.0.1, 13.1.8, , 13.5.1, 13.6.1.1, 13.6.2.1, 13.6.3.1, 13.6.4.3, 13.10.2, 13.12.2, 013.14.2, 14.1.16, 14.4.12, 14.5.1514.5.16, 15.1.5, 15.2.0.13.¶

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CaseBlock : { }_v

1. Return a new empty List.

CaseBlock : { CaseClauses_{opt} DefaultClause CaseClauses_{opt} }_v

1. If the first *CaseClauses* is present, let *names* be the VarDeclaredNames of the first *CaseClauses*.
2. Else let *names* be a new empty List.

3. Append to *names* the elements of the VarDeclaredNames of the *DefaultClause*.
4. If the second *CaseClauses* is not present, return *names*.
5. Else return the result of appending to *names* the elements of the VarDeclaredNames of the second *CaseClauses*.

CaseClauses : *CaseClauses CaseClause*

1. Let *names* be VarDeclaredNames of *CaseClauses*.
2. Append to *names* the elements of the VarDeclaredNames of *CaseClause*.
3. Return *names*.

Deleted: ¶

CaseClause : **case** *Expression* : *StatementList*_{opt}

1. If the *StatementList* is present, return the VarDeclaredNames of *StatementList*.
2. Else return a new empty List.

Deleted: ¶

DefaultClause : **default** : *StatementList*_{opt}

1. If the *StatementList* is present, return the VarDeclaredNames of *StatementList*.
2. Else return a new empty List.

Deleted: ¶

13.11.8 Static Semantics: VarScopedDeclarations

See also: [13.0.6](#), [13.1.12](#), [13.2.2.3](#), [13.5.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.6.4.8](#), [13.10.6](#), [13.12.13](#), [13.14.6](#), 14.1.19, 14.2.14, 15.1.6, 15.2.1.14.

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SwitchStatement : **switch** (*Expression*) *CaseBlock*

1. Return the VarScopedDeclarations of *CaseBlock*.

CaseBlock : { }

1. Return a new empty List.

CaseBlock : { *CaseClauses*_{opt} *DefaultClause* *CaseClauses*_{opt} }

1. If the first *CaseClauses* is present, let *declarations* be the VarScopedDeclarations of the first *CaseClauses*.
2. Else let *declarations* be a new empty List.
3. Append to *declarations* the elements of the VarScopedDeclarations of the *DefaultClause*.
4. If the second *CaseClauses* is not present, return *declarations*.
5. Else return the result of appending to *declarations* the elements of the VarScopedDeclarations of the second *CaseClauses*.

CaseClauses : *CaseClauses CaseClause*

Deleted: ¶

1. Let *declarations* be VarScopedDeclarations of *CaseClauses*.
2. Append to *declarations* the elements of the VarScopedDeclarations of *CaseClause*.
3. Return *declarations*.

CaseClause : **case** *Expression* : *StatementList*_{opt}

Deleted: ¶

1. If the *StatementList* is present, return the VarScopedDeclarations of *StatementList*.
2. Else return a new empty List.

DefaultClause : default : StatementList_{opt}

1. If the StatementList is present, return the VarScopedDeclarations of StatementList.
2. Else return a new empty List.

Deleted: ¶

13.11.9 Runtime Semantics: CaseBlockEvaluation

With argument *input*.

CaseBlock : { }

1. Return NormalCompletion(undefined).

Deleted: ¶

CaseBlock : { CaseClauses }

1. Let *V* = undefined.
2. Let *A* be the List of CaseClause items in CaseClauses, in source text order.
3. Let searching be true.
4. Repeat, for each CaseClause, *C*, in *A*
 - a. If searching is true, then
 - i. Let clauseSelector be the result of CaseSelectorEvaluation of *C*.
 - ii. ReturnIfAbrupt(clauseSelector).
 - iii. Let matched be the result of performing Strict Equality Comparison *input* === clauseSelector.
 - iv. If matched is true, then
 1. Set searching to false.
 2. If *C* has a StatementList, then
 - a. Let *V* be the result of evaluating *C*'s StatementList.
 - b. ReturnIfAbrupt(*V*).
 - b. Else searching is false,
 - i. If *C* has a StatementList, then
 1. Let *R* be the result of evaluating *C*'s StatementList.
 2. If *R*.[[value]] is not empty, let *V* = *R*.[[value]].
 3. If *R* is an abrupt completion, return Completion{[[type]]: *R*.[[type]], [[value]]: *V*, [[target]]: *R*.[[target]]}.
5. Return NormalCompletion(*V*).

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Comment [AWB635]: ES5 breaking change: completion reform

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Deleted: while searching is true

Deleted: Let *C* be the next CaseClause in *A*.

Deleted: there is no such CaseClause, return NormalCompletion(*V*).

Deleted: ¶

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Deleted: <#>Let *C* be the next CaseClause in *A*. If there is no such CaseClause, return NormalCompletion(*V*).¶

Deleted: ¶

Deleted: , then let

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Comment [AWB636]: ES5 breaking change: completion reform

Deleted: , then return

Deleted: , then let

CaseBlock : { CaseClauses_{opt} DefaultClause CaseClauses_{opt} }

1. Let *V* = undefined.
2. Let *A* be the list of CaseClause items in the first CaseClauses, in source text order. If the first CaseClauses is not present A is « ».
3. Let found be false.
4. Repeat letting *C* be in order each CaseClause in *A*
 - a. If found is false, then
 - i. Let clauseSelector be the result of CaseSelectorEvaluation of *C*.
 - ii. If clauseSelector is an abrupt completion, then
 1. If clauseSelector.[[value]] is empty, return Completion{[[type]]: clauseSelector.[[type]], [[value]]: undefined, [[target]]: clauseSelector.[[target]]}.
 2. Else, return clauseSelector.
 - iii. Let found be the result of performing Strict Equality Comparison *input* === clauseSelector.
 - b. If found is true, then
 - i. Let *R* be the result of evaluating CaseClause *C*.
 - ii. If *R*.[[value]] is not empty, let *V* = *R*.[[value]].

- iii. If R is an abrupt completion, return Completion{[[type]]: $R.[[type]]$, [[value]]: V , [[target]]: $R.[[target]]$ }.
- Deleted:** , then return
5. Let $foundInB$ be **false**.
- Deleted:** Let B be a new List containing the *CaseClause* items in the second *CaseClauses*, in source text order. If the second *CaseClauses* is not present B is « ».
- Deleted:** ¶
- Deleted:** If $found$ is **false**, then,
- a. Repeat, letting C be in order each *CaseClause* in B
- i. If $foundInB$ is **false**, then
1. Let *clauseSelector* be the result of *CaseSelectorEvaluation* of C .
 2. If *clauseSelector* is an abrupt completion, then
 - a. If *clauseSelector.[[value]]* is empty, return Completion{[[type]]: *clauseSelector.[[type]]*, [[value]]: **undefined**, [[target]]: *clauseSelector.[[target]]*}.
 - b. Else, return *clauseSelector*.
 3. Let $foundInB$ be the result of performing Strict Equality Comparison $input === clauseSelector$.
- ii. If $foundInB$ is **true**, then
1. Let R be the result of evaluating *CaseClause C*.
 2. If $R.[[value]]$ is not empty, let $V = R.[[value]]$.
 3. If R is an abrupt completion, return Completion{[[type]]: $R.[[type]]$, [[value]]: V , [[target]]: $R.[[target]]$ }.
- Deleted:** , then let
- Deleted:** , then return
- Deleted:** , then let
- Deleted:** , then return
8. If $foundInB$ is **true**, return NormalCompletion(V).
- Deleted:** , then return
9. Let R be the result of evaluating *DefaultClause*.
- Deleted:** , then let
10. If $R.[[value]]$ is not empty, let $V = R.[[value]]$.
- Deleted:** , then let
11. If R is an abrupt completion, return Completion{[[type]]: $R.[[type]]$, [[value]]: V , [[target]]: $R.[[target]]$ }.
- Deleted:** , then return
12. Repeat, letting C be in order each *CaseClause* in B (NOTE this is another complete iteration of the second *CaseClauses*)
- a. Let R be the result of evaluating *CaseClause C*.
- b. If $R.[[value]]$ is not empty, let $V = R.[[value]]$.
- c. If R is an abrupt completion, return Completion{[[type]]: $R.[[type]]$, [[value]]: V , [[target]]: $R.[[target]]$ }.
- Deleted:** , then let
- Deleted:** , then return
13. Return NormalCompletion(V).

13.11.10 Runtime Semantics: CaseSelectorEvaluation

- CaseClause* : **case** *Expression* : *StatementList*_{opt}
- Deleted:** ¶
1. Let *exprRef* be the result of evaluating *Expression*.
 2. Return GetValue(*exprRef*).

NOTE CaseSelectorEvaluation does not execute the associated *StatementList*. It simply evaluates the *Expression* and returns the value, which the *CaseBlock* algorithm uses to determine which *StatementList* to start executing.

13.11.11 Runtime Semantics: Evaluation

- SwitchStatement* : **switch** (*Expression*) *CaseBlock*
- Deleted:** ¶
1. Let *exprRef* be the result of evaluating *Expression*.
 2. Let *switchValue* be GetValue(*exprRef*).
 3. ReturnIfAbrupt(*switchValue*).
 4. Let *oldEnv* be the running execution context's LexicalEnvironment.
 5. Let *blockEnv* be NewDeclarativeEnvironment(*oldEnv*).
 6. Perform BlockDeclarationInstantiation(*CaseBlock*, *blockEnv*).
- Deleted:**
- Deleted:**

7. Let R be the result of performing CaseBlockEvaluation of *CaseBlock* with argument *switchValue*.
8. Set the running execution context's LexicalEnvironment to *oldEnv*.
9. Return R .

NOTE No matter how control leaves the *SwitchStatement* the LexicalEnvironment is always restored to its former state.

CaseClause : **case** *Expression* :

1. Return NormalCompletion(empty).

Deleted: ¶

CaseClause : **case** *Expression* : *StatementList*

1. Return the result of evaluating *StatementList*.

Deleted: ¶

DefaultClause : **default** :

1. Return NormalCompletion(empty).

Deleted: ¶

DefaultClause : **default** : *StatementList*

1. Return the result of evaluating *StatementList*.

Deleted: ¶

13.12 Labelled Statements

Syntax

LabelledStatement[?Yield, ?Return] :

LabelIdentifier[?Yield] : *LabelledItem*[?Yield, ?Return]

Deleted: Statement

LabelledItem[?Yield, ?Return] :

Statement[?Yield, ?Return]
FunctionDeclaration[?Yield]

NOTE A *Statement* may be prefixed by a label. Labelled statements are only used in conjunction with labelled *break* and *continue* statements. ECMAScript has no *goto* statement. A *Statement* can be part of a *LabelledStatement*, which itself can be part of a *LabelledStatement*, and so on. The labels introduced this way are collectively referred to as the “current label set” when describing the semantics of individual statements. A *LabelledStatement* has no semantic meaning other than the introduction of a label to a *label set*.

Deleted: The label set of an *IterationStatement* or a *SwitchStatement* initially contains the single element **empty**. The label set of any other statement is initially empty.

13.12.1 Static Semantics: Early Errors

LabelledItem : *FunctionDeclaration*

- It is a Syntax Error if any source code matches this rule.

Deleted: *LabelledStatement* : *LabelIdentifier* :
LabelledItemStatement¶
<#>It is a Syntax Error if the immediately enclosing CurrentLabelSet a *LabelledStatement* is directly or indirectly enclosed by a *LabelledStatement* and contains the StringValue of this *LabelIdentifier* is the same as the StringValue of the *LabelIdentifier* of the enclosing *LabelledStatement*. This does not apply to a *LabelledStatement* appearing within a *FunctionBody* and a *LabelledStatement* that indirectly encloses the *FunctionBody*. ¶

NOTE An alternative definition for this rule is provided in B.3.2.

13.12.2 Static Semantics: ContainsDuplicateLabels

With argument *labelSet*.

See also: 13.0.1, 13.1.2, 13.5.2, 13.6.1.1, 13.6.2.1, 13.6.3.2, 13.6.4.3, 13.10.2, 13.11.2, 13.14.2, 15.2.1.2.

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LabelledStatement : LabelIdentifier : LabelledItem

1. Let *label* be the StringValue of *LabelIdentifier*.
2. If *label* is an element of *labelSet*, return true.
3. Let *newLabelSet* be a copy of *labelSet* with *label* appended.
4. Return ContainsDuplicateLabels of *LabelledItem* with argument *newLabelSet*.

Deleted: , then return

LabelledItem : FunctionDeclaration

1. Return false.

Deleted: 1

13.12.3 Static Semantics: ContainsUndefinedBreakTarget

With argument *labelSet*.

See also: 13.0.2, 13.1.3, 13.5.3, 13.6.1.2, 13.6.2.2, 13.6.3.3, 13.6.4.4, 13.8.2, 13.10.3, 13.11.3, 13.14.3, 15.2.1.3.

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LabelledStatement : LabelIdentifier : LabelledItem

1. Let *label* be the StringValue of *LabelIdentifier*.
2. Let *newLabelSet* be a copy of *labelSet* with *label* appended.
3. Return ContainsUndefinedBreakTarget of *LabelledItem* with argument *newLabelSet*.

Deleted: 1

LabelledItem : FunctionDeclaration

1. Return false.

13.12.4 Static Semantics: ContainsUndefinedContinueTarget

With arguments *iterationSet* and *labelSet*.

See also: 13.0.3, 13.1.4, 13.5.4, 13.6.1.3, 13.6.2.3, 13.6.3.4, 13.6.4.5, 13.7.2, 13.10.4, 13.11.4, 13.14.4, 15.2.1.4.

LabelledStatement : LabelIdentifier : LabelledItem

1. Let *label* be the StringValue of *LabelIdentifier*.
2. Let *newLabelSet* be a copy of *labelSet* with *label* appended.
3. Return ContainsUndefinedContinueTarget of *LabelledItem* with arguments *iterationSet* and *newLabelSet*.

Deleted: 1

LabelledItem : FunctionDeclaration

1. Return false.

13.12.5 Static Semantics: IsLabelledFunction (*stmt*)

The abstract operation *IsLabelledFunction* with argument *stmt* performs the following steps:

1. If *stmt* is not a *LabelledStatement*, return false.
2. Let *item* be the *LabelledItem* component of *stmt*.
3. If *item* is *LabelledItem : FunctionDeclaration*, return true.
4. Let *subStmt* be the *Statement* component of *item*.
5. Return *IsLabelledFunction*(*subStmt*).

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Deleted: , then return

Deleted: e

Deleted: , then return

Deleted: *stmt*

13.12.6 Static Semantics: LexicallyDeclaredNames

See also: [13.1.2](#), [13.11.2](#), [14.1.15](#), [14.2.10](#), [15.1.3](#), [15.2.1.11](#)

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14.1.14

Deleted: 15.2.1.10

LabelledStatement : LabelIdentifier : LabelledItem

1. Return the LexicallyDeclaredNames of *LabelledItem*.

LabelledItem : Statement

1. Return a new empty List.

Deleted: ¶

LabelledItem : FunctionDeclaration

1. Return BoundNames of *FunctionDeclaration*.

Deleted: LexicallyDeclared

13.12.7 Static Semantics: LexicallyScopedDeclarations

See also: [13.1.6](#), [13.11.6](#), [14.1.16](#), [14.2.11](#), [15.1.4](#), [15.2.1.12](#), [15.2.3.8](#)

Deleted: 13.1.3

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LabelledStatement : LabelIdentifier : LabelledItem

1. Return the LexicallyScopedDeclarations of *LabelledItem*.

LabelledItem : Statement

1. Return a new empty List.

Deleted: ¶

LabelledItem : FunctionDeclaration

1. Return a new List containing *FunctionDeclaration*.

13.12.8 Static Semantics: TopLevelLexicallyDeclaredNames

See also: [13.1.7](#)

Deleted: 13.1.4

LabelledStatement : LabelIdentifier : LabelledItem

1. Return a new empty List.

13.12.9 Static Semantics: TopLevelLexicallyScopedDeclarations

See also: [13.1.8](#)

Deleted: 13.1.5

LabelledStatement : LabelIdentifier : LabelledItem

1. Return a new empty List.

13.12.10 Static Semantics: TopLevelVarDeclaredNames

See also: [13.1.9](#)

Deleted: 13.1.6

LabelledStatement : LabelIdentifier : LabelledItem

1. Return the TopLevelVarDeclaredNames of *LabelledItem*.

LabelledItem : Statement

1. If Statement is Statement : LabelledStatement, return TopLevelVarDeclaredNames of Statement.
2. Return VarDeclaredNames of Statement.

Deleted: ¶

Deleted: then

LabelledItem : FunctionDeclaration

1. Return BoundNames of FunctionDeclaration.

Deleted: LexicallyDeclared

13.12.11 Static Semantics: TopLevelVarScopedDeclarations

See also: 13.1.10.

Deleted: 13.1.7

LabelledStatement : LabelIdentifier : LabelledItem

1. Return the TopLevelVarScopedDeclarations of LabelledItem.

Deleted: ¶

Deleted: then

LabelledItem : Statement

1. If Statement is Statement : LabelledStatement, return TopLevelVarScopedDeclarations of Statement.
2. Return VarScopedDeclarations of Statement.

LabelledItem : FunctionDeclaration

1. Return a new List containing FunctionDeclaration.

13.12.12 Static Semantics: VarDeclaredNames

See also: 13.0.5, 13.1.11, 13.2.2.2, 13.5.5, 13.6.1.4, 13.6.2.4, 13.6.3.5, 13.6.4.7, 13.10.5, 13.11.7, 13.14.5, 14.1.18, 14.2.13, 15.1.5, 15.2.1.13.

Deleted: See also: 13.0.1, 13.1.8, 13.2.2.2, 13.5.2, 13.6.1.1, 13.6.3.213.6.2.1, 13.6.3.1, 13.6.4.3, 13.10.2¶, 13.11.4, 13.14.2, 14.1.1814.1.17, 14.2.13, 15.1.5, 15.2.1.1313.0.1, 13.1.8, , 13.5.1, 13.6.1.1, 13.6.2.1, 13.6.3.1, 13.6.4.3, 13.10.2, 13.11.4, 013.14.2, 14.1.16, 14.4.12, 14.5.1514.5.16, 15.1.5, 15.2.0.13.¶

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LabelledStatement : LabelIdentifier : LabelledItem

1. Return the VarDeclaredNames of LabelledItem.

LabelledItem : FunctionDeclaration

1. Return a new empty List.

13.12.13 Static Semantics: VarScopedDeclarations

See also: 13.0.6, 13.1.12, 13.2.2.3, 13.5.6, 13.6.1.5, 13.6.2.5, 13.6.3.6, 13.6.4.8, 13.10.6, 13.11.8, 13.14.6, 14.1.19, 14.2.14, 15.1.6, 15.2.1.14.

LabelledStatement : LabelIdentifier : LabelledItem

1. Return the VarScopedDeclarations of LabelledItem.

LabelledItem : FunctionDeclaration

1. Return a new empty List.

13.12.14 Runtime Semantics: LabelledEvaluation

With argument *labelSet*.

See also: [13.0.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.6.4.11](#)

LabelledStatement : LabelIdentifier : LabelledItem

1. Let *label* be the StringValue of *LabelIdentifier*.
2. Append *label* as an element of *labelSet*.
3. Let *stmtResult* be the result of performing *LabelledEvaluation* of *LabelledItem* with argument *labelSet*.
4. If *stmtResult*.[[type]] is *break* and SameValue(*stmtResult*.[[target]], *label*), then
 - a. Return *NormalCompletion*(*stmtResult*.[[value]]).
5. Return *stmtResult*.

LabelledItem : Statement

1. If *Statement* is either a *LabelledStatement* or a *BreakableStatement*, then
 - a. Return the result of performing *LabelledEvaluation* of *Statement* with argument *labelSet*.
2. Else,
 - a. Return the result of evaluating *Statement*.

LabelledItem: FunctionDeclaration

1. Return the result of evaluating *FunctionDeclaration*.

13.12.15 Runtime Semantics: Evaluation

LabelledStatement : LabelIdentifier : LabelledItem

1. Let *newLabelSet* be a new empty List.
2. Return the result of performing *LabelledEvaluation* of *LabelledItem* with argument *newLabelSet*.

13.13 The throw Statement

Syntax

```
ThrowStatement[Yield] :
  throw [no LineTerminator here] Expression[In, ?Yield] ;
```

13.13.1 Runtime Semantics: Evaluation

ThrowStatement : throw Expression ;

1. Let *exprRef* be the result of evaluating *Expression*.
2. Let *exprValue* be *GetValue*(*exprRef*).
3. ReturnIfAbrupt(*exprValue*).
4. Return *Completion*{[[type]]: *throw*, [[value]]: *exprValue*, [[target]]: empty}.

13.14 The try Statement

Syntax

```
TryStatement[Yield, Return] :
  try Block[?Yield, ?Return] Catch[?Yield, ?Return]
  try Block[?Yield, ?Return] Finally[?Yield, ?Return]
  try Block[?Yield, ?Return] Catch[?Yield, ?Return] Finally[?Yield, ?Return]
```

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Deleted: Statement
Deleted: Let <i>newLabelSet</i> be a new List containing and the elements of
Deleted: Return
Deleted: <i>b</i>
Deleted: <i>newL</i>
Deleted: <#> <i>LabelledStatementEvaluation(label, Statement, labelSet)</i> .
Deleted: <#>Runtime Semantics: <i>LabelledStatementEvaluation(label, stmt, labelSet)</i> ¶
Deleted: <#>The abstract operation <i>LabelledStatementEvaluation</i> with arguments <i>label</i> , <i>stmt</i> , and <i>labelSet</i> is performed as follows:¶ Let <i>newLabelSet</i> be a new List containing <i>label</i> and the elements of <i>labelSet</i> .¶
Deleted: <i>stmt</i>
Deleted: Let <i>stmtResult</i> be
Deleted: <i>stmt</i>
Deleted: <i>newLabelSet</i>
Deleted: Let <i>stmtResult</i> be
Deleted: <i>stmt</i>
Deleted: <#>If <i>stmtResult</i> .[[type]] is <i>break</i> and SameValue(<i>stmtResult</i> .[[target]], <i>label</i>), then¶ <#>Let <i>result</i> be <i>NormalCompletion</i> (<i>stmtResult</i> .[[value]]).¶ <#>Else,¶ <#>Let <i>result</i> be <i>stmtResult</i> .¶ <#>Return <i>result</i> .¶
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Catch_[Yield, Return] :
catch (*CatchParameter_[?Yield]*) *Block_[?Yield, ?Return]*

Finally_[Yield, Return] :
finally *Block_[?Yield, ?Return]*

CatchParameter_[Yield] :
BindingIdentifier_[?Yield]
BindingPattern_[?Yield]

Deleted: ,

NOTE The **try** statement encloses a block of code in which an exceptional condition can occur, such as a runtime error or a **throw** statement. The **catch** clause provides the exception-handling code. When a catch clause catches an exception, its *CatchParameter* is bound to that exception.

13.14.1 Static Semantics: Early Errors

Catch : **catch** (*CatchParameter*) *Block*

Deleted: ¶

- It is a Syntax Error if any element of the *BoundNames* of *CatchParameter* also occurs in the *LexicallyDeclaredNames* of *Block*.
- It is a Syntax Error if any element of the *BoundNames* of *CatchParameter* also occurs in the *VarDeclaredNames* of *Block*.

NOTE An alternative static semantics for this production is given in B.3.5

Deleted: B.3.3

13.14.2 Static Semantics: ContainsDuplicateLabels

With argument *labelSet*.

See also: 13.0.1, 13.1.2, 13.5.2, 13.6.1.1, 13.6.2.1, 13.6.3.2, 13.6.4.3, 13.10.2, 13.11.2, 15.2.1.2.

TryStatement : **try** *Block* *Catch*

Deleted: ¶

1. Let *hasDuplicates* be *ContainsDuplicateLabels* of *Block* with argument *labelSet*.
2. If *hasDuplicates* is **true**, **return true**.
3. Return *ContainsDuplicateLabels* of *Catch* with argument *labelSet*.

Deleted: , then return

TryStatement : **try** *Block* *Finally*

Deleted: ¶

1. Let *hasDuplicates* be *ContainsDuplicateLabels* of *Block* with argument *labelSet*.
2. If *hasDuplicates* is **true**, **return true**.
3. Return *ContainsDuplicateLabels* of *Finally* with argument *labelSet*.

Deleted: , then return

TryStatement : **try** *Block* *Catch* *Finally*

Deleted: ¶

1. Let *hasDuplicates* be *ContainsDuplicateLabels* of *Block* with argument *labelSet*.
2. If *hasDuplicates* is **true**, **return true**.
3. Let *hasDuplicates* be *ContainsDuplicateLabels* of *Catch* with argument *labelSet*.
4. If *hasDuplicates* is **true**, **return true**.
5. Return *ContainsDuplicateLabels* of *Finally* with argument *labelSet*.

Deleted: , then return

Deleted: , then return

Catch : **catch** (*CatchParameter*) *Block*

Deleted: ¶

1. Return *ContainsDuplicateLabels* of *Block* with argument *labelSet*.

13.14.3 Static Semantics: ContainsUndefinedBreakTarget

With argument *labelSet*.

See also: 13.0.2, 13.1.3, 13.5.3, 13.6.1.2, 13.6.2.2, 13.6.3.3, 13.6.4.4, 13.8.2, 13.10.3, 13.11.3, 13.12.3, 15.2.1.3.

TryStatement : try Block Catch

1. Let *hasUndefinedLabels* be ContainsUndefinedBreakTarget of *Block* with argument *labelSet*.
2. If *hasUndefinedLabels* is true, return true.
3. Return ContainsUndefinedBreakTarget of *Catch* with argument *labelSet*.

Deleted: ¶

Deleted: , then return

TryStatement : try Block Finally

1. Let *hasUndefinedLabels* be ContainsUndefinedBreakTarget of *Block* with argument *labelSet*.
2. If *hasUndefinedLabels* is true, return true.
3. Return ContainsUndefinedBreakTarget of *Finally* with argument *labelSet*.

Deleted: ¶

Deleted: , then return

TryStatement : try Block Catch Finally

1. Let *hasUndefinedLabels* be ContainsUndefinedBreakTarget of *Block* with argument *labelSet*.
2. If *hasUndefinedLabels* is true, return true.
3. Let *hasUndefinedLabels* be ContainsUndefinedBreakTarget of *Catch* with argument *labelSet*.
4. If *hasUndefinedLabels* is true, return true.
5. Return ContainsUndefinedBreakTarget of *Finally* with argument *labelSet*.

Deleted: ¶

Deleted: , then return

Deleted: , then return

Catch : catch (*CatchParameter*) *Block*

1. Return ContainsUndefinedBreakTarget of *Block* with argument *labelSet*.

Deleted: ¶

13.14.4 Static Semantics: ContainsUndefinedContinueTarget

With arguments *iterationSet* and *labelSet*.

See also: 13.0.3, 13.1.4, 13.5.4, 13.6.1.3, 13.6.2.3, 13.6.3.4, 13.6.4.5, 13.7.2, 13.10.4, 13.11.4, 13.12.4, 15.2.1.4.

TryStatement : try Block Catch

1. Let *hasUndefinedLabels* be ContainsUndefinedContinueTarget of *Block* with arguments *iterationSet* and « ».
2. If *hasUndefinedLabels* is true, return true.
3. Return ContainsUndefinedContinueTarget of *Catch* with arguments *iterationSet* and « ».

Deleted: ¶

Deleted: , then return

TryStatement : try Block Finally

1. Let *hasUndefinedLabels* be ContainsUndefinedContinueTarget of *Block* with arguments *iterationSet* and « ».
2. If *hasUndefinedLabels* is true, return true.
3. Return ContainsUndefinedContinueTarget of *Finally* with arguments *iterationSet* and « ».

Deleted: ¶

Deleted: , then return

TryStatement : try Block Catch Finally

1. Let `hasUndefinedLabels` be `ContainsUndefinedContinueTarget` of `Block` with arguments `iterationSet` and « ».
2. If `hasUndefinedLabels` is `true`, `return true`.
3. Let `hasUndefinedLabels` be `ContainsUndefinedContinueTarget` of `Catch` with arguments `iterationSet` and « ».
4. If `hasUndefinedLabels` is `true`, `return true`.
5. Return `ContainsUndefinedContinueTarget` of `Finally` with arguments `iterationSet` and « ».

Deleted: ¶

Deleted: , then return

Deleted: , then return

Deleted: ¶

Catch : catch (CatchParameter) Block

1. Return `ContainsUndefinedContinueTarget` of `Block` with arguments `iterationSet` and « ».

13.14.5 Static Semantics: VarDeclaredNames

See also: [13.0.5](#), [13.1.11](#), [13.2.2.2](#), [13.5.5](#), [13.6.1.4](#), [13.6.2.4](#), [13.6.3.5](#), [13.6.4.7](#), [13.10.5](#), [13.11.7](#), [13.12.12](#), [14.1.18](#), [14.2.13](#), [15.1.5](#), [15.2.1.13](#).

TryStatement : try Block Catch

1. Let `names` be `VarDeclaredNames` of `Block`.
2. Append to `names` the elements of the `VarDeclaredNames` of `Catch`.
3. Return `names`.

Deleted: See also: [13.0.1](#), [13.1.8](#), [13.2.2.2](#), [13.5.2](#), [13.6.1.1](#), [13.6.3.2](#), [13.6.3.1](#), [13.6.4.3](#), [13.10.2](#), [13.11.4](#), [13.12.10](#), [14.1.18](#), [14.2.13](#), [15.1.5](#), [15.2.1.13](#). ¶

Deleted: ¶

TryStatement : try Block Finally

1. Let `names` be `VarDeclaredNames` of `Block`.
2. Append to `names` the elements of the `VarDeclaredNames` of `Finally`.
3. Return `names`.

Deleted: ¶

TryStatement : try Block Catch Finally

1. Let `names` be `VarDeclaredNames` of `Block`.
2. Append to `names` the elements of the `VarDeclaredNames` of `Catch`.
3. Append to `names` the elements of the `VarDeclaredNames` of `Finally`.
4. Return `names`.

Deleted: ¶

Catch : catch (CatchParameter) Block

1. Return the `VarDeclaredNames` of `Block`.

Deleted: ¶

Deleted: 13.0.3

Deleted: 13.1.9

Deleted: 13.5.3

Deleted: 13.6.1.2

Deleted: 13.6.2.2

Deleted: 13.6.3.3

Deleted: 13.6.4.4

Deleted: 13.10.3

Deleted: 13.11.5

Deleted: 13.12.11

Deleted: ¶

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13.14.6 Static Semantics: VarScopedDeclarations

See also: [13.0.6](#), [13.1.12](#), [13.2.2.3](#), [13.5.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.6.4.8](#), [13.10.6](#), [13.11.8](#), [13.12.13](#), [14.1.19](#), [14.2.14](#), [15.1.6](#), [15.2.1.14](#).

TryStatement : try Block Catch

1. Let `declarations` be `VarScopedDeclarations` of `Block`.
2. Append to `declarations` the elements of the `VarScopedDeclarations` of `Catch`.
3. Return `declarations`.

TryStatement : try Block Finally

1. Let `declarations` be `VarScopedDeclarations` of `Block`.

2. Append to *declarations* the elements of the *VarScopedDeclarations* of *Finally*.
3. Return *declarations*.

TryStatement : **try** Block **Catch** **Finally**

1. Let *declarations* be *VarScopedDeclarations* of *Block*.
2. Append to *declarations* the elements of the *VarScopedDeclarations* of *Catch*.
3. Append to *declarations* the elements of the *VarScopedDeclarations* of *Finally*.
4. Return *declarations*.

Deleted: ¶

Catch : **catch** (*CatchParameter*) *Block*

1. Return the *VarScopedDeclarations* of *Block*.

Deleted: ¶

13.14.7 Runtime Semantics: CatchClauseEvaluation

with parameter *thrownValue*

Catch : **catch** (*CatchParameter*) *Block*

1. Let *oldEnv* be the running execution context's *LexicalEnvironment*.
2. Let *catchEnv* be *NewDeclarativeEnvironment*(*oldEnv*).
3. For each element *argName* of the *BoundNames* of *CatchParameter*, do
 - a. Call the *CreateMutableBinding* concrete method of *catchEnv* passing *argName* as the argument.
 - b. Assert: The above call to *CreateMutableBinding* will never return an abrupt completion.
4. Set the running execution context's *LexicalEnvironment* to *catchEnv*.
5. Let *status* be the result of performing *BindingInitialization* for *CatchParameter* passing *thrownValue* and *catchEnv* as arguments.
6. If *status* is an abrupt completion, then
 - a. Set the running execution context's *LexicalEnvironment* to *oldEnv*.
 - b. Return *status*.
7. Let *B* be the result of evaluating *Block*.
8. Set the running execution context's *LexicalEnvironment* to *oldEnv*.
9. Return *B*.

Deleted: <#>Runtime Semantics: BindingInitialization¶

With arguments *value* and *environment*.¶
 NOTE *undefined* is passed for *environment* to indicate that a *PutValue* operation should be used to assign the initialization value. . This is the case for *vaz* statements and the formal parameter lists of some non-strict functions (see 9.2.13). In those cases a lexical binding is hoisted and preinitialized prior to evaluation of its initializer. ¶

See also: 12.1.4, , 13.2.2.4, 13.6.4.5, 13.2.3.512.2.4.2.2, **Error!** Reference source not found.12.1.2, 13.2.2.2, 13.2.3.4. - ¶

CatchParameter : BindingPattern¶

<#>Let *obj* be *ToObject*(*obj*).If *Type*(*value*) is not Object, then throw a **TypeError** exception.¶

<#>ReturnIfAbrupt(*obj*).¶

<#>Return the result of performing *BindingInitialization* for *BindingPattern* passing *value* *objvalue* and *environment* as the arguments.¶

Deleted: ¶

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Deleted: <#>ReturnIfAbrupt(*status*).¶
 <#>Set the running execution context's *LexicalEnvironment* to *catchEnv*.¶

Deleted: ¶

NOTE No matter how control leaves the *Block* the *LexicalEnvironment* is always restored to its former state.

13.14.8 Runtime Semantics: Evaluation

TryStatement : **try** *Block* **Catch**

1. Let *B* be the result of evaluating *Block*.
2. If *B*.[[type]] is not **throw**, return *B*.
3. Return the result of performing *CatchClauseEvaluation* of *Catch* with parameter *B*.[[value]].

Deleted: ¶

TryStatement : **try** *Block* **Finally**

1. Let *B* be the result of evaluating *Block*.
2. Let *F* be the result of evaluating *Finally*.
3. If *F*.[[type]] is normal, return *B*.
4. Return *F*.

Deleted: ¶

TryStatement : **try** *Block* **Catch** **Finally**

1. Let *B* be the result of evaluating *Block*.

Deleted: ¶

2. If $B.[[type]]$ is throw, then
 - a. Let C be the result of performing CatchClauseEvaluation of *Catch* with parameter $B.[[value]]$.
3. Else $B.[[type]]$ is not throw,
 - a. Let C be B .
4. Let F be the result of evaluating *Finally*.
5. If $F.[[type]]$ is normal, return C .
6. Return F .

13.15 The `debugger` statement

Syntax

DebuggerStatement :
 debugger ;

13.15.1 Runtime Semantics: Evaluation

NOTE Evaluating the *DebuggerStatement* production may allow an implementation to cause a breakpoint when run under a debugger. If a debugger is not present or active this statement has no observable effect.

DebuggerStatement : debugger ;

1. If an implementation defined debugging facility is available and enabled, then
 - a. Perform an implementation defined debugging action.
 - b. Let $result$ be an implementation defined Completion value.
2. Else
 - a. Let $result$ be NormalCompletion(empty).
3. Return $result$.

Deleted: ¶

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14 ECMAScript Language: Functions and Classes

NOTE Various ECMAScript language elements cause the creation of ECMAScript function objects (9.1.14). Evaluation of such functions starts with the execution of their $[[\text{Call}]]$ internal method (9.2.2).

Deleted: Error! Reference source not found.9.2.1

14.1 Function Definitions

Syntax

FunctionDeclaration[*Yield*, *Default*] :
 function *BindingIdentifier*?*Yield* (*FormalParameters*) { *FunctionBody* }
 [+*Default*] function (*FormalParameters*) { *FunctionBody* }

Deleted: , ?*Default*

FunctionExpression :
 function *BindingIdentifier*?*opt* (*FormalParameters*) { *FunctionBody* }

StrictFormalParameters[*Yield*, *GeneratorParameter*] :
FormalParameters?*Yield*, ?*GeneratorParameter*,

Deleted: ¶

FormalParameters[*Yield*,*GeneratorParameter*] :
 [empty]
FormalParameterList?*Yield*, ?*GeneratorParameter*

FormalParameterList_[Yield,GeneratorParameter] :

- FunctionRestParameter_[?Yield]*
- FormalsList_[?Yield, ?GeneratorParameter]*
- FormalsList_[?Yield, ?GeneratorParameter], FunctionRestParameter_[?Yield]*

FormalsList_[Yield,GeneratorParameter] :

- FormalParameter_[?Yield, ?GeneratorParameter]*
- FormalsList_[?Yield, ?GeneratorParameter], FormalParameter_[?Yield,?GeneratorParameter]*

FunctionRestParameter_[Yield] :

- BindingRestElement_[?Yield]*

FormalParameter_[Yield,GeneratorParameter] :

- BindingElement_[?Yield, ?GeneratorParameter]*

FunctionBody_[Yield] :

- FunctionStatementList_[?Yield]*

FunctionStatementList_[Yield] :

- StatementList_[?Yield, ReturnOpt]*

14.1.1 Directive Prologues and the Use Strict Directive

A Directive Prologue is the longest sequence of *ExpressionStatement* productions occurring as the initial *StatementListItem* productions of a *FunctionBody* or a *ScriptBody* and where each *ExpressionStatement* in the sequence consists entirely of a *StringLiteral* token followed by a semicolon. The semicolon may appear explicitly or may be inserted by automatic semicolon insertion. A Directive Prologue may be an empty sequence.

A Use Strict Directive is an *ExpressionStatement* in a Directive Prologue whose *StringLiteral* is either the exact code unit sequences "use strict" or 'use strict'. A Use Strict Directive may not contain an *EscapeSequence* or *LineContinuation*.

A Directive Prologue may contain more than one Use Strict Directive. However, an implementation may issue a warning if this occurs.

NOTE The *ExpressionStatement* productions of a Directive Prologue are evaluated normally during evaluation of the containing production. Implementations may define implementation specific meanings for *ExpressionStatement* productions which are not a Use Strict Directive and which occur in a Directive Prologue. If an appropriate notification mechanism exists, an implementation should issue a warning if it encounters in a Directive Prologue an *ExpressionStatement* that is not a Use Strict Directive and which does not have a meaning defined by the implementation.

14.1.2 Static Semantics: Early Errors

FunctionDeclaration : **function** *BindingIdentifier* (*FormalParameters*) { *FunctionBody* }

and

FunctionExpression : **function** *BindingIdentifier_{opt}* (*FormalParameters*) { *FunctionBody* }

- If the source code matching this production is strict code, the Early Error rules for *StrictFormalParameters* : *FormalParameters* are applied.
- If the source code matching this production is strict code, it is a Syntax Error if *BindingIdentifier* is the *IdentifierName eval* or the *IdentifierName arguments*.

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- It is a Syntax Error if any element of the BoundNames of *FormalParameters* also occurs in the LexicallyDeclaredNames of *FunctionBody*.
- It is a Syntax Error if *FormalParameters* Contains *SuperCall* is true.
- It is a Syntax Error if *FunctionBody* Contains *SuperCall* is true.

NOTE The LexicallyDeclaredNames of a *FunctionBody* does not include identifiers bound using var or function declarations.

Deleted: <#>It is a Syntax Error if IsSimpleParameterList of *FormalParameters* is false and any element of the BoundNames of *FormalParameters* also occurs in the VarDeclaredNames of *FunctionBody*.||

Deleted:

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StrictFormalParameters : *FormalParameters*

- It is a Syntax Error if BoundNames of *FormalParameters* contains any duplicate elements.

FormalParameters : *FormalParameterList*

- It is a Syntax Error if IsSimpleParameterList of *FormalParameterList* is false and BoundNames of *FormalParameterList* contains any duplicate elements.

Deleted: Simple parameter lists bind identifiers as VarDeclaredNames. Parameter lists that contain destructuring patterns, default value initializers, or a rest parameter bind identifiers as LexicallyDeclaredNames.

Deleted: ¶

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NOTE Multiple occurrences of the same *BindingIdentifier* in a *FormalParameterList* is only allowed for non-strict functions and generator functions that have simple parameter lists.

FunctionBody : *FunctionStatementList*

- It is a Syntax Error if the LexicallyDeclaredNames of *FunctionStatementList* contains any duplicate entries.
- It is a Syntax Error if any element of the LexicallyDeclaredNames of *FunctionStatementList* also occurs in the VarDeclaredNames of *FunctionStatementList*.
- It is a Syntax Error if ContainsDuplicateLabels of *FunctionStatementList* with argument « » is true.
- It is a Syntax Error if ContainsUndefinedBreakTarget of *FunctionStatementList* with argument « » is true.
- It is a Syntax Error if ContainsUndefinedContineTarget of *FunctionStatementList* with arguments « » and « » is true.

Deleted: *FunctionStatementList*

Deleted: ¶

14.1.3 Static Semantics: BoundNames

See also: 13.2.1.2, 13.2.2.1, 12.1.2, [13.6.4.2](#), 14.2.2, 14.4.2, 14.5.2, [15.2.2.2](#), [15.2.3.1](#)

Deleted: ¶ 13.6.4.2

Deleted: 15.2.1.2

Deleted: 15.2.2.1

FunctionDeclaration : **function** *BindingIdentifier* (*FormalParameters*) { *FunctionBody* }

1. Return the BoundNames of *BindingIdentifier*.

FunctionDeclaration : **function** (*FormalParameters*) { *FunctionBody* }

1. Return «*default*».

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Deleted:)

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NOTE «*default*» is used within this specification as a synthetic name for hoistable anonymous functions that are defined using *export* declarations.

FormalParameters : [empty]

1. Return an empty List.

FormalParameterList : *FormalsList* , *FunctionRestParameter*

1. Let *names* be BoundNames of *FormalsList*.
2. Append to *names* the BoundNames of *FunctionRestParameter*.

3. Return *names*.

FormalsList : *FormalsList* , *FormalParameter*

1. Let *names* be *BoundNames* of *FormalsList*.
2. Append to *names* the elements of *BoundNames* of *FormalParameter*.
3. Return *names*.

Deleted: ¶

14.1.4 Static Semantics: Contains

With parameter symbol.

See also: 5.3, 12.2.5.2, 12.3.1.1, 14.2.3, [14.4.4](#), 14.5.4

Deleted: 014.4.3

FunctionDeclaration : **function** *BindingIdentifier* (*FormalParameters*) { *FunctionBody* }

1. Return **false**.

FunctionExpression : **function** *BindingIdentifier*_{opt} (*FormalParameters*) { *FunctionBody* }

1. Return **false**.

NOTE Static semantic rules that depend upon substructure generally do not look into function definitions.

14.1.5 Static Semantics: ContainsExpression

See also: 13.2.3.2, 14.2.4.

FormalParameters : [empty]

1. Return **false**.

FormalParameterList : *FunctionRestParameter*

1. Return **false**.

FormalParameterList : *FormalsList* , *FunctionRestParameter*

1. Return ContainsExpression of *FormalsList*.

FormalsList : *FormalsList* , *FormalParameter*

1. If ContainsExpression of *FormalsList* is **true**, **return true**.
2. Return ContainsExpression of *FormalParameter*.

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14.1.6 Static Semantics: ExpectedArgumentCount

See also: 14.2.6, 14.3.2.

FormalParameters : [empty]

1. Return 0.

FormalParameterList : *FunctionRestParameter*

1. Return 0.

FormalParameterList : *FormalsList* , *FunctionRestParameter*

1. Return the ExpectedArgumentCount of *FormalsList*.

NOTE The ExpectedArgumentCount of a *FormalParameterList* is the number of *FormalParameters* to the left of either the rest parameter or the first *FormalParameter* with an Initializer. A *FormalParameter* without an initializer is allowed after the first parameter with an initializer but such parameters are considered to be optional with **undefined** as their default value.

FormalsList : *FormalParameter*

1. If HasInitializer of *FormalParameter* is **true** return 0
2. Return 1.

FormalsList : *FormalsList* , *FormalParameter*

1. Let *count* be the ExpectedArgumentCount of *FormalsList*.
2. If HasInitializer of *FormalsList* is **true** or HasInitializer of *FormalParameter* is **true**, **return** *count*.
3. Return *count*+1.

14.1.7 Static Semantics: *FormalParameters*

FunctionDeclaration : **function** *BindingIdentifier* (*FormalParameters*) { *FunctionBody* }

1. Return *FormalParameters*.

14.1.8 Static Semantics: *HasInitializer*

See also: 13.2.3.3, 14.2.7.

FormalParameters : [empty]

1. Return **false**.

FormalParameterList : *FunctionRestParameter*

1. Return **false**.

FormalParameterList : *FormalsList* , *FunctionRestParameter*

1. If HasInitializer of *FormalsList* is **true**, **return** **true**.
2. Return **false**.

FormalsList : *FormalsList* , *FormalParameter*

1. If HasInitializer of *FormalsList* is **true**, **return** **true**.
2. Return HasInitializer of *FormalParameter*.

14.1.9 Static Semantics: *HasName*

See also: 14.2.8, 14.4.6, 14.5.6.

FunctionExpression : **function** (*FormalParameters*) { *FunctionBody* }

1. Return **false**.

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FunctionExpression : **function** *BindingIdentifier* (*FormalParameters*) { *FunctionBody* }

1. Return **true**.

14.1.10 Static Semantics: IsAnonymousFunctionDefinition (production) Abstract Operation

The abstract operation *IsAnonymousFunctionDefinition* determines if its argument is a function definition that does not bind a name. The argument *production* is the result of parsing an *AssignmentExpression* or *Initializer*. The following steps are taken:

1. If *IsFunctionDefinition* of *production* is **false**, return **false**.
2. Let *hasName* be the result of *HasName* of *production*.
3. If *hasName* is **true**, return **false**.
4. Return **true**.

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14.1.11 Static Semantics: IsConstantDeclaration

See also: 13.2.1.3, [14.4.8](#), 14.5.7, [15.2.3.7](#)

FunctionDeclaration : **function** *BindingIdentifier* (*FormalParameters*) { *FunctionBody* }
FunctionDeclaration : **function** (*FormalParameters*) { *FunctionBody* }

Deleted: 14.4.7

Deleted: 15.2.3.6

Deleted: 13.2.1.3, 14.4.5, 14.5.5

1. Return **false**.

14.1.12 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, [12.2.9.2](#), 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, 14.4.8, 14.5.8.

Deleted: 12.2.9.212.2.10.2

FunctionExpression : **function** (*FormalParameters*) { *FunctionBody* }

1. Return **true**.

FunctionExpression : **function** *BindingIdentifier* (*FormalParameters*) { *FunctionBody* }

1. Return **true**.

14.1.13 Static Semantics: IsSimpleParameterList

See also: 13.2.3.4, 14.2.8

FormalParameters : [empty]

1. Return **true**.

FormalParameterList : *FunctionRestParameter*

1. Return **false**.

FormalParameterList : *FormalsList* , *FunctionRestParameter*

1. Return **false**.

FormalsList : *FormalsList* , *FormalParameter*

1. If *IsSimpleParameterList* of *FormalsList* is **false**, return **false**.

Deleted: ¶

2. Return `IsSimpleParameterList` of `FormalParameter`.

`FormalParameter : BindingElement`

1. Return `IsSimpleParameterList` of `BindingElement`.

Deleted: ¶

14.1.14 Static Semantics: `IsStrict`

See also: 15.1.2, 15.2.1.7

`FunctionStatementList : StatementListopt`

1. If this `FunctionStatementList` is contained in strict code or if `StatementList` is strict code, `return true`. Otherwise, return `false`.

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Comment [AWB1037]: Need a better definition

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Deleted: 15.2.1.10

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14.1.15 Static Semantics: `LexicallyDeclaredNames`

See also: 13.1.2, 13.11.2, 13.12.6, 14.2.10, 15.1.3, 15.2.1.11

`FunctionStatementList : [empty]`

1. Return an empty List.

`FunctionStatementList : StatementList`

1. Return `TopLevelLexicallyDeclaredNames` of `StatementList`.

14.1.16 Static Semantics: `LexicallyScopredDeclarations`

See also: 13.1.6, 13.11.6, 13.12.7, 14.2.11, 15.1.4, 15.2.1.12, 15.2.3.8

`FunctionStatementList : [empty]`

1. Return an empty List.

`FunctionStatementList : StatementList`

1. Return the `TopLevelLexicallyScopredDeclarations` of `StatementList`.

14.1.17 Static Semantics: `NeedsSuperBinding`

See also: 14.2.12, 14.3.7, 14.4.11

`FunctionDeclaration : function BindingIdentifier (FormalParameters) { FunctionBody }`

`FunctionDeclaration : function (FormalParameters) { FunctionBody }`

1. If `FormalParameters` Contains `SuperProperty` is `true`, `return true`.
 2. Return `FunctionBody` Contains `SuperProperty`.

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Deleted: 13.11.3

Deleted: 13.12.5

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`FunctionExpression : function BindingIdentifieropt (FormalParameters) { FunctionBody }`

1. If `FormalParameters` Contains `SuperProperty` is `true`, `return true`.
 2. Return `FunctionBody` Contains `SuperProperty`.

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`FormalParameters : [empty]`

1. Return `false`.

FormalParameters : *FormalParameterList*

1. Return *FormalParameterList* Contains *SuperProperty*.

FunctionBody : *FunctionStatementList*

1. Return *FunctionStatementList* Contains *SuperProperty*.

14.1.18 Static Semantics: VarDeclaredNames

See also: [13.0.5](#), [13.1.11](#), [13.2.2.2](#), [13.5.5](#), [13.6.1.4](#), [13.6.2.4](#), [13.6.3.5](#), [13.6.4.7](#), [13.10.5](#), [13.11.7](#), [13.12.12](#), [13.14.5](#), [14.2.13](#), [15.1.5](#), [15.2.1.13](#).

FunctionStatementList : [empty]

1. Return an empty List.

FunctionStatementList : *StatementList*

1. Return TopLevelVarDeclaredNames of *StatementList*.

14.1.19 Static Semantics: VarScopedDeclarations

See also: [13.0.6](#), [13.1.12](#), [13.2.2.3](#), [13.5.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.6.4.8](#), [13.10.6](#), [13.11.8](#), [13.12.13](#), [13.14.6](#), [14.2.14](#), [15.1.6](#), [15.2.1.14](#).

FunctionStatementList : [empty]

1. Return an empty List.

FunctionStatementList : *StatementList*

1. Return the TopLevelVarScopedDeclarations of *StatementList*.

14.1.20 Runtime Semantics: EvaluateBody

With parameter *functionObject*.

See also: [14.2.16](#), [14.4.12](#).

FunctionBody : *FunctionStatementList*

1. The code of this *FunctionBody* is strict mode code if it is contained in strict mode code or if the Directive Prologue (14.1.1) of its *FunctionStatementList* contains a Use Strict Directive or if any of the conditions in 10.2.1 apply. If the code of this *FunctionBody* is strict mode code, *FunctionStatementList* is evaluated in the following steps as strict mode code. Otherwise, *StatementList* is evaluated in the following steps as non-strict mode code.
2. **Return** the result of evaluating *FunctionStatementList*.

14.1.21 Runtime Semantics: IteratorBindingInitialization

With parameters *iterator* and *environment*.

NOTE When **undefined** is passed for *environment* it indicates that a PutValue operation should be used to assign the initialization value. This is the case for formal parameter lists of non-strict functions. In that case the formal parameter bindings are preinitialized in order to deal with the possibility of multiple parameters with the same name.

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Deleted: \emptyset
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Deleted: Let <i>result</i> be
Deleted: <#>If <i>result</i> .[[type]] is return then ...
Deleted: .
Deleted: \emptyset

See also: 13.2.3.6, [14.2.15](#).

FormalParameters : [empty]

1. Return NormalCompletion(empty).

FormalParameterList : *FormalsList* , *FunctionRestParameter*

1. Let *restIndex* be the result of performing IteratorBindingInitialization for *FormalsList* using *iterator*, and *environment* as the arguments.
2. ReturnIfAbrupt(*restIndex*).
3. Return the result of performing IteratorBindingInitialization for *FunctionRestParameter* using *iterator* and *environment* as the arguments.

FormalsList : *FormalsList* , *FormalParameter*

1. Let *status* be the result of performing IteratorBindingInitialization for *FormalsList* using *iterator* and *environment* as the arguments.
2. ReturnIfAbrupt(*status*).
3. Return the result of performing IteratorBindingInitialization for *FormalParameter* using *iterator* and *environment* as the arguments.

14.1.22 Runtime Semantics: InstantiateFunctionObject

With parameter *scope*.

See also: [14.4.13](#),

Deleted: 14.4.1214.4.1214.4.1214.4.1514.4.15
14.4.14

FunctionDeclaration : **function** *BindingIdentifier* (*FormalParameters*) { *FunctionBody* }

1. If the *FunctionDeclaration* is contained in strict code or if its *FunctionBody* is strict code, let *strict* be **true**. Otherwise let *strict* be **false**.
2. Let *name* be *StringValue* of *BindingIdentifier*.
3. Let *F* be *FunctionCreate*(*Normal*, *FormalParameters*, *FunctionBody*, *scope*, *strict*).
4. If *NeedsSuperBinding* of *FunctionDeclaration* is **true**, then
 - a. Perform *MakeMethod*(*F*, **undefined**).
5. Perform *MakeConstructor*(*F*).
6. **Perform** *SetFunctionName*(*F*, *name*).
7. **Return** *F*.

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FunctionDeclaration : **function** (*FormalParameters*) { *FunctionBody* }

1. If the *FunctionDeclaration* is contained in strict code or if its *FunctionBody* is strict code, let *strict* be **true**. Otherwise let *strict* be **false**.
2. Let *F* be *FunctionCreate*(*Normal*, *FormalParameters*, *FunctionBody*, *scope*, *strict*).
3. If *NeedsSuperBinding* of *FunctionDeclaration* is **true**, then
 - a. Perform *MakeMethod*(*F*, **undefined**).
4. Perform *MakeConstructor*(*F*).
5. **Perform** *SetFunctionName*(*F*, "default").
6. **Return** *F*.

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NOTE An anonymous *FunctionDeclaration* can only occur as part of an *export default* declaration.

14.1.23 Runtime Semantics: Evaluation

FunctionDeclaration : function BindingIdentifier (FormalParameters) { FunctionBody }
FunctionDeclaration : function (FormalParameters) { FunctionBody }

1. Return NormalCompletion(empty)

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FunctionExpression : function (FormalParameters) { FunctionBody }

1. If the *FunctionExpression* is contained in strict code or if its *FunctionBody* is strict code, let *strict* be **true**. Otherwise let *strict* be **false**.
2. Let *scope* be the LexicalEnvironment of the running execution context.
3. Let *closure* be *FunctionCreate(Normal, FormalParameters, FunctionBody, scope, strict)*.
4. If *NeedsSuperBinding* of *FunctionExpression* is **true**, then
 - a. Perform *MakeMethod(closure, undefined)*.
5. Perform *MakeConstructor(closure)*.
6. Return *closure*.

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Deleted: undefined,

FunctionExpression : function BindingIdentifier (FormalParameters) { FunctionBody }

1. If the *FunctionExpression* is contained in strict code or if its *FunctionBody* is strict code, let *strict* be **true**. Otherwise let *strict* be **false**.
2. Let *runningContext* be the running execution context's Lexical Environment.
3. Let *funcEnv* be *NewDeclarativeEnvironment(runningContext)*.
4. Let *envRec* be *funcEnv*'s environment record.
5. Let *name* be StringValue of *BindingIdentifier*.
6. Call the *CreateImmutableBinding* concrete method of *envRec* passing *name* as the argument.
7. Let *closure* be *FunctionCreate(Normal, FormalParameters, FunctionBody, funcEnv, strict)*.
8. If *NeedsSuperBinding* of *FunctionExpression* is **true**, then
 - a. Perform *MakeMethod(closure, undefined)*.
9. Perform *MakeConstructor(closure)*.
10. Perform *SetFunctionName(closure, name)*.
11. Call the *InitializeBinding* concrete method of *envRec* passing *name* and *closure* as the arguments.
12. Return NormalCompletion(*closure*).

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Deleted: <#>Assert: SetFunctionName will not return an abrupt completion.¶

NOTE 1 The *BindingIdentifier* in a *FunctionExpression* can be referenced from inside the *FunctionExpression*'s *FunctionBody* to allow the function to call itself recursively. However, unlike in a *FunctionDeclaration*, the *BindingIdentifier* in a *FunctionExpression* cannot be referenced from and does not affect the scope enclosing the *FunctionExpression*.

NOTE 2 A **prototype** property is automatically created for every function defined using a *FunctionDeclaration* or *FunctionExpression*, to allow for the possibility that the function will be used as a constructor.

FunctionStatementList : [empty]

1. Return NormalCompletion(**undefined**).

Deleted: ¶

14.2 Arrow Function Definitions

Syntax

ArrowFunction[In, Yield] :
ArrowParameters[?Yield][no LineTerminator here] => ConciseBody[?In]

Deleted:

ArrowParameters_[yield] :
BindingIdentifier_[?yield]
CoverParenthesizedExpressionAndArrowParameterList_[?yield]

ConciseBody_[in] :
 [lookahead ≠ {}] *AssignmentExpression_[?in]*
 { *FunctionBody* }

Supplemental Syntax

When the production

ArrowParameters_[yield] : *CoverParenthesizedExpressionAndArrowParameterList_[?yield]*

is recognized the following grammar is used to refine the interpretation of
CoverParenthesizedExpressionAndArrowParameterList:

ArrowFormalParameters_[yield, GeneratorParameter] :
 (*StrictFormalParameters_[?yield, ?GeneratorParameter]*)

14.2.1 Static Semantics: Early Errors

ArrowFunction : *ArrowParameters* => *ConciseBody*

- It is a Syntax Error if any element of the *BoundNames* of *ArrowParameters* also occurs in the *LexicallyDeclaredNames* of *ConciseBody*.

ArrowParameters_[yield] : *CoverParenthesizedExpressionAndArrowParameterList_[?yield]*

- If the *[yield]* grammar parameter is present on *ArrowParameters*, it is a Syntax Error if the lexical token sequence matched by *CoverParenthesizedExpressionAndArrowParameterList_[?yield]* cannot be parsed with no tokens left over using *ArrowFormalParameters_[yield, GeneratorParameter]* as the goal symbol.
- If the *[yield]* grammar parameter is not present on *ArrowParameters*, it is a Syntax Error if the lexical token sequence matched by *CoverParenthesizedExpressionAndArrowParameterList_[?yield]* cannot be parsed with no tokens left over using *ArrowFormalParameters* as the goal symbol.
- All early errors rules for *ArrowFormalParameters* and its derived productions also apply to *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList_[?yield]*.

NOTE The *yield* operator cannot be used within expressions that are part of an *ArrowFormalParameters*.

14.2.2 Static Semantics: BoundNames

See also: 13.2.1.2, 13.2.2.1, 12.1.2, [13.6.4.2](#), 14.1.3, 14.4.2, 14.5.2, 15.2.2.2, 15.2.3.1,

ArrowParameters_[yield] : *CoverParenthesizedExpressionAndArrowParameterList_[?yield]*

- Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList_[?yield]*.
- Return the *BoundNames* of *formals*.

14.2.3 Static Semantics: Contains

With parameter *symbol*.

See also: 5.3, 12.2.5.2, 12.3.1.1, 14.1.4, [14.4.4](#), 14.5.4

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ArrowFunction : *ArrowParameters* => *ConciseBody*

1. If *symbol* is not one of *SuperProperty*, *SuperCall*, *super* or *this*, return **false**.
2. If *ArrowParameters* Contains *symbol* is **true**, return **true**;
3. Return *ConciseBody* Contains *symbol* .

NOTE Normally, Contains does not look inside most function forms However, Contains is used to detect **this** and **super** usage within an *ArrowFunction*.

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*ArrowParameters*_[*Yield*] : *CoverParenthesizedExpressionAndArrowParameterList*_[?*Yield*]

1. Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList*_[?*Yield*].
2. Return *formals* Contains *symbol*.

14.2.4 Static Semantics: ContainsExpression

See also: 13.2.3.2, 14.1.5.

ArrowParameters : *BindingIdentifier*,

1. Return **false**.

Deleted: ¶

*ArrowParameters*_[*Yield*] : *CoverParenthesizedExpressionAndArrowParameterList*_[?*Yield*]

Deleted: ¶

1. Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList*_[?*Yield*].
2. Return the *ContainsExpression* of *formals*.

14.2.5 Static Semantics: CoveredFormalsList

ArrowParameters : *BindingIdentifier*,

1. Return *BindingIdentifier*.

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*CoverParenthesizedExpressionAndArrowParameterList*_[*Yield*]:

(*Expression*)
 ()
 (... *BindingIdentifier*)
 (*Expression* , ... *BindingIdentifier*)

Deleted:

1. If the *[*Yield*]* grammar parameter is present for *CoverParenthesizedExpressionAndArrowParameterList*_[*Yield*], return the result of parsing the lexical token stream matched by *CoverParenthesizedExpressionAndArrowParameterList*_[*Yield*] using *ArrowFormalParameters*_[*Yield*, *GeneratorParameter*] as the goal symbol.
2. If the *[*Yield*]* grammar parameter is not present for *CoverParenthesizedExpressionAndArrowParameterList*_[*Yield*], return the result of parsing the lexical token stream matched by *CoverParenthesizedExpressionAndArrowParameterList* using *ArrowFormalParameters* as the goal symbol.

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14.2.6 Static Semantics: ExpectedArgumentCount

See also: 14.1.5, 14.3.2.

ArrowParameters : *BindingIdentifier*

1. Return 1.

Deleted: ¶

ArrowParameters [Yield] : *CoverParenthesizedExpressionAndArrowParameterList* [?Yield]

1. Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList* [?Yield].
2. Return the *ExpectedArgumentCount* of *formals*.

Deleted: ¶

14.2.7 Static Semantics: HasInitializer

See also: 13.2.3.3, 14.1.7.

ArrowParameters : *BindingIdentifier*

1. Return **false**.

Deleted: ¶

ArrowParameters : *CoverParenthesizedExpressionAndArrowParameterList*

1. Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList*.
2. Return the *HasInitializer* of *formals*.

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14.2.8 Static Semantics: HasName

See also: [14.1.9](#), [14.4.6](#), [14.5.6](#).

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ArrowFunction : *ArrowParameters* => *ConciseBody*

1. Return **false**.

14.2.9 Static Semantics: IsSimpleParameterList

See also: 13.2.3.4, [14.1.12](#).

ArrowParameters : *BindingIdentifier*

1. Return **true**.

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ArrowParameters [Yield] : *CoverParenthesizedExpressionAndArrowParameterList* [?Yield]

1. Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList* [?Yield].
2. Return the *IsSimpleParameterList* of *formals*.

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14.2.10 Static Semantics: LexicallyDeclaredNames

See also: [13.1.2](#), [13.11.2](#), [13.12.6](#), [14.1.15](#), [15.1.3](#), [15.2.1.11](#).

ConciseBody : *AssignmentExpression*

1. Return an empty List.

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See also: [13.1.6](#), [13.11.6](#), [13.12.7](#), [14.1.16](#), [15.1.4](#), [15.2.1.12](#), [15.2.3.8](#).

ConciseBody : *AssignmentExpression*

1. Return an empty List.

Deleted: ¶

14.2.12 Static Semantics: NeedsSuperBinding

See also: [14.1.17](#), [14.3.7](#), [14.4.11](#)

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ArrowFunction : *ArrowParameters* => *ConciseBody*

1. Return **false**.

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14.2.13 Static Semantics: VarDeclaredNames

See also: [13.0.5](#), [13.1.11](#), [13.2.2.2](#), [13.5.5](#), [13.6.1.4](#), [13.6.2.4](#), [13.6.3.5](#), [13.6.4.7](#), [13.10.5](#), [13.11.7](#), [13.12.12](#), [13.14.5](#), [14.1.18](#), [15.1.5](#), [15.2.1.13](#).

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ConciseBody : *AssignmentExpression*

1. Return an empty List.

Deleted: See also: 13.0.1, 13.1.8, 13.2.2.2, 13.5.2, 13.6.1.1, 13.6.3.213.6.2.1, 13.6.3.1, 13.6.4.3, 13.10.2, , 13.11.4, 13.12.10, 13.14.2, 14.1.1814.1.17, 15.1.5, 15.2.1.1313.0.1, 13.1.8, , 13.5.1, 13.6.1.1, 13.6.2.1, 13.6.3.1, 13.6.4.3, 13.10.2, 13.11.4, 13.12.2, 013.14.2, 14.4.12, 14.5.1514.5.16, 15.1.5, 15.2.0.13.¶

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ConciseBody : *AssignmentExpression*

1. Return an empty List.

14.2.15 Runtime Semantics: IteratorBindingInitialization

With parameters *iterator* and *environment*.

See also: [13.2.3.6](#), [14.1.21](#).

NOTE When **undefined** is passed for *environment* it indicates that a PutValue operation should be used to assign the initialization value. This is the case for formal parameter lists of non-strict functions. In that case the formal parameter bindings are preinitialized in order to deal with the possibility of multiple parameters with the same name.

ArrowParameters : *BindingIdentifier*

1. Let *next* be *IteratorStep(iterator)*.
2. *ReturnIfAbrupt(next)*.
3. If *next* is **false**, **let** *v* be **undefined**,
4. Else
 - a. Let *v* be *IteratorValue(next)*.
 - b. *ReturnIfAbrupt(v)*.
5. Return the result of performing *BindingInitialization* for *BindingIdentifier* using *v* and *environment* as the arguments.

ArrowParameters_[?Yield] : *CoverParenthesizedExpressionAndArrowParameterList_[?Yield]*

1. Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList_[?Yield]*.
2. Return the result of performing *IteratorBindingInitialization* of *formals* with arguments *iterator* and *environment*.

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14.2.16 Runtime Semantics: EvaluateBody

With parameter *functionObject*.

See also: 14.1.20, 14.4.12

Deleted: 14.4.11

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ConciseBody : *AssignmentExpression*

1. The code of this *ConciseBody* is strict mode code if it is contained in strict mode code or if any of the conditions in 10.2.1 apply. If the code of this *ConciseBody* is strict mode code, *AssignmentExpression* is evaluated in the following steps as strict mode code. Otherwise, *AssignmentExpression* is evaluated in the following steps as non-strict mode code.
2. Let *exprRef* be the result of evaluating *AssignmentExpression*.
3. Let *exprValue* be *GetValue(exprRef)*.
4. ReturnIfAbrupt(*exprValue*).
5. Return *Completion{[[type]]: return, [[value]]: exprValue, [[target]]: empty}*.

Deleted: <#> If *exprValue.[[type]]* is return then return *NormalCompletion(exprValue.[[value]])*. ¶

Deleted: *NormalCompletion(exprValue)*

Deleted: NOTE In the absence of extensions to this specification, the test in step 4 will never be true. ¶

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14.2.17 Runtime Semantics: Evaluation

ArrowFunction_[?Yield] : *ArrowParameters_[?Yield]* => *ConciseBody*

1. If the code of this *ArrowFunction* is contained in strict mode code or if any of the conditions in 10.2.1 apply, *let strict* be **true**. Otherwise let *strict* be **false**.
2. Let *scope* be the *LexicalEnvironment* of the running execution context.
3. Let *parameters* be *CoveredFormalsList* of *ArrowParameters_[?Yield]*.
4. Let *closure* be *FunctionCreate(Arrow, parameters, ConciseBody, scope, strict)*.
5. Return *closure*.

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NOTE An *ArrowFunction* does not define local bindings for *arguments*, *super*, or *this*. Any reference to *arguments*, *super*, or *this* within an *ArrowFunction* must resolve to a binding in a lexically enclosing *environment*. Typically this will be the *Function Environment* of an immediately enclosing function. Even though an *ArrowFunction* may contain references to *super*, the function object created in step 4 is not made into a method by performing *MakeMethod*. An *ArrowFunction* that references *super* is always contained within a non-*ArrowFunction* and the necessary state to implement *super* is accessible via the *scope* that is captured by the function object of the *ArrowFunction*.

14.3 Method Definitions

Syntax

MethodDefinition_[?Yield] :

```
PropertyName[?Yield] ( StrictFormalParameters ) { FunctionBody }
GeneratorMethod[?Yield]
get PropertyName[?Yield] ( ) { FunctionBody }
set PropertyName[?Yield] ( PropertySetParameterList ) { FunctionBody }
```

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PropertySetParameterList :
FormalParameter

Deleted: ¶

14.3.1 Static Semantics: Early Errors

MethodDefinition : *PropertyName* (*StrictFormalParameters*) { *FunctionBody* }

- It is a Syntax Error if any element of the *BoundNames* of *StrictFormalParameters* also occurs in the *LexicallyDeclaredNames* of *FunctionBody*.

MethodDefinition : set *PropertyName* (*PropertySetParameterList*) { *FunctionBody* }

- It is a Syntax Error if *BoundNames* of *PropertySetParameterList* contains any duplicate elements.
- It is a Syntax Error if any element of the *BoundNames* of *PropertySetParameterList* also occurs in the *LexicallyDeclaredNames* of *FunctionBody*.

14.3.2 Static Semantics: ComputedPropertyContains

With parameter *symbol*.

See also: 12.2.5.2, [14.4.3](#), 14.5.5.

MethodDefinition :

```
PropertyName ( StrictFormalParameters ) { FunctionBody }
  get PropertyName ( ) { FunctionBody }
  set PropertyName ( PropertySetParameterList ) { FunctionBody }
```

1. Return the result of ComputedPropertyContains for *PropertyName* with argument *symbol*.

14.3.3 Static Semantics: ExpectedArgumentCount

See also: 14.1.5, 14.2.6.

PropertySetParameterList : *FormalParameter*

Deleted: ¶

1. If HasInitializer of *FormalParameter* is true return 0
2. Return 1.

14.3.4 Static Semantics: HasComputedPropertyKey

See also: 12.2.5.4, [14.4.5](#).

Deleted: ¶

MethodDefinition :

```
PropertyName ( StrictFormalParameters ) { FunctionBody }
  get PropertyName ( ) { FunctionBody }
  set PropertyName ( PropertySetParameterList ) { FunctionBody }
```

1. Return HasComputedPropertyKey of *PropertyName*.

Deleted: ¶

14.3.5 Static Semantics: HasDirectSuper

See also: 14.4.6.

MethodDefinition : PropertyName (StrictFormalParameters) { FunctionBody }

1. If *StrictFormalParameters* Contains *SuperCall* is true, return true.
2. Return *FunctionBody* Contains *SuperCall*.

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Deleted: <#>If *StrictFormalParameters* Contains *NewSuper* is true, then return, return true.¶

Deleted: , then return

Deleted: <#>If *FunctionBody* Contains *NewSuper* is true, then return, return true.¶

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Deleted: <#>If *FunctionBody* Contains *NewSuper* is true, then return, return true.¶

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Deleted: <#>If *PropertySetParameterList* Contains *NewSuper* is true, then return, return true.¶

Deleted: , then return

Deleted: <#>If *FunctionBody* Contains *NewSuper* is true, then return, return true.¶

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14.3.6 Static Semantics: PropName

See also: 12.2.5.6, [14.4.10](#), [14.5.12](#)

MethodDefinition :

```
PropertyName ( StrictFormalParameters ) { FunctionBody }
get PropertyName ( ) { FunctionBody }
set PropertyName ( PropertySetParameterList ) { FunctionBody }
```

1. Return *PropName* of *PropertyName*.

14.3.7 Static Semantics: NeedsSuperBinding

See also: [14.1.17](#), [14.2.12](#), [14.4.11](#)

MethodDefinition : PropertyName (StrictFormalParameters) { FunctionBody }

1. If *StrictFormalParameters* Contains *SuperProperty* is true, return true.
2. Return *FunctionBody* Contains *SuperProperty*.

MethodDefinition : get PropertyName () { FunctionBody }

1. Return *FunctionBody* Contains *SuperProperty*.

MethodDefinition : set PropertyName (PropertySetParameterList) { FunctionBody }

1. If *PropertySetParameterList* Contains *SuperProperty* is true, return true.
2. Return *FunctionBody* Contains *SuperProperty*.

14.3.8 Static Semantics: SpecialMethod

MethodDefinition : PropertyName (StrictFormalParameters) { FunctionBody }

1. Return false.

MethodDefinition :

```
GeneratorMethod
get PropertyName ( ) { FunctionBody }
set PropertyName ( PropertySetParameterList ) { FunctionBody }
```

1. Return true.

Deleted: ¶

14.3.9 Runtime Semantics: DefineMethod

With parameters *object* and optional parameter *functionPrototype*

Deleted: ¶

MethodDefinition : *PropertyName* (*StrictFormalParameters*) { *FunctionBody* }

1. Let *propKey* be the result of evaluating *PropertyName*.
2. ReturnIfAbrupt(*propKey*).
3. Let *strict* be IsStrict of *FunctionBody*.
4. Let *scope* be the running execution context's LexicalEnvironment.
5. Let *closure* be FunctionCreate(*Method*, *StrictFormalParameters*, *FunctionBody*, *scope*, *strict*). If *functionPrototype* was passed as a parameter then pass its value as the *functionPrototype* optional argument of FunctionCreate.
6. If NeedsSuperBinding of *MethodDefinition* is **true**, then
 - a. Perform MakeMethod(*closure*, *object*).
7. Return the Record{[[key]]: *propKey*, [[closure]]: *closure* }.

Deleted: .

Deleted: ¶

Deleted: ReferencesSuper

Deleted: *propKey*,

Deleted: <#>SetFunctionName(*closure*, *propKey*).¶

14.3.10 Runtime Semantics: PropertyDefinitionEvaluation

With parameters *object* and enumerable

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Deleted: ¶

Deleted: 14.4.13

Deleted: 014.4.1314.4.1314.4.1614.4.1614.4.15

Deleted: the result of

Deleted: of this

Deleted: ¶

Deleted: <#>Assert: SetFunctionName will not return an abrupt completion.¶

Deleted: <#>Let *desc* be the Property Descriptor{[[Value]]: *methodDef*.[[closure]], [[Writable]]: true, [[Enumerable]]: *enumerable*, [[Configurable]]: true}.

Deleted: *DefinePropertyOrThrow*(*object*, *methodDef*.[[key]], *desc*).

MethodDefinition : GeneratorMethod

See 14.4.

MethodDefinition : **get** *PropertyName* (), { *FunctionBody* }

1. Let *propKey* be the result of evaluating *PropertyName*.
2. ReturnIfAbrupt(*propKey*).
3. Let *strict* be IsStrict of *FunctionBody*.
4. Let *scope* be the running execution context's LexicalEnvironment.
5. Let *formalParameterList* be the production *FormalParameters* : [empty]
6. Let *closure* be FunctionCreate(*Method*, *formalParameterList*, *FunctionBody*, *scope*, *strict*).
7. If NeedsSuperBinding of *MethodDefinition* is **true**, then
 - a. Perform MakeMethod(*closure*, *object*).
8. Perform SetFunctionName(*closure*, *propKey*, "get").
9. Let *desc* be the PropertyDescriptor{[[Get]]: *closure*, [[Enumerable]]: *enumerable*, [[Configurable]]: true}
10. Return *DefinePropertyOrThrow*(*object*, *propKey*, *desc*).

Deleted: CreateData

Deleted: *methodDef*.[[closure]]

Deleted: *desc*

Deleted: ¶

Deleted: :

Deleted: ¶

Deleted: *MethodDefinition* : **get** *PropertyName* () { *FunctionBody* }¶

Deleted: ReferencesSuper

Deleted: *propKey*,

Deleted: <#>Assert: SetFunctionName will not return an abrupt completion.¶

Deleted: true

Deleted:

2. ReturnIfAbrupt(*propKey*).
 3. Let *strict* be IsStrict of *FunctionBody*.
 4. Let *scope* be the running execution context's LexicalEnvironment.
 5. Let *closure* be FunctionCreate(*Method*, *PropertySetParameterList*, *FunctionBody*, *scope*, *strict*).
 6. If *NeedsSuperBinding* of *MethodDefinition* is true, then
 a. Perform MakeMethod(*closure*, *object*).
 7. Perform SetFunctionName(*closure*, *propKey*, "set").
 8. Let *desc* be the PropertyDescriptor{[[Set]]: *closure*, [[Enumerable]]: enumerable, [[Configurable]]: true}
 9. Return DefinePropertyOrThrow(*object*, *propKey*, *desc*).

Deleted: ReferencesSuper

Deleted: propKey,

Deleted: <#>Assert: SetFunctionName will not return an abrupt completion.¶

Deleted: true

14.4 Generator Function Definitions

Syntax

GeneratorMethod[yield] :
 * *PropertyName*[?Yield] (*StrictFormalParameters*[Yield,GeneratorParameter]) { *GeneratorBody*[Yield] }

GeneratorDeclaration[Yield, Default] :
 function * *BindingIdentifier*[?Yield] (*FormalParameters*[Yield,GeneratorParameter]) { *GeneratorBody*[Yield] }
 [+Default] **function** * (*FormalParameters*[Yield,GeneratorParameter]) { *GeneratorBody*[Yield] }

GeneratorExpression :
 function * *BindingIdentifier*[Yield]opt (*FormalParameters*[Yield,GeneratorParameter]) { *GeneratorBody*[Yield] }

GeneratorBody[Yield] :
 FunctionBody[?Yield]

Deleted: FunctionBody

Deleted: ¶

Deleted: ,?Default

Deleted: FunctionBody

Deleted: FunctionBody

NOTE 1 *YieldExpression* cannot be used within the *FormalParameters* of a generator function because any expressions that are part of *FormalParameters* are evaluated before the resulting generator object is in a resumable state.

NOTE 2 Abstract operations relating to generator objects are defined in 25.3.3.

14.4.1 Static Semantics: Early Errors

GeneratorMethod : * *PropertyName* (*StrictFormalParameters*) { *GeneratorBody* }

- It is a Syntax Error if HasDirectSuper(*GeneratorMethod*) is true.
- It is a Syntax Error if any element of the *BoundNames* of *StrictFormalParameters* also occurs in the *LexicallyDeclaredNames* of *GeneratorBody*.

GeneratorDeclaration : **function** * *BindingIdentifier* (*FormalParameters*) { *GeneratorBody* }

- It is a Syntax Error if HasDirectSuper(*GeneratorDeclaration*) is true .

GeneratorExpression : **function** * *BindingIdentifier*opt (*FormalParameters*) { *GeneratorBody* }

- It is a Syntax Error if HasDirectSuper(*GeneratorExpression*) is true .

Comment [AWB1038]: This actually doesn't accomplish anything because a similar annotation within MemberExpression takes care of the possibility of a leading RegExp here.

Comment [AWB1039]: This actually doesn't accomplish anything because a similar annotation within MemberExpression takes care of the possibility of a leading RegExp here.

Deleted: ¶

Deleted: Supplemental Syntax¶

The following productions are used as an aid in specifying the semantics of certain ECMAScript language features. They are not used when parsing ECMAScript source code. ¶

GeneratorBody:¶
 FunctionBody
 Comprehension¶

Deleted: :

Deleted: FunctionBody

Deleted: this

Deleted: GeneratorDefinitionMethod contains NewSuper

Deleted: <#>It is a Syntax Error if any element of the *BoundNames* of *StrictFormalParameters* also occurs in the *VarDeclaredNames* of *FunctionBody*.¶

Deleted: FunctionBody

*GeneratorDeclaration : function * BindingIdentifier (FormalParameters) { GeneratorBody }*

Deleted: FunctionBody

*GeneratorExpression : function * BindingIdentifier_{opt} (FormalParameters) { GeneratorBody }*

Deleted: FunctionBody

- If the source code matching this production is strict code, the Early Error rules for StrictFormalParameters : FormalParameters are applied.
- If the source code matching this production is strict code, it is a Syntax Error if *BindingIdentifier* is the IdentifierName *eval* or the IdentifierName *arguments*.
- It is a Syntax Error if any element of the BoundNames of *FormalParameters* also occurs in the LexicallyDeclaredNames of *GeneratorBody*.

Deleted: <#>GeneratorExpression : function * BindingIdentifier_{opt} (FormalParameters) { FunctionBody } ¶

Deleted: the

Deleted: <#>It is a Syntax Error if IsSimpleParameterList of *FormalParameters* is false and any element of the BoundNames of *FormalParameters* also occurs in the VarDeclaredNames of *FunctionBody*. ¶

Deleted: FunctionBody

Deleted: | 13.6.4.2

Deleted: 15.2.1.2

Deleted: 15.2.2.1

Deleted: FunctionBody

Deleted: (

Deleted:)

Deleted: ¶

14.4.2 Static Semantics: BoundNames

See also: 13.2.1.2, 13.2.2.1, 12.1.2, [13.6.4.2](#), 14.1.3, 14.2.2, 14.5.2, [15.2.2.2](#), [15.2.3.1](#),

*GeneratorDeclaration : function * BindingIdentifier (FormalParameters) { GeneratorBody }*

- Return the BoundNames of *BindingIdentifier*.

*GeneratorDeclaration : function * (FormalParameters) { GeneratorBody }*

- Return `/*default*/`.

NOTE `/*default*/` is used within this specification as a synthetic name for hoistable anonymous functions that are defined using export declarations.

14.4.3 Static Semantics: ComputedPropertyContains

With parameter *symbol*.

See also: 12.2.5.2, 14.3.2, 14.5.5.

*GeneratorMethod : * PropertyName (StrictFormalParameters) { GeneratorBody }*

Deleted: FunctionBody

- Return the result of ComputedPropertyContains for *PropertyName* with argument *symbol*.

14.4.4 Static Semantics: Contains

With parameter *symbol*.

See also: 5.3, 12.2.5.2, 12.3.1.1, 14.1.4, 14.2.3, 14.5.4

*GeneratorDeclaration : function * BindingIdentifier (FormalParameters) { GeneratorBody }*

Deleted: FunctionBody

*GeneratorDeclaration : function * (FormalParameters) { GeneratorBody }*

- Return **false**.

*GeneratorExpression : function * BindingIdentifier_{opt} (FormalParameters) { GeneratorBody }*

Deleted: FunctionBody

- Return **false**.

NOTE Static semantic rules that depend upon substructure generally do not look into function definitions.

14.4.5 Static Semantics: HasComputedPropertyKey

See also: 12.2.5.4, 14.3.4.

GeneratorMethod : * *PropertyName* (*StrictFormalParameters*) { *GeneratorBody* }

1. Return *IsComputedPropertyKey* of *PropertyName*.

Deleted: ¶

Deleted: *FunctionBody*

14.4.6 Static Semantics: HasDirectSuper

See also: 14.3.5.

GeneratorMethod : * *PropertyName* (*StrictFormalParameters*) { *GeneratorBody* }

1. If *StrictFormalParameters* Contains *SuperCall* is true, return true.
2. Return *GeneratorBody* Contains *SuperCall*.

Deleted: ¶

Deleted: <#>If *StrictFormalParameters* Contains *NewSuper* is true, then return, return true.¶

Deleted: , then return

Deleted: <#>If *GeneratorBody* Contains *NewSuper* is true, then return, return true.¶

Deleted: 14.1.914.1.8

Deleted: *FunctionBody*

14.4.7 Static Semantics: HasName

See also: 14.1.9, 14.2.8, 14.5.6.

GeneratorExpression : **function** * (*FormalParameters*) { *GeneratorBody* }

1. Return false.

Deleted: *FunctionBody*

1. Return true.

14.4.8 Static Semantics: IsConstantDeclaration

See also: 13.2.1.3, 14.1.11, 14.5.7, 15.2.3.7.

GeneratorDeclaration : **function** * *BindingIdentifier* (*FormalParameters*) { *GeneratorBody* }

GeneratorDeclaration : **function** * (*FormalParameters*) { *GeneratorBody* }

Deleted: 15.2.3.6

Deleted: 13.2.1.3, 14.1.8, 14.5.5

Deleted: *FunctionBody*

1. Return false.

14.4.9 Static Semantics: IsFunctionDefinition

See also: 12.2.0.2, 12.2.9.2, 12.3.1.2, 12.4.2, 12.5.2, 12.6.1, 12.7.1, 12.8.1, 12.9.1, 12.10.1, 12.11.1, 12.12.1, 12.13.1, 12.14.2, 12.15.1, 14.1.12, 14.5.8.

GeneratorExpression : **function** * (*FormalParameters*) { *GeneratorBody* }

1. Return true.

Deleted: 12.2.9.212.2.10.2

Deleted: 14.1.11

Deleted: *FunctionBody*

GeneratorExpression : **function** * *BindingIdentifier* (*FormalParameters*) { *GeneratorBody* }

1. Return true.

Deleted: *FunctionBody*

14.4.10 Static Semantics: PropName

See also: 12.2.5.6, 14.3.5, 14.5.12.

Deleted: <#>Static Semantics: LexicallyDeclaredNames¶

GeneratorDeclaration : **function** * *BindingIdentifier* (*FormalParameters*) { *FunctionBody* }¶
<#>Return the BoundNames of *BindingIdentifier*.¶

Deleted: ¶

*GeneratorMethod : * PropertyName (StrictFormalParameters) { GeneratorBody }*

1. Return PropName of *PropertyName*.

14.4.11 Static Semantics: NeedsSuperBinding

See also: [14.1.17](#), [14.2.12](#), [14.3.7](#).

*GeneratorDeclaration : function * BindingIdentifier (FormalParameters) { GeneratorBody }*

*GeneratorDeclaration : function * (FormalParameters) { GeneratorBody }*

1. If *FormalParameters* Contains *SuperProperty* is true, return true.
2. Return *GeneratorBody* Contains *SuperProperty*.

*GeneratorExpression : function * BindingIdentifier_{opt} (FormalParameters) { GeneratorBody }*

1. If *FormalParameters* Contains *SuperProperty* is true, return true.
2. Return *GeneratorBody* Contains *SuperProperty*.

*GeneratorMethod : * PropertyName (StrictFormalParameters) { GeneratorBody }*

1. If *StrictFormalParameters* Contains *SuperProperty* is true, return true.
2. Return *GeneratorBody* Contains *SuperProperty*.

14.4.12 Runtime Semantics: EvaluateBody

With parameter *functionObject*.

See also: [14.1.20](#), [14.2.16](#).

GeneratorBody : FunctionBody

1. Let *G* be OrdinaryCreateFromConstructor(*functionObject*, "%GeneratorPrototype%", *[[GeneratorState]]*, *[[GeneratorContext]]*).
2. ReturnIfAbrupt(*G*).
3. Let *result* be GeneratorStart(*G*, *FunctionBody*).
4. ReturnIfAbrupt(*result*).
5. Return Completion{[[type]]: return, [[value]]: *result*, [[target]]: empty}.

NOTE If the generator was invoked using *[[Call]]*, the *this* binding will have already been initialized in the normal manner. If the generator was invoked using *[[Construct]]*, the *this* bind is not initialized and any references to *this* within the *FunctionBody* will produce a *ReferenceError* exception.

14.4.13 Runtime Semantics: InstantiateFunctionObject

With parameter *scope*.

See also: [14.1.22](#).

*GeneratorDeclaration : function * BindingIdentifier (FormalParameters) { GeneratorBody }*

1. If the *GeneratorDeclaration* is contained in strict code or if its *GeneratorBody* is strict code, let *strict* be true. Otherwise let *strict* be false.
2. Let *name* be StringValue of *BindingIdentifier*.
3. Let *F* be GeneratorFunctionCreate(Normal, *FormalParameters*, *GeneratorBody*, *scope*, *strict*).

Deleted: *FunctionBody*

Deleted: *ReferencesSuper*

Deleted: ,

Deleted: *FunctionBody*

Deleted: *super*

Deleted: , then return

Deleted: *FunctionBody*

Deleted: *super*

Deleted: *FunctionBody*

Deleted: *super*

Deleted: , then return

Deleted: *FunctionBody*

Deleted: *super*

Deleted: *FunctionBody*

Deleted: ¶

Deleted: *super*

Deleted: , then return

Deleted: *FunctionBody*

Deleted: *super*

Deleted: <#>Static Semantics: VarDeclaredNames¶

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Deleted: ¶

Deleted: <#>Assert: A Function Environment

Deleted: <#>Let env be GetThisEnvironment

Deleted: (...[GeneratorState]],

Deleted: new

Deleted: <#>Let G be newG.¶

Deleted: Return

Deleted:

Deleted: *GeneratorBody : Comprehension* ¶

Deleted: *FunctionBody*

Deleted: *FunctionBody*

Deleted: , then let

Deleted: .

Deleted: <#>Using *FunctionBody* from the

Deleted: body,

Deleted: *scope*

4. If NeedsSuperBinding of *GeneratorDeclaration* is **true**, then
 - a. Perform *MakeMethod*(*F*, **undefined**).
5. Let *prototype* be *ObjectCreate*(%GeneratorPrototype%).
6. Perform *MakeConstructor*(*F*, **true**, *prototype*).
7. **Perform** *SetFunctionName*(*F*, *name*).
8. **Return** *F*.

GeneratorDeclaration : `function * (FormalParameters) { GeneratorBody }`

1. If the *GeneratorDeclaration* is contained in strict code or if its *GeneratorBody* is strict code, let *strict* be **true**. Otherwise let *strict* be **false**.
2. Let *F* be *GeneratorFunctionCreate*(Normal, *FormalParameters*, *GeneratorBody*, *scope*, *strict*).
3. If NeedsSuperBinding of *GeneratorDeclaration* is **true**, then
 - a. Perform *MakeMethod*(*F*, **undefined**).
4. Let *prototype* be *ObjectCreate*(%GeneratorPrototype%).
5. Perform *MakeConstructor*(*F*, **true**, *prototype*).
6. **Perform** *SetFunctionName*(*F*, "default").
7. **Return** *F*.

NOTE An anonymous *GeneratorDeclaration* can only occur as part of an `export default` declaration.

14.4.14 Runtime Semantics: PropertyDefinitionEvaluation

With parameter *object* and enumerable.

See also: 12.2.5.9, [14.3.10](#), B.3.1

GeneratorMethod : * *PropertyName* (*StrictFormalParameters*) { *GeneratorBody* }

1. Let *propKey* be the result of evaluating *PropertyName*.
2. **ReturnIfAbrupt**(*propKey*).
3. Let *strict* be *IsStrict* of *GeneratorBody*.
4. Let *scope* be the running execution context's *LexicalEnvironment*.
5. Let *closure* be *GeneratorFunctionCreate*(Method, *StrictFormalParameters*, *GeneratorBody*, *scope*, *strict*).
6. If NeedsSuperBinding of *GeneratorMethod* is **true**, then
 - a. Perform *MakeMethod*(*closure*, *object*).
7. Let *prototype* be *ObjectCreate*(%GeneratorPrototype%).
8. Perform *MakeConstructor*(*closure*, **true**, *prototype*).
9. **Perform** *SetFunctionName*(*closure*, *propKey*).
10. Let *desc* be the *Property Descriptor*{[[Value]]: *closure*, [[Writable]]: **true**, [[Enumerable]]: enumerable, [[Configurable]]: **true**}.
11. **Return** *DefinePropertyOrThrow*(*object*, *propKey*, *desc*).

14.4.15 Runtime Semantics: Evaluation

GeneratorExpression : `function * (FormalParameters) { GeneratorBody }`

1. Let *strict* be *IsStrict* of *GeneratorBody*.
2. Let *scope* be the *LexicalEnvironment* of the running execution context.
3. Let *closure* be *GeneratorFunctionCreate*(Normal, *FormalParameters*, *GeneratorBody*, *scope*, *strict*).
4. If NeedsSuperBinding of *GeneratorExpression* is **true**, then

Deleted: ReferencesSuper
Deleted: <i>name</i> ,
Deleted: <#>Assert: SetFunctionName will not return an abrupt completion.¶
Deleted: , then let
Deleted: <u>undefined</u> ,
Deleted:
Deleted: 14.3.9
Deleted: <i>FunctionBody</i>
Deleted: <i>FunctionBody</i>
Deleted: .
Deleted: ¶
Deleted: <#>Using <i>FunctionBody</i> from the production that is being evaluated, let <i>body</i> be the supplemental syntactic grammar production: <i>GeneratorBody</i> : <i>FunctionBody</i> .¶
Deleted: <i>body</i>
Deleted: ReferencesSuper
Deleted: <i>propKey</i> ,
Deleted: <i>homeObject</i>
Deleted: Assert: SetFunctionName will not return an abrupt completion.
Deleted: <#>Let <i>desc</i> be the <i>Property Descriptor</i> {[[Value]]: <i>closure</i> , [[Writable]]: true , [[Enumerable]]: true , [[Configurable]]: true }.
Deleted: DefinePropertyOrThrow
Deleted: CreateData
Deleted: <i>closure</i>
Deleted: <i>desc</i>
Deleted: <i>GeneratorDeclaration</i> : <code>function *</code> <i>BindingIdentifier</i> (<i>FormalParameters</i>) { <i>GeneratorBody FunctionBody</i> } ↵ <i>GeneratorDeclaration</i> : <code>function *</code> (<i>FormalParameters</i>) { <i>GeneratorBody</i> } ¶ ↵ <#>Return NormalCompletion(empty)¶
Deleted: <i>FunctionBody</i>
Deleted: <i>FunctionBody</i>
Deleted: If the <i>GeneratorExpression</i> is contained in strict code or if its <i>FunctionBody</i> is strict code, then let <i>strict</i> be true . Otherwise let <i>strict</i> be false .
Deleted: <#>Using <i>FunctionBody</i> from the production that is being evaluated, let <i>body</i> be ...
Deleted: <i>body</i>
Deleted: ReferencesSuper

- a. Perform MakeMethod(*closure*, **undefined**).
- 5. Let *prototype* be ObjectCreate(%GeneratorPrototype%).
- 6. Perform MakeConstructor(*closure*, **true**, *prototype*).
- 7. Return *closure*.

Deleted: **undefined**.

GeneratorExpression : **function** * *BindingIdentifier* (*FormalParameters*) { *GeneratorBody* }

1. **Let strict** be IsStrict of *GeneratorBody*.
2. Let *runningContext* be the running execution context's Lexical Environment.
3. Let *funcEnv* be NewDeclarativeEnvironment(*runningContext*).
4. Let *envRec* be *funcEnv*'s environment record.
5. Let *name* be StringValue of *BindingIdentifier*.
6. Call the CreateImmutableBinding concrete method of *envRec* passing *name* as the argument.
7. Let *closure* be GeneratorFunctionCreate(Normal, *FormalParameters*, *GeneratorBody*, *funcEnv*, *strict*).
8. If *NeedsSuperBinding* of *GeneratorExpression* is **true**, then
 - a. Perform MakeMethod(*closure*, **undefined**).
9. Let *prototype* be ObjectCreate(%GeneratorPrototype%).
10. Perform MakeConstructor (*closure*, **true**, *prototype*).
11. **Perform** SetFunctionName(*closure*, *name*).
12. Call the InitializeBinding concrete method of *envRec* passing *name* and *closure* as the arguments.
13. Return *closure*.

Deleted: *FunctionBody*

Deleted: *FunctionBody*

Deleted: If the *GeneratorExpression* is contained in strict code or if its *FunctionBody* is strict code, then let *strict* be **true**. Otherwise let *strict* be **false**.

Deleted: <#>Using *FunctionBody* from the production that is being evaluated, let *body* be the supplemental syntactic grammar production: *GeneratorBody* : *FunctionBody*!¶

Deleted: *body*

Deleted: *ReferencesSuper*

Deleted: *name*,

Deleted: <#>Assert: SetFunctionName will not return an abrupt completion.¶

NOTE 1 The *BindingIdentifier* in a *GeneratorExpression* can be referenced from inside the *GeneratorExpression*'s *FunctionBody* to allow the generator code to call itself recursively. However, unlike in a *GeneratorDeclaration*, the *BindingIdentifier* in a *GeneratorExpression* cannot be referenced from and does not affect the scope enclosing the *GeneratorExpression*.

YieldExpression : **yield** ▾

1. Return GeneratorYield(CreateIterResultObject(**undefined**, **false**)).

Deleted: ¶

YieldExpression : **yield** *AssignmentExpression* ▾

1. Let *exprRef* be the result of evaluating *AssignmentExpression*.
2. Let *value* be GetValue(*exprRef*).
3. ReturnIfAbrupt(*value*).
4. Return GeneratorYield(CreateIterResultObject(*value*, **false**)).

Deleted: ¶

YieldExpression : **yield** * *AssignmentExpression* ▾

1. Let *exprRef* be the result of evaluating *AssignmentExpression*.
2. Let *value* be GetValue(*exprRef*).
3. Let *iterator* be GetIterator(*value*).
4. ReturnIfAbrupt(*iterator*).
5. Let *received* be NormalCompletion(**undefined**).
6. Repeat
 - a. If *received*.[[type]] is normal, then
 - i. Let *innerResult* be IteratorNext(*iterator*, *received*.[[value]]).
 - ii. ReturnIfAbrupt(*innerResult*).
 - iii. Let *done* be IteratorComplete(*innerResult*).
 - iv. ReturnIfAbrupt(*done*).
 - v. If *done* is **true**, then
 1. Return IteratorValue (*innerResult*).

Deleted: ¶

Deleted: <#>ReturnIfAbrupt(*value*).¶

Deleted: ToObject(

Deleted:)

Deleted: ¶

Deleted: <#>Let *innerResult* be empty.¶

- vi. Let `received` be `GeneratorYield(innerResult)`.
- b. Else if `received.[[type]]` is `throw`, then
- Let `throw` be `GetMethod(iterator, "throw")`.
 - `ReturnIfAbrupt(throw)`.
 - If `throw` is not `undefined`, then
 - Let `innerResult` be `Call(throw, iterator, [received.[[value]]])`.
 - `ReturnIfAbrupt(innerResult)`.
 - NOTE: Exceptions from the inner iterator `throw` method are propagated. Normal completions from an inner `throw` method are processed similarly to an inner `next`.
 - If `Type(innerResult)` is not `Object`, throw a `TypeError` exception.
 - Let `done` be `IteratorComplete(innerResult)`.
 - `ReturnIfAbrupt(done)`.
 - If `done` is `true`, then
 - Return Completion{[[type]]: `return`, [[value]]: `IteratorValue(innerResult)`, [[target]]: `empty`}
 - Let `received` be `GeneratorYield(innerResult)`.
 - Else
 - NOTE: If `iterator` does not have a `throw` method, this `throw` is going to terminate the `yield*` loop. But first we need to give `iterator` a chance to clean up.
 - Let `closeResult` = `IteratorClose(iterator, received)`.
 - `ReturnIfAbrupt(closeResult)`.
 - Throw a `TypeError` exception.
- c. Else,
- Assert: `received.[[type]]` is `return`.
 - Let `return` be `GetMethod(iterator, "return")`.
 - `ReturnIfAbrupt(return)`.
 - If `return` is `undefined`, return `received`.
 - Let `innerReturnResult` be `Call(return, iterator, [received.[[value]]])`.
 - `ReturnIfAbrupt(innerReturnResult)`.
 - If `Type(innerReturnResult)` is not `Object`, throw a `TypeError` exception.
 - Let `done` be `IteratorComplete(innerReturnResult)`.
 - `ReturnIfAbrupt(done)`.
 - If `done` is `true`, then
 - Return Completion{[[type]]: `return`, [[value]]: `IteratorValue(innerReturnResult)`, [[target]]: `empty`}
 - Let `received` be `GeneratorYield(innerReturnResult)`.

14.5 Class Definitions

Syntax

```

ClassDeclaration[Yield,Default] :
  class BindingIdentifier[?Yield] ClassTail[?Yield]
  [+Default] class ClassTail[?Yield]

ClassExpression[Yield,GeneratorParameter] :
  class BindingIdentifier[?Yield]opt ClassTail[?Yield,?GeneratorParameter]opt

ClassTail[Yield,GeneratorParameter] :
  [-GeneratorParameter] ClassHeritage[?Yield]opt { ClassBody[?Yield]opt }
  [+GeneratorParameter] ClassHeritage[opt] { ClassBody[opt] }

```

Deleted: ¶
Deleted: <code>hasThrow...hrow</code> be <code>HasProperty</code>
Deleted: :
Deleted: Assert: <code>received.[[type]]</code> is <code>throw</code>
Deleted: <code>hasT</code>
Deleted: <code>hasThrowHasProperty(iterator, "throw") ... not true</code>
Deleted: <code>Invoke...all(throw, iterator, ...)</code>
Deleted: <code>(...eceived.[[value]])</code>
Formatted
Deleted: R
Deleted: <#> <code>return received</code> .¶
Deleted: if...assert: <code>received.[[type]]</code> is
Deleted: ¶
Deleted: <code>hasR...eturn</code> be <code>HasProperty</code>
Deleted: :
Deleted: <code>hasR</code>
Deleted: <code>hasR...eturn</code> is false
Deleted: , then <code>return</code>
Deleted: ¶
Deleted: <code>Value...esult</code> be <code>Invoke...all(result, ...)</code>
Deleted: <code>(...eceived.[[value]])</code>
Deleted: <code>Value</code>
Deleted: <code>Value</code>
Deleted: , then <code>throw</code>
Deleted: <code>returnValue</code>
Deleted: <#> <code>ReturnIfAbrupt(innerResult)</code> .¶
Deleted: <#>If <code>Type(innerResult)</code> is not <code>Object</code> , then throw a <code>TypeError</code> exception.¶
Deleted: <#>Else, <code>return received</code> .¶
Deleted: <#>Let <code>done</code> be <code>IteratorComplete(innerResult)</code> .¶
Deleted: <#> <code>ReturnIfAbrupt(done)</code> .¶
Deleted: <#>If <code>done</code> is <code>true</code> , then <#> <code>Return IteratorValue (innerResult)</code> .¶ <#>Let <code>received</code> be <code>GeneratorYield(innerResult)</code> .¶
Deleted: , <code>Default</code>
Deleted: , <code>?Default</code>
Deleted: ¶
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ClassHeritage_[Yield] :
extends *LeftHandSideExpression_[?Yield]*

ClassBody_[Yield] :
ClassElementList_[?Yield]

ClassElementList_[Yield] :
ClassElement_[?Yield]
ClassElementList_[?Yield] *ClassElement_[?Yield]*

ClassElement_[Yield] :
MethodDefinition_[?Yield]
static *MethodDefinition_[?Yield]*
 ;

NOTE A *ClassBody* is always strict code.

14.5.1 Static Semantics: Early Errors

ClassBody : *ClassElementList*

- It is a Syntax Error if PrototypePropertyNameList of *ClassElementList* contains more than one occurrence of "constructor".

ClassElement : *MethodDefinition*

- It is a Syntax Error if PropName of *MethodDefinition* is not "constructor" and HasDirectSuper(*MethodDefinition*) is true.
- It is a Syntax Error if PropName of *MethodDefinition* is "constructor" and SpecialMethod of *MethodDefinition* is true.

ClassElement : **static** *MethodDefinition*

- It is a Syntax Error if HasDirectSuper(*MethodDefinition*) is true.
- It is a Syntax Error if PropName of *MethodDefinition* is "prototype".

14.5.2 Static Semantics: BoundNames

See also: 13.2.1.2, 13.2.2.1, 12.1.2, [13.6.4.2](#), 14.1.3, 14.2.2, 14.4.2, [15.2.2.2](#), [15.2.3.1](#)

ClassDeclaration : **class** *BindingIdentifier* *ClassTail*

1. Return the BoundNames of *BindingIdentifier*.

ClassDeclaration : **class** *ClassTail*

1. Return «*default*».

14.5.3 Static Semantics: ConstructorMethod

ClassElementList : *ClassElement*

1. If *ClassElement* is the production *ClassElement* : ; , return empty.
2. If IsStatic of *ClassElement* is true, return empty.

Deleted: ¶

Deleted: *ClassDeclaration* : **class**
BindingIdentifier *ClassTail* ¶
ClassExpression : **class** *BindingIdentifier*
ClassTail ¶
 $\text{<!--} \text{It is a Syntax Error if the StringValue of BindingIdentifier is "let".--}}</math>$

Deleted: ¶

Deleted: any duplicate entries, unless the following condition is true for each duplicate entry: The duplicated entry occurs exactly twice in the list and one occurrence was obtained from a **get** accessor *MethodDefinition* and the other occurrence was obtained from a **set** accessor *MethodDefinition*. ¶

Deleted: $\text{<!--} \text{It is a Syntax Error if StaticPropertyNameList of ClassElementList contains any duplicate entries, unless the following condition is true for each duplicate entry: The duplicated entry occurs exactly twice in the list and one occurrence was obtained from a get accessor MethodDefinition and the other occurrence was obtained from a set accessor MethodDefinition.--}}</math>$

Deleted: ¶

Deleted: *MethodDefinition* contains *NewSuper*

Deleted: "

Deleted: "

Deleted:

Deleted: ¶

Deleted: *MethodDefinition* contains *NewSuper*

Deleted: "

Deleted: "

Deleted: ¶

Deleted: ¶ 13.6.4.2

Deleted: 15.2.1.2

Deleted: 15.2.2.1

Deleted: ¶

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Deleted: then,

3. If PropName of *ClassElement* is not "constructor", return empty.
 4. Return *ClassElement*.

Deleted: "

Deleted: "

Deleted: ¶

ClassElementList : *ClassElementList ClassElement*

1. Let *head* be ConstructorMethod of *ClassElementList*.
2. If *head* is not empty, return *head*.
3. If *ClassElement* is the production *ClassElement* : ;, return empty.
4. If IsStatic of *ClassElement* is **true**, return empty.
5. If PropName of *ClassElement* is not "constructor", return empty.
6. Return *ClassElement*.

Deleted: then,

Deleted: "

Deleted: "

Deleted: ¶

NOTE Early Error rules ensure that there is only one method definition named "constructor" and that it is not an accessor property or generator definition.

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14.5.4 Static Semantics: Contains

With parameter *symbol*.

See also: 5.3, 12.2.5.2, 12.3.1.1, 14.1.4, 14.2.3, [14.4.4](#)

Deleted: 014.4.3

ClassTail : *ClassHeritage_{opt}* { *ClassBody* }

1. If *symbol* is *ClassBody*, return **true**.
2. If *symbol* is *ClassHeritage*, then
 - a. If *ClassHeritage* is present, return **true** otherwise return **false**.
3. Let *inHeritage* be *ClassHeritage Contains symbol*.
4. If *inHeritage* is **true**, return **true**.
5. Return the result of ComputedPropertyContains for *ClassBody* with argument *symbol*.

Deleted: ¶

Deleted: .

Deleted: ¶

Deleted: the result of Contains for

Deleted: with argument

Deleted: , then return

NOTE Static semantic rules that depend upon substructure generally do not look into class bodies except for *PropertyName* productions.

14.5.5 Static Semantics: ComputedPropertyContains

With parameter *symbol*.

See also: 12.2.5.2, 14.3.2, [14.4.3](#)

Deleted: 14.4.3

ClassElementList : *ClassElementList ClassElement*

Deleted: ¶

1. Let *inList* be the result of ComputedPropertyContains for *ClassElementList* with argument *symbol*.
2. If *inList* is **true**, return **true**.
3. Return the result of ComputedPropertyContains for *ClassElement* with argument *symbol*.

Deleted: , then return

ClassElement : *MethodDefinition*

Deleted: ¶

1. Return the result of ComputedPropertyContains for *MethodDefinition* with argument *symbol*.

ClassElement : **static** *MethodDefinition*

Deleted: ¶

1. Return the result of ComputedPropertyContains for *MethodDefinition* with argument *symbol*.

ClassElement : ;

Deleted: ¶

1. Return **false**.

14.5.6 Static Semantics: HasName

See also: [14.1.9](#), [14.2.8](#), [14.4.6](#).

Deleted: [14.1.9](#)[14.1.8](#)

ClassExpression : **class** *ClassTail*

Deleted: ¶

1. Return **false**.

ClassExpression : **class** *BindingIdentifier ClassTail*

Deleted: ¶

1. Return **true**.

14.5.7 Static Semantics: IsConstantDeclaration

See also: [13.2.1.3](#), [14.1.11](#), [14.4.8](#), [15.2.3.7](#).

Deleted: [14.4.7](#)

Deleted: [15.2.3.6](#)

Deleted: [13.2.1.3](#), [14.1.8](#), [14.4.5](#)

Deleted: ¶

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ClassDeclaration : **class** *BindingIdentifier ClassTail*

ClassDeclaration : **class** *ClassTail*

1. Return **false**.

14.5.8 Static Semantics: IsFunctionDefinition

See also: [12.2.0.2](#), [12.2.9.2](#), [12.3.1.2](#), [12.4.2](#), [12.5.2](#), [12.6.1](#), [12.7.1](#), [12.8.1](#), [12.9.1](#), [12.10.1](#), [12.11.1](#), [12.12.1](#), [12.13.1](#), [12.14.2](#), [12.15.1](#), [14.1.12](#), [14.4.8](#).

Deleted: [12.2.9.2](#)[12.2.10.2](#)

Deleted: [14.1.11](#)

ClassExpression : **class** *ClassTail*

Deleted: ¶

1. Return **true**.

ClassExpression : **class** *BindingIdentifier ClassTail*

Deleted: ¶

1. Return **true**.

14.5.9 Static Semantics: IsStatic

ClassElement : **MethodDefinition**

Deleted: ¶

1. Return **false**.

ClassElement : **static** *MethodDefinition*

Deleted: ¶

Deleted: ¶

1. Return **true**.

ClassElement : ;

Deleted: ¶

1. Return **false**.

14.5.10 Static Semantics: NonConstructorMethodDefinitions

ClassElementList : *ClassElement*

1. If *ClassElement* is the production *ClassElement* : ; return a new empty List.

2. If **IsStatic** of *ClassElement* is **false** and PropName of *ClassElement* is "constructor", return a new empty List.

3. Return a List containing *ClassElement*.

Deleted: [PrototypeMethodDefinitions](#)

Deleted: then,

Deleted: ¶

<#>If **IsStatic** of *ClassElement* is **true**, return a new empty List.

Deleted: "

Deleted: "

ClassElementList : *ClassElementList ClassElement*

1. Let *list* be NonConstructorMethodDefinitions of *ClassElementList*.
2. If *ClassElement* is the production *ClassElement* : ;, return *list*.
3. If *IsStatic* of *ClassElement* is false, and *PropName* of *ClassElement* is "constructor", return *list*.
4. Append *ClassElement* to the end of *list*.
5. Return *list*.

14.5.11 Static Semantics: PrototypePropertyNameList

ClassElementList : *ClassElement*

1. If *PropName* of *ClassElement* is empty, return a new empty List.
2. If *IsStatic* of *ClassElement* is true, return a new empty List.
3. Return a List containing *PropName* of *ClassElement*.

ClassElementList : *ClassElementList ClassElement*

1. Let *list* be *PrototypePropertyNameList* of *ClassElementList*.
2. If *PropName* of *ClassElement* is empty, return *list*.
3. If *IsStatic* of *ClassElement* is true, return *list*.
4. Append *PropName* of *ClassElement* to the end of *list*.
5. Return *list*.

14.5.12 Static Semantics: PropName

See also: 12.2.5.6, 14.3.5, [14.4.10](#)

ClassElement : ;

1. Return empty.

14.5.13 Static Semantics: StaticPropertyNameList

ClassElementList : *ClassElement*

1. If *PropName* of *ClassElement* is empty, return a new empty List.
2. If *IsStatic* of *ClassElement* is false, return a new empty List.
3. Return a List containing *PropName* of *ClassElement*.

ClassElementList : *ClassElementList ClassElement*

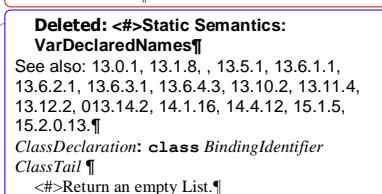
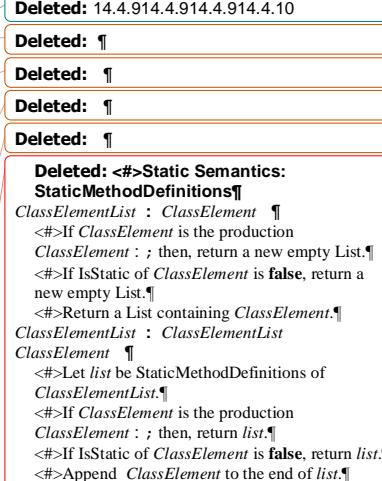
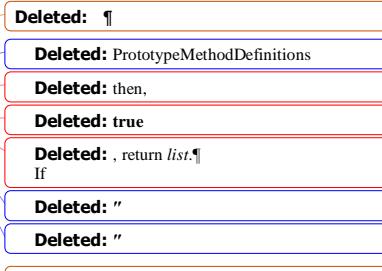
1. Let *list* be *StaticPropertyNameList* of *ClassElementList*.
2. If *PropName* of *ClassElement* is empty, return *list*.
3. If *IsStatic* of *ClassElement* is false, return *list*.
4. Append *PropName* of *ClassElement* to the end of *list*.
5. Return *list*.

14.5.14 Runtime Semantics: ClassDefinitionEvaluation

With parameter *className*.

ClassTail : *ClassHeritage_{opt}* { *ClassBody_{opt}* }

1. Let *lex* be the *LexicalEnvironment* of the running execution context.



2. Let `classScope` be `NewDeclarativeEnvironment(lex)`.
1. Let `classScopeEnvRec` be `classScope`'s environment record.
2. If `className` is not `undefined`, then
 - a. Call the `CreateImmutableBinding` concrete method of `classScopeEnvRec`, passing `className` and `true` as the arguments.
3. If `ClassHeritageopt` is not present, then
 - a. Let `protoParent` be the intrinsic object `%ObjectPrototype%`.
 - b. Let `constructorParent` be the intrinsic object `%FunctionPrototype%`.
4. Else
 - a. Set the running execution context's `LexicalEnvironment` to `classScope`.
 - b. Let `superclass` be the result of evaluating `ClassHeritage`.
 - c. Set the running execution context's `LexicalEnvironment` to `lex`.
 - d. `ReturnIfAbrupt(superclass)`.
 - e. If `superclass` is `null`, then
 - i. Let `protoParent` be `null`.
 - ii. Let `constructorParent` be the intrinsic object `%FunctionPrototype%`.
 - f. Else if `IsConstructor(superclass)` is `false`, throw a `TypeError` exception.
 - g. Else
 - i. If `superclass` has a `[[FunctionKind]]` internal slot whose value is "generator", throw a `TypeError` exception.
 - ii. Let `protoParent` be `Get(superclass, "prototype")`.
 - iii. `ReturnIfAbrupt(protoParent)`.
 - iv. If `Type(protoParent)` is neither Object nor Null, throw a `TypeError` exception.
 - v. Let `constructorParent` be `superclass`.
5. Let `proto` be `ObjectCreate(protoParent)`.
6. If `ClassBodyopt` is present, let `constructor` be `ConstructorMethod` of `ClassBody`.
7. Else
 - a. If `ClassHeritageopt` is present, then
 - i. Let `constructor` be the result of parsing the String "`constructor(... args) { super (...args); }`" using the syntactic grammar with the goal symbol `MethodDefinition`.
 - b. Else,
 - i. Let `constructor` be the result of parsing the String "`constructor() { }`" using the syntactic grammar with the goal symbol `MethodDefinition`.
8. Set the running execution context's `LexicalEnvironment` to `classScope`.
9. Let `constructorInfo` be the result of performing `DefineMethod` for `constructor` with arguments `proto` and `constructorParent` as the optional `functionPrototype` argument.
10. Let `F` be `constructorInfo.[[closure]]`
11. If `ClassHeritageopt` is present, set `F`'s `[[ConstructorKind]]` internal slot to "derived".
12. Perform `MakeConstructor(F, false, proto)`.
13. Perform `MakeClassConstructor(F)`.
14. Let `desc` be the `PropertyDescriptor{ [[Value]]: F, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true }`.
15. Call the `[[DefineOwnProperty]]` internal method of `proto` with arguments "constructor" and `desc`.
16. If `ClassBodyopt` is not present, let `methods` be a new empty List.
17. Else, let `methods` be `NonConstructorMethodDefinitions` of `ClassBody`.
18. For each `ClassElement m` in order from `methods`
 - a. If `IsStatic` of `m` is `false`, then
 - i. Let `status` be the result of performing `PropertyDefinitionEvaluation` for `m` with arguments `proto` and `false`.
 - b. Else,

Deleted: <#>If `className` is not `undefined`, then ¶

Deleted: `envRec`

Deleted: `envRec`

Deleted: ¶

Deleted: , then throw

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Deleted: , then throw

Deleted: ¶

Deleted: <#>Let `lex` be the `LexicalEnvironment` of the running execution context.¶

<#>If `className` is not `undefined`, then ¶

<#>Let `scope` be `NewDeclarativeEnvironment(lex)`.¶

<#>Let `envRec` be `scope`'s environment record.¶

<#>Call the `CreateImmutableBinding` concrete method of `envRec` passing `className` and `true` as the arguments.¶

<#>Set the running execution context's `LexicalEnvironment` to `scope`.¶

Deleted: `not`

Deleted: , then let

Deleted: `constructor` be empty.¶

Else, Let let

Deleted: If `constructor` is empty, the

Deleted: `n`

Deleted: and `SameValue(constructorParent, ...)`

Deleted: ¶

Deleted: <#>Let `strict` be `true`. ¶

Comment [AWB840]: As it now stands, thi... ¶

Deleted: `SameValue(constructorParent, ...)`

Deleted: the abstract operation

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Deleted: as the optional `writablePrototype` ¶

Deleted: as the optional `prototype` argument

Deleted: `[[Writable]]: true`,

Deleted: , then let

Deleted: Let

Deleted: `protoMethods`

Deleted: `Prototype`

Deleted: `MethodDefinition`

Deleted: `protoMethods`

Deleted: `ReturnIfAbrupt(status)`

Deleted: .

- i. Let *status* be the result of performing *PropertyDefinitionEvaluation* for *m* with arguments *F* and *false*.
- c. If *status* is an abrupt completion, then
 - i. Set the running execution context's *LexicalEnvironment* to *lex*.
 - ii. Return *status*.
19. Set the running execution context's *LexicalEnvironment* to *lex*.
20. If *className* is not **undefined**, then
 - a. Call the *InitializeBinding* concrete method of *classScopeEnvRec* passing *className* and *F* as the arguments.
21. Return *F*.

14.5.15 Runtime Semantics: *BindingClassDeclarationEvaluation*

ClassDeclaration : **class** *BindingIdentifier* *ClassTail*

1. Let *className* be StringValue of *BindingIdentifier*.
2. Let *value* be the result of *ClassDefinitionEvaluation* of *classTail* with argument *className*.
3. ReturnIfAbrupt(*value*).
4. Let *hasNameProperty* be *HasOwnProperty*(*value*, "name").
5. ReturnIfAbrupt(*hasNameProperty*).
6. If *hasNameProperty* is **false**, then perform *SetFunctionName*(*value*, *className*).
7. Let *env* be the running execution context's *LexicalEnvironment*.
8. Let *status* be the result of *InitializeBoundName*(*className*, *value*, *env*).
9. ReturnIfAbrupt(*status*).
10. Return *value*.

ClassDeclaration : **class** *ClassTail*

1. Return the result of *ClassDefinitionEvaluation* of *ClassTail* with argument **undefined**.

NOTE *ClassDeclaration* : **class** *ClassTail* only occurs as part of an *ExportDeclaration* and the setting of a *name* property and establishing its binding are handled as part of the evaluation action for that production. See 15.2.3.10.

14.5.16 Runtime Semantics: *Evaluation*

ClassDeclaration : **class** *BindingIdentifier* *ClassTail*

1. Let *status* be the result of *BindingClassDeclarationEvaluation* of this *ClassDeclaration*.
2. ReturnIfAbrupt(*status*).
3. Return *NormalCompletion*(empty).

NOTE *ClassDeclaration* : **class** *ClassTail* only occurs as part of an *ExportDeclaration* and is never directly evaluated.

ClassExpression : **class** *BindingIdentifier*_{opt} *ClassTail*

1. If *BindingIdentifier*_{opt} is not present, let *className* be **undefined**.
2. Else, let *className* be StringValue of *BindingIdentifier*_{opt}.
3. Let *value* be the result of *ClassDefinitionEvaluation* of *ClassTail* with argument *className*.
4. ReturnIfAbrupt(*value*).
5. If *className* is not **undefined**, then
 - a. Let *hasNameProperty* be *HasOwnProperty*(*value*, "name").
 - b. ReturnIfAbrupt(*hasNameProperty*).
 - c. If *hasNameProperty* is **false**, then
 - i. Perform *SetFunctionName*(*value*, *className*).

Deleted: <#>Let *staticMethods* be *StaticMethodDefinitions* of *ClassBody*.
<#>For each *MethodDefinition* *s* in order from *staticMethods* ¶

Deleted: *s*

Deleted: IfAbrupt(

Deleted:)

Deleted: ¶

Deleted: *envRec*

Deleted: ¶

Deleted: *Evaluation*

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Deleted: *ClassDeclaration* : **class** *BindingIdentifier* *ClassTail* ¶
<#>Let *className* be StringValue(of *BindingIdentifier*). ¶

Deleted: *ClassTail*

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P

Deleted: <#>Assert: *SetFunctionName* will not return an abrupt completion. ¶

Deleted: performing *BindingInitialization* for

Deleted: *BindingIdentifier* passing

Deleted: and

Deleted: as the arguments

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Deleted: *ClassDeclaration* : **class** *ClassTail*

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Deleted:).

6. Return `NormalCompletion(value)`.

NOTE If the class definition included a "name" static method then that method is not over-written with a "name" data property for the class name.

Deleted: <#>Assert: SetFunctionName will not return an abrupt completion.¶

14.6 Tail Position Calls

14.6.1 Static Semantics: `IsInTailPosition(nonterminal)` Abstract Operation

The abstract operation `IsInTailPosition` with argument `nonterminal` performs the following steps:

1. Assert: `nonterminal` is a parsed grammar production.
2. If the source code matching `nonterminal` is not strict code, **return false**.
3. If `nonterminal` is not contained within a `FunctionBody` or `ConciseBody`, **return false**.
4. Let `body` be the `FunctionBody` or `ConciseBody` that most closely contains `nonterminal`.
5. If `body` is the `FunctionBody` of a `GeneratorMethod`, `GeneratorDeclaration`, or a `GeneratorExpression`, **return false**.
6. Return the result of `HasProductionInTailPosition` of `body` with argument `nonterminal`.

NOTE Tail Position calls are only defined in strict mode code because of a common non-standard language extension (see 9.2.8) that enables observation of the chain of caller contexts.

Deleted: , then return
Deleted: , then return
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Deleted: ¶
Deleted: , then return
Deleted: ¶

14.6.2 Static Semantics: `HasProductionInTailPosition`

With parameter `nonterminal`.

NOTE `nonterminal` is a parsed grammar production that represent a specific range of source code. When the following algorithms compare `nonterminal` to other grammar symbols they are testing whether the same source code was matched by both symbols.

Deleted: ¶

14.6.2.1 Statement Rules

`ConciseBody : AssignmentExpression`,

Deleted: ¶

1. Return `HasProductionInTailPosition` of `AssignmentExpression` with argument `nonterminal`.

`StatementList : StatementList StatementListItem`,

Deleted: ¶

1. Let `has` be `HasProductionInTailPosition` of `StatementList` with argument `nonterminal`.
2. If `has` is `true`, **return true**.
3. Return `HasProductionInTailPosition` of `StatementListItem` with argument `nonterminal`.

Deleted: , then return

`FunctionStatementList : [empty]`,

Deleted: ¶

`StatementListItem : Declaration`,

Deleted: ¶

`Statement :`

`VariableStatement`
`EmptyStatement`
`ExpressionStatement`
`ContinueStatement`
`BreakStatement`
`ThrowStatement`
`DebuggerStatement`

Block : { }

ReturnStatement : return ;

LabelledItem : FunctionDeclaration

IterationStatement :

for (LeftHandSideExpression in Expression) Statement
for (var ForBinding in Expression) Statement
for (ForDeclaration in Expression) Statement
for (LeftHandSideExpression of AssignmentExpression) Statement
for (var ForBinding of AssignmentExpression) Statement
for (ForDeclaration of AssignmentExpression) Statement

CaseBlock : { }

1. Return **false**.

IfStatement : if (Expression) Statement else Statement

1. Let *has* be HasProductionInTailPosition of the first *Statement* with argument *nonterminal*.
2. If *has* is **true**, **return true**.
3. Return HasProductionInTailPosition of the second *Statement* with argument *nonterminal*.

IfStatement : if (Expression) Statement

IterationStatement :

do Statement while (Expression) ;^{opt}
while (Expression) Statement
for (Expression_{opt} ; Expression_{opt} ; Expression_{opt}) Statement
for (var VariableDeclarationList ; Expression_{opt} ; Expression_{opt}) Statement
for (LexicalDeclaration Expression_{opt} ; Expression_{opt}) Statement

WithStatement : with (Expression) Statement

1. Return HasProductionInTailPosition of *Statement* with argument *nonterminal*.

LabelledStatement :

LabelIdentifier : LabelledItem

1. Return HasProductionInTailPosition of LabelledItem with argument *nonterminal*.

ReturnStatement : return Expression ;

1. Return HasProductionInTailPosition of *Expression* with argument *nonterminal*.

SwitchStatement : switch (Expression) CaseBlock

1. Return HasProductionInTailPosition of *CaseBlock* with argument *nonterminal*.

CaseBlock : { CaseClauses_{opt} DefaultClause CaseClauses_{opt} }

1. Let *has* be **false**.
2. If the first *CaseClauses* is present, let *has* be HasProductionInTailPosition of the first *CaseClauses* with argument *nonterminal*.
3. If *has* is **true**, **return true**.
4. Let *has* be HasProductionInTailPosition of the *DefaultClause* with argument *nonterminal*.
5. If *has* is **true**, **return true**.
6. If the second *CaseClauses* is present, let *has* be HasProductionInTailPosition of the second *CaseClauses* with argument *nonterminal*.
7. Return *has*.

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Deleted: ¶

Deleted: , then return

Deleted: ¶

Deleted:
for (LeftHandSideExpression in Expression) Statement
for (var ForBinding in Expression) Statement
for (ForDeclaration in Expression) Statement
for (LeftHandSideExpression of AssignmentExpression) Statement
for (var ForBinding of AssignmentExpression) Statement
for (ForDeclaration of AssignmentExpression) Statement

Deleted: ¶

Deleted: IdentifierReference

Deleted: Statement

Deleted:
yield : Statement

Deleted: Statement

Deleted: ¶

Deleted: ¶

Deleted: , then return

Deleted: , then return

<i>CaseClauses</i> : <i>CaseClauses CaseClause</i>	Deleted: ¶
1. Let <i>has</i> be HasProductionInTailPosition of <i>CaseClauses</i> with argument <i>nonterminal</i> . 2. If <i>has</i> is true , return true . 3. Return HasProductionInTailPosition of <i>CaseClause</i> with argument <i>nonterminal</i> .	Deleted: , then return
<i>CaseClause</i> : case <i>Expression</i> : <i>StatementList</i> _{opt}	Deleted: ¶
<i>DefaultClause</i> : default : <i>StatementList</i> _{opt}	Deleted: ¶
1. If <i>StatementList</i> is present, return HasProductionInTailPosition of <i>StatementList</i> with argument <i>nonterminal</i> . 2. Return false .	
<i>TryStatement</i> : try <i>Block Catch</i>	Deleted: ¶
1. Return HasProductionInTailPosition of <i>Catch</i> with argument <i>nonterminal</i> .	
<i>TryStatement</i> : try <i>Block Finally</i>	Deleted: ¶
<i>TryStatement</i> : try <i>Block Catch Finally</i>	Deleted: ¶
1. Return HasProductionInTailPosition of <i>Finally</i> with argument <i>nonterminal</i> .	
<i>Catch</i> : catch (<i>CatchParameter</i>) <i>Block</i>	Deleted: ¶
1. Return HasProductionInTailPosition of <i>Block</i> with argument <i>nonterminal</i> .	Deleted: Finally
14.6.2.2 Expression Rules	
NOTE A potential tail position call that is immediately followed by return GetValue of the call result is also a possible tail position call. Function calls cannot return reference values, so such a GetValue operation will always returns the same value as the actual function call result.	Deleted: al Deleted:
<i>AssignmentExpression</i> :	
<i>YieldExpression</i>	
<i>ArrowFunction</i>	
<i>LeftHandSideExpression</i> = <i>AssignmentExpression</i>	
<i>LeftHandSideExpression AssignmentOperator AssignmentExpression</i>	Deleted: ¶
<i>BitwiseANDExpression</i> : <i>BitwiseANDExpression & EqualityExpression</i>	
<i>BitwiseXORExpression</i> : <i>BitwiseXORExpression ^ BitwiseANDExpression</i>	
<i>BitwiseORExpression</i> : <i>BitwiseORExpression BitwiseXORExpression</i>	
<i>EqualityExpression</i> :	
<i>EqualityExpression == RelationalExpression</i>	
<i>EqualityExpression != RelationalExpression</i>	
<i>EqualityExpression === RelationalExpression</i>	
<i>EqualityExpression !== RelationalExpression</i>	
<i>RelationalExpression</i> :	
<i>RelationalExpression < ShiftExpression</i>	
<i>RelationalExpression > ShiftExpression</i>	
<i>RelationalExpression <= ShiftExpression</i>	
<i>RelationalExpression >= ShiftExpression</i>	
<i>RelationalExpression instanceof ShiftExpression</i>	
<i>RelationalExpression in ShiftExpression</i>	

ShiftExpression :

- ShiftExpression << AdditiveExpression*
- ShiftExpression >> AdditiveExpression*
- ShiftExpression >>> AdditiveExpression*

AdditiveExpression :

- AdditiveExpression + MultiplicativeExpression*
- AdditiveExpression - MultiplicativeExpression*

MultiplicativeExpression :

- MultiplicativeExpression MultiplicativeOperator UnaryExpression*

UnaryExpression :

- delete** UnaryExpression
- void** UnaryExpression
- typeof** UnaryExpression
- ++** UnaryExpression
- UnaryExpression
- + UnaryExpression**
- UnaryExpression**
- ~ UnaryExpression**
- ! UnaryExpression**

PostfixExpression :

- LeftHandSideExpression **++***
- LeftHandSideExpression **--***

CallExpression :

- CallExpression [Expression]*
- CallExpression . IdentifierName*

MemberExpression :

- MemberExpression [Expression]*
- MemberExpression . IdentifierName*
- SuperProperty*

PrimaryExpression :

- this**
- IdentifierReference*
- Literal*
- ArrayLiteral*
- ObjectLiteral*
- FunctionExpression*
- ClassExpression*
- GeneratorExpression*
- RegularExpressionLiteral*
- TemplateLiteral*

1. Return **false**.

Expression :

- AssignmentExpression*
- Expression , AssignmentExpression*

1. Return HasProductionInTailPosition of *AssignmentExpression* with argument *nonterminal*.

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UnaryExpression
MultiplicativeExpression / UnaryExpression ↵

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Deleted: *super [Expression]*
Deleted: *super . IdentifierName*

Deleted: *Initializer*

Deleted: *GeneratorComprehension ↵*

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ConditionalExpression : *LogicalORExpression* ? *AssignmentExpression* : *AssignmentExpression*

1. Let *has* be HasProductionInTailPosition of the first *AssignmentExpression* with argument *nonterminal*.
2. If *has* is true, return true.
3. Return HasProductionInTailPosition of the second *AssignmentExpression* with argument *nonterminal*.

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LogicalANDExpression : *LogicalANDExpression* && *BitwiseORExpression*

1. Return HasProductionInTailPosition of *BitwiseORExpression* with argument *nonterminal*.

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LogicalORExpression : *LogicalORExpression* || *LogicalANDExpression*

1. Return HasProductionInTailPosition of *LogicalANDExpression* with argument *nonterminal*.

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CallExpression :

MemberExpression Arguments

SuperCall

CallExpression Arguments

CallExpression TemplateLiteral

1. If this *CallExpression* is nonterminal, return true.
2. Return false.

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MemberExpression :

MemberExpression TemplateLiteral

new MemberExpression Arguments

1. If this *MemberExpression* is nonterminal, return true.
2. Return false.

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NewExpression : *new NewExpression*

1. If this *NewExpression* is nonterminal, return true.
2. Return false.

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PrimaryExpression : *CoverParenthesizedExpressionAndArrowParameterList*

1. Let *expr* be *CoverParenthesizedExpression* of *CoverParenthesizedExpressionAndArrowParameterList*.
2. Return HasProductionInTailPosition of *expr* with argument *nonterminal*.

ParenthesizedExpression :

(*Expression*)

1. Return HasProductionInTailPosition of *Expression* with argument *nonterminal*.

14.6.3 Runtime Semantics: PrepareForTailCall()

The abstract operation *PrepareForTailCall* performs the following steps:

1. Let *leafContext* be the running execution context.
2. Suspend *leafContext*.
3. Pop *leafContext* from the execution context context stack. The execution context now on the top of the stack becomes the running execution context.
4. Assert: *leafContext* has no further use. It will never be activated as the running execution context.

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A tail position call must either release any transient internal resources associated with the currently executing function execution context before invoking the target function or reuse those resources in support of the target function.

NOTE For example, a tail position call should only grow an implementation's activation record stack by the amount that the size of the target function's activation record exceeds the size of the calling function's activation record. If the target function's activation record is smaller, then the total size of the stack should decrease.

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15 ECMAScript Language: Scripts and Modules

15.1 Scripts

Syntax

Script :
 *ScriptBody*_{opt}

ScriptBody :
 StatementList

15.1.1 Static Semantics: Early Errors

ScriptBody : *StatementList*

- It is a Syntax Error if the LexicallyDeclaredNames of *StatementList* contains any duplicate entries.
- It is a Syntax Error if any element of the LexicallyDeclaredNames of *StatementList* also occurs in the VarDeclaredNames of *StatementList*.
- It is a Syntax Error if *StatementList* Contains *super* unless the source code containing *super* is eval code that is being processed by a direct *eval* that is contained in function code.
- It is a Syntax Error if *StatementList* Contains *NewTarget* unless the source code containing *NewTarget* is eval code that is being processed by a direct *eval* that is contained in function code.
- It is a Syntax Error if ContainsDuplicateLabels of *StatementList* with argument « » is true.
- It is a Syntax Error if ContainsUndefinedBreakTarget of *StatementList* with argument « » is true.
- It is a Syntax Error if ContainsUndefinedContinueTarget of *StatementList* with arguments « » and « » is true.

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Deleted: NOTE Additional error conditions relating to conflicting or duplicate declarations are checked during module linking prior to evaluation of a *Script*. If any such errors are detected the *Script* is not evaluated. ¶

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Comment [AWB1041]: Need a better definition

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15.1.2 Static Semantics: IsStrict

See also: [14.1.14](#), [15.2.1.9](#)

ScriptBody : *StatementList*

1. If this *ScriptBody* is contained in strict code or if *StatementList* is strict code, return true.
Otherwise, return false.]

15.1.3 Static Semantics: LexicallyDeclaredNames

See also: [13.1.2](#), [13.11.2](#), [13.12.6](#), [14.1.15](#), [14.2.10](#), [15.2.1.11](#)

ScriptBody : *StatementList*

1. Return TopLevelLexicallyDeclaredNames of *StatementList*.

NOTE At the top level of a *Script*, function declarations are treated like var declarations rather than like lexical declarations.

15.1.4 Static Semantics: LexicallyScopedDeclarations

[See also: 13.1.6](#), [13.11.6](#), [13.12.7](#), [14.1.16](#), [14.2.11](#), [15.2.1.12](#), [15.2.3.8](#).

ScriptBody : *StatementList*

1. Return TopLevelLexicallyScopedDeclarations of *StatementList*.

15.1.5 Static Semantics: VarDeclaredNames

See also: [13.0.5](#), [13.1.11](#), [13.2.2.2](#), [13.5.5](#), [13.6.1.4](#), [13.6.2.4](#), [13.6.3.5](#), [13.6.4.7](#), [13.10.5](#), [13.11.7](#), [13.12.12](#), [13.14.5](#), [14.1.18](#), [14.2.13](#), [15.2.1.13](#).

ScriptBody : StatementList

1. Return TopLevelVarDeclaredNames of *StatementList*.

15.1.6 Static Semantics: VarScopedDeclarations

See also: [13.0.6](#), [13.1.12](#), [13.2.2.3](#), [13.5.6](#), [13.6.1.5](#), [13.6.2.5](#), [13.6.3.6](#), [13.6.4.8](#), [13.10.6](#), [13.11.8](#),
[13.12.13](#), [13.14.6](#), [14.1.19](#), [14.2.14](#), [15.2.1.14](#).

ScriptBody : *StatementList*

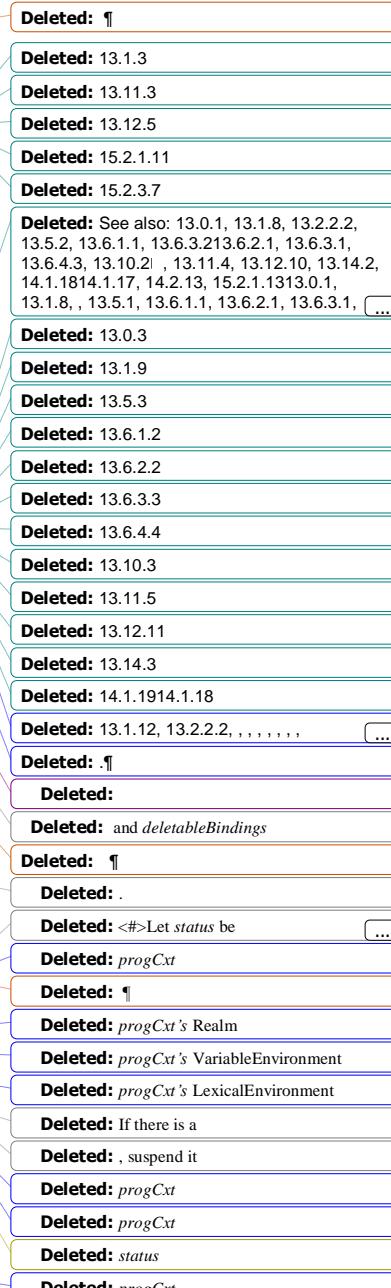
1. Return TopLevelVarScopedDeclarations of *StatementList*.

15.1.7 Runtime Semantics: ScriptEvaluation

With argument *realm*

Script : *ScriptBody_{opt}*

1. The code of this *Script* is strict mode code if the Directive Prologue (14.1.1) of its *ScriptBody* contains a Use Strict Directive or if any of the conditions of 10.2.1 apply. If the code of this *Script* is strict mode code, *ScriptBody* is evaluated in the following steps as strict mode code. Otherwise *ScriptBody* is evaluated in the following steps as non-strict mode code.
 2. If *ScriptBody* is not present, return NormalCompletion(empty).
 3. Let *globalEnv* be *realm*.*[globalEnv]*.
 4. Let *scriptCxt* be a new ECMAScript code execution context.
 5. Set the Function of *scriptCxt* to null.
 6. Set the Realm of *scriptCxt* to *realm*.
 7. Set the VariableEnvironment of *scriptCxt* to *globalEnv*.
 8. Set the LexicalEnvironment of *scriptCxt* to *globalEnv*.
 9. Suspend the currently running execution context.
 10. Push *scriptCxt* on to the execution context stack; *scriptCxt* is now the running execution context.
 11. Let *result* be GlobalDeclarationInstantiation(*ScriptBody*, *globalEnv*).
 12. If *result*.*[type]* is normal, then
 - a. Let *result* be the result of evaluating *ScriptBody*.
 13. If *result*.*[type]* is normal and *result*.*[value]* is empty, then
 - a. Let *result* be NormalCompletion(*undefined*).
 14. Suspend *scriptCxt* and remove it from the execution context stack.



15. Assert: the execution context stack is not empty.

16. Resume the context that is now on the top of the execution context stack as the running execution context.

17. Return *result*.

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Deleted: Otherwise, the execution context stack is now empty and there is no running execution context.

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Deleted: NOTE The processes for initiating the evaluation of a *Script* and for dealing with the result of such an evaluation are defined by an ECMAScript implementation and not by this specification.¶

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15.1.8 Runtime Semantics: GlobalDeclarationInstantiation (*script*, *env*)

NOTE When an execution context is established for evaluating scripts, declarations are instantiated in the current global environment. Each global binding declared in the code is instantiated.¶

GlobalDeclarationInstantiation is performed as follows using arguments *script* and *env*, *script* is the *ScriptBody* for which the execution context is being established. *env* is the global lexical environment in which bindings are to be created.¶

1. Let *envRec* be *env*'s environment record.
2. Assert: *envRec* is a Global Environment Record.
3. Let *lexNames* be the LexicallyDeclaredNames of *script*.
4. Let *varNames* be the VarDeclaredNames of *script*.
5. For each *name* in *lexNames*, do
 - a. If the result of calling *envRec*'s HasVarDeclaration concrete method passing *name* as the argument is **true**, throw a **SyntaxError** exception.
 - b. If the result of calling *envRec*'s HasLexicalDeclaration concrete method passing *name* as the argument is **true**, throw a **SyntaxError** exception.
 - c. If the result of calling *envRec*'s HasRestrictedGlobalProperty concrete method passing *name* as the argument is **true**, throw a **SyntaxError** exception.
6. For each *name* in *varNames*, do
 - a. If the result of calling *envRec*'s HasLexicalDeclaration concrete method passing *name* as the argument is **true**, throw a **SyntaxError** exception.
7. Let *varDeclarations* be the VarScopedDeclarations of *script*.
8. Let *functionsToInitialize* be an empty List.
9. Let *declaredFunctionNames* be an empty List.
10. For each *d* in *varDeclarations*, in reverse list order do
 - a. If *d* is neither a **VariableDeclaration** or a **ForBinding**, then
 - i. Assert: *d* is either a **FunctionDeclaration** or a **GeneratorDeclaration**.
 - ii. NOTE If there are multiple **FunctionDeclarations** for the same name, the last declaration is used.¶
 - iii. Let *fn* be the sole element of the BoundNames of *d*.
 - iv. If *fn* is not an element of *declaredFunctionNames*, then
 1. Let *fnDefinable* be the result of calling *envRec*'s CanDeclareGlobalFunction concrete method passing *fn* as the argument.
 2. If *fnDefinable* is **false**, throw **TypeError** exception.
 3. Append *fn* to *declaredFunctionNames*.
 4. Insert *d* as the first element of *functionsToInitialize*.
11. Let *declaredVarNames* be an empty List.
12. For each *d* in *varDeclarations*, do
 - a. If *d* is a **VariableDeclaration** or a **ForBinding**, then
 - i. For each String *vn* in the BoundNames of *d*, do
 1. If *vn* is not an element of *declaredFunctionNames*, then
 - a. Let *vnDefinable* be the result of calling *envRec*'s CanDeclareGlobalVar concrete method passing *vn* as the argument.
 - b. If *vnDefinable* is **false**, throw **TypeError** exception.
 - c. If *vn* is not an element of *declaredVarNames*, then
 - i. Append *vn* to *declaredVarNames*.

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- 13.** NOTE: No abnormal terminations occur after this algorithm step if the global object is an ordinary object. However, if the global object is a Proxy exotic object it may exhibit behaviours that cause abnormal terminations in some of the following steps.
- 14.** Let *lexDeclarations* be the LexicallyScopedDeclarations of *script*.
- 15.** For each element *d* in *lexDeclarations* do
- a. NOTE Lexically declared names are only instantiated here but not initialized.
 - b. For each element *dn* of the BoundNames of *d* do
 - i. If IsConstantDeclaration of *d* is **true**, then
 - 1. Let *status* be the result of calling *envRec*'s CreateImmutableBinding concrete method passing *dn* and **true** as the arguments.
 - ii. Else,
 - 1. Let *status* be the result of calling *envRec*'s CreateMutableBinding concrete method passing *dn* and **false** as the arguments.
 - iii. *ReturnIfAbrupt(status)*.
- 16.** For each *production* *f* in *functionsToInitialize*, do
- a. Let *fn* be the sole element of the BoundNames of *f*.
 - b. Let *fo* be the result of performing *InstantiateFunctionObject* for *f* with argument *env*.
 - c. Let *status* be the result of calling *envRec*'s CreateGlobalFunctionBinding concrete method passing *fn*, *fo*, and **false** as the arguments.
 - d. *ReturnIfAbrupt(status)*.
- 17.** For each String *vn* in *declaredVarNames*, in list order do
- a. Let *status* be the result of calling *envRec*'s CreateGlobalVarBinding concrete method passing *vn* and **false** as the argument.
 - b. *ReturnIfAbrupt(status)*.
- 18.** *Return NormalCompletion(empty)*

NOTE Early errors specified in 15.1.1 prevent name conflicts between function/var declarations and let/const/class declarations as well as redeclaration of let/const/class bindings for declaration contained within a single *Script*. However, such conflicts and redeclarations that span more than one *Script* are detected as runtime errors during GlobalDeclarationInstantiation. If any such errors are detected, no bindings are instantiated for the script. However, if the global object is defined using Proxy exotic objects then the runtime tests for conflicting declarations may be unreliable resulting in an abrupt completion and some global declarations not being instantiated. If this occurs, the code for the Script is not evaluated.

Unlike explicit var or function declarations, properties that are directly created on the global object result in global bindings that may be shadowed by let/const/class declarations.

15.1.9 Runtime Semantics: ScriptEvaluationJob (*sourceCodeId*)

The job *ScriptEvaluationJob* with parameter *sourceCodeId* parses, validates, and evaluates the *Script* whose source code is host accessible using *sourceCodeId*.

1. Assert: *sourceCodeId* is a host provided script source code identifier.
2. Let *source* be *HostGetSource(sourceCodeId)*.
3. If *source* is an abrupt completion, let *script* be *source*.
4. Else,
 - a. Assert: *source* is a SourceCharacter sequence (see 10).
 - b. Parse *source* using *Script* as the goal symbol and analyze the parse result for any Early Error conditions. If the parse was successful and no early errors were found, let *script* be the resulting parse tree. Otherwise, let *script* be an indication of one or more parsing errors and/or early errors. Parsing and early error detection may be interwoven in an implementation dependent manner. If more than one parse or early error is present, the number and ordering of reported errors is implementation dependent but at least one error must be reported.

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Deleted: <#>Let *lexDeclarations* be the LexicallyScopedDeclarations of *script*.¶
<#>For each element *d* in *lexDeclarations* do¶
<#>NOTE Except for generator function declarations, lexically declared names are only instantiated here but not initialized. ¶
<#>For each element *dn* of the BoundNames of *d* do¶
<#>If IsConstantDeclaration of *d* is **true**, then¶
<#>Let *status* be the result of calling *env*'s CreateImmutableBinding concrete method passing *dn* as the argument.¶
<#>Else ¶
<#>Let *status* be the result of calling *env*'s CreateMutableBinding concrete method passing *dn* and **false** as the arguments.¶
<#>Assert: *status* is never an abrupt completion for lexically declared names.¶
<#>If *d* is a GeneratorDeclaration production, then¶
<#>Let *fn* be the sole element of the BoundNames of *d*.¶
<#>Let *fo* be the result of performing *InstantiateFunctionObject* for *d* with argument *env*.¶
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5. If *script* is an error indication, then
 - a. Report or log the error(s) in an implementation dependent manner.
 - b. Let *status* be NormalCompletion(***undefined***).
6. Else,
 - a. Let *realm* be the running execution context's Realm.
 - b. Let *status* be the result of ScriptEvaluation of *script* with argument *realm*.
7. NextJob *status*.

NOTE An implementation may parse a *Script* and analyze it for Early Error conditions prior to the execution of the *ScriptEvaluationJob* for that *Script*. However, the reporting of any errors must be deferred until the *ScriptEvaluationJob* is actually executed.

15.2 Modules

Syntax

Module :
*ModuleBody*_{opt}

ModuleBody :
ModuleItemList

ModuleItemList :
ModuleItem
ModuleItemList ModuleItem

ModuleItem :
ImportDeclaration
ExportDeclaration
*StatementList*_{item}

15.2.1 Module Semantics

15.2.1.1 Static Semantics: Early Errors

ModuleBody : *ModuleItemList*

- It is a Syntax Error if the LexicallyDeclaredNames of *ModuleItemList* contains any duplicate entries.
- It is a Syntax Error if any element of the LexicallyDeclaredNames of *ModuleItemList* also occurs in the VarDeclaredNames of *ModuleItemList*.
- It is a Syntax Error if the ExportedNames of *ModuleItemList* contains any duplicate entries.
- It is a Syntax Error if any element of the ExportedBindings of *ModuleItemList* do not also occurs in either the VarDeclaredNames of *ModuleItemList*, or the LexicallyDeclaredNames of *ModuleItemList*.
- It is a Syntax Error if *ModuleItemList* Contains **super**.
- It is a Syntax Error if *ModuleItemList* Contains **NewTarget**.
- It is a Syntax Error if ContainsDuplicateLabels of *ModuleItemList* with argument « » is **true**.
- It is a Syntax Error if ContainsUndefinedBreakTarget of *ModuleItemList* with argument « » is **true**.
- It is a Syntax Error if ContainsUndefinedContinueTarget of *ModuleItemList* with arguments « » and « » is **true**.

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Deleted: <#>Analysize *script* for any Early Error conditions.
 <#>If any Early Errors were found, then report or log the errors in an implementation dependent manner.
 <#>Else,
 ¶

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Deleted: <#>It is a Syntax Error if more than one of the *ModuleItems* in *ModuleItemList* is a *ExportDeclaration* that includes the **default** keyword.
 ¶

Deleted: <#>It is a Syntax Error if the ImportedBindings of *ModuleItemList* contains any duplicate entries.
 <#>It is a Syntax Error if the ExportedBindings of *ModuleItemList* contains any duplicate entries.
 ¶

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Deleted: <#>It is a Syntax Error if any element of the VarDeclaredNames of *ModuleItemList* also occurs in the ImportedBindings of *ModuleItemList*.
 ¶

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NOTE The duplicate ExportedNames rule implies that multiple `export default ExportDeclaration` items within a `ModuleBody` is a Syntax Error. Additional error conditions relating to conflicting or duplicate declarations are checked during module linking prior to evaluation of a `Module`. If any such errors are detected the `Module` is not evaluated.

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15.2.1.2 Static Semantics: ContainsDuplicateLabels

With argument `labelSet`.

See also: 13.0.1, 13.1.2, 13.5.2, 13.6.1.1, 13.6.2.1, 13.6.3.2, 13.6.4.3, 13.10.2, 13.11.2, 13.12.2, 13.14.2.

ModuleItemList : ModuleItemList ModuleItem

1. Let `hasDuplicates` be `ContainsDuplicateLabels` of `ModuleItemList` with argument `labelSet`.
2. If `hasDuplicates` is `true`, return `true`.
3. Return `ContainsDuplicateLabels` of `ModuleItem` with argument `labelSet`.

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ModuleItem :

ImportDeclaration
ExportDeclaration

1. Return `false`.

15.2.1.3 Static Semantics: ContainsUndefinedBreakTarget

With argument `labelSet`.

See also: 13.0.2, 13.1.3, 13.5.3, 13.6.1.2, 13.6.2.2, 13.6.3.3, 13.6.4.4, 13.8.2, 13.10.3, 13.11.3, 13.12.3, 13.14.3.

ModuleItemList : ModuleItemList ModuleItem

1. Let `hasUndefinedLabels` be `ContainsUndefinedBreakTarget` of `ModuleItemList` with argument `labelSet`.
2. If `hasUndefinedLabels` is `true`, return `true`.
3. Return `ContainsUndefinedBreakTarget` of `ModuleItem` with argument `labelSet`.

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ModuleItem :

ImportDeclaration
ExportDeclaration

1. Return `false`.

15.2.1.4 Static Semantics: ContainsUndefinedContinueTarget

With arguments `iterationSet` and `labelSet`.

See also: 13.0.3, 13.1.4, 13.5.4, 13.6.1.3, 13.6.2.3, 13.6.3.4, 13.6.4.5, 13.7.2, 13.10.4, 13.11.4, 13.12.4, 13.14.4.

ModuleItemList : ModuleItemList ModuleItem

1. Let `hasUndefinedLabels` be `ContainsUndefinedContinueTarget` of `ModuleItemList` with arguments `iterationSet` and « ».
2. If `hasUndefinedLabels` is `true`, return `true`.
3. Return `ContainsUndefinedContinueTarget` of `ModuleItem` with arguments `iterationSet` and « ».

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ModuleItem :
ImportDeclaration
ExportDeclaration

- ### 1. Return false.

15.2.1.5 Static Semantics: ExportedBindings

See also:15.2.3.3

NOTE ExportedBindings are the locally bound names that are explicitly associated with a *Module*'s ExportedNames.

ModuleItemList : ModuleItemList ModuleItem

1. Let $names$ be ExportedBindings of $ModuleItemList$.
 2. Append to $names$ the elements of the ExportedBindings of $ModuleItem$.
 3. Return $names$.

ModuleItem :
 ImportDeclaration
 StatementListItem

1. Return a new empty List.

15.2.1.6 Static Semantics: ExportedNames

See also: 15.2.3.4.

NOTE ExportedNames are the externally visible names that a *Module* explicitly maps to one of its local name bindings.

-ModuleItemList : ModuleItemList *ModuleItem*

1. Let $names$ be ExportedNames of *ModuleItemList*.
 2. Append to $names$ the elements of the ExportedNames of *ModuleItem*.
 3. Return $names$.

ModuleItem : *ExportDeclaration*

1. Return the `ExportedNames` of `ExportDeclaration`.

ModuleItem :

ImportDeclaration StatementListItem

1. Return a new empty List.

15.2.1.7 Static Semantics: ExportEntries

See also: [15.2.3.5](#).

Module: [empty]

1. Return a new empty List.

Deleted: <#>Static Semantics:
DeclaredNames¶

Module : [empty] ¶
<#>Return a new empty List.¶

Module : ModuleBody ¶
<#>Let names be LexicallyDeclaredNames of
ModuleBody.¶
<#>Append to names the elements of the
VarDeclaredNames of *ModuleBody*.¶
<#>Return names.¶

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ExportEntries¶
See also: 15.2.3.415.2.2.3.¶
ModuleItemList : [empty]¶
<#>Return a new empty List.¶
ModuleItemList : **ModuleItemList** **ModuleItem** ¶
<#>Let entries be ExportEntries of
ModuleItemList.¶
<#>Append to entries the elements of the
ExportEntries of **ModuleItem**.¶
<#>Return entries.¶
ModuleItem : ¶
ImportDeclaration
StatementList ¶
<#>Return a new empty List.¶

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Deleted: **ModuleItemList** : [empty]¶
<#>Return a new empty List.¶

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ModuleItemList : ModuleItemList ModuleItem

1. Let *entries* be ExportEntries of *ModuleItemList*.
2. Append to *entries* the elements of the ExportEntries of *ModuleItem*.
3. Return *entries*.

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ModuleItem :

ImportDeclaration
StatementListItem

1. Return a new empty List.

15.2.1.8 Static Semantics: ImportEntries

See also: [15.2.2.3](#)

Deleted: 15.2.2.315.2.1.3

Module : [empty]

1. Return a new empty List.

Deleted: *ItemList*

ModuleItemList : ModuleItemList ModuleItem

Deleted: ¶

1. Let *entries* be ImportEntries of *ModuleItemList*.
2. Append to *entries* the elements of the ImportEntries of *ModuleItem*.
3. Return *entries*.

ModuleItem :

ExportDeclaration
StatementListItem

1. Return a new empty List.

15.2.1.9 Static Semantics: IsStrict

See also: [14.1.14](#), [15.1.2](#)

Deleted: 14.1.1414.1.13

Module : [empty]

ModuleBody : *ModuleItemList*

1. Return **true**.

Deleted: ¶

15.2.1.10 Static Semantics: ModuleRequests

See also: [15.2.2.5](#), [15.2.3.7](#)

Module : [empty]

1. Return a new empty List.

ModuleItemList : ModuleItem

1. Return ModuleRequests of *ModuleItem*.

ModuleItemList : ModuleItemList ModuleItem

1. Let *moduleNames* be ModuleRequests of *ModuleItemList*.
2. Let *additionalNames* be ModuleRequests of *ModuleItem*.

Deleted: <#>Static Semantics:
KnownExportEntries¶
ModuleBody : *ModuleItemList* ¶
<#>Let *allEntries* be ExportEntries of
ModuleItemList.¶
<#>Return a new List containing all the entries of
allEntries whose [[ImportName]] field is not
"*"all.¶

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Deleted: *ItemList*

Deleted: ¶

Deleted: ¶

3. Append to *moduleNames* each element of *additionalNames* that is not already an element of *moduleNames*.
4. Return *moduleNames*.

ModuleItem : *StatementListItem*

1. Return a new empty List.

15.2.1.11 Static Semantics: LexicallyDeclaredNames

See also: 13.1.2, 13.11.2, [13.12.6](#), 14.1.15, 14.2.10, 15.1.3.

NOTE The LexicallyDeclaredNames of a *Module* includes the names of all of its imported bindings.

ModuleItemList : *ModuleItemList* *ModuleItem*

1. Let *names* be LexicallyDeclaredNames of *ModuleItemList*.
2. Append to *names* the elements of the LexicallyDeclaredNames of *ModuleItem*.
3. Return *names*.

ModuleItem : *ImportDeclaration*

1. Return the BoundNames of *ImportDeclaration*.

ModuleItem : *ExportDeclaration*

1. If *ExportDeclaration* is **export VariableStatement**, return a new empty List.
2. Return the BoundNames of *ExportDeclaration*.

ModuleItem : *StatementListItem*

1. Return LexicallyDeclaredNames of *StatementListItem*.

NOTE At the top level of a *Module*, function declarations are treated like lexical declarations rather than like var declarations.

15.2.1.12 Static Semantics: LexicallyScopedDeclarations

See also: [13.1.6](#), [13.11.6](#), [13.12.7](#), 14.1.16, 14.2.11, 15.1.4, [15.2.3.8](#)

Module : [empty]

1. Return a new empty List.

ModuleItemList : *ModuleItemList* *ModuleItem*

1. Let *declarations* be LexicallyScopedDeclarations of *ModuleItemList*.
2. Append to *declarations* the elements of the LexicallyScopedDeclarations of *ModuleItem*.
3. Return *declarations*.

ModuleItem : *ImportDeclaration*

1. Return a new empty List.

Deleted: 13.12.4

Deleted: *ModuleItemList* : [empty]
->Return a new empty List.

Deleted: ¶

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Deleted: 13.12.5

Deleted: 15.2.3.7

Deleted: *ItemList*

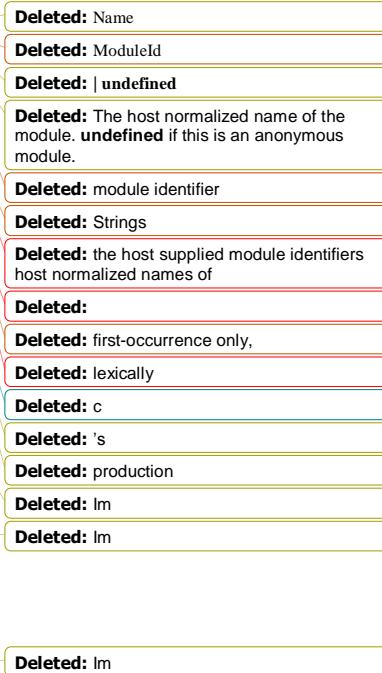
Deleted: ¶

Deleted: <#>If the BoundNames of *ImportDeclarations* is empty, then return an empty List.
Deleted: containing *ImportDeclaration*

Table 37 — Module Record Fields

Field Name	Value Type	Meaning
<code>[[SourceCodeId]]</code>	<code>String</code>	A host supplied <code>sourceCodeId</code> that uniquely identifies the source code of this module.
<code>[[ImportedModules]]</code>	<code>List of Module Records</code>	A List of all the modules that are directly imported by the module represented by this record. The List is <code>source code ordered based upon the first explicit import of each module in the list</code> .
<code>[[ECMAScriptCode]]</code>	<code>a parse result</code>	The result of parsing the source code of this module, using <code>Module</code> as the goal symbol.
<code>[[ImportEntries]]</code>	<code>List of ImportEntry Records</code>	A List of ImportEntry records derived from the code of this module. Module names within the ImportEntry records have been host normalized.
<code>[[LocalExportEntries]]</code>	<code>List of ExportEntry Records</code>	A List of ExportEntry records derived from the code of this module that correspond to declarations that occur within the module. Module names within the ImportEntry records have been host normalized.
<code>[[IndirectExportEntries]]</code>	<code>List of ExportEntry Records</code>	A List of ExportEntry records derived from the code of this module that correspond to reexported imports that occur within the module. Module names within the ImportEntry records have been host normalized.
<code>[[StarExportEntries]]</code>	<code>List of ExportEntry Records</code>	A List of ExportEntry records derived from the code of this module that correspond to export * declarations that occur within the module. Module names within the ImportEntry records have been host normalized.
<code>[[Environment]]</code>	<code>Lexical Environment</code>	The Lexical Environment containing the top level bindings for this module. This field is set when the module is linked.
<code>[[Namespace]]</code>	<code>Object undefined</code>	The Module Namespace Object (26.3) if one has been created for this module. Otherwise <code>undefined</code> .
<code>[[Evaluated]]</code>	<code>Boolean</code>	Initially <code>false</code> . <code>true</code> if evaluation of this module has started. Remains <code>true</code> when evaluation completes, even if it is an abrupt completion.

An ImportEntry Record is a Record that digests information about a single declarative import. Each ImportEntry Record has the fields defined in Table 38.



Field Code Changed

Table 38 — ImportEntry Record Fields

Field Name	Value Type	Meaning
<code>[[ModuleRequest]]</code>	<code>String</code>	The module name that was stated in the <i>FromClause</i> of the <i>ImportDeclaration</i> .
<code>[[ImportModule]]</code>	Module Record	The Module Record that the <i>FromClause</i> resolved to.
<code>[[ImportName]]</code>	<code>String</code>	The name under which the desired binding is exported by <code>[[ImportModule]]</code> . The value "*" indicates that the import request is for the target module's namespace object.
<code>[[LocalName]]</code>	<code>String</code>	The name that is used to locally access the imported value from within the importing module.

NOTE The following table gives examples of `ImportStatementForm` fields used to represent the syntactic import forms:

Import Statement Form	<code>[[ModuleRequest]]</code>	<code>[[ImportName]]</code>	<code>[[LocalName]]</code>
<code>import v from "mod";</code>	"mod"	"default"	"v"
<code>import * as ns from "mod";</code>	"mod"	"*"	"ns"
<code>import {x} from "mod";</code>	"mod"	"x"	"x"
<code>import {x as v} from "mod";</code>	"mod"	"x"	"v"
<code>import from "mod";</code>			An ImportEntry Records is not created.

An `ExportEntry Record` is a Record that digests information about a single declarative export. Each `ExportEntry Record` has the fields defined in Table 39:

Table 39 — ExportEntry Record Fields

Field Name	Value Type	Meaning
<code>[[ExportName]]</code>	<code>String</code>	The name under which the desired binding is exported by <code>this</code> module.
<code>[[ModuleRequest]]</code>	<code>String null</code>	The module name that was stated in the <i>FromClause</i> of the <i>ExportDeclaration</i> . <code>null</code> if the <i>ExportDeclaration</i> does not have a <i>FromClause</i> .
<code>[[ImportModule]]</code>	Module Record	The Module Record that the <i>FromClause</i> resolved to.
<code>[[ImportName]]</code>	<code>String null</code>	The name under which the desired binding is exported by the target module named by <code>[[ModuleRequest]]</code> . <code>null</code> if the <i>ExportDeclaration</i> does not have a <i>FromClause</i> . The value "*" indicates that the export request is for all exported bindings.
<code>[[LocalName]]</code>	<code>String null</code>	The name that is used to locally access the exported value from within the importing module. <code>null</code> if the exported value is not locally accessible from within the module.

NOTE The following table gives examples of the `ExportStatementForm` fields used to represent the syntactic export forms:

Export Statement Form	[[ExportName]]	[[ModuleRequest]]	[[ImportName]]	[[LocalName]]
export var v;	"v"	null	null	"v"
export default function f() {};	"default"	null	null	"f"
export default function() {};	"default"	null	null	"*default*"
export default 42;	"default"	null	null	"*default*"
export {x};	"x"	null	null	"x"
export {v as x};	"x"	null	null	"v"
export {x} from "mod";	"x"	"mod"	"x"	null
export {v as x} from "mod";	"x"	"mod"	"x"	null
export * from "mod";	null	"mod"	"*"	null

15.2.1.15.1 CreateModule(*sourceCodeId*) Abstract Operation

The abstract operation CreateModule creates and returns a new Module Record. The argument *sourceCodeId* is a host supplied module identifier.

The following steps are taken:

1. Let *mod* be a new Module Record.
2. Set *mod*.[[Evaluated]] to false.
3. Set *mod*.[[SourceCodeId]] to *sourceCodeId*.
4. Set all other fields of *mod* to undefined.
5. Return *mod*.

15.2.1.15.2 ModuleAt(*list*, *sourceCodeId*)

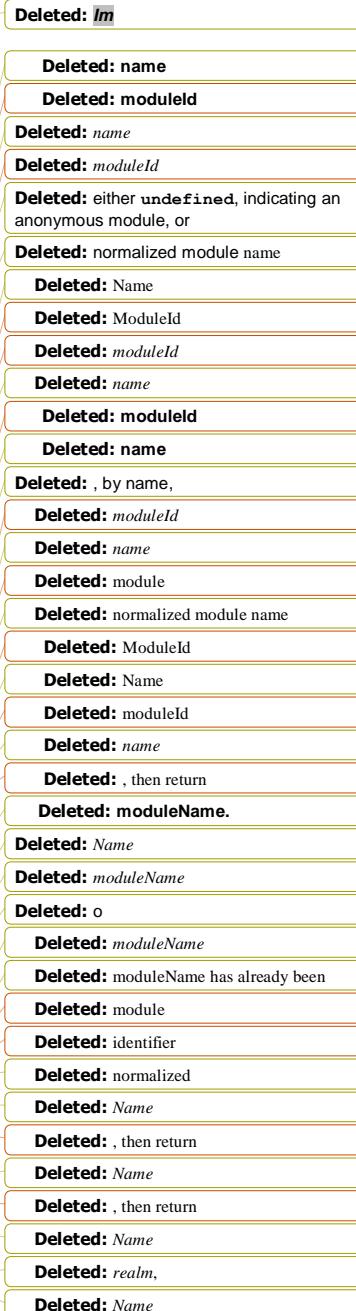
The abstract operation ModuleAt retrieves a Module Record from a List of Module Records. The following steps are taken:

1. Assert: *list* is a List whose elements are Module Records.
2. Assert: *sourceCodeId* is a String that is a host supplied sourceCodeId identifier.
3. For each element *m* of *list*, do
 - a. If SameValue(*m*.[[SourceCodeId]], *sourceCodeId*) is true, return *m*.
4. Return undefined.

15.2.1.16 Static Semantics: ParseModuleAndImports (*realm*, *moduleSrcId*, *visited*)

The abstract operation ParseModuleAndImports with arguments *realm*, *moduleSrcId*, and *visited* creates the Module Record for the module *source code*, identified by its *moduleSrcId* argument. It also creates module records (if they do not already exist) for modules that are directly or indirectly imported by the named module. ParseModuleAndImports performs the following steps:

1. Assert: Type(*moduleSrcId*) is String.
2. Assert: *moduleSrcId* is a host supplied sourceCodeId.
3. Let *vm* be ModuleAt(*visited*, *moduleSrcId*).
4. If *vm* is not undefined, return *vm*.
5. Let *mods* be *realm*.[[modules]].
6. Let *rm* be ModuleAt(*mods*, *moduleSrcId*).
7. If *rm* is not undefined, return *rm*.
8. Let *m* be CreateModule(*moduleSrcId*).
9. Append *m* to *visited*.
10. Let *src* be HostGetSource(*moduleSrcId*).
11. If *src* is an abrupt completion or any other implementation defined error indication, then



- a. Let *errors* be *src*.
12. Else
- a. Let *source* be *src.[[value]]*. Deleted: ¶
 - b. Assert: *source* is a *SourceCharacter* sequence (see clause 10).
 - c. Parse *source* using *Module* as the goal symbol and analyze the parse result for any Early Error conditions. If the parse was successful and no early errors were found, let *body* be the resulting parse tree. Otherwise, let *errors* be an indication of one or more parsing errors and/or early errors. Parsing and early error detection may be interleaved in an implementation dependent manner. If more than one parse or early error is present, the number and ordering of reported errors is implementation dependent but at least one error must be reported. Deleted: then
13. If *errors* is an abrupt completion or error indication, then
- a. Throw a *SyntaxError* exception. Additional implementation dependent errors information may be attached to the exception object.
14. Set *m.[[ECMAScriptCode]]* to *body*.
15. Let *requestedModules* be the *ModuleRequests* of *body*.
16. Let *importedModules* be a new empty List.
17. For each String *requestedName* in *requestedModules*, do
- a. Let *requestedSrcID* be *NormalizeModuleName(requestedName, moduleSrcId)*. Deleted: oi
 - b. ReturnIfAbrupt(*requestedSrcID*). Deleted: normalizedRequest
 - c. Let *importedModule* be *ParseModuleAndImports(realm, requestedSrcID, visited)*. Deleted: M
 - d. ReturnIfAbrupt(*importedModule*). Deleted: realm, Deleted: M
 - e. If *importedModule* is not an element of *importedModules*, append *importedModule* to *importedModules*. Deleted: normalizedRequest
18. Set *m.[[ImportedModules]]* to *importedModules*. Deleted: <#>If requestedMID normalizedRequest is not an element of importedModules, then append requestedMID normalizedRequest to ImportedModules.¶
19. Let *importEntries* be *ImportEntries* of *body*.
20. For each record *ie* in *importEntries*, do
- a. Let *requestedSrcID* be *NormalizeModuleName(ie.[[ModuleRequest]], moduleSrcId)*. Deleted: Status
 - b. ReturnIfAbrupt(*normalizedRequest*). Deleted: M
 - c. Assert: *importedModules* includes a *Module Record* whose *[[SourceCodeId]]* is *requestedSrcID*. Deleted: normalizedRequest
 - d. Set *ie.[[ImportModule]]* to *ModuleAt(importedModules, requestedSrcID)*. Deleted: importStatus
21. Set *m.[[ImportEntries]]* to *importEntries*. Deleted: ¶
22. Let *indirectExportEntries* be a new empty List. Deleted: I
23. Let *localExportEntries* be a new empty List. Deleted: M
24. Let *starExportEntries* be a new empty List. Deleted: normalizedRequest
25. Let *exportEntries* be *ExportEntries* of *body*. Deleted: realm, Deleted: normalizedRequest
26. For each record *ee* in *exportEntries*, do
- a. If *ee.[[ModuleRequest]]* is *null*, then
 - i. Append *ee* to *localExportEntries*. Deleted: .
 - b. Else,
 - i. Let *requestedSrcID* be *NormalizeModuleName(ee.[[ModuleRequest]], moduleSrcId)*. Deleted: M
 - ii. ReturnIfAbrupt(*requestedSrcID*). Deleted: normalizedRequest
 - iii. Assert: *importedModules* includes a *Module Record* whose *[[SourceCodeId]]* is *requestedSrcID*. Deleted: s
 - iv. Set *ee.[[ImportModule]]* to *ModuleAt(importedModules, requestedSrcID)*. Deleted: M
 - v. If *ee.[[ImportName]]* is *"*"*, then
 - 1. Append *ee* to *starExportEntries*. Deleted: normalizedRequest
 - vi. Else,
 - 1. Append *ee* to *indirectExportEntries*. Deleted: realm, Deleted: M
27. Set *m.[[LocalExportEntries]]* to *localExportEntries*. Deleted: normalizedRequest
28. Set *m.[[IndirectExportEntries]]* to *indirectExportEntries*. Deleted: ModuleRequestId
29. Set *m.[[StarExportEntries]]* to *starExportEntries*. Deleted: .
30. Return *m*. Deleted: M

NOTE An implementation may parse the source code identified by a host supplied module identifier as a *Module* and analyze it for Early Error conditions prior to the evaluation of a *ParseModuleAndImports* for that module identifier. However, the reporting of any errors must be deferred until such a *ParseModuleAndImports* is actually evaluated.

15.2.1.16.1 NormalizeModuleName(unnormalizedName, refererSrcId)

1. Let *moduleSrcId* be *HostNormalizeModuleName(unnormalizedName, refererSrcId)*.
2. If *moduleSrcId* is undefined, throw a *SyntaxError* exception.
3. Return *moduleSrcId*.

15.2.1.17 Static Semantics: GetExportedNames(module, circularitySet)

The abstract operation *GetExportedNames* with arguments *module* and *circularitySet* returns a list of all names that are either directly or indirectly exported from a module. It performs the following steps:

1. Assert: *module* is a Module Record.
2. If *circularitySet* contains *module*, then
 - a. Assert: We've reached the starting point of an import * circularity.
 - b. Return a new empty List.
3. Append *module* to *circularitySet*.
4. Let *exportedNames* be a new empty List.
5. For each ExportEntry Record *e* in *module*.[[LocalExportEntries]], do
 - a. Assert: *module* provides the leaf binding for this export.
 - b. Append *e*.[[ExportName]] to *exportedNames*.
6. For each ExportEntry Record *e* in *module*.[[IndirectExportEntries]], do
 - a. Assert: *module* imports a specific binding for this export.
 - b. Append *e*.[[ExportName]] to *exportedNames*.
7. For each ExportEntry Record *e* in *module*.[[StarExportEntries]], do
 - a. Let *circularitySetCopy* be a copy of the *circularitySet* List.
 - b. Let *starNames* be *GetExportedNames(e.||ImportModule||, circularitySetCopy)*.
 - c. For each element *n* of *starNames*, do
 - i. If *n* is not an element of *exportedNames*, then
 1. If *SameValue(n, "default")* is false, then
 - a. Append *n* to *exportedNames*.
8. Return *exportedNames*.

NOTE *GetExportedNames* does not filter out or throw an exception for names that have ambiguous bindings.

15.2.1.18 Static Semantics: ResolveExport(module, exportName, circularitySet)

The abstract operation *ResolveExport* with arguments *module*, *exportName*, and *circularitySet* performs the following steps:

1. Assert: *module* is a Module Record.
2. For each Record *r* {{[module]], [[exportName]]} in *circularitySet*, do:
 - a. If *module* and *r* are the same Module Record and *SameValue(exportName, r.||exportName||)* is true, then
 - i. Assert: this is a circular import request.
 - ii. Throw a *SyntaxError* exception.
3. Append the Record {{[module]: *module*, [[exportName]]: *exportName*} to *circularitySet*.
4. For each ExportEntry Record *e* in *module*.[[LocalExportEntries]], do
 - a. If *SameValue(exportName, e.||ExportName||)* is true, then
 - i. Assert: *module* provides the leaf binding for this export.

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Deleted: realm,	...
Deleted: <#>Let <i>map</i> be <i>realm</i> .[[nameMap]].	...
<#>For each <i>r</i> in <i>map</i> , do	...
<#>If <i>SameValue(unnormalizedName, r. unnormalized)</i> is true, then	...
<#>If <i>r. normalized </i> is undefined, then	...
throw a <i>SyntaxError</i> exception.	...
<#>Return <i>r. normalized </i>
Deleted: <#>Append the Record	...
{}{{[unnormalized]]: <i>unnormalizedName</i> ,	...
Deleted: then	...
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Deleted: Name	...
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Deleted: <i>SameValue(moduleNamId, ...)</i>	...
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Deleted: <i>m</i>	...

- ii. Return `Record{[[module]]: module, [[bindingName]]: module, [[LocalName]]: LocalName}`.
5. For each ExportEntry Record `e` in `module.[[IndirectExportEntries]]`, do
 - a. If `SameValue(exportName, e.[[ExportName]])` is `true`, then
 - i. Assert: `module` imports a specific binding for this export.
 - ii. Return `ResolveExport(e.[[ImportModule]], e.[[ImportName]], circularitySet)`.
 6. If `SameValue(exportName, "default")` is `true`, then
 - a. Assert: A `default` export was not explicitly defined by this module.
 - b. Throw a `SyntaxError` exception.
 - c. NOTE A `default` export cannot be provided by an `export *`.
 7. Let `starResolution` be `null`.
 8. For each ExportEntry Record `e` in `module.[[StarExportEntries]]`, do
 - a. Let `circularitySetCopy` be a copy of the `circularitySet` List.
 - b. Let `resolution` be `ResolveExport(e.[[ImportModule]], exportName, circularitySetCopy)`.
 - c. ReturnIfAbrupt(`resolution`).
 - d. If `resolution` is not `null`, then
 - i. If `starResolution` is not `null`, then
 1. Assert: there is more than one `*` import that includes the requested name.
 2. Throw a `SyntaxError` exception.
 - ii. Let `starResolution` be `resolution`.
 9. Return `starResolution`.

NOTE `ResolveExport` attempts to resolve an imported binding to the actual defining module and local binding name. The defining module may be the module passed as the `module` parameter or some other module that is imported by that module. The parameter `circularitySet` is used to detect unresolved circular import/export paths. If a pair consisting of specific module record and `exportName` is reached that is already in `circularitySet`, an import circularity has been encountered. Before recursively calling `ResolveExport`, a pair consisting of `module` and `exportName` is added to `circularitySet`.

If a defining module is found a Record `{[[module]], [[bindingName]]}` is returned. This record identifies the resolved binding of the originally requested export. If no definition was found, `null` is returned. If the request is found to be circular or ambiguous a `SyntaxError` exception is thrown.

15.2.1.19 Runtime Semantics: `ModuleEvaluationJob(sourceCodeId)`

A `ModuleEvaluationJob` with parameter `sourceCodeId` is a job that fetches, parses, validates, and evaluates the `Module` whose source code is host accessible using `sourceCodeId`.

1. Assert: Type(`sourceCodeId`) is String.
2. Assert: `sourceCodeId` is a host provided module source code identifier.
3. Let `realm` be the running execution context's Realm.
4. Let `mods` be `realm.[[modules]]`.
5. Let `m` be `ModuleAt(mods, sourceCodeId)`.
6. If `m` is undefined, then
 - a. Let `newModules` be an empty List.
 - b. Let `m` be `ParseModuleAndImports(realm, sourceCodeId, newModules)`.
 - c. If `m` is an abrupt completion or any other implementation defined error indication, then
 - i. Report or log the error(s) in an implementation dependent manner.
 - ii. NextJob NormalCompletion(`undefined`).
 - d. Let `linkStatus` be `LinkModules(realm, newModules)`.
 - e. If `linkStatus` is an abrupt completion, then
 - i. Report or log a module linking error in an implementation dependent manner.
 - ii. NextJob NormalCompletion(`undefined`).
7. Let `status` be the result of `ModuleEvaluation(m, realm)`.

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Deleted: the current `moduleNameId`
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Deleted: `Id`
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Deleted: `moduleNameId`
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Deleted: `moduleNameId`
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Deleted: `moduleName`
Deleted: `.[[ECMAScriptCode]]`

8. NextJob status.

15.2.1.20 Runtime Semantics: LinkModules(realm, newModuleSet)

The abstract operation `LinkModules` with arguments `realm` and `newModuleSet` performs the following steps:

1. Let `modules` be a copy of the List `realm.[[modules]]`.
2. Append to `modules` the elements of `newModuleSet`.
3. For each Module Record `m` that is an element of `newModuleSet`, do
 - a. Let `status` be `ModuleDeclarationInstantiation(m, realm, modules)`.
 - b. `ReturnIfAbrupt(status)`.
4. Assert: all elements of `newModuleSet` have been instantiated and are ready to be evaluated.
5. Append to `realm.[[modules]]` the elements of `newModuleSet`.
6. Return `NormalCompletion(empty)`.

15.2.1.21 Runtime Semantics: ModuleDeclarationInstantiation(module, realm, moduleSet)

`ModuleDeclarationInstantiation` is performed as follows using arguments `module`, `realm`, and `moduleSet`. `module` is the Module Record for which a `ModuleEnvironment` is being established. `realm` is the Realm Record with which the module is associated, and `moduleSet` is a List of Module Records from which this module may import bindings.

1. Let `code` be `module.[[ECMAScriptCode]]`.
2. For each `ExportEntry` Record `e` in `module.[[IndirectExportEntries]]`, do
 - a. Let `resolution` be `ResolveExport(module, e.[[ExportName]])`.
 - b. `ReturnIfAbrupt(resolution)`.
 - c. If `resolution` is `null`, throw a `SyntaxError` exception.
3. Assert: all named exports from `module` are resolvable.
4. Let `env` be `NewModuleEnvironment(realm, [[globalEnv]])`.
5. Let `envRec` be `env`'s environment record.
6. Set `module.[[Environment]]` to `env`.
7. For each `ImportEntry` Record `in` in `module.[[ImportEntries]]`, do
 - a. If `in.[[ImportName]]` is `"*"`, then
 - i. Let `importedModule` be `in.[[ImportModule]]`.
 - ii. Assert: `importedModule` is not `undefined`.
 - iii. Let `namespace` be `importedModule.[[Namespace]]`.
 - iv. If `namespace` is `undefined`, then
 1. Let `exportedNames` be `GetExportedNames(importedModule)`.
 2. Let `namespace` be `ModuleNameSpaceCreate(importedModule, exportedNames)`.
 - v. Let `status` be the result of calling `envRec`'s `CreateImmutableBinding` concrete method passing `in.[[LocalName]]` and `true` as the arguments.
 - vi. Assert: `status` is not an abrupt completion.
 - vii. Call `envRec`'s `InitializeBinding` concrete method passing `in.[[LocalName]]`, and `namespace` as the arguments.
 - b. else,
 - i. Let `resolution` be `ResolveExport(in.[[ImportModule]] , in.[[ImportName]])`.
 - ii. `ReturnIfAbrupt(resolution)`.
 - iii. If `resolution` is `null`, throw a `SyntaxError` exception.
 - iv. Call `envRec`'s `CreateImportBinding` concrete method passing `in.[[LocalName]]`, `resolution.[[module]]`, `resolution.[[bindingName]]` as the argument.
8. Let `varDeclarations` be the `VarScopedDeclarations` of `code`.
9. For each element `d` in `varDeclarations` do
 - a. For each element `dn` of the `BoundNames` of `d` do

Deleted: <#>Assert: Type(`moduleName`) is String.
 <#>Assert: `moduleName` has already been normalized.
Deleted: n
Deleted: b
Deleted: a
Deleted: for
Deleted: n
Deleted: code, env
Deleted: ¶
Deleted: <#> For each element `d` in `declarations` do
 <#>For each element `dn` of the `BoundNames` of `d` do
 <#>If `IsConstantDeclaration` of `d` is `true`, then
 <#>Call `env`'s `CreateImmutableBinding` concrete method passing `dn` as the argument.
 <#>Else,
 <#>Let `status` be the result of calling `env`'s `CreateMutableBinding` concrete method passing `dn` and `false` as the arguments.
 <#>Assert: `status` is never an abrupt completion.
 <#>If `d` is a `GeneratorDeclaration` production or a `FunctionDeclaration` production, then
Deleted: Set, `moduleNameId`
Deleted: ()
Deleted:)}
Deleted: then
Deleted: ¶
Deleted: Name
Deleted: Id
Deleted: ModuleRequestId
Deleted: <#>Let `importedModule` be
Deleted: moduleSet,
Deleted: Name
Deleted: Id
Deleted: ()
Deleted:)
Deleted: ;
Deleted: S
Deleted: realm,
Deleted: moduleSet,
Deleted: ModuleRequestId
Deleted: ()
Deleted: then

- i. Let *status* be the result of calling *envRec*'s `CreateMutableBinding` concrete method passing *dn* and `false` as the arguments.
 - ii. Assert: *status* is not an abrupt completion.
 - iii. Call *envRec*'s `InitializeBinding` concrete method passing *dn*, and `undefined` as the arguments.
10. Let *lexDeclarations* be the `LexicallyScopedDeclarations` of *code*.
11. For each element *d* in *lexDeclarations* do
- a. For each element *dn* of the `BoundNames` of *d* do
 - i. If `IsConstantDeclaration` of *d* is `true`, then
 - 1. Let *status* be the result of calling *envRec*'s `CreateImmutableBinding` concrete method passing *dn* and `true` as the arguments.
 - ii. Else,
 - 1. Let *status* be the result of calling *envRec*'s `CreateMutableBinding` concrete method passing *dn* and `false` as the arguments.
 - iii. Assert: *status* is not an abrupt completion.
 - iv. If *d* is a `GeneratorDeclaration` production or a `FunctionDeclaration` production, then
 - 1. Let *fo* be the result of performing `InstantiateFunctionObject` for *d* with argument *env*.
 - 2. Call *envRec*'s `InitializeBinding` concrete method passing *dn*, and *fo* as the arguments.
12. Return `NormalCompletion(empty)`.

15.2.1.22 Runtime Semantics: ModuleEvaluation(*module*, *realm*)

- 1. If *module*.`[[Evaluated]]` is `true`, return `undefined`.
- 2. Set *module*.`[[Evaluated]]` to `true`.
- 3. For each **Module Record required** that is an element of *module*.`[[ImportedModules]]`, do
 - a. Assert: *realm*.`[[modules]]` **includes required**.
 - b. Let *status* be `ModuleEvaluation(required, realm)`.
 - c. ReturnIfAbrupt(*status*).
- 4. Let *moduleCxt* be a new ECMAScript code execution context.
- 5. Set the Function of *moduleCxt* to `null`.
- 6. Set the Realm of *moduleCxt* to *realm*.
- 7. Assert: *module* has been linked and declarations in its module environment have been instantiated.
- 8. Set the VariableEnvironment of *moduleCxt* to *module*.`[[Environment]]`.
- 9. Set the LexicalEnvironment of *moduleCxt* to *module*.`[[Environment]]`.
- 10. Suspend the currently running execution context.
- 11. Push *moduleCxt* on to the execution context stack; *moduleCxt* is now the running execution context.
- 12. Let *result* be the result of evaluating *module*.`[[ECMAScriptCode]]`.
- 13. Suspend *moduleCxt* and remove it from the execution context stack.
- 14. Resume the context that is now on the top of the execution context stack as the running execution context.
- 15. Return *result*.

Deleted: , then return

Deleted:

Deleted: *name*

Deleted: *id*

Deleted:

Deleted: has an element whose `[[NameModuleId]]` field is *nameid*

Deleted: <#>Let *requires* be the element of *ModuleAt(realm, [[modules]])* whose `[[Name]]` field is *,nameid*.¶

Deleted: *s*

Deleted: ¶

15.2.1.23 Runtime Semantics: Evaluation

Module : [empty]

Deleted: ¶

- 1. Return `NormalCompletion(undefined)`.

ModuleItemList : *ModuleItemList* *ModuleItem*

Deleted: ¶

- 1. Let *sl* be the result of evaluating *ModuleItemList*.
- 2. ReturnIfAbrupt(*sl*).
- 3. Let *s* be the result of evaluating *ModuleItem*.

4. If $s.[[type]]$ is `throw`, return s .
 5. If $s.[[value]]$ is empty, let $V = sl.[[value]]$, otherwise let $V = s.[[value]]$.
 6. Return $\text{Completion}\{[[type]]: s.[[type]], [[value]]: V, [[target]]: s.[[target]]\}$.

NOTE Steps 5 and 6 of the above algorithm ensure that the value of a `ModuleItemList` is the value of the last value producing item in the `ModuleItemList`.

Deleted: ¶

`ModuleItem : ImportDeclaration`

1. Return `NormalCompletion(empty)`.

Deleted: ¶

15.2.2 Imports

Syntax

`ImportDeclaration :`

```
import ImportClause FromClause ;
import ModuleSpecifier ;
```

Deleted: ¶

Deleted: `ModuleImport`

`ImportClause :`

```
ImportedDefaultBinding
NameSpaceImport
NamedImports
ImportedDefaultBinding , NameSpaceImport
ImportedDefaultBinding , NamedImports
```

Deleted: `ImportedBinding , NamedImports`
`NamedImports`

`ImportedDefaultBinding :`

```
ImportedBinding
```

`NameSpaceImport :`

```
* as ImportedBinding
```

`NamedImports :`

```
{ }
{ ImportsList }
{ ImportsList , }
```

`FromClause :`

```
from ModuleSpecifier
```

Deleted: `ModuleImport :¶`
`module [no LineTerminator here]`
`ImportedBinding FromClause ;¶`

`ImportsList :`

```
ImportSpecifier
ImportsList , ImportSpecifier
```

`ImportSpecifier :`

```
ImportedBinding
IdentifierName as ImportedBinding
```

`ModuleSpecifier :`

```
StringLiteral
```

Deleted:

`ImportedBinding :`

```
BindingIdentifier
```

Deleted: .

15.2.2.1 Static Semantics: Early Errors

ModuleItem : ImportDeclaration

- It is a Syntax Error if the BoundNames of *ImportDeclaration* contains any duplicate entries.

15.2.2.2 Static Semantics: BoundNames

See also: 13.2.1.2, 13.2.2.1, 12.1.2, [13.6.4.2](#), 14.1.3, 14.2.2, 14.4.2, 14.5.2, [15.2.3.1](#)

Deleted: 13.6.4.2

Deleted: 15.2.2.1

ImportDeclaration : import ImportClause FromClause ;

1. Return the BoundNames of *ImportClause*.

ImportDeclaration : import ModuleSpecifier ;

1. Return a new empty List.

ImportClause : ImportedDefaultBinding , NameSpaceImport

1. Let *names* be the BoundNames of *ImportedDefaultBinding*.
2. Append to *names* the elements of the BoundNames of *NameSpaceImport*.
3. Return *names*.

ImportClause : ImportedDefaultBinding , NamedImports

1. Let *names* be the BoundNames of *ImportedDefaultBinding*.
2. Append to *names* the elements of the BoundNames of *NamedImports*.
3. Return *names*.

NamedImports : { }

1. Return a new empty List.

ImportsList : ImportsList , ImportSpecifier

1. Let *names* be the BoundNames of *ImportsList*.
2. Append to *names* the elements of the BoundNames of *ImportSpecifier*.
3. Return *names*.

ImportSpecifier : IdentifierName as ImportedBinding

1. Return the BoundNames of *ImportedBinding*.

15.2.2.3 Static Semantics: ImportEntries

See also: [15.2.1.7](#)

Deleted: 15.2.1.6 15.2.0.6

ImportDeclaration : import ImportClause FromClause ;

1. Let *module* be the sole element of *ModuleRequests* of *FromClause*.
2. Return *ImportEntriesForModule* of *ImportClause* with argument *module*.

ImportDeclaration : import ModuleSpecifier ;

1. Return a new empty List.

15.2.2.4 Static Semantics: ImportEntriesForModule

With parameter *module*.

ImportClause : *ImportedDefaultBinding* , *NameSpaceImport*

1. Let *entries* be *ImportEntriesForModule* of *ImportedDefaultBinding* with argument *module*.
2. Append to *entries* the elements of the *ImportEntriesForModule* of *NameSpaceImport* with argument *module*.
3. Return *entries*.

ImportClause : *ImportedDefaultBinding* , *NamedImports*

1. Let *entries* be *ImportEntriesForModule* of *ImportedDefaultBinding* with argument *module*.
2. Append to *entries* the elements of the *ImportEntriesForModule* of *NamedImports* with argument *module*.
3. Return *entries*.

ImportedDefaultBinding: *ImportedBinding*

1. Let *localName* be the sole element of *BoundNames* of *ImportedBinding*.
2. Let *defaultEntry* be the Record {[[ModuleRequest]]: *module*, [[ImportName]]: "default", [[LocalName]]: *localName* }.
3. Return a new List containing *defaultEntry*.

NameSpaceImport : * as *ImportedBinding*

1. Let *localName* be the String Value of *ImportedBinding*.
2. Let *entry* be the Record {[[ModuleRequest]]: *module*, [[ImportName]]: "*", [[LocalName]]: *localName* }.
3. Return a new List containing *entry*.

NamedImports : { }

1. Return a new empty List.

ImportsList : *ImportsList* , *ImportSpecifier*

1. Let *specs* be the *ImportEntriesForModule* of *ImportsList* with argument *module*.
2. Append to *specs* the elements of the *ImportEntriesForModule* of *ImportSpecifier* with argument *module*.
3. Return *specs*.

Deleted: *ModuleImport* : *module*
ImportedBinding *FromClause* ¶
 <#>Let *module* be *ModuleRequests* of *FromClause*. ¶
 <#>Let *localName* be the String Value of *ImportedBinding*. ¶
 <#>Let *entry* be the Record {[[ModuleRequest]]: *module*, [[ImportName]]: "default", [[LocalName]]: *localName* }. ¶
 <#>Return a new List containing *entry*. ¶

Deleted: *ImportClause* : *ImportedBinding* , *NamedImports* ¶
 <#>Let *localName* be the String Value of *ImportedBinding*. ¶
 <#>Let *defaultEntry* be the Record {[[ModuleRequest]]: *module*, [[ImportName]]: "default", [[LocalName]]: *localName* }. ¶
 <#>Return a new List containing *defaultEntry*. ¶

Deleted: *NamedImports* ¶
Deleted: <#>Let *localName* be the String Value of *ImportedBinding*. ¶
 <#>Let *defaultEntry* be the Record {[[ModuleRequest]]: *module*, [[ImportName]]: "default", [[LocalName]]: *localName* }. ¶
Deleted: Let *entries* be a new List containing *defaultEntry*.

ImportSpecifier : *ImportedBinding*

1. Let *localName* be the sole element of *BoundNames* of *ImportedBinding*.
2. Let *entry* be the Record {[[ModuleRequest]]: *module*, [[ImportName]]: *localName* , [[LocalName]]: *localName* }.
3. Return a new List containing *entry*.

Deleted: Let *localName* be the String Value of *ImportedBinding*.

ImportSpecifier : *IdentifierName* as *ImportedBinding*

1. Let *importName* be the String Value of *IdentifierName*.
2. Let *localName* be the String Value of *ImportedBinding*.
3. Let *entry* be the Record {[[ModuleRequest]]: *module*, [[ImportName]]: *importName* , [[LocalName]]: *localName* }.

4. Return a new List containing *entry*.

15.2.2.5 Static Semantics: ModuleRequests

See also: [15.2.1.10](#), [15.2.3.7](#)

ImportDeclaration : **import** *ImportClause* *FromClause* ;

1. Return ModuleRequests of *FromClause*.

ModuleSpecifier : *StringLiteral*

1. Return a List containing the StringValue of *StringLiteral*.

15.2.2.6 Runtime Semantics: Evaluation

See [15.2.1.23](#).

15.2.3 Exports

Syntax

ExportDeclaration :

```

export * FromClause ;
export ExportClause FromClause ;
export ExportClause ;
export VariableStatement
export Declaration
export default HoistableDeclaration[Default]
export default ClassDeclaration[Default]
export default [lookahead notin { function, class }] AssignmentExpression[In] ;

```

ExportClause :

```

{ }
{ ExportsList }
{ ExportsList , }

```

ExportsList :

```

ExportSpecifier
ExportsList , ExportSpecifier

```

ExportSpecifier :

```

IdentifierName
IdentifierName as IdentifierName

```

15.2.3.1 Static Semantics: Early Errors

ExportDeclaration : **export** *ExportClause* ;

- For each *IdentifierName* *n* in ReferencedBindings of *ExportClause*: It is a Syntax Error if StringValue of *n* is a ReservedWord or if the StringValue of *n* is one of: "implements", "interface", "let", "package", "private", "protected", "public", "static", or "yield".

Deleted: 15.2.1.915.2.0.9
Deleted: 15.2.3.615.2.2.5
Deleted: <i>ModuleImport</i> : <i>module</i> <i>ImportedBinding</i> <i>FromClause</i> ;¶ ->Return ModuleRequests of <i>FromClause</i> .¶
Deleted: <->Runtime Semantics: Module Objects¶
<i>ModuleImport</i> : <i>module</i> <i>ImportedBinding</i> <i>FromClause</i> ;¶ An <i>ModuleImport</i> imports a module and introduces a single binding within the containing module environment. The value of such a binding as a <i>Module object</i> . ¶ A <i>Module object</i> is an exotic object whose own properties corresponding corresponding to the ExportedBindings of the module identified by the <i>ModuleImport FromClause</i> . Each property name is the StringValue of the corresponding exported binding. These are the only properties of an <i>Module object</i> . Each one is a read-only property with attributes {[Configurable]: false, [[Enumerable]]: true}. <i>Module objects</i> are not extensible. ¶
TO DO ¶
Needs to decide whether a module object is an ordinary or an exotic object. Whether properties are accessor or defined via [[Get]], etc.¶
Deleted: ¶
Deleted: [NoReference]
Deleted: [Default]
Deleted: #
Formatted: Font: (Default) Courier New, Bold
Deleted: [NoReference]
Deleted: [?NoReference]
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Deleted: [NoReference]
Deleted: [-NoReference] <i>IdentifierReference</i> [-NoReference] <i>IdentifierReference as</i> <i>IdentifierName</i> ~ [+NoReference]
Deleted: [+NoReference]
Deleted: NOTE <i>ExportSpecifier</i> is used to export bindings from the enclosing module <i>Module</i> . <i>ExportSpecifier</i> [NoReference] is used to export bindings from a referenced <i>Module</i> . In that case <i>IdentifierReference</i> restrictions are not applied to the naming of the items too be exported

NOTE The above rule means that each Referenced *Bindings* of *ExportClause* is treated as an *IdentifierReference*.

15.2.3.2 Static Semantics: BoundNames

See also: 13.2.1.2, 13.2.2.1, 12.1.2, 13.6.4.2, 14.1.3, 14.2.2, 14.4.2, 14.5.2, 15.2.2.2

ExportDeclaration :

```
export * FromClause ;
export ExportClause FromClause ;
export ExportClause ;
```

1. Return a new empty List.

ExportDeclaration : **export** *VariableStatement*

1. Return the *BoundNames* of *VariableStatement*.

ExportDeclaration : **export** *Declaration*

1. Return the *BoundNames* of *Declaration*.

ExportDeclaration : **export default** *HoistableDeclaration*

1. Let *declarationNames* be the *BoundNames* of *HoistableDeclaration*.
2. If *declarationNames* does not include the element "***default***", append "***default***" to *declarationNames*.
3. Return *declarationNames*.

ExportDeclaration : **export default** *ClassDeclaration*

1. Let *declarationNames* be the *BoundNames* of *ClassDeclaration*.
2. If *declarationNames* does not include the element "***default***", append "***default***" to *declarationNames*.
3. Return *declarationNames*.

ExportDeclaration : **export default** *AssignmentExpression* ;

1. Return **"*default*"**.

15.2.3.3 Static Semantics: ExportedBindings

See also: 15.2.1.2,

Deleted: Names

Deleted: ¶

Deleted: , | 013.6.4.2,

Deleted:

Deleted: 15.2.1.2

Deleted: ;

Deleted: ;

Deleted: [Default]

Deleted: AssignmentExpression

Deleted: ;

Deleted: Return

Deleted: [Default]

Deleted: then

Deleted: a List containing "default".

Deleted: ¶

Deleted: then

Deleted: ¶

Deleted: (

Deleted:)

Deleted: 15.2.1.215.2.0.2

Deleted: ExportDeclaration : export * FromClause ; ¶

Deleted: ExportDeclaration : ¶

 export ExportClause FromClause ;

 export ExportClause ; ¶

Deleted: this

ExportDeclaration : `export` *VariableStatement*

1. Return the *BoundNames* of *VariableStatement*.

ExportDeclaration : `export` *Declaration*

1. Return the *BoundNames* of *Declaration*.

ExportDeclaration : `export default` *HoistableDeclaration*

ExportDeclaration : `export default` *ClassDeclaration*

ExportDeclaration : `export default` *AssignmentExpression* ;

1. Return the *BoundNames* of this *ExportDeclaration*.

ExportClause : { }

1. Return a new empty List.

ExportsList : *ExportsList* , *ExportSpecifier*

1. Let *names* be the ExportedBindings of *ExportsList*.
2. Append to *names* the elements of the ExportedBindings of *ExportSpecifier*.
3. Return *names*.

ExportSpecifier : *IdentifierName*

1. Return a List containing the StringValue of *IdentifierName*.

ExportSpecifier : *IdentifierName* `as` *IdentifierName*

1. Return a List containing the StringValue of the *first IdentifierName*.

15.2.3.4 Static Semantics: ExportedNames

See also: 15.2.1.6.

ExportDeclaration : `export` * *FromClause* ;

1. Return a new empty List.

ExportDeclaration :

`export` *ExportClause* *FromClause* ;
`export` *ExportClause* ;

1. Return the *ExportedNames* of *ExportClause*.

ExportDeclaration : `export` *VariableStatement*

1. Return the *BoundNames* of *VariableStatement*.

ExportDeclaration : `export` *Declaration*

1. Return the *BoundNames* of *Declaration*.

Deleted:

Deleted: `export` *VariableStatement* ↴
`export` *Declaration*[Default] ↴

Deleted: *this*

Deleted: *ExportDeclaration*

Deleted: [Default]

Deleted:

Deleted: .

Deleted: a List containing

Deleted: «("default")»

Deleted: .

Deleted:)

Deleted: *ExportDeclaration* : `export`
ExportClause *FromClause*opt ; ↴
Return the ExportedBindings of *ExportClause*. ↴

Deleted: *ExportSpecifier* : *IdentifierReference* ↴
Return a List containing the StringValue of
IdentifierReference. ↴
ExportSpecifier : *IdentifierReference* `as` *IdentifierName* ↴
Return a List containing the StringValue of
IdentifierName. ↴

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ExportDeclaration : **export default** HoistableDeclaration
ExportDeclaration : **export default** ClassDeclaration
ExportDeclaration : **export default** AssignmentExpression ;

1. Return «**default**».

ExportClause : { }

1. Return a new empty List.

ExportsList : ExportsList , ExportSpecifier

1. Let *names* be the ExportedNames of *ExportsList*.
2. Append to *names* the elements of the ExportedNames of *ExportSpecifier*.
3. Return *names*.

ExportSpecifier : IdentifierName

1. Return a List containing the StringValue of *IdentifierName*.

ExportSpecifier : IdentifierName as IdentifierName

1. Return a List containing the StringValue of the second *IdentifierName*.

15.2.3.5 Static Semantics: ExportEntries

See also: [15.2.1.7](#)

ExportDeclaration : **export** * FromClause ;

1. Let *module* be the sole element of ModuleRequests of *FromClause*.
2. Let *entry* be the Record {[ModuleRequest]: *module*, [ImportName]: /*, [LocalName]: **null**, [ExportName]: **null** }.
3. Return a new List containing *entry*.

Deleted: *ExportDeclaration : export default HoistableDeclaration*
ExportDeclaration : export default ClassDeclaration
ExportDeclaration : export default AssignmentExpression ;

Deleted: ¶

Deleted: 15.2.1.5

ExportDeclaration : **export** ExportClause FromClause ;

1. Let *module* be the sole element of ModuleRequests of *FromClause*.
2. Return ExportEntriesForModule of *ExportClause* with argument *module*.

Deleted: all

ExportDeclaration : **export** ExportClause ;

1. Return ExportEntriesForModule of *ExportClause* with argument **null**.

Deleted: <#>Let *module* be the sole element of ModuleRequests of *FromClause*.¶

ExportDeclaration : **export** VariableStatement

Deleted: ;

1. Let *entries* be a new empty List.
2. Let *names* be the BoundNames of *VariableStatement*.
3. Repeat for each *name* in *names*,
 - a. Append to *entries* the Record {[ModuleRequest]: **null**, [ImportName]: **null**, [LocalName]: *name*, [ExportName]: *name* }.
4. Return *entries*.

Deleted: ¶

ExportDeclaration : **export** Declaration

Deleted: ;

1. Let *entries* be a new empty List.

2. Let *names* be the BoundNames of *Declaration*.
3. Repeat for each *name* in *names*,
 - a. Append to *entries* the Record `{[[ModuleRequest]]: null, [[ImportName]]: null, [[LocalName]]: name, [[ExportName]]: name }`.
4. Return *entries*.

Deleted: ¶

ExportDeclaration : export default HoistableDeclaration

1. Let *names* be BoundNames of *HoistableDeclaration*.
2. Let *localName* be the sole element of *names*.
3. Return a new List containing the Record `{[[ModuleRequest]]: null, [[ImportName]]: null, [[LocalName]]: localName, [[ExportName]]: "default" }`.

Deleted: [Default]

Deleted: [Default]

ExportDeclaration : export default ClassDeclaration

1. Let *names* be BoundNames of *ClassDeclaration*.
2. Let *localName* be the sole element of *names*.
3. Return a new List containing the Record `{[[ModuleRequest]]: null, [[ImportName]]: null, [[LocalName]]: localName, [[ExportName]]: "default" }`.

Deleted: NOTE `"*default"` is used within this specification as a synthetic name for hoistable anonymous functions that are defined using export declarations. ¶

Deleted: "default"

ExportDeclaration : export default AssignmentExpression ;

1. Let *entry* be the Record `{[[ModuleRequest]]: null, [[ImportName]]: null, [[LocalName]]: "*default*", [[ExportName]]: "default" }`.
2. Return a new List containing *entry*.

NOTE `"*default"` is used within this specification as a synthetic name for anonymous default export values.

Deleted: ¶

15.2.3.6 Static Semantics: ExportEntriesForModule

With parameter *module*.

ExportClause : { }

1. Return a new empty List.

ExportsList : ExportsList , ExportSpecifier

1. Let *specs* be the ExportEntriesForModule of *ExportsList* with argument *module*.
2. Append to *specs* the elements of the ExportEntriesForModule of *ExportSpecifier* with argument *module*.
3. Return *specs*.

Deleted: *ExportSpecifier : IdentifierReference*
<#>Let localName be the StringValue of IdentifierReference.¶
<#>Return a new List containing the Record
{[[ModuleRequest]]: module, [[ImportName]]: null, [[LocalName]]: localName, [[ExportName]]: localName }¶

ExportSpecifier : IdentifierReference as IdentifierName
<#>Let localName be the StringValue of IdentifierReference.¶
<#>Let exportName be the StringValue of IdentifierName.¶
<#>Return a new List containing the Record
{[[ModuleRequest]]: module, [[ImportName]]: null, [[LocalName]]: localName, [[ExportName]]: exportName }.¶

Deleted: *sourceName*

Deleted: *null*

ExportSpecifier : IdentifierName

1. Let *sourceName* be the StringValue of *IdentifierName*.
2. If *module* is `null`, then
 - a. Let *localName* be *sourceName*.
 - b. Let *importName* be `null`.
3. Else
 - a. Let *localName* be `null`.
 - b. Let *importName* be *sourceName*.
4. Return a new List containing the Record `{[[ModuleRequest]]: module, [[ImportName]]: importName, [[LocalName]]: localName, [[ExportName]]: sourceName }`.

ExportSpecifier : *IdentifierName* *as IdentifierName*

1. Let *sourceName* be the StringValue of the first *IdentifierName*.
2. Let *exportName* be the StringValue of the second *IdentifierName*.
3. If *module* is **null**, then
 - a. Let *localName* be *sourceName*.
 - b. Let *importName* be **null**.
4. Else
 - a. Let *localName* be **null**.
 - b. Let *importName* be *sourceName*.
5. Return a new List containing the Record {[[ModuleRequest]]: *module*, [[ImportName]]: *importName*, [[LocalName]]: *localName*, [[ExportName]]: *exportName* }.

Deleted: *IdentifierReference*

15.2.3.7 Static Semantics: IsConstantDeclaration

See also: 13.2.1.3, 14.1.9, 14.4.5, 14.5.5.

ExportDeclaration :

```
export * FromClause ;
export ExportClause FromClause ;
export ExportClause ;
export default AssignmentExpression ;
```

1. Return **false**.

NOTE It is not necessary to treat *export default AssignmentExpression* as a constant declaration because there is no syntax that permits assignment to the internal bound name used to reference a module's default object.

Deleted: *sourceName*

Deleted: **null**

15.2.3.8 Static Semantics: LexicallyScopedDeclarations

See also: 13.1.6, 13.11.6, 13.12.7, 14.1.16, 14.2.11, 15.1.4, 15.2.1.12

ExportDeclaration :

```
export * FromClause ;
export ExportClause FromClause ;
export ExportClause ;
export VariableStatement
```

1. Return a new empty List.

Deleted: *ExportDeclaration : export default AssignmentExpression ;*
<#>Return true.

Deleted: 13.1.3

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ExportDeclaration : export Declaration

1. Return a new List containing DeclarationPart of *Declaration*.

ExportDeclaration : export default HoistableDeclaration

1. Return a new List containing DeclarationPart of *HoistableDeclaration*.

ExportDeclaration : export default ClassDeclaration

1. Return a new List containing *ClassDeclaration*.

ExportDeclaration : export default AssignmentExpression ;

1. Return a new List containing this *ExportDeclaration*.

15.2.3.9 Static Semantics: ModuleRequests

See also: [15.2.1.10](#), [15.2.2.5](#)

ExportDeclaration : `export * FromClause ;`

ExportDeclaration : `export ExportClause FromClause ;`

1. Return the ModuleRequests of *FromClause*.

ExportDeclaration :

```

    export ExportClause ;
    export VariableStatement
    export Declaration
    export default HoistableDeclaration
    export default ClassDeclaration
    export default AssignmentExpression ;
  
```

1. Return a new empty List.

15.2.3.10 Static Semantics: ReferencedBindings

ExportClause : `{ }`

1. Return a new empty List.

ExportsList : `ExportsList , ExportSpecifier`

1. Let *names* be the ReferencedBindings of *ExportsList*.
2. Append to *names* the elements of the ReferencedBindings of *ExportSpecifier*.
3. Return *names*.

ExportSpecifier : `IdentifierName`

1. Return a List containing the *IdentifierName*.

ExportSpecifier : `IdentifierName as IdentifierName`

1. Return a List containing the first *IdentifierName*.

15.2.3.11 Runtime Semantics: Evaluation

ExportDeclaration :

```

    export * FromClause ;
    export ExportClause FromClause ;
    export ExportClause ;
  
```

1. Return NormalCompletion(empty).

ExportDeclaration : `export VariableStatement`

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Deleted: <#>Runtime Semantics: Loader State¶

<#>Loader Records and Loader Objects¶
Loader Records contain the state of a of distinct module loading context. Each Loader Record has the fields defined in Table 35Table 35Table 34Table 34Table 34. Loader objects (26.226.3) are ECMAScript objects that permit ECMAScript code to define and manage module loading contexts. ¶

Deleted: <#>Table 353534 — Loader Record Fields¶

Field Name

```

Deleted: <#>Set load.[[LinkSets]] to a new
empty List.¶
<#>Set load.[[Metadata]] to metadata
ObjectCreate(%ObjectPrototype%).¶
<#>Set all other fields of load to undefined.¶
<#>Return load.¶
  
```

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1. Return the result of evaluating *VariableStatement*.

ExportDeclaration : **export Declaration**

1. Return the result of evaluating *Declaration*.

ExportDeclaration : **export default HoistableDeclaration**

1. Return the result of evaluating *HoistableDeclaration*.

ExportDeclaration : **export default ClassDeclaration**

1. Let *value* be the result of *BindingClassDeclarationEvaluation* of *ClassDeclaration*.
2. *ReturnIfAbrupt*(*value*).
3. Let *className* be the sole element of *BoundNames* of *ClassDeclaration*.
4. If *className* is ***default***, then
 - a. Let *hasNameProperty* be *HasOwnProperty*(*value*, "name").
 - b. *ReturnIfAbrupt*(*hasNameProperty*).
 - c. If *hasNameProperty* is false, *perform* *SetFunctionName*(*value*, "default").
 - d. Let *env* be the running execution context's *LexicalEnvironment*.
 - e. Let *status* be *InitializeBoundName*("*default*", *value*, *env*).
 - f. *ReturnIfAbrupt*(*status*).
5. *Return NormalCompletion(empty)*.

ExportDeclaration : **export default AssignmentExpression ;**

1. Let *rhs* be the result of evaluating *AssignmentExpression*.
2. Let *value* be *GetValue*(*rhs*).
3. *ReturnIfAbrupt*(*value*).
4. If *IsAnonymousFunctionDefinition*(*AssignmentExpression*) is true, then
 - a. Let *hasNameProperty* be *HasOwnProperty*(*value*, "name").
 - b. *ReturnIfAbrupt*(*hasNameProperty*).
 - c. If *hasNameProperty* is false, *perform* *SetFunctionName*(*value*, "default").
5. Let *env* be the running execution context's *LexicalEnvironment*.
6. Let *status* be *InitializeBoundName*("*default*", *value*, *env*).
7. *Return NormalCompletion(empty)*.

16 Error Handling and Language Extensions

An implementation must report most errors at the time the relevant ECMAScript language construct is evaluated. An *early error* is an error that can be detected and reported prior to the evaluation of any construct in the *Script* containing the error. *The presence of an early error prevents the evaluation of the construct*. An implementation must report early errors in a *Script* as part of the *ScriptEvaluationJob* for that *Script*. *Early errors in a Module are reported at the point when the Module would be evaluated and the Module is never initialized*. Early errors in *eval* code are reported at the time *eval* is called and prevent evaluation of the *eval* code. All errors that are not early errors are runtime errors.

An implementation must *report* as an early error any occurrence of a condition that is listed in a "Static Semantics: Early Errors" subclause of this specification.

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Deleted: <#>Assert: SetFunctionName will not return an abrupt completion.¶
Deleted: <#>LinkDeclarativeModules (loads, loader)
The abstract operation <i>LinkDeclarativeModules</i> with arguments <i>loads</i> and <i>loader</i> performs the following steps: <ol style="list-style-type: none"> <#>Let <i>unlinked</i> be a new empty List.¶ <#>For each <i>load</i> in <i>loads</i>, do <ol style="list-style-type: none"> <#>If <i>load</i>.[[Status]] is not linked, then <ol style="list-style-type: none"> <#>Let <i>module</i> be <i>CreateModuleLinkageRecord</i>(<i>loader</i>, <i>load</i>.[[Body]]).¶ <#>Let <i>pair</i> be the record {[[Module]: <i>module</i>, [[Load]: <i>load</i>]]}.¶ <#>Add <i>pair</i> to <i>unlinked</i>.¶ <#>For each pair in <i>unlinked</i>, do <ol style="list-style-type: none"> <#>Let <i>resolvedDeps</i> be a new empty List.¶ <#>Let <i>unlinkedDeps</i> be a new empty List.¶ <#>For each element <i>dep</i> in <i>pair</i>.[[Load]].[[Dependencies]], do <ol style="list-style-type: none"> <#>Let <i>requestName</i> be <i>dep</i>.[[Key]].¶ <#>Let <i>normalizedName</i> be <i>dep</i>.[[Value]].¶
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An implementation shall not treat other kinds of errors as early errors even if the compiler can prove that a construct cannot execute without error under any circumstances. An implementation may issue an early warning in such a case, but it should not report the error until the relevant construct is actually executed.

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An implementation shall report all errors as specified, except for the following:

- Except as restricted in 16.1, an implementation may extend Script syntax, Module syntax, and regular expression pattern or flag syntax. To permit this, all operations (such as calling eval, using a regular expression literal, or using the Function or RegExp constructor) that are allowed to throw SyntaxError are permitted to exhibit implementation-defined behaviour instead of throwing SyntaxError when they encounter an implementation-defined extension to the script syntax or regular expression pattern or flag syntax.
- Except as restricted in 16.1, an implementation may provide additional types, values, objects, properties, and functions beyond those described in this specification. This may cause constructs (such as looking up a variable in the global scope) to have implementation-defined behaviour instead of throwing an error (such as ReferenceError).

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An implementation may define behaviour other than throwing RangeError for toFixed, toExponential, and toPrecision when the fractionDigits or precision argument is outside the specified range.

16.1 Forbidden Extensions

An implementation must not extend this specification in the following ways:

- Other than as defined in this specification, ECMAScript Function objects defined using syntactic constructors in strict code must not be created with own properties named "caller" or "arguments" other than those that are created by applying the AddRestrictedFunctionProperties abstract operation (9.2.8) to the function. Such own properties also must not be created for function objects defined in non-strict code using an ArrowFunction, MethodDefinition, GeneratorDeclaration, GeneratorExpression, ClassDeclaration, or ClassExpression. Built-in functions, strict mode functions created using the Function constructor, generator functions created using the Generator constructor, and functions created using the bind method also must not be created with such own properties.
- If an implementation extends non-strict functions with an own property named "caller" the value of that property, as observed using [[Get]] or [[GetOwnProperty]], must not be a strict mode function object.
- The behaviour of the following methods must not be extended except as specified in ECMA-402: Object.prototype.toLocaleString, Array.prototype.toLocaleString, Number.prototype.toLocaleString, Date.prototype.toLocaleDateString, Date.prototype.toLocaleString, Date.prototype.toLocaleTimeString, String.prototype.localeCompare.
- The RegExp pattern grammars in 21.2.1 and B.1.4 must not be extended to recognize any of the source characters A-Z or a-z as IdentifierEscape_{1..1} when the U grammar parameter is present.
- The Syntactic Grammar must not be extended in any manner that allows the token : to immediate follow source code that matches the BindingIdentifier nonterminal symbol.
- When processing strict mode code, the syntax of NumericLiteral must not be extended to include LegacyOctalIntegerLiteral as defined in B.1.1.

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- *TemplateCharacter* (11.8.6) must not be extended to include *LegacyOctalEscapeSequence* as defined in B.1.2.
- When processing strict mode code, the extensions defined in B.3.1, B.3.2, B.3.3, and B.3.4 must not be supported.
- When parsing for the *Module* goal symbol, the lexical grammar extensions defined in B.1.3 must not be supported.

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17 ECMAScript Standard Built-in Objects

There are certain built-in objects available whenever an ECMAScript *Script* or *Module* begins execution. One, the global object, is part of the lexical environment of the executing program. Others are accessible as initial properties of the global object or indirectly as properties of accessible built-in objects.

Unless specified otherwise, a built-in object that is callable as a function is a Built-in Function object with the characteristics described in 9.3. Unless specified otherwise, the *[[Extensible]]* internal slot of a built-in object initially has the value **true**. Every built-in *Function object* has a *[[Realm]]* internal slot whose value is the code Realm for which the object was initially created.

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Many built-in objects are functions: they can be invoked with arguments. Some of them furthermore are constructors: they are functions intended for use with the *new* operator. For each built-in function, this specification describes the arguments required by that function and properties of the Function object. For each built-in constructor, this specification furthermore describes properties of the prototype object of that constructor and properties of specific object instances returned by a *new* expression that invokes that constructor.

Unless otherwise specified in the description of a particular function, if a built-in function or constructor is given fewer arguments than the function is specified to require, the function or constructor shall behave exactly as if it had been given sufficient additional arguments, each such argument being the **undefined** value. Such missing arguments are considered to be “not present” and may be identified in that manner by specification algorithms. In the description of a particular function, the terms “**this** value” and “**NewTarget**” have the meanings given in 9.3.

Unless otherwise specified in the description of a particular function, if a built-in function or constructor described is given more arguments than the function is specified to allow, the extra arguments are evaluated by the call and then ignored by the function. However, an implementation may define implementation specific behaviour relating to such arguments as long as the behaviour is not the throwing of a **TypeError** exception that is predicated simply on the presence of an extra argument.

NOTE Implementations that add additional capabilities to the set of built-in functions are encouraged to do so by adding new functions rather than adding new parameters to existing functions.

Unless otherwise specified every built-in function and every built-in constructor has the Function prototype object, which is the initial value of the expression *Function.prototype* (19.2.3), as the value of its *[[Prototype]]* internal slot.

Unless otherwise specified every built-in prototype object has the Object prototype object, which is the initial value of the expression *Object.prototype* (19.1.3), as the value of its *[[Prototype]]* internal slot, except the Object prototype object itself.

Built-in function objects that are not identified as constructors do not implement the *[[Construct]]* internal method unless otherwise specified in the description of a particular function.

Unless otherwise specified, each built-in function defined in clauses 18 through 26 is created as if by calling the CreateBuiltinFunction abstract operation (9.3.3).

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Every built-in Function object, including constructors, has a `length` property whose value is an integer. Unless otherwise specified, this value is equal to the largest number of named arguments shown in the subclause headings for the function description, including optional parameters. However, rest parameters shown using the form "...name" are not included in the default argument count.

NOTE For example, the Function object that is the initial value of the `slice` property of the String prototype object is described under the subclause heading "String.prototype.slice (start, end)" which shows the two named arguments start and end; therefore the value of the `length` property of that Function object is 2.

Unless otherwise specified, the `length` property of a built-in Function object has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.

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Every built-in Function object, including constructors, that is not identified as an anonymous function has a `name` property whose value is a String. Unless otherwise specified, this value is the name that is given to the function in this specification. For functions that are specified as properties of objects, the `name` value is the property name string used to access the function. Functions that are specified as get or set accessor functions of built-in properties have "get " or "set " prepended to the property name string. The value of the `name` property is explicitly specified for each built-in functions whose property key is a symbol value.

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Unless otherwise specified, the `name` property of a built-in Function object, if it exists, has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.

Every other data property described in clauses 18 through 26 and in Annex B.2 has the attributes { [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true } unless otherwise specified.

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Every accessor property described in clauses 18 through 26 and in Annex B.2 has the attributes { [[Enumerable]]: false, [[Configurable]]: true } unless otherwise specified. If only a get accessor function is described, the set accessor function is the default value, undefined. If only a set accessor is described the get accessor is the default value, undefined.

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18 The Global Object

The unique `global` object is created before control enters any execution context.

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The global object does not have a [[Construct]] internal method; it is not possible to use the global object as a constructor with the `new` operator.

The global object does not have a [[Call]] internal method; it is not possible to invoke the global object as a function.

The value of the [[Prototype]] internal slot of the global object is implementation-dependent.

In addition to the properties defined in this specification the global object may have additional host defined properties. This may include a property whose value is the global object itself; for example, in the HTML document object model the `window` property of the global object is the global object itself.

18.1 Value Properties of the Global Object

18.1.1 Infinity

The value of `Infinity` is $+\infty$ (see 6.1.6). This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

18.1.2 NaN

The value of `NaN` is `NaN` (see 6.1.6). This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

18.1.3 undefined

The value of `undefined` is `undefined` (see 6.1.1). This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

18.2 Function Properties of the Global Object

18.2.1 eval (x)

The `eval` function is the %eval% intrinsic object. When the `eval` function is called with one argument `x`, the following steps are taken:

1. Let `evalRealm` be the value of the active function object's `[[Realm]]` internal slot.
2. Let `strictCaller` be `false`.
3. Let `directEval` be `false`.
4. Return `PerformEval(x, evalRealm, strictCaller, directEval)`.

18.2.1.1 Runtime Semantics: PerformEval(x, evalRealm, strictCaller, direct)

The abstract operation `PerformEval` takes with arguments `x`, `evalRealm`, `strictCaller`, and `direct` performs the following steps:

1. Assert: If `direct` is `false` then `strictCaller` is also `false`.
2. If `Type(x)` is not `String`, return `x`.
3. Let `script` be the ECMAScript code that is the result of parsing `x`, interpreted as UTF-16 encoded Unicode text as described in 6.1.4, for the goal symbol `Script`. If the parse fails or any early errors are detected, throw a `SyntaxError` exception (but see also clause 16).
4. If `script` Contains `ScriptBody` is `false`, return `undefined`.
5. Let `body` be the `ScriptBody` of `script`.
6. If `strictCaller` is `true`, let `strictEval` be `true`.
7. Else, let `strictEval` be `IsStrict` of `script`.
8. Let `ctx` be the running execution context. If `direct` is `true` `ctx` will be the execution context that performed the direct `eval`. If `direct` is `false` `ctx` will be the execution context for the invocation of the `eval` function.
9. If `direct` is `true`, then
 - a. Let `lexEnv` be `NewDeclarativeEnvironment`(`ctx`'s LexicalEnvironment).
 - b. Let `varEnv` be `ctx`'s VariableEnvironment.
10. Else,
 - a. Let `lexEnv` be `NewDeclarativeEnvironment`(`evalRealm.[[globalEnv]]`).
 - b. Let `varEnv` be `evalRealm.[[globalEnv]]`.

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Deleted: <#>If this is a direct call to eval (18.2.1.1), let direct be true, otherwise let direct be false.
<#>If direct is true and the code that made the direct call to eval is strict code, then let strictCaller be true. Otherwise, let strictCaller be false.
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Deleted: <#>Let evalRealm be ctx's Realm.
<#>If direct is false and strictScript is false, then
<#>Return the result of Script Evaluation for script with arguments evalRealm and true.
<#>If direct is true, strictScript is false, strictCaller is false, and ctx's LexicalEnvironment is the same as evalRealm.[[globalEnv]], then
<#>Return the result of Script Evaluation for script with arguments evalRealm and true.
<#>If direct is true, then
<#>If the code that made the direct call to eval is function code and ValidInFunction of script is false, then throw a SyntaxError exception.
<#>If the code that made the direct call to eval is module code and ValidInModule of script is false, then throw a SyntaxError exception.

11. If `strictEval` is `true`, then
 - a. Let `varEnv` be `lexEnv`.
12. If `ctx` is not already suspended, Suspend `ctx`.
13. Let `evalCxt` be a new ECMAScript code execution context.
14. Set the `evalCxt`'s Realm to `evalRealm`.
15. Set the `evalCxt`'s VariableEnvironment to `varEnv`.
16. Set the `evalCxt`'s LexicalEnvironment to `lexEnv`.
17. Push `evalCxt` on to the execution context stack; `evalCxt` is now the running execution context.
18. Let `result` be `EvalDeclarationInstantiation(body, varEnv, lexEnv, strictEval)`.
19. If `result.[[type]]` is normal, then
 - a. Let `result` be the result of evaluating `body`.
20. If `result.[[type]]` is normal and `result.[[value]]` is empty, then
 - a. Let `result` be `NormalCompletion(undefined)`.
21. Suspend `evalCxt` and remove it from the execution context stack.
22. Resume the context that is now on the top of the execution context stack as the running execution context.
23. Return `result`.

NOTE The eval code cannot instantiate variable or function bindings in the variable environment of the calling context that invoked the eval if either the code of the calling context or the eval code is strict code. Instead such bindings are instantiated in a new VariableEnvironment that is only accessible to the eval code. Bindings introduced by `let`, `const`, or `class` declarations are always instantiated in the LexicalEnvironment.

18.2.1.2 Runtime Semantics: `EvalDeclarationInstantiation(body, varEnv, lexEnv, strict)`

1. Let `lexNames` be the LexicallyDeclaredNames of `body`.
2. Let `varNames` be the VarDeclaredNames of `body`.
3. Let `varDeclarations` be the VarScopedDeclarations of `body`.
4. Let `lexEnvRec` be `lexEnv`'s environment record.
5. Let `varEnvRec` be `varEnv`'s environment record.
6. If `strict` is `false`, then
 - a. If `varEnvRec` is a GlobalEnvironmentRecord, then
 - i. For each `name` in `varNames`, do
 1. If the result of calling `varEnvRec`'s `HasLexicalDeclaration` concrete method passing `name` as the argument is `true`, throw a `SyntaxError` exception.
 2. NOTE: `eval` will not create a global var delaration that would be shadowed by a global lexical declaration.
 - b. Else If `varEnvRec` is a Function Environment Record, then
 - i. Let `topLexEnvRec` be `varEnvRec.[[topLex]]`.
 - ii. For each `name` in `varNames`, do
 1. Assert: `lexEnvRec` contains the top-level lexical declarations for the function.
 2. If the result of calling `topLexEnvRec`'s `HasBinding` concrete method passing `name` as the argument is `true`, throw a `SyntaxError` exception.
 3. NOTE: Within a function, a direct `eval` will not create a top-level var delaration that would be shadowed by a top-level lexical declaration.
 7. Let `functionsToInitialize` be an empty List.
 8. Let `declaredFunctionNames` be an empty List.
 9. For each `d` in `varDeclarations`, in reverse list order do
 - a. If `d` is neither a `VariableDeclaration` or a `ForBinding`, then
 - i. Assert: `d` is either a `FunctionDeclaration` or a `GeneratorDeclaration`.
 - ii. NOTE If there are multiple `FunctionDeclarations` for the same name, the last declaration is used.
 - iii. Let `fn` be the sole element of the `BoundNames` of `d`.

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- Deleted:** or if `direct` is `true` and `strictCaller` is `true`
- Deleted:** <#>Let `strictVarEnv` be `NewDeclarativeEnvironment(lexEnv)`.
<#>Let `lexEnv` be `strictVarEnv`.¶
- Deleted:** `strictVarEnv`
- Deleted:** <#>Let `status` be the result of performing Eval Declaration Instantiation as described in 18.2.1.2 with `script`, `varEnv`, and `lexEnv`.¶
<#>ReturnIfAbrupt(status).¶
- Deleted:** `then`
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- Deleted:** <#>If there is a currently running execution context, suspend it.¶
- Deleted:** `script`
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- Deleted:** Direct Call to Eval¶
- A direct call to the eval function is one that is expressed as a `CallExpression` that meets all of the following conditions:¶
 - <#>The Reference that is the result of evaluating the MemberExpression in the `CallExpression` has will always have an environment record as its base value and its referenced name is "eval".¶
 - <#>If the base value of the Reference has `true` acalls its `withEnvironment` value, then its binding object is an object that uses the ordinary definition of the `[[Call]]` internal method (9.3.1)¶
 - <#>The result of calling the abstract operation `GetValue` with that Reference as the argument is the standard built-in function defined in 18.2.1.¶
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- iv. If *fn* is not an element of *declaredFunctionNames*, then
1. If *varEnvRec* is a GlobalEnvironmentRecord, then
 - a. Let *fnDefinable* be the result of calling *varEnvRec*'s *CanDeclareGlobalFunction* concrete method passing *fn* as the argument.
 - b. If *fnDefinable* is false, throw **SyntaxError** exception.
 2. Append *fn* to *declaredFunctionNames*.
 3. Insert *d* as the first element of *functionsToInitialize*.
10. Let *declaredVarNames* be an empty List.
11. For each *d* in *varDeclarations*, do
- a. If *d* is a *VariableDeclaration* or a *ForBinding*, then
 - i. For each String *vn* in the *BoundNames* of *d*, do
 1. If *vn* is not an element of *declaredFunctionNames*, then
 - a. If *varEnvRec* is a GlobalEnvironmentRecord, then
 - i. Let *vnDefinable* be the result of calling *varEnvRec*'s *CanDeclareGlobalVar* concrete method passing *vn* as the argument.
 - ii. If *vnDefinable* is false, throw **SyntaxError** exception.
 - b. If *vn* is not an element of *declaredVarNames*, then
 - i. Append *vn* to *declaredVarNames*.

12. NOTE: No abnormal terminations occur after this algorithm step unless *varEnvRec* is a GlobalEnvironmentRecord and the global object is a Proxy exotic object.

13. Let *lexDeclarations* be the LexicallyScopedDeclarations of *body*.

14. For each element *d* in *lexDeclarations* do

 - a. NOTE Lexically declared names are only instantiated here but not initialized.
 - b. For each element *dn* of the *BoundNames* of *d* do
 - i. If *IsConstantDeclaration* of *d* is true, then
 1. Let *status* be the result of calling *lexEnvRec*'s *CreateImmutableBinding* concrete method passing *dn* and true as the arguments.
 - ii. Else,
 1. Let *status* be the result of calling *lexEnvRec*'s *CreateMutableBinding* concrete method passing *dn* and false as the arguments.
 - iii. *ReturnIfAbrupt*(*status*).

15. For each production *f* in *functionsToInitialize*, do

 - a. Let *fn* be the sole element of the *BoundNames* of *f*.
 - b. Let *fo* be the result of performing *InstantiateFunctionObject* for *f* with argument *lexEnv*.
 - c. If *varEnvRec* is a GlobalEnvironmentRecord, then
 - i. Let *status* be the result of calling *varEnvRec*'s *CreateGlobalFunctionBinding* concrete method passing *fn*, *fo*, and true as the arguments.
 - ii. *ReturnIfAbrupt*(*status*).
 - d. Else,
 - i. Let *status* be the result of calling *varEnvRec*'s *CreateMutableBinding* concrete method passing *fn* and true as the arguments.
 - ii. *ReturnIfAbrupt*(*status*).
 - iii. Call *varEnvRec*'s *InitializeBinding* concrete method passing *fn* and *fo* as arguments.

16. For each String *vn* in *declaredVarNames*, in list order do

 - a. If *varEnvRec* is a GlobalEnvironmentRecord, then
 - i. Let *status* be the result of calling *varEnvRec*'s *CreateGlobalVarBinding* concrete method passing *vn* and true as the argument.
 - b. Else,
 - i. Let *status* be the result of calling *varEnvRec*'s *CreateMutableBinding* concrete method passing *vn* and true as the arguments.
 - c. *ReturnIfAbrupt*(*status*).
 - d. Call *varEnvRec*'s *InitializeBinding* concrete method passing *vn* and undefined as arguments.

17. Return *NormalCompletion*(empty)

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18.2.2 `isFinite (number)`

Returns **false** if the argument coerces to **NaN**, **+∞**, or **-∞**, and otherwise returns **true**.

1. Let *num* be `ToNumber(number)`.
2. ReturnIfAbrupt(*num*).
3. If *num* is **NaN**, **+∞**, or **-∞**, return **false**.
4. Otherwise, return **true**.

18.2.3 `isNaN (number)`

Returns **true** if the argument coerces to **NaN**, and otherwise returns **false**.

1. Let *num* be `ToNumber(number)`.
2. ReturnIfAbrupt(*num*).
3. If *num* is **NaN**, return **true**.
4. Otherwise, return **false**.

NOTE A reliable way for ECMAScript code to test if a value *x* is a **NaN** is an expression of the form *x* \neq *x*. The result will be **true** if and only if *x* is a **NaN**.

18.2.4 `parseFloat (string)`

The `parseFloat` function produces a `Number` value dictated by interpretation of the contents of the *string* argument as a decimal literal.

When the `parseFloat` function is called, the following steps are taken:

5. Let *inputString* be `ToString(string)`.
6. ReturnIfAbrupt(*inputString*).
7. Let *trimmedString* be a substring of *inputString* consisting of the leftmost code unit that is not a *StrWhiteSpaceChar* and all code units to the right of that code unit. (In other words, remove leading white space.) If *inputString* does not contain any such code units, let *trimmedString* be the empty string.
8. If neither *trimmedString* nor any prefix of *trimmedString* satisfies the syntax of a *StrDecimalLiteral* (see 7.1.3.1), return **NaN**.
9. Let *numberString* be the longest prefix of *trimmedString*, which might be *trimmedString* itself, that satisfies the syntax of a *StrDecimalLiteral*.
10. Let *mathFloat* be MV of *numberString*.
11. If *mathFloat*=0, then
 - a. If the first code unit of *trimmedString* is "- ", return -0.
 - b. Return +0.
12. Return the Number value for *mathFloat*.

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NOTE `parseFloat` may interpret only a leading portion of *string* as a `Number` value; it ignores any code units that cannot be interpreted as part of the notation of an decimal literal, and no indication is given that any such code units were ignored.

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18.2.5 `parseInt (string , radix)`

The `parseInt` function produces an integer value dictated by interpretation of the contents of the *string* argument according to the specified *radix*. Leading white space in *string* is ignored. If *radix* is **undefined** or 0, it is assumed to be 10 except when the number begins with the code unit pairs **0x** or **0X**, in which

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case a radix of 16 is assumed. If *radix* is 16, the number may also optionally begin with the code unit pairs **0x** or **0X**.

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When the `parseInt` function is called, the following steps are taken:

1. Let *inputString* be `ToString(string)`.
2. ReturnIfAbrupt(*string*).
3. Let *S* be a newly created substring of *inputString* consisting of the first code unit that is not a *StrWhiteSpaceChar* and all code unit following that code unit. (In other words, remove leading white space.) If *inputString* does not contain any such code unit, let *S* be the empty string.
4. Let *sign* be `1`.
5. If *S* is not empty and the first code unit of *S* is **U+002D (HYPHEN-MINUS)**, let *sign* be `-1`.
6. If *S* is not empty and the first code unit of *S* is **U+002B (PLUS SIGN)** or **U+002D (HYPHEN-MINUS)**, remove the first code unit from *S*.
7. Let *R* = `ToInt32(radix)`.
8. ReturnIfAbrupt(*R*).
9. Let *stripPrefix* be `true`.
10. If *R* ≠ `0`, then
 - a. If *R* < `2` or *R* > `36`, return `Nan`.
 - b. If *R* ≠ `16`, let *stripPrefix* be `false`.
11. Else *R* = `0`,
 - a. Let *R* = `10`.
12. If *stripPrefix* is `true`, then
 - a. If the length of *S* is at least `2` and the first two code units of *S* are either “**0x**” or “**0X**”, remove the first two code units from *S* and let *R* = `16`.
13. If *S* contains any code units that is not a radix-*R* digit, let *Z* be the substring of *S* consisting of all code units before the first such code unit; otherwise, let *Z* be *S*.
14. If *Z* is empty, return `Nan`.
15. Let *mathInt* be the mathematical integer value that is represented by *Z* in radix-*R* notation, using the letters **A-Z** and **a-z** for digits with values `10` through `35`. (However, if *R* is `10` and *Z* contains more than `20` significant digits, every significant digit after the `20`th may be replaced by a **0** digit, at the option of the implementation; and if *R* is not `2`, `4`, `8`, `10`, `16`, or `32`, then *mathInt* may be an implementation-dependent approximation to the mathematical integer value that is represented by *Z* in radix-*R* notation.)
16. If *mathFloat* = `0`, then
 - a. If *sign* = `-1`, return `-0`.
 - b. Return `+0`.
17. Let *number* be the Number value for *mathInt*.
18. Return *sign* × *number*.

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NOTE `parseInt` may interpret only a leading portion of *string* as an integer value; it ignores any code units that cannot be interpreted as part of the notation of an integer, and no indication is given that any such code units were ignored.

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18.2.6 URI Handling Functions

Uniform Resource Identifiers, or URIs, are Strings that identify resources (e.g. web pages or files) and transport protocols by which to access them (e.g. HTTP or FTP) on the Internet. The ECMAScript language itself does not provide any support for using URIs except for functions that encode and decode URIs as described in 18.2.6.2, 18.2.6.3, 18.2.6.4 and 18.2.6.5.

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NOTE Many implementations of ECMAScript provide additional functions and methods that manipulate web pages; these functions are beyond the scope of this standard.

18.2.6.1 URI Syntax and Semantics

A URI is composed of a sequence of components separated by component separators. The general form is:

Scheme : *First* / *Second* ; *Third* ? *Fourth*

where the italicized names represent components and “:”, “/”, “;” and “?” are reserved for use as separators. The `encodeURI` and `decodeURI` functions are intended to work with complete URIs; they assume that any reserved code units in the URI are intended to have special meaning and so are not encoded. The `encodeURIComponent` and `decodeURIComponent` functions are intended to work with the individual component parts of a URI; they assume that any reserved code units represent text and so must be encoded so that they are not interpreted as reserved code units when the component is part of a complete URI.

The following lexical grammar specifies the form of encoded URIs.

Syntax

uri ::=

 *uriCharacters*_{opt}

uriCharacters ::=

 uriCharacter *uriCharacters*_{opt}

uriCharacter ::=

 uriReserved

 uriUnescaped

 uriEscaped

uriReserved :: one of

 ; / ? : @ & = + \$,

uriUnescaped ::=

 uriAlpha

 DecimalDigit

 uriMark

uriEscaped ::=

 % *HexDigit* *HexDigit*

uriAlpha :: one of

 a b c d e f g h i j k l m n o p q r s t u v w x y z

 A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

uriMark :: one of

 - _ . ! ~ * ' ()

NOTE The above syntax is based upon RFC 2396 and does not reflect changes introduced by the more recent
RFC 3986

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Runtime Semantics

When a code unit to be included in a URI is not listed above or is not intended to have the special meaning sometimes given to the reserved code units, that code unit must be encoded. The code unit is transformed into its UTF-8 encoding, with surrogate pairs first converted from UTF-16 to the corresponding code point value. (Note that for code units in the range [0,127] this results in a single octet with the same value.) The resulting sequence of octets is then transformed into a String with each octet represented by an escape sequence of the form "%xx".

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18.2.6.1.1 Runtime Semantics: Encode Abstract Operation

The encoding and escaping process is described by the abstract operation Encode taking two String arguments *string* and *unescapeSet*.

1. Let *strLen* be the number of code units in *string*. | **Deleted:** characters
2. Let *R* be the empty String.
3. Let *k* be 0.
4. Repeat
 - a. If *k* equals *strLen*, return *R*.
 - b. Let *C* be the code unit at index *k* within *string*.
 - c. If *C* is in *unescapeSet*, then
 - i. Let *S* be a String containing only the code unit *C*.
 - ii. Let *R* be a new String value computed by concatenating the previous value of *R* and *S*.
 - d. Else *C* is not in *unescapeSet*,
 - i. If the code unit value of *C* is not less than 0xDC00 and not greater than 0xDFFF, throw a **URIError** exception.
 - ii. If the code unit value of *C* is less than 0xD800 or greater than 0xDBFF, then
 1. Let *V* be the code unit value of *C*.
 - iii. Else,
 1. Increase *k* by 1.
 2. If *k* equals *strLen*, throw a **URIError** exception.
 3. Let *kChar* be the code unit value of the code unit at index *k* within *string*.
 4. If *kChar* is less than 0xDC00 or greater than 0xDFFF, throw a **URIError** exception.
 5. Let *V* be ((the code unit value of *C*) - 0xD800 + (*kChar* - 0xDC00) + 0x10000).
 - iv. Let *Octets* be the array of octets resulting by applying the UTF-8 transformation to *V*, and let *L* be the array size.
 - v. Let *j* be 0.
 - vi. Repeat, while *j* < *L*
 1. Let *jOctet* be the value at index *j* within *Octets*.
 2. Let *S* be a String containing three code units "%XY" where XY are two uppercase hexadecimal digits encoding the value of *jOctet*.
 3. Let *R* be a new String value computed by concatenating the previous value of *R* and *S*.
 4. Increase *j* by 1.
 - e. Increase *k* by 1.

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18.2.6.1.2 Runtime Semantics: Decode Abstract Operation

The unescaping and decoding process is described by the abstract operation Decode taking two String arguments *string* and *reservedSet*.

1. Let *strLen* be the number of code units in *string*. | **Deleted:** characters
2. Let *R* be the empty String.

3. Let k be 0.
4. Repeat
- a. If k equals strLen , return R .
 - b. Let C be the code unit at index k within string.
 - c. If C is not '%', then
 - i. Let S be the String containing only the code unit C .
 - ii. If $k + 2$ is greater than or equal to strLen , throw a **URIError** exception.
 - iii. If the code units at index $(k+1)$ and $(k + 2)$ within string do not represent hexadecimal digits, throw a **URIError** exception.
 - iv. Let B be the 8-bit value represented by the two hexadecimal digits at index $(k + 1)$ and $(k + 2)$.
 - v. Increment k by 2.
 - vi. If the most significant bit in B is 0, then
 1. Let C be the code unit with code unit value B .
 2. If C is not in reservedSet, then
 - a. Let S be the String containing only the code unit C .
 3. Else C is in reservedSet,
 - a. Let S be the substring of string from index start to index k inclusive.
 - vii. Else the most significant bit in B is 1,
 1. Let n be the smallest nonnegative integer such that $(B \ll n) \& 0x80$ is equal to 0.
 2. If n equals 1 or n is greater than 4, throw a **URIError** exception.
 3. Let Octets be an array of 8-bit integers of size n .
 4. Put B into Octets at index 0.
 5. If $k + (3 \times (n - 1))$ is greater than or equal to strLen , throw a **URIError** exception.
 6. Let j be 1.
 7. Repeat, while $j < n$
 - a. Increment k by 1.
 - b. If the code unit at index k within string is not "%", throw a **URIError** exception.
 - c. If the code units at index $(k + 1)$ and $(k + 2)$ within string do not represent hexadecimal digits, throw a **URIError** exception.
 - d. Let B be the 8-bit value represented by the two hexadecimal digits at index $(k + 1)$ and $(k + 2)$.
 - e. If the two most significant bits in B are not 10, throw a **URIError** exception.
 - f. Increment k by 2.
 - g. Put B into Octets at index j .
 - h. Increment j by 1.
 8. Let V be the value obtained by applying the UTF-8 transformation to Octets , that is, from an array of octets into a 21-bit value. If Octets does not contain a valid UTF-8 encoding of a Unicode code point throw a **URIError** exception.
 9. If $V < 0x10000$, then
 - a. Let C be the code unit V .
 - b. If C is not in reservedSet, then
 - i. Let S be the String containing only the code unit C .
 - c. Else C is in reservedSet,
 - i. Let S be the substring of string from index start to index k inclusive.
 10. Else $V \geq 0x10000$,
 - a. Let L be $((V - 0x10000) \& 0x3FF) + 0xDC00$.
 - b. Let H be $((((V - 0x10000) \gg 10) \& 0x3FF) + 0xD800)$.
 - c. Let S be the String containing the two code units H and L .
 - e. Let R be a new String value computed by concatenating the previous value of R and S .

f. Increase k by 1.

NOTE This syntax of Uniform Resource Identifiers is based upon RFC 2396 and does not reflect the more recent RFC 3986 which replaces RFC 2396. A formal description and implementation of UTF-8 is given in RFC 3629.

In UTF-8, characters are encoded using sequences of 1 to 6 octets. The only octet of a "sequence" of one has the higher-order bit set to 0, the remaining 7 bits being used to encode the character value. In a sequence of n octets, $n > 1$, the initial octet has the n higher-order bits set to 1, followed by a bit set to 0. The remaining bits of that octet contain bits from the value of the character to be encoded. The following octets all have the higher-order bit set to 1 and the following bit set to 0, leaving 6 bits in each to contain bits from the character to be encoded. The possible UTF-8 encodings of ECMAScript characters are specified in [Table 40](#).

Table 40 — UTF-8 Encodings

Code Unit Value	Representation	1 st Octet	2 nd Octet	3 rd Octet	4 th Octet
0x0000 – 0x007F	00000000 0zzzzzzz	0zzzzzzz			
0x0080 – 0x07FF	0000yyy yyzzzzzz	110yyyyy	10zzzzzz		
0x0800 – 0xD7FF	xxxxyyyy yyzzzzzz	1110xxxx	10yyyyyy	10zzzzzz	
0xD800 – 0xDBFF followed by 0xDC00 – 0xDFFF	110110vv vvwwwwxx followed by 110111yy yyzzzzzz	11110uuu	10uuwwww	10xxyyyy	10zzzzzz
0xDC00 – 0xDBFF not followed by 0xDC00 – 0xDFFF	causes URIError				
0xDC00 – 0xDFFF	causes URIError				
0xE000 – 0xFFFF	xxxxyyyy yyzzzzzz	1110xxxx	10yyyyyy	10zzzzzz	

Where

$$uuuu = vvvv + 1$$

to account for the addition of 0x10000 as in Surrogates, section 3.7, of the Unicode Standard.

The range of code unit values 0xD800-0xFFFF is used to encode surrogate pairs; the above transformation combines a UTF-16 surrogate pair into a UTF-32 representation and encodes the resulting 21-bit value in UTF-8. Decoding reconstructs the surrogate pair.

RFC 3629 prohibits the decoding of invalid UTF-8 octet sequences. For example, the invalid sequence C0 80 must not decode into the [code unit](#) U+0000. Implementations of the Decode algorithm are required to throw a [URIError](#) when encountering such invalid sequences.

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18.2.6.2 decodeURI (encodedURI)

The [decodeURI](#) function computes a new version of a URI in which each escape sequence and UTF-8 encoding of the sort that might be introduced by the [encodeURI](#) function is replaced with the [UTF-16 encoding of the code points](#) that it represents. Escape sequences that could not have been introduced by [encodeURI](#) are not replaced.

When the [decodeURI](#) function is called with one argument *encodedURI*, the following steps are taken:

1. Let *uriString* be `ToString(encodedURI)`.
2. ReturnIfAbrupt(*uriString*).
3. Let *reservedURISet* be a String containing one instance of each [code unit](#) valid in *uriReserved* plus "#".
4. Return [Decode\(uriString, reservedURISet\)](#).

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NOTE The code point "#" is not decoded from escape sequences even though it is not a reserved URI code point.

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18.2.6.3 decodeURIComponent (encodedURIComponent)

The `decodeURIComponent` function computes a new version of a URI in which each escape sequence and UTF-8 encoding of the sort that might be introduced by the `encodeURIComponent` function is replaced with the UTF-16 encoding of the code points that it represents.

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When the `decodeURIComponent` function is called with one argument `encodedURIComponent`, the following steps are taken:

1. Let `componentString` be `ToString(encodedURIComponent)`.
2. ReturnIfAbrupt(`componentString`).
3. Let `reservedURIComponentSet` be the empty String.
4. Return Decode(componentString, reservedURIComponentSet)

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18.2.6.4 encodeURIComponent (uri)

The `encodeURIComponent` function computes a new version of an UTF-16 encoded (6.1.4) URI in which each instance of certain code points is replaced by one, two, three, or four escape sequences representing the UTF-8 encoding of the code points.

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When the `encodeURIComponent` function is called with one argument `uri`, the following steps are taken:

1. Let `uriString` be `ToString(uri)`.
2. ReturnIfAbrupt(`uriString`).
3. Let `unescapeURISet` be a String containing one instance of each code unit valid in `uriReserved` and `uriUnescaped` plus "#".
4. Return Encode(uriString, unescapeURISet)

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NOTE The code point "#" is not encoded to an escape sequence even though it is not a reserved or unescaped URI code point.

18.2.6.5 encodeURIComponent (uriComponent)

The `encodeURIComponent` function computes a new version of an UTF-16 encoded (6.1.4) URI in which each instance of certain code points is replaced by one, two, three, or four escape sequences representing the UTF-8 encoding of the code point.

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When the `encodeURIComponent` function is called with one argument `uriComponent`, the following steps are taken:

1. Let `componentString` be `ToString(uriComponent)`.
2. ReturnIfAbrupt(`componentString`).
3. Let `unescapeURIComponentSet` be a String containing one instance of each code unit valid in `uriUnescaped`.
4. Return Encode(componentString, unescapeURIComponentSet)

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18.3 Constructor Properties of the Global Object

18.3.1 `Array (...)`

See 22.1.1.

18.3.2 `ArrayBuffer (...)`

See 24.1.2.

18.3.3 `Boolean (...)`

See 19.3.1.

18.3.4 `DataView (...)`

See 24.2.2.

18.3.5 `Date (...)`

See 20.3.2.

18.3.6 `Error (...)`

See 19.5.1.

18.3.7 `EvalError (...)`

See 19.5.5.1.

18.3.8 `Float32Array (...)`

See 22.2.4.

18.3.9 `Float64Array (...)`

See 22.2.4.

18.3.10 `Function (...)`

See 19.2.1.

18.3.11 `Int8Array (...)`

See 22.2.4.

18.3.12 `Int16Array (...)`

See 22.2.4.

**18.3.13 Int32Array (. . .)**

See 22.2.4.

18.3.14 Map (. . .)

See 23.1.1.

18.3.15 Number (. . .)

See 20.1.1.

18.3.16 Object (. . .)

See 19.1.1.

18.3.17 Proxy (. . .)

See 26.2.1.

18.3.18 Promise (. . .)

See 25.4.3.

18.3.19 RangeError (. . .)

See 19.5.5.2.

18.3.20 ReferenceError (. . .)

See 19.5.5.3.

18.3.21 RegExp (. . .)

See 21.2.3.

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18.3.22 Set (. . .)

See 23.2.1.

18.3.23 String (. . .)

See 21.1.1.

18.3.24 Symbol (. . .)

See 19.4.1.

18.3.25 SyntaxError (. . .)

See 19.5.5.4.

18.3.26 TypeError (. . .)

See 19.5.5.

18.3.27 Uint8Array (. . .)

See 22.2.4.

18.3.28 Uint8ClampedArray (. . .)

See 22.2.4.

18.3.29 Uint16Array (. . .)

See 22.2.4.

18.3.30 Uint32Array (. . .)

See 22.2.4.

18.3.31 URIError (. . .)

See 19.5.5.6.

18.3.32 WeakMap (. . .)

See 23.3.1.

18.3.33 WeakSet (. . .)

See 23.4.

18.4 Other Properties of the Global Object

18.4.1 JSON

See 24.3.

18.4.2 Math

See 20.2.

18.4.3 Reflect

See 26.1.

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See 26.2.126.4.126.5.1.¶

19 Fundamental Objects

19.1 Object Objects

19.1.1 The Object Constructor

The `Object` constructor is the `%Object%` intrinsic object and the initial value of the `Object` property of the global object. When called as a constructor it creates new ordinary object. When `Object` is called as a function rather than as a constructor, it performs a type conversion.

The `Object` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class definition.

19.1.1.1 `Object([value])`

When `Object` function is called with optional argument `value`, the following steps are taken:

1. If `NewTarget` is neither `undefined` nor the active function, then
 - a. Return `OrdinaryCreateFromConstructor(NewTarget, "%ObjectPrototype%")`.
2. If `value` is `null`, `undefined` or not supplied, return `ObjectCreate(%ObjectPrototype%)`.
3. Return `ToObject(value)`.

19.1.2 Properties of the Object Constructor

The value of the `[[Prototype]]` internal slot of the `Object` constructor is the `intrinsic object %FunctionPrototype%`.

Besides the `length` property (whose value is `1`), the `Object` constructor has the following properties:

19.1.2.1 `Object.assign(target, ...sources)`

The `assign` function is used to copy the values of all of the enumerable own properties from `one or more source objects` to a `target` object. When the `assign` function is called, the following steps are taken:

1. Let `to` be `ToObject(target)`.
2. ReturnIfAbrupt(`to`).
3. If only one argument was passed, return `to`.
4. Let `source` be the List of argument values starting with the second argument.
5. For each element `nextSource` of `sources`, in ascending index order,
 - a. If `nextSource` is `undefined` or `null`, let `keys` be an empty List.
 - b. Else,
 - i. Let `from` be `ToObject(nextSource)`.
 - ii. ReturnIfAbrupt(`from`).
 - iii. Let `keys` be the result of calling the `[[OwnPropertyKeys]]` internal method of `from`.
 - iv. ReturnIfAbrupt(`keys`).
 - c. Repeat for each element `nextKey` of `keys` in List order,
 - i. Let `desc` be the result of calling the `[[GetOwnProperty]]` internal method of `from` with argument `nextKey`.
 - ii. ReturnIfAbrupt(`desc`).
 - iii. If `desc` is not `undefined` and `desc.[[Enumerable]]` is `true`, then
 1. Let `propValue` be `Get(from, nextKey)`.
 2. ReturnIfAbrupt(`propValue`).

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Deleted: NOTE Subclass constructors that inherit from the <code>Object</code> constructor typically ...	
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Deleted: <#>Let lenValue be Get(keysArra...)	...
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Deleted: <#>Let nextKey be Get(keysArra...)	...
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3. Let *status* be *Put(to, nextKey, propValue, true)*;
4. [ReturnIfAbrupt\(status\)](#)
6. Return *to*.

The `length` property of the `assign` method is 2.

19.1.2.2 Object.create (*O* [, *Properties*])

The `create` function creates a new object with a specified prototype. When the `create` function is called, the following steps are taken:

1. If `Type(O)` is not `Object` or `Null` throw a `TypeError` exception.
2. Let *obj* be `ObjectCreate(O)`.
3. If the argument *Properties* is present and not `undefined`, then
 - a. Return the result of the abstract operation `ObjectDefineProperties(obj, Properties)`.
4. Return *obj*.

19.1.2.3 Object.defineProperties (*O* , *Properties*)

The `defineProperties` function is used to add own properties and/or update the attributes of existing own properties of an object. When the `defineProperties` function is called, the following steps are taken:

1. Return the result of the abstract operation `ObjectDefineProperties` with arguments *O* and *Properties*.

19.1.2.3.1 Runtime Semantics: ObjectDefineProperties Abstract Operation

The abstract operation `ObjectDefineProperties` with arguments *O* and *Properties* performs the following steps:

1. If `Type(O)` is not `Object` throw a `TypeError` exception.
2. Let *props* be `ToObject(Properties)`.
3. [Let *keys* be the result of calling the `\[\[OwnPropertyKeys\]\]` internal method of *props*.](#)
4. [ReturnIfAbrupt\(*keys*\)](#).
5. Let *descriptors* be an empty List.
6. [Repeat for each element *nextKey* of *keys* in List order,](#)
 - a. [Let *propDesc* be the result of calling the `\[\[GetProperty\]\]` internal method of *props* with argument *nextKey*.](#)
 - b. [ReturnIfAbrupt\(*propDesc*\)](#).
 - c. [If *propDesc* is not `undefined` and *propDesc.\[\[Enumerable\]\]* is `true`, then](#)
 - i. Let *descObj* be the result of `Get(props, nextKey)`.
 - ii. [ReturnIfAbrupt\(*descObj*\)](#).
 - iii. Let *desc* be `ToPropertyDescriptor(descObj)`.
 - iv. [ReturnIfAbrupt\(*desc*\)](#).
 - v. Append the pair (a two element List) consisting of *nextKey* and *desc* to the end of *descriptors*.
7. [For each *pair* from *descriptors* in list order,](#)
 - a. Let *P* be the first element of *pair*.
 - b. Let *desc* be the second element of *pair*.
 - c. Let *status* be the result of `DefinePropertyOrThrow(O, P, desc)`.
 - d. [ReturnIfAbrupt\(*status*\)](#).
8. [Return *O*.](#)

Deleted: <#>If *pendingException* is empty`undefined`, then set *pendingException* to *propValue*.
 <#>else||

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Deleted: If *status* is an abrupt completion, then

Deleted: <#>If *pendingException* is empty`undefined`, then set *pendingException* to *status*.
 <#>Increment *nextIndex* by 1.
 <#>If *pendingException* is not empty`undefined`, then return *pendingException*.||

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Deleted: <#>Let *names* be a List containing the keys of each enumerable own property of *props*.||

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Deleted: <#>Let *lenValue* be `Get(keysArray, "length").||
 <#>Let len be ToLength(lenValue).||
 <#>ReturnIfAbrupt(len).||
 <#>Let nextIndex be 0.||`

Deleted: while *nextIndex* < *len*,

Deleted: For each element *P* of *names* in list order,

Deleted: <#>Let *nextKey* be `Get(keysArray, ToString(nextIndex)).||
 <#>ReturnIfAbrupt(nextKey).||
 <#>Increment nextIndex by 1.||`

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Deleted: *P*

Deleted: <#>Let *pendingException* be empty`undefined`.||

Deleted: If *status* is an abrupt completion then,

Deleted: <#> If *pendingException* is empty`undefined`, then set *pendingException* to *status*.
 <#>ReturnIfAbruptIf (*pendingException*) is not empty then, return *pendingException*.||

19.1.2.4 `Object.defineProperty (O, P, Attributes)`

The **defineProperty** function is used to add an own property and/or update the attributes of an existing own property of an object. When the **defineProperty** function is called, the following steps are taken:

1. If `Type(O)` is not `Object` throw a `TypeError` exception.
2. Let `key` be `ToPropertyKey(P)`.
3. `ReturnIfAbrupt(key)`.
4. Let `desc` be `ToPropertyDescriptor(Attributes)`.
5. `ReturnIfAbrupt(desc)`.
6. Let `success` be `DefinePropertyOrThrow(O, key, desc)`.
7. `ReturnIfAbrupt(success)`.
8. Return `O`.

Deleted: If an implementation defines a specific order of enumeration for the `for-in` statement, that same enumeration order must be used to order the list elements in step 3 of this algorithm.¹¹

Deleted: NOTE An exception in defining an individual property in step 7–13 does not terminate the process of defining other properties. All valid property definitions are processed.¹¹

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19.1.2.5 `Object.freeze (O)`

When the **freeze** function is called, the following steps are taken:

1. If `Type(O)` is not `Object`, return `O`.
2. Let `status` be the result of `SetIntegrityLevel(O, "frozen")`.
3. `ReturnIfAbrupt(status)`.
4. If `status` is `false`, throw a `TypeError` exception.
5. Return `O`.

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19.1.2.6 `Object.getOwnPropertyDescriptor (O, P)`

When the **getOwnPropertyDescriptor** function is called, the following steps are taken:

1. Let `obj` be `ToObject(O)`.
2. `ReturnIfAbrupt(obj)`.
3. Let `key` be `ToPropertyKey(P)`.
4. `ReturnIfAbrupt(key)`.
5. Let `desc` be the result of calling the `[[GetOwnProperty]]` internal method of `obj` with argument `key`.
6. `ReturnIfAbrupt(desc)`.
7. Return `FromPropertyDescriptor(desc)`.

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19.1.2.7 `Object.getOwnPropertyNames (O)`

When the **getOwnPropertyNames** function is called, the following steps are taken:

1. Return `GetOwnPropertyKeys(O, String)`.

19.1.2.8 `Object.getOwnPropertySymbols (O)`

When the **getOwnPropertySymbols** function is called with argument `O`, the following steps are taken:

1. Return `GetOwnPropertyKeys(O, Symbol)`.

19.1.2.8.1 `GetOwnPropertyKeys (O, Type) Abstract Operation`

The abstract operation `GetOwnPropertyKeys` is called with arguments `O` and `Type` where `O` is an Object and `Type` is one of the ECMAScript specification types `String` or `Symbol`. The following steps are taken:

1. Let `obj` be `ToObject(O)`.
2. `ReturnIfAbrupt(obj)`.

3. Let *keys* be the result of calling the [[OwnPropertyKeys]] internal method of *obj*.
4. ReturnIfAbrupt(*keys*).
5. Let *nameList* be a new empty List.
6. Repeat for each element *nextKey* of *keys* in List order.
 - a. If Type(*nextKey*) is Type, then
 - i. Append *nextKey* as the last element of *nameList*.
7. Return CreateArrayFromList(*nameList*).

19.1.2.9 Object.getPrototypeOf (*O*)

When the **getPrototypeOf** function is called with argument *O*, the following steps are taken:

1. Let *obj* be ToObject(*O*).
2. ReturnIfAbrupt(*obj*).
3. Return the result of calling the [[GetPrototypeOf]] internal method of *obj*.

19.1.2.10 Object.is (*value1*, *value2*)

When the **is** function is called with arguments *value1* and *value2* the following steps are taken:

1. Return SameValue(*value1*, *value2*).

19.1.2.11 Object.isExtensible (*O*)

When the **isExtensible** function is called with argument *O*, the following steps are taken:

1. If Type(*O*) is not Object, return **false**.
2. Return the result of IsExtensible(*O*).

19.1.2.12 Object.isFrozen (*O*)

When the **isFrozen** function is called with argument *O*, the following steps are taken:

1. If Type(*O*) is not Object, return **true**.
2. Return TestIntegrityLevel(*O*, "frozen").

19.1.2.13 Object.isSealed (*O*)

When the **isSealed** function is called with argument *O*, the following steps are taken:

1. If Type(*O*) is not Object, return **true**.
2. Return TestIntegrityLevel(*O*, "sealed").

19.1.2.14 Object.keys (*O*)

When the **keys** function is called with argument *O*, the following steps are taken:

1. Let *obj* be ToObject(*O*).
2. ReturnIfAbrupt(*obj*).
3. Let *nameList* be EnumerableOwnNames(*obj*).
4. ReturnIfAbrupt(*nameList*).
5. Return CreateArrayFromList(*nameList*).

If an implementation defines a specific order of enumeration for the for-in statement, the same order must be used for the elements of the array returned in step 4.

```

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Deleted: <#>Let lenValue be Get(keysArray, "length").
<#>Let len be ToLength(lenValue).¶
<#>ReturnIfAbrupt(len).¶
<#>Let nextIndex be 0.¶
Deleted: <#>Let getAllNames be false.¶
Deleted: while nextIndex < len
Deleted: getAllNames is false
Deleted: <#>Let nextKey next be
Get(keysArray, ToString(nextIndex))the result of
IteratorStep(keys).¶
<#>ReturnIfAbrupt(next).¶
<#>If next is false, then let getAllNames be true.¶
<#>Else,¶
<#>Let nextKey be IteratorValue(next).¶
<#>ReturnIfAbrupt(nextKey).¶
Deleted: <#>Increment nextIndex by 1.¶

```

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Deleted: <#>Let keysArray be the result of
calling the [[OwnPropertyKeys]] internal method of
obj.¶
<#>ReturnIfAbrupt(keysArray).¶
<#>Let lenValue be Get(keysArray, "length").¶
<#>Let len be ToLength(lenValue).¶
<#>ReturnIfAbrupt(len).¶
<#>Let nextIndex be 0.¶
<#>Let nameList be a new empty List.¶
<#>Let getAllNames be false.¶
<#>Repeat while nextIndex < len
  getAllNames is
  false.¶
    <#>Let nextKey be Get(keysArray,
    ToString(nextIndex)), the result of
    IteratorStep(keys).¶
    <#>ReturnIfAbrupt(next).¶
    <#>If next is false, then let getAllNames be true.¶
    <#>Else,¶
    <#>Let nextKey be IteratorValue(next).¶
    <#>ReturnIfAbrupt(nextKey).¶
    <#>If Type(nextKey) is String, then
      <#>Let desc be the result of calling the
      [[GetOwnProperty]] internal method of O with
      argument nextKey.¶
      <#>ReturnIfAbrupt(desc).¶
      <#>If desc is not undefined and
      desc.[[Enumerable]] is true, then
        <#>Append nextKey as the last element of
        nameList.¶
    <#>Increment nextIndex by 1.¶
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```

19.1.2.15 Object.preventExtensions (O)

When the **preventExtensions** function is called, the following steps are taken:

1. If $\text{Type}(O)$ is not Object, return O .
2. Let status be the result of calling the **[[PreventExtensions]]** internal method of O .
3. $\text{ReturnIfAbrupt}(\text{status})$.
4. If status is **false**, throw a **TypeError** exception.
5. Return O .

19.1.2.16 Object.prototype

The initial value of **Object.prototype** is the [intrinsic object %ObjectPrototype%](#) (19.1.3).

This property has the attributes `{[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

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19.1.2.17 Object.seal (O)

When the **seal** function is called, the following steps are taken:

1. If $\text{Type}(O)$ is not Object, return O .
2. Let status be the result of **SetIntegrityLevel**(O , "sealed").
3. $\text{ReturnIfAbrupt}(\text{status})$.
4. If status is **false**, throw a **TypeError** exception.
5. Return O .

19.1.2.18 Object.setPrototypeOf (O, proto)

When the **setPrototypeOf** function is called with arguments O and proto , the following steps are taken:

1. Let O be [RequireObjectCoercible](#)(O).
2. $\text{ReturnIfAbrupt}(O)$.
3. If $\text{Type}(\text{proto})$ is neither Object nor Null, throw a **TypeError** exception.
4. If $\text{Type}(O)$ is not Object, **return** O .
5. Let status be the result of calling the **[[SetPrototypeOf]]** internal method of O with argument proto .
6. $\text{ReturnIfAbrupt}(\text{status})$.
7. If status is **false**, throw a **TypeError** exception.
8. **Return** O .

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19.1.3 Properties of the Object Prototype Object

The Object prototype object is an ordinary object.

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The value of the **[[Prototype]]** internal slot of the Object prototype object is **null** and the initial value of the **[[Extensible]]** internal slot is **true**.

19.1.3.1 Object.prototype.constructor

The initial value of **Object.prototype.constructor** is the [intrinsic object %Object%](#).

Deleted: standard built-in **object** constructor

19.1.3.2 Object.prototype.hasOwnProperty (V)

When the **hasOwnProperty** method is called with argument V , the following steps are taken:

1. Let P be $\text{ToPropertyKey}(V)$.
2. ReturnIfAbrupt(P).
3. Let O be the result of calling ToObject passing the **this** value as the argument.
4. ReturnIfAbrupt(O).
5. Return the result of $\text{HasOwnProperty}(O, P)$.

NOTE The ordering of steps 1 and 3 is chosen to ensure that any exception that would have been thrown by step 1 in previous editions of this specification will continue to be thrown even if the **this** value is **undefined** or **null**.

19.1.3.3 Object.prototype.isPrototypeOf (V)

When the **isPrototypeOf** method is called with argument V , the following steps are taken:

1. If Type(V) is not Object, return **false**.
2. Let O be the result of calling ToObject passing the **this** value as the argument.
3. ReturnIfAbrupt(O).
4. Repeat
 - a. Let V be the result of calling the **[[GetPrototypeOf]]** internal method of V with no arguments.
 - b. If V is **null**, return **false**
 - c. If $\text{SameValue}(O, V)$ is **true**, return **true**.

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NOTE The ordering of steps 1 and 2 preserves the behaviour specified by previous editions of this specification for the case where V is not an object and the **this** value is **undefined** or **null**.

19.1.3.4 Object.prototype.propertyIsEnumerable (V)

When the **propertyIsEnumerable** method is called with argument V , the following steps are taken:

1. Let P be $\text{ToPropertyKey}(V)$.
2. ReturnIfAbrupt(P).
3. Let O be the result of calling ToObject passing the **this** value as the argument.
4. ReturnIfAbrupt(O).
5. Let $desc$ be the result of calling the **[[GetOwnProperty]]** internal method of O passing P as the argument.
6. **ReturnIfAbrupt(desc)**.
7. If $desc$ is **undefined**, return **false**.
8. Return the value of $desc.[[Enumerable]]$.

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NOTE 1 This method does not consider objects in the prototype chain.

NOTE 2 The ordering of steps 1 and 3 is chosen to ensure that any exception that would have been thrown by step 1 in previous editions of this specification will continue to be thrown even if the **this** value is **undefined** or **null**.

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19.1.3.5 Object.prototype.toLocaleString ([reserved1 [, reserved2]])

When the **toLocaleString** method is called, the following steps are taken:

1. Let O be the **this** value.
2. Return the result of $\text{Invoke}(O, \text{"toString"})$.

The optional parameters to this function are not used but are intended to correspond to the parameter pattern used by ECMA-402 **toLocaleString** functions. Implementations that do not include ECMA-402 support must not use those parameter positions for other purposes.

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NOTE 1 This [function provides a generic `toLocaleString` implementation for objects that have no locale-specific `toString` behaviour](#). [Array](#), [Number](#), [Date](#), and [Typed Arrays](#) provide their own locale-sensitive `toLocaleString` methods.

NOTE 2 ECMA-402 intentionally does not provide an alternative to this default implementation.

19.1.3.6 Object.prototype.toString ()

When the `toString` method is called, the following steps are taken:

1. If the **this** value is **undefined**, return "[object Undefined]".
 2. If the **this** value is **null**, return "[object Null]".
 3. Let *O* be the result of calling **ToObject** passing the **this** value as the argument.
 4. If **IsArray(O)** is **true**, let **builtinTag** be "Array".
 5. Else, if *O* is an exotic String object, let **builtinTag** be "String".
 6. Else, if *O* has an **[[ParameterMap]]** internal slot, let **builtinTag** be "Arguments".
 7. Else, if *O* has a **[[Call]]** internal method, let **builtinTag** be "Function".
 8. Else, if *O* has an **[[ErrorData]]** internal slot, let **builtinTag** be "Error".
 9. Else, if *O* has a **[[BooleanData]]** internal slot, let **builtinTag** be "Boolean".
 10. Else, if *O* has a **[[NumberData]]** internal slot, let **builtinTag** be "Number".
 11. Else, if *O* has a **[[DateValue]]** internal slot, let **builtinTag** be "Date".
 12. Else, if *O* has a **[[RegExpMatcher]]** internal slot, let **builtinTag** be "RegExp".
 13. Else, let **builtinTag** be "Object".
 14. Let **tag** be the result of **Get(O, @@toStringTag)**.
 15. ReturnIfAbrupt(**tag**).
 16. If **Type(tag)** is not **String**, let **tag** be **builtinTag**.
 17. Return the String that is the result of concatenating "[object ", **tag**, and "]>".

NOTE Historically, this function was occasionally used to access the string value of the [[Class]] internal slot that was used in previous editions of this specification as a nominal type tag for various built-in objects. The above definition of `toString` preserves compatibility for legacy code that uses `toString` as a test for those specific kinds of built-in objects. It does not provide a reliable type testing mechanism for other kinds of built-in or program defined objects. In addition, programs can use `@@toStringTag` in ways that will invalidate the reliability of such legacy type tests.

19.1.3.7 Object.prototype.valueOf()

When the **valueOf** method is called, the following steps are taken:

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
 2. Return O .

19.1.4 Properties of Object Instances

Object instances have no special properties beyond those inherited from the Object prototype object.

19.2 Function Objects

19.2.1 The Function Constructor

The `Function` constructor is the `%Function%` intrinsic object and the initial value of the `Function` property of the global object. When `Function` is called as a function rather than as a constructor, it

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creates and initializes a new Function object. Thus the function call `Function(...)` is equivalent to the object creation expression `new Function(...)` with the same arguments.

The `Function` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class definition. Subclass constructors that intend to inherit the specified `Function` behaviour must include a `super` call to the `Function` constructor to create and initialize a subclass instances with the internal slots necessary for built-in function behaviour. All ECMAScript syntactic forms for defining function objects create instances of `Function`. There is no syntactic means to create instances of `Function` subclasses except for the built-in Generator Function subclass.

19.2.1.1 `Function(p1, p2, ..., pn, body)`

The last argument specifies the body (executable code) of a function; any preceding arguments specify formal parameters.

When the `Function` function is called with some arguments $p_1, p_2, \dots, p_n, body$ (where n might be 0, that is, there are no “ p ” arguments, and where $body$ might also not be provided), the following steps are taken:

1. Let C be the active function object.
2. Let $args$ be the `argumentsList` that was passed to this function by `[[Call]]` or `[[Construct]]`.
3. Return `CreateDynamicFunction(C, NewTarget, "normal", args)`.

NOTE It is permissible but not necessary to have one argument for each formal parameter to be specified. For example, all three of the following expressions produce the same result:

```
new Function("a", "b", "c", "return a+b+c")
new Function("a, b, c", "return a+b+c")
new Function("a,b", "c", "return a+b+c")
```

19.2.1.1.1 RuntimeSemantics: CreateDynamicFunction(constructor, newTarget, kind, args)

The abstract operation `CreateDynamicFunction` is called with arguments `constructor`, `newTarget`, `kind`, and `args`. `constructor` is the constructor function that is performing this action. `newTarget` is the constructor that `new` was initially applied to, `kind` is either “`normal`” or “`generator`”, and `args` is a List containing the actual argument values that were passed to a `constructor`. The following steps are taken:

1. If `newTarget` is `undefined`, let `newTarget` be `constructor`.
2. If `kind` is “`normal`”, then
 - a. Let `goal` be the grammar symbol `FunctionBody`.
 - b. Let `parameterGoal` be the grammar symbol `FormalParameters`.
 - c. Let `fallbackProto` be “`%FunctionPrototype%`”.
3. Else,
 - a. Let `goal` be the grammar symbol `GeneratorBody[Yield]`.
 - b. Let `parameterGoal` be the grammar symbol `FormalParameters[Yield, GeneratorParameter]`.
 - c. Let `fallbackProto` be “`%Generator%`”.
4. Let `argCount` be the number of elements in `args`.
5. Let `P` be the empty String.
6. If `argCount` = 0, let `bodyText` be the empty String.
7. Else if `argCount` = 1, let `bodyText` be `args[0]`.
8. Else `argCount` > 1,
 - a. Let `firstArg` be `args[0]`.
 - b. Let `P` be `ToString(firstArg)`.

Deleted: However, if the `this` value passed in the call is an Object with an `[[ECMAScriptCode]]` internal slot whose value is `undefined`, it initializes the `this` value using the argument values. This permits `Function` to be used both as factory method and to perform constructor instance initialisation.

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- c. ReturnIfAbrupt(P).
- d. Let k be \perp .
- e. Repeat, while $k < argCount - 1$
 - i. Let $nextArg$ be $args[k]$.
 - ii. Let $nextArgString$ be $\text{ToString}(nextArg)$.
 - iii. ReturnIfAbrupt($nextArgString$).
 - iv. Let P be the result of concatenating the previous value of P , the String $" , "$ (a comma), and $nextArgString$.
 - v. Increase k by 1.
- f. Let $bodyText$ be $args[k]$.
- 9. Let $bodyText$ be $\text{ToString}(bodyText)$.
- 10. ReturnIfAbrupt($bodyText$).
- 11. Let $body$ be the result of parsing $bodyText$, interpreted as UTF-16 encoded Unicode text as described in 6.1.4, using $goal$ as the goal symbol. Throw a **SyntaxError** exception if the parse fails or if any static semantics errors are detected.**
- 12. If $bodyText$ is strict mode code (see 10.2.1) then let $strict$ be **true**, else let $strict$ be **false**.**
- 13. Let $parameters$ be the result of parsing P , interpreted as UTF-16 encoded Unicode text as described in 6.1.4, using $parameterGoal$ as the goal symbol. Throw a **SyntaxError** exception if the parse fails or if any static semantics errors are detected. **If $strict$ is **true**, the Early Error rules for StrictFormalParameters : FormalParameters are applied.**
- 14. If any element of the BoundNames of $parameters$ also occurs in the LexicallyDeclaredNames of $body$, throw a **SyntaxError** exception.**
- 15. If $body$ Contains **SuperCall** is **true**, throw a **SyntaxError** exception.**
- 16. If $parameters$ Contains **SuperCall** is **true**, throw a **SyntaxError** exception.**
- 17. If $strict$ is **true**, then**
 - a. If BoundNames of **FormalParameters** contains any duplicate elements
- 18. Let $proto$ be the result of $\text{GetPrototypeOfFromConstructor}(newTarget, fallbackProto)$.**
- 19. ReturnIfAbrupt($proto$).
- 20. Let F be $\text{FunctionAllocate}(proto, strict, kind)$.
- 21. ReturnIfAbrupt(F).**
- 22. Let $realmF$ be the value of F 's $[[Realm]]$ internal slot.**
- 23. Let $scope$ be $realmF.[[globalEnv]]$.**
- 24. Perform $\text{FunctionInitialize}(F, \text{Normal}, strict, parameters, body, scope)$.**
- 25. If NeedsSuperBinding of $body$ is **true** or NeedsSuperBinding of $parameters$ is **true**, then**
 - a. Perform $\text{MakeMethod}(F, \text{undefined})$.
- 26. If $kind$ is "**generator**", then**
 - a. Let $prototype$ be $\text{ObjectCreate}(\%GeneratorPrototype\%)$.
 - b. ReturnIfAbrupt($prototype$).
 - c. Perform $\text{MakeConstructor}(F, \text{true}, prototype)$.
- 27. Else, perform $\text{MakeConstructor}(F)$.**
- 28. Perform $\text{SetFunctionName}(F, \text{"anonymous"})$.**
- 29. Return F .

NOTE A **prototype** property is automatically created for every function created using **CreateDynamicFunction**, to provide for the possibility that the function will be used as a constructor.

19.2.2 Properties of the Function Constructor

The **Function** constructor is itself a built-in **function** object. The value of the $[[\text{Prototype}]]$ internal slot of the **Function** constructor is **%FunctionPrototype%**, the intrinsic Function prototype object (19.2.3).

The value of the $[[\text{Extensible}]]$ internal slot of the Function constructor is **true**.

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- Deleted:** <#>If $\text{IsSimpleParameterList}$ of $parameters$ is **false**
- Deleted:** then
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- Deleted:** <#>Let $scope$ be the Global
- Deleted:** the **this** value
- Deleted:** <#>If $\text{Type}(F)$ is not Object or if F has a $[[\text{Extensible}]]$ internal slot
- Deleted:** <#>Else, set F 's $[[\text{Strict}]]$ internal slot to **false**
- Deleted:** <#>If the value of F 's $[[\text{Extensible}]]$ internal slot is **true**
- Deleted:** <#>Let $isExtensible$ be true
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- Deleted:** Function

The Function constructor has the following properties:

19.2.2.1 Function.length

This is a data property with a value of 1. This property has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.

19.2.2.2 Function.prototype

The value of `Function.prototype` is %FunctionPrototype%, the intrinsic Function prototype object (19.2.3).

This property has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }.

19.2.3 Properties of the Function Prototype Object

The Function prototype object is itself a Built-in Function object. When invoked, it accepts any arguments and returns `undefined`. It does not have a [[Construct]] internal method so it is not a constructor.

NOTE The Function prototype object is specified to be a function object to ensure compatibility with ECMAScript code that was created prior to the 6th Edition of this specification.

The value of the [[Prototype]] internal slot of the Function prototype object is the intrinsic object %ObjectPrototype% (19.1.3). The initial value of the [[Extensible]] internal slot of the Function prototype object is **true**.

The Function prototype object does not have a `prototype` property.

The value of `the length` property of the Function prototype object is **0**.

The value of the `name` property of the Function prototype object is the empty String.

19.2.3.1 Function.prototype.apply (thisArg, argArray)

When the `apply` method is called on an object `func` with arguments `thisArg` and `argArray`, the following steps are taken:

1. If `IsCallable(func)` is **false**, throw a `TypeError` exception.
2. If `argArray` is `null` or `undefined`, then
 - a. Return `Call(func, thisArg)`.
3. Let `argList` be the result of `CreateListFromArrayLike(argArray)`.
4. `ReturnIfAbrupt(argList)`.
5. Perform `PrepareForTailCall()`.
6. Return `Call(func, thisArg, argList)`.

The `length` property of the `apply` method is **2**.

NOTE 1 The `thisArg` value is passed without modification as the `this` value. This is a change from Edition 3, where an `undefined` or `null` `thisArg` is replaced with the global object and `ToObject` is applied to all other values and that result is passed as the `this` value. Even though the `thisArg` is passed without modification, non-strict mode functions still perform these transformations upon entry to the function.

Deleted: The [[CreateAction]] of the Function constructor identifies the following abstract operation:

The Function CreateAction abstract operation when called with arguments `constructor` and `argumentsList` of performs the following steps:

- <#>Let `proto` be the result of `GetPrototypeFromConstructor(constructor, "%FunctionPrototype%")`.
- <#>ReturnIfAbrupt(proto).
- <#>Return `FunctionAllocate(proto, false)`.

NOTE The Function CreateAction passes `false` as the `strict` parameter to `FunctionAllocate`. This causes the allocated ECMAScript function object to have the internal methods of a non-strict constructor function. The `Function` constructor may reset the functions [[Strict]] internal slot to `true`. It is up to the implementation whether this also changes the internal methods.

Deleted: <#>`Function[@@create] ()`

The @@create method of an object `F` performs the following steps:

- <#>Let `F` be the `this` value.
- <#>Let `proto` be the result of `GetPrototypeFromConstructor(F, "%FunctionPrototype%")`.
- <#>ReturnIfAbrupt(proto).
- <#>Let `obj` be the result of calling `ReturnFunctionAllocate(` with arguments `proto`, and `false`).`)`.

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NOTE 2 If *func* is an arrow function or a bound function then the *thisArg* will be ignored by the function *[[Call]]* in step 6.

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19.2.3.2 Function.prototype.bind (*thisArg*, ...*args*)

When the *bind* method is called with argument *thisArg* and zero or more *args*, it performs the following steps:

1. Let *Target* be the **this** value.
2. If *IsCallable*(*Target*) is **false**, throw a **TypeError** exception.
3. Let *args* be a new (possibly empty) List consisting of all of the argument values provided after *thisArg* in order.
4. Let *F* be *BoundFunctionCreate*(*Target*, *thisArg*, *args*).
5. Let *targetHasLength* be *HasOwnProperty*(*Target*, "length").
6. *ReturnIfAbrupt*(*targetHasLength*).
7. If *targetHasLength* is **true**, then
 - a. Let *targetLen* be *Get*(*Target*, "length").
 - b. *ReturnIfAbrupt*(*targetLen*).
 - c. If *Type*(*targetLen*) is not **Number**, let *L* be 0.
 - d. Else,
 - i. Let *targetLen* be *ToInteger*(*targetLen*).
 - ii. Let *L* be the larger of 0 and the result of *targetLen* minus the number of elements of *args*.
8. Else let *L* be 0.
9. Let *status* be *DefinePropertyOrThrow*(*F*, "length", PropertyDescriptor {[[Value]]: *L*, [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **true**}).
10. Assert: *status* is not an abrupt completion.
11. Let *targetName* be *Get*(*Target*, "name").
12. *ReturnIfAbrupt*(*targetName*).
13. If *Type*(*targetName*) is not **String**, let *targetName* be the empty string.
14. Perform *SetFunctionName*(*F*, *targetName*, "bound").
15. Return *F*.

The **length** property of the *bind* method is 1.

NOTE 1 Function objects created using *Function.prototype.bind* are exotic objects. They also do not have a **prototype** property.

NOTE 2 If *Target* is an arrow function or a bound function, then the *thisArg* passed to this method will not be used by subsequent calls to *F*.

19.2.3.3 Function.prototype.call (*thisArg*, ...*args*)

When the *call* method is called on an object *func* with argument *thisArg* and zero or more *args*, the following steps are taken:

1. If *IsCallable*(*func*) is **false**, throw a **TypeError** exception.
2. Let *argList* be an empty List.
3. If this method was called with more than one argument then in left to right order starting with *the second argument* append each argument as the last element of *argList*
4. Perform *PrepareForTailCall*.
5. Return *Call*(*func*, *thisArg*, *argList*).

The **length** property of the *call* method is 1.

NOTE 1 The `thisArg` value is passed without modification as the `this` value. This is a change from Edition 3, where an `undefined` or `null` `thisArg` is replaced with the global object and `ToObject` is applied to all other values and that result is passed as the `this` value. Even though the `thisArg` is passed without modification, non-strict mode functions still perform these transformations upon entry to the function.

NOTE 2 If `func` is an arrow function or a bound function then the `thisArg` will be ignored by the function `[[Call]]` in step 5.

19.2.3.4 `Function.prototype.constructor`

The initial value of `Function.prototype.constructor` is the intrinsic object `%Function%`.

19.2.3.5 `Function.prototype.toString()`

When the `toString` method is called on an object `func` the following steps are taken:

1. If `func` is a Bound Function exotic object, then
 - a. Return an implementation-dependent String source code representation of `func`. The representation must conform to the rules below. It is implementation dependent whether the representation includes bound function information or information about the target function.
2. If `Type(func)` is Object and is either a Built-in function object or has an `[[ECMAScriptCode]]` internal slot, then
 - a. Return an implementation-dependent String source code representation of `func`. The representation must conform to the rules below.
3. Throw a `TypeError` exception.

toString Representation Requirements:

- The string representation must have the syntax of a `FunctionDeclaration`, `FunctionExpression`, `GeneratorDeclaration`, `GeneratorExpression`, `ClassDeclaration`, `ClassExpression`, `ArrowFunction`, `MethodDefinition`, or `GeneratorMethod` depending upon the actual characteristics of the object.
- The use and placement of white space, line terminators, and semicolons within the representation String is implementation-dependent.
- If the object was defined using ECMAScript code and the returned string representation is not in the form of a `MethodDefinition` or `GeneratorMethod` then the representation must be such that if the string is evaluated, using `eval` in a lexical context that is equivalent to the lexical context used to create the original object, it will result in a new functionally equivalent object. In that case the returned source code must not mention freely any variables that were not mentioned freely by the original function's source code, even if these "extra" names were originally in scope.
- If the implementation cannot produce a source code string that meets these criteria then it must return a string for which `eval` will throw a `SyntaxError` exception.

19.2.3.6 `Function.prototype[@@hasInstance](V)`

When the `@@hasInstance` method of an object `F` is called with value `V`, the following steps are taken:

1. Let `F` be the `this` value.
2. Return the result of `OrdinaryHasInstance(F, V)`.

The value of the `name` property of this function is "`[Symbol.hasInstance]`".

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

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Comment [AWB2242]: Do we also want to copy func's length property? If so, it probably happens in clone method

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When the `toMethod` method is called on an object `func` with argument `superBinding newHome` and optional argument `methodName` the following steps are taken:

`<#>If IsCallable(func) is false, then throw a`

`TypeError exception.`

`<#>If Type(newHome) is not Object, then throw a`

`TypeError exception.`

`<#>If func is an ECMAScript function object or an exotic Built-in function object, then`

`<#>NOTE func may be a Built-in function that is implemented as an ECMAScript function.`

`<#>If Type(newHome) is not Object, then throw a`

`TypeError exception.`

`<#>If methodName is not undefined, then`

`<#>Let methodName be`

`ToPropertyKey(methodName).`

`<#>Return IfAbrupt(methodName).`

`<#>Return CloneMethod(func, newHome,`

`methodName).`

`<#>If func is a standard exotic Built-in function`

`object, then`

`<#>Return a new exotic Built-in function object that implements the same Built-in function as`

`func and with the same Realm association.`

`<#>If func is an Bound Function exotic object, then throw a`

`TypeError exception return`

`BoundFunctionClone(func).`

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NOTE This is the default implementation of `@@hasInstance` that most functions inherit. `@@hasInstance` is called by the `instanceof` operator to determine whether a value is an instance of a specific constructor. An expression such as

```
v instanceof F
```

evaluates as

```
F[@@hasInstance](v)
```

A constructor function can control which objects are recognized as its instances by `instanceof` by exposing a different `@@hasInstance` method on the function.

This property is non-writable and non-configurable to prevent tampering that could be used to globally expose the target function of a bound function.

19.2.4 Function Instances

Every function instance is an ECMAScript function object and has the internal slots listed in [Table 28](#). Function instances created using the `Function.prototype.bind` method (19.2.3.2) have the internal slots listed in [Table 29](#).

The Function instances have the following properties:

19.2.4.1 length

The value of the `length` property is an integer that indicates the typical number of arguments expected by the function. However, the language permits the function to be invoked with some other number of arguments. The behaviour of a function when invoked on a number of arguments other than the number specified by its `length` property depends on the function. This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true` }.

19.2.4.2 name

The value of the `name` property is an String that is descriptive of the function. The name has no semantic significance but is typically a variable or property name that is used to refer to the function at its point of definition in ECMAScript code. This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true` }.

Anonymous functions objects that do not have a contextual name associated with them by this specification do not have a `name` own property but inherit the `name` property of `%FunctionPrototype%`.

19.2.4.3 prototype

Function instances that can be used as a constructor have a `prototype` property. Whenever such a function instance is created another ordinary object is also created and is the initial value of the function's `prototype` property. Unless otherwise specified, the value of the `prototype` property is used to initialize the `[[Prototype]]` internal slot of a newly created ordinary object before the Function object is invoked as a constructor for that newly created object.

This property has the attributes { `[[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: false` }.

NOTE Function objects created using `Function.prototype.bind`, or by evaluating a `MethodDefinition` (that are not a `GeneratorMethod`) or an `ArrowFunction` grammar production do not have a `prototype` property.

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Deleted: Function instances that correspond to strict mode functions and function instances created using the `Function.prototype.bind` method (19.2.3.2) have properties named `caller` and `arguments` that throw a `TypeError` exception. An ECMAScript implementation must not associate any implementation specific behaviour with accesses of these properties from strict mode function code. ¶

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19.3 Boolean Objects

19.3.1 The Boolean Constructor

The Boolean constructor is the %Boolean% intrinsic object and the initial value of the `Boolean` property of the global object. When called as a constructor it creates and initializes a new Boolean object. When `Boolean` is called as a function rather than as a constructor, it performs a type conversion.

The `Boolean` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class definition. Subclass constructors that intend to inherit the specified `Boolean` behaviour must include a `super` call to the `Boolean` constructor to create and initialize the subclass instance with a `[[BooleanData]]` internal slot.

19.3.1.1 Boolean (value)

When `Boolean` is called with argument `value`, the following steps are taken:

1. Let `b` be `ToBoolean(value)`.
2. If `NewTarget` is `undefined`, return `b`.
3. Let `O` be `OrdinaryCreateFromConstructor(NewTarget, "%BooleanPrototype%", «[[BooleanData]]»)`.
4. `ReturnIfAbrupt(O)`.
5. Set the value of `O`'s `[[BooleanData]]` internal slot to `b`.
6. Return `O`.

19.3.2 Properties of the Boolean Constructor

The value of the `[[Prototype]]` internal slot of the Boolean constructor is the [intrinsic object %FunctionPrototype%](#) (19.2.3).

Besides the `length` property (whose value is 1), the Boolean constructor has the following properties:

19.3.2.1 Boolean.prototype

The initial value of `Boolean.prototype` is the Boolean prototype object (19.3.3).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

19.3.3 Properties of the Boolean Prototype Object

The Boolean prototype object is an ordinary object. It is not a Boolean instance and does not have a `[[BooleanData]]` internal slot.

The value of the `[[Prototype]]` internal slot of the Boolean prototype object is the [intrinsic object %ObjectPrototype%](#) (19.1.3).

The abstract operation `thisBooleanValue(value)` performs the following steps:

1. If `Type(value)` is Boolean, return `value`.
2. If `Type(value)` is Object and `value` has a `[[BooleanData]]` internal slot, then
 - a. `Assert: value's [[BooleanData]] internal slot is a Boolean value.`
 - b. `Return` the value of `value`'s `[[BooleanData]]` internal slot.

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Deleted: However, if the `this` value passed in the call is an Object with an uninitialized `[[BooleanData]]` internal slot, it initializes this value using the argument value. . This permits `Boolean` to be used both to perform type conversion and to perform constructor instance initialization.

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Deleted: <#>Let `O` be the `this` value.¶

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Deleted: If `Type(O)` is Object and `O` has a `[[BooleanData]]` internal slot and the value of `[[BooleanData]]` is `undefined`, then

Deleted: <#>Return `b`.¶ <#>`new Boolean (...argumentsList)`

When `Boolean` is called as part of a new expression , it initializes a newly created object:¶ <#>Let `F` be the `Boolean` function object on which the `new` operator was applied.¶ <#>Let `argumentsList` be the `argumentsList` argument of the `[[Construct]]` internal method that was invoked by the `new` operator.¶ <#>Return the result of `Construct(F, argumentsList)`.¶

If `Boolean` is implemented as an ECMAScript function object, its `[[Construct]]` internal method will perform the above steps.¶

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Deleted: <#>`Boolean[@@create]()`

Deleted: The `[[CreateAction]]` of the Boolean constructor identifies the following abstract operation:¶

The Boolean CreateAction abstract operation when called with arguments `constructor` and `argumentsList` of performs the following steps:¶ The `@@create` method of an object `F` performs the following steps:¶

<#>Let `F` be the `this` value.¶ <#>Let `obj` be the result of calling `OrdinaryCreateFromConstructor(constructorF, "%BooleanPrototype%", «[[BooleanData]]»)`.¶ <#>Return `obj`.¶

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3. Throw a **TypeError** exception.

Deleted: <#>If *b* is not **undefined**, then return *b*. ¶

19.3.3.1 Boolean.prototype.constructor

The initial value of **Boolean.prototype.constructor** is the **intrinsic object %Boolean%**.

19.3.3.2 Boolean.prototype.toString ()

The following steps are taken:

1. Let *b* be **thisBooleanValue(this value)**.
2. ReturnIfAbrupt(*b*).
3. If *b* is **true**, **return "true"**; else **return "false"**.

19.3.3.3 Boolean.prototype.valueOf ()

The following steps are taken:

1. **Return thisBooleanValue(this value)**.

19.3.4 Properties of Boolean Instances

Boolean instances are ordinary objects that inherit properties from the Boolean prototype object. Boolean instances have a **[[BooleanData]]** internal slot. The **[[BooleanData]]** internal slot is the Boolean value represented by this Boolean object.

19.4 Symbol Objects

19.4.1 The Symbol Constructor

The **Symbol** constructor is the **%Symbol%** intrinsic object and the initial value of the **Symbol** property of the global object. When **Symbol** is called as a function, it returns a new **Symbol** value.

The **Symbol** constructor is not intended to be used with the **new** operator or to be subclassed. It may be used as the value of an **extends** clause of a class **definition**, but a **super** call to the **Symbol** constructor will **cause an exception**.

19.4.1.1 Symbol ([description])

When **Symbol** is called with optional argument *description*, the following steps are taken:

1. If **NewTarget** is not **undefined**, throw a **TypeError** exception.
2. If *description* is **undefined**, let *descString* be **undefined**.
3. Else, let *descString* be **ToString(description)**.
4. ReturnIfAbrupt(*descString*).
5. Return a new unique **Symbol** value whose **[[Description]]** **value** is *descString*.

19.4.2 Properties of the Symbol Constructor

The value of the **[[Prototype]]** internal slot of the **Symbol** constructor is the **intrinsic object %FunctionPrototype%** (19.2.3).

Besides the **length** property (whose value is **1**), the **Symbol** constructor has the following properties:

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Deleted: <#>**new Symbol** (...**argumentsList**) ¶

When **Symbol** is called as part of a new expression , it initializes a newly created object: ¶

<#>Let *F* be the **Symbol** function object on which the **new** operator was applied. ¶

<#>Let *argumentsList* be the **argumentsList** argument of the **[[Construct]]** internal method that was invoked by the **new** operator. ¶

<#>Return the result of **Construct** (*F*, *argumentsList*). ¶

If **Symbol** is implemented as an ECMAScript function object, its **[[Construct]]** internal method will perform the above steps. ¶

NOTE **Symbol** has ordinary **[[Construct]]** behaviour but the definition of its **@@create** method **CreateAction** causes **new Symbol** to throw a **TypeError** exception. . ¶

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Deleted: Besides the **length** property (whose value is **01**), the **Symbol** constructor has the following properties: ¶

<#>**Symbol.create** ¶

The initial value of **Symbol.create** is the well known symbol **@@create** (Table 1). ¶

This property has the attributes { **[[Writable]]: false**, **[[Enumerable]]: false**, **[[Configurable]]: false** }. ¶

<#>**Symbol[@@create] ()** ¶

Deleted: The **[[CreateAction]]** of the **Symbol** constructor identifies the following abstract operation: ¶

The **Symbol CreateAction** abstract operation when called with arguments **constructor** and **argumentsList** performs the following steps: ¶

The **@@create** method of a **Symbol** object *F* performs the following steps: ¶

<#>Throw a **TypeError** exception. ¶

Deleted: The value of the **name** property of this function is "**[Symbol.create]**". ¶

19.4.2.1 `Symbol.for (key)`

When `Symbol.for` is called with argument `key` it performs the following steps:

1. Let `stringKey` be `ToString(key)`.
2. ReturnIfAbrupt(`stringKey`).
3. For each element `e` of the GlobalSymbolRegistry List,
 - a. If `SameValue(e.[[key]], stringKey)` is `true`, return `e.[[symbol]]`.
4. Assert: GlobalSymbolRegistry does not currently contain an entry for `stringKey`.
5. Let `newSymbol` be a new unique Symbol value whose `[Description]` is `stringKey`.
6. Append the record `{ [[key]]: stringKey, [[symbol]]: newSymbol }` to the GlobalSymbolRegistry List.
7. Return `newSymbol`.

The GlobalSymbolRegistry is a List that is globally available. It is shared by all Code Realms. Prior to the evaluation of any ECMAScript code it is initialized as an empty List. Elements of the GlobalSymbolRegistry are Records with the structure defined in Table 41.

Table 41 — GlobalSymbolRegistry Record Fields

Field Name	Value	Usage
<code>[[key]]</code>	A String	A string key used to globally identify a Symbol.
<code>[[symbol]]</code>	A Symbol	A symbol that can be retrieved from any Realm.

19.4.2.2 `Symbol.hasInstance`

The initial value of `Symbol.hasInstance` is the well known symbol `@@hasInstance` (Table 1).

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

19.4.2.3 `Symbol.isConcatSpreadable`

The initial value of `Symbol.isConcatSpreadable` is the well known symbol `@@isConcatSpreadable` (Table 1).

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

19.4.2.4 `Symbol.iterator`

The initial value of `Symbol.iterator` is the well known symbol `@@iterator` (Table 1).

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

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19.4.2.5 `Symbol.keyFor (sym)`

When `Symbol.keyFor` is called with argument `sym` it performs the following steps:

1. If `Type(sym)` is not `Symbol`, throw a `TypeError` exception.
2. For each element `e` of the GlobalSymbolRegistry List (see 19.4.2.1),
 - a. If `SameValue(e.[[symbol]], sym)` is `true`, return `e.[[key]]`.
3. Assert: GlobalSymbolRegistry does not currently contain an entry for `sym`.
4. Return `undefined`.

Deleted: <#>`Symbol.isRegExp`

The initial value of `Symbol.isRegExp` is the well known symbol `@@isRegExp` (Table 1). This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

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19.4.2.6 Symbol.match

The initial value of `Symbol.match` is the well known symbol `@@match` (Table 1).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

19.4.2.7 Symbol.prototype

The initial value of `Symbol.prototype` is the Symbol prototype object (19.4.3).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

19.4.2.8 Symbol.replace

The initial value of `Symbol.replace` is the well known symbol `@@replace` (Table 1).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

19.4.2.9 Symbol.search

The initial value of `Symbol.search` is the well known symbol `@@search` (Table 1).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

19.4.2.10 Symbol.species

The initial value of `Symbol.species` is the well known symbol `@@species` (Table 1).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

19.4.2.11 Symbol.split

The initial value of `Symbol.split` is the well known symbol `@@split` (Table 1).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

19.4.2.12 Symbol.toPrimitive

The initial value of `Symbol.toPrimitive` is the well known symbol `@@toPrimitive` (Table 1).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

19.4.2.13 Symbol.toStringTag

The initial value of `Symbol.toStringTag` is the well known symbol `@@toStringTag` (Table 1).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

19.4.2.14 Symbol.unscopables

The initial value of `Symbol.unscopables` is the well known symbol `@@unscopables` (Table 1).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

19.4.3 Properties of the Symbol Prototype Object

The Symbol prototype object is an ordinary object. It is not a Symbol instance and does not have a `[[SymbolData]]` internal slot.

The value of the `[[Prototype]]` internal slot of the Symbol prototype object is the [intrinsic object %ObjectPrototype%](#) (19.1.3).

Deleted: standard built-in Object prototype object

19.4.3.1 `Symbol.prototype.constructor`

The initial value of `Symbol.prototype.constructor` is the [intrinsic object %Symbol%](#).

Deleted: built-in `Symbol` constructor

19.4.3.2 `Symbol.prototype.toString()`

The following steps are taken:

1. Let `s` be the `this` value.
2. If `Type(s)` is `Symbol`, let `sym` be `s`.
3. Else,
 - a. If `Type(s)` is not `Object`, throw a `TypeError` exception.
 - b. If `s` does not have a `[[SymbolData]]` internal slot, throw a `TypeError` exception.
 - c. Let `sym` be the value of `s`'s `[[SymbolData]]` internal slot.
4. Return `SymbolDescriptiveString(sym)`.

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Deleted: Let `desc` be the value of `sym`'s `[[Description]]` attribute

Deleted: <#>If `desc` is undefined, then let `desc` be the empty string.
 <#>Assert: `Type(desc)` is `String`.
 <#>Let `result` be the result of concatenating the strings "Symbol(", `desc`, and ") ".
 <#>Return `result`.

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19.4.3.2.1 `SymbolDescriptiveString(sym)` Abstract Operation

When the abstract operation `SymbolDescriptiveString` is called with argument `sym`, the following steps are taken:

1. Assert: `Type(sym)` is `Symbol`.
2. Let `desc` be the value of `sym`'s `[[Description]]` attribute.
3. If `desc` is `undefined`, let `desc` be the empty string.
4. Assert: `Type(desc)` is `String`.
5. Let `result` be the result of concatenating the strings "Symbol(", `desc`, and ") ".
6. Return `result`.

19.4.3.3 `Symbol.prototype.valueOf()`

The following steps are taken:

1. Let `s` be the `this` value.
2. If `Type(s)` is `Symbol`, return `s`.
3. If `Type(s)` is not `Object`, throw a `TypeError` exception.
4. If `s` does not have a `[[SymbolData]]` internal slot, throw a `TypeError` exception.
5. Return the value of `s`'s `[[SymbolData]]` internal slot.

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19.4.3.4 `Symbol.prototype[@@toPrimitive](hint)`

This function is called by ECMAScript language operators to convert an object to a primitive value. The allowed values for `hint` are "default", "number", and "string".

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When the `@@toPrimitive` method is called with argument `hint`, the following steps are taken:

1. Let `s` be the `this` value.
2. If `Type(s)` is `Symbol`, return `s`.
3. If `Type(s)` is not `Object`, throw a `TypeError` exception.
4. If `s` does not have a `[[SymbolData]]` internal slot, throw a `TypeError` exception.
5. Return the value of `s`'s `[[SymbolData]]` internal slot.

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Deleted: <#>Throw a `TypeError` exception.¶

The value of the `name` property of this function is "`[Symbol.toPrimitive]`".

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }`.

19.4.3.5 `Symbol.prototype [@@toStringTag]`

The initial value of the `@@toStringTag` property is the string value "`Symbol`".

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }`.

19.4.4 Properties of Symbol Instances

Symbol instances are ordinary objects that inherit properties from the Symbol prototype object. Symbol instances have a `[[SymbolData]]` internal slot. The `[[SymbolData]]` internal slot is the Symbol value represented by this Symbol object.

19.5 Error Objects

Instances of Error objects are thrown as exceptions when runtime errors occur. The Error objects may also serve as base objects for user-defined exception classes.

19.5.1 The Error Constructor

The Error constructor is the `%Error%` intrinsic object and the initial value of the `Error` property of the global object. When `Error` is called as a function rather than as a constructor, it creates and initializes a new Error object. Thus the function call `Error(...)` is equivalent to the object creation expression `new Error(...)` with the same arguments.

The `Error` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class `definition`. Subclass constructors that intend to inherit the specified `Error` behaviour must include a `super` call to the `Error` constructor to `create and initialize` subclass instances `with a [[ErrorData]] internal slot`.

19.5.1.1 `Error (message)`

When the `Error` function is called with argument `message` the following steps are taken:

1. If `NewTarget` is `undefined`, let `newTarget` be the active function object, else let `newTarget` be `NewTarget`.
2. Let `O` be `OrdinaryCreateFromConstructor(newTarget, "%ErrorPrototype%", <[ErrorData]>)`.
3. `ReturnIfAbrupt(O)`.
4. If `message` is not `undefined`, then
 - a. Let `msg` be `ToString(message)`.
 - b. `ReturnIfAbrupt(msg)`.

Deleted: However, if the `this` value passed in the call is an Object with an uninitialized `[[ErrorData]]` internal slot, it initializes the `this` value using the argument value rather than creating a new object. This permits `Error` to be used both as factory method and to perform constructor instance initialisation.

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Deleted: <#>Let `O` be the `this` value.
 <#>If `Type(O)` is not `Object` or `Type(O)` is `Object` and `O` does not have an `[[ErrorData]]` internal slot or `Type(O)` is `Object` and `O` has an `[[ErrorData]]` internal slot and the value of `[[ErrorData]]` is not `undefined`, then¶

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Deleted: <#>Assert: `Type(O)` is `Object`.
 <#>Set the value of `O`'s `[[ErrorData]]` internal slot to any value other than `undefined`.¶

- c. Let `msgDesc` be the `PropertyDescriptor{[[Value]]: msg, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true}`.
 - d. Let `status` be the result of `DefinePropertyOrThrow(O, "message", msgDesc)`.
 - e. **Assert:** `status` is not an abrupt completion.
5. Return `O`.

Deleted: `ReturnIfAbrupt(status)`
Deleted: `)`

19.5.2 Properties of the Error Constructor

The value of the `[[Prototype]]` internal slot of the `Error` constructor is the [intrinsic object %FunctionPrototype%](#) (19.2.3).

Besides the `length` property (whose value is `1`), the `Error` constructor has the following properties:

19.5.2.1 `Error.prototype`

The initial value of `Error.prototype` is the `Error` prototype object (19.5.3).

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

19.5.3 Properties of the Error Prototype Object

The `Error` prototype object is an ordinary object. It is not an `Error` instance and does not have an `[[ErrorData]]` internal slot.

The value of the `[[Prototype]]` internal slot of the `Error` prototype object is the [intrinsic object %ObjectPrototype%](#) (19.1.3).

19.5.3.1 `Error.prototype.constructor`

The initial value of `Error.prototype.constructor` is the [intrinsic object %Error%](#).

19.5.3.2 `Error.prototype.message`

The initial value of `Error.prototype.message` is the empty String.

19.5.3.3 `Error.prototype.name`

The initial value of `Error.prototype.name` is `"Error"`.

19.5.3.4 `Error.prototype.toString()`

The following steps are taken:

1. Let `O` be the `this` value.
2. If `Type(O)` is not `Object`, throw a `TypeError` exception.
3. Let `name` be the result of `Get(O, "name")`.
4. `ReturnIfAbrupt(name)`.
5. If `name` is `undefined`, let `name` be `"Error"`; otherwise let `name` be `ToString(name)`.
6. **ReturnIfAbrupt(name)**.
7. Let `msg` be the result of `Get(O, "message")`.
8. `ReturnIfAbrupt(msg)`.
9. If `msg` is `undefined`, let `msg` be the empty String; otherwise let `msg` be `ToString(msg)`.

Deleted: `<#>new Error(...argumentsList)`

When `Error` called as part of a new expression with argument list `argumentsList` it performs the following steps:

`<#>Let F be the Error function object on which the new operator was applied.`
`<#>Let argumentsList be the argumentsList argument of the [[Construct]] internal method that was invoked by the new operator.`
`<#>Return the result of Construct(F, argumentsList).`

If `Error` is implemented as an ECMAScript function object, its `[[Construct]]` internal method will perform the above steps.

Deleted: Function prototype object

Deleted: The `[[CreateAction]]` of the `Error` constructor identifies the following abstract operation:

The `[[CreateAction]]` abstract operation when called with arguments `constructor` and `argumentsList` performs the following steps:

`<#>Error[@@create]()`
The `@@create` method of an object `F` performs the following steps:
`<#>Let F be the this value.`
`<#>Let obj be the return result of calling OrdinaryCreateFromConstructor(constructorF, "%ErrorPrototype%", « [[ErrorData]] »).`

Deleted: `<#>Return obj`
The value of the `name` property of this function is `"[Symbol.create]"`.
This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }`.

Deleted: NOTE - `[[ErrorData]]` is initially assigned the value `undefined` as a flag to indicate that the instance has not yet been initialized by the `Error` constructor. This flag value is never directly exposed to ECMAScript code; hence implementations may choose to encode the flag in some other manner.

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10. ReturnIfAbrupt(*msg*)

11. If *name* is the empty String, return *msg*.
12. If *msg* is the empty String, return *name*.
13. Return the result of concatenating *name*, [the code unit U+003A \(COLON\)](#), [the code unit U+0020 \(SPACE\)](#), and *msg*.

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19.5.4 Properties of Error Instances

Error instances are ordinary objects that inherit properties from the Error prototype object and have an `[[ErrorData]]` internal slot whose initial value is `undefined`. The only specified uses of `[[ErrorData]]` is to flag whether or not an Error instance has been initialized by the Error constructor and to identify them as Error objects within `Object.prototype.toString`.

19.5.5 Native Error Types Used in This Standard

A new instance of one of the *NativeError* objects below is thrown when a runtime error is detected. All of these objects share the same structure, as described in 19.5.6.

19.5.5.1 EvalError

This exception is not currently used within this specification. This object remains for compatibility with previous editions of this specification.

19.5.5.2 RangeError

Indicates a value that is not in the set or range of allowable values.

Deleted: See 15.4.2.2, 15.4.5.1, 15.7.4.2, 15.7.4.5, 15.7.4.6, 15.7.4.7, and 15.9.5.43.

19.5.5.3 ReferenceError

Indicate that an invalid reference value has been detected.

Deleted: See 8.9.1, 8.9.2, 10.2.1, 10.2.1.1.4, 10.2.1.2.4, and 11.13.1.

19.5.5.4 SyntaxError

Indicates that a parsing error has occurred.

Deleted: See 11.1.5, 11.3.1, 11.3.2, 11.4.1, 11.4.4, 11.4.5, 11.13.1, 11.13.2, 12.2.1, 12.10.1, 12.14.1, 13.1, 15.1.2.1, 15.3.2.1, 15.10.2.2, 15.10.2.5, 15.10.2.9, 15.10.2.15, 15.10.2.19, 15.10.4.1, and 15.12.2.

19.5.5.5 TypeError

Indicates the actual type of an operand is different than the expected type.

Deleted: See 8.6.2, 8.9.2, 8.10.5, 8.12.5, 8.12.7, 8.12.8, 8.12.9, 9.9, 9.10, 10.2.1, 10.2.1.1.3, 10.6, 11.2.2, 11.2.3, 11.4.1, 11.4.1, 11.8.7, 11.3.1, 13.2, 13.2.3, 15, 15.2.3.2, 15.2.3.3, 15.2.3.4, 15.2.3.5, 15.2.3.6, 15.2.3.7, 15.2.3.8, 15.2.3.9, 15.2.3.10, 15.2.3.11, 15.2.3.12, 15.2.3.13, 15.2.3.14, 15.2.4.3, 15.3.3.2, 15.3.3.3, 15.3.3.4, 15.3.3.5, 15.3.3.5.2, 15.3.3.5.3, 15.3.4, 15.3.4.3, 15.3.4.4, 15.4.3.3, 15.4.3.11, 15.4.3.16, 15.4.3.17, 15.4.3.18, 15.4.3.19, 15.4.3.20, 15.4.3.21, 15.4.3.22, 15.4.5.1, 15.5.4.2, 15.5.4.3, 15.6.4.2, 15.6.4.3, 15.7.4, 15.7.4.2, 15.7.4.4, 15.9.5, 15.9.5.44, 15.10.4.1, 15.10.6, 15.11.4.4 and 15.12.3.

Deleted: . See 15.1.3

For each error object, references to *NativeError* in the definition should be replaced with the appropriate error object name from 19.5.5.

19.5.6.1 *NativeError Constructors*

When a *NativeError* constructor is called as a function rather than as a constructor, it creates and initializes a new *NativeError* object. A call of the object as a function is equivalent to calling it as a constructor with the same arguments. Thus the function call *NativeError*(...) is equivalent to the object creation expression `new NativeError(...)` with the same arguments.

Each *NativeError* constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class `definition`. Subclass constructors that intend to inherit the specified *NativeError* behaviour must include a `super` call to the *NativeError* constructor to create and initialize subclass instances with a `[[ErrorData]]` internal slot.

19.5.6.1.1 *NativeError (message)*

When a *NativeError* function is called with argument *message* the following steps are taken:

1. If NewTarget is undefined, let *newTarget* be the active function object, else let *newTarget* be NewTarget.
2. Let *O* be OrdinaryCreateFromConstructor(*newTarget*, "%NativeErrorPrototype%", `[[ErrorData]]`).
3. ReturnIfAbrupt(*O*).
4. If *message* is not undefined, then
 - a. Let *msg* be ToString(*message*).
 - b. Let *msgDesc* be the PropertyDescriptor{`[[Value]]: msg, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true`}.
 - c. Let *status* be the result of DefinePropertyOrThrow(*O*, "message", *msgDesc*).
 - d. Assert: *status* is not an abrupt completion.
5. Return *O*.

The actual value of the string passed in step 2 is either "%EvalErrorPrototype%", "%RangeErrorPrototype%", "%ReferenceErrorPrototype%", "%SyntaxErrorPrototype%", "%TypeErrorPrototype%", or "%URIErrorPrototype%" corresponding to which *NativeError* constructor is being defined.

19.5.6.2 *Properties of the NativeError Constructors*

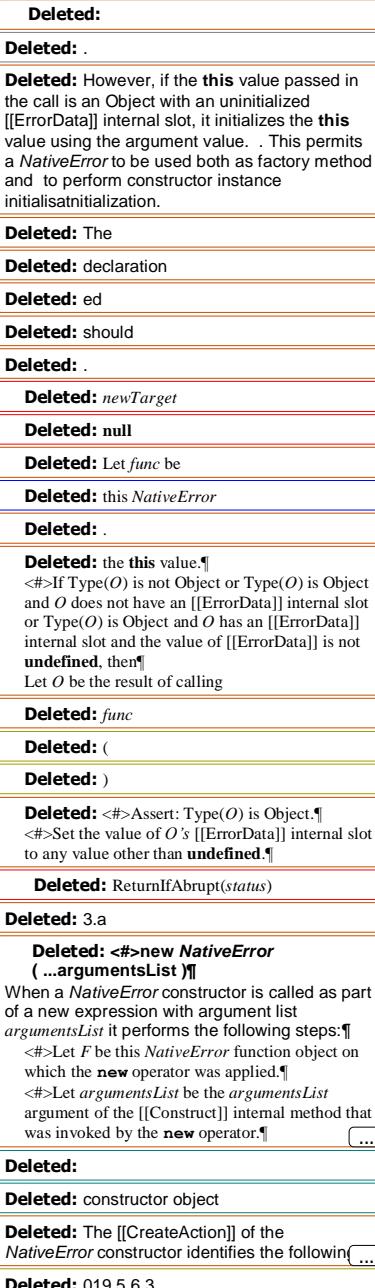
The value of the `[[Prototype]]` internal slot of a *NativeError* constructor is the intrinsic object %Error% (19.5.1).

Besides the `length` property (whose value is 1), each *NativeError* constructor has the following properties:

19.5.6.2.1 *NativeError.prototype*

The initial value of *NativeError.prototype* is a *NativeError* prototype object (19.5.6.3). Each *NativeError* constructor has a separate prototype object.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.



19.5.6.3 Properties of the `NativeError` Prototype Objects

Each `NativeError` prototype object is an ordinary object. It is not an Error instance and does not have an `[[ErrorData]]` internal slot.

The value of the `[[Prototype]]` internal slot of each `NativeError` prototype object is the [intrinsic object %ErrorPrototype%](#) (19.5.3).

19.5.6.3.1 `NativeError.prototype.constructor`

The initial value of the `constructor` property of the prototype for a given `NativeError` constructor is the [corresponding intrinsic object %NativeError%](#) (19.5.6.1).

19.5.6.3.2 `NativeError.prototype.message`

The initial value of the `message` property of the prototype for a given `NativeError` constructor is the empty String.

19.5.6.3.3 `NativeError.prototype.name`

The initial value of the `name` property of the prototype for a given `NativeError` constructor is a string consisting of the name of the constructor (the name used instead of `NativeError`).

19.5.6.4 Properties of `NativeError` Instances

`NativeError` instances are ordinary objects that inherit properties from their `NativeError` prototype object and have an `[[ErrorData]]` internal slot whose initial value is `undefined`. The only specified use of `[[ErrorData]]` is to flag whether or not an `Error` or `NativeError` instance has been initialized by its constructor.

20 Numbers and Dates

20.1 Number Objects

20.1.1 The Number Constructor

The `Number` constructor is the `%Number%` intrinsic object and the initial value of the `Number` property of the global object. [When called as a constructor, it creates and initializes a new Number object](#). When `Number` is called as a function rather than as a constructor, it performs a type conversion.

The `Number` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class [definition](#). Subclass constructors that intend to inherit the specified `Number` behaviour must include a `super` call to the `Number` constructor to [create and initialize the subclass instance with a \[\[NumberData\]\] internal slot](#).

20.1.1.1 `Number ([value])`

When `Number` is called with argument `number`, the following steps are taken:

1. If no arguments were passed to this function invocation, let `n` be `+0`.
2. Else, let `n` be `ToNumber(value)`.

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Deleted: However, if the `this` value passed in the call is an Object with an uninitialized `[[NumberData]]` internal slot, it initializes the `this` value using the argument value. . This permits `Number` to be used both to perform type conversion and to perform constructor instance initialisation.

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3. ReturnIfAbrupt(*n*).
4. If NewTarget is **undefined**, return *n*.
5. Let *O* be OrdinaryCreateFromConstructor(NewTarget, "%NumberPrototype%", «[[NumberData]]»).
6. ReturnIfAbrupt(*O*).
7. Set the value of *O*'s [[NumberData]] internal slot to *n*.
8. Return *O*.

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Deleted: If Type(*O*) is Object and *O* has a [[NumberData]] internal slot and the value of [[NumberData]] is **undefined**, then

20.1.2 Properties of the Number Constructor

The value of the [[Prototype]] internal slot of the Number constructor is the [intrinsic object %FunctionPrototype%](#). (19.2.3).

Besides the **length** property (whose value is 1), the Number constructor has the following properties:

20.1.2.1 Number.EPSILON

The value of Number.EPSILON is the difference between 1 and the smallest value greater than 1 that is representable as a Number value, which is approximately $2.2204460492503130808472633361816 \times 10^{-16}$.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

20.1.2.2 Number.isFinite (*number*)

When the **Number.isFinite** is called with one argument *number*, the following steps are taken:

1. If Type(*number*) is not Number, return **false**.
2. If *number* is NaN, +∞, or -∞, return **false**.
3. Otherwise, return **true**.

20.1.2.3 Number.isInteger (*number*)

When the **Number.isInteger** is called with one argument *number*, the following steps are taken:

1. If Type(*number*) is not Number, return **false**.
2. If *number* is NaN, +∞, or -∞, return **false**.
3. Let *integer* be ToInteger(*number*).
4. If *integer* is not equal to *number*, return **false**.
5. Otherwise, return **true**.

20.1.2.4 Number.isNaN (*number*)

When the **Number.isNaN** is called with one argument *number*, the following steps are taken:

1. If Type(*number*) is not Number, return **false**.
2. If *number* is NaN, return **true**.
3. Otherwise, return **false**.

NOTE This function differs from the global isNaN function (18.2.3) is that it does not convert its argument to a Number before determining whether it is NaN.

Deleted: <#>Return *n*.

Deleted: <#>new Number (...argumentsList)

When **Number** is called as part of a new expression with argument list *argumentsList* performs the following steps:

<#>Let *F* be the **Number** function object on which the **new** operator was applied.
 <#>Let *argumentsList* be the *argumentsList* argument of the [[Construct]] internal method that was invoked by the **new** operator.
 <#>Return Construct (*F*, *argumentsList*).
 If **Number** is implemented as an ECMAScript function object, its [[Construct]] internal method will perform the above steps.

Deleted: Function prototype object

Deleted: The [[CreateAction]] of the Number constructor identifies the following abstract operation:
 The Number CreateAction abstract operation when called with arguments *constructor* and *argumentsList* of the *Number* constructor performs the following steps:

<#>Number[@@create] ()
 The @@create method of an object *F* performs the following steps:
 <#>Let *F* be the **this** value.
 <#>Let *obj* beReturn OrdinaryCreateFromConstructor(*constructorF*, "%NumberPrototype%", «[[NumberData]]»).
 <#>Return *obj*.

The value of the **name** property of this function is "**[Symbol.create]**".
 This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **true** }.
 NOTE - [[NumberData]] is initially assigned the value **undefined** as a flag to indicate that the instance has not yet been initialized by the Number constructor. This flag value is never directly exposed to ECMAScript code; hence implementations may choose to encode the flag in some other manner.

20.1.2.5 Number.isSafeInteger (number)

When the `Number.isSafeInteger` is called with one argument `number`, the following steps are taken:

1. If `Type(number)` is not `Number`, return `false`.
2. If `number` is `NaN`, $+\infty$, or $-\infty$, return `false`.
3. Let `integer` be `ToInteger(number)`.
4. If `integer` is not equal to `number`, return `false`.
5. If $\text{abs}(\text{integer}) \leq 2^{53}-1$, return `true`.
6. Otherwise, return `false`.

Deleted: , then return

20.1.2.6 Number.MAX_SAFE_INTEGER

NOTE The value of `Number.MAX_SAFE_INTEGER` is the largest integer `n` such that `n` and `n + 1` are both exactly representable as a `Number` value.

The value of `Number.MAX_SAFE_INTEGER` is 9007199254740991 ($2^{53}-1$).

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This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

20.1.2.7 Number.MAX_VALUE

The value of `Number.MAX_VALUE` is the largest positive finite value of the `Number` type, which is approximately $1.7976931348623157 \times 10^{308}$.

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

20.1.2.8 Number.MIN_SAFE_INTEGER

NOTE The value of `Number.MIN_SAFE_INTEGER` is the smallest integer `n` such that `n` and `n - 1` are both exactly representable as a `Number` value.

The value of `Number.MIN_SAFE_INTEGER` is -9007199254740991 ($-(2^{53}-1)$).

Deleted: <#>Number.NaN¶
The value of `Number.NaN` is `NaN`.¶
This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.¶
<#>Number.NEGATIVE_INFINITY¶
The value of `Number.NEGATIVE_INFINITY` is $-\infty$.¶
This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.¶

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20.1.2.9 Number.MIN_VALUE

The value of `Number.MIN_VALUE` is the smallest positive value of the `Number` type, which is approximately 5×10^{-324} .

In the IEEE-764 double precision binary representation, the smallest possible value is a denormalized number. If an implementation does not support denormalized values, the value of `Number.MIN_VALUE` must be the smallest non-zero positive value that can actually be represented by the implementation.

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This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

20.1.2.10 Number.NaN

The value of `Number.NaN` is `NaN`.

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

20.1.2.11 Number.NEGATIVE_INFINITY

The value of Number.NEGATIVE_INFINITY is $-\infty$.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

20.1.2.12 Number.parseFloat (string)

The value of the `Number.parseFloat` data property is the same built-in function object that is the value of the `parseFloat` property of the global object defined in 18.2.4.

20.1.2.13 Number.parseInt (string, radix)

The value of the `Number.parseInt` data property is the same built-in function object that is the value of the `parseInt` property of the global object defined in 18.2.5.

20.1.2.14 Number.POSITIVE_INFINITY

The value of Number.POSITIVE_INFINITY is $+\infty$.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

20.1.2.15 Number.prototype

The initial value of `Number.prototype` is the [intrinsic object %NumberPrototype%](#) (20.1.3).

Deleted: Number prototype object

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

20.1.3 Properties of the Number Prototype Object

The Number prototype object is an ordinary object. It is not a Number instance and does not have a [[NumberData]] internal slot.

The value of the [[Prototype]] internal slot of the Number prototype object is the [intrinsic object %ObjectPrototype%](#) (19.1.3).

Deleted: standard built-in Object prototype object

Unless explicitly stated otherwise, the methods of the Number prototype object defined below are not generic and the `this` value passed to them must be either a Number value or an object that has a [[NumberData]] internal slot that has been initialized to a Number value.

The abstract operation `thisNumberValue(value)` performs the following steps:

1. If `Type(value)` is Number, return `value`.
2. If `Type(value)` is Object and `value` has a [[NumberData]] internal slot, then
 - a. Assert: `value`'s [[NumberData]] internal slot is a Number value.
 - b. Return the value of `value`'s [[NumberData]] internal slot.
3. Throw a `TypeError` exception.

Deleted: Let `n` be

Deleted: <#>If `n` is not `undefined`, then return `n`. ¶

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The phrase “this Number value” within the specification of a method refers to the result returned by calling the abstract operation `thisNumberValue` with the `this` value of the method invocation passed as the argument. ¶

20.1.3.1 Number.prototype.constructor

The initial value of `Number.prototype.constructor` is the [intrinsic object %Number%](#).

Deleted: built-in `Number` constructor

20.1.3.2 Number.prototype.toExponential (*fractionDigits*)

Return a String containing this Number value represented in decimal exponential notation with one digit before the significand's decimal point and *fractionDigits* digits after the significand's decimal point. If *fractionDigits* is **undefined**, include as many significand digits as necessary to uniquely specify the Number (just like in `ToString` except that in this case the Number is always output in exponential notation). Specifically, perform the following steps:

1. Let *x* be `thisNumberValue(this` value).
2. `ReturnIfAbrupt(x).`
3. Let *f* be `ToInteger(fractionDigits).`
4. Assert: *f* is 0, when *fractionDigits* is **undefined**.
5. `ReturnIfAbrupt(f).`
6. If *x* is **NaN**, return the String "**NaN**".
7. Let *s* be the empty String.
8. If *x* < 0, then
 - a. Let *s* be "-".
 - b. Let *x* = *-x*.
9. If *x* = $+\infty$, then
 - a. Return the concatenation of the Strings *s* and "**Infinity**".
10. If *f* < 0 or *f* > 20, throw a **RangeError** exception. [However, an implementation is permitted to extend the behaviour of `toExponential` for values of *f* less than 0 or greater than 20. In this case `toExponential` would not necessarily throw `RangeError` for such values.](#)

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11. If *x* = 0, then
 - a. Let *m* be the String consisting of *f*+1 occurrences of the code unit 0x0030.
 - b. Let *e* = 0.
12. Else *x* ≠ 0,
 - a. If *fractionDigits* is not **undefined**, then
 - i. Let *e* and *n* be integers such that $10^f \leq n < 10^{f+1}$ and for which the exact mathematical value of $n \times 10^{e-f} - x$ is as close to zero as possible. If there are two such sets of *e* and *n*, pick the *e* and *n* for which $n \times 10^{e-f}$ is larger.
 - b. Else *fractionDigits* is **undefined**.
 - i. Let *e*, *n*, and *f* be integers such that $f \geq 0$, $10^f \leq n < 10^{f+1}$, the **Number** value for $n \times 10^{e-f}$ is *x*, and *f* is as small as possible. Note that the decimal representation of *n* has *f*+1 digits, *n* is not divisible by 10, and the least significant digit of *n* is not necessarily uniquely determined by these criteria.
 - ii. Let *m* be the String consisting of the digits of the decimal representation of *n* (in order, with no leading zeroes).
13. If *f* ≠ 0, then
 - a. Let *a* be the first element of *m*, and let *b* be the remaining *f* elements of *m*.
 - b. Let *m* be the concatenation of the three Strings *a*, ". ", and *b*.
14. If *e* = 0, then
 - a. Let *c* = "+".
 - b. Let *d* = "0".
15. Else
 - a. If *e* > 0, **let** *c* = "+".
 - b. Else *e* ≤ 0,
 - i. Let *c* = "-".

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- ii. Let $e = -e$.
- c. Let d be the String consisting of the digits of the decimal representation of e (in order, with no leading zeroes).
- 16. Let m be the concatenation of the four Strings m , "e", c , and d .
- 17. Return the concatenation of the Strings s and m .

The `length` property of the `toExponential` method is 1.

If the `toExponential` method is called with more than one argument, then the behaviour is undefined (see clause 17).

NOTE For implementations that provide more accurate conversions than required by the rules above, it is recommended that the following alternative version of step 12.b.i be used as a guideline:

- i. Let e , n , and f be integers such that $f \geq 0$, $10^f \leq n < 10^{f+1}$, the Number value for $n \times 10^{e-f}$ is x , and f is as small as possible. If there are multiple possibilities for n , choose the value of n for which $n \times 10^{e-f}$ is closest in value to x . If there are two such possible values of n , choose the one that is even.

Deleted: An implementation is permitted to extend the behaviour of `toExponential` for values of `fractionDigits` less than 0 or greater than 20. In this case `toExponential` would not necessarily throw `RangeError` for such values.¶

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20.1.3.3 Number.prototype.toFixed (fractionDigits)

Note `toFixed` returns a String containing this Number value represented in decimal fixed-point notation with `fractionDigits` digits after the decimal point. If `fractionDigits` is `undefined`, 0 is assumed.

The following steps are performed:

1. Let x be `thisNumberValue(this value)`.
2. ReturnIfAbrupt(x).
3. Let f be `ToInteger(fractionDigits)`. (If `fractionDigits` is `undefined`, this step produces the value 0).
4. ReturnIfAbrupt(f).
5. If $f < 0$ or $f > 20$, throw a `RangeError` exception. However, an implementation is permitted to extend the behaviour of `toFixed` for values of f less than 0 or greater than 20. In this case `toFixed` would not necessarily throw `RangeError` for such values.
6. If x is `NaN`, return the String "`NaN`".
7. Let s be the empty String.
8. If $x < 0$, then
 - a. Let s be "-".
 - b. Let $x = -x$.
9. If $x \geq 10^{21}$, then
 - a. Let $m = \text{ToString}(x)$.
10. Else $x < 10^{21}$,
 - a. Let n be an integer for which the exact mathematical value of $n / 10^f - x$ is as close to zero as possible. If there are two such n , pick the larger n .
 - b. If $n = 0$, let m be the String "0". Otherwise, let m be the String consisting of the digits of the decimal representation of n (in order, with no leading zeroes).
 - c. If $f \neq 0$, then
 - i. Let k be the number of elements in m .
 - ii. If $k \leq f$, then
 1. Let z be the String consisting of $f+1-k$ occurrences of the code unit 0x0030.
 2. Let m be the concatenation of Strings z and m .
 3. Let $k = f + 1$.
 - iii. Let a be the first $k-f$ elements of m , and let b be the remaining f elements of m .
 - iv. Let m be the concatenation of the three Strings a , ".", and b .
11. Return the concatenation of the Strings s and m .

The `length` property of the `toFixed` method is **1**.

If the `toFixed` method is called with more than one argument, then the behaviour is undefined (see clause 17).

NOTE The output of `toFixed` may be more precise than `toString` for some values because `toString` only prints enough significant digits to distinguish the number from adjacent number values. For example, `(1000000000000000128).toString()` returns "1000000000000000100", while `(1000000000000000128).toFixed(0)` returns "1000000000000000128".

Deleted: An implementation is permitted to extend the behaviour of `toFixed` for values of `fractionDigits` less than 0 or greater than 20. In this case `toFixed` would not necessarily throw `RangeError` for such values.¹¹

20.1.3.4 Number.prototype.toLocaleString([reserved1 [, reserved2]])

An ECMAScript implementation that includes the ECMA-402 Internationalization API must implement the `Number.prototype.toLocaleString` method as specified in the ECMA-402 specification. If an ECMAScript implementation does not include the ECMA-402 API the following specification of the `toLocaleString` method is used.

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Produces a String value that represents this Number value formatted according to the conventions of the host environment's current locale. This function is implementation-dependent, and it is permissible, but not encouraged, for it to return the same thing as `toString`.

The meanings of the optional parameters to this method are defined in the ECMA-402 specification; implementations that do not include ECMA-402 support must not use those parameter positions¹² for anything else.

The `length` property of the `toLocaleString` method is **0**.

20.1.3.5 Number.prototype.toPrecision (precision)

Return a String containing this Number value represented either in decimal exponential notation with one digit before the significand's decimal point and `precision`-1 digits after the significand's decimal point or in decimal fixed notation with `precision` significant digits. If `precision` is `undefined`, call `ToString` (7.1.12) instead. Specifically, perform the following steps:

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1. Let `x` be `thisNumberValue(this value)`.
2. ReturnIfAbrupt(`x`).
3. If `precision` is `undefined`, return `ToString(x)`.
4. Let `p` be `ToInteger(precision)`.
5. ReturnIfAbrupt(`p`).
6. If `x` is `NaN`, return the String "`NaN`".
7. Let `s` be the empty String.
8. If `x < 0`, then
 - a. Let `s` be `code unit U+002D (HYPHEN-MINUS)`.
 - b. Let `x = -x`.
9. If `x = +∞`, then
 - a. Return the `String that is the concatenation of s and "Infinity"`.
10. If `p < 1` or `p > 21`, throw a `RangeError` exception. However, an implementation is permitted to extend the behaviour of `toPrecision` for values of `p` less than 1 or greater than 21. In this case `toPrecision` would not necessarily throw `RangeError` for such values.
11. If `x = 0`, then
 - a. Let `m` be the String consisting of `p` occurrences of the code unit `U+0030 (DIGIT ZERO)`.
 - b. Let `e = 0`.

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12. Else $x \neq 0$,
 - a. Let e and n be integers such that $10^{p-1} \leq n < 10^p$ and for which the exact mathematical value of $n \times 10^{e-p+1} - x$ is as close to zero as possible. If there are two such sets of e and n , pick the e and n for which $n \times 10^{e-p+1}$ is larger.
 - b. Let m be the String consisting of the digits of the decimal representation of n (in order, with no leading zeroes).
 - c. If $e < -6$ or $e \geq p$, then
 - i. Assert: $e \neq 0$
 - ii. Let a be the first element of m , and let b be the remaining $p-1$ elements of m .
 - iii. Let m be the concatenation of a , [code unit U+002E \(FULL STOP\)](#), and b .
 - iv. If $e > 0$, then
 1. Let c [be code unit U+002B \(PLUS SIGN\)](#),
 - v. Else $e < 0$,
 1. Let c [be code unit U+002D \(HYPHEN-MINUS\)](#),
 2. Let $e = -e$.
 - vi. Let d be the String consisting of the digits of the decimal representation of e (in order, with no leading zeroes).
 - vii. Return the concatenation of s , m , [code unit U+0065 \(LATIN SMALL LETTER E\)](#), c , and d .
 13. If $e = p-1$, [return](#) the concatenation of the Strings s and m .
 14. If $e \geq 0$, then
 - a. Let m be the concatenation of the first $e+1$ elements of m , the code unit [U+002E \(FULL STOP\)](#), and the remaining $p-(e+1)$ elements of m .
 15. Else $e < 0$,
 - a. Let m be the [String formed by the](#) concatenation of [code unit U+0030 \(DIGIT ZERO\)](#), [code unit U+002E \(FULL STOP\)](#), $-(e+1)$ occurrences of [code unit U+0030 \(DIGIT ZERO\)](#), and the String m .
 16. Return the [String that is the](#) concatenation of s and m .

The `length` property of the `toPrecision` method is 1.

If the `toPrecision` method is called with more than one argument, then the behaviour is undefined (see clause 17).

20.1.3.6 `Number.prototype.toString ([radix])`

NOTE The optional `radix` should be an integer value in the inclusive range 2 to 36. If `radix` not present or is `undefined` the Number 10 is used as the value of `radix`.

The following steps are performed:

1. [Let \$x\$ be thisNumberValue\(this value\).](#)
2. [ReturnIfAbrupt\(x\).](#)
3. [If `radix` is not present, let `radixNumber` be 10.](#)
4. [Else if `radix` is `undefined`, let `radixNumber` be 10.](#)
5. [Else let `radixNumber` be `ToInteger\(radix\)`.](#)
6. [ReturnIfAbrupt\(`radixNumber`\).](#)
7. [If `radixNumber < 2` or `radixNumber > 36`, throw a `RangeError` exception.](#)
8. [If `radixNumber = 10`, return `ToString\(x\)`.](#)
9. [Return the String representation of this Number value using the `radix` specified by `radixNumber`.](#)

Letters `a-z` are used for digits with values 10 through 35. The precise algorithm is implementation-dependent, however the algorithm should be a [generalization](#) of that specified in 7.1.12.1.

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Deleted: <code>"."</code>
Deleted: <code>"1"</code>
Deleted: <code>"="</code>
Deleted: <code>"+"</code>
Deleted: <code>"-"</code>
Deleted: the five Strings
Deleted: <code>"e"</code>
Deleted: <code>,</code> , then return
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Deleted: <code>ro</code>
Deleted: the String <code>"0 . "</code>
Deleted: <code>0x0030 (the Unicode character '0')</code>
Deleted: the Strings
Deleted: An implementation is permitted to extend the behaviour of <code>toPrecision</code> for values of <code>precision</code> less than 1 or greater than 21. In this case <code>toPrecision</code> would not necessarily throw <code>RangeError</code> for such values.
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Deleted: If <code>ToInteger(radix)</code> is the Number 10 then this Number value is given as an argument to the <code>ToString</code> abstract operation; the resulting String value is returned.
Deleted: If <code>ToInteger(radix)</code> is not an integer between 2 and 36 inclusive throw a <code>RangeError</code> exception. If <code>ToInteger(radix)</code> is an integer from 2 to 36, but not 10, the result is a String representation of this Number value using the specified radix. Letters <code>a-z</code> are used for digits with values 10 through 35. The precise algorithm is implementation-dependent if the radix is not 10, however the algorithm should be a generalisation of that specified in 7.1.12.1.
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The `toString` function is not generic; it throws a `TypeError` exception if its `this` value is not a Number or a Number object. Therefore, it cannot be transferred to other kinds of objects for use as a method.

20.1.3.7 `Number.prototype.valueOf()`

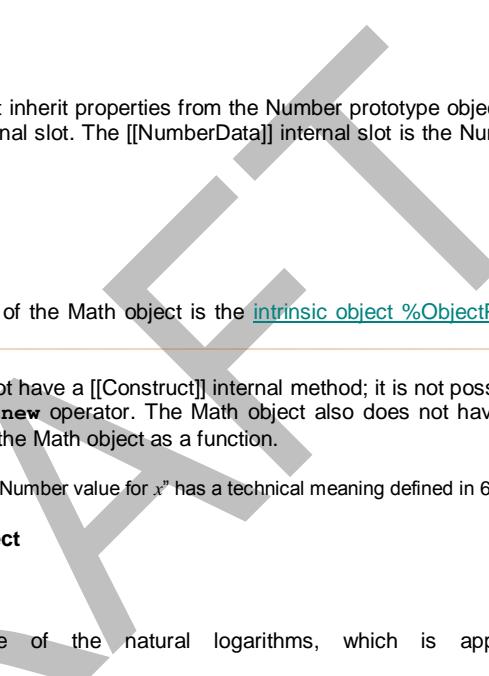
1. Let x be `thisNumberValue(this value)`.
2. Return x .

20.1.4 Properties of Number Instances

Number instances are ordinary objects that inherit properties from the Number prototype object. Number instances also have a `[[NumberData]]` internal slot. The `[[NumberData]]` internal slot is the Number value represented by this Number object.

20.2 The Math Object

The Math object is a single ordinary object.

The value of the `[[Prototype]]` internal slot of the Math object is the [intrinsic object %ObjectPrototype%](#) (19.1.3).


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The Math is not a function object. It does not have a `[[Construct]]` internal method; it is not possible to use the Math object as a constructor with the `new` operator. The Math object also does not have a `[[Call]]` internal method; it is not possible to invoke the Math object as a function.

NOTE In this specification, the phrase “the Number value for x ” has a technical meaning defined in 6.1.6.

20.2.1 Value Properties of the Math Object

20.2.1.1 `Math.E`

The Number value for e , the base of the natural logarithms, which is approximately 2.7182818284590452354.

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

20.2.1.2 `Math.LN10`

The Number value for the natural logarithm of 10, which is approximately 2.302585092994046.

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

20.2.1.3 `Math.LN2`

The Number value for the natural logarithm of 2, which is approximately 0.6931471805599453.

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

20.2.1.4 `Math.LOG10E`

The Number value for the base-10 logarithm of e , the base of the natural logarithms; this value is approximately 0.4342944819032518.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

NOTE The value of **Math.LOG10E** is approximately the reciprocal of the value of **Math.LN10**.

20.2.1.5 **Math.LOG2E**

The Number value for the base-2 logarithm of e , the base of the natural logarithms; this value is approximately 1.4426950408889634.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

NOTE The value of **Math.LOG2E** is approximately the reciprocal of the value of **Math.LN2**.

20.2.1.6 **Math.PI**

The Number value for π , the ratio of the circumference of a circle to its diameter, which is approximately 3.1415926535897932.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

20.2.1.7 **Math.SQRT1_2**

The Number value for the square root of $\frac{1}{2}$, which is approximately 0.7071067811865476.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

NOTE The value of **Math.SQRT1_2** is approximately the reciprocal of the value of **Math.SQRT2**.

20.2.1.8 **Math.SQRT2**

The Number value for the square root of 2, which is approximately 1.4142135623730951.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

20.2.1.9 **Math [@@toStringTag]**

The initial value of the **@@toStringTag** property is the string value "**Math**".

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **true** }.

20.2.2 Function Properties of the Math Object

Each of the following **Math** object functions applies the **ToNumber** abstract operation to each of its arguments (in left-to-right order if there is more than one). If **ToNumber** returns an abrupt completion, that Completion Record is immediately returned. Otherwise, the function performs a computation on the resulting Number value(s). The value returned by each function is a Number.

Deleted: <#>**Math.LN2**
 The Number value for the natural logarithm of 2, which is approximately 0.6931471805599453.
 This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

In the function descriptions below, the symbols **Nan**, **-0**, **+0**, **$-\infty$** and **$+\infty$** refer to the Number values described in 6.1.6.

NOTE The behaviour of the functions `acos`, `acosh`, `asin`, `asinh`, `atan`, `atanh`, `atan2`, `cbrt`, `cos`, `cosh`, `exp`, `expm1`, `hypot`, `log`, `log1p`, `log2`, `log10`, `pow`, `random`, `sin`, `sinh`, `sqrt`, `tan`, and `tanh` is not precisely specified here except to require specific results for certain argument values that represent boundary cases of interest. For other argument values, these functions are intended to compute approximations to the results of familiar mathematical functions, but some latitude is allowed in the choice of approximation algorithms. The general intent is that an implementer should be able to use the same mathematical library for ECMAScript on a given hardware platform that is available to C programmers on that platform.

Although the choice of algorithms is left to the implementation, it is recommended (but not specified by this standard) that implementations use the approximation algorithms for IEEE 754 arithmetic contained in `fdlibm`, the freely distributable mathematical library from Sun Microsystems (<http://www.netlib.org/fdlibm>)

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20.2.2.1 Math.abs (*x*)

Returns the absolute value of *x*; the result has the same magnitude as *x* but has positive sign.

- If *x* is NaN, the result is NaN.
- If *x* is -0, the result is +0.
- If *x* is $-\infty$, the result is $+\infty$.

20.2.2.2 Math.acos (*x*)

Returns an implementation-dependent approximation to the arc cosine of *x*. The result is expressed in radians and ranges from +0 to $+\pi$.

- If *x* is NaN, the result is NaN.
- If *x* is greater than 1, the result is NaN.
- If *x* is less than -1, the result is NaN.
- If *x* is exactly 1, the result is +0.

20.2.2.3 Math.acosh(*x*)

Returns an implementation-dependent approximation to the inverse hyperbolic cosine of *x*

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- If *x* is NaN, the result is NaN.
- If *x* is less than 1, the result is NaN.
- If *x* is 1, the result is +0.
- If *x* is $+\infty$, the result is $+\infty$.

20.2.2.4 Math.asin (*x*)

Returns an implementation-dependent approximation to the arc sine of *x*. The result is expressed in radians and ranges from $-\pi/2$ to $+\pi/2$.

- If *x* is NaN, the result is NaN.
- If *x* is greater than 1, the result is NaN.
- If *x* is less than -1, the result is NaN.
- If *x* is +0, the result is +0.
- If *x* is -0, the result is -0.

20.2.2.5 Math.asinh(*x*)

Returns an implementation-dependent approximation to the inverse hyperbolic sine of *x*

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- If x is NaN, the result is NaN.
- If x is +0, the result is +0.
- If x is -0, the result is -0.
- If x is $+\infty$, the result is $+\infty$.
- If x is $-\infty$, the result is $-\infty$.

20.2.2.6 Math.atan(x)

Returns an implementation-dependent approximation to the arc tangent of x . The result is expressed in radians and ranges from $-\pi/2$ to $+\pi/2$.

- If x is NaN, the result is NaN.
- If x is +0, the result is +0.
- If x is -0, the result is -0.
- If x is $+\infty$, the result is an implementation-dependent approximation to $+\pi/2$.
- If x is $-\infty$, the result is an implementation-dependent approximation to $-\pi/2$.

20.2.2.7 Math.atanh(x)

Returns an implementation-dependent approximation to the inverse hyperbolic tangent of x .

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- If x is NaN, the result is NaN.
- If x is less than -1, the result is NaN.
- If x is greater than 1, the result is NaN.
- If x is -1, the result is $-\infty$.
- If x is +1, the result is $+\infty$.
- If x is +0, the result is +0.
- If x is -0, the result is -0.

20.2.2.8 Math.atan2(y , x)

Returns an implementation-dependent approximation to the arc tangent of the quotient y/x of the arguments y and x , where the signs of y and x are used to determine the quadrant of the result. Note that it is intentional and traditional for the two-argument arc tangent function that the argument named y be first and the argument named x be second. The result is expressed in radians and ranges from $-\pi$ to $+\pi$.

- If either x or y is NaN, the result is NaN.
- If $y > 0$ and x is +0, the result is an implementation-dependent approximation to $+\pi/2$.
- If $y > 0$ and x is -0, the result is an implementation-dependent approximation to $+\pi/2$.
- If y is +0 and $x > 0$, the result is +0.
- If y is +0 and x is +0, the result is +0.
- If y is +0 and x is -0, the result is an implementation-dependent approximation to $+\pi$.
- If y is -0 and $x < 0$, the result is an implementation-dependent approximation to $+\pi$.
- If y is -0 and $x > 0$, the result is -0.
- If y is -0 and x is +0, the result is -0.
- If y is -0 and x is -0, the result is an implementation-dependent approximation to $-\pi$.
- If y is -0 and $x < 0$, the result is an implementation-dependent approximation to $-\pi$.
- If $y < 0$ and x is +0, the result is an implementation-dependent approximation to $-\pi/2$.
- If $y < 0$ and x is -0, the result is an implementation-dependent approximation to $-\pi/2$.
- If $y > 0$ and y is finite and x is $+\infty$, the result is +0.
- If $y > 0$ and y is finite and x is $-\infty$, the result is an implementation-dependent approximation to $+\pi$.
- If $y < 0$ and y is finite and x is $+\infty$, the result is -0.

- If $y < 0$ and y is finite and x is $-\infty$, the result is an implementation-dependent approximation to $-\pi$.
- If y is $+\infty$ and x is finite, the result is an implementation-dependent approximation to $+\pi/2$.
- If y is $-\infty$ and x is finite, the result is an implementation-dependent approximation to $-\pi/2$.
- If y is $+\infty$ and x is $+\infty$, the result is an implementation-dependent approximation to $+\pi/4$.
- If y is $+\infty$ and x is $-\infty$, the result is an implementation-dependent approximation to $+3\pi/4$.
- If y is $-\infty$ and x is $+\infty$, the result is an implementation-dependent approximation to $-\pi/4$.
- If y is $-\infty$ and x is $-\infty$, the result is an implementation-dependent approximation to $-3\pi/4$.

20.2.2.9 Math.cbrt (x)

Returns an implementation-dependent approximation to the cube root of x .

- If x is NaN, the result is NaN.
- If x is $+0$, the result is $+0$.
- If x is -0 , the result is -0 .
- If x is $+\infty$, the result is $+\infty$.
- If x is $-\infty$, the result is $-\infty$.

20.2.2.10 Math.ceil (x)

Returns the smallest (closest to $-\infty$) Number value that is not less than x and is equal to a mathematical integer. If x is already an integer, the result is x .

- If x is NaN, the result is NaN.
- If x is $+0$, the result is $+0$.
- If x is -0 , the result is -0 .
- If x is $+\infty$, the result is $+\infty$.
- If x is $-\infty$, the result is $-\infty$.
- If x is less than 0 but greater than -1, the result is -0 .

The value of `Math.ceil(x)` is the same as the value of `-Math.floor(-x)`.

20.2.2.11 Math.clz32 (x)

When `Math.clz32` is called with one argument x , the following steps are taken:

1. Let n be `ToInt32(x)`.
2. Let p be the number of leading zero bits in the 32-bit binary representation of n .
3. Return p .

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NOTE If n is 0, p will be 32. If the most significant bit of the 32-bit binary encoding of n is 1, p will be 0.

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20.2.2.12 Math.cos (x)

Returns an implementation-dependent approximation to the cosine of x . The argument is expressed in radians.

- If x is NaN, the result is NaN.
- If x is $+0$, the result is 1.
- If x is -0 , the result is 1.
- If x is $+\infty$, the result is NaN.
- If x is $-\infty$, the result is NaN.

20.2.2.13 Math.cosh (x)

Returns an implementation-dependent approximation to the hyperbolic cosine of x . Deleted: 1

- If x is NaN, the result is NaN.
- If x is +0, the result is 1.
- If x is -0, the result is 1.
- If x is $+\infty$, the result is $+\infty$.
- If x is $-\infty$, the result is $+\infty$.

NOTE The value of $\cosh(x)$ is the same as $(\exp(x) + \exp(-x))/2$.

20.2.2.14 Math.exp (x)

Returns an implementation-dependent approximation to the exponential function of x (e raised to the power of x , where e is the base of the natural logarithms).

- If x is NaN, the result is NaN.
- If x is +0, the result is 1.
- If x is -0, the result is 1.
- If x is $+\infty$, the result is $+\infty$.
- If x is $-\infty$, the result is +0.

20.2.2.15 Math.expm1 (x)

Returns an implementation-dependent approximation to subtracting 1 from the exponential function of x (e raised to the power of x , where e is the base of the natural logarithms). The result is computed in a way that is accurate even when the value of x is close 0. Deleted: .

- If x is NaN, the result is NaN.
- If x is +0, the result is +0.
- If x is -0, the result is -0.
- If x is $+\infty$, the result is $+\infty$.
- If x is $-\infty$, the result is -1.

20.2.2.16 Math.floor (x)

Returns the greatest (closest to $+\infty$) Number value that is not greater than x and is equal to a mathematical integer. If x is already an integer, the result is x .

- If x is NaN, the result is NaN.
- If x is +0, the result is +0.
- If x is -0, the result is -0.
- If x is $+\infty$, the result is $+\infty$.
- If x is $-\infty$, the result is $-\infty$.
- If x is greater than 0 but less than 1, the result is +0.

NOTE The value of `Math.floor(x)` is the same as the value of `-Math.ceil(-x)`.

20.2.2.17 Math.fround (x)

When `Math.fround` is called with argument x the following steps are taken:

1. If x is NaN, return NaN.
2. If x is one of $+0, -0, +\infty, -\infty$, return x .
3. Let x_{32} be the result of converting x to a value in IEEE-754-2008 binary32 format using roundTiesToEven.
4. Let x_{64} be the result of converting x_{32} to a value in IEEE-754-2008 binary64 format.
5. Return the ECMAScript Number value corresponding to x_{64} .

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20.2.2.18 Math.hypot (value1 , value2 , ...values)

Math.hypot returns an implementation-dependent approximation of the square root of the sum of squares of its arguments.

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- If no arguments are passed, the result is $+0$.
- If any argument is $+\infty$, the result is $+\infty$.
- If any argument is $-\infty$, the result is $+\infty$.
- If no argument is $+\infty$ or $-\infty$, and any argument is NaN, the result is NaN.
- If all arguments are either $+0$ or -0 , the result is $+0$.

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The length property of the **hypot** function is 2.

NOTE Implementations should take care to avoid the loss of precision from overflows and underflows that are prone to occur in naive implementations when this function is called with two or more arguments.

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20.2.2.19 Math.imul (x , y)

When the **Math.imul** is called with arguments x and y the following steps are taken:

1. Let a be **ToUint32**(x).
2. Let b be **ToUint32**(y).
3. Let $product$ be $(a \times b)$ modulo 2^{32} .
4. If $product \geq 2^{31}$, return $product - 2^{32}$, otherwise return $product$.

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Deleted: <#>ReturnIfAbrupt(b).¶

20.2.2.20 Math.log (x)

Returns an implementation-dependent approximation to the natural logarithm of x .

- If x is NaN, the result is NaN.
- If x is less than 0, the result is NaN.
- If x is $+0$ or -0 , the result is $-\infty$.
- If x is 1, the result is $+0$.
- If x is $+\infty$, the result is $+\infty$.

20.2.2.21 Math.log1p (x)

Returns an implementation-dependent approximation to the natural logarithm of $1 + x$. The result is computed in a way that is accurate even when the value of x is close to zero.

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- If x is NaN, the result is NaN.
- If x is less than -1 , the result is NaN.
- If x is -1 , the result is $-\infty$.
- If x is $+0$, the result is $+0$.
- If x is -0 , the result is -0 .
- If x is $+\infty$, the result is $+\infty$.

20.2.2.22 Math.log10 (*x*)

Returns an implementation-dependent approximation to the base 10 logarithm of *x*.

- If *x* is NaN, the result is NaN.
- If *x* is less than 0, the result is NaN.
- If *x* is +0, the result is $-\infty$.
- If *x* is -0 , the result is $-\infty$.
- If *x* is 1, the result is +0.
- If *x* is $+\infty$, the result is $+\infty$.

20.2.2.23 Math.log2 (*x*)

Returns an implementation-dependent approximation to the base 2 logarithm of *x*.

- If *x* is NaN, the result is NaN.
- If *x* is less than 0, the result is NaN.
- If *x* is +0, the result is $-\infty$.
- If *x* is -0 , the result is $-\infty$.
- If *x* is 1, the result is +0.
- If *x* is $+\infty$, the result is $+\infty$.

20.2.2.24 Math.max (*value1*, *value2*, ...*values*)

Given zero or more arguments, calls ToNumber on each of the arguments and returns the largest of the resulting values.

- If no arguments are given, the result is $-\infty$.
- If any value is NaN, the result is NaN.
- The comparison of values to determine the largest value is done using the Abstract Relational Comparison algorithm (7.2.9) except that +0 is considered to be larger than -0 .

The `length` property of the `max` method is 2.

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20.2.2.25 Math.min (*value1*, *value2*, ...*values*)

Given zero or more arguments, calls ToNumber on each of the arguments and returns the smallest of the resulting values.

- If no arguments are given, the result is $+\infty$.
- If any value is NaN, the result is NaN.
- The comparison of values to determine the smallest value is done using the Abstract Relational Comparison algorithm (7.2.9) except that +0 is considered to be larger than -0 .

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The `length` property of the `min` method is 2.

20.2.2.26 Math.pow (*x*, *y*)

Returns an implementation-dependent approximation to the result of raising *x* to the power *y*.

- If *y* is NaN, the result is NaN.

- If y is $+0$, the result is 1 , even if x is NaN .
- If y is -0 , the result is 1 , even if x is NaN .
- If x is NaN and y is nonzero, the result is NaN .
- If $\text{abs}(x) > 1$ and y is $+\infty$, the result is $+\infty$.
- If $\text{abs}(x) > 1$ and y is $-\infty$, the result is $+0$.
- If $\text{abs}(x) = 1$ and y is $+\infty$, the result is NaN .
- If $\text{abs}(x) = 1$ and y is $-\infty$, the result is NaN .
- If $\text{abs}(x) < 1$ and y is $+\infty$, the result is $+0$.
- If $\text{abs}(x) < 1$ and y is $-\infty$, the result is $+\infty$.
- If x is $+\infty$ and $y > 0$, the result is $+\infty$.
- If x is $+\infty$ and $y < 0$, the result is $+0$.
- If x is $-\infty$ and $y > 0$ and y is an odd integer, the result is $-\infty$.
- If x is $-\infty$ and $y > 0$ and y is not an odd integer, the result is $+\infty$.
- If x is $-\infty$ and $y < 0$ and y is an odd integer, the result is -0 .
- If x is $-\infty$ and $y < 0$ and y is not an odd integer, the result is $+0$.
- If x is $+0$ and $y > 0$, the result is $+0$.
- If x is $+0$ and $y < 0$, the result is $+\infty$.
- If x is -0 and $y > 0$ and y is an odd integer, the result is -0 .
- If x is -0 and $y > 0$ and y is not an odd integer, the result is $+0$.
- If x is -0 and $y < 0$ and y is an odd integer, the result is $-\infty$.
- If x is -0 and $y < 0$ and y is not an odd integer, the result is $+\infty$.
- If $x < 0$ and x is finite and y is finite and y is not an integer, the result is NaN .

20.2.2.27 Math.random ()

Returns a Number value with positive sign, greater than or equal to 0 but less than 1 , chosen randomly or pseudo randomly with approximately uniform distribution over that range, using an implementation-dependent algorithm or strategy. This function takes no arguments.

Each `Math.random` function created for distinct code Realms must produce a distinct sequence of values from successive calls.

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20.2.2.28 Math.round (x)

Returns the Number value that is closest to x and is equal to a mathematical integer. If two integer Number values are equally close to x , then the result is the Number value that is closer to $+\infty$. If x is already an integer, the result is x .

- If x is NaN , the result is NaN .
- If x is $+0$, the result is $+0$.
- If x is -0 , the result is -0 .
- If x is $+\infty$, the result is $+\infty$.
- If x is $-\infty$, the result is $-\infty$.
- If x is greater than 0 but less than 0.5 , the result is $+0$.
- If x is less than 0 but greater than or equal to -0.5 , the result is -0 .

NOTE 1 `Math.round(3.5)` returns 4 , but `Math.round(-3.5)` returns -3 .

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+0. `Math.round(x)` may also differ from the value of `Math.floor(x+0.5)` because of internal rounding when computing $x=0.5$.

20.2.2.29 Math.sign(*x*)

Returns the sign of the *x*, indicating whether *x* is positive, negative or zero.

- If *x* is NaN, the result is NaN.
- If *x* is -0, the result is -0.
- If *x* is +0, the result is +0.
- If *x* is negative and not -0, the result is -1.
- If *x* is positive and not +0, the result is +1.

20.2.2.30 Math.sin (*x*)

Returns an implementation-dependent approximation to the sine of *x*. The argument is expressed in radians.

- If *x* is NaN, the result is NaN.
- If *x* is +0, the result is +0.
- If *x* is -0, the result is -0.
- If *x* is $+\infty$ or $-\infty$, the result is NaN.

20.2.2.31 Math.sinh(*x*)

Returns an implementation-dependent approximation to the hyperbolic sine of *x*.

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- If *x* is NaN, the result is NaN.
- If *x* is +0, the result is +0.
- If *x* is -0, the result is -0.
- If *x* is $+\infty$, the result is $+\infty$.
- If *x* is $-\infty$, the result is $-\infty$.

NOTE The value of sinh(*x*) is the same as $(\exp(x) - \exp(-x))/2$.

20.2.2.32 Math.sqrt (*x*)

Returns an implementation-dependent approximation to the square root of *x*.

- If *x* is NaN, the result is NaN.
- If *x* is less than 0, the result is NaN.
- If *x* is +0, the result is +0.
- If *x* is -0, the result is -0.
- If *x* is $+\infty$, the result is $+\infty$.

20.2.2.33 Math.tan (*x*)

Returns an implementation-dependent approximation to the tangent of *x*. The argument is expressed in radians.

- If *x* is NaN, the result is NaN.
- If *x* is +0, the result is +0.
- If *x* is -0, the result is -0.

- If x is $+\infty$ or $-\infty$, the result is NaN.

20.2.2.34 Math.tanh (x)

Returns an implementation-dependent approximation to the hyperbolic tangent of x .

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- If x is NaN, the result is NaN.
- If x is $+0$, the result is $+0$.
- If x is -0 , the result is -0 .
- If x is $+\infty$, the result is $+1$.
- If x is $-\infty$, the result is -1 .

NOTE The value of $\tanh(x)$ is the same as $(\exp(x) - \exp(-x)) / (\exp(x) + \exp(-x))$.

20.2.2.35 Math.trunc (x)

Returns the integral part of the number x , removing any fractional digits. If x is already an integer, the result is x .

- If x is NaN, the result is NaN.
- If x is -0 , the result is -0 .
- If x is $+0$, the result is $+0$.
- If x is $+\infty$, the result is $+\infty$.
- If x is $-\infty$, the result is $-\infty$.
- If x is greater than 0 but less than 1, the result is $+0$.
- If x is less than 0 but greater than -1 , the result is -0 .

20.3 Date Objects

20.3.1 Overview of Date Objects and Definitions of Abstract Operations

The following functions are abstract operations that operate on time values (defined in 20.3.1.1). Note that, in every case, if any argument to one of these functions is NaN, the result will be NaN.

20.3.1.1 Time Values and Time Range

A Date object contains a Number indicating a particular instant in time to within a millisecond. Such a Number is called a *time value*. A time value may also be NaN, indicating that the Date object does not represent a specific instant of time.

Time is measured in ECMAScript in milliseconds since 01 January, 1970 UTC. In time values leap seconds are ignored. It is assumed that there are exactly 86,400,000 milliseconds per day. ECMAScript Number values can represent all integers from $-9,007,199,254,740,992$ to $9,007,199,254,740,992$; this range suffices to measure times to millisecond precision for any instant that is within approximately 285,616 years, either forward or backward, from 01 January, 1970 UTC.

The actual range of times supported by ECMAScript Date objects is slightly smaller: exactly $-100,000,000$ days to $100,000,000$ days measured relative to midnight at the beginning of 01 January, 1970 UTC. This gives a range of 8,640,000,000,000 milliseconds to either side of 01 January, 1970 UTC.

The exact moment of midnight at the beginning of 01 January, 1970 UTC is represented by the value **+0**.

20.3.1.2 Day Number and Time within Day

A given time value t belongs to day number

$$\text{Day}(t) = \text{floor}(t / \text{msPerDay})$$

where the number of milliseconds per day is

$$\text{msPerDay} = 86400000$$

The remainder is called the time within the day:

$$\text{TimeWithinDay}(t) = t \bmod \text{msPerDay}$$

20.3.1.3 Year Number

ECMAScript uses an extrapolated Gregorian system to map a day number to a year number and to determine the month and date within that year. In this system, leap years are precisely those which are (divisible by 4) and ((not divisible by 100) or (divisible by 400)). The number of days in year number y is therefore defined by

$$\begin{aligned}\text{DaysInYear}(y) &= 365 \text{ if } (y \bmod 4) \neq 0 \\ &= 366 \text{ if } (y \bmod 4) = 0 \text{ and } (y \bmod 100) \neq 0 \\ &= 365 \text{ if } (y \bmod 100) = 0 \text{ and } (y \bmod 400) \neq 0 \\ &= 366 \text{ if } (y \bmod 400) = 0\end{aligned}$$

All non-leap years have 365 days with the usual number of days per month and leap years have an extra day in February. The day number of the first day of year y is given by:

$$\text{DayFromYear}(y) = 365 \times (y - 1970) + \text{floor}((y - 1969)/4) - \text{floor}((y - 1901)/100) + \text{floor}((y - 1601)/400)$$

The time value of the start of a year is:

$$\text{TimeFromYear}(y) = \text{msPerDay} \times \text{DayFromYear}(y)$$

A time value determines a year by:

$$\text{YearFromTime}(t) = \text{the largest integer } y \text{ (closest to positive infinity) such that } \text{TimeFromYear}(y) \leq t$$

The leap-year function is 1 for a time within a leap year and otherwise is zero:

$$\begin{aligned}\text{InLeapYear}(t) &= 0 \text{ if } \text{DaysInYear}(\text{YearFromTime}(t)) = 365 \\ &= 1 \text{ if } \text{DaysInYear}(\text{YearFromTime}(t)) = 366\end{aligned}$$

20.3.1.4 Month Number

Months are identified by an integer in the range 0 to 11, inclusive. The mapping $\text{MonthFromTime}(t)$ from a time value t to a month number is defined by:

$$\begin{aligned}\text{MonthFromTime}(t) &= 0 \text{ if } 0 \leq \text{DayWithinYear}(t) < 31 \\ &= 1 \text{ if } 31 \leq \text{DayWithinYear}(t) < 59 + \text{InLeapYear}(t) \\ &= 2 \text{ if } 59 + \text{InLeapYear}(t) \leq \text{DayWithinYear}(t) < 90 + \text{InLeapYear}(t) \\ &= 3 \text{ if } 90 + \text{InLeapYear}(t) \leq \text{DayWithinYear}(t) < 120 + \text{InLeapYear}(t) \\ &= 4 \text{ if } 120 + \text{InLeapYear}(t) \leq \text{DayWithinYear}(t) < 151 + \text{InLeapYear}(t) \\ &= 5 \text{ if } 151 + \text{InLeapYear}(t) \leq \text{DayWithinYear}(t) < 181 + \text{InLeapYear}(t) \\ &= 6 \text{ if } 181 + \text{InLeapYear}(t) \leq \text{DayWithinYear}(t) < 212 + \text{InLeapYear}(t)\end{aligned}$$

```
= 7 if 212+InLeapYear(t) ≤ DayWithinYear(t) < 243+InLeapYear(t)
= 8 if 243+InLeapYear(t) ≤ DayWithinYear(t) < 273+InLeapYear(t)
= 9 if 273+InLeapYear(t) ≤ DayWithinYear(t) < 304+InLeapYear(t)
= 10 if 304+InLeapYear(t) ≤ DayWithinYear(t) < 334+InLeapYear(t)
= 11 if 334+InLeapYear(t) ≤ DayWithinYear(t) < 365+InLeapYear(t)
```

where

$$\text{DayWithinYear}(t) = \text{Day}(t) - \text{DayFromYear}(\text{YearFromTime}(t))$$

A month value of 0 specifies January; 1 specifies February; 2 specifies March; 3 specifies April; 4 specifies May; 5 specifies June; 6 specifies July; 7 specifies August; 8 specifies September; 9 specifies October; 10 specifies November; and 11 specifies December. Note that $\text{MonthFromTime}(0) = 0$, corresponding to Thursday, 01 January, 1970.

20.3.1.5 Date Number

A date number is identified by an integer in the range 1 through 31, inclusive. The mapping $\text{DateFromTime}(t)$ from a time value t to a date number is defined by:

$\text{DateFromTime}(t) = \text{DayWithinYear}(t) +$	if $\text{MonthFromTime}(t) = 0$
$= \text{DayWithinYear}(t) - 30$	if $\text{MonthFromTime}(t) = 1$
$= \text{DayWithinYear}(t) - 58 - \text{InLeapYear}(t)$	if $\text{MonthFromTime}(t) = 2$
$= \text{DayWithinYear}(t) - 89 - \text{InLeapYear}(t)$	if $\text{MonthFromTime}(t) = 3$
$= \text{DayWithinYear}(t) - 119 - \text{InLeapYear}(t)$	if $\text{MonthFromTime}(t) = 4$
$= \text{DayWithinYear}(t) - 150 - \text{InLeapYear}(t)$	if $\text{MonthFromTime}(t) = 5$
$= \text{DayWithinYear}(t) - 180 - \text{InLeapYear}(t)$	if $\text{MonthFromTime}(t) = 6$
$= \text{DayWithinYear}(t) - 211 - \text{InLeapYear}(t)$	if $\text{MonthFromTime}(t) = 7$
$= \text{DayWithinYear}(t) - 242 - \text{InLeapYear}(t)$	if $\text{MonthFromTime}(t) = 8$
$= \text{DayWithinYear}(t) - 272 - \text{InLeapYear}(t)$	if $\text{MonthFromTime}(t) = 9$
$= \text{DayWithinYear}(t) - 303 - \text{InLeapYear}(t)$	if $\text{MonthFromTime}(t) = 10$
$= \text{DayWithinYear}(t) - 333 - \text{InLeapYear}(t)$	if $\text{MonthFromTime}(t) = 11$

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20.3.1.6 Week Day

The weekday for a particular time value t is defined as

$$\text{WeekDay}(t) = (\text{Day}(t) + 4) \bmod 7$$

A weekday value of 0 specifies Sunday; 1 specifies Monday; 2 specifies Tuesday; 3 specifies Wednesday; 4 specifies Thursday; 5 specifies Friday; and 6 specifies Saturday. Note that $\text{WeekDay}(0) = 4$, corresponding to Thursday, 01 January, 1970.

20.3.1.7 Local Time Zone Adjustment

An implementation of ECMAScript is expected to determine the local time zone adjustment. The local time zone adjustment is a value LocalTZA measured in milliseconds which when added to UTC represents the local standard time. Daylight saving time is *not* reflected by LocalTZA .

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NOTE It is recommended that implementations use the time zone information of the IANA Time Zone Database <http://www.iana.org/time-zones/>.

20.3.1.8 Daylight Saving Time Adjustment

An implementation dependent algorithm using best available information on time zones to determine the local daylight saving time adjustment $\text{DaylightSavingTA}(t)$, measured in milliseconds. An implementation of ECMAScript is expected to make its best effort to determine the local daylight saving time adjustment.

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NOTE It is recommended that implementations use the time zone information of the IANA Time Zone Database <http://www.iana.org/time-zones/>.

20.3.1.9 Local Time

Conversion from UTC to local time is defined by

$$\text{LocalTime}(t) = t + \text{LocalTZA} + \text{DaylightSavingTA}(t)$$

Conversion from local time to UTC is defined by

$$\text{UTC}(t) = t - \text{LocalTZA} - \text{DaylightSavingTA}(t - \text{LocalTZA})$$

NOTE $\text{UTC}(\text{LocalTime}(t))$ is not necessarily always equal to t .

20.3.1.10 Hours, Minutes, Second, and Milliseconds

The following functions are useful in decomposing time values:

$$\text{HourFromTime}(t) = \text{floor}(t / \text{msPerHour}) \bmod \text{HoursPerDay}$$

$$\text{MinFromTime}(t) = \text{floor}(t / \text{msPerMinute}) \bmod \text{MinutesPerHour}$$

$$\text{SecFromTime}(t) = \text{floor}(t / \text{msPerSecond}) \bmod \text{SecondsPerMinute}$$

$$\text{msFromTime}(t) = t \bmod \text{msPerSecond}$$

where

$$\text{HoursPerDay} = 24$$

$$\text{MinutesPerHour} = 60$$

$$\text{SecondsPerMinute} = 60$$

$$\text{msPerSecond} = 1000$$

$$\text{msPerMinute} = 60000 = \text{msPerSecond} \times \text{SecondsPerMinute}$$

$$\text{msPerHour} = 3600000 = \text{msPerMinute} \times \text{MinutesPerHour}$$

20.3.1.11 MakeTime (hour, min, sec, ms)

The operator `MakeTime` calculates a number of milliseconds from its four arguments, which must be ECMAScript Number values. This operator functions as follows:

1. If `hour` is not finite or `min` is not finite or `sec` is not finite or `ms` is not finite, return `NaN`.
2. Let `h` be `ToInteger(hour)`.
3. Let `m` be `ToInteger(min)`.
4. Let `s` be `ToInteger(sec)`.
5. Let `milli` be `ToInteger(ms)`.
6. Let `t` be `h * msPerHour + m * msPerMinute + s * msPerSecond + milli`, performing the arithmetic according to IEEE 754 rules (that is, as if using the ECMAScript operators `*` and `+`).
7. Return `t`.

20.3.1.12 MakeDay (year, month, date)

The operator MakeDay calculates a number of days from its three arguments, which must be ECMAScript Number values. This operator functions as follows:

1. If *year* is not finite or *month* is not finite or *date* is not finite, return **NaN**.
2. Let *y* be `ToInteger(year)`.
3. Let *m* be `ToInteger(month)`.
4. Let *dt* be `ToInteger(date)`.
5. Let *ym* be *y* + `floor(m / 12)`.
6. Let *mn* be *m* modulo 12.
7. Find a value *t* such that `YearFromTime(t)` is *ym* and `MonthFromTime(t)` is *mn* and `DateFromTime(t)` is 1; but if this is not possible (because some argument is out of range), return **NaN**.
8. Return `Day(t) + dt - 1`.

20.3.1.13 MakeDate (day, time)

The operator MakeDate calculates a number of milliseconds from its two arguments, which must be ECMAScript Number values. This operator functions as follows:

1. If *day* is not finite or *time* is not finite, return **NaN**.
2. Return *day* × `msPerDay` + *time*.

20.3.1.14 TimeClip (time)

The operator TimeClip calculates a number of milliseconds from its argument, which must be an ECMAScript Number value. This operator functions as follows:

1. If *time* is not finite, return **NaN**.
2. If $\text{abs}(\text{time}) > 8.64 \times 10^{15}$, return **NaN**.
3. Return `ToInteger(time) + (+0)`. (Adding a positive zero converts **-0** to **+0**.)

NOTE The point of step 3 is that an implementation is permitted a choice of internal representations of time values, for example as a 64-bit signed integer or as a 64-bit floating-point value. Depending on the implementation, this internal representation may or may not distinguish **-0** and **+0**.

20.3.1.15 Date Time String Format

ECMAScript defines a string interchange format for date-times based upon a simplification of the ISO 8601 Extended Format. The format is as follows: **YYYY-MM-DDTHH:mm:ss.sssZ**

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Where the fields are as follows:

- YYYY** is the decimal digits of the year 0000 to 9999 in the Gregorian calendar.
- “-” (hyphen) appears literally twice in the string.
- MM** is the month of the year from 01 (January) to 12 (December).
- DD** is the day of the month from 01 to 31.
- T** “T” appears literally in the string, to indicate the beginning of the time element.
- HH** is the number of complete hours that have passed since midnight as two decimal digits from 00 to 24.
- :** “:” (colon) appears literally twice in the string.

- mm** is the number of complete minutes since the start of the hour as two decimal digits from 00 to 59.
- ss** is the number of complete seconds since the start of the minute as two decimal digits from 00 to 59.
- .** “.” (dot) appears literally in the string.
- sss** is the number of complete milliseconds since the start of the second as three decimal digits.
- z** is the time zone offset specified as “z” (for UTC) or either “+” or “-” followed by a time expression **HH : mm**

This format includes date-only forms:

YYYY
YYYY-MM
YYYY-MM-DD

It also includes “date-time” forms that consist of one of the above date-only forms immediately followed by one of the following time forms with an optional time zone offset appended:

HHH:mm
HHH:mm:ss
HHH:mm:ss.sss

All numbers must be base 10. If the **MM** or **DD** fields are absent “01” is used as the value. If the **HH**, **mm**, or **ss** fields are absent “00” is used as the value and the value of an absent **sss** field is “000”. If the time zone offset is absent, the date-time is interpreted as a local time.

Illegal values (out-of-bounds as well as syntax errors) in a format string means that the format string is not a valid instance of this format.

NOTE 1 As every day both starts and ends with midnight, the two notations 00:00 and 24:00 are available to distinguish the two midnights that can be associated with one date. This means that the following two notations refer to exactly the same point in time: 1995-02-04T24:00 and 1995-02-05T00:00

NOTE 2 There exists no international standard that specifies abbreviations for civil time zones like CET, EST, etc. and sometimes the same abbreviation is even used for two very different time zones. For this reason, ISO 8601 and this format specifies numeric representations of date and time.

20.3.1.15.1 Extended years

ECMAScript requires the ability to specify 6 digit years (extended years); approximately 285,426 years, either forward or backward, from 01 January, 1970 UTC. To represent years before 0 or after 9999, ISO 8601 permits the expansion of the year representation, but only by prior agreement between the sender and the receiver. In the simplified ECMAScript format such an expanded year representation shall have 2 extra year digits and is always prefixed with a + or – sign. The year 0 is considered positive and hence prefixed with a + sign.

NOTE Examples of extended years:

-283457-03-21T15:00:59.008Z	283458 B.C.
-000001-01-01T00:00:00Z	2 B.C.
+000000-01-01T00:00:00Z	1 B.C.
+000001-01-01T00:00:00Z	1 A.D.

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+001970-01-01T00:00:00Z	1970 A.D.
+002009-12-15T00:00:00Z	2009 A.D.
+287396-10-12T08:59:00.992Z	287396 A.D.

20.3.2 The Date Constructor

The Date constructor is the %Date% intrinsic object and the initial value of the `Date` property of the global object. When called as a constructor it creates and initializes a new Date object. When `Date` is called as a function rather than as a constructor, it returns a String representing the current time (UTC).

The `Date` constructor is a single function whose behaviour is overloaded based upon the number and types of its arguments.

The `Date` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class definition. Subclass constructors that intend to inherit the specified `Date` behaviour must include a `super` call to the `Date` constructor to create and initialize the subclass instance with a [[DateValue]] internal slot.

20.3.2.1 Date (year, month [, date [, hours [, minutes [, seconds [, ms]]]]])

This description applies only if the Date constructor is called with at least two arguments.

When the `Date` function is called the following steps are taken:

1. Let `numberOfArgs` be the number of arguments passed to this function call.
2. Assert: `numberOfArgs` ≥ 2 .
3. If NewTarget is not undefined, then
 - a. Let `y` be `ToNumber(year)`.
 - b. `ReturnIfAbrupt(y)`.
 - c. Let `m` be `ToNumber(month)`.
 - d. `ReturnIfAbrupt(m)`.
 - e. If `date` is supplied, let `dt` be `ToNumber(date)`; else let `dt` be `1`.
 - f. `ReturnIfAbrupt(dt)`.
 - g. If `hours` is supplied, let `h` be `ToNumber(hours)`; else let `h` be `0`.
 - h. `ReturnIfAbrupt(h)`.
 - i. If `minutes` is supplied, let `min` be `ToNumber(minutes)`; else let `min` be `0`.
 - j. `ReturnIfAbrupt(min)`.
 - k. If `seconds` is supplied, let `s` be `ToNumber(seconds)`; else let `s` be `0`.
 - l. `ReturnIfAbrupt(s)`.
 - m. If `ms` is supplied, let `milli` be `ToNumber(ms)`; else let `milli` be `0`.
 - n. `ReturnIfAbrupt(milli)`.
 - o. If `y` is not `NaN` and $0 \leq \text{ToInteger}(y) \leq 99$, let `yr` be $1900 + \text{ToInteger}(y)$; otherwise, let `yr` be `y`.
 - p. Let `finalDate` be `MakeDate(MakeDay(yr, m, dt), MakeTime(h, min, s, milli))`.
 - q. Let `O` be `OrdinaryCreateFromConstructor(NewTarget, "%DatePrototype%", «[[DateValue]]»)`.
 - r. `ReturnIfAbrupt(O)`.
 - s. Set the `[[DateValue]]` internal slot of `O` to `TimeClip(UTC(finalDate))`.
 - t. Return `O`.
4. Else,
 - a. Let `now` be the Number that is the time value (UTC) identifying the current time.
 - b. Return `ToDateString(now)`.

Deleted: d

Deleted: However, if the `this` value passed in the call is an Object with an uninitialized `[[DateValue]]` internal slot, `Date` initializes the `this` object using the argument value. This permits `Date` to be used both as a function for creating data strings and to perform constructor instance initialization.

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Deleted: <#>Let `O` be the `this` value.¶

Deleted: null

Deleted: Type(`O`) is Object and `O` has a `[[DateValue]]` internal slot and the value of `[[DateValue]]` is `undefined`

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20.3.2.2 Date (value)

This description applies only if the Date constructor is called with exactly one argument.

When the `Date` function is called the following steps are taken:

1. Let `numberOfArgs` be the number of arguments passed to this `function` call.
2. Assert: `numberOfArgs` = 1.
3. If `NewTarget` is not `undefined`, then
 - a. If `Type(value)` is Object and `value` has a `[[DateValue]]` internal slot, then
 - i. Let `tv` be `thisTimeValue(value)`.
 - b. Else,
 - i. Let `v` be `ToPrimitive(value)`.
 - ii. If `Type(v)` is String, then
 1. Let `tv` be the result of parsing `v` as a date, in exactly the same manner as for the `parse` method (20.3.3.2). If the parse resulted in an abrupt completion, `tv` is the Completion Record.
 - iii. Else,
 1. Let `tv` be `ToNumber(v)`.
 - c. `ReturnIfAbrupt(tv)`.
 - d. Let `O` be `OrdinaryCreateFromConstructor(NewTarget, "%DatePrototype%", « [[DateValue]] »)`.
 - e. `ReturnIfAbrupt(O)`.
 - f. Set the `[[DateValue]]` internal slot of `O` to `TimeClip(tv)`.
 - g. Return `O`.
4. Else,
 - a. Let `now` be the Number that is the time value (UTC) identifying the current time.
 - b. Return `ToDateString(now)`.

Deleted: constructor

Deleted: <#>Let `O` be the `this` value.¶

Deleted: `null`

Deleted: `Type(O)` is Object and `O` has a `[[DateValue]]` internal slot and the value of `[[DateValue]]` is `undefined`

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Deleted: constructor

Deleted: <#>Let `O` be the `this` value.¶

Deleted: `null`

Deleted: `Type(O)` is Object and `O` has a `[[DateValue]]` internal slot and the value of `[[DateValue]]` is `undefined`

Deleted: <#>`new Date (...argumentsList)`¶

When `Date` is called as part of a new expression with argument list `argumentsList` it performs the following steps:¶

<#>Let `F` be the `Date` function object on which the `new` operator was applied.¶

<#>Let `argumentsList` be the `argumentsList` argument of the `[[Construct]]` internal method that was invoked by the `new` operator.¶

<#>Return `Construct(F, argumentsList)`.¶

If `Date` is implemented as an ECMAScript function object, its `[[Construct]]` internal method will perform the above steps.¶

Deleted: Function prototype object

Deleted: The `[[CreateAction]]` of the Date constructor identifies the following abstract operation:¶

The Date CreateAction abstract operation when called with arguments `constructor` and `argumentsList` performs the following steps:¶

<#>Return
 `OrdinaryCreateFromConstructor(Fconstructor,`
 `"%DatePrototype%", « ([[DateValue]]) »)`.¶

NOTE `[[DateValue]]` is initially assigned the value `undefined` as a flag to indicate that the instance has not yet been initialized by the Date constructor. This flag value is never directly exposed to ECMAScript code; hence implementations may choose to encode the flag in some other manner. ¶

20.3.2.3 Date ()

This description applies only if the Date constructor is called with no arguments.

When the `Date` function is called the following steps are taken:

1. Let `numberOfArgs` be the number of arguments passed to this `function` call.
2. Assert: `numberOfArgs` = 0.
3. If `NewTarget` is not `undefined`, then
 - a. Let `O` be `OrdinaryCreateFromConstructor(NewTarget, "%DatePrototype%", « [[DateValue]] »)`.
 - b. `ReturnIfAbrupt(O)`.
 - c. Set the `[[DateValue]]` internal slot of `O` to the time value (UTC) identifying the current time.
 - d. Return `O`.
4. Else,
 - a. Let `now` be the Number that is the time value (UTC) identifying the current time.
 - b. Return `ToDateString(now)`.

20.3.3 Properties of the Date Constructor

The value of the `[[Prototype]]` internal slot of the Date constructor is the `intrinsic object %FunctionPrototype%` (19.2.3).

Besides the `length` property (whose value is 7), the Date constructor has the following properties:

20.3.3.1 Date.now()

The `now` function return a Number value that is the time value designating the UTC date and time of the occurrence of the call to `now`.

20.3.3.2 Date.parse (string)

The `parse` function applies the `ToString` operator to its argument. If `ToString` results in an abrupt completion the Completion Record is immediately returned. Otherwise, `parse` interprets the resulting String as a date and time; it returns a Number, the UTC time value corresponding to the date and time. The String may be interpreted as a local time, a UTC time, or a time in some other time zone, depending on the contents of the String. The function first attempts to parse the format of the String according to the rules (including extended years) called out in Date Time String Format (20.3.1.15). If the String does not conform to that format the function may fall back to any implementation-specific heuristics or implementation-specific date formats. Unrecognizable Strings or dates containing illegal element values in the format String shall cause `Date.parse` to return `Nan`.

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If `x` is any Date object whose milliseconds amount is zero within a particular implementation of ECMAScript, then all of the following expressions should produce the same numeric value in that implementation, if all the properties referenced have their initial values:

```
x.valueOf()
Date.parse(x.toString())
Date.parse(x.toUTCString())
Date.parse(x.toISOString())
```

However, the expression

```
Date.parse(x.toLocaleString())
```

is not required to produce the same Number value as the preceding three expressions and, in general, the value produced by `Date.parse` is implementation-dependent when given any String value that does not conform to the Date Time String Format (20.3.1.15) and that could not be produced in that implementation by the `toString` or `toUTCString` method.

20.3.3.3 Date.prototype

The initial value of `Date.prototype` is the [intrinsic object %DatePrototype%](#) (20.3.4).

Deleted: built-in Date prototype object

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

20.3.3.4 Date.UTC (year, month [, date [, hours [, minutes [, seconds [, ms]]]]]])

When the `UTC` function is called with fewer than two arguments, the behaviour is implementation-dependent. When the `UTC` function is called with two to seven arguments, it computes the date from `year`, `month` and (optionally) `date`, `hours`, `minutes`, `seconds` and `ms`. The following steps are taken:

1. Let `y` be `ToNumber(year)`.
2. `ReturnIfAbrupt(y)`.
3. Let `m` be `ToNumber(month)`.
4. `ReturnIfAbrupt(m)`.
5. If `date` is supplied, let `dt` be `ToNumber(date)`; else let `dt` be `1`.
6. `ReturnIfAbrupt(dt)`.
7. If `hours` is supplied, let `h` be `ToNumber(hours)`; else let `h` be `0`.
8. `ReturnIfAbrupt(h)`.

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Deleted: then

9. If *minutes* is supplied, let *min* be `ToNumber(minutes)`; else let *min* be **0**. **Deleted:** then
10. ReturnIfAbrupt(*min*). **Deleted:** then
11. If *seconds* is supplied, let *s* be `ToNumber(seconds)`; else let *s* be **0**. **Deleted:** then
12. ReturnIfAbrupt(*s*). **Deleted:** then
13. If *ms* is supplied, let *milli* be `ToNumber(ms)`; else let *milli* be **0**. **Deleted:** then
14. ReturnIfAbrupt(*milli*). **Deleted:** then
15. If *y* is not `Nan` and $0 \leq \text{ToInteger}(y) \leq 99$, let *yr* be `1900 + \text{ToInteger}(y)`; otherwise, let *yr* be *y*. **Deleted:** , then let
16. Return `TimeClip(MakeDate(MakeDay(yr, m, dt), MakeTime(h, min, s, milli)))`.

The `length` property of the `UTC` function is **7**.

NOTE The `UTC` function differs from the `Date` constructor in two ways: it returns a time value as a Number, rather than creating a Date object, and it interprets the arguments in UTC rather than as local time.

20.3.4 Properties of the Date Prototype Object

The Date prototype object is itself an ordinary object. It is not a Date instance and does not have a `[[DateValue]]` internal slot.

The value of the `[[Prototype]]` internal slot of the Date prototype object is the [intrinsic object %ObjectPrototype%](#)(20.3.4).

Unless explicitly defined otherwise, the methods of the Date prototype object defined below are not generic and the `this` value passed to them must be an object that has a `[[DateValue]]` internal slot that has been initialized to a time value.

The abstract operation `thisTimeValue(value)` performs the following steps:

1. If `Type(value)` is Object and *value* has a `[[DateValue]]` internal slot, then
 - a. Return the value of *value*'s `[[DateValue]]` internal slot.
2. Throw a `TypeError` exception.

In following descriptions of functions that are properties of the Date prototype object, the phrase “this Date object” refers to the object that is the `this` value for the invocation of the function. [If the Type of the this value is not Object, a TypeError exception is thrown.](#) The phrase “this time value” within the specification of a method refers to the result returned by calling the abstract operation `thisTimeValue` with the `this` value of the method invocation passed as the argument.

20.3.4.1 Date.prototype.constructor

The initial value of `Date.prototype.constructor` is the [intrinsic object %Date%](#).

Deleted: `<#>Date[@@create]()`
 The `@@create` method of an object *F* performs the following steps:
`<#>Let obj be OrdinaryCreateFromConstructor(F, "%DatePrototype%", ([[DateValue]])).`
`<#>Return obj.`

The value of the `name` property of this function is "`[Symbol.create]`".
 This property has the attributes { `[[Writable]]`: false, `[[Enumerable]]`: false, `[[Configurable]]`: true }.
NOTE `[[DateValue]]` is initially assigned the value `undefined` as a flag to indicate that the instance has not yet been initialized by the `Date` constructor. This flag value is never directly exposed to ECMAScript code; hence implementations may choose to encode the flag in some other manner.

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20.3.4.2 Date.prototype.getDate()

1. Let *t* be this time value.
2. ReturnIfAbrupt(*t*).
3. If *t* is `Nan`, return `Nan`.
4. Return `DateFromTime(LocalTime(t))`.

20.3.4.3 Date.prototype.getDay()

1. Let *t* be this time value.

2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return WeekDay(LocalTime(t)).

20.3.4.4 Date.prototype.getFullYear ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return YearFromTime(LocalTime(t)).

20.3.4.5 Date.prototype.getHours ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return HourFromTime(LocalTime(t)).

20.3.4.6 Date.prototype.getMilliseconds ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return msFromTime(LocalTime(t)).

20.3.4.7 Date.prototype.getMinutes ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return MinFromTime(LocalTime(t)).

20.3.4.8 Date.prototype.getMonth ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return MonthFromTime(LocalTime(t)).

20.3.4.9 Date.prototype.getSeconds ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return SecFromTime(LocalTime(t)).

20.3.4.10 Date.prototype.getTime ()

1. Return this time value.

20.3.4.11 Date.prototype.getTimezoneOffset ()

Returns the difference between local time and UTC time in minutes.

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return $(t - \text{LocalTime}(t)) / \text{msPerMinute}$.

20.3.4.12 Date.prototype.getUTCDate ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return $\text{DateFromTime}(t)$.

20.3.4.13 Date.prototype.getUTCDay ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return $\text{WeekDay}(t)$.

20.3.4.14 Date.prototype.getUTCFullYear ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return $\text{YearFromTime}(t)$.

20.3.4.15 Date.prototype.getUTCHours ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return $\text{HourFromTime}(t)$.

20.3.4.16 Date.prototype.getUTCMilliseconds ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return $\text{msFromTime}(t)$.

20.3.4.17 Date.prototype.getUTCMinutes ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return $\text{MinFromTime}(t)$.

20.3.4.18 Date.prototype.getUTCMonth ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is NaN, return NaN.
4. Return MonthFromTime(t).

20.3.4.19 Date.prototype.getUTCSeconds ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is NaN, return NaN.
4. Return SecFromTime(t).

20.3.4.20 Date.prototype.setDate (date)

1. Let t be the result of LocalTime(this time value).
2. Let dt be ToNumber($date$).
3. ReturnIfAbrupt(dt)
4. Let $newDate$ be MakeDate(MakeDay(YearFromTime(t), MonthFromTime(t), dt), TimeWithinDay(t)).
5. Let u be TimeClip(UTC($newDate$)).
6. Set the [[DateValue]] internal slot of this Date object to u .
7. Return u .

20.3.4.21 Date.prototype.setFullYear (year [, month [, date]])

1. Let t be the result of LocalTime(this time value); but if this time value is NaN, let t be +0.
2. Let y be ToNumber($year$).
3. ReturnIfAbrupt(y)
4. If $month$ is not specified, let m be MonthFromTime(t); otherwise, let m be ToNumber($month$). Deleted: , then let
5. ReturnIfAbrupt(m)
6. If $date$ is not specified, let dt be DateFromTime(t); otherwise, let dt be ToNumber($date$). Deleted: , then let
7. ReturnIfAbrupt(dt)
8. Let $newDate$ be MakeDate(MakeDay(y , m , dt), TimeWithinDay(t)).
9. Let u be TimeClip(UTC($newDate$)).
10. Set the [[DateValue]] internal slot of this Date object to u .
11. Return u .

The `length` property of the `setFullYear` method is 3.

NOTE If $month$ is not specified, this method behaves as if $month$ were specified with the value `getMonth()`. If $date$ is not specified, it behaves as if $date$ were specified with the value `getDate()`.

20.3.4.22 Date.prototype.setHours (hour [, min [, sec [, ms]]])

1. Let t be the result of LocalTime(this time value).
2. Let h be ToNumber($hour$).
3. ReturnIfAbrupt(h)
4. If min is not specified, let m be MinFromTime(t); otherwise, let m be ToNumber(min). Deleted: , then let
5. ReturnIfAbrupt(m)
6. If sec is not specified, let s be SecFromTime(t); otherwise, let s be ToNumber(sec). Deleted: , then let

7. `ReturnIfAbrupt(s).`
8. If `ms` is not specified, let `milli` be `msFromTime(t)`; otherwise, let `milli` be `ToNumber(ms)`.
9. `ReturnIfAbrupt(milli).`
10. Let `date` be `MakeDate(Day(t), MakeTime(h, m, s, milli))`.
11. Let `u` be `TimeClip(UTC(date))`.
12. Set the `[[DateValue]]` internal slot of this Date object to `u`.
13. Return `u`.

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The `length` property of the `setHours` method is 4.

NOTE If `min` is not specified, this method behaves as if `min` were specified with the value `getMinutes()`. If `sec` is not specified, it behaves as if `sec` were specified with the value `getSeconds()`. If `ms` is not specified, it behaves as if `ms` were specified with the value `getMilliseconds()`.

20.3.4.23 Date.prototype.setMilliseconds (ms)

1. Let `t` be the result of `LocalTime(this time value)`.
2. Let `ms` be `ToNumber(ms)`.
3. `ReturnIfAbrupt(ms).`
4. Let `time` be `MakeTime(HourFromTime(t), MinFromTime(t), SecFromTime(t), ms)`.
5. Let `u` be `TimeClip(UTC(MakeDate(Day(t), time)))`.
6. Set the `[[DateValue]]` internal slot of this Date object to `u`.
7. Return `u`.

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20.3.4.24 Date.prototype.setMinutes (min [, sec [, ms]])

1. Let `t` be the result of `LocalTime(this time value)`.
2. Let `m` be `ToNumber(min)`.
3. `ReturnIfAbrupt(m).`
4. If `sec` is not specified, let `s` be `SecFromTime(t)`; otherwise, let `s` be `ToNumber(sec)`.
5. `ReturnIfAbrupt(s).`
6. If `ms` is not specified, let `milli` be `msFromTime(t)`; otherwise, let `milli` be `ToNumber(ms)`.
7. `ReturnIfAbrupt(milli).`
8. Let `date` be `MakeDate(Day(t), MakeTime(HourFromTime(t), m, s, milli))`.
9. Let `u` be `TimeClip(UTC(date))`.
10. Set the `[[DateValue]]` internal slot of this Date object to `u`.
11. Return `u`.

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The `length` property of the `setMinutes` method is 3.

NOTE If `sec` is not specified, this method behaves as if `sec` were specified with the value `getSeconds()`. If `ms` is not specified, this behaves as if `ms` were specified with the value `getMilliseconds()`.

20.3.4.25 Date.prototype.setMonth (month [, date])

1. Let `t` be the result of `LocalTime(this time value)`.
2. Let `m` be `ToNumber(month)`.
3. `ReturnIfAbrupt(m).`
4. If `date` is not specified, let `dt` be `DateFromTime(t)`; otherwise, let `dt` be `ToNumber(date)`.
5. `ReturnIfAbrupt(dt).`
6. Let `newDate` be `MakeDate(MakeDay(YearFromTime(t), m, dt), TimeWithinDay(t))`.
7. Let `u` be `TimeClip(UTC(newDate))`.

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8. Set the [[DateValue]] internal slot of this Date object to u .
9. Return u .

The `length` property of the `setMonth` method is **2**.

NOTE If $date$ is not specified, this method behaves as if $date$ were specified with the value `getDate()`.

20.3.4.26 Date.prototype.setSeconds (sec [, ms])

1. Let t be the result of `LocalTime(this time value)`.
2. Let s be `ToNumber(sec)`.
3. [ReturnIfAbrupt\(s\)](#).
4. If ms is not specified, let $milli$ be `msFromTime(t)`; otherwise, let $milli$ be `ToNumber(ms)`.
5. [ReturnIfAbrupt\(milli\)](#).
6. Let $date$ be `MakeDate(Day(t), MakeTime(HourFromTime(t), MinFromTime(t), s , milli))`.
7. Let u be `TimeClip(UTC(date))`.
8. Set the [[DateValue]] internal slot of this Date object to u .
9. Return u .

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The `length` property of the `setSeconds` method is **2**.

NOTE If ms is not specified, this method behaves as if ms were specified with the value `getMilliseconds()`.

20.3.4.27 Date.prototype.setTime (time)

1. [Let \$t\$ be `ToNumber\(time\)`](#).
2. [ReturnIfAbrupt\(t\)](#).
3. Let v be `TimeClip(t)`.
4. [Set the \[\[DateValue\]\] internal slot of this Date object to \$v\$](#) .
5. Return v .

Deleted: `ToNumber(time)`

Deleted: <#>`ReturnIfAbrupt(v)`>

20.3.4.28 Date.prototype.setUTCDate (date)

1. Let t be this time value.
2. `ReturnIfAbrupt(t)`.
3. Let dt be `ToNumber(date)`.
4. [ReturnIfAbrupt\(dt\)](#).
5. Let $newDate$ be `MakeDate(MakeDay(YearFromTime(t), MonthFromTime(t), dt), TimeWithinDay(t))`.
6. Let v be `TimeClip(newDate)`.
7. Set the [[DateValue]] internal slot of this Date object to v .
8. Return v .

20.3.4.29 Date.prototype.setUTCFullYear (year [, month [, date]])

1. Let t be this time value; but if this time value is `NaN`, let t be **+0**.
2. `ReturnIfAbrupt(t)`.
3. Let y be `ToNumber(year)`.
4. [ReturnIfAbrupt\(y\)](#).
5. If $month$ is not specified, let m be `MonthFromTime(t)`; otherwise, let m be `ToNumber(month)`.
6. [ReturnIfAbrupt\(m\)](#).
7. If $date$ is not specified, let dt be `DateFromTime(t)`; otherwise, let dt be `ToNumber(date)`.

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8. ReturnIfAbrupt(*dt*)
9. Let *newDate* be MakeDate(MakeDay(*y, m, dt*), TimeWithinDay(*t*)).
10. Let *v* be TimeClip(*newDate*).
11. Set the [[DateValue]] internal slot of this Date object to *v*.
12. Return *v*.

The `length` property of the `setUTCFullYear` method is 3.

NOTE If *month* is not specified, this method behaves as if *month* were specified with the value `getUTCMonth()`. If *date* is not specified, it behaves as if *date* were specified with the value `getUTCDate()`.

20.3.4.30 Date.prototype.setUTCHours (hour [, min [, sec [, ms]]])

1. Let *t* be this time value.
2. ReturnIfAbrupt(*t*).
3. Let *h* be ToNumber(*hour*).
4. ReturnIfAbrupt(*h*)
5. If *min* is not specified, let *m* be MinFromTime(*t*); otherwise, let *m* be ToNumber(*min*).
6. ReturnIfAbrupt(*m*)
7. If *sec* is not specified, let *s* be SecFromTime(*t*); otherwise, let *s* be ToNumber(*sec*).
8. ReturnIfAbrupt(*s*)
9. If *ms* is not specified, let *milli* be msFromTime(*t*); otherwise, let *milli* be ToNumber(*ms*).
10. ReturnIfAbrupt(*milli*)
11. Let *newDate* be MakeDate(Day(*t*), MakeTime(*h, m, s, milli*)).
12. Let *v* be TimeClip(*newDate*).
13. Set the [[DateValue]] internal slot of this Date object to *v*.
14. Return *v*.

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The `length` property of the `setUTCHours` method is 4.

NOTE If *min* is not specified, this method behaves as if *min* were specified with the value `getUTCMinutes()`. If *sec* is not specified, it behaves as if *sec* were specified with the value `getUTCSSeconds()`. If *ms* is not specified, it behaves as if *ms* were specified with the value `getUTCMilliseconds()`.

20.3.4.31 Date.prototype.setUTCMilliseconds (ms)

1. Let *t* be this time value.
2. ReturnIfAbrupt(*t*).
3. Let *milli* be ToNumber(*ms*)
4. ReturnIfAbrupt(*milli*)
5. Let *time* be MakeTime(HourFromTime(*t*), MinFromTime(*t*), SecFromTime(*t*), *milli*).
6. Let *v* be TimeClip(MakeDate(Day(*t*), *time*)).
7. Set the [[DateValue]] internal slot of this Date object to *v*.
8. Return *v*.

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20.3.4.32 Date.prototype.setUTCMinutes (min [, sec [, ms]])

1. Let *t* be this time value.
2. ReturnIfAbrupt(*t*).
3. Let *m* be ToNumber(*min*).
4. If *sec* is not specified, let *s* be SecFromTime(*t*); otherwise, let *s* be ToNumber(*sec*).
5. If *ms* is not specified, let *milli* be msFromTime(*t*); otherwise, let *milli* be ToNumber(*ms*).

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6. Let *date* be *MakeDate*(*Day*(*t*), *MakeTime*(*HourFromTime*(*t*), *m*, *s*, *milli*)).
7. Let *v* be *TimeClip*(*date*).
8. Set the ***[[DateValue]]*** internal slot of this Date object to *v*.
9. Return *v*.

The ***length*** property of the ***setUTCMilliseconds*** method is **3**.

NOTE If *sec* is not specified, this method behaves as if *sec* were specified with the value ***getUTCSeconds***(). If *ms* is not specified, it function behaves as if *ms* were specified with the value return by ***getUTCMilliseconds***().

20.3.4.33 Date.prototype.setUTCMonth (month [, date])

1. Let *t* be this time value.
2. ReturnIfAbrupt(*t*).
3. Let *m* be *ToNumber*(*month*).
4. If *date* is not specified, let *dt* be *DateFromTime*(*t*); otherwise, let *dt* be *ToNumber*(*date*).
5. Let *newDate* be *MakeDate*(*MakeDay*(*YearFromTime*(*t*), *m*, *dt*), *TimeWithinDay*(*t*)).
6. Let *v* be *TimeClip*(*newDate*).
7. Set the ***[[DateValue]]*** internal slot of this Date object to *v*.
8. Return *v*.

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The ***length*** property of the ***setUTCMonth*** method is **2**.

NOTE If *date* is not specified, this method behaves as if *date* were specified with the value ***getUTCDate***().

20.3.4.34 Date.prototype.setUTCSeconds (sec [, ms])

1. Let *t* be this time value.
2. ReturnIfAbrupt(*t*).
3. Let *s* be *ToNumber*(*sec*).
4. If *ms* is not specified, let *milli* be *msFromTime*(*t*); otherwise, let *milli* be *ToNumber*(*ms*).
5. Let *date* be *MakeDate*(*Day*(*t*), *MakeTime*(*HourFromTime*(*t*), *MinFromTime*(*t*), *s*, *milli*)).
6. Let *v* be *TimeClip*(*date*).
7. Set the ***[[DateValue]]*** internal slot of this Date object to *v*.
8. Return *v*.

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The ***length*** property of the ***setUTCSeconds*** method is **2**.

NOTE If *ms* is not specified, this method behaves as if *ms* were specified with the value ***getUTCMilliseconds***().

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20.3.4.35 Date.prototype.toDateString ()

This function returns a String value. The contents of the String are implementation-dependent, but are intended to represent the “date” portion of the Date in the current time zone in a convenient, human-readable form.

20.3.4.36 Date.prototype.toISOString ()

This function returns a String value representing the instance in time corresponding to this time value. The format of the String is the Date Time string format defined in 20.3.1.15. All fields are present in the String. The time zone is always UTC, denoted by the suffix Z. If this time value is not a finite Number or if

the year is not a value that can be represented in that format (if necessary using extended year format), a **RangeError** exception is thrown.

20.3.4.37 Date.prototype.toJSON (key)

This function provides a String representation of a Date object for use by **JSON.stringify** (24.3.2).

When the **toJSON** method is called with argument *key*, the following steps are taken:

1. Let *O* be the result of calling **ToObject**, giving it the **this** value as its argument.
2. Let *tv* be **ToPrimitive**(*O*, hint Number).
3. **ReturnIfAbrupt**(*tv*).
4. If **Type**(*tv*) is Number and *tv* is not finite, return **null**.
5. **Return Invoke**(*O*, "toISOString").

NOTE 1 The argument is ignored.

NOTE 2 The **toJSON** function is intentionally generic; it does not require that its **this** value be a Date object. Therefore, it can be transferred to other kinds of objects for use as a method. However, it does require that any such object have a **toISOString** method.

20.3.4.38 Date.prototype.toLocaleDateString ([reserved1 [, reserved2]])

An ECMAScript implementation that includes the ECMA-402 Internationalization API must implement the **Date.prototype.toLocaleDateString** method as specified in the ECMA-402 specification. If an ECMAScript implementation does not include the ECMA-402 API the following specification of the **toLocaleDateString** method is used.

This function returns a String value. The contents of the String are implementation-dependent, but are intended to represent the “date” portion of the Date in the current time zone in a convenient, human-readable form that corresponds to the conventions of the host environment’s current locale.

The meaning of the optional parameters to this method are defined in the ECMA-402 specification; implementations that do not include ECMA-402 support must not use those parameter positions for anything else.

The **length** property of the **toLocaleDateString** method is **0**.

20.3.4.39 Date.prototype.toLocaleString ([reserved1 [, reserved2]])

An ECMAScript implementation that includes the ECMA-402 Internationalization API must implement the **Date.prototype.toLocaleString** method as specified in the ECMA-402 specification. If an ECMAScript implementation does not include the ECMA-402 API the following specification of the **toLocaleString** method is used.

This function returns a String value. The contents of the String are implementation-dependent, but are intended to represent the Date in the current time zone in a convenient, human-readable form that corresponds to the conventions of the host environment’s current locale.

The meaning of the optional parameters to this method are defined in the ECMA-402 specification; implementations that do not include ECMA-402 support must not use those parameter positions for anything else.

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Deleted: Let <i>toISO</i> be the result of
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Deleted: <#> ReturnIfAbrupt (<i>toISO</i>). <#>If IsCallable (<i>toISO</i>) is false , throw a TypeError exception. <#>Return the result of calling the [[Call]] internal method of <i>toISO</i> with <i>O</i> as <i>thisArgument</i> and an empty List as <i>argumentsList</i> .
Deleted: An object is free to use the argument <i>key</i> to filter its stringification.

The `length` property of the `toLocaleString` method is **0**.

20.3.4.40 Date.prototype.toLocaleTimeString ([reserved1 [, reserved2]])

| An ECMAScript implementation that includes the ECMA-402 Internationalization API must implement the `Date.prototype.toLocaleTimeString` method as specified in the ECMA-402 specification. If an ECMAScript implementation does not include the ECMA-402 API the following specification of the `toLocaleString` method is used.

This function returns a String value. The contents of the String are implementation-dependent, but are intended to represent the “time” portion of the Date in the current time zone in a convenient, human-readable form that corresponds to the conventions of the host environment’s current locale.

| The meaning of the optional parameters to this method are defined in the ECMA-402 specification; implementations that do not include ECMA-402 support must not use those parameter positions for anything else.

The `length` property of the `toLocaleTimeString` method is **0**.

20.3.4.41 Date.prototype.toString ()

The following steps are performed:

1. Let O be this Date object.
2. If O does not have a `[[DateValue]]` internal slot, then
 - a. Let tv be `Nan`.
3. Else,
 - a. Let tv be this time value.
4. Return `ToDateString(tv)`.

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NOTE For any Date object d whose milliseconds amount is zero, the result of `Date.parse(d.toString())` is equal to `d.valueOf()`. See 20.3.3.2.

20.3.4.41.1 Runtime Semantics: `ToDateString(tv)` Abstract Operation

1. Assert: `Type(tv)` is Number.
2. If tv is `Nan`, return "Invalid Date".
3. Return an implementation-dependent String value that represents tv as a date and time in the current time zone using a convenient, human-readable form.

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20.3.4.42 Date.prototype.toTimeString ()

This function returns a String value. The contents of the String are implementation-dependent, but are intended to represent the “time” portion of the Date in the current time zone in a convenient, human-readable form.

20.3.4.43 Date.prototype.toUTCString ()

This function returns a String value. The contents of the String are implementation-dependent, but are intended to represent this time value in a convenient, human-readable form in UTC.

NOTE The intent is to produce a String representation of a date that is more readable than the format specified in 20.3.1.15. It is not essential that the chosen format be unambiguous or easily machine parseable. If an implementation does not have a preferred human-readable format it is recommended to use the format defined in 20.3.1.15 but with a space rather than a "T" used to separate the date and time elements.

20.3.4.44 Date.prototype.valueOf ()

The `valueOf` function returns a Number, which is this time value.

20.3.4.45 Date.prototype [@@toPrimitive] (hint),

This function is called by ECMAScript language operators to convert an object to a primitive value. The allowed values for `hint` are `"default"`, `"number"`, and `"string"`. Date objects, are unique among built-in ECMAScript objects in that they treat `"default"` as being equivalent to `"string"`. All other built-in ECMAScript objects treat `"default"` as being equivalent to `"number"`.

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When the `@@toPrimitive` method is called with argument `hint`, the following steps are taken:

1. Let `O` be the `this` value.
2. If `Type(O)` is not `Object`, throw a `TypeError` exception.
3. If `hint` is the string value `"string"` or the string value `"default"`, then
 - a. Let `tryFirst` be `"string"`.
4. Else if `hint` is the string value `"number"`, then
 - a. Let `tryFirst` be `"number"`.
5. Else, throw a `TypeError` exception.
6. Return the result of `OrdinaryToPrimitive(O, tryFirst)`.

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The value of the `name` property of this function is `"[Symbol.toPrimitive]"`.

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }`.

20.3.5 Properties of Date Instances

Date instances are ordinary objects that inherit properties from the `Date` prototype object. Date instances also have a `[[DateValue]]` internal slot. The `[[DateValue]]` internal slot is the time value represented by this `Date` object.

21 Text Processing

21.1 String Objects

21.1.1 The String Constructor

The `String` constructor is the `%String%` intrinsic object and the initial value of the `String` property of the global object. When called as a constructor it creates and initializes a new String object. When `String` is called as a function rather than as a constructor, it performs a type conversion.

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Deleted: However, if the `this` value passed in the call is an Object with an uninitialized `[[StringData]]` internal slot, it initializes the `this` value using the argument value. This permits `String` to be used both to perform type conversion and to perform constructor instance initialisation.

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21.1.1.1 String (value)

When **String** is called with argument *value*, the following steps are taken:

1. If no arguments were passed to this function invocation, let *s* be "".
2. Else
 - a. If *NewTarget* is **undefined**, and **Type**(*value*) is **Symbol**, return **SymbolDescriptiveString**(*value*).
 - b. Let *s* be **ToString**(*value*).
3. ReturnIfAbrupt(*s*).
4. If *NewTarget* is **undefined**, return *s*.
5. Return **StringCreate**(*s*, **GetPrototypeFromConstructor**(*NewTarget*, "%**StringPrototype**%")).

The **length** property of the **String** function is 1.

21.1.2 Properties of the String Constructor

The value of the **[[Prototype]]** internal slot of the **String** constructor is the **intrinsic object %FunctionPrototype%**. (19.2.3).

Besides the **length** property (whose value is 1), the **String** constructor has the following properties:

21.1.2.1 String.fromCharCode (...codeUnits)

The **String.fromCharCode** function may be called with **any** number of arguments which form the rest parameter *codeUnits*. The following steps are taken:

1. Let *codeUnits* be a List containing the arguments passed to this function.
2. Let *length* be the number of elements in *codeUnits*.
3. Let *elements* be a new List.
4. Let *nextIndex* be 0.
5. Repeat while *nextIndex* < *length*
 - a. Let *next* be *codeUnits*[*nextIndex*].
 - b. Let *nextCU* be **ToUint16**(*next*).
 - c. ReturnIfAbrupt(*nextCU*).
 - d. Append *nextCU* to the end of *elements*.
 - e. Let *nextIndex* be *nextIndex* + 1.
6. Return the **String** value whose elements are, in order, the elements in the List *elements*. If *length* is 0, the empty string is returned.

The **length** property of the **fromCharCode** function is 1.

21.1.2.2 String.fromCodePoint (...codePoints)

The **String.fromCodePoint** function may be called with **any** number of arguments which form the rest parameter *codePoints*. The following steps are taken:

1. Let *codePoints* be a List containing the arguments passed to this function.
2. Let *length* be the number of elements in *codePoints*.
3. Let *elements* be a new List.
4. Let *nextIndex* be 0.
5. Repeat while *nextIndex* < *length*
 - a. Let *next* be *codePoints*[*nextIndex*].
 - b. Let *nextCP* be **ToNumber**(*next*).

Deleted: <#>Let <i>O</i> be the this value.
Deleted: <#>If Type (<i>O</i>) is Object and <i>O</i> has a [[StringData]] internal slot and the value of [[StringData]] is undefined , then <#> Let initializing be true . <#>Else, let initializing be false .
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Deleted: <#>ReturnIfAbrupt(<i>O</i>). If Type (<i>O</i>) is Object and <i>O</i> has a [[StringData]] internal slot and the value of [[StringData]] is undefined , then <#> Let extensible be IsExtensible (<i>O</i>). ...
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- c. ReturnIfAbrupt(*nextCP*).
 - d. If SameValue(*nextCP*, ToInteger(*nextCP*)) is false, throw a **RangeError** exception.
 - e. If *nextCP* < 0 or *nextCP* > 0x10FFFF, throw a **RangeError** exception.
 - f. Append the elements of the UTF-16 Encoding (10.1.1) of *nextCP* to the end of *elements*.
 - g. Let *nextIndex* be *nextIndex* + 1.
6. Return the String value whose elements are, in order, the elements in the List *elements*. If *length* is 0, the empty string is returned.

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The `length` property of the `fromCodePoint` function is 1.

21.1.2.3 String.prototype

The initial value of `String.prototype` is the [intrinsic object %StringPrototype%](#) (21.1.3).

Deleted: standard built-in String prototype object

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

21.1.2.4 String.raw (template, ...substitutions)

The `String.raw` function may be called with a variable number of arguments. The first argument is template and the remainder of the arguments form the List substitutions. The following steps are taken:

1. Let *substitutions* be a List consisting of all of the arguments passed to this function, starting with the second argument. If fewer than two arguments were passed, the List is empty.
2. Let *numberOfSubstitutions* be the number of elements in *substitutions*.
3. Let *cooked* be `ToObject(template)`.
4. ReturnIfAbrupt(*cooked*).
5. Let *rawValue* be the result of `Get(cooked, "raw")`.
6. Let *raw* be `ToObject(rawValue)`.
7. ReturnIfAbrupt(*raw*).
8. Let *literalSegments* be the result of `ToLength(Get(raw, "length"))`.
9. ReturnIfAbrupt(*literalSegments*).
10. If *literalSegments* ≤ 0, return the empty string.
11. Let *stringElements* be a new List.
12. Let *nextIndex* be 0.
13. Repeat
 - a. Let *nextKey* be `ToString(nextIndex)`.
 - b. Let *next* be the result of `Get(raw, nextKey)`.
 - c. Let *nextSeg* be `ToString(next)`.
 - d. ReturnIfAbrupt(*nextSeg*).
 - e. Append in order the code unit elements of *nextSeg* to the end of *stringElements*.
 - f. If *nextIndex* + 1 = *literalSegments*, then
 - i. Return the string value whose code units are, in order, the elements in the List *stringElements*. If *stringElements* has no elements, the empty string is returned.
 - g. If *nextIndex* < *numberOfSubstitutions*, let *next* be *substitutions*[*nextIndex*].
 - h. Else, let *next* be the empty String.
 - i. Let *nextSub* be `ToString(next)`.
 - j. ReturnIfAbrupt(*nextSub*).
 - k. Append in order the code unit elements of *nextSub* to the end of *stringElements*.
 - l. Let *nextIndex* be *nextIndex* + 1.

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Deleted: <#>Let *literalSegments* be `ToLength(len)`.¶
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The `length` property of the `raw` function is 1.

NOTE `String.raw` is intended for use as a tag function of a Tagged Template (12.3.7). When called as such, the first argument will be a well formed template object and the rest parameter will contain the substitution values.

21.1.3 Properties of the String Prototype Object

The String prototype object is itself an ordinary object. It is not a String instance and does not have a `[[StringData]]` internal slot.

The value of the `[[Prototype]]` internal slot of the String prototype object is the [intrinsic object `%ObjectPrototype%`](#) (19.1.3).

Unless explicitly stated otherwise, the methods of the String prototype object defined below are not generic and the `this` value passed to them must be either a String value or an object that has a `[[StringData]]` internal slot that has been initialized to a String value.

The abstract operation `thisStringValue(value)` performs the following steps:

1. If `Type(value)` is String, return `value`.
2. If `Type(value)` is Object and `value` has a `[[StringData]]` internal slot, then
 - a. Assert: `value`'s `[[StringData]]` internal slot is a String value.
 - b. Return the value of `value`'s `[[StringData]]` internal slot.
3. Throw a **TypeError** exception.

The phrase “this String value” within the specification of a method refers to the result returned by calling the abstract operation `thisStringValue` with the `this` value of the method invocation passed as the argument.

21.1.3.1 `String.prototype.charAt(pos)`

NOTE Returns a single element String containing the code unit at `index pos` in the String value resulting from converting this object to a String. If there is no element at that `index`, the result is the empty String. The result is a String value, not a String object.

If `pos` is a value of Number type that is an integer, then the result of `x.charAt(pos)` is equal to the result of `x.substring(pos, pos+1)`.

When the `charAt` method is called with one argument `pos`, the following steps are taken:

1. Let `O` be RequireObjectCoercible(this value).
2. Let `S` be `Tostring(O)`.
3. ReturnIfAbrupt(`S`).
4. Let `position` be `ToInteger(pos)`.
5. ReturnIfAbrupt(`position`).
6. Let `size` be the number of elements in `S`.
7. If `position < 0` or `position ≥ size`, return the empty String.
8. Return a String of length 1, containing one code unit from `S`, namely the code unit at `index position`.

NOTE The `charAt` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

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The `@@create` method of an object `F` performs the following steps:¶

```
<#>Let F be the this value.¶
<#>Let proto be the result of
GetPrototypeOfFromConstructor(F,
"__StringPrototype__").¶
<#>ReturnIfAbrupt(proto).¶
<#>Let obj be the result of calling StringCreate
(proto).¶
<#>Return obj.¶
```

The value of the `name` property of this function is " `[Symbol.create]` ". ¶

This property has the attributes (`[[Writable]]`: `false`, `[[Enumerable]]`: `false`, `[[Configurable]]`: `true`).¶

NOTE - `[[StringData]]` is initially assigned the value `undefined` as a flag to indicate that the instance has not yet been initialized by the String constructor. This flag value is never directly exposed to ECMAScript code; hence implementations may choose to encode the flag in some other manner. ¶

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Deleted: <#>If `s` is not `undefined`, then return `s`.¶

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21.1.3.2 String.prototype.charCodeAt(pos)

NOTE Returns a Number (a nonnegative integer less than 2^{16}) that is the code unit value of the string element at `index`, `pos` in the String resulting from converting this object to a String. If there is no element at that `index`, the result is `NaN`.

When the `charCodeAt` method is called with one argument `pos`, the following steps are taken:

1. Let `O` be `RequireObjectCoercible(this value)`.
2. Let `S` be `ToString(O)`.
3. `ReturnIfAbrupt(S)`.
4. Let `position` be `ToInteger(pos)`.
5. `ReturnIfAbrupt(position)`.
6. Let `size` be the number of elements in `S`.
7. If `position < 0` or `position ≥ size`, return `NaN`.
8. Return a value of Number type, whose value is the code unit value of the element at `index position` in the String `S`.

NOTE The `charCodeAt` function is intentionally generic; it does not require that its `this` value be a String object. Therefore it can be transferred to other kinds of objects for use as a method.

21.1.3.3 String.prototype.codePointAt(pos)

NOTE Returns a nonnegative integer Number less than 1114112 (0x110000) that is the `code point value of the` UTF-16 encoded code point (6.1.4), starting at the string element at `index`, `pos` in the String resulting from converting this object to a String. If there is no element at that `index`, the result is `undefined`. If a valid UTF-16 surrogate pair does not begin at `pos`, the result is the code unit at `pos`.

When the `codePointAt` method is called with one argument `pos`, the following steps are taken:

1. Let `O` be `RequireObjectCoercible(this value)`.
2. Let `S` be `ToString(O)`.
3. `ReturnIfAbrupt(S)`.
4. Let `position` be `ToInteger(pos)`.
5. `ReturnIfAbrupt(position)`.
6. Let `size` be the number of elements in `S`.
7. If `position < 0` or `position ≥ size`, return `undefined`.
8. Let `first` be the code unit value of the element at index `position` in the String `S`.
9. If `first < 0xD800` or `first > 0xDBFF` or `position+1 = size`, `return first`.
10. Let `second` be the code unit value of the element at index `position+1` in the String `S`.
11. If `second < 0xDC00` or `second > 0xDFFF`, `return first`.
12. Return $((first - 0xD800) \times 1024) + (second - 0xDC00) + 0x10000$.

NOTE The `codePointAt` function is intentionally generic; it does not require that its `this` value be a String object. Therefore it can be transferred to other kinds of objects for use as a method.

21.1.3.4 String.prototype.concat(...args)

NOTE When the `concat` method is called it returns a String consisting of the `code units` of `the this` object (converted to a String) followed by the `code units` of each of the arguments converted to a String. The result is a String value, not a String object.

When the `concat` method is called with zero or more arguments the following steps are taken:

1. Let `O` be `RequireObjectCoercible(this value)`.

2. Let S be $\text{ToString}(O)$.
3. ReturnIfAbrupt(S).
4. Let $args$ be a List whose elements are the arguments passed to this function.
5. Let R be S .
6. Repeat, while $args$ is not empty
 - a. Remove the first element from $args$ and let $next$ be the value of that element.
 - b. Let $nextString$ be $\text{ToString}(next)$
 - c. ReturnIfAbrupt($nextString$).
 - d. Let R be the String value consisting of the code units of the previous value of R followed by the code units of $nextString$.
7. Return R .

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The **length** property of the **concat** method is **1**.

NOTE The **concat** function is intentionally generic; it does not require that its **this** value be a String object. Therefore it can be transferred to other kinds of objects for use as a method.

21.1.3.5 **String.prototype.constructor**

The initial value of **String.prototype.constructor** is the intrinsic object %String%,

Deleted: built-in **String** constructor

21.1.3.6 **String.prototype.endsWith (searchString [, endPosition])**

The following steps are taken:

1. Let O be $\text{RequireObjectCoercible}(\text{this value})$.
2. Let S be $\text{ToString}(O)$.
3. ReturnIfAbrupt(S).
4. Let $isRegExp$ be $\text{IsRegExp}(searchString)$.
5. ReturnIfAbrupt($isRegExp$).
6. If $isRegExp$ is **true**, throw a **TypeError** exception.
7. Let $searchStr$ be $\text{ToString}(searchString)$.
8. ReturnIfAbrupt($searchStr$).
9. Let len be the number of elements in S .
10. If $endPosition$ is **undefined**, let pos be len , else let pos be $\text{ToInteger}(endPosition)$.
11. ReturnIfAbrupt(pos).
12. Let end be $\min(\max(pos, 0), len)$.
13. Let $searchLength$ be the number of elements in $searchStr$.
14. Let $start$ be $end - searchLength$.
15. If $start$ is less than 0, return **false**.
16. If the $searchLength$ sequence of elements of S starting at $start$ is the same as the full element sequence of $searchStr$, return **true**.
17. Otherwise, return **false**.

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The **length** property of the **endsWith** method is **1**.

NOTE 1 Returns **true** if the sequence of elements of $searchString$ converted to a String is the same as the corresponding elements of this object (converted to a String) starting at $endPosition - \text{length}(\text{this})$. Otherwise returns **false**.

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NOTE 2 Throwing an exception if the first argument is a RegExp is specified in order to allow future editions to define extends that allow such argument values.

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NOTE 3 The `endsWith` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.7 `String.prototype.includes (searchString [, position])`

The `includes` method takes two arguments, `searchString` and `position`, and performs the following steps:

1. Let O be `RequireObjectCoercible(this value)`.
2. Let S be `ToString(O)`.
3. ReturnIfAbrupt(S).
4. Let $isRegExp$ be `IsRegExp(searchString)`.
5. ReturnIfAbrupt($isRegExp$).
6. If $isRegExp$ is `true`, throw a `TypeError` exception.
7. Let $searchStr$ be `ToString(searchString)`.
8. ReturnIfAbrupt($searchStr$).
9. Let pos be `ToInteger(position)`. (If `position` is `undefined`, this step produces the value `0`).
10. ReturnIfAbrupt(pos).
11. Let len be the number of elements in S .
12. Let $start$ be `min(max(pos, 0), len)`.
13. Let $searchLen$ be the number of elements in $searchStr$.
14. If there exists any integer k not smaller than $start$ such that $k + searchLen$ is not greater than len , and for all nonnegative integers j less than $searchLen$, the `code unit at index k+j of S` is the same as the `code unit at index j of searchStr`, return `true`; but if there is no such integer k , return `false`.

The `length` property of the `includes` method is `1`.

NOTE 1 If `searchString` appears as a substring of the result of converting this object to a String, at one or more `indices` that are greater than or equal to `position`, return `true`; otherwise, returns `false`. If `position` is `undefined`, `0` is assumed, so as to search all of the String.

NOTE 2 Throwing an exception if the first argument is a RegExp is specified in order to allow future editions to define extensions that allow such argument values.

NOTE 3 The `includes` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.8 `String.prototype.indexOf (searchString [, position])`

NOTE If `searchString` appears as a substring of the result of converting this object to a String, at one or more `indices` that are greater than or equal to `position`, then the `smallest such index` is returned; otherwise, `-1` is returned. If `position` is `undefined`, `0` is assumed, so as to search all of the String.

The `indexOf` method takes two arguments, `searchString` and `position`, and performs the following steps:

1. Let O be `RequireObjectCoercible(this value)`.
2. Let S be `ToString(O)`.
3. ReturnIfAbrupt(S).
4. Let $searchStr$ be `ToString(searchString)`.
5. ReturnIfAbrupt($searchStr$).
6. Let pos be `ToInteger(position)`. (If `position` is `undefined`, this step produces the value `0`).
7. ReturnIfAbrupt(pos).
8. Let len be the number of elements in S .
9. Let $start$ be `min(max(pos, 0), len)`.

10. Let *searchLen* be the number of elements in *searchStr*.
11. Return the smallest possible integer *k* not smaller than *start* such that *k+ searchLen* is not greater than *len*, and for all nonnegative integers *j* less than *searchLen*, the code unit at *index*_{*k+j*} of *S* is the same as the code unit at *index*_{*j*} of *searchStr*; but if there is no such integer *k*, return the value **-1**.

The **length** property of the **indexOf** method is **1**.

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NOTE The **indexOf** function is intentionally generic; it does not require that its **this** value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.9 **String.prototype.lastIndexOf (searchString [, position])**

NOTE If *searchString* appears as a substring of the result of converting this object to a String at one or more indices that are smaller than or equal to *position*, then the greatest such index is returned; otherwise, **-1** is returned. If *position* is **undefined**, the length of the String value is assumed, so as to search all of the String.

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The **lastIndexOf** method takes two arguments, *searchString* and *position*, and performs the following steps:

1. Let *O* be RequireObjectCoercible(**this** value).
2. Let *S* be **ToString**(*O*).
3. **ReturnIfAbrupt**(*S*).
4. Let *searchStr* be **ToString**(*searchString*).
5. **ReturnIfAbrupt**(*searchString*).
6. Let *numPos* be **ToNumber**(*position*). (If *position* is **undefined**, this step produces the value **Nan**).
7. **ReturnIfAbrupt**(*numPos*).
8. If *numPos* is **Nan**, let *pos* be **+∞**; otherwise, let *pos* be **ToInteger**(*numPos*).
9. Let *len* be the number of elements in *S*.
10. Let *start* be **min**(**max**(*pos*, **0**), *len*).
11. Let *searchLen* be the number of elements in *searchStr*.
12. Return the largest possible nonnegative integer *k* not larger than *start* such that *k+ searchLen* is not greater than *len*, and for all nonnegative integers *j* less than *searchLen*, the code unit at *index*_{*k+j*} of *S* is the same as the code unit at *index*_{*j*} of *searchStr*; but if there is no such integer *k*, return the value **-1**.

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The **length** property of the **lastIndexOf** method is **1**.

NOTE The **lastIndexOf** function is intentionally generic; it does not require that its **this** value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.10 **String.prototype.localeCompare (that [, reserved1 [, reserved2]])**

An ECMAScript implementation that includes the ECMA-402 Internationalization API must implement the **localeCompare** method as specified in the ECMA-402 specification. If an ECMAScript implementation does not include the ECMA-402 API the following specification of the **localeCompare** method is used.

When the **localeCompare** method is called with argument *that*, it returns a Number other than **Nan** that represents the result of a locale-sensitive String comparison of the **this** value (converted to a String) with *that* (converted to a String). The two Strings are *S* and *That*. The two Strings are compared in an implementation-defined fashion. The result is intended to order String values in the sort order specified by a host default locale, and will be negative, zero, or positive, depending on whether *S* comes before *That* in the sort order, the Strings are equal, or *S* comes after *That* in the sort order, respectively.

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Before perform the comparisons the following steps are performed to prepare the Strings:

1. Let O be RequireObjectCoercible(this value).
2. Let S be $\text{ToString}(O)$.
3. ReturnIfAbrupt(S).
4. Let $That$ be $\text{ToString}(that)$.
5. ReturnIfAbrupt($That$).

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The meaning of the optional second and third parameters to this method are defined in the ECMA-402 specification; implementations that do not include ECMA-402 support must not assign any other interpretation to those parameter positions.

The **localeCompare** method, if considered as a function of two arguments **this** and **that**, is a consistent comparison function (as defined in 22.1.3.24) on the set of all Strings.

The actual return values are implementation-defined to permit implementers to encode additional information in the value, but the function is required to define a total ordering on all Strings. This function must treat Strings that are canonically equivalent according to the Unicode standard as identical and must return 0 when comparing Strings that are considered canonically equivalent.

The **length** property of the **localeCompare** method is 1.

NOTE 1 The **localeCompare** method itself is not directly suitable as an argument to **Array.prototype.sort** because the latter requires a function of two arguments.

NOTE 2 This function is intended to rely on whatever language-sensitive comparison functionality is available to the ECMAScript environment from the host environment, and to compare according to the rules of the host environment's current locale. However, regardless of the host provided comparison capabilities, this function must treat Strings that are canonically equivalent according to the Unicode standard as identical. It is recommended that this function not honour Unicode compatibility equivalences or decompositions. For a definition and discussion of canonical equivalence see the Unicode Standard, chapters 2 and 3, as well as Unicode Annex #15, Unicode Normalization Forms and Unicode Technical Note #5 Canonical Equivalence in Applications. Also see Unicode Technical Standard #10, Unicode Collation Algorithm.

NOTE 3 The **localeCompare** function is intentionally generic; it does not require that its **this** value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.11 String.prototype.match (regexp)

When the **match** method is called with argument **regexp**, the following steps are taken:

1. Let O be RequireObjectCoercible(this value).
2. Let S be $\text{ToString}(O)$.
3. ReturnIfAbrupt(S).
4. If regexp is not undefined, then
 - a. Let $matcher$ be $\text{GetMethod}(regexp, @@match)$.
 - b. ReturnIfAbrupt($matcher$).
 - c. If matcher is not undefined, then
 - i. Return $\text{Call}(matcher, regexp, \langle S \rangle)$.
5. Let rx be $\text{RegExpCreate}(regexp, undefined)$ (see 21.2.3.3).
6. ReturnIfAbrupt(rx).
7. Return $\text{Invoke}(rx, @@match, \langle S \rangle)$.

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NOTE The `match` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.12 String.prototype.normalize ([form])

When the `normalize` method is called with one argument `form`, the following steps are taken:

1. Let `O` be RequireObjectCoercible(`this` value). **Deleted:** CheckObjectCoercible
2. Let `S` be `ToString(O)`.
3. ReturnIfAbrupt(`S`).
4. If `form` is not provided or `form` is undefined let `form` be "NFC".
5. Let `f` be `ToString(form)`.
6. ReturnIfAbrupt(`f`).
7. If `f` is not one of "NFC", "NFD", "NFKC", or "NFKD" throw a **RangeError** Exception. **Deleted:** , then throw
8. Let `ns` be the String value is the result of normalizing `S` into the normalization form named by `f` as specified in Unicode Standard Annex #15, Unicode Normalization Forms. **Deleted:** Normalizatoin
9. Return `ns`.

The `length` property of the `normalize` method is **0**.

NOTE The `normalize` function is intentionally generic; it does not require that its `this` value be a String object. Therefore it can be transferred to other kinds of objects for use as a method.

21.1.3.13 String.prototype.repeat (count)

The following steps are taken:

1. Let `O` be RequireObjectCoercible(`this` value). **Deleted:** CheckObjectCoercible
2. Let `S` be `ToString(O)`.
3. ReturnIfAbrupt(`S`).
4. Let `n` be ToInteger(count). **Deleted:** the result of calling
5. ReturnIfAbrupt(`n`). **Deleted:** , then throw
6. If `n < 0` throw a **RangeError** exception. **Deleted:** , then throw
7. If `n` is $+\infty$ throw a **RangeError** exception. **Deleted:** , then throw
8. Let `T` be a String value that is made from `n` copies of `S` appended together. If `n` is 0, `T` is the empty String. **Deleted:** , then throw
9. Return `T`.

NOTE 1 This method creates a String consisting of the code units of the `this` object (converted to String) repeated `count` times. **Deleted:** string elements
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NOTE 2 The `repeat` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.14 String.prototype.replace (searchValue, replaceValue)

When the `replace` method is called with arguments `searchValue` and `replaceValue` the following steps are taken:

1. Let `O` be RequireObjectCoercible(`this` value). **Deleted:** CheckObjectCoercible
2. Let `string` be `ToString(O)`. **Deleted:** .
3. ReturnIfAbrupt(`string`). **Deleted:** .
4. If `searchValue` is not undefined, then **Formatted**
 - a. Let `replacer` be GetMethod(`searchValue`, `@@replace`). **Deleted:** o

- b. `ReturnIfAbrupt(replacer).`
- c. If `replacer` is not `undefined`, then
 - i. Return `Call(replacer, searchString, string, replaceValue).`
- 5. Let `searchString` be `ToString(searchValue)`.
- 6. `ReturnIfAbrupt(searchString).`
- 7. Let `functionalReplace` be `IsCallable(replaceValue)`.
- 8. If `functionalReplace` is `false`, then
 - a. Let `replaceValue` be `ToString(replaceValue)`.
 - b. `ReturnIfAbrupt(replaceValue).`
- 9. Search `string` for the first occurrence of `searchString` and let `pos` be the index within `string` of the first code unit of the matched substring and let `matched` be `searchString`. If no occurrences of `searchString` were found, return `string`.
- 10. If `functionalReplace` is `true`, then
 - a. Let `replValue` be `Call(replaceValue, undefined, matched, pos, and string)`.
 - b. Let `replStr` be `ToString(replValue)`.
 - c. `ReturnIfAbrupt(replStr).`
- 11. Else,
 - a. Let `captures` be an empty List.
 - b. Let `replStr` be `GetReplaceSubstitution(matched, string, pos, captures, replaceValue)`.
- 12. Let `tailPos` be `pos + the number of code units in matched`.
- 13. Let `newString` be the String formed by concatenating the first `pos` code units of `string`, `replStr`, and the trailing substring of `string` starting at index `tailPos`. If `pos` is 0, the first element of the concatenation will be the empty String.
- 14. Return `newString`.

NOTE The `replace` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.14.1 Runtime Semantics: GetReplaceSubstitution Abstract Operation

The abstract operation `GetReplaceSubstitution(matched, string, position, captures, replacement)` performs the following steps:

1. Assert: `Type(matched)` is String.
2. Let `matchLength` be the number of code units in `matched`.
3. Assert: `Type(string)` is String.
4. Let `stringLength` be the number of code units in `string`.
5. Assert: `position` is a nonnegative integer.
6. Assert: `position ≤ stringLength`.
7. Assert: `captures` is a possibly empty List of Strings.
8. **Assert: `Type(replacement)` is String**
9. Let `tailPos` be `position + matchLength`.
10. Let `m` be the number of elements in `captures`.
11. Let `result` be a String value derived from `replacement` by copying code unit elements from `replacement` to `result` while performing replacements as specified in Table 42. These \$ replacements are done left-to-right, and, once such a replacement is performed, the new replacement text is not subject to further replacements.
12. Return `result`.

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Deleted: as the argument list
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Table 42— Replacement Text Symbol Substitutions

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Code units	Unicode Characters	Replacement text
0x0024, 0x0024	\$\$	\$
0x0024, 0x0026	\$&	matched
0x0024, 0x0060	\$`	If <i>position</i> is 0, the replacement is the empty String. Otherwise the replacement is the substring of <i>string</i> that starts at index 0 and whose last code point is at index <i>position</i> -1.
0x0024, 0x0027	\$'	If <i>tailPos</i> \geq <i>stringLength</i> , the replacement is the empty String. Otherwise the replacement is the substring of <i>string</i> that starts at index <i>tailPos</i> and continues to the end of <i>string</i> .
0x0024, N where $0x0031 \leq N \leq 0x0039$	\$n where n is one of 1 2 3 4 5 6 7 8 9 and \$n is not followed by a decimal digit	The <i>n</i> th element of <i>captures</i> , where <i>n</i> is a single digit in the range 1 to 9. If <i>n</i> \leq <i>m</i> and the <i>n</i> th element of <i>captures</i> is undefined , use the empty String instead. [If <i>n</i> $>$ <i>m</i> , the result is implementation-defined.]
0x0024, N, N where $0x0030 \leq N \leq 0x0039$	\$nn where n is one of 0 1 2 3 4 5 6 7 8 9	The <i>nn</i> th element of <i>captures</i> , where <i>nn</i> is a two-digit decimal number in the range 01 to 99. If <i>nn</i> \leq <i>m</i> and the <i>nn</i> th element of <i>captures</i> is undefined , use the empty String instead. [If <i>nn</i> is 00 or <i>nn</i> $>$ <i>m</i> , the result is implementation-defined.]
0x0024	\$ in any context that does not match <u>any</u> of the above.	\$

Comment [AWB1444]: Why is this impl defined? Can we specify this??

Comment [AWB1445]: "12345".replace("1", function(m,p,r) {x=[this,m,p,r]; return null})

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21.1.3.15 String.prototype.search (regexp)

When the search method is called with argument *regexp*, the following steps are taken:

1. Let *O* be RequireObjectCoercible(*this* value).
2. Let *string* be *ToString*(*O*).
3. ReturnIfAbrupt(*string*).
4. If *regexp* is not **undefined**, then
 - a. Let *searcher* be GetMethod(*regexp*, @@search).
 - b. ReturnIfAbrupt(*searcher*).
 - c. If *searcher* is not **undefined**, then
 - i. Return Call(*searcher*, *regexp*, «*string*»).
5. Let *rx* be RegExpCreate(*regexp*, **undefined**) (see 21.2.3.3).
6. ReturnIfAbrupt(*rx*).
7. Return Invoke(*rx*, @@search, «*string*»).

NOTE The *search* function is intentionally generic; it does not require that its *this* value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.16 String.prototype.slice (start, end)

The *slice* method takes two arguments, *start* and *end*, and returns a substring of the result of converting this object to a String, starting from index,*start* and running to, but not including, index,*end* (or through the end of the String if *end* is **undefined**). If *start* is negative, it is treated as *sourceLength*+*start* where *sourceLength* is the length of the String. If *end* is negative, it is treated as *sourceLength*+*end* where *sourceLength* is the length of the String. The result is a String value, not a String object. The following steps are taken:

1. Let O be RequireObjectCoercible(**this** value).
2. Let S be ToString(O).
3. ReturnIfAbrupt(S).
4. Let len be the number of elements in S .
5. Let $intStart$ be ToInteger($start$).
6. ReturnIfAbrupt(intStart).
7. If end is undefined, let $intEnd$ be len ; else let $intEnd$ be ToInteger(end).
8. ReturnIfAbrupt(intEnd).
9. If $intStart < 0$, let $from$ be max($len + intStart, 0$); otherwise let $from$ be min($intStart, len$).
10. If $intEnd < 0$, let to be max($len + intEnd, 0$); otherwise let to be min($intEnd, len$).
11. Let $span$ be max($to - from, 0$).
12. Return a String value containing $span$ consecutive elements from S beginning with the element at index from.

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The **length** property of the **slice** method is **2**.

NOTE The **slice** function is intentionally generic; it does not require that its **this** value be a String object. Therefore it can be transferred to other kinds of objects for use as a method.

21.1.3.17 String.prototype.split (separator, limit)

Returns an Array object into which substrings of the result of converting this object to a String have been stored. The substrings are determined by searching from left to right for occurrences of *separator*; these occurrences are not part of any substring in the returned array, but serve to divide up the String value. The value of *separator* may be a String of any length or it may be a RegExp object.

When the **split** method is called, the following steps are taken:

1. Let O be RequireObjectCoercible(**this** value).
2. ReturnIfAbrupt(O).
3. If separator is not undefined, then
 - a. Let $splitter$ be GetMethod(*separator*, @@split).
 - b. ReturnIfAbrupt(splitter).
 - c. If splitter is not undefined, then
 - i. Return Call(*splitter*, *separator*, O, limit)
4. Let S be ToString(O).
5. ReturnIfAbrupt(S).
6. Let A be ArrayCreate(0).
7. Let $lengthA$ be 0 .
8. If *limit* is undefined, let $lim = 2^{53} - 1$; else let $lim = \text{ToLength}(limit)$.
9. ReturnIfAbrupt(lim).
10. Let s be the number of elements in S .
11. Let $p = 0$.
12. Let R be ToString(*separator*).
13. ReturnIfAbrupt(R).
14. If $lim = 0$, return A .
15. If *separator* is undefined, then
 - a. Call CreateDataProperty(A , "0", S).
 - b. Assert: The above call will never result in an abrupt completion.
 - c. Return A .
16. If $s = 0$, then
 - a. Let z be the result of SplitMatch(S , 0 , R).

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- b. If z is not **false**, return A .
 c. Call CreateDataProperty(A , "0", S).
 d. Assert: The above call will never result in an abrupt completion.
 e. Return A .
17. Let $q = p$.
 18. Repeat, while $q \neq s$
- a. Let e be the result of SplitMatch(S , q , R).
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 - b. If e is **false**, let $q = q+1$.
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 - c. Else e is an integer index into S ,
 - i. If $e = p$, let $q = q+1$.
Deleted: positions
 - ii. Else $e \neq p$,
 - 1. Let T be a String value equal to the substring of S consisting of the code units at indices p (inclusive) through q (exclusive).
Deleted: positions
 - 2. Call CreateDataProperty(A , ToString($lengthA$), T).
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 - 3. Assert: The above call will never result in an abrupt completion.
 - 4. Increment $lengthA$ by 1.
 - 5. If $lengthA = lim$, return A .
 - 6. Let $p = e$.
 - 7. Let $q = p$.
19. Let T be a String value equal to the substring of S consisting of the code units at indices p (inclusive) through s (exclusive).
 20. Call CreateDataProperty(A , ToString($lengthA$), T).
 21. Assert: The above call will never result in an abrupt completion.
 22. Return A .

The **length** property of the **split** method is 2.

NOTE 1 The value of *separator* may be an empty String, an empty regular expression, or a regular expression that can match an empty String. In this case, *separator* does not match the empty substring at the beginning or end of the input String, nor does it match the empty substring at the end of the previous separator match. (For example, if *separator* is the empty String, the String is split up into individual code unit elements; the length of the result array equals the length of the String, and each substring contains one code unit.) If *separator* is a regular expression, only the first match at a given index of the **this** String is considered, even if backtracking could yield a non-empty-substring match at that index. (For example, "**ab**".split(/a*/**)** evaluates to the array **["a","b"]**, while "**ab**".split(/a*/**)** evaluates to the array **["","b"]**.)

If the **this** object is (or converts to) the empty String, the result depends on whether *separator* can match the empty String. If it can, the result array contains no elements. Otherwise, the result array contains one element, which is the empty String.

If *separator* is a regular expression that contains capturing parentheses, then each time *separator* is matched the results (including any **undefined** results) of the capturing parentheses are spliced into the output array. For example,

"**Aboldand<CODE>coded</CODE>**".split(/<(\w)/?([^\w]+)>/)

evaluates to the array

```
[ "A", undefined, "B", "bold", "/", "B", "and", undefined,  
"CODE", "coded", "/", "CODE", "" ]
```

If *separator* is **undefined**, then the result array contains just one String, which is the **this** value (converted to a String). If *limit* is not **undefined**, then the output array is truncated so that it contains no more than *limit* elements.

NOTE 2 The **split** function is intentionally generic; it does not require that its **this** value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.17.1 Runtime Semantics: SplitMatch Abstract Operation

The abstract operation SplitMatch takes three parameters, a String S , an integer q , and a String R , and performs the following in order to return either **false** or the end index of a match:

1. **Assert:** Type(R) is String.
2. Let r be the number of code units in R .
3. Let s be the number of code units in S .
4. If $q+r > s$, return **false**.
5. If there exists an integer i between 0 (inclusive) and r (exclusive) such that the code unit at $\text{index } q+i$ of S is different from the code unit at $\text{index } i$ of R , return **false**.
6. Return $q+r$.

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Deleted: The `length` property of the `split` method is 2.¶

NOTE The `split` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.¶

Deleted: CheckObjectCoercible

Deleted: <#>If Type(`searchString`) is Object, then¶
 <#>Let `isRegExp` be HasProperty(`searchString`,
 @@isRegExp).¶
 <#>If `isRegExp` is true, then throw a `TypeError` exception.¶

Formatted

Deleted: <#>If Type(`searchString`) is Object, then¶

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Deleted: ToBoolean(Get)

Deleted: , @@isRegExp

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Deleted: <#>Let `searchStr` be
`Tostring(searchString)`.¶
 <#>ReturnIfAbrupt(`searchStr`).¶

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21.1.3.18 String.prototype.startsWith (`searchString` [, `position`])

The following steps are taken:

1. Let O be **RequireObjectCoercible**(`this` value).
2. Let S be `ToString`(O).
3. ReturnIfAbrupt(S).
4. Let `isRegExp` be `IsRegExp`(`searchString`).
5. **ReturnIfAbrupt**(`isRegExp`).
6. If `isRegExp` is `true`, throw a `TypeError` exception.
7. Let `searchStr` be `ToString`(`searchString`).
8. **ReturnIfAbrupt**(`searchStr`).
9. Let `pos` be `ToInteger`(`position`). (If `position` is `undefined`, this step produces the value `0`).
10. ReturnIfAbrupt(`pos`).
11. Let `len` be the number of elements in S .
12. Let `start` be `min(max(pos, 0), len)`.
13. Let `searchLength` be the number of elements in `searchStr`.
14. If `searchLength+start` is greater than `len`, return **false**.
15. If the `searchLength` sequence of elements of S starting at `start` is the same as the full element sequence of `searchStr`, return **true**.
16. Otherwise, return **false**.

The `length` property of the `startsWith` method is `1`.

NOTE 1 This method returns `true` if the sequence of elements of `searchString` converted to a String is the same as the corresponding elements of this object (converted to a String) starting at `index position`. Otherwise returns **false**.

NOTE 2 Throwing an exception if the first argument is a RegExp is specified in order to allow future editions to define extends that allow such argument values.

NOTE 3 The `startsWith` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.19 String.prototype.substring (`start`, `end`)

The `substring` method takes two arguments, `start` and `end`, and returns a substring of the result of converting this object to a String, starting from `index start` and running to, but not including, `index end` of the String (or through the end of the String if `end` is `undefined`). The result is a String value, not a String object.

If either argument is **NaN** or negative, it is replaced with zero; if either argument is larger than the length of the String, it is replaced with the length of the String.

If *start* is larger than *end*, they are swapped.

The following steps are taken:

1. Let *O* be [RequireObjectCoercible\(this value\)](#).
2. Let *S* be [ToString\(O\)](#).
3. ReturnIfAbrupt(*S*).
4. Let *len* be the number of elements in *S*.
5. Let *intStart* be [ToInteger\(start\)](#).
6. [ReturnIfAbrupt\(intStart\)](#).
7. If *end* is **undefined**, let *intEnd* be *len*; else let *intEnd* be [ToInteger\(end\)](#).
8. [ReturnIfAbrupt\(intEnd\)](#).
9. Let *finalStart* be $\min(\max(\text{intStart}, 0), \text{len})$.
10. Let *finalEnd* be $\min(\max(\text{intEnd}, 0), \text{len})$.
11. Let *from* be $\min(\text{finalStart}, \text{finalEnd})$.
12. Let *to* be $\max(\text{finalStart}, \text{finalEnd})$.
13. Return a String whose length is *to - from*, containing code units from *S*, namely the code units with indices *from* through *to - 1*, in ascending order.

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The **length** property of the **substring** method is **2**.

NOTE The **substring** function is intentionally generic; it does not require that its **this** value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.20 String.prototype.toLocaleLowerCase ([\[reserved1\]](#), [\[reserved2\]](#))

This function interprets a string value as a sequence of code points, as described in 6.1.4.

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This function works exactly the same as **toLowerCase** except that its result is intended to yield the correct result for the host environment's current locale, rather than a locale-independent result. There will only be a difference in the few cases (such as Turkish) where the rules for that language conflict with the regular Unicode case mappings.

The length property of the toLocaleLowerCase method is 0.

NOTE 1 [The meaning of the optional first and second parameters to this method is reserved for use by the ECMA-402 specification;](#) it is recommended that implementations do not use [those parameter positions](#) for anything else.

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Deleted: The first parameter to this function is likely to be used in a future version of this standard;

Deleted: [this](#)

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NOTE 2 The **toLocaleLowerCase** function is intentionally generic; it does not require that its **this** value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.21 String.prototype.toLocaleUpperCase ([\[reserved1\]](#), [\[reserved2\]](#))

This function interprets a string value as a sequence of code points, as described in 6.1.4.

Deleted: [¶](#)

This function works exactly the same as **toUpperCase** except that its result is intended to yield the correct result for the host environment's current locale, rather than a locale-independent result. There will only be a difference in the few cases (such as Turkish) where the rules for that language conflict with the regular Unicode case mappings.

The `length` property of the `toLocaleUpperCase` method is **0**.

NOTE 1 The meaning of the optional first and second parameters to this method is reserved for use by the ECMA-402 specification; it is recommended that implementations do not use those parameter positions for anything else.

NOTE 2 The `toLocaleUpperCase` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

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21.1.3.22 String.prototype.toLowerCase ()

This function interprets a string value as a sequence of code points, as described in 6.1.4. The following steps are taken:

1. Let O be `RequireObjectCoercible(this value)`.
2. Let S be `ToString(O)`.
3. ReturnIfAbrupt(S).
4. Let $cpList$ be a List containing in order the code points as defined in 6.1.4 of S , starting at the first element of S .
5. For each code point c in $cpList$, if the Unicode Character Database provides a language insensitive lower case equivalent of c then replace c in $cpList$ with that equivalent code point(s).
6. Let $cuList$ be a new List.
7. For each code point c in $cpList$, in order, append to $cuList$ the elements of the UTF-16 Encoding (10.1.1) of c .
8. Let L be a String whose elements are, in order, the elements of $cuList$.
9. Return L .

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The result must be derived according to the locale-insensitive case mappings in the Unicode Character Database (this explicitly includes not only the `UnicodeData.txt` file, but also all locale-insensitive mappings in the `SpecialCasings.txt` file that accompanies it).

NOTE 1 The case mapping of some code points may produce multiple code points. In this case the result String may not be the same length as the source String. Because both `toUpperCase` and `toLowerCase` have context-sensitive behaviour, the functions are not symmetrical. In other words, `s.toUpperCase().toLowerCase()` is not necessarily equal to `s.toLowerCase()`.

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NOTE 2 The `toLowerCase` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.23 String.prototype.toString ()

When the `toString` method is called, the following steps are taken:

1. Let s be `thisStringValue(this value)`.
2. Return s .

NOTE For a String object, the `toString` method happens to return the same thing as the `valueOf` method.

21.1.3.24 String.prototype.toUpperCase ()

This function interprets a string value as a sequence of code points, as described in 6.1.4.

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This function behaves in exactly the same way as `String.prototype.toLowerCase`, except that code points are mapped to their uppercase equivalents as specified in the Unicode Character Database.

NOTE The `toUpperCase` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.25 String.prototype.trim ()

This function interprets a string value as a sequence of code points, as described in 6.1.4.

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The following steps are taken:

1. Let O be RequireObjectCoercible(`this` value).
2. Let S be `ToString`(O).
3. `ReturnIfAbrupt`(S).
4. Let T be a String value that is a copy of S with both leading and trailing white space removed. The definition of white space is the union of `WhiteSpace` and `LineTerminator`. When determining whether a Unicode code point is in Unicode general category “Zs”, code unit sequences are interpreted as UTF-16 encoded code point sequences as specified in 6.1.4.
5. Return T .

Deleted: `CheckObjectCoercible`

NOTE The `trim` function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

21.1.3.26 String.prototype.valueOf ()

When the `valueOf` method is called, the following steps are taken:

1. Let s be `thisStringValue`(`this` value).
2. Return s .

21.1.3.27 String.prototype [@@iterator]()

When the `[@@iterator]` method is called it returns an Iterator object (25.1.1.2) that iterates over the code points of a String value, returning each code point as a String value. The following steps are taken:

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The following steps are taken:

1. Let O be RequireObjectCoercible(`this` value).
2. Let S be `ToString`(O).
3. `ReturnIfAbrupt`(S).
4. Return `CreateStringIterator`(S).

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Deleted: the result of calling the

Deleted: abstract operation with argument

The value of the `name` property of this function is "`[Symbol.iterator]`".

21.1.4 Properties of String Instances

String instances are String exotic objects and have the internal methods specified for such objects. String instances inherit properties from the String prototype object. String instances also have a `[[StringData]]` internal slot.

String instances have a `length` property, and a set of enumerable properties with integer indexed names.

21.1.4.1 length

The number of elements in the String value represented by this String object.

Once a String object is initialized, this property is unchanging. It has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

21.1.5 String Iterator Objects

An String Iterator is an object, that represents a specific iteration over some specific String instance object. There is not a named constructor for String Iterator objects. Instead, String iterator objects are created by calling certain methods of String instance objects.

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21.1.5.1 CreateStringIterator Abstract Operation

Several methods of String objects return Iterator objects. The abstract operation CreateStringIterator with argument *string* is used to create such iterator objects. It performs the following steps:

1. **Assert: Type(*string*) is String.**
2. Let *iterator* be the result of ObjectCreate(%StringIteratorPrototype%, **[[IteratedString]]**, **[[StringIteratorNextIndex]]**).
3. Set *iterator*'s **[[IteratedString]]** internal slot to *string*.
4. Set *iterator*'s **[[StringIteratorNextIndex]]** internal slot to 0.
5. Return *iterator*.

Deleted: Let *s* be the result of calling ToString(*string*).
Deleted: <#>ReturnIfAbrupt(*s*).
Deleted: (
Deleted: t
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Deleted: *s*

21.1.5.2 The %StringIteratorPrototype% Object

All String Iterator Objects inherit properties from the %StringIteratorPrototype% intrinsic object. The %StringIteratorPrototype% object is an ordinary object and its [[Prototype]] internal slot is the %IteratorPrototype% intrinsic object (25.1.2). In addition, %StringIteratorPrototype% has the following properties:

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Deleted: ObjectPrototype

21.1.5.2.1 %StringIteratorPrototype%.next ()

1. Let *O* be the **this** value.
2. If Type(*O*) is not Object, throw a **TypeError** exception.
3. If *O* does not have all of the internal slots of an String Iterator Instance (21.1.5.3), throw a **TypeError** exception.
4. Let *s* be the value of the **[[IteratedString]]** internal slot of *O*.
5. If *s* is **undefined**, **return** CreateIterResultObject(**undefined**, **true**).
6. Let *position* be the value of the **[[StringIteratorNextIndex]]** internal slot of *O*.
7. Let *len* be the number of elements in *s*.
8. If *position* \geq *len*, then
 - a. Set the value of the **[[IteratedString]]** internal slot of *O* to **undefined**.
 - b. Return CreateIterResultObject(**undefined**, **true**).
9. Let *first* be the code unit value at index *position* in *s*.
10. If *first* $<$ 0xD800 or *first* $>$ 0xDBFF or *position*+1 = *len*, let *resultString* be the string consisting of the single code unit *first*.
11. Else
 - a. Let *second* be the code unit value at index *position*+1 in the String *S*.
 - b. If *second* $<$ 0xDC00 or *second* $>$ 0xDFFF, let *resultString* be the string consisting of the single code unit *first*.

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Deleted: , then return

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- c. Else, let *resultString* be the string consisting of the code unit *first* followed by the code unit *second*.
12. Let *resultSize* be the number of code units in *resultString*.
 13. Set the value of the `[[StringIteratorNextIndex]]` internal slot of *O* to *position+ resultSize*.
 14. Return `CreateIterResultObject(resultString, false)`.

21.1.5.2.2 %StringIteratorPrototype% [@@toStringTag]

The initial value of the `@@toStringTag` property is the string value `"String Iterator"`.

This property has the attributes { `[Writable]: false, [Enumerable]: false, [Configurable]: true` }.

21.1.5.3 Properties of String Iterator Instances

String Iterator instances are ordinary objects that inherit properties from the `%StringIteratorPrototype%` intrinsic object. String Iterator instances are initially created with the internal slots listed in [Table 45](#).

Table 43.— Internal Slots of String Iterator Instances

Internal Slot	Description
<code>[[IteratedString]]</code>	The String value whose elements are being iterated.
<code>[[StringIteratorNextIndex]]</code>	The integer index of the next string index to be examined by this iteration.

21.2 RegExp (Regular Expression) Objects

A `RegExp` object contains a regular expression and the associated flags.

NOTE The form and functionality of regular expressions is modelled after the regular expression facility in the Perl 5 programming language.

21.2.1 Patterns

The `RegExp` constructor applies the following grammar to the input pattern String. An error occurs if the grammar cannot interpret the String as an expansion of *Pattern*.

Syntax

*Pattern*_[?U] ::=
 *Disjunction*_[?U]

*Disjunction*_[?U] ::=
 *Alternative*_[?U]
 *Alternative*_[?U] | *Disjunction*_[?U]

*Alternative*_[?U] ::=
 [empty]
 *Alternative*_[?U] *Term*_[?U]

Deleted: <#>%StringIteratorPrototype%
[@@iterator] ()
The following steps are taken:
<#>Return the `this` value.
The value of the `name` property of this function
is "`[Symbol.iterator]`". ¶
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Term_[U] ::
Assertion_[?U]
Atom_[?U]
Atom_[?U] Quantifier

Assertion_[U] ::
 \wedge
 $\$$
 $\backslash b$
 $\backslash B$
 $(? = Disjunction_{[?U]})$
 $(? ! Disjunction_{[?U]})$

Quantifier ::
QuantifierPrefix
QuantifierPrefix ?

QuantifierPrefix ::
 $*$
 $+$
 $?$
 $\{ DecimalDigits \}$
 $\{ DecimalDigits , \}$
 $\{ DecimalDigits , DecimalDigits \}$

Atom_[U] ::
PatternCharacter
 $.$
 $\backslash AtomEscape_{[?U]}$
CharacterClass_[?U]
 $(Disjunction_{[?U]})$
 $(?: Disjunction_{[?U]})$

SyntaxCharacter :: one of
 \wedge $\$$ \backslash $.$ $*$ $+$ $?$ $($ $)$ $[$ $]$ $\{$ $\}$ $|$

PatternCharacter ::
~~SourceCharacter but not SyntaxCharacter~~

Deleted: ~~1~~

AtomEscape_[U] ::
DecimalEscape
CharacterEscape_[?U]
CharacterClassEscape

CharacterEscape_[U] ::
ControlEscape
~~c~~ *ControlLetter*
HexEscapeSequence
RegExpUnicodeEscapeSequence_[?U]
IdentityEscape_[?U]

ControlEscape :: one of
 f n r t v

ControlLetter :: one of

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

RegEx Unicode Escape Sequence_[U] ::

- [+U] u LeadSurrogate \u TrailSurrogate
- Hex4Digits
- [+U] u{ HexDigits }

- It is a Syntax Error if the MV of HexDigits > 1114111.

LeadSurrogate ::
 Hex4Digits [match only if the SV of Hex4Digits is in the inclusive range 0xD800 to 0xDBFF]

TrailSurrogate ::
 Hex4Digits [match only if the SV of Hex4Digits is in the inclusive range 0xDC00 to 0xDFFF]

IdentityEscape_[U] ::
 [+U] SyntaxCharacter
 [-U] SourceCharacter but not UnicodeIDContinue

DecimalEscape ::
 DecimalIntegerLiteral [lookahead \notin DecimalDigit]

CharacterClassEscape :: one of
 d D s S w W

CharacterClass_[U] ::
 [[lookahead \notin {^}] ClassRanges_[?U]]
 [^ ClassRanges_[?U]]

ClassRanges_[U] ::
 [empty]
 NonemptyClassRanges_[?U]

NonemptyClassRanges_[U] ::
 ClassAtom_[?U]
 ClassAtom_[?U] NonemptyClassRangesNoDash_[?U]
 ClassAtom_[?U] - ClassAtom_[?U] ClassRanges_[?U]

NonemptyClassRangesNoDash_[U] ::
 ClassAtom_[?U]
 ClassAtomNoDash_[?U] NonemptyClassRangesNoDash_[?U]
 ClassAtomNoDash_[?U] - ClassAtom_[?U] ClassRanges_[?U]

ClassAtom_[U] ::
 -
 ClassAtomNoDash_[?U]

Deleted: LeadSurrogate
 Deleted: TrailSurrogate

Deleted: ¶

Deleted: ¶
 Deleted: LeadSurrogate

Deleted: CV

Deleted: TailSurrogate

Deleted: CV

Deleted:

Deleted: IdentifierPart
 [-U] <ZWJ>
 [-U] <ZWNJ>

```
ClassAtomNoDash[U] ::
  SourceCharacter but not one of \ or ] or -
  \ ClassEscape[?U]
```

```
ClassEscape[U] ::
  DecimalEscape
  b
  +[U]-
  CharacterEscape[?U]
  CharacterClassEscape
```

21.2.2 Pattern Semantics

A regular expression pattern is converted into an internal procedure using the process described below. An implementation is encouraged to use more efficient algorithms than the ones listed below, as long as the results are the same. The internal procedure is used as the value of a `RegExp` object's `[[RegExpMatcher]]` internal slot.

A *Pattern* is either a BMP pattern or a Unicode pattern depending upon whether or not its associated flags contain an "`u`". A BMP pattern matches against a String interpreted as consisting of a sequence of [16-bit values that are Unicode code points in the range of the Basic Multilingual Plane](#). A Unicode pattern matches against a String interpreted as consisting of Unicode code points encoded using UTF-16. In the context of describing the behaviour of a BMP pattern "character" means a [single 16-bit Unicode BMP code point](#). In the context of describing the behaviour of a Unicode pattern "character" means a [UTF-16 encoded code point \(6.1.4\)](#). In either context, "character value" means the numeric value of the code unit or code point.

The semantics of *Pattern* is defined as if a *Pattern* was a List of *SourceCharacter* values where each *SourceCharacter* corresponds to a Unicode code point. If a BMP pattern contains a non-BMP *SourceCharacter* the entire pattern is encoded using UTF-16 and the individual code units of that encoding are used as the elements of the List.

NOTE For example, consider a pattern expressed in source code as the single non-BMP character U+1D11E (MUSICAL SYMBOL G CLEF). Interpreted as a Unicode pattern, it would be a single element (character) List consisting of the single code point 0x1D11E. However, interpreted as a BMP pattern, it is first UTF-16 encoded to produce a two element List consisting of the code units 0xD834 and 0xDD1E.

Patterns are passed to the `RegExp` constructor as ECMAScript string values in which non-BMP characters are UTF-16 encoded. For example, the single character MUSICAL SYMBOL G CLEF pattern, expressed as a string value, is a String of length 2 whose elements were the code units 0xD834 and 0xDD1E. So no further translation of the string would be necessary to process it as a BMP pattern consisting of two pattern characters. However, to process it as a Unicode pattern the string value must treated as if it was UTF-16 decoded into a List consisting of a single pattern character, the code point U+1D11E.

An implementation may not actually perform such translations to or from UTF-16, but the semantics of this specification requires that the result of pattern matching be as if such translations were performed.

21.2.2.1 Notation

The descriptions below use the following variables:

- *Input* is a List consisting of all of the characters, in order, of the String being matched by the regular expression pattern. Each character is either a code unit or a code point depending



upon the kind of pattern involved. The notation *input*[*n*] means the *n*th character of *input*, where *n* can range between 0 (inclusive) and *InputLength* (exclusive).

- *InputLength* is the number of characters in *Input*.
- *NcapturingParens* is the total number of left capturing parentheses (i.e. the total number of times the *Atom :: (Disjunction)* production is expanded) in the pattern. A left capturing parenthesis is any (pattern character that is matched by the (terminal of the *Atom :: (Disjunction)* production.
- *IgnoreCase* is **true** if the RegExp object's [[OriginalFlags]] internal slot contains "i" and otherwise is **false**.
- *Multiline* is **true** if the RegExp object's [[OriginalFlags]] internal slot contains "m" and otherwise is **false**.
- *Unicode* is **true** if the RegExp object's [[OriginalFlags]] internal slot contains "u" and otherwise is **false**.

Furthermore, the descriptions below use the following internal data structures:

- A *CharSet* is a mathematical set of characters, either code units or code points depending up the state of the *Unicode* flag. "All characters" means either all code unit values or all code point values also depending upon the state if *Unicode*.
- A *State* is an ordered pair (*endIndex*, *captures*) where *endIndex* is an integer and *captures* is a List of *NcapturingParens* values. *States* are used to represent partial match states in the regular expression matching algorithms. The *endIndex* is one plus the index of the last input character matched so far by the pattern, while *captures* holds the results of capturing parentheses. The *n*th element of *captures* is either a List that represents the value obtained by the *n*th set of capturing parentheses or **undefined** if the *n*th set of capturing parentheses hasn't been reached yet. Due to backtracking, many *States* may be in use at any time during the matching process.
- A *MatchResult* is either a *State* or the special token **failure** that indicates that the match failed.
- A *Continuation* procedure is an internal closure (i.e. an internal procedure with some arguments already bound to values) that takes one *State* argument and returns a *MatchResult* result. If an internal closure references variables which are bound in the function that creates the closure, the closure uses the values that these variables had at the time the closure was created. The *Continuation* attempts to match the remaining portion (specified by the closure's already-bound arguments) of the pattern against *Input*, starting at the intermediate state given by its *State* argument. If the match succeeds, the *Continuation* returns the final *State* that it reached; if the match fails, the *Continuation* returns **failure**.
- A *Matcher* procedure is an internal closure that takes two arguments → a *State* and a *Continuation* → and returns a *MatchResult* result. A *Matcher* attempts to match a middle subpattern (specified by the closure's already-bound arguments) of the pattern against *Input*, starting at the intermediate state given by its *State* argument. The *Continuation* argument should be a closure that matches the rest of the pattern. After matching the subpattern of a pattern to obtain a new *State*, the *Matcher* then calls *Continuation* on that new *State* to test if the rest of the pattern can match as well. If it can, the *Matcher* returns the *State* returned by *Continuation*; if not, the *Matcher* may try different choices at its choice points, repeatedly calling *Continuation* until it either succeeds or all possibilities have been exhausted.
- An *AssertionTester* procedure is an internal closure that takes a *State* argument and returns a Boolean result. The assertion tester tests a specific condition (specified by the closure's already-bound arguments) against the current place in *Input* and returns **true** if the condition matched or **false** if not.

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- An *EscapeValue* is either a character or an integer. An *EscapeValue* is used to denote the interpretation of a *DecimalEscape* escape sequence: a character *ch* means that the escape sequence is interpreted as the character *ch*, while an integer *n* means that the escape sequence is interpreted as a backreference to the *nth* set of capturing parentheses.

21.2.2.2 Pattern

The production *Pattern* :: *Disjunction* evaluates as follows:

1. Evaluate *Disjunction* to obtain a Matcher *m*.
2. Return an internal closure that takes two arguments, a String *str* and an integer *index*, and performs the following:
 1. If *Unicode* is **true**, let *Input* be a List consisting of the sequence of code points of *str* interpreted as a UTF-16 encoded (6.1.4) Unicode string. Otherwise, let *Input* be a List consisting of the sequence of code units that are the elements of *str*. *Input* will be used throughout the algorithms in 21.2.2. Each element of *Input* is considered to be a character.
 2. Let *listIndex* be the index into *Input* of the character that was obtained from element *index* of *str*.
 3. Let *InputLength* be the number of characters contained in *Input*. This variable will be used throughout the algorithms in 21.2.2.
 4. Let *c* be a Continuation that always returns its State argument as a successful MatchResult.
 5. Let *cap* be a List of *NcapturingParens* **undefined** values, indexed 1 through *NcapturingParens*.
 6. Let *x* be the State (*listIndex*, *cap*).
 7. Call *m*(*x*, *c*) and return its result.

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NOTE A Pattern evaluates ("compiles") to an internal procedure value. `RegExp.prototype.exec` and other methods can then apply this procedure to a String and an offset within the String to determine whether the pattern would match starting at exactly that offset within the String, and, if it does match, what the values of the capturing parentheses would be. The algorithms in 21.2.2 are designed so that compiling a pattern may throw a **SyntaxError** exception; on the other hand, once the pattern is successfully compiled, applying its result internal procedure to find a match in a String cannot throw an exception (except for any host-defined exceptions that can occur anywhere such as out-of-memory).

21.2.2.3 Disjunction

The production *Disjunction* :: *Alternative* evaluates by evaluating *Alternative* to obtain a Matcher and returning that Matcher.

The production *Disjunction* :: *Alternative* | *Disjunction* evaluates as follows:

1. Evaluate *Alternative* to obtain a Matcher *m1*.
2. Evaluate *Disjunction* to obtain a Matcher *m2*.
3. Return an internal Matcher closure that takes two arguments, a State *x* and a Continuation *c*, and performs the following steps when evaluated:
 1. Call *m1*(*x*, *c*) and let *r* be its result.
 2. If *r* isn't **failure**, return *r*.
 3. Call *m2*(*x*, *c*) and return its result.

NOTE The | regular expression operator separates two alternatives. The pattern first tries to match the left *Alternative* (followed by the sequel of the regular expression); if it fails, it tries to match the right *Disjunction* (followed by the sequel of the regular expression). If the left *Alternative*, the right *Disjunction*, and the sequel all have choice

points, all choices in the sequel are tried before moving on to the next choice in the left *Alternative*. If choices in the left *Alternative* are exhausted, the right *Disjunction* is tried instead of the left *Alternative*. Any capturing parentheses inside a portion of the pattern skipped by `|` produce **undefined** values instead of Strings. Thus, for example,

```
/a|ab/.exec("abc")
```

returns the result "a" and not "ab". Moreover,

```
/((a)|(ab))((c)|(bc))/.exec("abc")
```

returns the array

```
["abc", "a", "a", undefined, "bc", undefined, "bc"]
```

and not

```
["abc", "ab", undefined, "ab", "c", "c", undefined]
```

21.2.2.4 Alternative

The production *Alternative* :: [empty] evaluates by returning a Matcher that takes two arguments, a State *x* and a Continuation *c*, and returns the result of calling *c(x)*.

The production *Alternative* :: *Alternative Term* evaluates as follows:

1. Evaluate *Alternative* to obtain a Matcher *m1*.
2. Evaluate *Term* to obtain a Matcher *m2*.
3. Return an internal Matcher closure that takes two arguments, a State *x* and a Continuation *c*, and performs the following [steps when evaluated](#):
 1. Create a Continuation *d* that takes a State argument *y* and returns the result of calling *m2(y, c)*.
 2. Call *m1(x, d)* and return its result.

NOTE Consecutive *Terms* try to simultaneously match consecutive portions of *Input*. If the left *Alternative*, the right *Term*, and the sequel of the regular expression all have choice points, all choices in the sequel are tried before moving on to the next choice in the right *Term*, and all choices in the right *Term* are tried before moving on to the next choice in the left *Alternative*.

21.2.2.5 Term

The production *Term* :: *Assertion* evaluates by returning an internal Matcher closure that takes two arguments, a State *x* and a Continuation *c*, and performs the following [steps when evaluated](#):

1. Evaluate *Assertion* to obtain an AssertionTester *t*.
2. Call *t(x)* and let *r* be the resulting Boolean value.
3. If *r* is **false**, return **failure**.
4. Call *c(x)* and return its result.

The production *Term* :: *Atom* evaluates as follows:

1. Return the Matcher that is the result of evaluating *Atom*.

The production *Term* :: *Atom Quantifier* evaluates as follows:

1. Evaluate *Atom* to obtain a Matcher *m*.
2. Evaluate *Quantifier* to obtain the three results: an integer *min*, an integer (*or* ∞) *max*, and Boolean *greedy*.
3. If *max* is finite and less than *min*, throw a **SyntaxError** exception.
4. Let *parenIndex* be the number of left capturing parentheses in the entire regular expression that occur to the left of this production expansion's *Term*. This is the total number of times the *Atom* :: (

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Disjunction) production is expanded prior to this production's *Term* plus the total number of *Atom* :: (*Disjunction*) productions enclosing this *Term*.

5. Let *parenCount* be the number of left capturing parentheses in the expansion of this production's *Atom*. This is the total number of *Atom* :: (*Disjunction*) productions enclosed by this production's *Atom*.
6. Return an internal Matcher closure that takes two arguments, a State *x* and a Continuation *c*, and performs the following steps when evaluated:
 1. Call *RepeatMatcher*(*m*, *min*, *max*, *greedy*, *x*, *c*, *parenIndex*, *parenCount*) and return its result.

21.2.2.5.1 Runtime Semantics: RepeatMatcher Abstract Operation

The abstract operation *RepeatMatcher* takes eight parameters, a Matcher *m*, an integer *min*, an integer (or ∞) *max*, a Boolean *greedy*, a State *x*, a Continuation *c*, an integer *parenIndex*, and an integer *parenCount*, and performs the following steps:

1. If *max* is zero, return *c(x)*.
2. Create an internal Continuation closure *d* that takes one State argument *y* and performs the following steps when evaluated:
 1. If *min* is zero and *y*'s *endIndex* is equal to *x*'s *endIndex*, return **failure**.
 2. If *min* is zero, let *min2* be zero; otherwise let *min2* be *min*-1.
 3. If *max* is ∞ , let *max2* be ∞ ; otherwise let *max2* be *max*-1.
 4. Call *RepeatMatcher*(*m*, *min2*, *max2*, *greedy*, *y*, *c*, *parenIndex*, *parenCount*) and return its result.
3. Let *cap* be a fresh copy of *x*'s *captures* List.
4. For every integer *k* that satisfies *parenIndex* < *k* and *k* ≤ *parenIndex+parenCount*, set *cap[k]* to **undefined**.
5. Let *e* be *x*'s *endIndex*.
6. Let *xr* be the State (*e*, *cap*).
7. If *min* is not zero, return *m(xr, d)*.
8. If *greedy* is **false**, then
 - a. Call *c(x)* and let *z* be its result.
 - b. If *z* is not **failure**, return *z*.
 - c. Call *m(xr, d)* and return its result.
9. Call *m(xr, d)* and let *z* be its result.
10. If *z* is not **failure**, return *z*.
11. Call *c(x)* and return its result.

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NOTE 1 An *Atom* followed by a *Quantifier* is repeated the number of times specified by the *Quantifier*. A *Quantifier* can be non-greedy, in which case the *Atom* pattern is repeated as few times as possible while still matching the sequel, or it can be greedy, in which case the *Atom* pattern is repeated as many times as possible while still matching the sequel. The *Atom* pattern is repeated rather than the input character sequence that it matches, so different repetitions of the *Atom* can match different input substrings.

NOTE 2 If the *Atom* and the sequel of the regular expression all have choice points, the *Atom* is first matched as many (or as few, if non-greedy) times as possible. All choices in the sequel are tried before moving on to the next choice in the last repetition of *Atom*. All choices in the last (*n*th) repetition of *Atom* are tried before moving on to the next choice in the next-to-last (*n*-1)st repetition of *Atom*; at which point it may turn out that more or fewer repetitions of *Atom* are now possible; these are exhausted (again, starting with either as few or as many as possible) before moving on to the next choice in the (*n*-1)st repetition of *Atom* and so on.

Compare

```
/a[a-z]{2,4}/.exec("abcdefghijkl")
```

which returns "abcde" with

```
/a[a-z]{2,4}?.exec("abcdefghi")
```

which returns "abc".

Consider also

```
/(aa|aabaac|ba|b|c)*/.exec("aabaaac")
```

which, by the choice point ordering above, returns the array

```
["aabaa", "ba"]
```

and not any of:

```
["aabaaac", "aabaaac"]
["aabaaac", "c"]
```

The above ordering of choice points can be used to write a regular expression that calculates the greatest common divisor of two numbers (represented in unary notation). The following example calculates the gcd of 10 and 15:

```
"aaaaaaaaaaaaaaa".replace(/^(\w+)\1*,\1+$/,"$1")
```

which returns the gcd in unary notation "aaaaa".

NOTE 3 Step 5 of the RepeatMatcher clears *Atom*'s captures each time *Atom* is repeated. We can see its behaviour in the regular expression

```
/(z)((a+)?(b+)?(c)*)*/.exec("zaacbbbac")
```

which returns the array

```
["zaacbbbac", "z", "ac", "a", undefined, "c"]
```

and not

```
["zaacbbbac", "z", "ac", "a", "bbb", "c"]
```

because each iteration of the outermost ***** clears all captured Strings contained in the quantified *Atom*, which in this case includes capture Strings numbered 2, 3, 4, and 5.

NOTE 4 Step 1 of the RepeatMatcher's *d* closure states that, once the minimum number of repetitions has been satisfied, any more expansions of *Atom* that match the empty character sequence are not considered for further repetitions. This prevents the regular expression engine from falling into an infinite loop on patterns such as:

```
/(a*)*/.exec("b")
```

or the slightly more complicated:

```
/(a*)b\1*/.exec("baaaac")
```

which returns the array

```
["b", ""]
```

21.2.2.6 Assertion

The production *Assertion* :: **^** evaluates by returning an internal AssertionTester closure that takes a State argument *x* and performs the following [steps when evaluated](#):

1. Let *e* be *x*'s *endIndex*.
2. If *e* is zero, return **true**.
3. If *Multiline* is **false**, return **false**.
4. If the character *Input*[*e*-1] is one of *LineTerminator*, return **true**.
5. Return **false**.

NOTE Even when the **y** flag is used with a pattern, **^** always matches only at the beginning of *Input*, or (if *Multiline* is **true**) at the beginning of a line.

The production `Assertion :: $` evaluates by returning an internal AssertionTester closure that takes a State argument x and performs the following [steps when evaluated](#):

1. Let e be x 's `endIndex`.
2. If e is equal to `InputLength`, return **true**.
3. If `Multiline` is **false**, return **false**.
4. If the character $Input[e]$ is one of `LineTerminator`, return **true**.
5. Return **false**.

The production `Assertion :: \ b` evaluates by returning an internal AssertionTester closure that takes a State argument x and performs the following [steps when evaluated](#):

1. Let e be x 's `endIndex`.
2. Call `IsWordChar`($e-1$) and let a be the Boolean result.
3. Call `IsWordChar`(e) and let b be the Boolean result.
4. If a is **true** and b is **false**, return **true**.
5. If a is **false** and b is **true**, return **true**.
6. Return **false**.

The production `Assertion :: \ B` evaluates by returning an internal AssertionTester closure that takes a State argument x and performs the following [steps when evaluated](#):

1. Let e be x 's `endIndex`.
2. Call `IsWordChar`($e-1$) and let a be the Boolean result.
3. Call `IsWordChar`(e) and let b be the Boolean result.
4. If a is **true** and b is **false**, return **false**.
5. If a is **false** and b is **true**, return **false**.
6. Return **true**.

The production `Assertion :: (? = Disjunction)` evaluates as follows:

1. Evaluate `Disjunction` to obtain a Matcher m .
2. Return an internal Matcher closure that takes two arguments, a State x and a Continuation c , and performs the following steps:
 1. Let d be a Continuation that always returns its State argument as a successful `MatchResult`.
 2. Call $m(x, d)$ and let r be its result.
 3. If r is **failure**, return **failure**.
 4. Let y be r 's State.
 5. Let cap be y 's `captures` List.
 6. Let xe be x 's `endIndex`.
 7. Let z be the State (xe, cap) .
 8. Call $c(z)$ and return its result.

The production `Assertion :: (? ! Disjunction)` evaluates as follows:

1. Evaluate `Disjunction` to obtain a Matcher m .
2. Return an internal Matcher closure that takes two arguments, a State x and a Continuation c , and performs the following steps:
 1. Let d be a Continuation that always returns its State argument as a successful `MatchResult`.
 2. Call $m(x, d)$ and let r be its result.
 3. If r isn't **failure**, return **failure**.
 4. Call $c(x)$ and return its result.

21.2.2.6.1 Runtime Semantics: IsWordChar Abstract Operation

The abstract operation `IsWordChar` takes an integer parameter `e` and performs the following [steps](#):

1. If `e` is `-1` or `e` is `InputLength`, return `false`.
2. Let `c` be the character `Input[e]`.
3. If `c` is one of the sixty-three characters below, return `true`.

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9																

4. Return `false`.

21.2.2.7 Quantifier

The production `Quantifier :: QuantifierPrefix` evaluates as follows:

1. Evaluate `QuantifierPrefix` to obtain the two results: an integer `min` and an integer (or ∞) `max`.
2. Return the three results `min`, `max`, and `true`.

The production `Quantifier :: QuantifierPrefix ?` evaluates as follows:

1. Evaluate `QuantifierPrefix` to obtain the two results: an integer `min` and an integer (or ∞) `max`.
2. Return the three results `min`, `max`, and `false`.

The production `QuantifierPrefix :: *` evaluates as follows:

1. Return the two results `0` and ∞ .

The production `QuantifierPrefix :: +` evaluates as follows:

1. Return the two results `1` and ∞ .

The production `QuantifierPrefix :: ?` evaluates as follows:

1. Return the two results `0` and `1`.

The production `QuantifierPrefix :: { DecimalDigits }` evaluates as follows:

1. Let `i` be the MV of `DecimalDigits` (see 11.8.3).
2. Return the two results `i` and `i`.

The production `QuantifierPrefix :: { DecimalDigits , }` evaluates as follows:

1. Let `i` be the MV of `DecimalDigits`.
2. Return the two results `i` and ∞ .

The production `QuantifierPrefix :: { DecimalDigits , DecimalDigits }` evaluates as follows:

1. Let `i` be the MV of the first `DecimalDigits`.
2. Let `j` be the MV of the second `DecimalDigits`.
3. Return the two results `i` and `j`.

21.2.2.8 Atom

The production `Atom :: PatternCharacter` evaluates as follows:

1. Let *ch* be the character matched by *PatternCharacter*.
2. Let *A* be a one-element CharSet containing the character *ch*.
3. Call CharacterSetMatcher(*A*, **false**) and return its Matcher result.

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The production *Atom :: .* evaluates as follows:

1. Let *A* be the set of all characters except *LineTerminator*.
2. Call CharacterSetMatcher(*A*, **false**) and return its Matcher result.

The production *Atom :: \ AtomEscape* evaluates as follows:

1. Return the Matcher that is the result of evaluating *AtomEscape*.

The production *Atom :: CharacterClass* evaluates as follows:

1. Evaluate *CharacterClass* to obtain a CharSet *A* and a Boolean *invert*.
2. Call CharacterSetMatcher(*A*, *invert*) and return its Matcher result.

The production *Atom :: (Disjunction)* evaluates as follows:

1. Evaluate *Disjunction* to obtain a Matcher *m*.
2. Let *parenIndex* be the number of left capturing parentheses in the entire regular expression that occur to the left of this production expansion's initial left parenthesis. This is the total number of times the *Atom :: (Disjunction)* production is expanded prior to this production's *Atom* plus the total number of *Atom :: (Disjunction)* productions enclosing this *Atom*.
3. Return an internal Matcher closure that takes two arguments, a State *x* and a Continuation *c*, and performs the following steps:
 1. Create an internal Continuation closure *d* that takes one State argument *y* and performs the following steps:
 1. Let *cap* be a fresh copy of *y*'s *captures* List.
 2. Let *xe* be *x*'s *endIndex*.
 3. Let *ye* be *y*'s *endIndex*.
 4. Let *s* be a fresh List whose characters are the characters of *Input* at indices *xe* (inclusive) through *ye* (exclusive).
 5. Set *cap*[*parenIndex*+1] to *s*.
 6. Let *z* be the State (*ye*, *cap*).
 7. Call *c(z)* and return its result.
 2. Call *m(x, d)* and return its result.

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The production *Atom :: (? : Disjunction)* evaluates as follows:

1. Return the Matcher that is the result of evaluating *Disjunction*.

21.2.2.8.1 Runtime Semantics: CharacterSetMatcher Abstract Operation

The abstract operation CharacterSetMatcher takes two arguments, a CharSet *A* and a Boolean flag *invert*, and performs the following steps:

1. Return an internal Matcher closure that takes two arguments, a State *x* and a Continuation *c*, and performs the following steps steps when evaluated:
 1. Let *e* be *x*'s *endIndex*.
 2. If *e* is *InputLength*, return **failure**.
 3. Let *ch* be the character *Input[e]*.
 4. Let *cc* be the result of Canonicalize(*ch*).
 5. If *invert* is **false**, then

- a. If there does not exist a member a of set A such that $\text{Canonicalize}(a)$ is cc , return **failure**.
6. Else $invert$ is **true**.
 - a. If there exists a member a of set A such that $\text{Canonicalize}(a)$ is cc , return **failure**.
7. Let cap be x 's *captures* List.
8. Let y be the State $(e+1, cap)$.
9. Call $c(y)$ and return its result.

21.2.2.8.2 Runtime Semantics: Canonicalize Abstract Operation

The abstract operation `Canonicalize` takes a character parameter ch and performs the following steps:

1. If `IgnoreCase` is **false**, return ch .
2. If `Unicode` is **true**.
 - a. If the file `CaseFolding.txt` of the Unicode Character Database provides a simple or common case folding mapping for ch , return the result of applying that mapping to ch .
 - b. Else, return ch .
3. Else
 - a. Assert: ch is a UTF-16 code unit.
 - b. Let s be the ECMAScript String value consisting of the single code unit ch .
 - c. Let u be the same result produced as if by performing the algorithm for `String.prototype.toUpperCase` using s as the `this` value.
 - d. ReturnIfAbrupt(u).
 - e. Assert: u is a String value.
 - f. If u does not consist of a single code unit, return ch .
 - g. Let cu be u 's single code unit element.
 - h. If ch 's code unit value ≥ 128 and cu 's code unit value < 128 , return ch .
 - i. Return cu .

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NOTE 1 Parentheses of the form $(\ Disjunction)$ serve both to group the components of the *Disjunction* pattern together and to save the result of the match. The result can be used either in a backreference (\ followed by a nonzero decimal number), referenced in a replace String, or returned as part of an array from the regular expression matching internal procedure. To inhibit the capturing behaviour of parentheses, use the form $(?: \ Disjunction)$ instead.

NOTE 2 The form $(?= \ Disjunction)$ specifies a zero-width positive lookahead. In order for it to succeed, the pattern inside *Disjunction* must match at the current position, but the current position is not advanced before matching the sequel. If *Disjunction* can match at the current position in several ways, only the first one is tried. Unlike other regular expression operators, there is no backtracking into a $(?= \)$ form (this unusual behaviour is inherited from Perl). This only matters when the *Disjunction* contains capturing parentheses and the sequel of the pattern contains backreferences to those captures.

For example,

```
/(?=(a+))/.exec("baaabac")
```

matches the empty String immediately after the first **b** and therefore returns the array:

```
[ "", "aaa" ]
```

To illustrate the lack of backtracking into the lookahead, consider:

```
/(?=(a+))a*b\1/.exec("baaabac")
```

This expression returns

```
[ "aba", "a" ]
```

and not:

```
["aaaba", "a"]
```

NOTE 3 The form `(?! Disjunction)` specifies a zero-width negative lookahead. In order for it to succeed, the pattern inside `Disjunction` must fail to match at the current position. The current position is not advanced before matching the sequel. `Disjunction` can contain capturing parentheses, but backreferences to them only make sense from within `Disjunction` itself. Backreferences to these capturing parentheses from elsewhere in the pattern always return `undefined` because the negative lookahead must fail for the pattern to succeed. For example,

```
/(.*)?a(?! (a+)b\2) / .exec("baaaabaac")
```

looks for an `a` not immediately followed by some positive number `n` of `a`'s, a `b`, another `n` `a`'s (specified by the first `\2`) and a `c`. The second `\2` is outside the negative lookahead, so it matches against `undefined` and therefore always succeeds. The whole expression returns the array:

```
["baaaabaac", "ba", undefined, "abaac"]
```

NOTE 4 In case-insensitive matches when `Unicode` is `true`, all characters are implicitly case-folded using the simple mapping provided by the Unicode standard immediately before they are compared. The simple mapping always maps to a single code point, so it does not map, for example, "`B`" (`U+00DF`) to "`ss`". It may however map a code point outside the Basic Latin range to a character within, for example, "`f`" (`U+017F`) to "`s`". Such characters are not mapped if `Unicode` is `false`. This prevents Unicode code points such as `U+017F` and `U+212A` from matching regular expressions such as `/[a-z]/i`, but they will match `/[a-z]/ui`.

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21.2.2.9 AtomEscape

The production `AtomEscape :: DecimalEscape` evaluates as follows:

1. Evaluate `DecimalEscape` to obtain an `EscapeValue E`.
2. If `E` is a character, then
 - a. Let `ch` be `E`'s character.
 - b. Let `A` be a one-element `CharSet` containing the character `ch`.
 - c. Call `CharacterSetMatcher(A, false)` and return its `Matcher` result.
3. Assert: `E` must be an integer.
4. Let `n` be that integer.
5. If `n=0` or `n>NcapturingParens`, throw a `SyntaxError` exception.
6. Return an internal `Matcher` closure that takes two arguments, a `State x` and a `Continuation c`, and performs the following steps:
 1. Let `cap` be `x`'s `captures` List.
 2. Let `s` be `cap[n]`.
 3. If `s` is `undefined`, `return c(x)`.
 4. Let `e` be `x`'s `endIndex`.
 5. Let `len` be `s`'s length.
 6. Let `f` be `e+len`.
 7. If `f>InputLength`, return `failure`.
 8. If there exists an integer `i` between 0 (inclusive) and `len` (exclusive) such that `Canonicalize(s[i])` is not the same character value as `Canonicalize(Input[e+i])`, `return failure`.
 9. Let `y` be the `State (f, cap)`.
 10. Call `c(y)` and return its result.

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The production `AtomEscape :: CharacterEscape` evaluates as follows:

1. Evaluate `CharacterEscape` to obtain a character `ch`.
2. Let `A` be a one-element `CharSet` containing the character `ch`.
3. Call `CharacterSetMatcher(A, false)` and return its `Matcher` result.

The production *AtomEscape :: CharacterClassEscape* evaluates as follows:

1. Evaluate *CharacterClassEscape* to obtain a CharSet A.
2. Call *CharacterSetMatcher(A, false)* and return its Matcher result.

NOTE An escape sequence of the form `\` followed by a nonzero decimal number *n* matches the result of the *n*th set of capturing parentheses (see [21.2.2.11](#)). It is an error if the regular expression has fewer than *n* capturing parentheses. If the regular expression has *n* or more capturing parentheses but the *n*th one is **undefined** because it has not captured anything, then the backreference always succeeds.

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21.2.2.10 CharacterEscape

The production *CharacterEscape :: ControlEscape* evaluates by returning the character according to [Table 44](#).

Table 44 — ControlEscape Character Values

<i>ControlEscape</i>	<i>Character Value</i>	<i>Code Point</i>	<i>Unicode Name</i>	<i>Symbol</i>
t	9	U+0009	CHARACTER TABULATION	<HT>
n	10	U+000A	LINE FEED (LF)	<LF>
v	11	U+000B	LINE TABULATION	<VT>
f	12	U+000C	FORM FEED (FF)	<FF>
r	13	U+000D	CARRIAGE RETURN (CR)	<CR>

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Deleted: form feed

Deleted: carriage return

The production *CharacterEscape :: c ControlLetter* evaluates as follows:

1. Let *ch* be the character **matched** by *ControlLetter*.
2. Let *i* be *ch*'s character value.
3. Let *j* be the remainder of dividing *i* by 32.
4. Return the character whose character value is *j*.

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The production *CharacterEscape :: HexEscapeSequence* evaluates as follows:

1. Return the character whose code is the **SV** of *HexEscapeSequence*.

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The production *CharacterEscape :: RegExpUnicodeEscapeSequence* evaluates as follows:

1. Return the result of evaluating *RegExpUnicodeEscapeSequence*.

The production *CharacterEscape :: IdentityEscape* evaluates as follows:

1. Return the character **matched** by *IdentityEscape*.

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The production *RegExpUnicodeEscapeSequence :: u LeadSurrogate \u TrailSurrogate* evaluates as follows:

1. Let *lead* be the result of evaluating *LeadSurrogate*.
2. Let *trail* be the result of evaluating *TrailSurrogate*.
3. Let *cp* be *UTF16Decode(lead, trail)*.
4. Return the character whose character value is *cp*.

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The production *RegExpUnicodeEscapeSequence :: u Hex4Digits* evaluates as follows:

1. Return the character whose code is the **SV** of *Hex4Digits*.

Deleted: CV

The production *RegExpUnicodeEscapeSequence* :: **u{ HexDigits}** evaluates as follows:

1. Return the character whose code is the MV of *HexDigits*.

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The production *LeadSurrogate* :: *Hex4Digits* evaluates as follows:

1. Return the character whose code is the **SV** of *Hex4Digits*.

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The production *TailSurrogate* :: *Hex4Digits* evaluates as follows:

1. Return the character whose code is the **SV** of *Hex4Digits*.

21.2.2.11 DecimalEscape

The production *DecimalEscape* :: *DecimalIntegerLiteral* evaluates as follows:

1. Let *i* be the MV of *DecimalIntegerLiteral*.
2. If *i* is zero, return the EscapeValue consisting of the character U+0000 (NULL).
3. Return the EscapeValue consisting of the integer *i*.

The definition of “the MV of *DecimalIntegerLiteral*” is in 11.8.3.

NOTE If \ is followed by a decimal number *n* whose first digit is not 0, then the escape sequence is considered to be a backreference. It is an error if *n* is greater than the total number of left capturing parentheses in the entire regular expression. \0 represents the <NUL> character and cannot be followed by a decimal digit.

21.2.2.12 CharacterClassEscape

The production *CharacterClassEscape* :: **d** evaluates by returning the ten-element set of characters containing the characters 0 through 9 inclusive.

The production *CharacterClassEscape* :: **D** evaluates by returning the set of all characters not included in the set returned by *CharacterClassEscape* :: **d**.

The production *CharacterClassEscape* :: **s** evaluates by returning the set of characters containing the characters that are on the right-hand side of the *WhiteSpace* (11.2) or *LineTerminator* (11.3) productions.

The production *CharacterClassEscape* :: **S** evaluates by returning the set of all characters not included in the set returned by *CharacterClassEscape* :: **s**.

The production *CharacterClassEscape* :: **w** evaluates by returning the set of characters containing the sixty-three characters:

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	—															

The production *CharacterClassEscape* :: **w** evaluates by returning the set of all characters not included in the set returned by *CharacterClassEscape* :: **w**.

21.2.2.13 CharacterClass

The production *CharacterClass* :: [*ClassRanges*] evaluates by evaluating *ClassRanges* to obtain a CharSet and returning that CharSet and the Boolean **false**.

The production *CharacterClass* :: [^ *ClassRanges*] evaluates by evaluating *ClassRanges* to obtain a CharSet and returning that CharSet and the Boolean **true**.

21.2.2.14 ClassRanges

The production *ClassRanges* :: [empty] evaluates by returning the empty CharSet.

The production *ClassRanges* :: *NonemptyClassRanges* evaluates by evaluating *NonemptyClassRanges* to obtain a CharSet and returning that CharSet.

21.2.2.15 NonemptyClassRanges

The production *NonemptyClassRanges* :: *ClassAtom* evaluates as follows:

1. Return the CharSet that is the result of evaluating *ClassAtom*.

The production *NonemptyClassRanges* :: *ClassAtom* *NonemptyClassRangesNoDash* evaluates as follows:

1. Evaluate *ClassAtom* to obtain a CharSet *A*.
2. Evaluate *NonemptyClassRangesNoDash* to obtain a CharSet *B*.
3. Return the union of CharSets *A* and *B*.

The production *NonemptyClassRanges* :: *ClassAtom* – *ClassAtom* *ClassRanges* evaluates as follows:

1. Evaluate the first *ClassAtom* to obtain a CharSet *A*.
2. Evaluate the second *ClassAtom* to obtain a CharSet *B*.
3. Evaluate *ClassRanges* to obtain a CharSet *C*.
4. Call *CharacterRange*(*A*, *B*) and let *D* be the resulting CharSet.
5. Return the union of CharSets *D* and *C*.

21.2.2.15.1 Runtime Semantics: CharacterRange Abstract Operation

The abstract operation *CharacterRange* takes two CharSet parameters *A* and *B* and performs the following steps:

1. If *A* does not contain exactly one character or *B* does not contain exactly one character, **throw a ~~SyntaxError~~** exception. Deleted: then
2. Let *a* be the one character in CharSet *A*.
3. Let *b* be the one character in CharSet *B*.
4. Let *i* be the character value of character *a*.
5. Let *j* be the character value of character *b*.
6. If *i* > *j*, **throw a ~~SyntaxError~~** exception. Deleted: then
7. Return the set containing all characters numbered *i* through *j*, inclusive.

21.2.2.16 NonemptyClassRangesNoDash

The production *NonemptyClassRangesNoDash* :: *ClassAtom* evaluates as follows:

1. Return the CharSet that is the result of evaluating *ClassAtom*.

The production *NonemptyClassRangesNoDash :: ClassAtomNoDash NonemptyClassRangesNoDash* evaluates as follows:

1. Evaluate *ClassAtomNoDash* to obtain a CharSet *A*.
2. Evaluate *NonemptyClassRangesNoDash* to obtain a CharSet *B*.
3. Return the union of CharSets *A* and *B*.

The production *NonemptyClassRangesNoDash :: ClassAtomNoDash - ClassAtom ClassRanges* evaluates as follows:

1. Evaluate *ClassAtomNoDash* to obtain a CharSet *A*.
2. Evaluate *ClassAtom* to obtain a CharSet *B*.
3. Evaluate *ClassRanges* to obtain a CharSet *C*.
4. Call CharacterRange(*A*, *B*) and let *D* be the resulting CharSet.
5. Return the union of CharSets *D* and *C*.

NOTE 1 *ClassRanges* can expand into single *ClassAtoms* and/or ranges of two *ClassAtoms* separated by dashes. In the latter case the *ClassRanges* includes all characters between the first *ClassAtom* and the second *ClassAtom*, inclusive; an error occurs if either *ClassAtom* does not represent a single character (for example, if one is `\w`) or if the first *ClassAtom*'s character value is greater than the second *ClassAtom*'s character value.

NOTE 2 Even if the pattern ignores case, the case of the two ends of a range is significant in determining which characters belong to the range. Thus, for example, the pattern `/[E-F]/i` matches only the letters `E`, `F`, `e`, and `f`, while the pattern `/[E-f]/i` matches all upper and lower-case letters in the Unicode Basic Latin block as well as the symbols `[`, `\`, `]`, `^`, `_` and ```.

NOTE 3 A `-` character can be treated literally or it can denote a range. It is treated literally if it is the first or last character of *ClassRanges*, the beginning or end limit of a range specification, or immediately follows a range specification.

21.2.2.17 ClassAtom

The production *ClassAtom :: -* evaluates by returning the CharSet containing the one character `-`.

The production *ClassAtom :: ClassAtomNoDash* evaluates by evaluating *ClassAtomNoDash* to obtain a CharSet and returning that CharSet.

21.2.2.18 ClassAtomNoDash

The production *ClassAtomNoDash :: SourceCharacter but not one of \ or] or -* evaluates as follows:

1. Return the CharSet containing the character matched by *SourceCharacter*.

Deleted: that is

The production *ClassAtomNoDash :: \ ClassEscape* evaluates as follows:

1. Return the CharSet that is the result of evaluating *ClassEscape*.

21.2.2.19 ClassEscape

The production *ClassEscape :: DecimalEscape* evaluates as follows:

1. Evaluate *DecimalEscape* to obtain an *EscapeValue E*.
2. If *E* is not a character, throw a **SyntaxError** exception.
3. Let *ch* be *E*'s character.
4. Return the one-element CharSet containing the character *ch*.

Deleted: then

The production *ClassEscape :: b* evaluates as follows:

1. Return the CharSet containing the single character <BS> U+0008 (BACKSPACE).

The production *ClassEscape :: -* evaluates as follows:

1. Return the CharSet containing the single character - U+002D (HYPEN-MINUS).

The production *ClassEscape :: CharacterEscape* evaluates as follows:

1. Return the CharSet containing the single character that is the result of evaluating *CharacterEscape*.

The production *ClassEscape :: CharacterClassEscape* evaluates as follows:

1. Return the CharSet that is the result of evaluating *CharacterClassEscape*.

NOTE A *ClassAtom* can use any of the escape sequences that are allowed in the rest of the regular expression except for \b, \B, and backreferences. Inside a *CharacterClass*, \b means the backspace character, while \B and backreferences raise errors. Using a backreference inside a *ClassAtom* causes an error.

21.2.3 The RegExp Constructor

The *RegExp* constructor is the %*RegExp*% intrinsic object and the initial value of the *RegExp* property of the global object. When *RegExp* is called as a function rather than as a constructor, it creates and initializes a new *RegExp* object. Thus the function call *RegExp* (...) is equivalent to the object creation expression *new RegExp* (...) with the same arguments.

The *RegExp* constructor is designed to be subclassable. It may be used as the value of an *extends* clause of a class definition. Subclass constructors that intend to inherit the specified *RegExp* behaviour must include a *super* call to the *RegExp* constructor to create and initialize subclass instances with the necessary internal slots.

21.2.3.1 *RegExp* (pattern, flags)

The following steps are taken:

1. Let *patternIsRegExp* be *IsRegExp*(*pattern*).
2. ReturnIfAbrupt(*patternIsRegExp*).
3. If *NewTarget* is not undefined, let *newTarget* be *NewTarget*.
4. Else,
 - a. Let *newTarget* be the active function object.
 - b. If *patternIsRegExp* is true and *flags* is undefined, then
 - i. Let *patternConstructor* be *Get*(*pattern*, "constructor").
 - ii. ReturnIfAbrupt(*patternConstructor*).
 - iii. If *SameValue*(*newTarget*, *patternConstructor*) is true, return *pattern*.
5. If *Type*(*pattern*) is Object and *pattern* has a [[RegExMatcher]] internal slot, then
 - a. Let *P* be the value of *pattern*'s [[OriginalSource]] internal slot.
 - b. If *flags* is undefined, let *F* be the value of *pattern*'s [[OriginalFlags]] internal slot.
 - c. Else, let *F* be *flags*.
6. Else if *patternIsRegExp* is true, then
 - a. Let *P* be *Get*(*pattern*, "source").
 - b. ReturnIfAbrupt(*P*).
 - c. If *flags* is undefined, then
 - i. Let *F* be *Get*(*pattern*, "flags").

Deleted: However, if the **this** value passed in the call is an Object with a [[RegExMatcher]] internal slot whose value is undefined, it initializes the **this** value using the argument values. This permits *RegExp* to be used both as factory method and to perform constructor instance initialization.

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Deleted: <#>Let *func* be this *RegExp* the active function object.
<#>Let *O* be the **this** value.

Deleted: <#>Let *O* be *IsRegExp* be *IsRegExp*(*O*).
<#>ReturnIfAbrupt(*O*is*RegExp*).¶

Deleted: Type(*O*) is not Object or Type(*O*) is Object and *O* does not have a [[RegExMatcher]] internal slot or Type(*O*) is Object and *O* has a [[RegExMatcher]] internal slot and the value of [[RegExMatcher]] is not undefined

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Deleted: Type(*pattern*) is Object and *O*

Deleted: has a [[RegExMatcher]] internal slot

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Deleted: <#>Let *newTarget* be the active function object. ¶

Deleted: <#>Let *O* be the result of calling the abstract operation *RegExpAlloc* with argument *func*.¶
<#>ReturnIfAbrupt(*O*).¶

Deleted: <#>If the value of *pattern*'s [[RegExMatcher]] internal slot is undefined, then throw a *TypeError* exception.¶

Deleted: <#>If *flags* is not undefined, then throw a *TypeError* exception.¶

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- ii. ReturnIfAbrupt(F).
- d. Else, let F be $flags$.
7. Else,
 - a. Let P be $pattern$.
 - b. Let F be $flags$.
8. Let O be RegExpAlloc(newTarget).
9. ReturnIfAbrupt(O).
10. Return RegExpInitialize(O, P, F).

NOTE If pattern is supplied using a *StringLiteral*, the usual escape sequence substitutions are performed before the String is processed by RegExp. If pattern must contain an escape sequence to be recognized by RegExp, any REVERSE SOLIDUS (\) code points must be escaped within the *StringLiteral* to prevent them being removed when the contents of the *StringLiteral* are formed.

21.2.3.2 Abstract Operations for the RegExp Constructor

21.2.3.2.1 Runtime Semantics: RegExpAlloc Abstract Operation

When the abstract operation `RegExpAlloc` with argument $newTarget$ is called, the following steps are taken:

1. Let obj be OrdinaryCreateFromConstructor($newTarget$, "%RegExpPrototype%", $\langle[[\text{RegExpMatcher}]], [[\text{OriginalSource}]], [[\text{OriginalFlags}]]\rangle$).
2. ReturnIfAbrupt(obj).
3. Let $status$ be the result of `DefinePropertyOrThrow(obj , "lastIndex", PropertyDescriptor {[[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: false})`.
4. Assert: $status$ is not an abrupt completion.
5. Return obj .

21.2.3.2.2 Runtime Semantics: RegExInitialize Abstract Operation

When the abstract operation `RegExInitialize` with arguments obj , $pattern$, and $flags$ is called, the following steps are taken:

1. If $pattern$ is undefined, let P be the empty String.
2. Else, let P be `ToString(pattern)`.
3. ReturnIfAbrupt(P).
4. If $flags$ is undefined, let F be the empty String.
5. Else, let F be `ToString(flags).`
6. ReturnIfAbrupt(F).
7. If F contains any code unit other than "g", "i", "m", "u", or "y" or if it contains the same code unit more than once, throw a SyntaxError exception.
8. If F contains "u", let BMP be false; else let BMP be true.
9. If BMP is true, then
 - a. Parse P using the grammars in 21.2.1 and interpreting each of its 16-bit elements as a Unicode BMP code point. UTF-16 decoding is not applied to the elements. The goal symbol for the parse is `Pattern`. Throw a SyntaxError exception if P did not conform to the grammar or if any elements of P were not matched by the parse.
 - b. Let $patternCharacters$ be a List whose elements are the code unit elements of P .
10. Else
 - a. Parse P using the grammars in 21.2.1 and interpreting P as UTF-16 encoded Unicode code points (6.1.4). The goal symbol for the parse is `Pattern10`. Throw a SyntaxError exception if P did not conform to the grammar or if any elements of P were not matched by the parse.

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Deleted: code point
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Deleted: using the grammars in 21.2.1
Deleted: all
Deleted: characters
Deleted: code point
Deleted: h
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- b. Let *patternCharacters* be a List whose elements are the code points resulting from applying UTF-16 decoding to *P*'s sequence of elements.
11. Set the value of *obj*'s `[[OriginalSource]]` internal slot to *P*.
 12. Set the value of *obj*'s `[[OriginalFlags]]` internal slot to *F*.
 13. Set *obj*'s `[[RegExpMatcher]]` internal slot to the internal procedure that evaluates the above parse of *P* by applying the semantics provided in 21.2.2 using *patternCharacters* as the pattern's List of `SourceCharacter` values and *F* as the flag parameters.
 14. Let *putStatus* be the result of `Put(obj, "lastIndex", 0, true)`.
 15. `ReturnIfAbrupt(putStatus)`.
 16. Return *obj*.

21.2.3.2.3 Runtime Semantics: RegExpCreate Abstract Operation

When the abstract operation `RegExpCreate` with arguments *P* and *F* is called, the following steps are taken:

1. Let *obj* be `RegExpAlloc(%RegExp%)`.
2. `ReturnIfAbrupt(obj)`.
3. Return `RegExpInitialize(obj, P, F)`.

21.2.3.2.4 Runtime Semantics: EscapeRegExpPattern Abstract Operation

When the abstract operation `EscapeRegExpPattern` with arguments *P* and *F* is called, the following occurs:

1. Let *S* be a String in the form of a *Pattern* (*Pattern_U* if *F* contains "`u`") equivalent to *P* interpreted as UTF-16 encoded Unicode code points (6.1.4), in which certain code points are escaped as described below. *S* may or may not be identical to *P*; however, the internal procedure that would result from evaluating *S* as a *Pattern* (*Pattern_U* if *F* contains "`u`") must behave identically to the internal procedure given by the constructed object's `[[RegExpMatcher]]` internal slot. Multiple calls to this abstract operation using the same values for *P* and *F* must produce identical results.
2. The code points / or any *LineTerminator* occurring in the pattern shall be escaped in *S* as necessary to ensure that the String value formed by concatenating the Strings `"/", S, "/"`, and *F* can be parsed (in an appropriate lexical context) as a *RegularExpressionLiteral* that behaves identically to the constructed regular expression. For example, if *P* is `"/"`, then *S* could be `\/"` or `\u002F`, among other possibilities, but not `"/"`, because `///` followed by *F* would be parsed as a *SingleLineComment* rather than a *RegularExpressionLiteral*. If *P* is the empty String, this specification can be met by letting *S* be `"(?:)"`.
3. Return *S*.

21.2.4 Properties of the RegExp Constructor

The value of the `[[Prototype]]` internal slot of the `RegExp` constructor is the *intrinsic object %FunctionPrototype%* (19.2.3).

Besides the `length` property (whose value is **2**), the `RegExp` constructor has the following properties:

21.2.4.1 RegExp.prototype

The initial value of `RegExp.prototype` is the `RegExp` prototype object (21.2.5).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

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Deleted: interpreted as sequence of UTF-16 encoded Unicode code points.
Deleted: <#>If *obj*'s `[[RegExpMatcher]]` internal slot is not `undefined`, then throw a `TypeError` exception.
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- Deleted:** the result of calling the abstract operation
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- Deleted:** standard built-in Function prototype object
Deleted: The `[[CreateAction]]` of the `RegExp` constructor identifies the following abstract operation:
The `RegExp CreateAction` abstract operation when called with arguments *constructor* and *argumentsList* of performs the following steps:
<#>Return `RegExpAlloc` with argument *constructor*.
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21.2.4.2 get RegExp[@@species]

RegExp[@@species] is an accessor property whose set accessor function is undefined. Its get accessor function performs the following steps:

1. Return this.

The value of the name property of this function is "get [Symbol.species]".

NOTE RegExp prototype methods normally use their this object's constructor to create a derived object. However, a subclass constructor may over-ride that default behaviour by redefining its @@species property.

21.2.5 Properties of the RegExp Prototype Object

The RegExp prototype object is an ordinary object. It is not a RegExp instance and does not have a [[RegExpMatcher]] internal slot or any of the other internal slots of RegExp instance objects.

The value of the [[Prototype]] internal slot of the RegExp prototype object is the intrinsic object %ObjectPrototype%(19.1.3).

NOTE The RegExp prototype object does not have a valueOf property of its own; however, it inherits the valueOf property from the Object prototype object.

21.2.5.1 RegExp.prototype.constructor

The initial value of RegExp.prototype.constructor is the intrinsic object %RegExp%.

21.2.5.2 RegExp.prototype.exec (string)

Performs a regular expression match of string against the regular expression and returns an Array object containing the results of the match, or null if string did not match.

The String ToString(string) is searched for an occurrence of the regular expression pattern as follows:

1. Let R be the this value.
2. If Type(R) is not Object, throw a TypeError exception.
3. If R does not have a [[RegExpMatcher]] internal slot, throw a TypeError exception.
4. Let S be ToString(string).
5. ReturnIfAbrupt(S).
6. Return RegExpBuiltinExec(R, S).

21.2.5.2.1 Runtime Semantics: RegExpExec (R, S) Abstract Operation

The abstract operation RegExpExec with arguments R and S performs the following steps:

1. Assert: Type(R) is Object.
2. Assert: Type(S) is String.
3. Let exec be Get(R, "exec").
4. ReturnIfAbrupt(exec).
5. If IsCallable(exec) is true, then
 - a. Let result be Call(exec, R, «S»).
 - b. ReturnIfAbrupt(result).
 - c. If Type(result) is neither Object or Null, throw a TypeError exception.

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Deleted: <#>RegExp[@@create]()
The @@create method of an object F performs the following:
<#>Return the result of calling the abstract operation RegExpAlloc with argument F.
The value of the name property of this function is "[Symbol.create]". ¶
This property has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.

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Deleted: <#>If the value of R's [[RegExpMatcher]] internal slot is undefined, then throw a TypeError exception.¶

Deleted: <#>If R does not have a [[RegExpMatcher]] internal slot, then throw a TypeError exception.¶
<#>If the value of R's [[RegExpMatcher]] internal slot is undefined, then throw a TypeError exception.¶

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21. Assert: The value of A's "`length`" property is $n + 1$.
22. Let `matchIndex` be `lastIndex`.
23. Assert: The following CreateDataProperty calls will not result in an abrupt completion.
24. Perform CreateDataProperty(A, "`index`", `matchIndex`).
25. Perform CreateDataProperty(A, "`input`", S).
26. Let `matchedSubstr` be the matched substring (i.e. the portion of S between offset `lastIndex`, inclusive and offset e exclusive).
27. Perform CreateDataProperty(A, "`0`", `matchedSubstr`).
28. For each integer i such that $i > 0$ and $i \leq n$
 - a. Let `captureI` be i^{th} element of r 's `captures` List.
 - b. If `captureI` is `undefined`, let `capturedValue` be `undefined`.
 - c. Else if `fullUnicode` is `true`,
 - i. Assert: `captureI` is a List of code points.
 - ii. Let `capturedValue` be a string whose `code units` are the UTF-16 Encoding (10.1.1) of the code points of `captureI`.
 - d. Else, `fullUnicode` is `false`,
 - i. Assert: `captureI` is a List of code units.
 - ii. Let `capturedValue` be a string consisting of the code units of `captureI`.
 - e. Perform CreateDataProperty(A, `ToString(i)`, `capturedValue`).
29. Return A.

21.2.5.3 `get RegExp.prototype.flags`

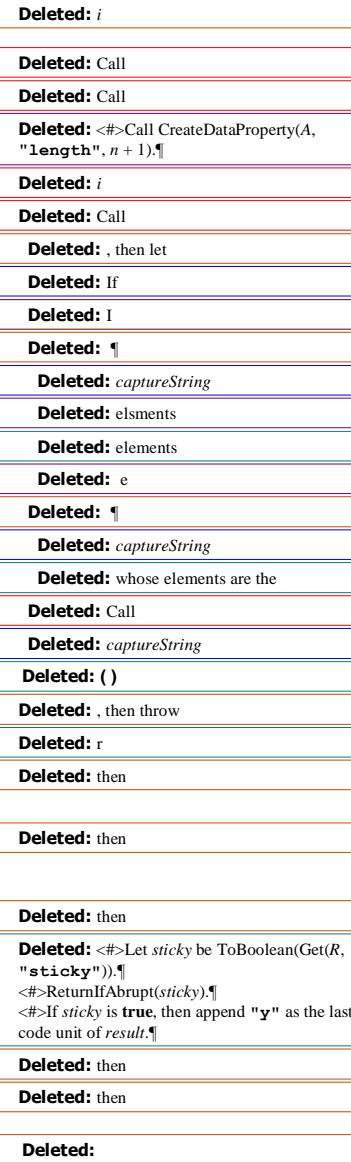
`RegExp.prototype.flags` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Let R be the `this` value.
2. If `Type(R)` is not `Object`, throw a `TypeError` exception.
3. Let `result` be the empty String.
4. Let `global` be `ToBoolean(Get(R, "global"))`.
5. ReturnIfAbrupt(global).
6. If `global` is `true`, append "`g`" as the last code unit of `result`.
7. Let `ignoreCase` be `ToBoolean(Get(R, "ignoreCase"))`.
8. ReturnIfAbrupt(ignoreCase).
9. If `ignoreCase` is `true`, append "`i`" as the last code unit of `result`.
10. Let `multiline` be `ToBoolean(Get(R, "multiline"))`.
11. ReturnIfAbrupt(multiline).
12. If `multiline` is `true`, append "`m`" as the last code unit of `result`.
13. Let `unicode` be `ToBoolean(Get(R, "unicode"))`.
14. ReturnIfAbrupt(unicode).
15. If `unicode` is `true`, append "`u`" as the last code unit of `result`.
16. Let `sticky` be `ToBoolean(Get(R, "sticky"))`.
17. ReturnIfAbrupt(sticky).
18. If `sticky` is `true`, append "`y`" as the last code unit of `result`.
19. Return result.

21.2.5.4 `get RegExp.prototype.global`

`RegExp.prototype.global` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Let R be the `this` value.



2. If Type(*R*) is not Object, throw a **TypeError** exception.
3. If *R* does not have an [[OriginalFlags]] internal slot throw a **TypeError** exception.
4. Let *flags* be the value of *R*'s [[OriginalFlags]] internal slot.
5. If *flags* contains the code unit "g", return true.
6. Return false.

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21.2.5.5 `get RegExp.prototype.ignoreCase`

`RegExp.prototype.ignoreCase` is an accessor property whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *R* be the **this** value.
2. If Type(*R*) is not Object, throw a **TypeError** exception.
3. If *R* does not have an [[OriginalFlags]] internal slot throw a **TypeError** exception.
4. Let *flags* be the value of *R*'s [[OriginalFlags]] internal slot.
5. If *flags* contains the code unit "i", return true.
6. Return false.

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21.2.5.6 `RegExp.prototype[@@match](string)`

When the `@@match` method is called with argument *string*, the following steps are taken:

1. Let *rx* be the **this** value.
2. If Type(*rx*) is not Object, throw a **TypeError** exception.
3. Let *S* be `ToString(string)`.
4. ReturnIfAbrupt(*S*).
5. Let *global* be `ToBoolean(Get(rx, "global"))`.
6. ReturnIfAbrupt(*global*).
7. If *global* is **false**, then
 - a. Return the result of `RegExpExec(rx, S)`.
8. Else *global* is **true**,
 - a. Let *putStatus* be `Put(rx, "lastIndex", 0, true)`.
 - b. ReturnIfAbrupt(*putStatus*).
 - c. Let *A* be `ArrayCreate(0)`.
 - d. Let *n* be 0.
 - e. Repeat,
 - i. Let *result* be `RegExpExec(rx, S)`.
 - ii. ReturnIfAbrupt(*result*).
 - iii. If *result* is **null**, then
 1. If *n*=0, return **null**.
 2. Else, return *A*.
 - iv. Else *result* is not **null**,
 1. Let *matchValue* be `Get(result, "0")`.
 2. ReturnIfAbrupt(*matchValue*).
 3. Let *matchStr* be `ToString(matchValue)`.
 4. ReturnIfAbrupt(*matchStr*).
 5. Let *status* be `CreateDataProperty(A, ToString(n), matchStr)`.
 6. Assert: *status* is **true**.
 7. If *matchStr* is the empty String, then
 - a. Let *thisIndex* be `ToLength(Get(rx, "lastIndex"))`.
 - b. ReturnIfAbrupt(*thisIndex*).
 - c. Let *putStatus* be `Put(rx, "lastIndex", thisIndex+1, true)`.
 - d. ReturnIfAbrupt(*putStatus*).

Deleted: , then throw
Deleted: <#>If *rx* does not have a [[RegExpMatcher]] internal slot, then throw a **TypeError** exception.¶
<#>If the value of *rx*'s [[RegExpMatcher]] internal slot is **undefined**, then throw a **TypeError** exception.¶
Deleted: not true**Deleted:****Deleted:** (see 21.2.5.2)**Deleted:** <#>Let *previousLastIndex* be 0.¶**Deleted:** <#>Let *lastMatch* be true.¶**Deleted:** while *lastMatch* is true**Deleted:** , then return**Deleted:** set *lastMatch* to false**Deleted:** Value
Deleted: <#>Let *matchStr* be `ToString(matchValue)`.¶
<#>ReturnIfAbrupt(*matchStr*).¶
Formatted**Deleted:****Deleted:** ToInteger**Deleted:** <#>If *thisIndex* = *previousLastIndex* then¶

8. Increment n .

The value of the `name` property of this function is "`[Symbol.match]`".

NOTE The `@@match` property is used by the `IsRegExp` abstract operation to identify objects that have the basic behaviour of regular expressions. The absence of a `@@match` property or the existence of such a property whose value does not Boolean coerce to `true` indicates that the object is not intended to be used as a regular expression object.

21.2.5.7 `get RegExp.prototype.multiline`

`RegExp.prototype.multiline` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Let R be the `this` value.
2. If `Type(R)` is not `Object`, **throw** a `TypeError` exception.
3. If R does not have an `[[OriginalFlags]]` internal slot throw a `TypeError` exception.
4. Let $flags$ be the value of R 's `[[OriginalFlags]]` internal slot.
5. If $flags$ contains the `code unit "m"`, **return** `true`.
6. Return `false`.

21.2.5.8 `RegExp.prototype.[@@replace](string, replaceValue)`

When the `@@replace` method is called with arguments `string` and `replaceValue` the following steps are taken:

1. Let rx be the `this` value.
2. If `Type(rx)` is not `Object`, **throw** a `TypeError` exception.
3. Let S be `ToString(string)`.
4. ReturnIfAbrupt(S).
5. Let $lengthS$ be the number of code unit elements in S .
6. Let $functionalReplace$ be `IsCallable(replaceValue)`.
7. If $functionalReplace$ is `false`, then
 - a. Let $replaceValue$ be `ToString(replaceValue)`.
 - b. ReturnIfAbrupt($replaceValue$).
8. Let $global$ be `ToBoolean(Get(rx, "global"))`.
9. ReturnIfAbrupt($global$).
10. If $global$ is `true`, then
 - a. Let $putStatus$ be `Put(rx, "lastIndex", 0, true)`.
 - b. ReturnIfAbrupt($putStatus$).
11. Let $results$ be a new empty List.
12. Let $done$ be `false`.
13. Repeat, while $done$ is `false`
 - a. Let $result$ be `RegExpExec(rx, S)`.
 - b. ReturnIfAbrupt($result$).
 - c. If $result$ is `null`, set $done$ to `true`.
 - d. Else $result$ is not `null`,
 - i. Append $result$ to the end of $results$.
 - ii. If $global$ is `false`, set $done$ to `true`.
 - iii. Else
 1. Let $matchStr$ be `ToString(Get(result, "0"))`.
 2. ReturnIfAbrupt($matchStr$).
 3. If $matchStr$ is the empty String, then

Deleted: <#>Set `previousLastIndex` to `thisIndex+1`.
Deleted: <#>Else
 <#>Set `previousLastIndex` to `thisIndex`.
 <#>Let `matchStr` be `Get(result, "0")`.
 <#>Let `defineStatus` status be `CreateDataPropertyOrThrow(A, ToString(n), matchStr)`.
 <#>Assert: `status` is `true`
`trueReturnIfAbrupt(defineStatus)`.

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Deleted: <#>If $n = 0$, then return `null`.
 <#>Return A .

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Deleted: <#>If $flags$ is `undefined`, then throw a `TypeError` exception.

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Deleted: <#>If rx does not have a `[[RegExpMatcher]]` internal slot, then throw a `TypeError` exception.
 <#>If the value of rx 's `[[RegExpMatcher]]` internal slot is `undefined`, then throw a `TypeError` exception.

Deleted: <#>Let $nCaptures$ be the number of left capturing parentheses in rx (using `NcapturingParens` as specified in 21.2.2.1).

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Deleted: <#>Let `accumulatedResult` be the empty String value.
 <#>Let `nextSrcPosition` be 0.

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Deleted: <#>Let `previousLastIndex` be 0.

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Deleted: If $result$ is not `null`, then ap

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- a. Let `thisIndex` be `ToLength`(`Get(rx, "lastIndex")`).
 b. ReturnIfAbrupt(`thisIndex`).
 c. Let `putStatus` be `Put(rx, "lastIndex", thisIndex+1, true).`
 d. ReturnIfAbrupt(`putStatus`).
14. Let `accumulatedResult` be the empty String value.
15. Let `nextSourcePosition` be 0.
16. Repeat, for each `result` in `results`.
- a. Let `nCaptures` be `ToLength`(`Get(result, "length")`).
 b. ReturnIfAbrupt(`nCaptures`).
 c. Let `nCaptures` be `max(nCaptures - 1, 0)`.
 d. Let `matched` be `ToString`(`Get(result, "0")`).
 e. ReturnIfAbrupt(`matched`).
 f. Let `matchLength` be the number of code units in `matched`.
 g. Let `position` be `ToInteger`(`Get(result, "index")`).
 h. ReturnIfAbrupt(`position`).
 i. Let `position` be `max(min(position, lengthS), 0)`.
 j. Let `n` be 1.
 k. Let `captures` be an empty List.
 l. Repeat while `n < nCaptures`
 - i. Let `capN` be `Get(result, ToString(n))`.
 ii. If `Type(capN)` is not `Undefined`, let `capN` be `ToString(capN)`.
 iii. ReturnIfAbrupt(`capN`).
 iv. Append `capN` as the last element of `captures`.
 v. Let `n` be `n+1`
 m. If `functionalReplace` is `true`, then
 - i. Let `replacerArgs` be the List (`matched`).
 ii. Append in list order the elements of `captures` to the end of the List `replacerArgs`.
 iii. Append `position` and `S` as the last two elements of `replacerArgs`.
 iv. Let `rep1Value` be `Call(replaceValue, undefined, replacerArgs)`.
 v. Let `replacement` be `ToString(rep1Value)`.
 n. Else,
 - i. Let `replacement` be `GetReplaceSubstitution(matched, S, position, captures, replaceValue)`.
 o. ReturnIfAbrupt(`replacement`).
 p. If `position > nextSourcePosition`, then
 - i. NOTE: `position` should not normally move backwards. If it does, it is in indication of a ill-behaving RegExp subclass or use of an access triggered side-effect to change the global flag or other characteristics of `rx`. In such cases, the corresponding substitution is ignored.
 - ii. Let `accumulatedResult` be the String formed by concatenating the code units of the current value of `accumulatedResult` with the substring of `S` consisting of the code units from `nextSourcePosition` (inclusive) up to `position` (exclusive) and with the code units of `replacement`.
 iii. Let `nextSourcePosition` be `position + matchLength`.
17. If `nextSourcePosition > lengthS`, return `accumulatedResult`.
18. Return the String formed by concatenating the code units of `accumulatedResult` with the substring of `S` consisting of the code units from `nextSourcePosition` (inclusive) up through the final code unit of `S` (inclusive).

The value of the `name` property of this function is "`[Symbol.replace]`".

21.2.5.9 `RegExp.prototype[@@search](string)`

When the `@@search` method is called with argument `string`, the following steps are taken:

1. Let `rx` be the `this` value.
2. If `Type(rx)` is not `Object`, throw a `TypeError` exception.
3. Let `S` be `ToString(string)`.
4. ReturnIfAbrupt(`S`).
5. Let `previousLastIndex` be `Get(rx, "lastIndex")`.
6. ReturnIfAbrupt(`previousLastIndex`).
7. Let `status` be `Put(rx, "lastIndex", 0, true)`.
8. ReturnIfAbrupt(`status`).
9. Let `result` be `RegExpExec(rx, S)`.
10. ReturnIfAbrupt(`result`).
11. Let `status` be `Put(rx, "lastIndex", previousLastIndex, true)`.
12. ReturnIfAbrupt(`status`).
13. If `result` is `null`, return `-1`.
14. Return `Get(result, "index")`.

The value of the `name` property of this function is "`[Symbol.search]`".

NOTE The `lastIndex` and `global` properties of this `RegExp` object are ignored when performing the search. The `lastIndex` property is left unchanged.

21.2.5.10 `get RegExp.prototype.source`

`RegExp.prototype.source` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Let `R` be the `this` value.
2. If `Type(R)` is not `Object`, throw a `TypeError` exception.
3. If `R` does not have an `[[OriginalSource]]` internal slot throw a `TypeError` exception.
4. If `R` does not have an `[[OriginalFlags]]` internal slot throw a `TypeError` exception.
5. Let `src` be the value of `R`'s `[[OriginalSource]]` internal slot.
6. Let `flags` be the value of `R`'s `[[OriginalFlags]]` internal slot.
7. Return `EscapeRegExpPattern(src, flags)`.

21.2.5.11 `RegExp.prototype[@@split](string, limit)`

NOTE Returns an `Array` object into which substrings of the result of converting `string` to a `String` have been stored. The substrings are determined by searching from left to right for matches of the `this` value regular expression; these occurrences are not part of any substring in the returned array, but serve to divide up the `String` value.

The `this` value may be an empty regular expression or a regular expression that can match an empty `String`. In this case, regular expression does not match the empty substring at the beginning or end of the input `String`, nor does it match the empty substring at the end of the previous separator match. (For example, if the regular expression matches the empty `String`, the `String` is split up into individual code unit elements; the length of the result array equals the length of the `String`, and each substring contains one code unit.) Only the first match at a given `index` of the `this` `String` is considered, even if backtracking could yield a non-empty-substring match at that `index`. (For example, `/a*?/[Symbol.split]("ab")` evaluates to the array `["a", "b"]`, while `/a*/[Symbol.split]("ab")` evaluates to the array `["", "b"]`.)

Deleted: If the `global` flag of this `RegExp` object is `true`, the search is done in the same manner as `RegExp.prototype.match`, including the update of `lastIndex`.

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Deleted: <#> If `rx` does not have a `[[RegExpMatcher]]` internal slot, then throw a `TypeError` exception.
<#> If the value of `rx`'s `[[RegExpMatcher]]` internal slot is `undefined`, then throw a `TypeError` exception.

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Deleted: <#> If either `src` or `flags` is `undefined`, then throw a `TypeError` exception.

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If the `string` is (or converts to) the empty String, the result depends on whether the regular expression can match the empty String. If it can, the result array contains no elements. Otherwise, the result array contains one element, which is the empty String.

If the regular expression that contains capturing parentheses, then each time `separator` is matched the results (including any `undefined` results) of the capturing parentheses are spliced into the output array. For example,

```
/<V>?([&lt;>]+)/Symbol.split("A<B>bold</B>and<CODE>coded</CODE>")
```

evaluates to the array
`["A", undefined, "B", "bold", "/", "B", "and", undefined, "CODE", "coded", "/", "CODE", ""]`

If `limit` is not `undefined`, then the output array is truncated so that it contains no more than `limit` elements.

When the `@@split` method is called, the following steps are taken:

1. Let `rx` be the `this` value.
2. If `Type(rx)` is not `Object`, throw a `TypeError` exception.
3. Let `S` be `ToString(string)`.
4. ReturnIfAbrupt(`S`).
5. Let `C` be `SpeciesConstructor(rx, %RegExp%)`.
6. ReturnIfAbrupt(`C`).
7. Let `flags` be `ToString(Get(rx, "flags"))`.
8. ReturnIfAbrupt(`flags`).
9. If `flags` contains "u", let `unicodeMatching` be `true`.
10. Else, let `unicodeMatching` be `false`.
11. If `flags` contains "v", let `newFlags` be `flags`.
12. Else, let `newFlags` be the string that is the concatenation of `flags` and "v".
13. Let `splitter` be `Construct(C, «rx, newFlags»)`.
14. ReturnIfAbrupt(`splitter`).
15. Let `A` be `ArrayCreate(0)`.
16. Let `lengthA` be `0`.
17. If `limit` is `undefined`, let `lim` = $2^{53}-1$; else let `lim` = `ToLength(limit)`.
18. ReturnIfAbrupt(lim).
19. Let `size` be the number of elements in `S`.
20. Let `p` = `0`.
21. If `lim` = `0`, return `A`.
22. If `size` = `0`, then
 - a. Let `z` be `RegExpExec(splitter, S)`.
 - b. ReturnIfAbrupt(`z`).
 - c. If `z` is not `null`, return `A`.
 - d. Assert: The following call will never result in an abrupt completion.
 - e. Call `CreateDataProperty(A, "0", S)`.
 - f. Return `A`.
23. Let `q` = `p`.
24. Repeat, while `q` < `size`
 - a. Let `putStatus` be `Put(splitter, "lastIndex", q, true)`.
 - b. ReturnIfAbrupt(putStatus).
 - c. Let `z` be `RegExpExec(splitter, S)`.
 - d. ReturnIfAbrupt(`z`).
 - e. If `z` is `null`, then
 - i. If `unicodeMatching` is `true`, then
 1. Let `first` be the code unit value of the element at index `q` in the String `S`.
 2. If `first` \geq `0xD800` and `first` \leq `0xDBFF` and `q+1` \neq `size`, then
 - a. Let `second` be the code unit value of the element at index `q+1` in the String `S`.

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Deleted: <#>If `rx` does not have a `[[RegExpMatcher]]` internal slot, then throw a `TypeError` exception.
 <#>If the value of `rx`'s `[[RegExpMatcher]]` internal slot is `undefined`, then throw a `TypeError` exception.
 <#>Let `matcher` be the value of `rx`'s `[[RegExpMatcher]]` internal slot.
 <#>If `matcher` is `undefined`, then throw a `TypeError` exception.

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Deleted: the result of calling the `matcher` with arguments `S` and `q`

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- b. If $second \geq 0xDC00$ and $second \leq 0xDFFF$, then
- Let $q = q+1$.
- f. Else z is not `null`,
- Let e be `ToLength(Get(splitter, "lastIndex"))`.
 - ReturnIfAbrupt(e).
 - If $e = p$, then
 - If `unicodeMatching` is `true`, then
 - Let $first$ be the code unit value of the element at index q in the String S .
 - If $first \geq 0xD800$ and $first \leq 0xDBFF$ and $q+1 \neq size$, then
 - Let $second$ be the code unit value of the element at index $q+1$ in the String S .
 - If $second \geq 0xDC00$ and $second \leq 0xDFFF$, then
 - Let $q = q+1$.
 - Let $q = q+1$.
 - Else $e \neq p$,
 - Let T be a String value equal to the substring of S consisting of the elements at `indices` p (inclusive) through q (exclusive).
 - Assert: The following call will never result in an abrupt completion.
 - Call `CreateDataProperty(A, ToString(lengthA), T)`.
 - Let $lengthA$ be $lengthA + 1$.
 - If $lengthA = lim$, return A .
 - Let $p = e$.
 - Let $i = 0$.
 - Let $numberOfCaptures$ be `ToLength(Get(z, "length"))`.
 - ReturnIfAbrupt($numberOfCaptures$).
 - Let $numberOfCaptures$ be `max(numberOfCaptures-1, 0)`.
 - Let i be 1 .
 - Repeat, while $i \leq numberOfCaptures$
 - Let $nextCapture$ be `Get(z, ToString(i))`.
 - ReturnIfAbrupt($nextCapture$).
 - Call `CreateDataProperty(A, ToString(lengthA), nextCapture)`.
 - Let i be $i + 1$.
 - Let $lengthA$ be $lengthA + 1$.
 - If $lengthA = lim$, return A .
 - Let $q = p$.
 - Let T be a String value equal to the substring of S consisting of the elements at `indices` p (inclusive) through `size` (exclusive).
 - Assert: The following call will never result in an abrupt completion.
 - Call `CreateDataProperty(A, ToString(lengthA), T)`.
 - Return A .

The `length` property of the `@@split` method is **2**.

The value of the `name` property of this function is "`[Symbol.split]`".

NOTE The `@@split` method ignores the value of the `global` and `sticky` properties of this RegExp object.

21.2.5.12 get RegExp.prototype.sticky

`RegExp.prototype.sticky` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

- Let R be the `this` value.

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Deleted: let $q = q+1$.
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2. If Type(*R*) is not Object, throw a **TypeError** exception.
3. If *R* does not have an [[OriginalFlags]] internal slot throw a **TypeError** exception.
4. Let *flags* be the value of *R*'s [[OriginalFlags]] internal slot.
5. If *flags* contains the code unit "y", return true.
6. Return false.

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<#>If the value of *R*'s [[RegExpMatcher]] internal slot is undefined, then throw a **TypeError** exception.¶**Deleted:** the result of**Deleted:** <#>Let *global* be the result of ToBoolean(Get(*R*, "global")).¶<#>ReturnIfAbrupt(*global*).¶<#>If *global* is true, then append "g" as the last code unit character of *result*.¶<#>Let *ignoreCase* be the result of ToBoolean(Get(*R*, "ignoreCase")).¶<#>ReturnIfAbrupt(*ignoreCase*).¶<#>If *ignoreCase* is true, then append "i" as the last code unit character of *result*.¶<#>Let be the result of ToBoolean(Get(*R*, "multiline")).¶<#>ReturnIfAbrupt(*multiline*).¶<#>If *multiline* is true, then append "m" as the last code unit character of *result*.¶<#>Let *unicode* be the result of ToBoolean(Get(*R*, "unicode")).¶<#>ReturnIfAbrupt(*unicode*).¶<#>If *unicode* is true, then append "u" as the last code unit character of *result*.¶<#>Let *sticky* be the result of ToBoolean(Get(*R*, "sticky")).¶<#>ReturnIfAbrupt(*sticky*).¶**Deleted:** ¶**Deleted:****Deleted:** , then throw**Deleted:** <#>If *flags* is undefined, then throw a **TypeError** exception.¶**Deleted:** character**Deleted:** , then return**Deleted:** <#>RegExp.prototype [@@isRegExp]¶

21.2.5.13 RegExp.prototype.test(*S*)

The following steps are taken:

1. Let *R* be the **this** value.
2. If Type(*R*) is not Object, throw a **TypeError** exception.
3. Let *string* be ToString(*S*).
4. ReturnIfAbrupt(*string*).
5. Let *match* be RegExpExec(*R*, *string*).
6. ReturnIfAbrupt(*match*).
7. If *match* is not null, return true; else return false.

21.2.5.14 RegExp.prototype.toString ()

1. Let *R* be the **this** value.
2. If Type(*R*) is not Object, throw a **TypeError** exception.
3. Let *pattern* be ToString(Get(*R*, "source")).
4. ReturnIfAbrupt(*pattern*).
5. Let *flags* be ToString(Get(*R*, "flags")).
6. ReturnIfAbrupt(*flags*).
7. Let *result* be the String value formed by concatenating "/", *pattern*, and "/".and flags.

NOTE The returned String has the form of a *RegularExpressionLiteral* that evaluates to another *RegExp* object with the same behaviour as this object.¶

21.2.5.15 get RegExp.prototype.unicode

RegExp.prototype.unicode is an accessor property whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *R* be the **this** value.
2. If Type(*R*) is not Object, throw a **TypeError** exception.
3. If *R* does not have an [[OriginalFlags]] internal slot throw a **TypeError** exception.
4. Let *flags* be the value of *R*'s [[OriginalFlags]] internal slot.
5. If *flags* contains the code unit "u", return true.
6. Return false.

21.2.6 Properties of RegExp Instances

RegExp instances are ordinary objects that inherit properties from the *RegExp* prototype object. *RegExp* instances have internal slots [[RegExpMatcher]], [[OriginalSource]], and [[OriginalFlags]]. The value of the [[RegExpMatcher]] internal slot is an implementation dependent representation of the *Pattern* of the *RegExp* object.

NOTE Prior to the 6th Edition, *RegExp* instances were specified as having the own data properties *source*, *global*, *ignoreCase*, and *multiline*. Those properties are now specified as accessor properties of *RegExp.prototype*.

RegExp instances also have the following property:

21.2.6.1 lastIndex

The value of the `lastIndex` property specifies the String `index` at which to start the next match. It is coerced to an integer when used (see [21.2.5.2.2](#)). This property shall have the attributes { `[[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: false` }.

22 Indexed Collections

22.1 Array Objects

Array objects are exotic objects that give special treatment to a certain class of property names. See [9.4.1.4](#) for a definition of this special treatment.

22.1.1 The Array Constructor

The `Array` constructor is the `%Array%` intrinsic object and the initial value of the `Array` property of the global object. When called as a constructor it creates and initializes a new exotic Array object. When `Array` is called as a function rather than as a constructor, it also creates and initializes a new Array object. Thus the function call `Array(...)` is equivalent to the object creation expression `new Array(...)` with the same arguments.

The `Array` constructor is a single function whose behaviour is overloaded based upon the number and types of its arguments.

The `Array` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class definition. Subclass constructors that intend to inherit the exotic Array behaviour must include a `super` call to the `Array` constructor to initialize subclass instances that are exotic Array objects. However, most of the `Array.prototype` methods are generic methods that are not dependent upon their `this` value being an exotic Array object.

The `length` property of the `Array` constructor function is 1.

22.1.1.1 Array()

This description applies if and only if the `Array` constructor is called with no arguments.

1. Let `numberOfArgs` be the number of arguments passed to this `function` call.
2. Assert: `numberOfArgs` = 0.
3. If `NewTarget` is undefined, let `newTarget` be the active function object, else let `newTarget` be `NewTarget`.
4. Let `proto` be `GetPrototypeOfFromConstructor(newTarget, "%ArrayPrototype%")`.
5. `ReturnIfAbrupt(proto)`.
6. `Return` `ArrayCreate(0, proto)`.

22.1.1.2 Array(len)

This description applies if and only if the `Array` constructor is called with exactly one argument.

1. Let `numberOfArgs` be the number of arguments passed to this `function` call.
2. Assert: `numberOfArgs` = 1.

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Deleted: An Array object, O , is said to be sparse if the following algorithm returns true: $\langle \# \rangle$ Let len be $\text{Get}(O, "length")$. $\langle \# \rangle$ For each integer i in the range $0 \leq i < \text{ToUint32}(len)$. $\langle \# \rangle$ Let $elem$ be the result of calling the <code>[[GetOwnProperty]]</code> internal method of O with argument <code>Tostring(i)</code> . $\langle \# \rangle$ If $elem$ is <code>undefined</code> , return true. $\langle \# \rangle$ Return false.
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Deleted: However, if the <code>this</code> value passed in the call is an Object with an <code>[[ArrayInitialisatnializationState]]</code> internal slot whose value is <code>undefined</code> , it initializes the <code>this</code> value using the argument values. . This permits <code>Array</code> to be used both as factory method and to perform constructor instance initialisatnialization.
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Deleted: $\langle \# \rangle$ Let O be the <code>this</code> value. $\langle \# \rangle$ If <code>Type(O)</code> is <code>Object</code> and O has an <code>[[ArrayInitialisatnializationState]]</code> internal slot and the value of <code>[[ArrayInitialisatnializationState]]</code> is <code>false</code> , then $\langle \# \rangle$ Set the value of O 's <code>[[ArrayInitialisatnializationState]]</code> internal slot to <code>true</code> . $\langle \# \rangle$ Let <code>array</code> be O . $\langle \# \rangle$ Else. $\langle \# \rangle$ Let F be this the active function.
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Deleted: Let <code>array</code> be
Deleted: $\langle \# \rangle$ ReturnIfAbrupt(array).
Deleted: $\langle \# \rangle$ Let <code>putStatus</code> be <code>Put(array, "length", 0, true)</code> . $\langle \# \rangle$ ReturnIfAbrupt(<code>putStatus</code>). $\langle \# \rangle$ Return <code>array</code> .
Deleted: constructor

3. If `NewTarget` is **undefined**, let `newTarget` be the active function object, else let `newTarget` be `NewTarget`.
4. Let `proto` be `GetPrototypeOfFromConstructor(newTarget, "%ArrayPrototype%")`.
5. `ReturnIfAbrupt(proto)`.
6. Let `array` be `ArrayCreate(0, proto)`.
7. If `Type(len)` is not `Number`, then
 - a. Let `defineStatus` be `CreateDataPropertyOrThrow(array, "0", len)`.
 - b. **Assert: defineStatus is not an abrupt completion.**
 - c. Let `intLen` be 1.
8. Else,
 - a. Let `intLen` be `ToUint32(len)`.
 - b. If `intLen ≠ len`, **throw a RangeError exception.**
9. Let `putStatus` be `Put(array, "length", intLen, true)`.
10. **Assert: putStatus is not an abrupt completion.**
11. `Return array`.

22.1.1.3 Array (...items)

This description applies if and only if the `Array` constructor is called with at least two arguments.

When the `Array` function is called the following steps are taken:

1. Let `numberOfArgs` be the number of arguments passed to this **function** call.
2. **Assert: numberOfArgs ≥ 2.**
3. If `NewTarget` is **undefined**, let `newTarget` be the active function object, else let `newTarget` be `NewTarget`.
4. Let `proto` be `GetPrototypeOfFromConstructor(newTarget, "%ArrayPrototype%")`.
5. `ReturnIfAbrupt(proto)`.
6. Let `array` be `ArrayCreate(numberOfArgs, proto)`.
7. `ReturnIfAbrupt(array)`.
8. Let `k` be 0.
9. Let `items` be a zero-originated List containing the argument items in order.
10. Repeat, while `k < numberOfArgs`
 - a. Let `Pk` be `ToString(k)`.
 - b. Let `itemK` be `kth` element of `items`.
 - c. Let `defineStatus` be `CreateDataPropertyOrThrow(array, Pk, itemK)`.
 - d. **Assert: defineStatus is not an abrupt completion.**
 - e. Increase `k` by 1.
11. **Assert: the value of array's length property is numberOfArgs.**
12. `Return array`.

22.1.2 Properties of the Array Constructor

The value of the `[[Prototype]]` internal slot of the `Array` constructor is the **intrinsic object %FunctionPrototype%** (19.2.3).

Besides the `length` property (whose value is 1), the `Array` constructor has the following properties:

22.1.2.1 `Array.from (items [, mapfn [, thisArg]])`

When the `from` method is called with argument `items` and optional arguments `mapfn` and `thisArg` the following steps are taken:

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Deleted: Let <code>O</code> be the <code>this</code> value.
Deleted: <#>If <code>Type(O)</code> is Object and <code>O</code> has an <code>[[ArrayInitialisatinitializationState]]</code> internal slot and the value of <code>[[ArrayInitialisatinitializationState]]</code> is <code>false</code> , then <#>Set the value of <code>O</code> 's <code>[[ArrayInitialisatinitializationState]]</code> internal slot to <code>true</code> . <#>Let <code>array</code> be <code>O</code> . <#>Else, <#>Let <code>F</code> be this the active function.
Deleted: <code>F</code>
Deleted: <#> <code>ReturnIfAbrupt(array)</code> .
Deleted: <code>ReturnIfAbrupt(</code>
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Deleted: <code>ReturnIfAbrupt(</code>
Deleted: <code>)</code> .
Deleted: <code>constructor</code>
Deleted: <code>null</code>
Deleted: Let <code>O</code> be the <code>this</code> value.
Deleted: <#>If <code>Type(O)</code> is Object and <code>O</code> has an <code>[[ArrayInitialisatinitializationState]]</code> internal slot and the value of <code>[[ArrayInitialisatinitializationState]]</code> is <code>false</code> , then <#>Set the value of <code>O</code> 's <code>[[ArrayInitialisatinitializationState]]</code> internal slot to <code>true</code>
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Deleted: <code>ReturnIfAbrupt(</code>
Deleted: <code>)</code>
Deleted: Let <code>putStatus</code> be <code>Put(</code>
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Deleted: <#> <code>ReturnIfAbrupt(putStatus)</code> .
Deleted: <#> <code>new Array (...)</code>
Deleted: Function prototype object
Deleted: The <code>[[CreateAction]]</code> of the <code>Array</code>
Deleted: <code>arrayLike</code>
Deleted: <code>arrayLike</code>

1. Let C be the **this** value.
2. If $mapfn$ is **undefined**, let $mapping$ be **false**.
3. else
- a. If $\text{IsCallable}(mapfn)$ is **false**, throw a **TypeError** exception.
 - b. If $thisArg$ was supplied, let T be $thisArg$; else let T be **undefined**.
 - c. Let $mapping$ be **true**
4. Let $usingIterator$ be [GetMethod\(items, @@iterator\)](#).
5. $\text{ReturnIfAbrupt}(usingIterator)$.
6. If $usingIterator$ is not **undefined**, then
- a. If $\text{IsConstructor}(C)$ is **true**, then
 - i. Let A be [Construct\(C\)](#).
 - b. Else,
 - i. Let A be [ArrayCreate\(0\)](#).
 - c. $\text{ReturnIfAbrupt}(A)$.
 - d. Let $iterator$ be [GetIterator\(items, usingIterator\)](#).
 - e. $\text{ReturnIfAbrupt}(iterator)$.
 - f. Let k be 0.
 - g. Repeat
 - i. Let Pk be [ToString\(k\)](#).
 - ii. Let $next$ be [IteratorStep\(iterator\)](#).
 - iii. If $next$ is an abrupt completion, return [IteratorClose\(iterator, next\)](#).
 - iv. If $next.[[value]]$ is **false**, then
 - 1. Let $putStatus$ be [Put\(A, "length", k, true\)](#).
 - 2. $\text{ReturnIfAbrupt}(putStatus)$.
 - 3. Return A .
 - v. Let $nextValue$ be [IteratorValue\(next.\[\[value\]\]\)](#).
 - vi. If $nextValue$ is an abrupt completion, return [IteratorClose\(iterator, nextValue\)](#).
 - vii. If $mapping$ is **true**, then
 - 1. Let $mappedValue$ be [Call\(mapfn, T, nextValue.\[\[value\]\], k\)](#).
 - 2. If $mappedValue$ is an abrupt completion, return [IteratorClose\(iterator, mappedValue\)](#).
 - viii. Else, let $mappedValue$ be $nextValue$.
 - ix. Let $defineStatus$ be [CreateDataPropertyOrThrow\(A, Pk, mappedValue.\[\[value\]\]\)](#).
 - x. If $defineStatus$ is an abrupt completion, return [IteratorClose\(iterator, defineStatus\)](#).
 - xi. Increase k by 1.
7. Assert: $items$ is not an **Iterable** so assume it is an array-like object.
8. Let $arrayLike$ be [ToObject\(items\)](#).
9. $\text{ReturnIfAbrupt}(arrayLike)$.
10. Let len be [ToLength\(Get\(arrayLike, "length"\)\)](#).
11. $\text{ReturnIfAbrupt}(len)$.
12. If $\text{IsConstructor}(C)$ is **true**, then
- a. Let A be [Construct\(C, len\)](#).
13. Else,
- a. Let A be [ArrayCreate\(len\)](#).
14. $\text{ReturnIfAbrupt}(A)$.
15. Let k be 0.
16. Repeat, while $k < len$
- a. Let Pk be [ToString\(k\)](#).
 - b. Let $kValue$ be [Get\(arrayLike, Pk\)](#).
 - c. $\text{ReturnIfAbrupt}(kValue)$.
 - d. If $mapping$ is **true**, then
 - i. Let $mappedValue$ be [Call\(mapfn, T, kValue, k\)](#).
 - ii. $\text{ReturnIfAbrupt}(mappedValue)$.

- e. Else, let *mappedValue* be *kValue*.
 - f. Let *defineStatus* be *CreateDataPropertyOrThrow(A, Pk, mappedValue)*.
 - g. *ReturnIfAbrupt(defineStatus)*.
 - h. Increase *k* by 1.
17. Let *putStatus* be *Put(A, "length", len, true)*.
18. *ReturnIfAbrupt(putStatus)*.
19. Return *A*.

The **length** property of the **from** method is **1**.

NOTE The **from** function is an intentionally generic factory method; it does not require that its **this** value be the Array constructor. Therefore it can be transferred to or inherited by any other constructors that may be called with a single numeric argument.

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22.1.2.2 **Array.isArray (arg)**

The **isArray** function takes one argument *arg*, and performs the following [steps](#):

1. *Return IsArray(arg)*.

22.1.2.3 **Array.of (...items)**

When the **of** method is called with any number of arguments, the following steps are taken:

1. Let *len* be [the actual number of arguments passed to this function](#).
2. Let *items* be [the List of arguments passed to this function](#).
3. Let *C* be the **this** value.
4. If *IsConstructor(C)* is **true**, then
 - a. Let *A* be *Construct(C, len)*.
5. Else,
 - a. Let *A* be *ArrayCreate(len)*.
6. *ReturnIfAbrupt(A)*.
7. Let *k* be 0.
8. Repeat, while *k < len*
 - a. Let *kValue* be [element k of items](#).
 - b. Let *Pk* be *ToString(k)*.
 - c. Let *defineStatus* be *CreateDataPropertyOrThrow(A, Pk, kValue.[[value]])*.
 - d. *ReturnIfAbrupt(defineStatus)*.
 - e. Increase *k* by 1.
9. Let *putStatus* be *Put(A, "length", len, true)*.
10. *ReturnIfAbrupt(putStatus)*.
11. Return *A*.

The **length** property of the **of** method is **0**.

NOTE 1 The *items* argument is assumed to be a well-formed rest argument value.

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NOTE 2 The **of** function is an intentionally generic factory method; it does not require that its **this** value be the Array constructor. Therefore it can be transferred to or inherited by other constructors that may be called with a single numeric argument.

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22.1.2.4 **Array.prototype**

The value of **Array.prototype** is **%ArrayPrototype%**, the intrinsic Array prototype object (22.1.3).

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

22.1.2.5 `_get Array [@@species]`

`Array[@@species]` is an accessor property whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Return **this**.

The value of the `name` property of this function is "`get [Symbol.species]`".

NOTE Array prototype methods normally use their `this` object's constructor to create a derived object. However, a subclass constructor may over-ride that default behaviour by redefining its `@@species` property.

22.1.3 Properties of the Array Prototype Object

The value of the `[[Prototype]]` internal slot of the Array prototype object is the intrinsic object `%ObjectPrototype%`.

The Array prototype object is itself an ordinary object. It is not an Array instance and does not have a `length` property.

NOTE The Array prototype object does not have a `valueOf` property of its own; however, it inherits the `valueOf` property from the standard built-in Object prototype Object.

22.1.3.1 `Array.prototype.concat (...arguments)`

When the `concat` method is called with zero or more arguments, it returns an array containing the array elements of the object followed by the array elements of each argument in order.

The following steps are taken:

1. Let `O` be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(`O`).
3. Let `A` be `ArraySpeciesCreate(O, 0)`.
4. ReturnIfAbrupt(`A`).
5. Let `n` be 0.
6. Let `items` be a List whose first element is `O` and whose subsequent elements are, in left to right order, the arguments that were passed to this function invocation.
7. Repeat, while `items` is not empty
 - a. Remove the first element from `items` and let `E` be the value of the element.
 - b. Let `spreadable` be `IsConcatSpreadable(E)`.
 - c. ReturnIfAbrupt(`spreadable`).
 - d. If `spreadable` is **true**, then
 - i. Let `k` be 0.
 - ii. Let `len` be `ToLength(Get(E, "length"))`.
 - iii. ReturnIfAbrupt(`len`).
 - iv. If $n + len + 2^{33} - 1$, throw a **TypeError** exception.
 - v. Repeat, while $k < len$
 1. Let `P` be `ToString(k)`.
 2. Let `exists` be `HasProperty(E, P)`.
 3. ReturnIfAbrupt(`exists`).
 4. If `exists` is **true**, then

Deleted: `<#>Array[@@create] ()`
The `@@create` method of an object `F` performs the following steps:

Deleted: `<#>Let F be the this value.`
`<#>Let proto be GetPrototypeOfFromConstructor(F, "%ArrayPrototype%").`
`<#>ReturnIfAbrupt(proto).`
`<#>Let obj be ArrayCreate(undefined, proto).`
`<#>Return obj.`

Deleted: The value of the `name` property of this function is `[Symbol.create]`.
This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **true** }.

Deleted: NOTE 1. Passing **undefined** as the first argument to `ArrayCreate` causes the `[[ArrayInitialisatInitializatState]]` internal slot of the array to be initially assigned the value **false**. This is a flag used to indicate that the instance has not yet been initialized by the `Array` constructor. This flag value is never directly exposed to ECMAScript code; hence implementations may choose to encode the flag in any unobservable manner.

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Deleted: NOTE 2. The `Array @@create` function is intentionally generic; it does not require that its `this` value be the `Array` constructor object. It can be transferred to other constructor functions for use as a `@@create` method. When used with other constructors, this function will create an exotic Array object whose `[[Prototype]]` value is obtained from the associated constructor.

Deleted: `<#>Let A be undefined.`
`<#>If O is an exotic Array object, then`
`<#>Let C be Get(O, "constructor").`
`<#>ReturnIfAbrupt(C).`
`<#>If IsConstructor(C) is true, then`
`<#>Let thisRealm be the running execution context's Realm.`
`<#>If SameValue(thisRealm and , GetFunctionRealm(the value of C'))`
`[[Realm]] internal slot are the same value is true, then`

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Deleted: `<#>Let len be ToLength(lenVal).`

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- a. Let *subElement* be Get(*E*, *P*).
- b. ReturnIfAbrupt(*subElement*).
- c. Let *status* be CreateDataPropertyOrThrow (*A*, ToString(*n*), *subElement*).
- d. ReturnIfAbrupt(*status*).
5. Increase *n* by 1.
6. Increase *k* by 1.
- e. Else *E* is added as a single item rather than spread,
 - i. If $n \geq 2^{53}-1$, throw a **TypeError** exception.
 - ii. Let *status* be CreateDataPropertyOrThrow (*A*, ToString(*n*), *E*).
 - iii. ReturnIfAbrupt(*status*).
 - iv. Increase *n* by 1.
8. Let *putStatus* be Put(*A*, "length", *n*, true).
9. ReturnIfAbrupt(*putStatus*).
10. Return *A*.

The `length` property of the `concat` method is 1.

NOTE 1 The explicit setting of the `length` property in step 10 is necessary to ensure that its value is correct in situations where the trailing elements of the result Array are not present.

NOTE 2 The `concat` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.1.1 IsConcatSpreadable (*O*) Abstract Operation

The abstract operation `IsConcatSpreadable` with argument *O* performs the following steps:

1. If Type(*O*) is not Object, return false.
2. Let *spreadable* be Get(*O*, @@isConcatSpreadable).
3. ReturnIfAbrupt(*spreadable*).
4. If *spreadable* is not undefined, return ToBoolean(*spreadable*).
5. Return IsArray(*O*).

22.1.3.2 Array.prototype.constructor

The initial value of `Array.prototype.constructor` is the intrinsic object %Array%.

22.1.3.3 Array.prototype.copyWithin (target, start [, end])

The `copyWithin` method takes up to three arguments *target*, *start* and *end*.

NOTE The *end* argument is optional with the length of the `this` object as its default value. If *target* is negative, it is treated as *length+target* where *length* is the length of the array. If *start* is negative, it is treated as *length+start*. If *end* is negative, it is treated as *length+end*.

Deleted: <#>If $n \geq 2^{53}-1$, then throw a **TypeError** exception.

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Deleted: <#>If *O* is an exotic Array object, then return true.

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Deleted: standard built-in `Array` constructor

The following steps are taken:

1. Let *O* be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(*O*).
3. Let *len* be ToLength(Get(*O*, "length")).
4. ReturnIfAbrupt(*len*).
5. Let *relativeTarget* be `ToInteger`(*target*).
6. ReturnIfAbrupt(*relativeTarget*).
7. If *relativeTarget* < 0, let *to* be max((*len* + *relativeTarget*), 0); else let *to* be min(*relativeTarget*, *len*).

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8. Let *relativeStart* be *ToInteger(start)*.
9. ReturnIfAbrupt(*relativeStart*).
10. If *relativeStart* ≤ 0 , let *from* be $\max((len + relativeStart), 0)$; else let *from* be $\min(relativeStart, len)$. | **Deleted:** is negative
11. If *end* is **undefined**, let *relativeEnd* be *len*; else let *relativeEnd* be *ToInteger(end)*.
12. ReturnIfAbrupt(*relativeEnd*).
13. If *relativeEnd* ≤ 0 , let *final* be $\max((len + relativeEnd), 0)$; else let *final* be $\min(relativeEnd, len)$. | **Deleted:** is negative
14. Let *count* be $\min(final - from, len - to)$.
15. If *from* $<$ *to* and *to* $<$ *from+count*
 - a. Let *direction* = -1.
 - b. Let *from* = *from* + *count* - 1.
 - c. Let *to* = *to* + *count* - 1.
16. Else,
 - a. Let *direction* = 1.
17. Repeat, while *count* > 0
 - a. Let *fromKey* be *Tostring(from)*.
 - b. Let *toKey* be *Tostring(to)*.
 - c. Let *fromPresent* be *HasProperty(O, fromKey)*.
 - d. ReturnIfAbrupt(*fromPresent*).
 - e. If *fromPresent* is **true**, then
 - i. Let *fromVal* be *Get(O, fromKey)*.
 - ii. ReturnIfAbrupt(*fromVal*).
 - iii. Let *putStatus* be *Put(O, toKey, fromVal, true)*.
 - iv. ReturnIfAbrupt(*putStatus*).
 - f. Else *fromPresent* is **false**,
 - i. Let *deleteStatus* be *DeletePropertyOrThrow(O, toKey)*.
 - ii. ReturnIfAbrupt(*deleteStatus*).
 - g. Let *from* be *from* + *direction*.
 - h. Let *to* be *to* + *direction*.
 - i. Let *count* be *count* - 1.
18. Return *O*.

The **length** property of the **copyWithin** method is **2**.

NOTE 1 The **copyWithin** function is intentionally generic; it does not require that its **this** value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.4 **Array.prototype.entries ()**

The following steps are taken:

1. Let *O* be the result of calling **ToObject** with the **this** value as its argument.
2. ReturnIfAbrupt(*O*).
3. Return **CreateArrayIterator**(*O*, "key+value").

Deleted: Whether the **copyWithin** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

22.1.3.5 **Array.prototype.every (callbackfn [,thisArg])**

NOTE *callbackfn* should be a function that accepts three arguments and returns a value that is coercible to the Boolean value **true** or **false**. **every** calls *callbackfn* once for each element present in the array, in ascending order, until it finds one where *callbackfn* returns **false**. If such an element is found, **every** immediately returns **false**. Otherwise, if *callbackfn* returned **true** for all elements, **every** will return **true**. *callbackfn* is called only for elements of the array which actually exist; it is not called for missing elements of the array.

If a `thisArg` parameter is provided, it will be used as the `this` value for each invocation of `callbackfn`. If it is not provided, `undefined` is used instead.

`callbackfn` is called with three arguments: the value of the element, the index of the element, and the object being traversed.

`every` does not directly mutate the object on which it is called but the object may be mutated by the calls to `callbackfn`.

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The range of elements processed by `every` is set before the first call to `callbackfn`. Elements which are appended to the array after the call to `every` begins will not be visited by `callbackfn`. If existing elements of the array are changed, their value as passed to `callbackfn` will be the value at the time `every` visits them; elements that are deleted after the call to `every` begins and before being visited are not visited. `every` acts like the "for all" quantifier in mathematics. In particular, for an empty array, it returns `true`.

When the `every` method is called with one or two arguments, the following steps are taken:

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. `ReturnIfAbrupt(O)`.
3. Let len be `ToLength(Get(O , "length"))`.
4. `ReturnIfAbrupt(len)`.
5. If `IsCallable(callbackfn)` is `false`, throw a `TypeError` exception.
6. If `thisArg` was supplied, let T be `thisArg`; else let T be `undefined`.
7. Let k be 0.
8. Repeat, while $k < len$
 - a. Let Pk be `ToString(k)`.
 - b. Let $kPresent$ be `HasProperty(O , Pk)`.
 - c. `ReturnIfAbrupt($kPresent$)`.
 - d. If $kPresent$ is `true`, then
 - i. Let $kValue$ be `Get(O , Pk)`.
 - ii. `ReturnIfAbrupt($kValue$)`.
 - iii. Let $testResult$ be `ToBoolean(Call(callbackfn, T , $\langle\langle kValue, k, O \rangle\rangle$)`.
 - iv. `ReturnIfAbrupt($testResult$)`.
 - v. If $testResult$ is `false`, return `false`.
 - e. Increase k by 1.
9. Return `true`.

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Deleted: <#>Let len be `ToLength(lenValue)`.¶

The `length` property of the `every` method is 1.

NOTE The `every` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.6 Array.prototype.fill (value [, start [, end]])

The `fill` method takes up to three arguments `value`, `start` and `end`.

NOTE The `start` and `end` arguments are optional with default values of 0 and the length of the `this` object. If `start` is negative, it is treated as $length+start$ where `length` is the length of the array. If `end` is negative, it is treated as $length+end$.

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Deleted: Whether the `every` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

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The following steps are taken:

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. `ReturnIfAbrupt(O)`.
3. Let len be `ToLength(Get(O , "length"))`.
4. `ReturnIfAbrupt(len)`.
5. Let $relativeStart$ be `ToInteger(start)`.

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6. ReturnIfAbrupt(relativeStart).
7. If *relativeStart* ≤ 0 , let *k* be $\max((len + relativeStart), 0)$; else let *k* be $\min(relativeStart, len)$.
8. If *end* is **undefined**, let *relativeEnd* be *len*; else let *relativeEnd* be *ToInteger(end)*.
9. ReturnIfAbrupt(*relativeEnd*).
10. If *relativeEnd* ≤ 0 , let *final* be $\max((len + relativeEnd), 0)$; else let *final* be $\min(relativeEnd, len)$.
11. Repeat, while *k* $< final
 - a. Let *Pk* be *ToString(k)*.
 - b. Let *putStatus* be *Put(O, Pk, value, true)*.
 - c. ReturnIfAbrupt(*putStatus*).
 - d. Increase *k* by 1.$
12. Return *O*.

The **length** property of the **fill** method is **1**.

NOTE 1 The **fill** function is intentionally generic; it does not require that its **this** value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

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22.1.3.7 Array.prototype.filter (callbackfn [, thisArg])

NOTE *callbackfn* should be a function that accepts three arguments and returns a value that is coercible to the Boolean value **true** or **false**. **filter** calls *callbackfn* once for each element in the array, in ascending order, and constructs a new array of all the values for which *callbackfn* returns **true**. *callbackfn* is called only for elements of the array which actually exist; it is not called for missing elements of the array.

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If a *thisArg* parameter is provided, it will be used as the **this** value for each invocation of *callbackfn*. If it is not provided, **undefined** is used instead.

callbackfn is called with three arguments: the value of the element, the index of the element, and the object being traversed.

filter does not directly mutate the object on which it is called but the object may be mutated by the calls to *callbackfn*.

The range of elements processed by **filter** is set before the first call to *callbackfn*. Elements which are appended to the array after the call to **filter** begins will not be visited by *callbackfn*. If existing elements of the array are changed their value as passed to *callbackfn* will be the value at the time **filter** visits them; elements that are deleted after the call to **filter** begins and before being visited are not visited.

When the **filter** method is called with one or two arguments, the following steps are taken:

1. Let *O* be the result of calling **ToObject** passing the **this** value as the argument.
2. ReturnIfAbrupt(*O*).
3. Let *len* be **ToLength**(*Get(O, "length")*).
4. ReturnIfAbrupt(*len*).
5. If **IsCallable(callbackfn)** is **false**, throw a **TypeError** exception.
6. If *thisArg* was supplied, let *T* be *thisArg*; else let *T* be **undefined**.
7. Let *A* be **ArraySpeciesCreate(O, 0).**
8. ReturnIfAbrupt(*A*).
9. Let *k* be **0**.
10. Let *to* be **0**.
11. Repeat, while *k* $< len$
 - a. Let *Pk* be *ToString(k)*.
 - b. Let *kPresent* be **HasProperty(O, Pk)**.
 - c. ReturnIfAbrupt(*kPresent*).
 - d. If *kPresent* is **true**, then

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Deleted: <#>Let *len* be **ToLength(lenValue)**.¶

Deleted: <#>Let *A* be **undefined**.¶
<#>If *O* is an exotic Array object, then¶
<#>Let *C* be **Get(O, "constructor").¶
<#>ReturnIfAbrupt(*C*).¶
<#>If **IsConstructor(C)** is **true**, then¶
<#>Let *thisRealm* be the running execution context's Realm.¶
<#>If **SameValue(thisRealm, and GetFunctionRealm(C))** is **true** *thisRealm* and the value of *C*'s **[[Realm]]** internal slot are the same value, then¶
<#>Let *A* be the result of calling the **[[Construct]]** internal method of *C* with an argument list containing the single item **0**.¶
<#>If *A* is **undefined**, then¶
<#>Let *A* be **ArrayCreate(0).¶****

- i. Let *kValue* be Get(*O*, *Pk*).
 - ii. ReturnIfAbrupt(*kValue*).
 - iii. Let *selected* be ToBoolean(Call(*callbackfn*, *T*, *kValue*, *k*, *O*)).
 - iv. ReturnIfAbrupt(*selected*).
 - v. If *selected* is true, then
 1. Let *status* be CreateDataPropertyOrThrow (*A*, ToString(*to*), *kValue*).
 2. ReturnIfAbrupt(*status*).
 3. Increase *to* by 1.
 - e. Increase *k* by 1.
12. Return *A*.

The **length** property of the **filter** method is 1.

NOTE The **filter** function is intentionally generic; it does not require that its **this** value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.8 Array.prototype.find (predicate [, thisArg])

The **find** method is called with one or two arguments, *predicate* and *thisArg*.

NOTE *predicate* should be a function that accepts three arguments and returns a value that is coercible to a Boolean value. **find** calls *predicate* once for each element of the array, in ascending order, until it finds one where *predicate* returns true. If such an element is found, **find** immediately returns that element value. Otherwise, **find** returns undefined.

If a *thisArg* parameter is provided, it will be used as the **this** value for each invocation of *predicate*. If it is not provided, **undefined** is used instead.

predicate is called with three arguments: the value of the element, the index of the element, and the object being traversed.

find does not directly mutate the object on which it is called but the object may be mutated by the calls to *predicate*.

The range of elements processed by **find** is set before the first call to *callbackfn*. Elements that are appended to the array after the call to **find** begins will not be visited by *callbackfn*. If existing elements of the array are changed, their value as passed to *predicate* will be the value at the time that **find** visits them; elements that correspond to non-existent properties are treated as if they existed and have the value **undefined**.

When the **find** method is called, the following steps are taken:

1. Let *O* be the result of calling **ToObject** passing the **this** value as the argument.
2. ReturnIfAbrupt(*O*).
3. Let *len* be **ToLength**(Get(*O*, "length")).
4. ReturnIfAbrupt(*len*).
5. If **IsCallable**(*predicate*) is false, throw a **TypeError** exception.
6. If *thisArg* was supplied, let *T* be *thisArg*; else let *T* be **undefined**.
7. Let *k* be 0.
8. Repeat, while *k* < *len*
 - a. Let *Pk* be **ToString**(*k*).
 - b. Let *kValue* be Get(*O*, *Pk*).
 - c. ReturnIfAbrupt(*kValue*).
 - d. Let *testResult* be ToBoolean(Call(*predicate*, *T*, *kValue*, *k*, *O*)).
 - e. ReturnIfAbrupt(*testResult*).
 - f. If *testResult* is true, return *kValue*.
 - g. Increase *k* by 1.

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Deleted: <#>Let *len* be **ToLength**(*lenValue*).¶
Deleted: <#>Let *kPresent* be **GetProperty**(*O*, *Pk*).¶
<#>ReturnIfAbrupt(*kPresent*).¶
<#>If *kPresent* is true, then¶
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9. Return **`undefined`**.

The `length` property of the `find` method is **1**.

NOTE The `find` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.9 `Array.prototype.findIndex (predicate [, thisArg])`

NOTE `predicate` should be a function that accepts three arguments and returns a value that is coercible to the Boolean value `true` or `false`. `findIndex` calls `predicate` once for each element of the array, in ascending order, until it finds one where `predicate` returns `true`. If such an element is found, `findIndex` immediately returns the index of that element value. Otherwise, `findIndex` returns `-1`.

If a `thisArg` parameter is provided, it will be used as the `this` value for each invocation of `predicate`. If it is not provided, `undefined` is used instead.

`predicate` is called with three arguments: the value of the element, the index of the element, and the object being traversed.

`findIndex` does not directly mutate the object on which it is called but the object may be mutated by the calls to `predicate`.

The range of elements processed by `findIndex` is set before the first call to `callbackfn`. Elements that are appended to the array after the call to `findIndex` begins will not be visited by `callbackfn`. If existing elements of the array are changed, their value as passed to `predicate` will be the value at the time that `findIndex` visits them; elements that are deleted after the call to `findIndex` begins and before being visited are not visited.

When the `findIndex` method is called with one or two arguments, the following steps are taken:

1. Let `O` be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(`O`).
3. Let `len` be `ToLength`(`Get(O, "length")`).
4. ReturnIfAbrupt(`len`).
5. If `IsCallable(predicate)` is `false`, throw a `TypeError` exception.
6. If `thisArg` was supplied, let `T` be `thisArg`; else let `T` be `undefined`.
7. Let `k` be `0`.
8. Repeat, while `k < len`
 - a. Let `Pk` be `ToString(k)`.
 - b. Let `kValue` be `Get(O, Pk)`.
 - c. ReturnIfAbrupt(`kValue`).
 - d. Let `testResult` be `ToBoolean(Call(predicate, T, kValue, k, O))`.
 - e. ReturnIfAbrupt(`testResult`).
 - f. If `testResult` is `true`, return `k`.
 - g. Increase `k` by 1.
9. Return `-1`.

The `length` property of the `findIndex` method is **1**.

NOTE The `findIndex` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

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Deleted: <#>Let `len` be `ToLength(lenValue)`.¶

Deleted: <#>Let `kPresent` be `HasProperty(O, Pk)`.¶
<#>ReturnIfAbrupt(`kPresent`).¶
<#>If `kPresent` is `true`, then¶

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22.1.3.10 Array.prototype.forEach (callbackfn [, thisArg])

NOTE *callbackfn* should be a function that accepts three arguments. **forEach** calls *callbackfn* once for each element present in the array, in ascending order. *callbackfn* is called only for elements of the array which actually exist; it is not called for missing elements of the array.

If a *thisArg* parameter is provided, it will be used as the **this** value for each invocation of *callbackfn*. If it is not provided, **undefined** is used instead.

callbackfn is called with three arguments: the value of the element, the index of the element, and the object being traversed.

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forEach does not directly mutate the object on which it is called but the object may be mutated by the calls to *callbackfn*.

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The range of elements processed by **forEach** is set before the first call to *callbackfn*. Elements which are appended to the array after the call to **forEach** begins will not be visited by *callbackfn*. If existing elements of the array are changed, their value as passed to *callbackfn* will be the value at the time **forEach** visits them; elements that are deleted after the call to **forEach** begins and before being visited are not visited.

When the **forEach** method is called with one or two arguments, the following steps are taken:

1. Let *O* be the result of calling **ToObject** passing the **this** value as the argument.
2. ReturnIfAbrupt(*O*).
3. Let *len* be **ToLength**(*Get*(*O*, "length")).
4. ReturnIfAbrupt(*len*).
5. If **IsCallable**(*callbackfn*) is **false**, throw a **TypeError** exception.
6. If *thisArg* was supplied, let *T* be *thisArg*; else let *T* be **undefined**.
7. Let *k* be 0.
8. Repeat, while *k* < *len*
 - a. Let *Pk* be **ToString**(*k*).
 - b. Let *kPresent* be **HasProperty**(*O*, *Pk*).
 - c. ReturnIfAbrupt(*kPresent*).
 - d. If *kPresent* is **true**, then
 - i. Let *kValue* be *Get*(*O*, *Pk*).
 - ii. ReturnIfAbrupt(*kValue*).
 - iii. Let *funcResult* be **Call**(*callbackfn*, *T*, *kValue*, *k*, *O*).
 - iv. ReturnIfAbrupt(*funcResult*).
 - e. Increase *k* by 1.
9. Return **undefined**.

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Deleted: <#>Let *len* be **ToLength**(*lenValue*).¶

The **length** property of the **forEach** method is 1.

NOTE The **forEach** function is intentionally generic; it does not require that its **this** value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.11 Array.prototype.indexOf (searchElement [, fromIndex])

NOTE **indexOf** compares *searchElement* to the elements of the array, in ascending order, using the Strict Equality Comparison algorithm (7.2.11), and if found at one or more *indices*, returns the **smallest** such *index*; otherwise, **-1** is returned.

The optional second argument *fromIndex* defaults to 0 (i.e. the whole array is searched). If it is greater than or equal to the length of the array, **-1** is returned, i.e. the array will not be searched. If it is negative, it is used as the offset from the end of the array to compute *fromIndex*. If the computed index is less than 0, the whole array will be searched.

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When the `indexOf` method is called with one or two arguments, the following steps are taken:

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(O).
3. Let len be `ToLength`(`Get`(O , "length")).
4. ReturnIfAbrupt(len).
5. If len is 0, return -1.
6. If argument `fromIndex` was passed let n be `ToInteger`(`fromIndex`); else let n be 0.
7. ReturnIfAbrupt(n).
8. If $n \geq len$, return -1.
9. If $n \geq 0$, then
 - a. Let k be n .
10. Else $n < 0$,
 - a. Let k be $len - abs(n)$.
 - b. If $k < 0$, let k be 0.
11. Repeat, while $k < len$
 - a. Let $kPresent$ be `HasProperty`(O , `ToString`(k)).
 - b. ReturnIfAbrupt($kPresent$).
 - c. If $kPresent$ is `true`, then
 - i. Let $elementK$ be the result of `Get`(O , `ToString`(k)).
 - ii. ReturnIfAbrupt($elementK$).
 - iii. Let $same$ be the result of performing Strict Equality Comparison $searchElement === elementK$.
 - iv. If $same$ is `true`, return k .
 - d. Increase k by 1.
12. Return -1.

The `length` property of the `indexOf` method is 1.

NOTE The `indexOf` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.12 `Array.prototype.join (separator)`

NOTE The elements of the array are converted to Strings, and these Strings are then concatenated, separated by occurrences of the `separator`. If no separator is provided, a single comma is used as the separator.

The `join` method takes one argument, `separator`, and performs the following steps:

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(O).
3. Let len be the result of `ToLength`(`Get`(O , "length")).
4. ReturnIfAbrupt(len).
5. If `separator` is `undefined`, let `separator` be the single-element String ", ".
6. Let `sep` be `ToString`(`separator`).
7. ReturnIfAbrupt(`sep`).
8. If len is zero, return the empty String.
9. Let `element0` be the result of `Get`(O , "0").
10. If `element0` is `undefined` or `null`, let R be the empty String; otherwise, let R be `ToString`(`element0`).
11. ReturnIfAbrupt(R).
12. Let k be 1.
13. Repeat, while $k < len$
 - a. Let S be the String value produced by concatenating R and `sep`.
 - b. Let `element` be `Get`(O , `ToString`(k)).

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- c. If *element* is **undefined** or **null**, let *next* be the empty String; otherwise, let *next* be *ToString(element)*.
 - d. *ReturnIfAbrupt(next)*.
 - e. Let *R* be a String value produced by concatenating *S* and *next*.
 - f. Increase *k* by 1.
14. Return *R*.

The **length** property of the **join** method is 1.

NOTE The **join** function is intentionally generic; it does not require that its **this** value be an Array object. Therefore, it can be transferred to other kinds of objects for use as a method.

22.1.3.13 Array.prototype.keys ()

The following steps are taken:

1. Let *O* be the result of calling **ToObject** with the **this** value as its argument.
2. *ReturnIfAbrupt(O)*.
3. Return **CreateArrayIterator(O, "key")**.

22.1.3.14 Array.prototype.lastIndexOf (*searchElement* [, *fromIndex*])

NOTE **lastIndexOf** compares *searchElement* to the elements of the array in descending order using the Strict Equality Comparison algorithm (7.2.11), and if found at one or more *indices*, returns the **largest** such *index*; otherwise, **-1** is returned.

The optional second argument *fromIndex* defaults to the array's length minus one (i.e. the whole array is searched). If it is greater than or equal to the length of the array, the whole array will be searched. If it is negative, it is used as the offset from the end of the array to compute *fromIndex*. If the computed index is less than 0, **-1** is returned.

When the **lastIndexOf** method is called with one or two arguments, the following steps are taken:

1. Let *O* be the result of calling **ToObject** passing the **this** value as the argument.
2. *ReturnIfAbrupt(O)*.
3. Let *len* be **ToLength**(*Get(O, "length")*).
4. *ReturnIfAbrupt(len)*.
5. If *len* is 0, return **-1**.
6. If argument *fromIndex* was passed let *n* be **ToInteger**(*fromIndex*); else let *n* be *len*-1.
7. *ReturnIfAbrupt(n)*.
8. If *n* \geq 0, let *k* be **min**(*n*, *len* - 1).
9. Else *n* < 0,
 - a. Let *k* be *len* - **abs**(*n*).
10. Repeat, while *k* \geq 0
 - a. Let *kPresent* be **HasProperty**(*O*, *ToString(k)*).
 - b. *ReturnIfAbrupt(kPresent)*.
 - c. If *kPresent* is **true**, then
 - i. Let *elementK* be *Get(O, ToString(k))*.
 - ii. *ReturnIfAbrupt(elementK)*.
 - iii. Let *same* be the result of performing Strict Equality Comparison *searchElement* === *elementK*.
 - iv. If *same* is **true**, return *k*.
 - d. Decrease *k* by 1.
11. Return **-1**.

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The `length` property of the `lastIndexOf` method is 1.

NOTE The `lastIndexOf` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.15 Array.prototype.map (callbackfn [, thisArg])

NOTE `callbackfn` should be a function that accepts three arguments. `map` calls `callbackfn` once for each element in the array, in ascending order, and constructs a new Array from the results. `callbackfn` is called only for elements of the array which actually exist; it is not called for missing elements of the array.

If a `thisArg` parameter is provided, it will be used as the `this` value for each invocation of `callbackfn`. If it is not provided, `undefined` is used instead.

`callbackfn` is called with three arguments: the value of the element, the index of the element, and the object being traversed.

`map` does not directly mutate the object on which it is called but the object may be mutated by the calls to `callbackfn`.

The range of elements processed by `map` is set before the first call to `callbackfn`. Elements which are appended to the array after the call to `map` begins will not be visited by `callbackfn`. If existing elements of the array are changed, their value as passed to `callbackfn` will be the value at the time `map` visits them; elements that are deleted after the call to `map` begins and before being visited are not visited.

When the `map` method is called with one or two arguments, the following steps are taken:

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(O).
3. Let len be `ToLength`(`Get`(O , "length")).
4. ReturnIfAbrupt(len).
5. If `IsCallable(callbackfn)` is `false`, throw a `TypeError` exception.
6. If `thisArg` was supplied, let T be `thisArg`; else let T be `undefined`.
7. Let A be `ArraySpeciesCreate`(O , len).
8. ReturnIfAbrupt(A).
9. Let k be 0.
10. Repeat, while $k < len$
 - a. Let Pk be `ToString`(k).
 - b. Let $kPresent$ be `HasProperty`(O , Pk).
 - c. ReturnIfAbrupt($kPresent$).
 - d. If $kPresent$ is `true`, then
 - i. Let $kValue$ be `Get`(O , Pk).
 - ii. ReturnIfAbrupt($kValue$).
 - iii. Let $mappedValue$ be `Call`(`callbackfn`, T , $kValue$, k , O).
 - iv. ReturnIfAbrupt($mappedValue$).
 - v. Let $status$ be `CreateDataPropertyOrThrow`(A , Pk , $mappedValue$).
 - vi. ReturnIfAbrupt($status$).
 - e. Increase k by 1.
11. Return A .

The `length` property of the `map` method is 1.

NOTE The `map` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

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Deleted: <#>Let len be `ToLength`($lenValue$).¶
Deleted: <#>Let A be `undefined`.¶
<#>If O is an exotic Array object, then¶
<#>Let C be `Get`(O , "constructor").¶
<#>ReturnIfAbrupt(C).¶
<#>If `IsConstructor`(C) is `true`, then¶
<#>Let `thisRealm` be the running execution context's Realm.¶
<#>If `SameValue`(`thisRealm`, and
`GetFunctionRealm`(C)) is `true` $thisRealm$ and
the value of C 's [[Realm]] internal slot are the same value, then¶
<#>Let A be the result of calling the
[[Construct]] internal method of C with an
argument list containing the single item len .¶
<#>If A is `undefined`, then¶
<#>Let A be `ArrayCreate`(len).¶
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applied successfully to an exotic object that is
not an Array is implementation-dependent.

22.1.3.16 Array.prototype.pop()

NOTE The last element of the array is removed from the array and returned.

When the `pop` method is called the following steps are taken:

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. `ReturnIfAbrupt(O)`.
3. Let len be `ToLength(Get(O , "length"))`.
4. `ReturnIfAbrupt(len)`.
5. If len is zero.
 - a. Let `putStatus` be `Put(O , "length", 0, true)`.
 - b. `ReturnIfAbrupt(putStatus)`.
 - c. Return `undefined`.
6. Else $len > 0$.
 - a. Let `newLen` be $len - 1$.
 - b. Let `indx` be `ToString(newLen)`.
 - c. Let `element` be `Get(O , indx)`.
 - d. `ReturnIfAbrupt(element)`.
 - e. Let `deleteStatus` be `DeletePropertyOrThrow(O , indx)`.
 - f. `ReturnIfAbrupt(deleteStatus)`.
 - g. Let `putStatus` be `Put(O , "length", newLen, true)`.
 - h. `ReturnIfAbrupt(putStatus)`.
 - i. Return `element`.

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NOTE The `pop` function is intentionally generic; it does not require that its `this` value be an `Array` object. Therefore it can be transferred to other kinds of objects for use as a method.

Deleted: Whether the `pop` function can be applied successfully to an exotic object that is not an `Array` is implementation-dependent.

22.1.3.17 Array.prototype.push(...items)

NOTE The arguments are appended to the end of the array, in the order in which they appear. The new length of the array is returned as the result of the call.

When the `push` method is called with zero or more arguments the following steps are taken:

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. `ReturnIfAbrupt(O)`.
3. Let len be `ToLength(Get(O , "length"))`.
4. `ReturnIfAbrupt(len)`.
5. Let `items` be a List whose elements are, in left to right order, the arguments that were passed to this function invocation.
6. Let `argCount` be the number of elements in `items`.
7. If $len + argCount > 2^{53} - 1$, throw a `TypeError` exception.
8. Repeat, while `items` is not empty
 - a. Remove the first element from `items` and let E be the value of the element.
 - b. Let `putStatus` be `Put(O , ToString(len), E , true)`.
 - c. `ReturnIfAbrupt(putStatus)`.
 - d. Let `len` be $len + 1$.
9. Let `putStatus` be `Put(O , "length", len, true)`.
10. `ReturnIfAbrupt(putStatus)`.
11. Return `len`.

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The `length` property of the `push` method is `1`.

NOTE The `push` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

Deleted: Whether the `push` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

22.1.3.18 Array.prototype.reduce (callbackfn [, initialValue])

NOTE `callbackfn` should be a function that takes four arguments. `reduce` calls the callback, as a function, once for each element present in the array, in ascending order.

`callbackfn` is called with four arguments: the `previousValue` (or value from the previous call to `callbackfn`), the `currentValue` (value of the current element), the `currentIndex`, and the object being traversed. The first time that callback is called, the `previousValue` and `currentValue` can be one of two values. If an `initialValue` was provided in the call to `reduce`, then `previousValue` will be equal to `initialValue` and `currentValue` will be equal to the first value in the array. If no `initialValue` was provided, then `previousValue` will be equal to the first value in the array and `currentValue` will be equal to the second. It is a **TypeError** if the array contains no elements and `initialValue` is not provided.

`reduce` does not directly mutate the object on which it is called but the object may be mutated by the calls to `callbackfn`.

The range of elements processed by `reduce` is set before the first call to `callbackfn`. Elements that are appended to the array after the call to `reduce` begins will not be visited by `callbackfn`. If existing elements of the array are changed, their value as passed to `callbackfn` will be the value at the time `reduce` visits them; elements that are deleted after the call to `reduce` begins and before being visited are not visited.

When the `reduce` method is called with one or two arguments, the following steps are taken:

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(O).
3. Let len be `ToLength`(`Get`(O , "length")).
4. ReturnIfAbrupt(len).
5. If `IsCallable(callbackfn)` is **false**, throw a **TypeError** exception.
6. If len is 0 and `initialValue` is not present, throw a **TypeError** exception.
7. Let k be 0.
8. If `initialValue` is present, then
 - a. Set `accumulator` to `initialValue`.
9. Else `initialValue` is not present,
 - a. Let $kPresent$ be **false**.
 - b. Repeat, while $kPresent$ is **false** and $k < len$
 - i. Let Pk be `ToString`(k).
 - ii. Let $kPresent$ be `HasProperty`(O , Pk).
 - iii. ReturnIfAbrupt($kPresent$).
 - iv. If $kPresent$ is **true**, then
 1. Let `accumulator` be `Get`(O , Pk).
 2. ReturnIfAbrupt(`accumulator`).
 - v. Increase k by 1.
 - c. If $kPresent$ is **false**, throw a **TypeError** exception.
10. Repeat, while $k < len$
 - a. Let Pk be `ToString`(k).
 - b. Let $kPresent$ be `HasProperty`(O , Pk).
 - c. ReturnIfAbrupt($kPresent$).
 - d. If $kPresent$ is **true**, then
 - i. Let $kValue$ be `Get`(O , Pk).
 - ii. ReturnIfAbrupt($kValue$).
 - iii. Let `accumulator` be `Call`(`callbackfn`, `undefined`, `[accumulator, kValue, k , O]`).
 - iv. ReturnIfAbrupt(`accumulator`).
 - e. Increase k by 1.

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11. Return *accumulator*.

The `length` property of the `reduce` method is **1**.

NOTE The `reduce` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

Deleted: Whether the `reduce` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

22.1.3.19 Array.prototype.reduceRight (*callbackfn* [, *initialValue*])

NOTE *callbackfn* should be a function that takes four arguments. `reduceRight` calls the callback, as a function, once for each element present in the array, in descending order.

callbackfn is called with four arguments: the *previousValue* (or value from the previous call to *callbackfn*), the *currentValue* (value of the current element), the *currentIndex*, and the object being traversed. The first time the function is called, the *previousValue* and *currentValue* can be one of two values. If an *initialValue* was provided in the call to `reduceRight`, then *previousValue* will be equal to *initialValue* and *currentValue* will be equal to the last value in the array. If no *initialValue* was provided, then *previousValue* will be equal to the last value in the array and *currentValue* will be equal to the second-to-last value. It is a **TypeError** if the array contains no elements and *initialValue* is not provided.

`reduceRight` does not directly mutate the object on which it is called but the object may be mutated by the calls to *callbackfn*.

The range of elements processed by `reduceRight` is set before the first call to *callbackfn*. Elements that are appended to the array after the call to `reduceRight` begins will not be visited by *callbackfn*. If existing elements of the array are changed by *callbackfn*, their value as passed to *callbackfn* will be the value at the time `reduceRight` visits them; elements that are deleted after the call to `reduceRight` begins and before being visited are not visited.

When the `reduceRight` method is called with one or two arguments, the following steps are taken:

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1. Let *O* be the result of calling `ToObject` passing the `this` value as the argument.
2. `ReturnIfAbrupt(O)`.
3. Let *len* be `ToLength(Get(O, "length"))`.
4. `ReturnIfAbrupt(len)`.
5. If `IsCallable(callbackfn)` is **false**, throw a **TypeError** exception.
6. If *len* is 0 and *initialValue* is not present, throw a **TypeError** exception.
7. Let *k* be *len*-1.
8. If *initialValue* is present, then
 - a. Set *accumulator* to *initialValue*.
9. Else *initialValue* is not present,
 - a. Let *kPresent* be **false**.
 - b. Repeat, while *kPresent* is **false** and *k* \geq 0
 - i. Let *Pk* be `ToString(k)`.
 - ii. Let *kPresent* be `HasProperty(O, Pk)`.
 - iii. `ReturnIfAbrupt(kPresent)`.
 - iv. If *kPresent* is **true**, then
 1. Let *accumulator* be `Get(O, Pk)`.
 2. `ReturnIfAbrupt(accumulator)`.
 - v. Decrease *k* by 1.
 - c. If *kPresent* is **false**, throw a **TypeError** exception.
10. Repeat, while *k* \geq 0
 - a. Let *Pk* be `ToString(k)`.
 - b. Let *kPresent* be `HasProperty(O, Pk)`.
 - c. `ReturnIfAbrupt(kPresent)`.
 - d. If *kPresent* is **true**, then
 1. Let *accumulator* be `Get(O, Pk)`.
 2. `ReturnIfAbrupt(accumulator)`.

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- i. Let *kValue* be Get(*O*, *Pk*).
- ii. ReturnIfAbrupt(*kValue*).
- iii. Let *accumulator* be Call(*callbackfn*, *undefined*, «*accumulator*, *kValue*, *k*, ¶»).
- iv. ReturnIfAbrupt(*accumulator*).
- e. Decrease *k* by 1.
11. Return *accumulator*.

The `length` property of the `reduceRight` method is 1.

NOTE The `reduceRight` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.20 Array.prototype.reverse ()

NOTE The elements of the array are rearranged so as to reverse their order. The object is returned as the result of the call.

When the `reverse` method is called the following steps are taken:

1. Let *O* be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(*O*).
3. Let *len* be `ToLength`(Get(*O*, "length")).
4. ReturnIfAbrupt(*len*).
5. Let *middle* be `floor`(*len*/2).
6. Let *lower* be 0.
7. Repeat, while *lower* ≠ *middle*
 - a. Let *upper* be *len* - *lower* - 1.
 - b. Let *upperP* be `ToString`(*upper*).
 - c. Let *lowerP* be `ToString`(*lower*).
 - d. Let *lowerExists* be `HasProperty`(*O*, *lowerP*).
 - e. ReturnIfAbrupt(*lowerExists*).
 - f. If *lowerExists* is true, then
 - i. Let *lowerValue* be Get(*O*, *lowerP*).
 - ii. ReturnIfAbrupt(*lowerValue*).
 - g. Let *upperExists* be `HasProperty`(*O*, *upperP*).
 - h. ReturnIfAbrupt(*upperExists*).
 - i. If *upperExists* is true, then
 - i. Let *upperValue* be Get(*O*, *upperP*).
 - ii. ReturnIfAbrupt(*upperValue*).
- j. If *lowerExists* is true and *upperExists* is true, then
 - i. Let *putStatus* be `Put`(*O*, *lowerP*, *upperValue*, true).
 - ii. ReturnIfAbrupt(*putStatus*).
 - iii. Let *putStatus* be `Put`(*O*, *upperP*, *lowerValue*, true).
 - iv. ReturnIfAbrupt(*putStatus*).
- k. Else if *lowerExists* is false and *upperExists* is true, then
 - i. Let *putStatus* be `Put`(*O*, *lowerP*, *upperValue*, true).
 - ii. ReturnIfAbrupt(*putStatus*).
 - iii. Let *deleteStatus* be `DeletePropertyOrThrow` (*O*, *upperP*).
 - iv. ReturnIfAbrupt(*deleteStatus*).
- l. Else if *lowerExists* is true and *upperExists* is false, then
 - i. Let *deleteStatus* be `DeletePropertyOrThrow` (*O*, *lowerP*).
 - ii. ReturnIfAbrupt(*deleteStatus*).
 - iii. Let *putStatus* be `Put`(*O*, *upperP*, *lowerValue*, true).

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Deleted: <#>Let *len* be `ToLength`(*lenVal*).¶

Deleted: <#>Let *lowerExists* be `HasProperty`(*O*, *lowerP*).¶
<#>ReturnIfAbrupt(*lowerExists*).¶
<#>Let *upperExists* be `HasProperty`(*O*, *upperP*).¶
<#>ReturnIfAbrupt(*upperExists*).¶

- iv. ReturnIfAbrupt(*putStatus*).
- m. Else both *lowerExists* and *upperExists* are **false**,
 - i. No action is required.
 - n. Increase *lower* by 1.
- 8. Return *O*.

NOTE The `reverse` function is intentionally generic; it does not require that its **this** value be an Array object. Therefore, it can be transferred to other kinds of objects for use as a method.

Deleted: Whether the `reverse` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

22.1.3.21 Array.prototype.shift ()

NOTE The first element of the array is removed from the array and returned.

When the `shift` method is called the following steps are taken:

1. Let *O* be the result of calling `ToObject` passing the **this** value as the argument.
2. ReturnIfAbrupt(*O*).
3. Let *len* be `ToLength`(*Get*(*O*, "length")).
4. ReturnIfAbrupt(*len*).
5. If *len* is zero, then
 - a. Let *putStatus* be `Put`(*O*, "length", 0, **true**).
 - b. ReturnIfAbrupt(*putStatus*).
 - c. Return **undefined**.
6. Let *first* be `Get`(*O*, "0").
7. ReturnIfAbrupt(*first*).
8. Let *k* be 1.
9. Repeat, while *k* < *len*
 - a. Let *from* be `ToString`(*k*).
 - b. Let *to* be `ToString`(*k*-1).
 - c. Let *fromPresent* be `HasProperty`(*O*, *from*).
 - d. ReturnIfAbrupt(*fromPresent*).
 - e. If *fromPresent* is **true**, then
 - i. Let *fromVal* be `Get`(*O*, *from*).
 - ii. ReturnIfAbrupt(*fromVal*).
 - iii. Let *putStatus* be `Put`(*O*, *to*, *fromVal*, **true**).
 - iv. ReturnIfAbrupt(*putStatus*).
 - f. Else *fromPresent* is **false**,
 - i. Let *deleteStatus* be `DeletePropertyOrThrow`(*O*, *to*).
 - ii. ReturnIfAbrupt(*deleteStatus*).
 - g. Increase *k* by 1.
10. Let *deleteStatus* be `DeletePropertyOrThrow`(*O*, `ToString`(*len*-1)).
11. ReturnIfAbrupt(*deleteStatus*).
12. Let *putStatus* be `Put`(*O*, "length", *len*-1, **true**).
13. ReturnIfAbrupt(*putStatus*).
14. Return *first*.

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NOTE The `shift` function is intentionally generic; it does not require that its **this** value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

Deleted: Whether the `shift` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

22.1.3.22 Array.prototype.slice (start, end)

NOTE The `slice` method takes two arguments, *start* and *end*, and returns an array containing the elements of the array from element *start* up to, but not including, element *end* (or through the end of the array if *end* is **undefined**).

If *start* is negative, it is treated as *length+start* where *length* is the length of the array. If *end* is negative, it is treated as *length+end* where *length* is the length of the array.

The following steps are taken:

1. Let *O* be the result of calling `ToObject` passing the `this` value as the argument.
2. `ReturnIfAbrupt(O)`.
3. Let *len* be `ToLength(Get(O, "length"))`.
4. `ReturnIfAbrupt(len)`.
5. Let *relativeStart* be `ToInteger(start)`.
6. `ReturnIfAbrupt(relativeStart)`.
7. If *relativeStart < 0*, let *k* be `max((len + relativeStart), 0)`; else let *k* be `min(relativeStart, len)`.
8. If *end* is `undefined`, let *relativeEnd* be *len*; else let *relativeEnd* be `ToInteger(end)`.
9. `ReturnIfAbrupt(relativeEnd)`.
10. If *relativeEnd ≤ 0*, let *final* be `max((len + relativeEnd), 0)`; else let *final* be `min(relativeEnd, len)`.
11. Let *count* be `max(final - k, 0)`.
12. `Let A be ArraySpeciesCreate(O, count)`.
13. `ReturnIfAbrupt(A)`.
14. Let *n* be 0.
15. Repeat, while *k < final*
 - a. Let *Pk* be `ToString(k)`.
 - b. Let *kPresent* be `HasProperty(O, Pk)`.
 - c. `ReturnIfAbrupt(kPresent)`.
 - d. If *kPresent* is `true`, then
 - i. Let *kValue* be `Get(O, Pk)`.
 - ii. `ReturnIfAbrupt(kValue)`.
 - iii. Let *status* be `CreateDataPropertyOrThrow(A, ToString(n), kValue)`.
 - iv. `ReturnIfAbrupt(status)`.
 - e. Increase *k* by 1.
 - f. Increase *n* by 1.
16. Let *putStatus* be `Put(A, "length", n, true)`.
17. `ReturnIfAbrupt(putStatus)`.
18. Return *A*.

The `length` property of the `slice` method is 2.

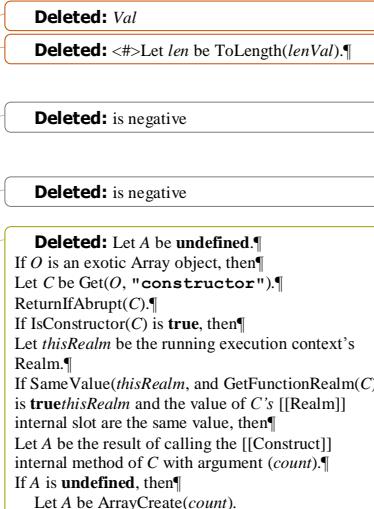
NOTE 1 The explicit setting of the `length` property of the result Array in step 19 is necessary to ensure that its value is correct in situations where the trailing elements of the result Array are not present.

NOTE 2 The `slice` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.23 `Array.prototype.some (callbackfn [, thisArg])`

NOTE `callbackfn` should be a function that accepts three arguments and returns a value that is coercible to the Boolean value `true` or `false`. `some` calls `callbackfn` once for each element present in the array, in ascending order, until it finds one where `callbackfn` returns `true`. If such an element is found, `some` immediately returns `true`. Otherwise, `some` returns `false`. `callbackfn` is called only for elements of the array which actually exist; it is not called for missing elements of the array.

If a `thisArg` parameter is provided, it will be used as the `this` value for each invocation of `callbackfn`. If it is not provided, `undefined` is used instead.



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callbackfn is called with three arguments: the value of the element, the index of the element, and the object being traversed.

`some` does not directly mutate the object on which it is called but the object may be mutated by the calls to *callbackfn*.

The range of elements processed by `some` is set before the first call to *callbackfn*. Elements that are appended to the array after the call to `some` begins will not be visited by *callbackfn*. If existing elements of the array are changed, their value as passed to *callbackfn* will be the value at the time that `some` visits them; elements that are deleted after the call to `some` begins and before being visited are not visited. `some` acts like the "exists" quantifier in mathematics. In particular, for an empty array, it returns `false`.

When the `some` method is called with one or two arguments, the following steps are taken:

1. Let *O* be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(*O*).
3. Let *len* be `ToLength`(`Get(O, "length")`).
4. ReturnIfAbrupt(*len*).
5. If `IsCallable(callbackfn)` is `false`, throw a `TypeError` exception.
6. If `thisArg` was supplied, let *T* be `thisArg`; else let *T* be `undefined`.
7. Let *k* be 0.
8. Repeat, while *k* < *len*
 - a. Let *Pk* be `ToString(k)`.
 - b. Let *kPresent* be `HasProperty(O, Pk)`.
 - c. ReturnIfAbrupt(*kPresent*).
 - d. If *kPresent* is `true`, then
 - i. Let *kValue* be `Get(O, Pk)`.
 - ii. ReturnIfAbrupt(*kValue*).
 - iii. Let *testResult* be `ToBoolean(Call(callbackfn, T, <kValue, k, and O>))`.
 - iv. ReturnIfAbrupt(*testResult*).
 - v. If *testResult* is `true`, return `true`.
 - e. Increase *k* by 1.
9. Return `false`.

The `length` property of the `some` method is 1.

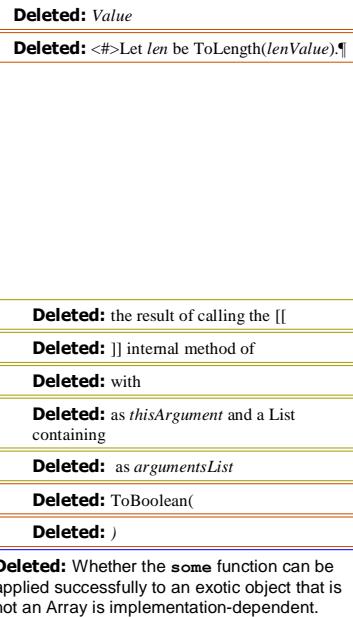
NOTE The `some` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.24 Array.prototype.sort (comparefn)

The elements of this array are sorted. The sort is not necessarily stable (that is, elements that compare equal do not necessarily remain in their original order). If `comparefn` is not `undefined`, it should be a function that accepts two arguments *x* and *y* and returns a negative value if *x* < *y*, zero if *x* = *y*, or a positive value if *x* > *y*.

Within this specification of the `sort` method, an Array object, *obj*, is said to be *sparse* if the following algorithm returns `true`:

1. Let *len* be `Get(obj, "length")`.
2. For each integer *i* in the range $0 \leq i < \text{ToUint32}(len)$
 - a. Let *elem* be the result of calling the `[[GetOwnProperty]]` internal method of *obj* with argument `ToString(i)`.
 - b. If *elem* is `undefined`, return `true`.
3. Return `false`.



Upon entry, the following steps are performed to initialize evaluation of the `sort` function:

1. Let `obj` be the result of calling `ToObject` passing the `this` value as the argument.
2. Let `len` be `ToLength(Get(obj, "length"))`.
3. `ReturnIfAbrupt(len)`.

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Deleted: <#>Let `len` be `ToLength(lenValue)`.¶

The `sort order` is the ordering of the array index property values of `obj` after completion of this function.

The result of the `sort` function is then determined as follows:

If `comparefn` is not `undefined` and is not a consistent comparison function for the elements of this array (see below), the `sort order` is implementation-defined. The `sort order` is also implementation-defined if `comparefn` is `undefined` and `SortCompare (22.1.3.24.1)` does not act as a consistent comparison function.

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Let `proto` be the result of calling the `[[GetPrototypeOf]]` internal method of `obj`. If `proto` is not `null` and there exists an integer `j` such that all of the conditions below are satisfied then the `sort order` is implementation-defined:

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- `obj` is sparse (22.1)
- $0 \leq j < len$
- The result of `HasProperty(proto, ToString(j))` is `true`.

The `sort order` is also implementation defined if `obj` is sparse and any of the following conditions are true:

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- The result of the predicate `IsExtensible(obj)` is `false`.
- Any array index property of `obj` whose name is a nonnegative integer less than `len` is a data property whose `[[Configurable]]` attribute is `false`.

The `sort order` is also implementation defined if any of the following conditions are true:

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- If `obj` is an exotic object (including `Proxy` exotic objects) whose behaviour for `[[Get]]`, `[[Set]]`, `[[Delete]]`, and `[[GetOwnProperty]]` is different from the ordinary object behaviour for these internal methods.
- If any array index property of `obj` whose name is a nonnegative integer less than `len` is an accessor property or is a data property whose `[[Writable]]` attribute is `false`.

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The following steps are taken:

1. Perform an implementation-dependent sequence of calls to the `[[Get]]`, `[[Set]]`, `[[Delete]]`, and `[[HasOwnProperty]]` abstract operation with `obj` as the first argument, and to `SortCompare` (described below), such that:
 - The property key argument for each call to `[[Get]]`, `[[Set]]`, `HasOwnProperty`, or `DeletePropertyOrThrow` is the string representation of a nonnegative integer less than `len`.
 - The arguments for calls to `SortCompare` are values returned by a previous call to the `[[Get]]` internal method, unless the properties accessed by those previous calls did not exist according to `[[HasOwnProperty]]`. If both perspective arguments to `SortCompare` correspond to non-existent properties, use `+0` instead of calling `SortCompare`. If only the first perspective argument is non-existent use `+1`. If only the second perspective argument is non-existent use `-1`.
 - If `obj` is not sparse then `DeletePropertyOrThrow` must not be called.
 - If any `[[Set]]` call returns `false` a `TypeError` exception is thrown.
 - If an abrupt completion is returned from any of these operations, it is immediately returned as the value of this function.
2. Return `obj`.

Unless the sort order is specified above to be implementation-defined, the returned object must have the following two characteristics:

- There must be some mathematical permutation π of the nonnegative integers less than len , such that for every nonnegative integer j less than len , if property $old[j]$ existed, then $new[\pi(j)]$ is exactly the same value as $old[j]$. But if property $old[j]$ did not exist, then $new[\pi(j)]$ does not exist.
- Then for all nonnegative integers j and k , each less than len , if $\text{SortCompare}(\text{old}[j], \text{old}[k]) < 0$ (see SortCompare below), then $\text{new}[\pi(j)] < \text{new}[\pi(k)]$.

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Here the notation $old[j]$ is used to refer to the hypothetical result of calling the $[[\text{Get}]]$ internal method of obj with argument j before this function is executed, and the notation $new[j]$ to refer to the hypothetical result of calling the $[[\text{Get}]]$ internal method of obj with argument j after this function has been executed.

A function comparefn is a consistent comparison function for a set of values S if all of the requirements below are met for all values a , b , and c (possibly the same value) in the set S : The notation $a <_{CF} b$ means $\text{comparefn}(a,b) < 0$; $a =_{CF} b$ means $\text{comparefn}(a,b) = 0$ (of either sign); and $a >_{CF} b$ means $\text{comparefn}(a,b) > 0$.

- Calling $\text{comparefn}(a,b)$ always returns the same value v when given a specific pair of values a and b as its two arguments. Furthermore, $\text{Type}(v)$ is Number , and v is not NaN . Note that this implies that exactly one of $a <_{CF} b$, $a =_{CF} b$, and $a >_{CF} b$ will be true for a given pair of a and b .
- Calling $\text{comparefn}(a,b)$ does not modify obj or any object on obj 's prototype chain.
- $a =_{CF} a$ (reflexivity)
- If $a =_{CF} b$, then $b =_{CF} a$ (symmetry)
- If $a =_{CF} b$ and $b =_{CF} c$, then $a =_{CF} c$ (transitivity of $=_{CF}$)
- If $a <_{CF} b$ and $b <_{CF} c$, then $a <_{CF} c$ (transitivity of $<_{CF}$)
- If $a >_{CF} b$ and $b >_{CF} c$, then $a >_{CF} c$ (transitivity of $>_{CF}$)

Comment [AWB2746]: however, this term currently isn't formally defined.

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 $\langle\#>\text{Let } kString \text{ be } \text{ToString}(k).\rangle$
 $\langle\#>\text{Let } hasj \text{ be } \text{HasProperty}(obj, jString).\rangle$
 $\langle\#>\text{ReturnIfAbrupt}(hasj).\rangle$
 $\langle\#>\text{Let } hask \text{ be } \text{HasProperty}(obj, kString).\rangle$
 $\langle\#>\text{ReturnIfAbrupt}(hask).\rangle$
 $\langle\#>\text{If } hasj \text{ and } hask \text{ are both false, then return } +0.\rangle$
 $\langle\#>\text{If } hasj \text{ is false, then return } 1.\rangle$
 $\langle\#>\text{If } hask \text{ is false, then return } -1.\rangle$
 $\langle\#>\text{Let } x \text{ be } \text{Get}(obj, jString).\rangle$
 $\langle\#>\text{ReturnIfAbrupt}(x).\rangle$
 $\langle\#>\text{Let } y \text{ be } \text{Get}(obj, kString).\rangle$
 $\langle\#>\text{ReturnIfAbrupt}(y).\rangle$

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NOTE 1 The above conditions are necessary and sufficient to ensure that comparefn divides the set S into equivalence classes and that these equivalence classes are totally ordered.

NOTE 2 The sort function is intentionally generic; it does not require that its this value be an Array object. Therefore, it can be transferred to other kinds of objects for use as a method.

22.1.3.24.1 Runtime Semantics: SortCompare Abstract Operation

When the SortCompare abstract operation is called with two arguments x and y , the following steps are taken:

1. If x and y are both **undefined**, return $+0$.
2. If x is **undefined**, return 1 .
3. If y is **undefined**, return -1 .
4. If the argument comparefn is not **undefined**, then
 - a. Let v be $\text{Call}(\text{comparefn}, \text{undefined}, \langle x, y \rangle)$.
 - b. $\text{ReturnIfAbrupt}(v)$.
 - c. If v is NaN , return $+0$.
 - d. $\text{Return } v$.
5. Let $xString$ be $\text{ToString}(x)$.
6. $\text{ReturnIfAbrupt}(xString)$.
7. Let $yString$ be $\text{ToString}(y)$.
8. $\text{ReturnIfAbrupt}(yString)$.
9. If $xString < yString$, return -1 .
10. If $xString > yString$, return 1 .
11. Return $+0$.

NOTE 1 Because non-existent property values always compare greater than **undefined** property values, and **undefined** always compares greater than any other value, **undefined** property values always sort to the end of the result, followed by non-existent property values.

NOTE 2 Method calls performed by the `ToString` abstract operations in steps 5 and 7 have the potential to cause `SortCompare` to not behave as a consistent comparison function.

22.1.3.25 Array.prototype.splice (start, deleteCount, ...items)

NOTE When the `splice` method is called with two or more arguments `start`, `deleteCount` and `zero` or more `items`, the `deleteCount` elements of the array starting at integer index `start` are replaced by the arguments `items`. An Array object containing the deleted elements (if any) is returned.

The following steps are taken:

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. `ReturnIfAbrupt(O)`.
3. Let len be `ToLength(Get(O , "length"))`.
4. `ReturnIfAbrupt(len)`.
5. Let $relativeStart$ be `ToInteger(start)`.
6. `ReturnIfAbrupt(relativeStart)`.
7. If $relativeStart \leq 0$, let $actualStart$ be $\max((len + relativeStart), 0)$; else let $actualStart$ be $\min(relativeStart, len)$.
8. If the number of actual arguments is 0, then
 - a. Let `insertCount` be 0.
 - b. Let `actualDeleteCount` be 0.
9. Else if the number of actual arguments is 1, then
 - a. Let `insertCount` be 0.
 - b. Let `actualDeleteCount` be $len - actualStart$
10. Else,
 - a. Let `insertCount` be the number of actual arguments minus 2.
 - b. Let dc be `ToInteger(deleteCount)`.
 - c. `ReturnIfAbrupt(dc)`.
 - d. Let `actualDeleteCount` be $\min(\max(dc, 0), len - actualStart)$.
11. If $len + insertCount - actualDeleteCount > 2^{53} - 1$, throw a `TypeError` exception.
12. Let A be `ArraySpeciesCreate(O , $actualDeleteCount$)`.
13. `ReturnIfAbrupt(A)`.
14. Let k be 0.
15. Repeat, while $k < actualDeleteCount$
 - a. Let `from` be `ToString(actualStart + k)`.
 - b. Let `fromPresent` be `HasProperty(O , from)`.
 - c. `ReturnIfAbrupt(fromPresent)`.
 - d. If `fromPresent` is `true`, then
 - i. Let `fromValue` be `Get(O , from)`.
 - ii. `ReturnIfAbrupt(fromValue)`.
 - iii. Let `status` be `CreateDataPropertyOrThrow(A , ToString(k), fromValue)`.
 - iv. `ReturnIfAbrupt(status)`.
 - e. Increment k by 1.
16. Let `putStatus` be `Put(A , "length", $actualDeleteCount$, true)`.
17. `ReturnIfAbrupt(putStatus)`.
18. Let `items` be a List whose elements are, in left to right order, the portion of the actual argument list starting with `the third argument`. The list is empty if fewer than three arguments were passed.
19. Let `itemCount` be the number of elements in `items`.

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Deleted: Let A be `undefined`.
 <#>If O is an exotic Array object, then
 <#>Let C be `Get(O , "constructor").
 <#>ReturnIfAbrupt(C).
 <#>If IsConstructor(C) is true, then
 <#>Let thisRealm be the running execution context's Realm.
 <#>If SameValue(thisRealm, and GetFunctionRealm(C)) is true thisRealm and the value of C 's [[Realm]] internal slot are the same value, then
 <#>Let A be the result of calling the [[Construct]] internal method of C with argument (actualDeleteCount).
 <#>If A is undefined, then
 Let A be ArrayCreate`

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20. If $itemCount < actualDeleteCount$, then
- Let k be $actualStart$.
 - Repeat, while $k < (len - actualDeleteCount)$
 - Let $from$ be $\text{ToString}(k + actualDeleteCount)$.
 - Let to be $\text{ToString}(k + itemCount)$.
 - Let $fromPresent$ be $\text{HasProperty}(O, from)$.
 - $\text{ReturnIfAbrupt}(fromPresent)$.
 - If $fromPresent$ is **true**, then
 - Let $fromValue$ be $\text{Get}(O, from)$.
 - $\text{ReturnIfAbrupt}(fromValue)$.
 - Let $putStatus$ be $\text{Put}(O, to, fromValue, \text{true})$.
 - $\text{ReturnIfAbrupt}(putStatus)$.
 - Else $fromPresent$ is **false**,
 - Let $deleteStatus$ be $\text{DeletePropertyOrThrow}(O, to)$.
 - $\text{ReturnIfAbrupt}(deleteStatus)$.
 - Increase k by 1.
 - Let k be len .
 - Repeat, while $k > (len - actualDeleteCount + itemCount)$
 - Let $deleteStatus$ be $\text{DeletePropertyOrThrow}(O, \text{ToString}(k - 1))$.
 - $\text{ReturnIfAbrupt}(deleteStatus)$.
 - Decrease k by 1.
21. Else if $itemCount > actualDeleteCount$, then
- Let k be $(len - actualDeleteCount)$.
 - Repeat, while $k > actualStart$
 - Let $from$ be $\text{ToString}(k + actualDeleteCount - 1)$.
 - Let to be $\text{ToString}(k + itemCount - 1)$.
 - Let $fromPresent$ be $\text{HasProperty}(O, from)$.
 - $\text{ReturnIfAbrupt}(fromPresent)$.
 - If $fromPresent$ is **true**, then
 - Let $fromValue$ be $\text{Get}(O, from)$.
 - $\text{ReturnIfAbrupt}(fromValue)$.
 - Let $putStatus$ be $\text{Put}(O, to, fromValue, \text{true})$.
 - $\text{ReturnIfAbrupt}(putStatus)$.
 - Else $fromPresent$ is **false**,
 - Let $deleteStatus$ be $\text{DeletePropertyOrThrow}(O, to)$.
 - $\text{ReturnIfAbrupt}(deleteStatus)$.
 - Increase k by 1.
 - Decrease k by 1.
22. Let k be $actualStart$.
23. Repeat, while $items$ is not empty
- Remove the first element from $items$ and let E be the value of that element.
 - Let $putStatus$ be $\text{Put}(O, \text{ToString}(k), E, \text{true})$.
 - $\text{ReturnIfAbrupt}(putStatus)$.
 - Increase k by 1.
24. Let $putStatus$ be $\text{Put}(O, \text{"length"}, len - actualDeleteCount + itemCount, \text{true})$.
25. $\text{ReturnIfAbrupt}(putStatus)$.
26. Return A .

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The **length** property of the **splice** method is **2**.

NOTE 1 The explicit setting of the **length** property of the result Array in step 18 is necessary to ensure that its value is correct in situations where its trailing elements are not present.

NOTE 2 The `splice` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.26 Array.prototype.toLocaleString ([`reserved1` [`reserved2`]])

An ECMAScript implementation that includes the ECMA-402 Internationalization API must implement the `Array.prototype.toLocaleString` method as specified in the ECMA-402 specification. If an ECMAScript implementation does not include the ECMA-402 API the following specification of the `toLocaleString` method is used.

NOTE The first edition of ECMA-402 did not include a replacement specification for the `Array.prototype.toLocaleString` method.

The meanings of the optional parameters to this method are defined in the ECMA-402 specification; implementations that do not include ECMA-402 support must not use those parameter positions for anything else.

The following steps are taken:

1. Let `array` be the result of calling `ToObject` passing the `this` value as the argument.
2. `ReturnIfAbrupt(array)`.
3. Let `len` be `ToLength(Get(array, "length"))`.
4. `ReturnIfAbrupt(len)`.
5. Let `separator` be the String value for the list-separator String appropriate for the host environment's current locale (this is derived in an implementation-defined way).
6. If `len` is zero, return the empty String.
7. Let `firstElement` be `Get(array, "0")`.
8. `ReturnIfAbrupt(firstElement)`.
9. If `firstElement` is `undefined` or `null`, then
 - a. Let `R` be the empty String.
10. Else
 - a. Let `R` be `ToString(Invoke(firstElement, "toLocaleString"))`.
 - b. `ReturnIfAbrupt(R)`.
11. Let `k` be 1.
12. Repeat, while $k < len$
 - a. Let `S` be a String value produced by concatenating `R` and `separator`.
 - b. Let `nextElement` be `Get(array, ToString(k))`.
 - c. `ReturnIfAbrupt(nextElement)`.
 - d. If `nextElement` is `undefined` or `null`, then
 - i. Let `R` be the empty String.
 - e. Else
 - i. Let `R` be `ToString(Invoke(nextElement, "toLocaleString"))`.
 - ii. `ReturnIfAbrupt(R)`.
 - f. Let `R` be a String value produced by concatenating `S` and `R`.
 - g. Increase `k` by 1.
13. Return `R`.

NOTE 1 The elements of the array are converted to Strings using their `toLocaleString` methods, and these Strings are then concatenated, separated by occurrences of a separator String that has been derived in an implementation-defined locale-specific way. The result of calling this function is intended to be analogous to the result of `toString`, except that the result of this function is intended to be locale-specific.

Deleted: Whether the `splice` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

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Deleted: <#>Let `len` be `ToLength(arrayLen)`.¶

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Comment [AWB747]: This `ToString` step was missing in ES<=5.1

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Comment [AWB748]: This `ToString` step was missing in ES<=5.1

Deleted: <#>Let `R` be `ToString(R)`.¶

NOTE 2 The `toLocaleString` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.27 Array.prototype.toString ()

When the `toString` method is called, the following steps are taken:

1. Let `array` be the result of calling `ToObject` on the `this` value.
2. ReturnIfAbrupt(`array`).
3. Let `func` be `Get(array, "join")`.
4. ReturnIfAbrupt(`func`).
5. If `IsCallable(func)` is `false`, let `func` be the intrinsic function `%ObjProto.%toString%` (19.1.3.6).
6. Return `Call(func, array)`.

NOTE The `toString` function is intentionally generic; it does not require that its `this` value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

22.1.3.28 Array.prototype.unshift (...items)

NOTE The arguments are prepended to the start of the array, such that their order within the array is the same as the order in which they appear in the argument list.

When the `unshift` method is called with zero or more arguments `item1`, `item2`, etc., the following steps are taken:

1. Let `O` be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(`O`).
3. Let `len` be `ToLength(Get(O, "length"))`.
4. ReturnIfAbrupt(`len`).
5. Let `argCount` be the number of actual arguments.
6. If `argCount > 0`, then
 - a. If `len + argCount > 253-1`, throw a `TypeError` exception.
 - b. Let `k` be `len`.
 - c. Repeat, while `k > 0`
 - i. Let `from` be `ToString(k-1)`.
 - ii. Let `to` be `ToString(k+argCount - 1)`.
 - iii. Let `fromPresent` be `HasProperty(O, from)`.
 - iv. ReturnIfAbrupt(`fromPresent`).
 - v. If `fromPresent` is `true`, then
 1. Let `fromValue` be the result of `Get(O, from)`.
 2. ReturnIfAbrupt(`fromValue`).
 3. Let `putStatus` be `Put(O, to, fromValue, true)`.
 4. ReturnIfAbrupt(`putStatus`).
 - vi. Else `fromPresent` is `false`,
 1. Let `deleteStatus` be `DeletePropertyOrThrow(O, to)`.
 2. ReturnIfAbrupt(`deleteStatus`).
 - vii. Decrease `k` by 1.
 - d. Let `j` be 0.
 - e. Let `items` be a List whose elements are, in left to right order, the arguments that were passed to this function invocation.
 - f. Repeat, while `items` is not empty
 - i. Remove the first element from `items` and let `E` be the value of that element.
 - ii. Let `putStatus` be `Put(O, ToString(j), E, true)`.

Deleted: NOTE 1 The first parameter to this function is likely to be used in a future version of this standard; it is recommended that implementations do not use this parameter position for anything else.¶

Deleted: Whether the `toLocaleString` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

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- iii. ReturnIfAbrupt(*putStatus*).
- iv. Increase *j* by 1.

7. Let *putStatus* be Put(*O*, "length", *len+argCount*, true).
8. ReturnIfAbrupt(*putStatus*).
9. Return *len+argCount*.

The **length** property of the **unshift** method is 1.

NOTE The **unshift** function is intentionally generic; it does not require that its **this** value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

Deleted: Whether the **unshift** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

22.1.3.29 Array.prototype.values ()

The following steps are taken:

1. Let *O* be the result of calling **ToObject** with the **this** value as its argument.
2. ReturnIfAbrupt(*O*).
3. Return **CreateArrayIterator**(*O*, "value").

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This function is the **%ArrayProto_values%** intrinsic object.

22.1.3.30 Array.prototype [@@iterator] ()

The initial value of the **@@iterator** property is the same function object as the initial value of the **Array.prototype.values** property.

22.1.3.31 Array.prototype [@@unscopables]

The initial value of the **@@unscopables** data property is an object created by the following steps:

1. Let *blackList* be **ObjectCreate**(null).
2. Perform **CreateDataProperty**(*blackList*, "copyWithin", true).
3. Perform **CreateDataProperty**(*blackList*, "entries", true).
4. Perform **CreateDataProperty**(*blackList*, "fill", true).
5. Perform **CreateDataProperty**(*blackList*, "find", true).
6. Perform **CreateDataProperty**(*blackList*, "findIndex", true).
7. Perform **CreateDataProperty**(*blackList*, "keys", true).
8. Perform **CreateDataProperty**(*blackList*, "values", true).
9. Assert: Each of the above calls will return true.
10. Return *blackList*.

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CreateDataProperty(*blackList*, "2", "fill").
<#>Perform CreateDataProperty(*blackList*, "3",
"copyWithin").
<#>Perform CreateDataProperty(*blackList*, "4",
"entries").

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Comment [AWB1749]: Should blacklist be frozen?

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This property has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.

NOTE The **own property names of this object** are property names that were not included as standard properties of **Array.prototype** prior to the sixth edition of this specification. These names are ignored for **with** statement binding purposes in order to preserve the behaviour of existing code that might use one of these names as a binding in an outer scope that is shadowed by a **with** statement whose binding object is an Array object.

22.1.4 Properties of Array Instances

Array instances are **Array** exotic objects and have the internal methods specified for such objects. Array instances inherit properties from the Array prototype object.

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Deleted: Array instances also have an [[ArrayInitializationState]] internal slot.

Array instances have a `length` property, and a set of enumerable properties with array index names.

22.1.4.1 `length`

The `length` property of an Array instance is a data property whose value is always numerically greater than the name of every configurable own property whose name is an array index.

The `length` property initially has the attributes { `[[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: false` }.

NOTE Attempting to set the `length` property of an Array object to a value that is numerically less than or equal to the largest numeric own property name of an existing array indexed configurable property of the array will result in the `length` being set to a numeric value that is one greater than that largest numeric own property name. See 9.4.2.1.

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22.1.5 Array Iterator Objects

An Array Iterator is an object, that represents a specific iteration over some specific Array instance object. There is not a named constructor for Array Iterator objects. Instead, Array iterator objects are created by calling certain methods of Array instance objects.

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22.1.5.1 CreateArrayIterator Abstract Operation

Several methods of Array objects return Iterator objects. The abstract operation `CreateArrayIterator` with arguments `array` and `kind` is used to create such iterator objects. It performs the following steps:

1. Assert: Type(array) is Object.
2. Let `iterator` be `ObjectCreate(%ArrayIteratorPrototype%, {[[IteratedObject]], [[ArrayIteratorNextIndex]], [[ArrayIterationKind]]}).`
3. Set `iterator`'s `[[IteratedObject]]` internal slot to `array`.
4. Set `iterator`'s `[[ArrayIteratorNextIndex]]` internal slot to 0.
5. Set `iterator`'s `[[ArrayIterationKind]]` internal slot to `kind`.
6. Return `iterator`.

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22.1.5.2 The %ArrayIteratorPrototype% Object

All Array Iterator Objects inherit properties from the `%ArrayIteratorPrototype%` intrinsic object. The `%ArrayIteratorPrototype%` object is an ordinary object and its `[[Prototype]]` internal slot is the `%IteratorPrototype%` intrinsic object (25.1.2). In addition, `%ArrayIteratorPrototype%` has the following properties:

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22.1.5.2.1 %ArrayIteratorPrototype%.next()

1. Let O be the `this` value.
2. If `Type(O)` is not `Object`, throw a `TypeError` exception.
3. If O does not have all of the internal slots of an Array Iterator Instance (22.1.5.3), throw a `TypeError` exception.
4. Let a be the value of the `[[IteratedObject]]` internal slot of O .
5. If a is `undefined`, return `CreateIterResultObject(undefined, true)`.
6. Let $index$ be the value of the `[[ArrayIteratorNextIndex]]` internal slot of O .
7. Let $itemKind$ be the value of the `[[ArrayIterationKind]]` internal slot of O .
8. If a has a `[[TypedArrayName]]` internal slot, then
 - a. Let len be the value of O 's `[[ArrayLength]]` internal slot.
9. Else,

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- a. Let *len* be `ToLength(Get(a, "length"))`.
b. `ReturnIfAbrupt(len)`.
10. If *index* \geq *len*, then
a. Set the value of the `[[IteratedObject]]` internal slot of *O* to `undefined`.
b. `Return CreateIterResultObject(undefined, true)`.
11. Set the value of the `[[ArrayIteratorNextIndex]]` internal slot of *O* to *index*+1.
[12. If itemKind is "key", CreateIterResultObject\(index, false\)](#)
13. Let *elementKey* be `ToString(index)`.
14. Let *elementValue* be `Get(a, elementKey)`.
15. `ReturnIfAbrupt(elementValue)`.
[16. If itemKind is "value", let result be elementValue.](#)
17. Else,
a. [Assert itemKind is "key+value"](#)
b. Let *result* be `ArrayCreate(2)`.
c. Assert: *result* is a new, well-formed Array object so the following operations will never fail.
d. Call `CreateDataProperty(result, "0", index)`.
e. Call `CreateDataProperty(result, "1", elementValue)`.
18. `Return CreateIterResultObject(result, false)`.

22.1.5.2.2 %ArrayIteratorPrototype% [@@toStringTag]

The initial value of the `@@toStringTag` property is the string value `"Array Iterator"`.

This property has the attributes { `[[Writable]]`: `false`, `[[Enumerable]]`: `false`, `[[Configurable]]`: `true` }.

22.1.5.3 Properties of Array Iterator Instances

Array Iterator instances are ordinary objects that inherit properties from the `%ArrayIteratorPrototype%` intrinsic object. Array Iterator instances are initially created with the internal slots listed in [Table 45](#),

Table 45— Internal Slots of Array Iterator Instances

Internal Slot	Description
<code>[[IteratedObject]]</code>	The object whose array elements are being iterated.
<code>[[ArrayIteratorNextIndex]]</code>	The integer index of the next array index to be examined by this iteration.
<code>[[ArrayIterationKind]]</code>	A string value that identifies what is to be returned for each element of the iteration. The possible values are: <code>"key"</code> , <code>"value"</code> , <code>"key+value"</code> .

22.2 TypedArray Objects

`TypedArray` objects present an array-like view of an underlying binary data buffer (24.1). Each element of a `TypedArray` instance has the same underlying binary scalar data type. There is a distinct `TypedArray` constructor, [listed](#) in [Table 46](#), for each of the nine supported element types. Each constructor in [Table 46](#), [has](#) a corresponding distinct prototype object.

Table 46 – The *TypedArray* Constructors

Constructor Name and Intrinsic	Element Type	Element Size	Conversion Operation	Description	Equivalent C Type
Int8Array %Int8Array%	Int8	1	ToInt8	8-bit 2's complement signed integer	signed char
Uint8Array %Uint8Array%	Uint8	1	ToUInt8	8-bit unsigned integer	unsigned char
Uint8ClampedArray %Uint8ClampedArray%	Uint8C	1	ToUInt8Clamp	8-bit unsigned integer (clamped conversion)	unsigned char
Int16Array %Int16Array%	Int16	2	ToInt16	16-bit 2's complement signed integer	short
Uint16Array %Uint16Array%	Uint16	2	ToUInt16	16-bit unsigned integer	unsigned short
Int32Array %Int32Array%	Int32	4	ToInt32	32-bit 2's complement signed integer	int
Uint32Array %Uint32Array%	Uint32	4	ToUInt32	32-bit unsigned integer	unsigned int
Float32Array %Float32Array%	Float32	4		32-bit IEEE floating point	float
Float64Array %Float64Array%	Float64	8		64-bit IEEE floating point	double

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In the definitions below, references to *TypedArray* should be replaced with the appropriate constructor name from the above table. The phrase “the element size in bytes” refers to the value in the Element Size column of the table in the row corresponding to the constructor. The phrase “element Type” refers to the value in the Element Type column for that row.

22.2.1 The %TypedArray% Intrinsic Object

The %TypedArray% intrinsic object is a constructor function object that all of the *TypedArray* constructor object inherit from. %TypedArray% and its corresponding prototype object provide common properties that are inherited by all *TypedArray* constructors and their instances. The %TypedArray% intrinsic does not have a global name or appear as a property of the global object.

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The %TypedArray% intrinsic function object is designed to act as the superclass of the various *TypedArray* constructors. Those constructors use %TypedArray% to initialize their instances by invoking %TypedArray% as if by making a *super* call. The %TypedArray% intrinsic function is not designed to be directly called in any other way. If %TypedArray% is directly called or called as part of a *new* expression an exception is thrown.

Deleted: If the *this* value passed in the call is an Object with a [[ViewedArrayBuffer]] internal slot whose value is *undefined*, it initializes the *this* value using the argument values. . This permits super invocation of the *TypedArray* constructors by *TypedArray* subclasses.¶

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22.2.1.1 %TypedArray% (length)

This description applies only if the %TypedArray% function is called and the Type of the first argument is not Object.

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%TypedArray% called with argument *length* performs the following steps:

1. Assert: Type(*length*) is not Object.
- 2. If NewTarget is undefined, throw a TypeError exception.**
3. Let *numberLength* be ToNumber(*length*).
4. Let *elementLength* be ToLength(*numberLength*).
5. ReturnIfAbrupt(*elementLength*).
6. If SameValueZero(*numberLength*, *elementLength*) is false, throw a RangeError exception.
- 7. Return AllocateTypedArray(NewTarget, *elementLength*).**

22.2.1.1 Runtime Semantics: AllocateTypedArray (newTarget, length)

The abstract operation `AllocateTypedArray` with argument *newTarget* and optional argument *length* is used to validate and create an instance of a `TypedArray` constructor. If the *length* argument is passed an `ArrayBuffer` of that length is also allocated and associated with the new `Typed Array` instance. `AllocateTypedArray` provides common semantics that is used by all of the %TypeArray% overloads and other methods. `AllocateTypedArray` performs the following steps:

- 1. If SameValue(%TypedArray%, newTarget) is true, throw a TypeError exception.**
- 2. Let *constructorName* be undefined.**
- 3. Let *subclass* be *newTarget*.**
- 4. Repeat while *constructorName* is undefined**
 - a. If *subclass* is null, throw a `TypeError` exception.
 - b. If SameValue(%TypedArray%, *subclass*) is true, throw a `TypeError` exception.
 - c. If *subclass* has a `[[TypedArrayConstructorName]]` internal slot, let *constructorName* be the value of *subclass*'s `[[TypedArrayConstructorName]]` internal slot.
 - d. Let *subclass* be the result of calling the `[[GetPrototypeOf]]` internal method of *subclass* with no arguments.
 - e. ReturnIfAbrupt(*subclass*).
- 5. Let *proto* be `GetPrototypeOfFromConstructor(newTarget, "%TypedArrayPrototype%")`.**
- 6. ReturnIfAbrupt(*proto*).**
- 7. Let *obj* be `IntegerIndexedObjectCreate(proto, [[ViewedArrayBuffer]], [[TypedArrayName]], [[ByteLength]], [[ByteOffset]], [[ArrayLength]]).`**
- 8. Assert: The `[[ViewedArrayBuffer]]` internal slot of *obj* is undefined.**
- 9. Set *obj*'s `[[TypedArrayName]]` internal slot to *constructorName*.**
- 10. If *length* was not passed, then**
 - a. Set *obj*'s `[[ByteLength]]` internal slot to 0.
 - b. Set *obj*'s `[[ByteOffset]]` internal slot to 0.
 - c. Set *obj*'s `[[ArrayLength]]` internal slot to 0.
- 11. Else,**
 - a. Let *elementSize* be the Element Size value in Table 46 for *constructorName*.
 - b. Let *byteLength* be *elementSize* × *length*.
 - c. Let *data* be `AllocateArrayBuffer(%ArrayBuffer%, byteLength)`.
 - d. ReturnIfAbrupt(*data*).
 - e. Set *obj*'s `[[ViewedArrayBuffer]]` internal slot to *data*.
 - f. Set *obj*'s `[[ByteLength]]` internal slot to *byteLength*.
 - g. Set *obj*'s `[[ByteOffset]]` internal slot to 0.
 - h. Set *obj*'s `[[ArrayLength]]` internal slot to *length*.
- 12. Return *obj*.**

Deleted: , then throw

Deleted: <#>Let *O* be the this value.
<#>If Type(*O*) is not Object, then throw a `TypeError` exception.
<#>If the value of *O*'s `[[TypedArrayName]]` internal slot, then throw a `TypeError` exception.
<#>If the value of *O*'s `[[ViewedArrayBuffer]]` internal slot is undefined, then throw a `TypeError` exception.
<#>Assert: *O* has a `[[ViewedArrayBuffer]]` internal slot.
<#>If the value of *O*'s `[[ViewedArrayBuffer]]` internal slot is not undefined, then throw a `TypeError` exception.

Deleted: <#>Let *constructorName* be the string value of *O*'s `[[TypedArrayName]]` internal slot.
<#>Let *elementType* be the string value of the Element Type value in Table 46Table 45Table 45Table 44 for *constructorName*.
<#>Let *numberLength* be `ToNumber(length)`.
<#>Let *elementLength* be `ToLength(numberLength)`.
<#>ReturnIfAbrupt(*elementLength*).
<#>If SameValueZero(*numberLength*, *elementLength*) is false, then throw a `RangeError` exception.
<#>Let *data* be `AllocateArrayBuffer(%ArrayBuffer%)`.
<#>ReturnIfAbrupt(*data*).
<#>If the value of *O*'s `[[ViewedArrayBuffer]]` internal slot is not undefined, then throw a `TypeError` exception.
<#>Let *elementSize* be the Size Element Size value in Table 46Table 45Table 45Table 44 for *constructorName*.
<#>Let *byteLength* be *elementSize* × *elementLength*.

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Deleted: *byteLength*

Deleted: <#>Let *status* be the result of `SetArrayBufferData(data, byteLength)`.
<#>ReturnIfAbrupt(*status*).
<#>Set *O*'s `[[ViewedArrayBuffer]]` internal slot to *data*.
<#>Set *O*'s `[[ByteLength]]` internal slot to *byteLength*.
<#>Set *O*'s `[[ByteOffset]]` internal slot to 0.
<#>Set *O*'s `[[ArrayLength]]` internal slot to *elementLength*.
<#>Return *O*.

Deleted: to

Deleted: <#>If *newTarget* is null, throw a `TypeError` exception.

Deleted: *typedArrayKind*

Deleted: *abstractConstructor*

22.2.1.2 %TypedArray% (typedArray)

This description applies only if the %TypedArray% function is called with at least one argument and the Type of the first argument is Object and that object has a [[TypedArrayName]] internal slot.

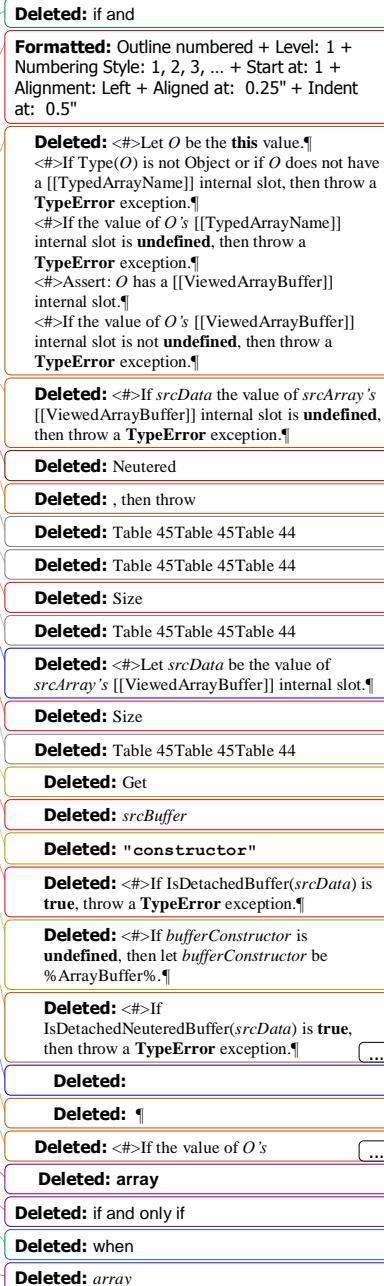
%TypedArray% called with argument *typedArray* performs the following steps:

1. Assert: Type(*typedArray*) is Object and *typedArray* has a [[TypedArrayName]] internal slot.
2. If NewTarget is undefined, throw a **TypeError** exception.
3. Let *O* be AllocateTypedArray(NewTarget).
4. ReturnIfAbrupt(*O*).
5. Let *srcArray* be *typedArray*.
6. Let *srcData* be the value of *srcArray*'s [[ViewedArrayBuffer]] internal slot.
7. If IsDetachedBuffer(*srcData*) is true, throw a **TypeError** exception.
8. Let *constructorName* be the string value of *O*'s [[TypedArrayName]] internal slot.
9. Let *elementType* be the string value of the Element Type value in Table 46 for *constructorName*.
10. Let *elementLength* be the value of *srcArray*'s [[ArrayLength]] internal slot.
11. Let *srcName* be the string value of *srcArray*'s [[TypedArrayName]] internal slot.
12. Let *srcType* be the string value of the Element Type value in Table 46 for *srcName*.
13. Let *srcElementSize* be the Element Size value in Table 46 for *srcName*.
14. Let *srcByteOffset* be the value of *srcArray*'s [[ByteOffset]] internal slot.
15. Let *elementSize* be the Element Size value in Table 46 for *constructorName*.
16. Let *byteLength* be *elementSize* × *elementLength*.
17. If SameValue(*elementType*, *srcType*) is true, then
 - a. Let *data* be CloneArrayBuffer(*srcData*, *srcByteOffset*).
 - b. ReturnIfAbrupt(*data*).
18. Else,
 - a. Let *bufferConstructor* be SpeciesConstructor(*srcData*, %ArrayBuffer%).
 - b. ReturnIfAbrupt(*bufferConstructor*).
 - c. Let *data* be AllocateArrayBuffer(*bufferConstructor*, *byteLength*).
 - d. If IsDetachedBuffer(*srcData*) is true, throw a **TypeError** exception.
 - e. Let *srcByteIndex* be *srcByteOffset*.
 - f. Let *targetByteIndex* be 0.
 - g. Let *count* be *elementLength*.
 - h. Repeat, while *count* > 0
 - i. Let *value* be GetValueFromBuffer(*srcData*, *srcByteIndex*, *srcType*).
 - ii. Let *status* be SetValueInBuffer(*data*, *targetByteIndex*, *elementType*, *value*).
 - iii. Set *srcByteIndex* to *srcByteIndex* + *srcElementSize*.
 - iv. Set *targetByteIndex* to *targetByteIndex* + *elementSize*.
 - v. Decrement *count* by 1.
19. Set *O*'s [[ViewedArrayBuffer]] internal slot to *data*.
20. Set *O*'s [[ByteLength]] internal slot to *byteLength*.
21. Set *O*'s [[ByteOffset]] internal slot to 0.
22. Set *O*'s [[ArrayLength]] internal slot to *elementLength*.
23. Return *O*.

22.2.1.3 %TypedArray% (*object*)

This description applies only if the %TypedArray% function is called with at least one argument and the Type of first argument is Object and that object does not have either a [[TypedArrayName]] or an [[ArrayBufferData]] internal slot.

%TypedArray% called with argument *object* performs the following steps:



1. Assert: Type(*object*) is Object and *object* does not have either a [[TypedArrayName]] or an [[ArrayBufferData]] internal slot.
2. If *NewTarget* is **undefined**, throw a **TypeError** exception.
3. Return *TypedArrayFrom(NewTarget, object, undefined, undefined)*.

22.2.1.4 %TypedArray% (buffer [, byteOffset [, length]])

This description applies only if the %TypedArray% function is called with at least one argument and the Type of the first argument is Object and that object has an [[ArrayBufferData]] internal slot.

%TypedArray% called with arguments *buffer*, *byteOffset*, and *length* performs the following steps:

1. Assert: Type(*buffer*) is Object and *buffer* has an [[ArrayBufferData]] internal slot.
2. If *NewTarget* is **undefined**, throw a **TypeError** exception.
3. Let *O* be *AllocateTypedArray(NewTarget)*.
4. ReturnIfAbrupt(*O*).
5. Let *constructorName* be the string value of *O*'s [[TypedArrayName]] internal slot.
6. Let *elementSize* be the Number value of the Element Size value in Table 46 for *constructorName*.
7. Let *offset* be *ToInteger(byteOffset)*.
8. ReturnIfAbrupt(*offset*).
9. If *offset* < 0, throw a **RangeError** exception.
10. If *offset* modulo *elementSize* ≠ 0, throw a **RangeError** exception.
11. If *IsDetachedBuffer(buffer)* is **true**, throw a **TypeError** exception.
12. Let *bufferByteLength* be the value of *buffer*'s [[ArrayBufferByteLength]] internal slot.
13. If *length* is **undefined**, then
 - a. If *bufferByteLength* modulo *elementSize* ≠ 0, throw a **RangeError** exception.
 - b. Let *newByteLength* be *bufferByteLength - offset*.
 - c. If *newByteLength* < 0, throw a **RangeError** exception.
14. Else,
 - a. Let *newLength* be *ToLength(length)*.
 - b. ReturnIfAbrupt(*newLength*).
 - c. Let *newByteLength* be *newLength × elementSize*.
 - d. If *offset+newByteLength* > *bufferByteLength*, throw a **RangeError** exception.
15. Set *O*'s [[ViewedArrayBuffer]] **internal slot** to *buffer*.
16. Set *O*'s [[ByteLength]] internal slot to *newByteLength*.
17. Set *O*'s [[ByteOffset]] internal slot to *offset*.
18. Set *O*'s [[ArrayLength]] internal slot to *newByteLength / elementSize*.
19. Return *O*.

22.2.1.5 %TypedArray% (all other argument combinations)

If the %TypedArray% function is called with arguments that do not match any of the preceding argument descriptions a **TypeError** exception is thrown.

22.2.2 Properties of the %TypedArray% Intrinsic Object

The %TypedArray% intrinsic object is a built-in function object. The value of the [[Prototype]] internal slot of %TypedArray% is the [intrinsic object %FunctionPrototype%](#) (19.2.3).

Besides a **length** property whose value is 3 and a **name** property whose value is "**TypedArray**", %TypedArray% has the following properties:

Deleted:
Deleted: <i>array</i>
Deleted: <i>array</i>
Deleted: <#>Let <i>O</i> be the <i>this</i> value.¶
Deleted: <#>Let <i>srcArray</i> constructor be <i>array</i> this constructor function.¶
Deleted: <#>If Type(<i>O</i>) is not Object or if <i>O</i> does not have a [[TypedArrayName]] internal slot, then throw a TypeError exception.¶
<#>If the value of <i>O</i> 's [[TypedArrayName]] internal slot is undefined , then throw a TypeError exception.¶
<#>Assert: <i>O</i> has a [[ViewedArrayBuffer]] internal slot.¶
<#>If the value of <i>O</i> 's [[ViewedArrayBuffer]] internal slot is not undefined , then throw a TypeError exception.¶
Deleted: <#>Let <i>items</i> be <i>ToObject(object)</i> .¶
<#>ReturnIfAbrupt(<i>items</i>).¶
Deleted: <#>Let <i>constructorName</i> be the string value of <i>O</i> 's [[TypedArrayName]] internal slot.¶
<#>Let <i>elementType</i> be the string value of the Element Type value in Table 44 for <i>constructorName</i> .¶
<#>Let <i>arrayLength</i> be <i>Get(srcArray, "length")</i> .¶
<#>Let <i>elementLength</i> be <i>ToLength(arrayLength)</i> .¶
Deleted: <i>undefined</i>
Deleted: <i>constructor</i>
Deleted: <i>O</i> ,
Deleted: <i>items</i>
Deleted: <i>O</i>
Deleted: if and only if
Deleted: when
Deleted: <#>Let <i>O</i> be the <i>this</i> value.¶
Deleted: <#>If Type(<i>O</i>) is not Object or if <i>O</i> ...¶
Deleted: <#>Let <i>elementType</i> be the string ...
Deleted: Table 45Table 45Table 44
Deleted: , then throw
Deleted: <#>If the value of <i>O</i> 's ...
Deleted: <i>e</i>
Deleted: Function prototype object
Deleted: The [[CreateAction]] of the ...

22.2.2.1 %TypedArray%.from (source [, mapfn [, thisArg]])

When the `from` method is called with argument `source`, and optional arguments `mapfn` and `thisArg`, the following steps are taken:

1. Let `C` be the `this` value.
2. If `IsConstructor(C)` is `false`, throw a `TypeError` exception.
3. If `mapfn` was supplied, let `f` be `mapfn`; otherwise let `f` be `undefined`.
4. If `f` is not `undefined`, then
 - a. If `IsCallable(f)` is `false`, throw a `TypeError` exception.
5. If `thisArg` was supplied, let `t` be `thisArg`; else let `t` be `undefined`.
6. Return `TypedArrayFrom(C, source, f, t)`.

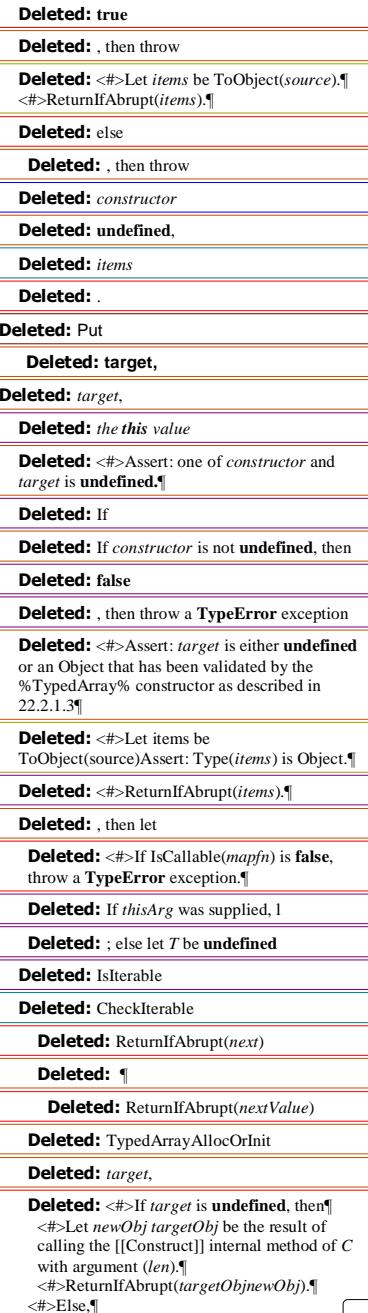
The `length` property of the `from` method is `1`.

NOTE The `from` function is an intentionally generic factory method; it does not require that its `this` value be a Typed Array constructor. Therefore it can be transferred to or inherited by any other constructors that may be called with a single numeric argument. This function uses `[[Set]]` to store elements into a newly created object and assume that the constructor sets the `length` property of the new object to the argument value passed to it.

22.2.2.1.1 Runtime Semantics: TypedArrayFrom(constructor, items, mapfn, thisArg)

When the `TypedArrayFrom` abstract operation is called with arguments `constructor`, `items`, `mapfn`, and `thisArg`, the following steps are taken:

1. Let `C` be `constructor`.
2. **Assert:** `IsConstructor(C)` is `true`.
3. **Assert:** `Type(mapfn)` is either a callable Object or `Undefined`.
4. If `mapfn` is `undefined`, let `mapping` be `false`.
5. else
 - a. Let `T` be `thisArg`.
 - b. Let `mapping` be `true`.
6. Let `usingIterator` be `GetMethod(items, @@iterator)`.
7. `ReturnIfAbrupt(usingIterator)`.
8. If `usingIterator` is not `undefined`, then
 - a. Let `iterator` be `GetIterator(items, usingIterator)`.
 - b. `ReturnIfAbrupt(iterator)`.
 - c. Let `values` be a new empty List.
 - d. Let `next` be `true`.
 - e. Repeat, while `next` is not `false`
 - i. Let `next` be `IteratorStep(iterator)`.
 - ii. **If** `next` is an abrupt completion, **return** `IteratorClose(iterator, next)`.
 - iii. Let `next` be `next.[[value]]`.
 - iv. If `next` is not `false`, then
 - i. Let `nextValue` be `IteratorValue(next)`.
 - ii. **If** `nextValue` is an abrupt completion, **return** `IteratorClose(iterator, nextValue)`.
 - iii. Append `nextValue.[[value]]` to the end of the List `values`.
 - h. Let `len` be the number of elements in `values`.
 - i. Let `targetObj` be `AllocateTypedArray(C, len)`.
 - j. `ReturnIfAbrupt(targetObj)`.
 - k. Let `k` be `0`.
 - l. Repeat, while `k < len`
 - i. Let `Pk` be `ToString(k)`.



- ii. Let *kValue* be the first element of *values* and remove that element from *list*.
 - iii. If *mapping* is **true**, then
 1. Let *mappedValue* be *Call(mapfn, T, kValue, k)*,
 2. ReturnIfAbrupt(*mappedValue*).
 - iv. Else, let *mappedValue* be *kValue*.
 - v. Let *putStatus* be *Put(targetObj, Pk, mappedValue, true)*.
 - vi. ReturnIfAbrupt(*putStatus*).
 - vii. Increase *k* by 1.
 - m. Assert: *values* is now an empty List.
 - n. Return *targetObj*.
9. Assert: *items* is not an **Iterable** so assume it is an array-like object.
10. Let *arrayLike* be *ToObject(items)*.
11. ReturnIfAbrupt(*arrayLike*).
12. Let *len* be *ToLength(Get(arrayLike, "length"))*.
13. ReturnIfAbrupt(*len*).
14. Let *targetObj* be *AllocateTypedArray(C, len)*.
15. ReturnIfAbrupt(*targetObj*).
16. Let *k* be 0.
17. Repeat, while *k < len*
 - a. Let *Pk* be *ToString(k)*.
 - b. Let *kValue* be *Get(arrayLike, Pk)*.
 - c. ReturnIfAbrupt(*kValue*).
 - d. If *mapping* is **true**, then
 - i. Let *mappedValue* be *Call(mapfn, T, kValue, k)*,
 - ii. ReturnIfAbrupt(*mappedValue*).
 - e. Else, let *mappedValue* be *kValue*.
 - f. Let *putStatus* be *Put(targetObj, Pk, mappedValue, true)*.
 - g. ReturnIfAbrupt(*putStatus*).
 - h. Increase *k* by 1.
18. Return *targetObj*.

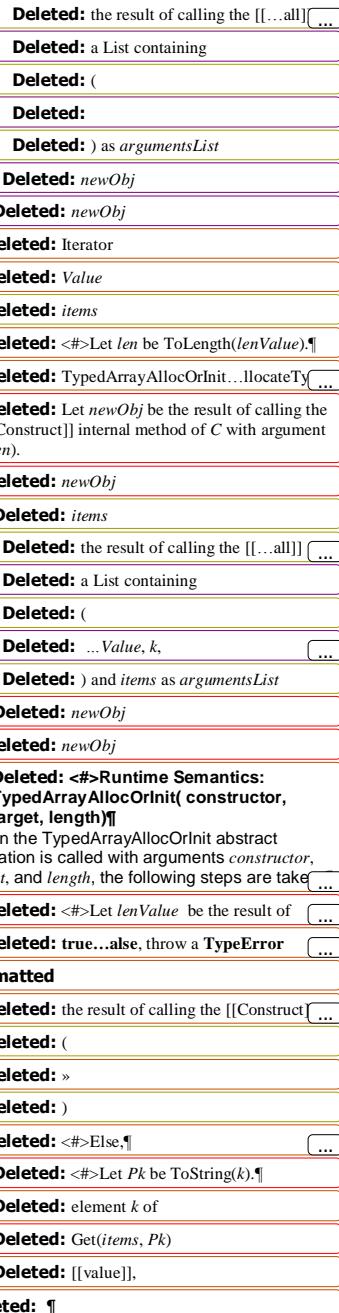
22.2.2.2 %TypedArray%.of (...items)

When the **of** method is called with any number of arguments, the following steps are taken:

- 1. Let *len* be the actual number of arguments passed to this function.
- 2. Let *items* be the List of arguments passed to this function.
- 3. Let *C* be the **this** value.
- 4. If *IsConstructor(C)* is **false**, throw a **TypeError** exception.
- 5. Let *newObj* be *AllocateTypedArray(C, len)*.
- 6. ReturnIfAbrupt(*newObj*).
- 7. Let *k* be 0.
- 8. Repeat, while *k < len*
 - a. Let *kValue* be *items[k]*.
 - b. Let *Pk* be *ToString(k)*.
 - c. Let *status* be *Put(newObj, Pk, kValue, true)*.
 - d. ReturnIfAbrupt(*status*).
 - e. Increase *k* by 1.
- 9. Return *newObj*.

The **length** property of the **of** method is **0**.

NOTE 1 The *items* argument is assumed to be a well-formed rest argument value.



22.2.2.3 %TypedArray%.prototype

The initial value of %TypedArray%.prototype is the %TypedArrayPrototype% intrinsic object (22.2.3).

This property has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }.

22.2.2.4 get %TypedArray% [@@species]

%TypedArray% [@@species] is an accessor property whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Return **this**.

The value of the **name** property of this function is "get [Symbol.species]."

NOTE Typed Array **prototype** methods normally their **this** object's constructor to create a derived object. However, a subclass constructor may over-ride that default behaviour by redefining its **@@species** property.

22.2.3 Properties of the %TypedArrayPrototype% Object

The value of the [[Prototype]] internal slot of the %TypedArrayPrototype% object is the [intrinsic object %ObjectPrototype%](#) (19.1.3). The %TypedArrayPrototype% object is an ordinary object. It does not have a [[ViewedArrayBuffer]] or any other of the internal slots that are specific to **TypedArray** instance objects.

22.2.3.1 get %TypedArray%.prototype.buffer

%TypedArray%.prototype.buffer is an accessor property whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let **O** be the **this** value.
2. If Type(**O**) is not Object, throw a **TypeError** exception.
3. If **O** does not have a [[ViewedArrayBuffer]] internal slot throw a **TypeError** exception.
4. Let **buffer** be the value of **O**'s [[ViewedArrayBuffer]] internal slot.
5. Return **buffer**.

22.2.3.2 get %TypedArray%.prototype.byteLength

%TypedArray%.prototype.byteLength is an accessor property whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let **O** be the **this** value.
2. If Type(**O**) is not Object, throw a **TypeError** exception.
3. If **O** does not have a [[ViewedArrayBuffer]] internal slot throw a **TypeError** exception.
4. Let **buffer** be the value of **O**'s [[ViewedArrayBuffer]] internal slot.
5. If **IsDetachedBuffer(buffer)** is true, return 0.
6. Let **size** be the value of **O**'s [[ByteLength]] internal slot.
7. Return **size**.

22.2.3.3 get %TypedArray%.prototype.byteOffset

%TypedArray%.prototype.byteOffset is an accessor property whose set accessor function is **undefined**. Its get accessor function performs the following steps:

Deleted: NOTE 2 The **of** function is an intentionally generic factory method; it does not require that its **this** value be a **TypedArray** constructor. Therefore it can be transferred to or inherited by other constructors that may be called with a single numeric argument. However, it does assume that constructor creates and initializes a length property that is initialized to its argument value.¶

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Deleted: instance

Deleted: use the instance

Deleted: ¶

Deleted: <#>%TypedArray% [@@create] ()¶

The @@create method of %TypedArray% performs the following steps:¶

```
<#>Let F be the this value.¶
<#>If Type(F) is not Object, then throw a
TypeError exception.¶
<#>Let proto be GetPrototypeOfFromConstructor(F,
"%TypedArrayPrototype%").¶
<#>ReturnIfAbrupt(proto).¶
<#>Let obj be IntegerIndexedObjectCreate
(proto, ([[[ViewedArrayBuffer]],
[[TypedArrayName]], [[ByteLength]],
[[ByteOffset]], [[ArrayLength]])).¶
<#>Add aAssert: The [[ViewedArrayBuffer]]
internal slot of obj is and set its initial value to
undefined.¶
<#>Assert: The Add a [[TypedArrayName]]
internal slot to of obj and set its initial value tois
undefined.¶
<#>Add aSet the [[ByteLength]] internal slot to of
obj and set its initial value to 0.¶
<#>Set the Add a [[ByteOffset]] internal slot of to
obj and set its initial value to 0.¶
<#>Set the Add an [[ArrayLength]] internal slot
of to obj and set its initial value to 0.¶
...
```

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object

Comment [AWB1350]: buffer needs to be an
accessor both to comply with WebIDL

Deleted: <#>If **buffer** is **undefined**, then throw
a **TypeError** exception.¶

Comment [AWB1351]: buffer needs to be an
accessor both to comply with WebIDL

Deleted: <#>If **buffer** is **undefined**, then throw
a **TypeError** exceptionreturn Othrow a
TypeError exception.¶

Deleted: Neutered

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Comment [AWB1352]: buffer needs to be an
accessor both to comply with WebIDL

1. Let O be the **this** value.
2. If $\text{Type}(O)$ is not **Object**, throw a **TypeError** exception.
3. If O does not have a **[[ViewedArrayBuffer]]** internal slot throw a **TypeError** exception.
4. Let $buffer$ be the value of O 's **[[ViewedArrayBuffer]]** internal slot.
5. If $\text{IsDetachedBuffer}(buffer)$ is true, return 0.
6. Let $offset$ be the value of O 's **[[ByteOffset]]** internal slot.
7. Return $offset$.

Deleted: <#>If $buffer$ is **undefined**, then throw a **TypeError** exception instead of returning 0.
Deleted: Neutered
Deleted: , then return

22.2.3.4 %TypedArray%.prototype.constructor

The initial value of **%TypedArray%.prototype.constructor** is the **%TypedArray%** intrinsic object.

22.2.3.5 %TypedArray%.prototype.copyWithin (target, start[, end])

%TypedArray%.prototype.copyWithin is a distinct function that implements the same algorithm as **Array.prototype.copyWithin** as defined in 22.1.3.3 except that the **this** object's **[[ArrayLength]]** internal slot is accessed in place of performing a **[[Get]]** of "**length**". The implementation of the algorithm may be optimized with the knowledge that the **this** value is an object that has a fixed length and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm.

Deleted: = $this.length$

This function is not generic. ValidateTypedArray is applied to the **this** value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.

Deleted: If
Deleted: is not an object with a **[[TypedArrayName]]** internal slot, a **TypeError** exception is immediately thrown when this function is called. A **TypeError** exception is also immediately thrown if the **this** value's **isDetached** or its **[[ViewedArrayBuffer]]** is **undefined**
Deleted: or has been neutered.

The **length** property of the **copyWithin** method is 2.

22.2.3.5.1 Runtime Semantics: ValidateTypedArray (O)

When called with argument O the following steps are taken:

1. If $\text{Type}(O)$ is not **Object**, throw a **TypeError** exception.
2. If O does not have a **[[TypedArrayName]]** internal slot, throw a **TypeError** exception.
3. If O does not have a **[[ViewedArrayBuffer]]** internal slot throw a **TypeError** exception.
4. Let $buffer$ be the value of O 's **[[ViewedArrayBuffer]]** internal slot.
5. If $\text{IsDetachedBuffer}(buffer)$ is true, throw a **TypeError** exception.
6. Return $buffer$.

22.2.3.6 %TypedArray%.prototype.entries ()

When **entries** is called with **this** value O , the following steps are taken:

1. Let O be the **this** value.
2. Let $valid$ be **ValidateTypedArray**(O).
3. ReturnIfAbrupt($valid$).
4. Return **CreateArrayIterator**(O , "**key+value**").

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Deleted: <#>Let O be the result of calling **ToObject** with the **this** value as its argument.
<#>ReturnIfAbrupt(O).
Deleted: <#>If O is not **Object**, throw a **TypeError** exception.
<#>If O does not have a **[[ViewedArrayBuffer]]** internal slot throw a **TypeError** exception.
<#>Let $buffer$ be the value of O 's **[[ViewedArrayBuffer]]** internal slot.
<#>If $buffer$ is **undefined**, then throw a **TypeError** exception.
<#>If $\text{IsDetachedNeuteredBuffer}(buffer)$ is true, throw a **TypeError** exception.

22.2.3.7 %TypedArray%.prototype.every (callbackfn [, thisArg])

%TypedArray%.prototype.every is a distinct function that implements the same algorithm as **Array.prototype.every** as defined in 22.1.3.5 except that the **this** object's **[[ArrayLength]]** internal slot is accessed in place of performing a **[[Get]]** of "**length**". The implementation of the algorithm may be optimized with the knowledge that the **this** value is an object that has a fixed length and whose integer

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indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm and must take into account the possibility that calls to `callbackfn` may cause the `this` value to become detached.

This function is not generic. `ValidateTypedArray` is applied to the `this` value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.

The `length` property of the `every` method is 1.

22.2.3.8 %TypedArray%.prototype.fill (value [, start [, end]])

`%TypedArray%.prototype.fill` is a distinct function that implements the same algorithm as `Array.prototype.fill` as defined in 22.1.3.6 except that the `this` object's `[[ArrayLength]]` internal slot is accessed in place of performing a `[[Get]]` of `"length"`. The implementation of the algorithm may be optimized with the knowledge that the `this` value is an object that has a fixed length and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm.

This function is not generic. `ValidateTypedArray` is applied to the `this` value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.

The `length` property of the `fill` method is 1.

22.2.3.9 %TypedArray%.prototype.filter (callbackfn [, thisArg])

The interpretation and use of the arguments of `%TypedArray%.prototype.filter` are the same as for `Array.prototype.filter` as defined in 22.1.3.7.

When the `filter` method is called with one or two arguments, the following steps are taken:

1. Let O be the `this` value.
2. Let $valid$ be `ValidateTypedArray(O)`.
3. ReturnIfAbrupt(valid).
4. Let len be the value of O 's `[[ArrayLength]]` internal slot.
5. If `IsCallable(callbackfn)` is `false`, throw a **TypeError** exception.
6. If $thisArg$ was supplied, let T be $thisArg$; else let T be `undefined`.
7. Let $defaultConstructor$ be the intrinsic object listed in column one of Table 46 for the value of O 's `[[TypedArrayName]]` internal slot.
8. Let C be `SpeciesConstructor(O, defaultConstructor)`.
9. ReturnIfAbrupt(C).
10. Let $kept$ be a new empty List.
11. Let k be 0.
12. Let $captured$ be 0.
13. Repeat, while $k < len$
 - a. Let Pk be `ToString(k)`.
 - b. Let $kValue$ be `Get(O, Pk)`.
 - c. ReturnIfAbrupt(kValue).
 - d. Let $selected$ be `ToBoolean(Call(callbackfn, T, «kValue, k, O»))`.
 - e. ReturnIfAbrupt(selected).
 - f. If $selected$ is `true`, then
 - i. Append $kValue$ to the end of $kept$.
 - ii. Increase $captured$ by 1.

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 <#>If O does not have a `[[TypedArrayName]]` internal slot, then throw a **TypeError** exception.
 <#>Let $buffer$ be the value of O 's `[[ViewedArrayBuffer]]` internal slot.
 <#>If $buffer$ is `undefined`, then throw a **TypeError** exception.
 <#>If `IsDetachedNeuteredBuffer(buffer)` is `true`, throw a **TypeError** exception.¶

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 <#>Throw a **TypeError** exception.¶

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- g. Increase k by 1.
14. Let A be `AllocateTypedArray(C, captured)`.
 15. ReturnIfAbrupt(A).
 16. Let n be 0.
 17. For each element e of $kept$
 - a. Let $status$ be `Put(A, ToString(n), e , true)`.
 - b. ReturnIfAbrupt($status$).
 - c. Increment n by 1.
 18. Return A .

This function is not generic. The `this` value must be an object with a `[[TypedArrayName]]` internal slot.

The `length` property of the `filter` method is 1.

22.2.3.10 %TypedArray%.prototype.find (predicate [, thisArg])

`%TypedArray%.prototype.find` is a distinct function that implements the same algorithm as `Array.prototype.find` as defined in 22.1.3.8 except that the `this` object's `[[ArrayLength]]` internal slot is accessed in place of performing a `[[Get]]` of `"length"`. The implementation of the algorithm may be optimized with the knowledge that the `this` value is an object that has a fixed `length` and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm and must take into account the possibility that calls to `predicate` may cause the `this` value to become detached.

This function is not generic. ValidateTypedArray is applied to the `this` value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.

The `length` property of the `find` method is 1.

22.2.3.11 %TypedArray%.prototype.findIndex (predicate [, thisArg])

`%TypedArray%.prototype.findIndex` is a distinct function that implements the same algorithm as `Array.prototype.findIndex` as defined in 22.1.3.9 except that the `this` object's `[[ArrayLength]]` internal slot is accessed in place of performing a `[[Get]]` of `"length"`. The implementation of the algorithm may be optimized with the knowledge that the `this` value is an object that has a fixed `length` and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm and must take into account the possibility that calls to `predicate` may cause the `this` value to become detached.

This function is not generic. ValidateTypedArray is applied to the `this` value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.

The `length` property of the `findIndex` method is 1.

22.2.3.12 %TypedArray%.prototype.forEach (callbackfn [, thisArg])

`%TypedArray%.prototype.forEach` is a distinct function that implements the same algorithm as `Array.prototype.forEach` as defined in 22.1.3.10 except that the `this` object's `[[ArrayLength]]` internal slot is accessed in place of performing a `[[Get]]` of `"length"`. The implementation of the algorithm may be optimized with the knowledge that the `this` value is an object that has a fixed `length` and whose integer indexed properties are not sparse. However, such optimization must not introduce any

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observable changes in the specified behaviour of the algorithm and must take into account the possibility that calls to `callbackfn` may cause the `this` value to become detached.

This function is not generic. ValidateTypedArray is applied to the `this` value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.

The `length` property of the `forEach` method is 1.

22.2.3.13 %TypedArray%.prototype.indexOf (searchElement [, fromIndex])

`%TypedArray%.prototype.indexOf` is a distinct function that implements the same algorithm as `Array.prototype.indexOf` as defined in 22.1.3.11 except that the `this` object's `[[ArrayLength]]` internal slot is accessed in place of performing a `[[Get]]` of `"length"`. The implementation of the algorithm may be optimized with the knowledge that the `this` value is an object that has a fixed length and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm.

This function is not generic. ValidateTypedArray is applied to the `this` value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.

The `length` property of the `indexOf` method is 1.

22.2.3.14 %TypedArray%.prototype.join (separator)

`%TypedArray%.prototype.join` is a distinct function that implements the same algorithm as `Array.prototype.join` as defined in 22.1.3.12 except that the `this` object's `[[ArrayLength]]` internal slot is accessed in place of performing a `[[Get]]` of `"length"`. The implementation of the algorithm may be optimized with the knowledge that the `this` value is an object that has a fixed length and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm.

This function is not generic. ValidateTypedArray is applied to the `this` value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.

22.2.3.15 %TypedArray%.prototype.keys ()

The following steps are taken:

1. Let `O` be the `this` value.
2. Let `valid` be `ValidateTypedArray(O)`.
3. ReturnIfAbrupt(`valid`).
4. Return `CreateArrayIterator(O, "key")`.

22.2.3.16 %TypedArray%.prototype.lastIndexOf (searchElement [, fromIndex])

`%TypedArray%.prototype.lastIndexOf` is a distinct function that implements the same algorithm as `Array.prototype.lastIndexOf` as defined in 22.1.3.14 except that the `this` object's `[[ArrayLength]]` internal slot is accessed in place of performing a `[[Get]]` of `"length"`. The implementation of the algorithm may be optimized with the knowledge that the `this` value is an object that has a fixed length and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm.

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Deleted: If the `this` value is not an object with a `[[TypedArrayName]]` internal slot, a `TypeError` exception is immediately thrown when this function is called. A `TypeError` exception is also immediately thrown if the `this` value's is detached or if its `[[ViewedArrayBuffer]]` is `undefined` or has been neutered..

Deleted: If the `this` value is not an object with a `[[TypedArrayName]]` internal slot, a `TypeError` exception is immediately thrown when this function is called. A `TypeError` exception is also immediately thrown if the `this` value's is detached or if its `[[ViewedArrayBuffer]]` is `undefined` or has been neutered..

Deleted: <#>Let `O` be the result of calling `ToObject` with the `this` value as its argument.
<#>ReturnIfAbrupt(`O`).¶

Deleted: If `Type(O)` is not `Object`, throw a `TypeError` exception.

Deleted: If `O` does not have a `[[ViewedArrayBuffer]]` internal slot throw a `TypeError` exception.

Deleted: <#>Let `buffer` be the value of `O`'s `[[ViewedArrayBuffer]]` internal slot.¶
<#>If `buffer` is `undefined`, then throw a `TypeError` exception.¶
<#>If `IsDetachedNeuteredBuffer(buffer)` is `true`, throw a `TypeError` exception.¶

Deleted: The initial value of the `%TypedArray%.prototype.keys` data property is the same built-in function object as the `Array.prototype.keys` method defined in 22.1.3.13.¶

This function is not generic. `ValidateTypedArray` is applied to the `this` value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.

The `length` property of the `lastIndexOf` method is 1.

22.2.3.17 `get %TypedArray%.prototype.length`

`%TypedArray%.prototype.length` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Let O be the `this` value.
2. If `Type(O)` is not `Object`, throw a `TypeError` exception.
3. If O does not have a `[[TypedArrayName]]` internal slot, throw a `TypeError` exception.
4. Assert: O has `[[ViewedArrayBuffer]]` and `[[ArrayLength]]` internal slots.
5. Let $buffer$ be the value of O 's `[[ViewedArrayBuffer]]` internal slot.
6. If `IsDetachedBuffer(buffer)` is `true`, return 0.
7. Let $length$ be the value of O 's `[[ArrayLength]]` internal slot.
8. Return $length$.

This function is not generic. The `this` value must be an object with a `[[TypedArrayName]]` internal slot.

22.2.3.18 `%TypedArray%.prototype.map (callbackfn [, thisArg])`

The interpretation and use of the arguments of `%TypedArray%.prototype.map` are the same as for `Array.prototype.map` as defined in 22.1.3.15.

When the `map` method is called with one or two arguments, the following steps are taken:

1. Let O be the `this` value.
2. Let $valid$ be `ValidateTypedArray(O)`.
3. ReturnIfAbrupt($valid$).
4. Let len be the value of O 's `[[ArrayLength]]` internal slot.
5. If `IsCallable(callbackfn)` is `false`, throw a `TypeError` exception.
6. If `thisArg` was supplied, let T be `thisArg`; else let T be `undefined`.
7. Let `defaultConstructor` be the intrinsic object listed in column one of Table 46 for the value of O 's `[[TypedArrayName]]` internal slot.
8. Let C be `SpeciesConstructor(O , defaultConstructor).`
9. ReturnIfAbrupt(C).
10. Let A be `AllocateTypedArray(C , len)`.
11. ReturnIfAbrupt(A).
12. Let k be 0.
13. Repeat, while $k < len$
 - a. Let Pk be `ToString(k).`
 - b. Let $kValue$ be `Get(O , Pk)`.
 - c. ReturnIfAbrupt($kValue$).
 - d. Let $mappedValue$ be `Call(callbackfn, T , « $kValue$, k , O »)`.
 - e. ReturnIfAbrupt($mappedValue$).
 - f. Let $status$ be `Put(A , Pk , $mappedValue$, true).`
 - g. ReturnIfAbrupt($status$).
 - h. Increase k by 1.
14. Return A .

This function is not generic. The `this` value must be an object with a `[[TypedArrayName]]` internal slot.

Deleted: If the `this` value is not an object with a `[[TypedArrayName]]` internal slot, a `TypeError` exception is immediately thrown when this function is called. A `TypeError` exception is also immediately thrown if the `this` value's `[[ViewedArrayBuffer]]` is `undefined` or has been neutered..

Comment [AWB1353]: buffer needs to be an accessor both to comply with WebIDL requirements and to support the Kronos neutering strawman requirements.

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Deleted: <#>If `buffer` is `undefined`, then throw a `TypeError` exception throw a `TypeError` exceptionreturn 0.

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 <#>If O does not have a `[[TypedArrayName]]` internal slot, then throw a `TypeError` exception.
 <#>Let $buffer$ be the value of O 's `[[ViewedArrayBuffer]]` internal slot.
 <#>If `buffer` is `undefined`, then throw a `TypeError` exception.
 <#>If `IsDetachedNeuteredBuffer(buffer)` is `true`, throw a `TypeError` exception.

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Deleted: <#>If `IsConstructor(C)` is `true`, then
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The `length` property of the `map` method is 1.

22.2.3.19 %TypedArray%.prototype.reduce (callbackfn [, initialValue])

`%TypedArray%.prototype.reduce` is a distinct function that implements the same algorithm as `Array.prototype.reduce` as defined in 22.1.3.18 except that the `this` object's `[[ArrayLength]]` internal slot is accessed in place of performing a `[[Get]]` of `"length"`. The implementation of the algorithm may be optimized with the knowledge that the `this` value is an object that has a fixed length and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm [and must take into account the possibility that calls to `callbackfn` may cause the `this` value to become detached.](#)

This function is not generic. [ValidateTypedArray is applied to the `this` value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.](#)

The `length` property of the `reduce` method is 1.

22.2.3.20 %TypedArray%.prototype.reduceRight (callbackfn [, initialValue])

`%TypedArray%.prototype.reduceRight` is a distinct function that implements the same algorithm as `Array.prototype.reduceRight` as defined in 22.1.3.19 except that the `this` object's `[[ArrayLength]]` internal slot is accessed in place of performing a `[[Get]]` of `"length"`. The implementation of the algorithm may be optimized with the knowledge that the `this` value is an object that has a fixed length and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm [and must take into account the possibility that calls to `callbackfn` may cause the `this` value to become detached.](#)

This function is not generic. [ValidateTypedArray is applied to the `this` value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.](#)

The `length` property of the `reduceRight` method is 1.

22.2.3.21 %TypedArray%.prototype.reverse ()

`%TypedArray%.prototype.reverse` is a distinct function that implements the same algorithm as `Array.prototype.reverse` as defined in 22.1.3.20 except that the `this` object's `[[ArrayLength]]` internal slot is accessed in place of performing a `[[Get]]` of `"length"`. The implementation of the algorithm may be optimized with the knowledge that the `this` value is an object that has a fixed length and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm.

This function is not generic. [ValidateTypedArray is applied to the `this` value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.](#)

22.2.3.22 %TypedArray%.prototype.set (overloaded [, offset])

`%TypedArray%.prototype.set` is a single function whose behaviour is overloaded based upon the type of its first argument.

This function is not generic. The `this` value must be an object with a `[[TypedArrayName]]` internal slot.

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Deleted: If the `this` value is not an object with a `[[TypedArrayName]]` internal slot, a `TypeError` exception is immediately thrown when this function is called. A `TypeError` exception is also immediately thrown if the `this` value's is detached or if its `[[ViewedArrayBuffer]]` is `undefined` or has been neutered..

The `length` property of the `set` method is 1.

22.2.3.22.1%TypedArray%.prototype.set(array [, offset])

Set multiple values in this `TypedArray`, reading the values from the object `array`. The optional `offset` value indicates the first element index in this `TypedArray` where values are written. If omitted, it is assumed to be 0.

1. Assert: `array` does not have a `[[TypedArrayName]]` internal slot. If it does, the definition in [22.2.3.22.2](#) applies.
2. Let `target` be the `this` value.
3. If `Type(target)` is not `Object`, throw a **TypeError** exception.
4. If `target` does not have a `[[TypedArrayName]]` internal slot, **throw** a **TypeError** exception.
5. Assert: `target` has [a](#) `[[ViewedArrayBuffer]]` internal slot.
6. Let `targetOffset` be `ToInteger(offset)`.
7. **ReturnIfAbrupt(targetOffset).**
8. If `targetOffset < 0`, **throw** a **RangeError** exception.
9. Let `targetBuffer` be the value of `target`'s `[[ViewedArrayBuffer]]` internal slot.
10. If `IsDetachedBuffer(targetBuffer)` is `true`, **throw** a **TypeError** exception.
11. Let `targetLength` be the value of `target`'s `[[ArrayLength]]` internal slot.
12. Let `targetName` be the string value [of](#) `target`'s `[[TypedArrayName]]` internal slot.
13. Let `targetElementSize` be the Number value of the Element Size value specified in [Table 46](#) for `targetName`.
14. Let `targetType` be the string value of the Element Type value in [Table 46](#) for `targetName`.
15. Let `targetByteOffset` be the value of `target`'s `[[ByteOffset]]` internal slot.
16. Let `src` be `ToObject(array)`.
17. **ReturnIfAbrupt(src).**
18. Let `srcLen` be `Get(src, "length")`.
19. Let `numberLength` be `ToNumber(srcLen)`.
20. Let `srcLength` be `ToInteger(numberLength)`.
21. **ReturnIfAbrupt(srcLength).**
22. If `numberLength ≠ srcLength` or `srcLength < 0`, **throw** a **TypeError** exception.
23. If `srcLength + targetOffset > targetLength`, **throw** a **RangeError** exception.
24. Let `targetByteIndex` be `targetOffset × targetElementSize + targetByteOffset`.
25. Let `k` be 0.
26. Let `limit` be `targetByteIndex + targetElementSize × min(srcLength, targetLength - targetOffset)`.
27. Repeat, while `targetByteIndex < limit`
 - a. Let `Pk` be `ToString(k)`.
 - b. Let `kValue` be `Get(src, Pk)`.
 - c. Let `kNumber` be `ToNumber(kValue)`.
 - d. **ReturnIfAbrupt(kNumber).**
 - e. If `IsDetachedBuffer(targetBuffer)` is `true`, **throw** a **TypeError** exception.
 - f. Perform `SetValueInBuffer(targetBuffer, targetByteIndex, targetType, kNumber)`.
 - g. Set `k` to `k + 1`.
 - h. Set `targetByteIndex` to `targetByteIndex + targetElementSize`.
28. Return `undefined`.

22.2.3.22.2%TypedArray%.prototype.set(typedArray [, offset])

Set multiple values in this `TypedArray`, reading the values from the `typedArray` argument object. The optional `offset` value indicates the first element index in this `TypedArray` where values are written. If omitted, it is assumed to be 0.

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Deleted: <#>Let `targetBuffer` be the value of `target`'s `[[ViewedArrayBuffer]]` internal slot.
 <#>If `targetBuffer` is `undefined`, then throw a **TypeError** exception.
 <#>If `IsDetachedBuffer(targetBuffer)` is `true`, then throw a **TypeError** exception.
 <#>Let `targetLength` be the value of `target`'s `[[ArrayLength]]` internal slot.

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1. Assert: *typedArray* has a `[[TypedArrayName]]` internal slot. If it does not, the definition in [22.2.3.22.1](#) applies.
2. Let *target* be the `this` value.
3. If `Type(target)` is not `Object`, throw a `TypeError` exception.
4. If *target* does not have a `[[TypedArrayName]]` internal slot, throw a `TypeError` exception.
5. Assert: *target* has a `[[ViewedArrayBuffer]]` internal slot.
6. Let *targetOffset* be `ToInteger(offset)`
7. ReturnIfAbrupt(*targetOffset*).
8. If *targetOffset* < 0, throw a `RangeError` exception.
9. Let *targetBuffer* be the value of *target*'s `[[ViewedArrayBuffer]]` internal slot.
10. If `IsDetachedBuffer(targetBuffer)` is `true`, throw a `TypeError` exception.
11. Let *targetLength* be the value of *target*'s `[[ArrayLength]]` internal slot.
12. Let *srcBuffer* be the value of *typedArray*'s `[[ViewedArrayBuffer]]` internal slot.
13. If `IsDetachedBuffer(srcBuffer)` is `true`, throw a `TypeError` exception.
14. Let *targetName* be the string value of *target*'s `[[TypedArrayName]]` internal slot.
15. Let *targetType* be the string value of the Element Type value in [Table 46](#) for *targetName*.
16. Let *targetElementSize* be the Number value of the Element Size value specified in [Table 46](#) for *targetName*.
17. Let *targetByteOffset* be the value of *target*'s `[[ByteOffset]]` internal slot.
18. Let *srcName* be the string value of *typedArray*'s `[[TypedArrayName]]` internal slot.
19. Let *srcType* be the string value of the Element Type value in [Table 46](#) for *srcName*.
20. Let *srcElementSize* be the Number value of the Element Size value specified in [Table 46](#) for *srcName*.
21. Let *srcLength* be the value of *typedArray*'s `[[ArrayLength]]` internal slot.
22. Let *srcByteOffset* be the value of *typedArray*'s `[[ByteOffset]]` internal slot.
23. If *srcLength* + *targetOffset* > *targetLength*, throw a `RangeError` exception.
24. If `SameValue(srcBuffer, targetBuffer)` is `true`, then
 - a. Let *srcBuffer* be `CloneArrayBuffer(targetBuffer, srcByteOffset, %ArrayPrototype%)`.
 - b. NOTE: `%ArrayPrototype%` is used to clone *targetBuffer* because it is known to not have any observable side-effects.
 - c. ReturnIfAbrupt(srcBuffer).
 - d. Let *srcByteIndex* be 0.
25. Else, let *srcByteIndex* be *srcByteOffset*.
26. Let *targetByteIndex* be *targetOffset* × *targetElementSize* + *targetByteOffset*.
27. Let *limit* be *targetByteIndex* + *targetElementSize* × `min(srcLength, targetLength - targetOffset)`.
28. Repeat, while *targetByteIndex* < *limit*
 - a. Let *value* be `GetValueFromBuffer(srcBuffer, srcByteIndex, srcType).`
 - b. Let *status* be `SetValueInBuffer(targetBuffer, targetByteIndex, targetType, value).`
 - c. Set *srcByteIndex* to *srcByteIndex* + *srcElementSize*.
 - d. Set *targetByteIndex* to *targetByteIndex* + *targetElementSize*.
29. Return `undefined`.

22.2.3.23 %TypedArray%.prototype.slice (start, end)

The interpretation and use of the arguments of `%TypedArray%.prototype.slice` are the same as for `Array.prototype.slice` as defined in 22.1.3.22. The following steps are taken:

1. Let *O* be the `this` value.
2. Let *valid* be `ValidateTypedArray(O).`
3. ReturnIfAbrupt(valid).
4. Let *len* be the value of *O*'s `[[ArrayLength]]` internal slot.
5. Let *relativeStart* be `ToInteger(start)`.
6. ReturnIfAbrupt(relativeStart).

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Deleted: <#>Let *targetBuffer* be the value of *target*'s `[[ViewedArrayBuffer]]` internal slot.
 <#>If *targetBuffer* is `undefined`, then throw a `TypeError` exception.
 <#>Let *srcBuffer* be the value of *typedArray*'s `[[ViewedArrayBuffer]]` internal slot.
 <#>If *srcBuffer* is `undefined`, then throw a `TypeError` exception.
 <#>Let *targetLength* be the value of *target*'s `[[ArrayLength]]` internal slot.
 <#>Let *targetName* be the string value of *target*'s `[[TypedArrayName]]` internal slot.

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Deleted: Table 45Table 45Table 44

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Deleted: <#>If `IsDetachedNeuteredBuffer(targetBuffer)` is `true`, then throw, throw a `TypeError` exception.

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Deleted: <#>If `Type(O)` is not `Object`, throw a `TypeError` exception.
 <#>If *O* does not have a `[[TypedArrayName]]` internal slot, then throw a `TypeError` exception.
 <#>Let *buffer* be the value of *O*'s `[[ViewedArrayBuffer]]` internal slot.
 <#>If *buffer* is `undefined`, then throw a `TypeError` exception.
 <#>If `IsDetachedNeuteredBuffer(buffer)` is `true`, throw a `TypeError` exception.
 <#>NOTE Side-effects of subsequent operations may still neuter detach *buffer*, but that will be detected by any accesses that are made to the content of *buffer*.

7. If *relativeStart* ≤ 0 , let *k* be $\max((\text{len} + \text{relativeStart}), 0)$; else let *k* be $\min(\text{relativeStart}, \text{len})$.
8. If *end* is **undefined**, let *relativeEnd* be *len*; else let *relativeEnd* be *ToInteger(end)*.
9. *ReturnIfAbrupt(relativeEnd)*.
10. If *relativeEnd* ≤ 0 , let *final* be $\max((\text{len} + \text{relativeEnd}), 0)$; else let *final* be $\min(\text{relativeEnd}, \text{len})$.
11. Let *count* be $\max(\text{final} - \text{k}, 0)$.
- 12. Let *defaultConstructor* be the intrinsic object listed in column one of Table 46 for the value of *O*'s **[[TypedArrayName]]** internal slot.**
13. Let *C* be *SpeciesConstructor(O, defaultConstructor)*.
14. *ReturnIfAbrupt(C)*.
- 15. Let *A* *AllocateTypedArray(C, count)*.**
16. *ReturnIfAbrupt(A)*.
17. Let *n* be 0.
18. Repeat, while *k* $< \text{final}$
 - a. Let *Pk* be *ToString(k)*.
 - b. Let *kValue* be *Get(O, Pk)*.
 - c. *ReturnIfAbrupt(kValue)*.
 - d. Let *status* be *Put(A, ToString(n), kValue, true)*.
 - e. *ReturnIfAbrupt(status)*.
 - f. Increase *k* by 1.
 - g. Increase *n* by 1.
19. *Return A*.

This function is not generic. **The *this* value must be an object with a **[[TypedArrayName]]** internal slot**.

The **length** property of the **slice** method is 2.

22.2.3.24 %TypedArray%.prototype.some (callbackfn [, thisArg])

%TypedArray%.prototype.some is a distinct function that implements the same algorithm as **Array.prototype.some** as defined in 22.1.3.23 except that the **this** object's **[[ArrayLength]]** internal slot is accessed in place of performing a **[[Get]]** of "length". The implementation of the algorithm may be optimized with the knowledge that the **this** value is an object that has a fixed length and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm **and must take into account the possibility that calls to *callbackfn* may cause the *this* value to become detached**.

This function is not generic. **ValidateTypedArray is applied to the *this* value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.**

The **length** property of the **some** method is 1.

22.2.3.25 %TypedArray%.prototype.sort (comparefn)

%TypedArray%.prototype.sort is a distinct function that, except as described below, implements the same requirements as those of **Array.prototype.sort** as defined in 22.1.3.24. The implementation of the %TypedArray%.prototype.sort specification may be optimized with the knowledge that the **this** value is an object that has a fixed length and whose integer indexed properties are not sparse. The only internal methods of the **this** object that the algorithm may call are **[[Get]]** and **[[Set]]**.

This function is not generic. **The *this* value must be an object with a **[[TypedArrayName]]** internal slot**.

Deleted: is negative

Deleted: is negative

Deleted: Get

Deleted: "constructor"

Deleted: <#>If IsConstructor(*C*) is **true**, then
[[Construct]] internal method of *C* with argument
«*count*»

Deleted:)

Deleted: <#>Else, ¶
<#>Throw a **TypeError** exception. ¶

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immediately thrown when this function is called

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Deleted: If the **this** value is not an object with
a **[[TypedArrayName]]** internal slot, a **TypeError**
exception is immediately thrown when this
function is called. A **TypeError** exception is also
immediately thrown if the **this** value's **is
detached** or if its **[[ViewedArrayBuffer]]** is
undefined or has been neutered.

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immediately thrown when it is called

Upon entry, the following steps are performed to initialize evaluation of the `sort` function. These steps are used instead of the entry steps in 22.1.3.24:

1. Let `obj` be the `this` value as the argument.
2. Let `buffer` be `ValidateTypedArray(obj)`.
3. `ReturnIfAbrupt(buffer)`.
4. Let `len` be the value of `obj`'s `[[ArrayLength]]` internal slot.

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The following version of `SortCompare` is used by `%TypedArray%.prototype.sort`. It performs a numeric comparison rather than the string `comparison` used in 22.1.3.24.

The Typed Array `SortCompare` abstract operation is called with two arguments `x` and `y`, the following steps are taken:

1. Assert: Both `Type(x)` and `Type(y)` is `Number`.
2. If the argument `comparefn` is not `undefined`, then
 - a. Let `v` be `Call(comparefn, undefined, [x, y])`.
 - b. `ReturnIfAbrupt(v)`.
 - c. If `IsDetachedBuffer(buffer)` is `true`, throw a `TypeError` exception.
 - d. If `v` is `NaN`, return `+0`.
 - e. `Return v`.
3. If `x` and `y` are both `NaN`, return `+0`.
4. If `x` is `NaN`, return `1`.
5. If `y` is `NaN`, return `-1`.
6. If `x < y`, return `-1`.
7. If `x > y`, return `1`.
8. Return `+0`.

Deleted: <#>If `obj` does not have a `[[TypedArrayName]]` internal slot, then throw a `TypeError` exception.
 <#>Let `buffer` be the value of `obj`'s `[[ViewedArrayBuffer]]` internal slot.
 <#>If `buffer` is `undefined`, then throw a `TypeError` exception.
 <#>If `IsNeuteredDetachedBuffer(buffer)` is `true`, then throw a `TypeError` exception.

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Deleted: k

Deleted: <#>Let `jString` be `ToString(j)`.
 <#>Let `kString` be `ToString(k)`.
 <#>Let `x` be `Get(obj, jString)`.
 <#>ReturnIfAbrupt(`x`).
 <#>Let `y` be the result of `Get(obj, kString)`.
 <#>ReturnIfAbrupt(`y`).
 <#>Return `+0`.

Deleted: <#>If `x` and `y` are both `NaN`, return `+0`.
 <#>If `x` is `NaN`, return `1`.
 <#>If `y` is `NaN`, return `-1`.

Deleted: <#>If `IsCallable(comparefn)` is `false`, throw a `TypeError` exception.

Deleted: Return

Deleted: the result of calling the `[[`

Deleted: `]]` internal method of

Deleted: passing

Deleted: as `thisArgument` and with a `List` containing the values of

Deleted: and

Deleted: as the `argumentsList`

Deleted: , then throw

Deleted: , then return

Deleted: , then throw

Deleted: <#>If `buffer` is `undefined`, then throw a `TypeError` exception.

Deleted: , then let

Deleted: , then let

Deleted: , then let

Deleted: , then let

NOTE 1 Because `NaN` always compares greater than any other value, `NaN` property values always sort to the end of the result when a `comparefn` is not provided.

22.2.3.26 `%TypedArray%.prototype.subarray([begin [, end]])`

Returns a new `TypedArray` object whose element types is the same as this `TypedArray` and whose `ArrayBuffer` is the same as the `ArrayBuffer` of this `TypedArray`, referencing the elements at `begin`, inclusive, up to `end`, exclusive. If either `begin` or `end` is negative, it refers to an index from the end of the array, as opposed to from the beginning.

1. Let `O` be the `this` value.
2. If `Type(O)` is not `Object`, throw a `TypeError` exception.
3. If `O` does not have a `[[TypedArrayName]]` internal slot, throw a `TypeError` exception.
4. Assert: `O` has a `[[ViewedArrayBuffer]]` internal slot.
5. Let `buffer` be the value of `O`'s `[[ViewedArrayBuffer]]` internal slot.
6. Let `srcLength` be the value of `O`'s `[[ArrayLength]]` internal slot.
7. Let `beginInt` be `ToInteger(begin)`.
8. `ReturnIfAbrupt(beginInt)`.
9. If `beginInt < 0`, let `beginInt` be `srcLength + beginInt`.
10. Let `beginIndex` be `min(srcLength, max(0, beginInt))`.
11. If `end` is `undefined`, let `end` be `srcLength`.
12. Let `endInt` be `ToInteger(end)`.
13. `ReturnIfAbrupt(endInt)`.
14. If `endInt < 0`, let `endInt` be `srcLength + endInt`.
15. Let `endIndex` be `max(0, min(srcLength, endInt))`.
16. If `endIndex < beginIndex`, let `endIndex` be `beginIndex`.

17. Let *newLength* be *endIndex* - *beginIndex*.
18. Let *constructorName* be the string value of *O*'s [[TypedArrayName]] internal slot.
19. Let *elementSize* be the Number value of the Element Size value specified in [Table 46](#) for *constructorName*.
20. Let *srcByteOffset* be the value of *O*'s [[ByteOffset]] internal slot.
21. Let *beginByteOffset* be *srcByteOffset* + *beginIndex* × *elementSize*.
22. Let *defaultConstructor* be the intrinsic object listed in column one of Table 46 for *constructorName*.
23. Let *constructor* be *SpeciesConstructor(O, defaultConstructor)*.
24. ReturnIfAbrupt(*constructor*).
25. Let *argumentsList* be ⟨*buffer*, *beginByteOffset*, *newLength*⟩.
26. Return *Construct(constructor, argumentsList)*.

This function is not generic. The **this** value must be an object with a [[TypedArrayName]] internal slot.

The **length** property of the **subarray** method is **2**.

22.2.3.27 %TypedArray%.prototype.toLocaleString ([reserved1 [, reserved2]])

%TypedArray%.prototype.toLocaleString is a distinct function that implements the same algorithm as Array.prototype.toLocaleString as defined in 22.1.3.26 except that the **this** object's [[ArrayLength]] internal slot is accessed in place of performing a [[Get]] of "length". The implementation of the algorithm may be optimized with the knowledge that the **this** value is an object that has a fixed length and whose integer indexed properties are not sparse. However, such optimization must not introduce any observable changes in the specified behaviour of the algorithm.

This function is not generic. ValidateTypedArray is applied to the **this** value prior to evaluating the algorithm. If its result is an abrupt completion that exception is thrown instead of evaluating the algorithm.

22.2.3.28 %TypedArray%.prototype.toString ()

The initial value of the %TypedArray%.prototype.toString data property is the same built-in function object as the Array.prototype.toString method defined in 22.1.3.27.

22.2.3.29 %TypedArray%.prototype.values ()

The following steps are taken:

1. Let *O* be the **this** value.
2. Let *valid* be ValidateTypedArray(*O*).
3. ReturnIfAbrupt(*valid*).
4. Return CreateArrayIterator(*O*, "value").

22.2.3.30 %TypedArray%.prototype [@@iterator] ()

The initial value of the @@iterator property is the same function object as the initial value of the %TypedArray%.prototype.values property.

22.2.3.31 get %TypedArray%.prototype [@@toStringTag]

%TypedArray%.prototype[@@toStringTag] is an accessor property whose set accessor function is **undefined**. Its get accessor function performs the following steps:

- Deleted:** <#>Let *elementType* be the string value of the Element Type value in Table 46Table 45Table 45Table 44 for *constructorName*.¶
- Deleted:** Table 45Table 45Table 44
- Deleted:** Get
- Deleted:** "constructor"
- Deleted:** <#>If IsConstructor(*constructor*) is false, then throw a **TypeError** exception.¶
- Deleted:** a List consisting of
- Deleted:** and
- Deleted:** the result of calling the [[
- Deleted:**]] internal method of
- Deleted:** with argument
- Deleted:** as the argument
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- Deleted:** The initial value of the %TypedArray%.prototype.toLocaleString data property is the same built-in function object as the Array.prototype.toLocaleString method defined in 22.1.3.26.¶
- Deleted:** If the **this** value is not an object with a [[TypedArrayName]] internal slot, a **TypeError** exception is immediately thrown when this function is called. A **TypeError** exception is also immediately thrown if the **this** value is detached or if its [[ViewedArrayBuffer]] is **undefined**.

- Deleted:** <#>Let *O* be the result of calling ToObject with the **this** value as its argument.¶
- <#>ReturnIfAbrupt(*O*).¶
- Deleted:** <#>If Type(*O*) is not Object, throw a **TypeError** exception.¶
- <#>If *O* does not have a [[ViewedArrayBuffer]] internal slot throw a **TypeError** exception.¶
- <#>Let *buffer* be the value of *O*'s [[ViewedArrayBuffer]] internal slot.¶
- <#>If *buffer* is **undefined**, then throw a **TypeError** exception.¶
- <#>If IsNeuteredDetachedBuffer(*buffer*) is true, throw a **TypeError** exception.¶

- Deleted:** The initial value of the %TypedArray%.prototype.values data property is the same built-in function object as the **Array.prototype.values** method defined in 22.1.3.29.¶

1. Let O be the **this** value.
2. If $\text{Type}(O)$ is not Object, return **undefined**.
3. If O does not have a **[[TypedArrayName]]** internal slot, return **undefined**.
4. Let name be the value of O 's **[[TypedArrayName]]** internal slot.
5. Assert: name is a String value.
6. Return name .

This property has the attributes { **[[Enumerable]]**: **false**, **[[Configurable]]**: **true** }.

The initial value of the **name** property of this function is "**get [Symbol.toStringTag]**".

22.2.4 The **TypedArray** Constructors

Each of these **TypedArray** constructor objects **is an intrinsic object that** has the structure described below, differing only in the name used as the constructor name instead of **TypedArray**, in [Table 46](#).

The TypedArray constructors are not intended to be called as a function and will throw an exception when called in that manner.

The **TypedArray** constructors are designed to be subclassable. They may be used as the value of an **extends** clause of a class **definition**. Subclass constructors that intend to inherit the specified **TypedArray** behaviour must include a **super** call to the **TypedArray** constructor to **create and initialize the subclass instance with the internal state necessary to support the %TypedArray%.prototype built-in methods**.

22.2.4.1 **TypedArray(... argumentsList)**

A **TypedArray** constructor with a list of arguments **argumentsList** performs the following steps:

1. If **NewTarget** is **undefined**, throw a **TypeError** exception.
2. Let **here** be the active function.
3. Let **super** be the result of calling the **[[GetPrototypeOf]]** internal method of **here** with no arguments.
4. **ReturnIfAbrupt(super)**.
5. If **IsConstructor(constructor)** is **false**, throw a **TypeError** exception.
6. Let **argumentsList** be the **argumentsList** argument of the **[[Construct]]** internal **method that invoked the active function**.
7. **Return Construct(super, argumentsList, NewTarget)**.

22.2.5 Properties of the **TypedArray** Constructors

The value of the **[[Prototype]]** internal slot of each **TypedArray** constructor is the **%TypedArray%** intrinsic object (22.2.1).

Each TypedArray constructor has a **[[TypedArrayConstructorName]] internal slot property whose value is the String value of the constructor name specified for it in Table 46.**

Each TypedArray constructor has a **name property whose value is the String value of the constructor name specified for it in Table 46.**

Besides a **length** property (whose value is 3), each **TypedArray** constructor has the following properties:

- Deleted:** .
- Deleted:** throw a
- Deleted:** **TypeError**
- Deleted:** exception
- Deleted:** throw a **TypeError** exception
- Deleted:** <#>If **name** the value of O 's **[[TypedArrayName]]** internal slot is **undefined**, return **undefined**throw a **TypeError** exception.
- Deleted:** Table 45Table 45Table 44
- Deleted:** When a
- Deleted:** is
- Deleted:** called as a function rather than as a constructor, it initializes a new **TypedArray** object. The **this** value passed in the call must be an Object with a **[[TypedArrayName]]** internal slot and a **[[ViewedArrayBuffer]]** internal slot whose value is **undefined**. The constructor function initializes the **this** value using the argument values. . ¶
- Deleted:** declaration
- Deleted:** ed
- Deleted:** to
- Deleted:** initialize subclass instances.
- Deleted:**
- Deleted:** null
- Deleted:** <#>Let O be the **this** value. ¶ <#>If $\text{Type}(O)$ is not Object, then throw a **TypeError** exception. ¶
- Deleted:** realmF
- Deleted:** GetFunctionRealm(F)
- Deleted:** F 's **[[Realm]]** internal slot
- Deleted:**
- Deleted:** realmF's
- Deleted:** realmF.**[[intrinsic]]**.**[%TypedArr...**
- Deleted:** intrinsic object
- Deleted:** Call
- Deleted:**
- Deleted:** <#>method that invoked F . ¶
- Deleted:** the result of calling the **[[Call]]** internal method of ($super$, wi...
- Deleted:** <#>**new TypedArray(...**
- Deleted:** The **[[CreateAction]]** of each
- Deleted:** r
- Deleted:** Table 45Table 45Table 44

22.2.5.1 *TypedArray.BYTES_PER_ELEMENT*

The value of *TypedArray.BYTES_PER_ELEMENT* is the Number value of the Element Size value specified in [Table 46](#) for *TypedArray*.

Deleted: Table 45Table 45Table 44

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

22.2.5.2 *TypedArray.prototype*

The initial value of *TypedArray.prototype* is the corresponding *TypedArray* prototype object (22.2.6).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

22.2.6 Properties of *TypedArray* Prototype Objects

The value of the `[[Prototype]]` internal slot of a *TypedArray* prototype object is the [intrinsic object %TypedArrayPrototype%](#) (22.2.3). A *TypedArray* prototype object is an ordinary object. It does not have a `[[ViewedArrayBuffer]]` or any other of the internal slots that are specific to *TypedArray* instance objects.

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Deleted: object

22.2.6.1 *TypedArray.prototype.BYTES_PER_ELEMENT*

The value of *TypedArray.prototype.BYTES_PER_ELEMENT* is the Number value of the Element Size value specified in [Table 46](#) for *TypedArray*.

Deleted: Table 45Table 45Table 44

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

22.2.6.2 *TypedArray.prototype.constructor*

The initial value of a *TypedArray.prototype.constructor* is the corresponding [%TypedArray% intrinsic object](#).

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Deleted: constructor

22.2.7 Properties of *TypedArray* Instances

TypedArray instances are Integer Indexed exotic objects. Each *TypedArray* instances inherits properties from the corresponding *TypedArray* prototype object. Each *TypedArray* instances have the following internal slots: `[[TypedArrayName]], [[ViewedArrayBuffer]], [[ByteLength]], [[ByteOffset]], and [[ArrayLength]]`.

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23 Keyed Collection

23.1 Map Objects

Map objects are collections of key/value pairs where both the keys and values may be arbitrary ECMAScript language values. A distinct key value may only occur in one key/value pair within the Map's collection. Distinct key values are discriminated using the [SameValueZero](#) comparison algorithm.

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23.1.1 The Map Constructor

The `Map` constructor is the `%Map%` intrinsic object and the initial value of the `Map` property of the global object. When called as a constructor it creates and initializes a new `Map` object. `Map` is not intended to be called as a function and will throw an exception when called in that manner.

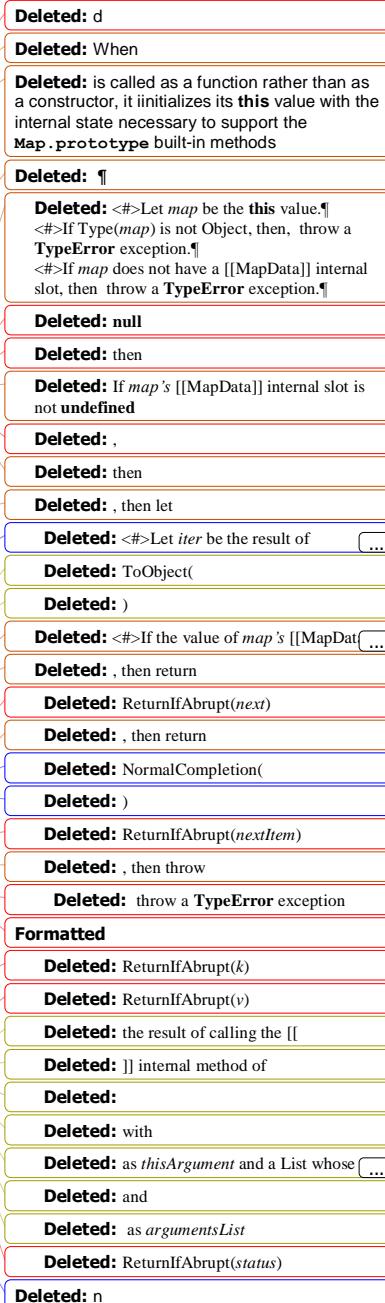
The `Map` constructor is designed to be subclassable. It may be used as the value in an `extends` clause of a class definition. Subclass constructors that intend to inherit the specified `Map` behaviour must include a `super` call to [the `Map` constructor to create and initialize the subclass instance with the internal state necessary to support the `Map.prototype` built-in methods](#).

23.1.1.1 `Map([iterable])`

When the `Map` function is called with optional argument the following steps are taken:

1. If `NewTarget` is `undefined`, throw a `TypeError` exception.
2. Let `map` be `OrdinaryCreateFromConstructor(NewTarget, "%MapPrototype%", «[[MapData]]»).`
3. `ReturnIfAbrupt(map).`
4. Set `map`'s `[[MapData]]` internal slot to a new empty List.
5. If `iterable` is not present, let `iterable` be `undefined`.
6. If `iterable` is either `undefined` or `null`, let `iter` be `undefined`.
7. Else,
 - a. Let `adder` be the result of `Get(map, "set")`.
 - b. `ReturnIfAbrupt(adder)`.
 - c. If `IsCallable(adder)` is `false`, throw a `TypeError` Exception.
 - d. Let `iter` be the result of `GetIterator(iterable)`.
 - e. `ReturnIfAbrupt(iter)`.
8. If `iter` is `undefined`, return `map`.
9. Repeat
 - a. Let `next` be the result of `IteratorStep(iter)`.
 - b. If `next` is an abrupt completion, return `IteratorClose(iter, next)`.
 - c. If `next.[[value]]` is `false`, return `map`.
 - d. Let `nextItem` be `IteratorValue(next.[[value]])`.
 - e. If `nextItem` is an abrupt completion, return `IteratorClose(iter, nextItem)`.
 - f. If `Type(nextItem.[[value]])` is not `Object`,
 - i. Let `error` be `Completion{[[type]]: throw, [[value]]: a newly created TypeError object, [[target]]:empty}.`
 - ii. `Return IteratorClose(iter, error)`.
 - g. Let `k` be the result of `Get(nextItem.[[value]], "0")`.
 - h. If `k` is an abrupt completion, return `IteratorClose(iter, k)`.
 - i. Let `v` be the result of `Get(nextItem.[[value]], "1")`.
 - j. If `v` is an abrupt completion, return `IteratorClose(iter, v)`.
 - k. Let `status` be `Call(adder, map, «k.[[value]], v.[[value]]»)`.
 - l. If `status` is an abrupt completion, return `IteratorClose(iter, status)`.

NOTE If the parameter `iterable` is present, it is expected to be an object that implements an `@@iterator` method that returns an iterator object that produces a two element array-like object whose first element is a value that will be used as a `Map` key and whose second element is the value to associate with that key.



23.1.2 Properties of the Map Constructor

The value of the `[[Prototype]]` internal slot of the `Map` constructor is the [intrinsic object `%FunctionPrototype%`](#) (19.2.3).

Besides the `length` property (whose value is `1`), the `Map` constructor has the following properties:

23.1.2.1 `Map.prototype`

The initial value of `Map.prototype` is the `Map` prototype object (23.1.3).

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

23.1.2.2 `get Map[@@species]`,

`Map[@@species]` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Return `this`.

The value of the `name` property of this function is "`get [Symbol.species]`".

NOTE `Map` prototype methods normally use their `this` object's constructor to create a derived object. However, a subclass constructor may over-ride that default behaviour by redefining its `@@species` property.

23.1.3 Properties of the `Map` Prototype Object

The value of the `[[Prototype]]` internal slot of the `Map` prototype object is the [intrinsic object `%ObjectPrototype%`](#) (19.1.3). The `Map` prototype object is an ordinary object. It does not have a `[[MapData]]` internal slot.

23.1.3.1 `Map.prototype.clear()`

The following steps are taken:

1. Let `M` be the `this` value.
2. If `Type(M)` is not `Object`, throw a `TypeError` exception.
3. If `M` does not have a `[[MapData]]` internal slot throw a `TypeError` exception.
4. Let `entries` be the List that is the value of `M`'s `[[MapData]]` internal slot.
5. Repeat for each Record {`[[key]], [[value]]`} `p` that is an element of `entries`,
 - a. Set `p.[[key]]` to empty.
 - b. Set `p.[[value]]` to empty.
6. Return `undefined`.

NOTE The existing `[[MapData]]` List is preserved because there may be existing MapIterator objects that are suspended midway through iterating over that List.

23.1.3.2 `Map.prototype.constructor`

The initial value of `Map.prototype.constructor` is the [intrinsic object `%Map%`](#).

Deleted: `<#>new Map (... argumentsList)`
 When `Map` is called as part of a `new` expression it is a constructor: it initializes a newly created object. ¶

`Map` called as part of a new expression with argument list `argumentsList` performs the following steps: ¶

`<#>Let F be the Map function object on which the new operator was applied.¶`
`<#>Let argumentsList be the argumentsList argument of the [[Construct]] internal method that was invoked by the new operator.¶`
`<#>Return the result of Construct(F, argumentsList).¶`

If `Map` is implemented as an ECMAScript function object, its `[[Construct]]` internal method will perform the above steps. ¶

Deleted: Function prototype object

Deleted: The `[[CreateAction]]` of the `Map` constructor identifies the following abstract operation: ¶

The `Map` `CreateAction` abstract operation when called with arguments `constructor` and `argumentsList` of performs the following steps: ¶

`<#>Return OrdinaryCreateFromConstructor(constructor, "%MapPrototype%", «[[MapData]]»).¶`

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Deleted: instance

Deleted: the instance

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Deleted: `<#>Map[@@create]()`
 The `@@create` method of a `Map` function object

`F` performs the following steps: ¶

`<#>Let F be the this value.¶`
`<#>Let obj be the result of calling OrdinaryCreateFromConstructor(F, "%MapPrototype%", «[[MapData]]»).¶`
`<#>Return obj.¶`

The value of the `name` property of this function is "`[Symbol.create]`". ¶

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: true` }. ¶

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Deleted: `<#>If M's [[MapData]] internal slot is undefined, then throw a TypeError exception.¶`

Deleted: built-in `Map` constructor

23.1.3.3 Map.prototype.delete (key)

The following steps are taken:

1. Let M be the **this** value.
2. If $\text{Type}(M)$ is not **Object**, throw a **TypeError** exception.
3. If M does not have a $[[\text{MapData}]]$ internal slot throw a **TypeError** exception.
4. Let entries be the List that is the value of M 's $[[\text{MapData}]]$ internal slot.
5. Repeat for each Record $\{[[\text{key}]], [[\text{value}]]\}$ p that is an element of entries ,
 - a. If $p.[[\text{key}]]$ is not **empty** and $\text{SameValueZero}(p.[[\text{key}]], \text{key})$ is **true**, then
 - i. Set $p.[[\text{key}]]$ to **empty**.
 - ii. Set $p.[[\text{value}]]$ to **empty**.
 - iii. Return **true**.
6. Return **false**.

NOTE The value **empty** is used as a specification device to indicate that an entry has been deleted. Actual implementations may take other actions such as physically removing the entry from internal data structures.

23.1.3.4 Map.prototype.entries ()

The following steps are taken:

1. Let M be the **this** value.
2. Return $\text{CreateMapIterator}(M, "key+value")$.

23.1.3.5 Map.prototype.forEach (callbackfn [, thisArg])

NOTE callbackfn should be a function that accepts three arguments. forEach calls callbackfn once for each key/value pair present in the map object, in key insertion order. callbackfn is called only for keys of the map which actually exist; it is not called for keys that have been deleted from the map.

If a thisArg parameter is provided, it will be used as the **this** value for each invocation of callbackfn . If it is not provided, **undefined** is used instead.

callbackfn is called with three arguments: the value of the item, the key of the item, and the Map object being traversed.

forEach does not directly mutate the object on which it is called but the object may be mutated by the calls to callbackfn .

When the **forEach** method is called with one or two arguments, the following steps are taken:

1. Let M be the **this** value.
2. If $\text{Type}(M)$ is not **Object**, throw a **TypeError** exception.
3. If M does not have a $[[\text{MapData}]]$ internal slot throw a **TypeError** exception.
4. If $\text{IsCallable}(\text{callbackfn})$ is **false**, throw a **TypeError** exception.
5. If thisArg was supplied, let T be thisArg ; else let T be **undefined**.
6. Let entries be the List that is the value of M 's $[[\text{MapData}]]$ internal slot.
7. Repeat for each Record $\{[[\text{key}]], [[\text{value}]]\}$ e that is an element of entries , in original key insertion order
 - a. If $e.[[\text{key}]]$ is not **empty**, then
 - i. Let funcResult be $\text{Call}(\text{callbackfn}, T, \{[[\text{value}]], e.[[\text{key}]], M\})$.
 - ii. $\text{ReturnIfAbrupt}(\text{funcResult})$.
8. Return **undefined**.

Deleted: , then throw

Deleted: <#>If M 's $[[\text{MapData}]]$ internal slot is **undefined**, then throw a **TypeError** exception.

Deleted: the result of calling the

Deleted: abstract operation with arguments

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Deleted: , then throw

Deleted: <#>If M 's $[[\text{MapData}]]$ internal slot is **undefined**, then throw a **TypeError** exception.

Deleted: the result of calling the $[[$

Deleted: $]]$ internal method of

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Deleted: as thisArgument and a List containing

Deleted: and

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The `length` property of the `forEach` method is 1.

23.1.3.6 Map.prototype.get (key)

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, **throw** a `TypeError` exception.
3. If M does not have a `[[MapData]]` internal slot throw a `TypeError` exception.
4. Let entries be the List that is the value of M 's `[[MapData]]` internal slot.
5. Repeat for each Record $\{[[\text{key}]], [[\text{value}]]\}$ p that is an element of entries ,
 - a. If $p.[[\text{key}]]$ is not empty and $\text{SameValueZero}(p.[[\text{key}]], \text{key})$ is `true`, **return** $p.[[\text{value}]]$.
6. Return `undefined`.

Deleted: , then throw

Deleted: <#>If M 's `[[MapData]]` internal slot is undefined, then throw a `TypeError` exception.

Deleted: , then return

23.1.3.7 Map.prototype.has (key)

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, **throw** a `TypeError` exception.
3. If M does not have a `[[MapData]]` internal slot throw a `TypeError` exception.
4. Let entries be the List that is the value of M 's `[[MapData]]` internal slot.
5. Repeat for each Record $\{[[\text{key}]], [[\text{value}]]\}$ p that is an element of entries ,
 - a. If $p.[[\text{key}]]$ is not empty and $\text{SameValueZero}(p.[[\text{key}]], \text{key})$ is `true`, **return** `true`.
6. Return `false`.

Deleted: , then throw

Deleted: <#>If M 's `[[MapData]]` internal slot is undefined, then throw a `TypeError` exception.

Deleted: , then return

23.1.3.8 Map.prototype.keys ()

The following steps are taken:

1. Let M be the `this` value.
2. Return `CreateMapIterator`(M , "key").

Deleted: the result of calling the

Deleted: abstract operation with arguments

Deleted: and

23.1.3.9 Map.prototype.set (key , value)

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, **throw** a `TypeError` exception.
3. If M does not have a `[[MapData]]` internal slot throw a `TypeError` exception.
4. Let entries be the List that is the value of M 's `[[MapData]]` internal slot.
5. Repeat for each Record $\{[[\text{key}]], [[\text{value}]]\}$ p that is an element of entries ,
 - a. If $p.[[\text{key}]]$ is not empty and $\text{SameValueZero}(p.[[\text{key}]], \text{key})$ is `true`, then
 - i. Set $p.[[\text{value}]]$ to value .
 - ii. Return M .
6. If key is -0 , **let** key be $+0$.
7. Let p be the Record $\{[[\text{key}]]: \text{key}, [[\text{value}]]: \text{value}\}$.
8. Append p as the last element of entries .
9. Return M .

Deleted: , then throw

Deleted: <#>If M 's `[[MapData]]` internal slot is undefined, then throw a `TypeError` exception.

Deleted: , then let

23.1.3.10 get Map.prototype.size

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`Map.prototype.size` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Let M be the **this** value.
2. If $\text{Type}(M)$ is not **Object**, **throw** a **TypeError** exception.
3. If M does not have a **[[MapData]]** internal slot throw a **TypeError** exception.
4. Let entries be the List that is the value of M 's **[[MapData]]** internal slot.
5. Let count be 0.
6. For each Record $\{[[\text{key}]], [[\text{value}]]\}$ p that is an element of entries
 - a. If $p.[[\text{key}]]$ is not empty, **set** count to $\text{count}+1$.
7. Return count .

Deleted: , then throw

Deleted: <#>If M 's **[[MapData]]** internal slot is **undefined**, then throw a **TypeError** exception.¶

Deleted: then¶
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23.1.3.11 Map.prototype.values ()

The following steps are taken:

1. Let M be the **this** value.
2. Return **CreateMapIterator abstract**(M , "value").

Deleted: the result of calling the

Deleted: operation with arguments

Deleted: and

23.1.3.12 Map.prototype [@@iterator]()

The initial value of the **@@iterator** property is the same function object as the initial value of the **entries** property.

23.1.3.13 Map.prototype [@@toStringTag]

The initial value of the **@@toStringTag** property is the string value "**Map**".

This property has the attributes $\{ [[\text{Writable}]]: \text{false}, [[\text{Enumerable}]]: \text{false}, [[\text{Configurable}]]: \text{true} \}$.

23.1.4 Properties of Map Instances

Map instances are ordinary objects that inherit properties from the Map prototype. Map instances also have a **[[MapData]]** internal slot.

23.1.5 Map Iterator Objects

A Map Iterator is an object, that represents a specific iteration over some specific Map instance object. There is not a named constructor for Map Iterator objects. Instead, map iterator objects are created by calling certain methods of Map instance objects.

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23.1.5.1 CreateMapIterator Abstract Operation

Several methods of Map objects return Iterator objects. The abstract operation **CreateMapIterator** with arguments map and $kind$ is used to create such iterator objects. It performs the following steps:

1. If $\text{Type}(map)$ is not **Object**, **throw** a **TypeError** exception.
2. If map does not have a **[[MapData]]** internal slot throw a **TypeError** exception.
3. Let iterator be the result of **ObjectCreate(%MapIteratorPrototype%, $\{[[\text{Map}]], [[\text{MapNextIndex}]], [[\text{MapIterationKind}]]\}$)**.
4. Set iterator 's **[[Map]]** internal slot to map .
5. Set iterator 's **[[MapNextIndex]]** internal slot to 0.
6. Set iterator 's **[[MapIterationKind]]** internal slot to $kind$.
7. Return iterator .

Deleted: <#>If the value of map 's **[[MapData]]** internal slot is **undefined**, then throw a **TypeError** exception.¶

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23.1.5.2 The %MapIteratorPrototype% Object

All Map Iterator Objects inherit properties from the %MapIteratorPrototype% intrinsic object. The %MapIteratorPrototype% intrinsic object is an ordinary object and its [[Prototype]] internal slot is the %IteratorPrototype% intrinsic object (25.1.2). In addition, %MapIteratorPrototype% has the following properties:

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Deleted: ObjectPrototype

23.1.5.2.1 %MapIteratorPrototype%.next()

1. Let O be the **this** value.
2. If $\text{Type}(O)$ is not **Object**, throw a **TypeError** exception.
3. If O does not have all of the internal slots of a Map Iterator Instance (23.1.5.3), throw a **TypeError** exception.
4. Let m be the value of the [[Map]] internal slot of O .
5. Let $index$ be the value of the [[MapNextIndex]] internal slot of O .
6. Let $itemKind$ be the value of the [[MapIterationKind]] internal slot of O .
7. If m is **undefined**, return CreateIterResultObject(**undefined**, **true**)
8. Assert: m has a [[MapData]] internal slot.
9. Let $entries$ be the List that is the value of the [[MapData]] internal slot of m .
10. Repeat while $index$ is less than the total number of elements of $entries$. The number of elements must be redetermined each time this method is evaluated.
 - a. Let e be the Record {{[key]}, {[value]}} that is the value of $entries[index]$.
 - b. Set $index$ to $index+1$;
 - c. Set the [[MapNextIndex]] internal slot of O to $index$.
 - d. If $e.[[key]]$ is not **empty**, then
 - i. If $itemKind$ is "key", let $result$ be $e.[[key]]$.
 - ii. Else if $itemKind$ is "value", let $result$ be $e.[[value]]$.
 - iii. Else,
 1. Assert: $itemKind$ is "key+value".
 2. Let $result$ be the result of performing **ArrayCreate**(2).
 3. Assert: $result$ is a new, well-formed Array object so the following operations will never fail.
 4. Call **CreateDataProperty**($result$, "0", $e.[[key]]$).
 5. Call **CreateDataProperty**($result$, "1", $e.[[value]]$).
 - iv. Return **CreateIterResultObject**($result$, **false**).
11. Set the [[Map]] internal slot of O to **undefined**.
12. Return **CreateIterResultObject**(**undefined**, **true**).

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Deleted: , then return

Deleted: and m has been initialized so the value of [[MapData]] is not **undefined**

Deleted: then,

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23.1.5.2.2 %MapIteratorPrototype% [@@toStringTag]

The initial value of the @@toStringTag property is the string value "**Map Iterator**".

Deleted: <#> %MapIteratorPrototype% [@@iterator] ()¶

The following steps are taken:¶

<#>Return the **this** value.¶

The value of the **name** property of this function is "[Symbol.iterator]"..¶

23.1.5.3 Properties of Map Iterator Instances

Map Iterator instances are ordinary objects that inherit properties from the %MapIteratorPrototype% intrinsic object. Map Iterator instances are initially created with the internal slots described in Table 47.

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Table 47 — Internal Slots of Map Iterator Instances

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Internal Slot	Description
---------------	-------------

[[Map]]	The Map object that is being iterated.
[[MapNextIndex]]	The integer index of the next Map data element to be examined by this iterator.
[[MapIterationKind]]	A string value that identifies what is to be returned for each element of the iteration. The possible values are: "key", "value", "key+value".

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23.2 Set Objects

Set objects are collections of ECMAScript language values. A distinct value may only occur once as an element of a Set's collection. Distinct values are discriminated using the SameValueZero comparison algorithm.

Set objects must be implemented using either hash tables or other mechanisms that, on average, provide access times that are sublinear on the number of elements in the collection. The data structures used in this Set objects specification is only intended to describe the required observable semantics of Set objects. It is not intended to be a viable implementation model.

23.2.1 The Set Constructor

The Set constructor is the %Set% intrinsic object and the initial value of the **set** property of the global object. When called as a constructor it creates and initializes a new Set object. **set** is not intended to be called as a function and will throw an exception when called in that manner.

The **Set** constructor is designed to be subclassable. It may be used as the value in an **extends** clause of a class definition. Subclass constructors that intend to inherit the specified **Set** behaviour must include a **super** call to the Set constructor to create and initialize the subclass instance with the internal state necessary to support the Set.prototype built-in methods.

23.2.1.1 Set ([iterable])

When the **set** function is called with optional argument *iterable* the following steps are taken:

1. If **NewTarget** is **undefined**, throw a **TypeError** exception.
2. Let **set** be OrdinaryCreateFromConstructor(NewTarget, "%SetPrototype%", «[[SetData]]»).
3. ReturnIfAbrupt(set).
4. Set set's [[SetData]] internal slot to a new empty List.
5. If *iterable* is not present, let *iterable* be **undefined**.
6. If *iterable* is either **undefined** or **null**, let **iter** be **undefined**.
7. Else,
 - a. Let **adder** be the result of Get(set, "add").
 - b. ReturnIfAbrupt(adder).
 - c. If IsCallable(adder) is **false**, throw a **TypeError** Exception.
 - d. Let **iter** be the result of GetIterator(iterable).
 - e. ReturnIfAbrupt(iter).
8. If **iter** is **undefined**, return set.
9. Repeat
 - a. Let **next** be the result of IteratorStep(iter).
 - b. If **next** is an abrupt completion, return IteratorClose(iter, next).
 - c. If **next.[[value]]** is **false**, return set.
 - d. Let **nextValue** be IteratorValue(next.[[value]]).

Deleted: SameValue0

Deleted: i

Deleted: A Set object can iterate its elements in insertion order.

Deleted: .

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Deleted: When **set** is called as a function rather than as a constructor, it initializes its **this** value with the internal state necessary to support the **Set.prototype** built-in methods.

Deleted: .

Deleted: <#>Let **set** be the **this** value.
 <#>If **Type(set)** is not **Object**, then, throw a **TypeError** exception.
 <#>If **set** does not have a **[[SetData]]** internal slot, then throw a **TypeError** exception.

Deleted: null

Deleted: If **set**'s **[[SetData]]** internal slot is not **undefined**

Deleted: then

Deleted: map

Deleted: , then let

Deleted: <#>Let **iter** be the result of GetIterator(iterable).
 <#>ReturnIfAbrupt(iter).

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Deleted: <#>If the value of **sets**'s **[[SetData]]** internal slot is not **undefined**, then throw, throw a **TypeError** exception.

Deleted: <#>Assert: **set** has not been reentrantly initialized.
 <#>Set **set**'s **[[SetData]]** internal slot to a new empty List.

Deleted: , then return

Deleted: ReturnIfAbrupt(next)

Deleted: , then return

- e. If `nextValue` is an abrupt completion, return `IteratorClose(iter, nextValue)`
- f. Let `status` be `Call(adder, set, [nextValue, [value]])`,
- g. If `status` is an abrupt completion, return `IteratorClose(iter, status)`.

NOTE Using a method call for inserting values during initialization enables subclasses to that redefine `add` to still make a super call to the inherited constructor.

23.2.2 Properties of the Set Constructor

The value of the `[[Prototype]]` internal slot of the Set constructor is the intrinsic object `%FunctionPrototype%` (19.2.3).

Besides the `length` property (whose value is 1), the Set constructor has the following properties:

23.2.2.1 Set.prototype

The initial value of `Set.prototype` is the intrinsic `%SetPrototype%` object (23.2.3).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

23.2.2.2 get Set[@@species]

`Set[@@species]` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Return `this`.

The value of the `name` property of this function is "get `[Symbol.species]`".

NOTE Set prototype methods normally use their `this` object's constructor to create a derived object. However, a subclass constructor may over-ride that default behaviour by redefining its `@@species` property.

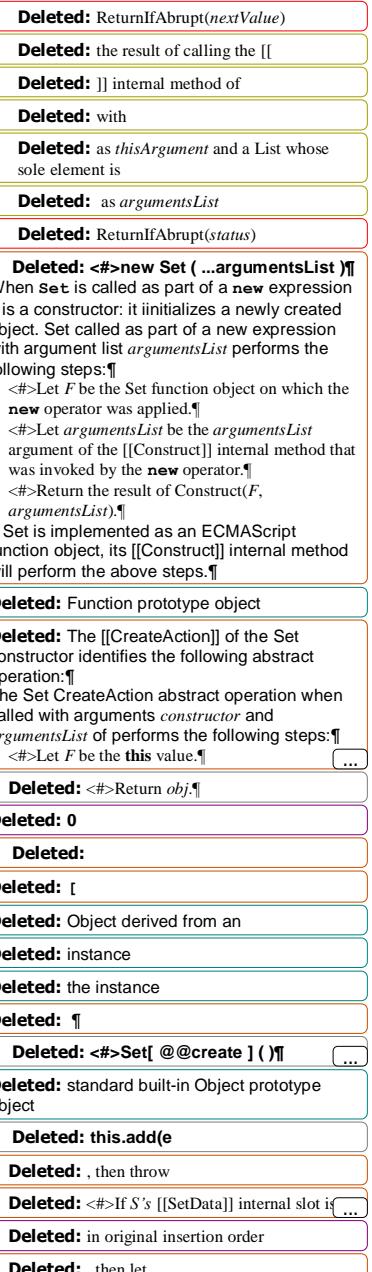
23.2.3 Properties of the Set Prototype Object

The value of the `[[Prototype]]` internal slot of the Set prototype object is the intrinsic object `%ObjectPrototype%` (19.1.3). The Set prototype object is an ordinary object. It does not have a `[[SetData]]` internal slot.

23.2.3.1 Set.prototype.add (value)

The following steps are taken:

1. Let `S` be the `this` value.
2. If `Type(S)` is not `Object`, throw a `TypeError` exception.
3. If `S` does not have a `[[SetData]]` internal slot throw a `TypeError` exception.
4. Let `entries` be the List that is the value of `S`'s `[[SetData]]` internal slot.
5. Repeat for each `e` that is an element of `entries`,
 - a. If `e` is not `empty` and `SameValueZero(e, value)` is `true`, then
 - i. Return `S`.
6. If `value` is `-0`, let `value` be `+0`.
7. Append `value` as the last element of `entries`.
8. Return `S`.



23.2.3.2 Set.prototype.clear ()

The following steps are taken:

1. Let S be the **this** value.
2. If $\text{Type}(S)$ is not **Object**, throw a **TypeError** exception.
3. If S does not have a **[[SetData]]** internal slot throw a **TypeError** exception.
4. Let entries be the List that is the value of S 's **[[SetData]]** internal slot.
5. Repeat for each e that is an element of entries ,
 - a. Replace the element of entries whose value is e with an element whose value is **empty**.
6. Return **undefined**.

Deleted: , then throw

Deleted: <#>If S 's **[[SetData]]** internal slot is **undefined**, then throw a **TypeError** exception.¶

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23.2.3.3 Set.prototype.constructor

The initial value of **Set.prototype.constructor** is the [intrinsic object %Set%](#).

Deleted: built-in **Set** constructor

23.2.3.4 Set.prototype.delete (value)

The following steps are taken:

1. Let S be the **this** value.
2. If $\text{Type}(S)$ is not **Object**, throw a **TypeError** exception.
3. If S does not have a **[[SetData]]** internal slot throw a **TypeError** exception.
4. Let entries be the List that is the value of S 's **[[SetData]]** internal slot.
5. Repeat for each e that is an element of entries ,
 - a. If e is not **empty** and $\text{SameValueZero}(e, \text{value})$ is **true**, then
 - i. Replace the element of entries whose value is e with an element whose value is **empty**.
 - ii. Return **true**.
6. Return **false**.

Deleted: , then throw

Deleted: <#>If S 's **[[SetData]]** internal slot is **undefined**, then throw a **TypeError** exception.¶

Deleted: in original insertion order

NOTE The value **empty** is used as a specification device to indicate that an entry has been deleted. Actual implementations may take other actions such as physically removing the entry from internal data structures.

23.2.3.5 Set.prototype.entries ()

The following steps are taken:

1. Let S be the **this** value.
2. Return $\text{CreateSetIterator}(S, \text{"key+value"})$.

Deleted: the result of calling the

Deleted: abstract operation with arguments

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NOTE For iteration purposes, a Set appears similar to a Map where each entry has the same value for its key and value.

23.2.3.6 Set.prototype.forEach (callbackfn [,thisArg])

NOTE callbackfn should be a function that accepts three arguments. **forEach** calls callbackfn once for each value present in the set object, in value insertion order. callbackfn is called only for values of the Set which actually exist; it is not called for keys that have been deleted from the set.

If a **thisArg** parameter is provided, it will be used as the **this** value for each invocation of callbackfn . If it is not provided, **undefined** is used instead.

callbackfn is called with three arguments: the first two arguments are a value contained in the Set. The same value is passed for both arguments. The Set object being traversed is passed as the third argument.

Deleted: If callbackfn is an Arrow Function, this was lexically bound when the function was created so **thisArg** will have no effect. ¶

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The `callbackfn` is called with three arguments to be consistent with the call back functions used by `forEach` methods for Map and Array. For Sets, each item value is considered to be both the key and the value.

`forEach` does not directly mutate the object on which it is called but the object may be mutated by the calls to `callbackfn`.

Each value is normally visited only once. However, a value will be revisited if it is deleted after it has been visited and then re-added before the to `forEach` call completes. Values that are deleted after the call to `forEach` begins and before being visited are not visited unless the value is added again before the to `forEach` call completes. New values added, after the call to `forEach` begins are visited.

When the `forEach` method is called with one or two arguments, the following steps are taken:

1. Let S be the `this` value.
2. If `Type(S)` is not `Object`, throw a `TypeError` exception.
3. If S does not have a `[[SetData]]` internal slot throw a `TypeError` exception.
4. If `IsCallable(callbackfn)` is `false`, throw a `TypeError` exception.
5. If `thisArg` was supplied, let T be `thisArg`; else let T be `undefined`.
6. Let $entries$ be the List that is the value of S 's `[[SetData]]` internal slot.
7. Repeat for each e that is an element of $entries$, in original insertion order
 - a. If e is not empty, then
 - i. Let $funcResult$ be `Call(callbackfn, T, e, S)`,
 - ii. `ReturnIfAbrupt(funcResult)`.
8. Return `undefined`.

The `length` property of the `forEach` method is `1`.

23.2.3.7 Set.prototype.has (value)

The following steps are taken:

1. Let S be the `this` value.
2. If `Type(S)` is not `Object`, throw a `TypeError` exception.
3. If S does not have a `[[SetData]]` internal slot throw a `TypeError` exception.
4. Let $entries$ be the List that is the value of S 's `[[SetData]]` internal slot.
5. Repeat for each e that is an element of $entries$,
 - a. If e is not empty and `SameValueZero(e, value)` is `true`, return `true`.
6. Return `false`.

23.2.3.8 Set.prototype.keys ()

The initial value of the `keys` property is the same function object as the initial value of the `values` property.

Comment [AWB1054]: Do we really want to do this sort of method sharing.

NOTE For iteration purposes, a Set appears similar to a Map where each entry has the same value for its key and value.

23.2.3.9 get Set.prototype.size

`Set.prototype.size` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Let S be the `this` value.
2. If `Type(S)` is not `Object`, throw a `TypeError` exception.
3. If S does not have a `[[SetData]]` internal slot throw a `TypeError` exception.

4. Let *entries* be the List that is the value of *S*'s [[SetData]] internal slot.
5. Let *count* be 0.
6. For each *e* that is an element of *entries*
 - a. If *e* is not empty, set *count* to *count*+1.
7. Return *count*.

Deleted: <#>If *S*'s [[SetData]] internal slot is undefined, then throw a **TypeError** exception.

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Deleted: then
S

23.2.3.10 Set.prototype.values ()

The following steps are taken:

1. Let *S* be the **this** value.
2. Return CreateSetIterator(*S*, "value").

Deleted: the result of calling the

Deleted: abstract operation with argument

Deleted: and

23.2.3.11 Set.prototype [@@iterator] ()

The initial value of the @@iterator property is the same function object as the initial value of the **values** property.

23.2.3.12 Set.prototype [@@toStringTag]

The initial value of the @@toStringTag property is the string value "Set".

This property has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.

23.2.4 Properties of Set Instances

Set instances are ordinary objects that inherit properties from the Set prototype. After initialization by the Set constructor, Set instances also have a [[SetData]] internal slot.

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23.2.5 Set Iterator Objects

A Set Iterator is an ordinary object, with the structure defined below, that represents a specific iteration over some specific Set instance object. There is not a named constructor for Set Iterator objects. Instead, set iterator objects are created by calling certain methods of Set instance objects.

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23.2.5.1 CreateSetIterator Abstract Operation

Several methods of Set objects return Iterator objects. The abstract operation CreateSetIterator with arguments *set* and *kind* is used to create such iterator objects. It performs the following steps:

1. If Type(*set*) is not Object, throw a **TypeError** exception.
2. If *set* does not have a [[SetData]] internal slot throw a **TypeError** exception.
3. Let *iterator* be the result of ObjectCreate(%SetIteratorPrototype%, *[[IteratedSet]]*, *[[SetNextIndex]]*, *[[SetIterationKind]]*).
4. Set *iterator*'s [[IteratedSet]] internal slot to *set*.
5. Set *iterator*'s [[SetNextIndex]] internal slot to 0.
6. Set *iterator*'s [[SetIterationKind]] internal slot to *kind*.
7. Return *iterator*.

Deleted: <#>If *set*'s [[SetData]] internal slot is undefined, then throw a **TypeError** exception.

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23.2.5.2 The %SetIteratorPrototype% Object

All Set Iterator Objects inherit properties from the %SetIteratorPrototype% intrinsic object. The %SetIteratorPrototype% intrinsic object is an ordinary object and its [[Prototype]] internal slot is the

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`%IteratorPrototype%` intrinsic object [\(25.1.2\)](#). In addition, `%SetIteratorPrototype%` has the following properties:

Deleted: ObjectPrototype

23.2.5.2.1 `%SetIteratorPrototype%.next()`

1. Let O be the `this` value.
2. If $\text{Type}(O)$ is not `Object`, throw a `TypeError` exception.
3. If O does not have all of the internal slots of a Set Iterator Instance [\(23.2.5.3\)](#), throw a `TypeError` exception.
4. Let s be the value of the `[[IteratedSet]]` internal slot of O .
5. Let $index$ be the value of the `[[SetNextIndex]]` internal slot of O .
6. Let $itemKind$ be the value of the `[[SetIterationKind]]` internal slot of O .
7. If s is `undefined`, **return** `CreateIterResultObject(undefined, true)`.
8. Assert: s has a `[[SetData]]` internal slot.
9. Let $entries$ be the List that is the value of the `[[SetData]]` internal slot of s .
10. Repeat while $index$ is less than the total number of elements of $entries$. The number of elements must be redetermined each time this method is evaluated.
 - a. Let e be $entries[index]$.
 - b. Set $index$ to $index+1$;
 - c. Set the `[[SetNextIndex]]` internal slot of O to $index$.
 - d. If e is not `empty`, then
 - i. If $itemKind$ is "`key+value`", then
 1. Let $result$ be the result of performing `ArrayCreate(2)`.
 2. Assert: $result$ is a new, well-formed Array object so the following operations will never fail.
 3. Call `CreateDataProperty(result, "0", e)`.
 4. Call `CreateDataProperty(result, "1", e)`.
 5. Return `CreateIterResultObject(result, false)`.
 - ii. Return `CreateIterResultObject(e, false)`.
11. Set the `[[IteratedSet]]` internal slot of O to `undefined`.
12. Return `CreateIterResultObject(undefined, true)`.

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Deleted: , then return

Deleted: and s has been initialized so the value of `[[SetData]]` is not `undefined`

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23.2.5.2.2 `%SetIteratorPrototype% [@@toStringTag]`

The initial value of the `@@toStringTag` property is the string value `"Set Iterator"`.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true` }.

Deleted: ¶

Deleted: <#>%SetIteratorPrototype%
[@@iterator] ()¶
The following steps are taken:¶
<#>Return the `this` value.¶
The value of the `name` property of this function
is "`[Symbol.iterator]`". ¶

23.2.5.3 Properties of Set Iterator Instances

Set Iterator instances are ordinary objects that inherit properties from the `%SetIteratorPrototype%` intrinsic object. Set Iterator instances are initially created with the internal slots specified [in Table 48](#).

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Table 48—Internal Slots of Set Iterator Instances

Internal Slot	Description
<code>[[IteratedSet]]</code>	The Set object that is being iterated.
<code>[[SetNextIndex]]</code>	The integer index of the next Set data element to be examined by this iterator
<code>[[SetIterationKind]]</code>	A string value that identifies what is to be returned for each element of the iteration. The possible values are: <code>"key"</code> , <code>"value"</code> .

Deleted: .

"key+value". "key" and "value" have the same meaning.

23.3 WeakMap Objects

WeakMap objects are collections of key/value pairs where the keys are objects and values may be arbitrary ECMAScript language values. A WeakMap may be queried to see if it contains an key/value pair with a specific key, but no mechanisms is provided for enumerating the objects it holds as keys. If an object that is being used as the key of a WeakMap key/value pair is only reachable by following a chain of references that start within that WeakMap, then that key/value pair is inaccessible and is automatically removed from the WeakMap. WeakMap implementations must detect and remove such key/value pairs and any associated resources.

An implementation may impose an arbitrarily determined latency between the time a key/value pair of a WeakMap becomes inaccessible and the time when the key/value pair is removed from the WeakMap. If this latency was observable to ECMAScript program, it would be a source of indeterminacy that could impact program execution. For that reason, an ECMAScript implementation must not provide any means to observe a key of a WeakMap that does not require the observer to present the observed key.

WeakMap objects must be implemented using either hash tables or other mechanisms that, on average, provide access times that are sublinear on the number of key/value pairs in the collection. The data structure used in this WeakMap objects specification are only intended to describe the required observable semantics of WeakMap objects. It is not intended to be a viable implementation model.

NOTE WeakMap and WeakSets are intended to provide mechanisms for dynamically associating state with an object in a manner that does not "leak" memory resources if, in the absence of the WeakMap or WeakSet, the object otherwise became inaccessible and subject to resource reclamation by the implementation's garbage collection mechanisms. Achieving this characteristic can be achieved by using an inverted per-object mapping of weak map instances to keys. Alternatively each weak map may internally store its key to value mappings but this approach requires coordination between the WeakMap or WeakSet implementation and the garbage collector. The following references describe mechanism that may be useful to implementations of WeakMap and WeakSets:

Barry Hayes. 1997. Ephemerons: a new finalization mechanism. In *Proceedings of the 12th ACM SIGPLAN conference on Object-oriented programming, systems, languages, and applications (OOPSLA '97)*, A. Michael Berman (Ed.). ACM, New York, NY, USA, 176-183. <http://doi.acm.org/10.1145/263698.263733>.

Alexandra Barros, Roberto Ierusalimschy, Eliminating Cycles in Weak Tables. Journal of Universal Computer Science - J.UCS , vol. 14, no. 21, pp. 3481-3497, 2008.
http://www.jucs.org/jucs_14_21/eliminating_cycles_in_weak

23.3.1 The WeakMap Constructor

The WeakMap constructor is the %WeakMap% intrinsic object and the initial value of the **WeakMap** property of the global object. When called as a constructor it creates and initializes a new WeakMap object. WeakMap is not intended to be called as a function and will throw an exception when called in that manner.

The **WeakMap** constructor is designed to be subclassable. It may be used as the value in an **extends** clause of a class definition. Subclass constructors that intend to inherit the specified **WeakMap** behaviour must include a **super** call to the **WeakMap** constructor to create and initialize the subclass instance with the internal state necessary to support the **WeakMap.prototype** built-in methods.

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Deleted: When WeakMap is called as a function rather than as a constructor, it initializes its **this** value with the internal state necessary to support the **WeakMap.prototype** built-in methods

23.3.1.1 WeakMap ([iterable])

When the `WeakMap` function is called with optional argument `iterable` the following steps are taken:

1. If `NewTarget` is `undefined`, throw a `TypeError` exception.
2. Let `map` be `OrdinaryCreateFromConstructor(NewTarget, "%WeakMapPrototype%", «[[WeakMapData]]»).`
3. `ReturnIfAbrupt(map).`
4. Set `map`'s `[[WeakMapData]]` internal slot to a new empty List.
5. If `iterable` is not present, let `iterable` be `undefined`.
6. If `iterable` is either `undefined` or `null`, let `iter` be `undefined`.
7. Else,
 - a. Let `adder` be the result of `Get(map, "set")`.
 - b. `ReturnIfAbrupt(adder)`.
 - c. If `IsCallable(adder)` is `false`, throw a `TypeError` Exception.
 - d. Let `iter` be the result of `GetIterator(iterable)`.
 - e. `ReturnIfAbrupt(iter)`.
8. If `iter` is `undefined`, `return map`.
9. Repeat
 - a. Let `next` be the result of `IteratorStep(iter)`.
 - b. If `next` is an abrupt completion, return `IteratorClose(iter, next)`.
 - c. If `next.[[value]]` is `false`, `return map`.
 - d. Let `nextItem` be `IteratorValue(next.[[value]])`.
 - e. If `nextItem` is an abrupt completion, return `IteratorClose(iter, nextItem)`.
 - f. If `Type(nextItem.[[value]])` is not Object,
 - i. Let `error` be `Completion{[[type]]: throw, [[value]]: a newly created TypeError object, [[target]]: empty}`.
 - ii. `Return IteratorClose(iter, error)`.
 - g. Let `k` be the result of `Get(nextItem.[[value]], "0")`.
 - h. If `k` is an abrupt completion, return `IteratorClose(iter, k)`.
 - i. Let `v` be the result of `Get(nextItem.[[value]], "1")`.
 - j. If `v` is an abrupt completion, return `IteratorClose(iter, v)`.
 - k. Let `status` be `Call(adder, map, k.[[value]], v.[[value]])`.
 - l. If `status` is an abrupt completion, return `IteratorClose(iter, status)`.

NOTE If the parameter `iterable` is present, it is expected to be an object that implements an `@@iterator` method that returns an iterator object that produces a two element array-like object whose first element is a value that will be used as a `WeakMap` key and whose second element is the value to associate with that key.

23.3.2 Properties of the WeakMap Constructor

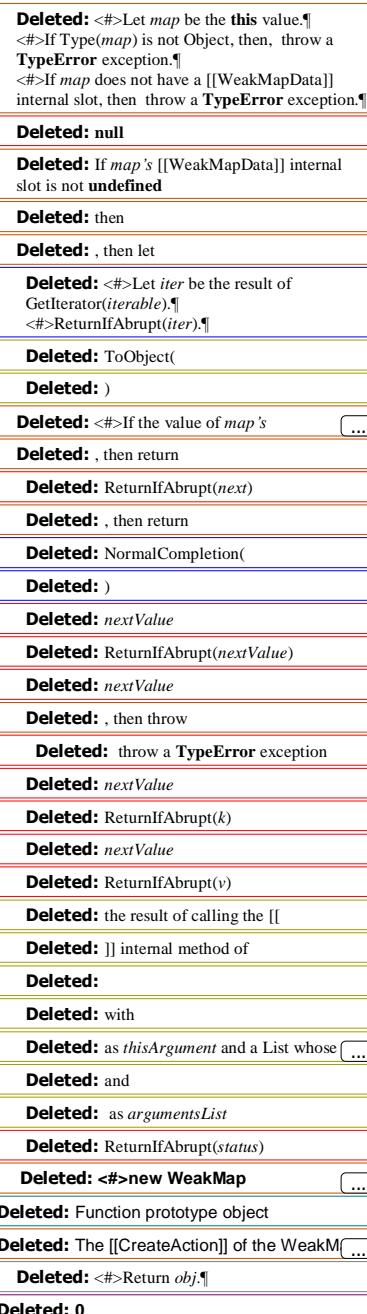
The value of the `[[Prototype]]` internal slot of the `WeakMap` constructor is the `intrinsic object %FunctionPrototype%` (19.2.3).

Besides the `length` property (whose value is `1`), the `WeakMap` constructor has the following properties:

23.3.2.1 WeakMap.prototype

The initial value of `WeakMap.prototype` is the `WeakMap` prototype object (23.3.3).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.



23.3.3 Properties of the WeakMap Prototype Object

The value of the `[[Prototype]]` internal slot of the WeakMap prototype object is the [intrinsic object %ObjectPrototype%](#) (19.1.3). The WeakMap prototype object is an ordinary object. It does not have a `[[WeakMapData]]` internal slot.

23.3.3.1 WeakMap.prototype.constructor

The initial value of `WeakMap.prototype.constructor` is the [intrinsic object %WeakMap%](#).

23.3.3.2 WeakMap.prototype.delete (key)

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, [throw](#) a `TypeError` exception.
3. If M does not have a `[[WeakMapData]]` internal slot throw a `TypeError` exception.
4. Let $entries$ be the List that is the value of M 's `[[WeakMapData]]` internal slot.
5. If $\text{Type}(key)$ is not `Object`, [return](#) `false`.
6. Repeat for each Record $\{[[key]], [[value]]\}$ p that is an element of $entries$,
 - a. If $p.[[key]]$ is not empty and $\text{SameValue}(p.[[key]], key)$ is `true`, then
 - i. Set $p.[[key]]$ to empty.
 - ii. Set $p.[[value]]$ to empty.
 - iii. Return `true`.
7. Return `false`.

NOTE The value `empty` is used as a specification device to indicate that an entry has been deleted. Actual implementations may take other actions such as physically removing the entry from internal data structures.

23.3.3.3 WeakMap.prototype.get (key)

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, [throw](#) a `TypeError` exception.
3. If M does not have a `[[WeakMapData]]` internal slot throw a `TypeError` exception.
4. Let $entries$ be the List that is the value of M 's `[[WeakMapData]]` internal slot.
5. If $\text{Type}(key)$ is not `Object`, [return](#) `undefined`.
6. Repeat for each Record $\{[[key]], [[value]]\}$ p that is an element of $entries$,
 - a. If $p.[[key]]$ is not empty and $\text{SameValue}(p.[[key]], key)$ is `true`, [return](#) $p.[[value]]$.
7. Return `undefined`.

Deleted: `<#>WeakMap[@@create]()`
 The `@@create` method of a WeakMap object F performs the following steps:
 The value of the `name` property of this function is `"Symbol.create"`.
 This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.`

Deleted: standard built-in Object prototype object

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Deleted: `<#>WeakMap.prototype.clear ()`
 The following steps are taken:
`<#>Let M be the this value.
<#>If $\text{Type}(M)$ is not Object, then throw a TypeError exception.
<#>If M does not have a [[WeakMapData]] internal slot throw a TypeError exception.
<#>If M 's [[WeakMapData]] internal slot is undefined, then throw a TypeError exception.
<#>Set the value of M 's [[WeakMapData]] internal slot to a new empty List.
<#>Return undefined.`

Deleted: built-in `WeakMap` constructor

Deleted: `,`, then throw

Deleted: `<#>If $entries$ is undefined, then throw a TypeError exception.`

Deleted: `,`, then return

23.3.3.4 WeakMap.prototype.has (key)

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, [throw](#) a `TypeError` exception.
3. If M does not have a `[[WeakMapData]]` internal slot throw a `TypeError` exception.
4. Let $entries$ be the List that is the value of M 's `[[WeakMapData]]` internal slot.
5. If $\text{Type}(key)$ is not `Object`, [return](#) `false`.
6. Repeat for each Record $\{[[key]], [[value]]\}$ p that is an element of $entries$,
 - a. If $p.[[key]]$ is not empty and $\text{SameValue}(p.[[key]], key)$ is `true`, [return](#) `true`.
7. Return `false`.

Deleted: `,`, then throw

Deleted: `<#>If $entries$ is undefined, then throw a TypeError exception.`

Deleted: `,`, then return

Deleted: `,`, then return

23.3.3.5 WeakMap.prototype.set (key , value)

The following steps are taken:

1. Let M be the **this** value.
2. If $\text{Type}(M)$ is not **Object**, **throw** a **TypeError** exception.
3. If M does not have a $[[\text{WeakMapData}]]$ internal slot throw a **TypeError** exception.
4. Let entries be the List that is the value of M 's $[[\text{WeakMapData}]]$ internal slot.
5. If $\text{Type}(\text{key})$ is not **Object**, **throw** a **TypeError** exception.
6. Repeat for each Record $\{[[\text{key}]], [[\text{value}]]\}$ p that is an element of entries ,
 - a. If $p.[[\text{key}]]$ is not **empty** and $\text{SameValue}(p.[[\text{key}]], \text{key})$ is **true**, then
 - i. Set $p.[[\text{value}]]$ to value .
 - ii. Return M .
7. Let p be the Record $\{[[\text{key}]]: \text{key}, [[\text{value}]]: \text{value}\}$.
8. Append p as the last element of entries .
9. Return M .

Deleted: , then throw

Deleted: <#>If entries is **undefined**, then throw a **TypeError** exception.

Deleted: , then throw

23.3.3.6 WeakMap.prototype [@@toStringTag]

The initial value of the **@@toStringTag** property is the string value **"WeakMap"**.

This property has the attributes $\{ [[\text{Writable}]]: \text{false}, [[\text{Enumerable}]]: \text{false}, [[\text{Configurable}]]: \text{true} \}$.

23.3.4 Properties of WeakMap Instances

WeakMap instances are ordinary objects that inherit properties from the WeakMap prototype. WeakMap instances also have a $[[\text{WeakMapData}]]$ internal slot.

23.4 WeakSet Objects

WeakSet objects are collections of objects. A distinct object may only occur once as an element of a WeakSet's collection. A WeakSet may be queried to see if it contains a specific object, but no mechanisms are provided for enumerating the objects it holds. If an object that is contain by a WeakSet is only reachable by following a chain of references that start within that WeakSet, then that object is inaccessible and is automatically removed from the WeakSet. WeakSet implementations must detect and remove such objects and any associated resources.

An implementation may impose an arbitrarily determined latency between the time an object contained in a WeakSet becomes inaccessible and the time when the object is removed from the WeakSet. If this latency was observable to ECMAScript program, it would be a source of indeterminacy that could impact program execution. For that reason, an ECMAScript implementation must not provide any means to determine if a WeakSet contains a particular object that does not require the observer to present the observed object.

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WeakSet objects must be implemented using either hash tables or other mechanisms that, on average, provide access times that are sublinear on the number of elements in the collection. The data structure used in this WeakSet objects specification is only intended to describe the required observable semantics of WeakSet objects. It is not intended to be a viable implementation model.

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NOTE See the NOTE in 23.3.

23.4.1 The WeakSet Constructor

The `WeakSet` constructor is the `%WeakSet%` intrinsic object and the initial value of the `WeakSet` property of the global object. When called as a constructor it creates and initializes a new `WeakSet` object. `WeakSet` is not intended to be called as a function and will throw an exception when called in that manner.

The `WeakSet` constructor is designed to be subclassable. It may be used as the value in an `extends` clause of a class definition. Subclass constructors that intend to inherit the specified `WeakSet` behaviour must include a `super` call to the `WeakSet` constructor to create and initialize the subclass instance with the internal state necessary to support the `WeakSet.prototype` built-in methods.

23.4.1.1 WeakSet ([iterable])

When the `WeakSet` function is called with optional argument `iterable` the following steps are taken:

1. If `NewTarget` is `undefined`, throw a `TypeError` exception.
2. Let `set` be `OrdinaryCreateFromConstructor(NewTarget, "%WeakSetPrototype%", [[WeakSetData]]).`
3. ReturnIfAbrupt(set).
4. Set `set`'s `[[WeakSetData]` internal slot to a new empty List.
5. If `iterable` is not present, let `iterable` be `undefined`.
6. If `iterable` is either `undefined` or `null`, let `iter` be `undefined`.
7. Else,
 - a. Let `adder` be the result of `Get(set, "add")`.
 - b. `ReturnIfAbrupt(adder)`.
 - c. If `IsCallable(adder)` is `false`, throw a `TypeError` Exception.
 - d. Let `iter` be the result of `GetIterator(iterable)`.
 - e. `ReturnIfAbrupt(iter)`.
8. If `iter` is `undefined`, return `set`.
9. Repeat
 - a. Let `next` be the result of `IteratorStep(iter)`.
 - b. If `next.[[value]]` is an abrupt completion, return `IteratorClose(iter, next)`.
 - c. If `next` is `false`, return `set`.
 - d. Let `nextValue` be `IteratorValue(next.[[value]])`.
 - e. If `nextValue` is an abrupt completion, return `IteratorClose(iter, nextValue)`.
 - f. Let `status` be `Call(adder, set, [[nextValue.[[value]]]])`.
 - g. If `status` is an abrupt completion, return `IteratorClose(iter, status)`.

23.4.2 Properties of the WeakSet Constructor

The value of the `[[Prototype]]` internal slot of the `WeakSet` constructor is the `intrinsic object %FunctionPrototype%` (19.2.3).

Besides the `length` property (whose value is `1`), the `WeakSet` constructor has the following properties:

23.4.2.1 WeakSet.prototype

The initial value of `WeakSet.prototype` is the intrinsic `%WeakSetPrototype%` object (23.4.3).

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

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Deleted: When `WeakSet` is called as a function rather than as a constructor, it initializes its `this` value with the internal state necessary to support the `WeakSet.prototype` built-in methods

Deleted: <#>Let `set` be the `this` value.
 <#>If `Type(set)` is not `Object`, then, throw a `TypeError` exception.
 <#>If `set` does not have a `[[WeakSetData]]` internal slot, then throw a `TypeError` exception.

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Deleted: `set`'s `[[WeakSetData]]` internal slot is not `undefined`

Deleted: then

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Deleted: <#>Let `iter` be the result of `GetIterator(iterable)`.
 <#>ReturnIfAbrupt(`iter`).

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Deleted: <#>If the value of `sets`'s `[[WeakSetData]]` internal slot is not `undefined`, then throw a `TypeError` exception.
 <#>Assert: `set` has not been reentrantly initialized.
 <#>Set `set`'s `[[WeakSetData]]` internal slot to a new empty List.

Deleted: , then return

Deleted: `ReturnIfAbrupt(next)`

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Deleted: `NormalCompletion(`

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Deleted: `ReturnIfAbrupt(nextValue)`

Deleted: the result of calling the `[[`

Deleted: `]]` internal method of

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Deleted: as `thisArgument` and a List whose sole element is

Deleted: as `argumentsList`

Deleted: `ReturnIfAbrupt(status)`

Deleted: <#>`new WeakSet`

Deleted: Function prototype object

Deleted: The `[[CreateAction]]` of the `WeakS...`

Deleted: <#>`Return obj`.

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23.4.3 Properties of the WeakSet Prototype Object

The value of the `[[Prototype]]` internal slot of the `WeakSet` prototype object is the [intrinsic object %ObjectPrototype%](#) (19.1.3). The `WeakSet` prototype object is an ordinary object. It does not have a `[[WeakSetData]]` internal slot.

23.4.3.1 WeakSet.prototype.add (value)

The following steps are taken:

1. Let S be the `this` value.
2. If `Type(S)` is not `Object`, **throw** a `TypeError` exception.
3. If S does not have a `[[WeakSetData]]` internal slot **throw** a `TypeError` exception.
4. If `Type(value)` is not `Object`, **throw** a `TypeError` exception.
5. Let $entries$ be the List that is the value of S 's `[[WeakSetData]]` internal slot.
6. Repeat for each e that is an element of $entries$,
 - a. If e is not `empty` and `SameValue(e, value)` is `true`, then
 - i. Return S .
7. Append $value$ as the last element of $entries$.
8. Return S .

23.4.3.2 WeakSet.prototype.constructor

The initial value of `WeakSet.prototype.constructor` is the `%WeakSet%` intrinsic object.

23.4.3.3 WeakSet.prototype.delete (value)

The following steps are taken:

1. Let S be the `this` value.
2. If `Type(S)` is not `Object`, **throw** a `TypeError` exception.
3. If S does not have a `[[WeakSetData]]` internal slot **throw** a `TypeError` exception.
4. If `Type(value)` is not `Object`, **return false**.
5. Let $entries$ be the List that is the value of S 's `[[WeakSetData]]` internal slot.
6. Repeat for each e that is an element of $entries$,
 - a. If e is not `empty` and `SameValue(e, value)` is `true`, then
 - i. Replace the element of $entries$ whose value is e with an element whose value is `empty`.
 - ii. Return `true`.
7. **Return false**.

NOTE The value `empty` is used as a specification device to indicate that an entry has been deleted. Actual implementations may take other actions such as physically removing the entry from internal data structures.

23.4.3.4 WeakSet.prototype.has (value)

The following steps are taken:

1. Let S be the `this` value.
2. If `Type(S)` is not `Object`, **throw** a `TypeError` exception.
3. If S does not have a `[[WeakSetData]]` internal slot **throw** a `TypeError` exception.
4. Let $entries$ be the List that is the value of S 's `[[WeakSetData]]` internal slot.
5. If `Type(value)` is not `Object`, **return false**.
6. Repeat for each e that is an element of $entries$,
 - a. If e is not `empty` and `SameValue(e, value)`, **return true**.

Deleted: <#>`WeakSet [@@create]()`
 The @ `@@create` method of a `WeakSet` function object F performs the following steps:
 The value of the `name` property of this function is `"Symbol.create"`.
 This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.`

Deleted: standard built-in Object prototype object

Deleted: , then throw

Deleted: <#>If S 's `[[WeakSetData]]` internal slot is `undefined`, then throw a `TypeError` exception.

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Deleted: <#>`WeakSet.prototype.clear ()`
 The following steps are taken:
 <#>Let S be `this` value.
 <#>If `Type(S)` is not `Object`, then throw a `TypeError` exception.
 <#>If S does not have a `[[WeakSetData]]` internal slot **throw** a `TypeError` exception.
 <#>If S 's `[[WeakSetData]]` internal slot is `undefined`, then throw a `TypeError` exception.
 <#>Set the value of S 's `[[WeakSetData]]` internal slot to a new empty List.
 <#>Return `undefined`.

Deleted: , then throw

Deleted: <#>If S 's `[[WeakSetData]]` internal slot is `undefined`, then throw a `TypeError` exception.

Deleted: , then return

Deleted: in original insertion order

Deleted: , then throw

Deleted: <#>If S 's `[[WeakSetData]]` internal slot is `undefined`, then throw a `TypeError` exception.

Deleted: , then return

Deleted: , then return

7. Return **false**.

23.4.3.5 WeakSet.prototype [@@toStringTag]

The initial value of the @@toStringTag property is the string value "**Weakset**".

This property has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.

23.4.4 Properties of WeakSet Instances

WeakSet instances are ordinary objects that inherit properties from the WeakSet prototype. After initialization by the WeakSet constructor, WeakSet instances also have a [[WeakSetData]] internal slot.

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24 Structured Data

24.1 ArrayBuffer Objects

24.1.1 Abstract Operations For ArrayBuffer Objects

24.1.1.1 AllocateArrayBuffer(constructor, byteLength)

The abstract operation AllocateArrayBuffer with arguments constructor and byteLength is used to create an ArrayBuffer object. It performs the following steps:

1. Let obj be OrdinaryCreateFromConstructor(constructor, "%**ArrayBufferPrototype**%", [[ArrayBufferData]], [[ArrayBufferByteLength]]).
Deleted: uninitialized
2. ReturnIfAbrupt(obj).
Deleted: the result of calling
3. Assert: byteLength is a positive integer.
Deleted: (
4. Let block be CreateByteDataBlock(byteLength).
Deleted:)
5. ReturnIfAbrupt(block).
Deleted:)
6. Set obj's [[ArrayBufferData]] internal slot to block.
Deleted: <#>Set the [[ArrayBufferData]] internal slot of obj to 0.¶
7. Set obj's [[ArrayBufferByteLength]] internal slot to byteLength.
Deleted: Neutered
8. Return obj.
Deleted: Neutered

24.1.1.2 IsDetachedBuffer(arrayBuffer)

The abstract operation IsDetachedBuffer with argument arrayBuffer performs the following steps:

1. Assert: Type(arrayBuffer) is Object and it has [[ArrayBufferData]] internal slot.
Deleted: Neutered
2. If arrayBuffer's [[ArrayBufferData]] internal slot is null, return **true**.
Deleted: , then return
3. Return **false**.
Deleted: Neutered

24.1.1.3 DetachArrayBuffer(arrayBuffer)

The abstract operation DetachArrayBuffer with argument arrayBuffer performs the following steps:

1. Assert: Type(arrayBuffer) is Object and it has [[ArrayBufferData]] and [[ArrayBufferByteLength]] internal slots.
Deleted: Neutered
2. Set arrayBuffer's [[ArrayBufferData]] internal slot to null.
Deleted: Neutered
3. Set arrayBuffer's [[ArrayBufferByteLength]] internal slot to 0.
Deleted: Neutered
4. Return NormalCompletion(null).
Deleted: Neutered

NOTE Detaching an ArrayBuffer instance disassociates the Data Block used as its backing store from the instance and sets the byte length of the buffer to 0. No operations defined by this specification uses the `DetachArrayBuffer` abstract operation. However, an ECMAScript implementation or host environment may define such operations.

24.1.1.4 `CloneArrayBuffer(srcBuffer, srcByteOffset [, cloneConstructor])`

The abstract operation `CloneArrayBuffer` takes two parameters, an ArrayBuffer `srcBuffer`, an integer `srcByteOffset` and optional parameter `cloneConstructor`. It creates a new ArrayBuffer whose data is a copy of `srcBuffer`'s data starting at `srcByteOffset`. This operation performs the following steps:

1. Assert: Type(`srcBuffer`) is Object and it has an `[[ArrayBufferData]]` internal slot.
2. If `cloneConstructor` is not present, then
 - a. Let `cloneConstructor` be `SpeciesConstructor(srcBuffer, %ArrayBuffer%)`.
 - b. `ReturnIfAbrupt(cloneConstructor)`.
 - c. If `IsDetachedBuffer(srcBuffer)` is true, throw a `TypeError` exception.
3. Else, assert `IsConstructor(cloneConstructor)` is true.
4. Let `srcLength` be the value of `srcBuffer`'s `[[ArrayBufferByteLength]]` internal slot.
5. Assert: `srcByteOffset < srcLength`.
6. Let `cloneLength` be `srcLength - srcByteOffset`.
7. Let `srcBlock` be the value of `srcBuffer`'s `[[ArrayBufferData]]` internal slot.
8. Let `targetBuffer` be `AllocateArrayBuffer(cloneConstructor, cloneLength)`.
9. `ReturnIfAbrupt(targetBuffer)`.
10. If `IsDetachedBuffer(srcBuffer)` is true, throw a `TypeError` exception.
11. Let `targetBlock` be the value of `targetBuffer`'s `[[ArrayBufferData]]` internal slot.
12. Perform `CopyDataBlock(Bytes(targetBlock, 0, srcBlock, srcByteOffset, cloneLength))`.
13. Return `targetBuffer`.

24.1.1.5 `GetValueFromBuffer (arrayBuffer, byteIndex, type, isLittleEndian)`

The abstract operation `GetValueFromBuffer` takes four parameters, an ArrayBuffer `arrayBuffer`, an integer `byteIndex`, a String `type`, and optionally a Boolean `isLittleEndian`. This operation performs the following steps:

1. Assert: `IsDetachedBuffer(arrayBuffer)` is false.
2. Assert: There are sufficient bytes in `arrayBuffer` starting at `byteIndex` to represent a value of `type`.
3. Assert: `byteIndex` is a positive integer.
4. Let `block` be `arrayBuffer`'s `[[ArrayBufferData]]` internal slot.
5. Let `elementSize` be the Number value of the Element Size value specified in Table 46 for `Element Type type`.
6. Let `rawValue` be a List of `elementSize` containing, in order, the `elementSize` sequence of bytes starting with `block[byteIndex]`.
7. If `isLittleEndian` is not present, set `isLittleEndian` to either true or false. The choice is implementation dependent and should be the alternative that is most efficient for the implementation. An implementation must use the same value each time this step is executed and the same value must be used for the corresponding step in the `SetValueInBuffer` abstract operation.
8. If `isLittleEndian` is false, reverse the order of the elements of `rawValue`.
9. If `type` is "Float32", then
 - a. Let `value` be the byte elements of `rawValue` concatenated and interpreted as a little-endian bit string encoding of an IEEE 754-2008 binary32 value.
 - b. If `value` is an IEEE 754-2008 binary32 NaN value, return the NaN Number value.
 - c. Return the Number value that corresponds to `value`.
10. If `type` is "Float64", then

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The abstract operation <code>SetArrayBufferData</code> with arguments <code>arrayBuffer</code> and <code>bytes</code> is used to initialize the storage block encapsulated by an ArrayBuffer object. It performs the following steps: <#> <code>ReturnIfAbrupt(arrayBuffer)</code> . <#>Assert: Type(<code>arrayBuffer</code>) is Object and it has an <code>[[ArrayBufferData]]</code> internal slot. <#>Assert: <code>bytes</code> is a positive integer. <#>Let <code>block</code> be the result of <code>CreateDataBlock(bytes)</code> . <#> <code>ReturnIfAbrupt(block)</code>
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- a. Let *value* be the byte elements of *rawValue* concatenated and interpreted as a little-endian bit string encoding of an IEEE 754-2008 binary64 value.
 - b. If *value* is an IEEE 754-2008 binary64 NaN value, return the **NaN** Number value.
 - c. Return the Number value that corresponds to *value*.
11. If the first code unit of *type* is "U", then
- a. Let *intValue* be the byte elements of *rawValue* concatenated and interpreted as a bit string encoding of an unsigned little-endian binary number.
12. Else
- a. Let *intValue* be the byte elements of *rawValue* concatenated and interpreted as a bit string encoding of a binary little-endian 2's complement number of bit length *elementSize* × 8.
13. Return the Number value that corresponds to *intValue*.

24.1.1.6 SetValueInBuffer (*arrayBuffer*, *byteIndex*, *type*, *value*, *isLittleEndian*)

The abstract operation *SetValueInBuffer* takes five parameters, an *ArrayBuffer* *arrayBuffer*, an integer *byteIndex*, a String *type*, a Number *value*, and optionally a Boolean *isLittleEndian*. This operation performs the following steps:

1. Assert: IsDetachedBuffer(*arrayBuffer*) is false.
2. Assert: There are sufficient bytes in *arrayBuffer* starting at *byteIndex* to represent a value of *type*.
3. Assert: *byteIndex* is a positive integer.
4. Assert: Type(*value*) is Number.
5. Let *block* be *arrayBuffer*'s `[[ArrayBufferData]]` internal slot.
6. Assert: *block* is not undefined.
7. Let *elementSize* be the Number value of the Element Size specified in Table 46 for Element Type *type*.
8. If *isLittleEndian* is not present, set *isLittleEndian* to either **true** or **false**. The choice is implementation dependent and should be the alternative that is most efficient for the implementation. An implementation must use the same value each time this step is executed and the same value must be used for the corresponding step in the *GetValueFromBuffer* abstract operation.
9. If *type* is "Float32", then
 - a. Set *rawValue* to a List containing the 4 bytes that are the result of converting *value* to IEEE-754-2008 binary32 format using "Round to nearest, ties to even" rounding mode. If *isLittleEndian* is **false**, the bytes are arranged in big endian order. Otherwise, the bytes are arranged in little endian order. If *value* is **NaN**, *rawValue* may be set to any implementation chosen non-signaling NaN encoding. An implementation must always choose the same non-signaling NaN encoding for a distinct Not-a-Number value.
10. Else, if *type* is "Float64", then
 - a. Set *rawValue* to a List containing the 8 bytes that are the IEEE-754-2008 binary64 format encoding of *value*. If *isLittleEndian* is **false**, the bytes are arranged in big endian order. Otherwise, the bytes are arranged in little endian order. If *value* is **NaN**, *rawValue* may be set to any implementation chosen non-signaling NaN encoding. An implementation must always choose the same non-signaling NaN encoding for a distinct Not-a-Number value.
11. Else,
 - a. Let *n* be the Number value of the Element Size specified in Table 46 for Element Type *type*.
 - b. Let *convOp* be the abstract operation named in the Conversion Operation column in Table 46 for Element Type *type*.
 - c. Let *intValue* be the result of calling *convOp* with *value* as its argument .
 - d. If *intValue* ≥ 0, then
 - i. Let *rawBytes* be a List containing the *n*-byte binary encoding of *intValue*. If *isLittleEndian* is **false**, the bytes are ordered in big endian order. Otherwise, the bytes are ordered in little endian order.
 - e. Else,

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i. Let `rawBytes` be a List containing the n -byte binary 2's complement encoding of `intValue`.
 If `isLittleEndian` is `false`, the bytes are ordered in big endian order. Otherwise, the bytes are ordered in little endian order.

12. Store the individual bytes of `rawBytes` into `block`, in order, starting at `block[byteIndex]`.
13. Return NormalCompletion (`undefined`).

24.1.2 The ArrayBuffer Constructor

The `ArrayBuffer` constructor is the `%ArrayBuffer%` intrinsic object and the initial value of the `ArrayBuffer` property of the global object. When called as a constructor it creates and initializes a new `ArrayBuffer` object. `ArrayBuffer` is not intended to be called as a function and will throw an exception when called in that manner.

The `ArrayBuffer` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class definition. Subclass constructors that intend to inherit the specified `ArrayBuffer` behaviour must include a `super` call to the `ArrayBuffer` constructor to create and initialize subclass instances with the internal state necessary to support the `ArrayBuffer.prototype` built-in methods.

24.1.2.1 ArrayBuffer(length)

`ArrayBuffer` called with argument `length` performs the following steps:

1. If `NewTarget` is `undefined`, throw a `TypeError` exception.
2. Let `numberLength` be `ToNumber(length)`.
3. Let `byteLength` be `ToLength(numberLength)`.
4. ReturnIfAbrupt(`byteLength`).
5. If `SameValueZero(numberLength, byteLength)` is `false`, throw a `RangeError` exception.
6. Return `AllocateArrayBuffer(NewTarget, byteLength)`.

24.1.3 Properties of the ArrayBuffer Constructor

The value of the `[[Prototype]]` internal slot of the `ArrayBuffer` constructor is the `intrinsic object %FunctionPrototype%` (19.2.3).

Besides its `length` property (whose value is 1), the `ArrayBuffer` constructor has the following properties:

24.1.3.1 ArrayBuffer.isView (arg)

The `isView` function takes one argument `arg`, and performs the following steps are taken:

1. If `Type(arg)` is not `Object`, return `false`.
2. If `arg` has a `[[ViewedArrayBuffer]]` internal slot, return true.
3. Return `false`.

24.1.3.2 ArrayBuffer.prototype

The initial value of `ArrayBuffer.prototype` is the `ArrayBuffer` prototype object (24.1.4).

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

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ArrayBuffer called as part of a new expression performs the following steps:¶ <#>Let <code>F</code> be the <code>ArrayBuffer</code> function object on which the <code>new</code> operator was applied.¶ <#>Let <code>argumentsList</code> be the <code>argumentsList</code> argument of the <code>[[Construct]]</code> internal method that was invoked by the <code>new</code> operator.¶ <#>Return the result of <code>Construct(F, argumentsList)</code> .¶ If <code>ArrayBuffer</code> is implemented as an ECMAScript function object, its <code>[[Construct]]</code> internal method will perform the above steps.¶
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24.1.3.3 get ArrayBuffer [@@species]

`ArrayBuffer[@@species]` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Return `this`.

The value of the `name` property of this function is "`get [Symbol.species]`".

NOTE `ArrayBuffer` prototype methods normally use their `this` object's constructor to create a derived object. However, a subclass constructor may over-ride that default behaviour by redefining its `@@species` property.

24.1.4 Properties of the ArrayBuffer Prototype Object

The value of the `[[Prototype]]` internal slot of the `ArrayBuffer` prototype object is the [intrinsic object %ObjectPrototype%](#) (19.1.3). The `ArrayBuffer` prototype object is an ordinary object. It does not have an `[[ArrayBufferData]]` or `[[ArrayBufferByteLength]]` internal slot.

24.1.4.1 get ArrayBuffer.prototype.byteLength

`ArrayBuffer.prototype.byteLength` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Let `O` be the `this` value.
2. If `Type(O)` is not `Object`, throw a `TypeError` exception.
3. If `O` does not have an `[[ArrayBufferData]]` internal slot throw a `TypeError` exception.
4. **If `IsDetachedBuffer(O)` is true, throw a `TypeError` exception.**
5. Let `length` be the value of `O`'s `[[ArrayBufferByteLength]]` internal slot.
6. Return `length`.

24.1.4.2 ArrayBuffer.prototype.constructor

The initial value of `ArrayBuffer.prototype.constructor` is the [intrinsic object %ArrayBuffer%](#).

24.1.4.3 ArrayBuffer.prototype.slice (start , end)

The following steps are taken:

1. Let `O` be the `this` value.
2. If `Type(O)` is not `Object`, throw a `TypeError` exception.
3. If `O` does not have an `[[ArrayBufferData]]` internal slot throw a `TypeError` exception.
4. **If `IsDetachedBuffer(O)` is true, throw a `TypeError` exception.**
5. Let `len` be the value of `O`'s `[[ArrayBufferByteLength]]` internal slot.
6. Let `relativeStart` be `ToInteger(start)`.
7. ReturnIfAbrupt(`relativeStart`).
8. If `relativeStart < 0`, let `first` be `max((len + relativeStart),0)`; else let `first` be `min(relativeStart, len)`.
9. If `end` is `undefined`, let `relativeEnd` be `len`; else let `relativeEnd` be `ToInteger(end)`.
10. ReturnIfAbrupt(`relativeEnd`).
11. If `relativeEnd < 0`, let `final` be `max((len + relativeEnd),0)`; else let `final` be `min(relativeEnd, len)`.
12. Let `newLen` be `max(final - first, 0)`.
13. Let `ctor` be `SpeciesConstructor(O, %ArrayBuffer%)`.
14. ReturnIfAbrupt(`ctor`).
15. Let `new` be `Construct(ctor, <newLen>)`.
16. ReturnIfAbrupt(`new`).

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The `@@create` method of an `ArrayBuffer` function object `F` performs the following steps:
 <#>Let `F` be the `this` value.
 <#>Return the result of calling `AllocateArrayBuffer(F)`.

The value of the `name` property of this function is "`[Symbol.create]`".

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true` }.

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Comment [AWB2655]: Note the Khronos spec. said that neutered arraybuffers have a `byteLength` of 0 about the June 2014 TC39 meeting decide that accessing it should be an error

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17. If *new* does not have an `[[ArrayBufferData]]` internal slot throw a **TypeError** exception.
- 18. If `IsDetachedBuffer(new)` is `true`, throw a **TypeError** exception.**
- 19. If `SameValue(new, O)` is `true`, throw a **TypeError** exception.**
20. If the value of *new*'s `[[ArrayBufferByteLength]]` internal slot *newLen* **< newLen**, throw a **TypeError** exception.
- 21. NOTE: Side-effects of the above steps may have detached *O*.**
- 22. If `IsDetachedBuffer(O)` is `true`, throw a **TypeError** exception.**
23. Let *fromBuf* be the value of *O*'s `[[ArrayBufferData]]` internal slot.
24. Let *toBuf* be the value of *new*'s `[[ArrayBufferData]]` internal slot.
25. Perform `CopyDataBlockBytes(toBuf, 0, fromBuf, first, newLen)`.
26. Return *new*.

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24.1.4.4 `ArrayBuffer.prototype [@@toStringTag]`

The initial value of the `@@toStringTag` property is the string value **"ArrayBuffer"**.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true` }.

24.1.5 Properties of the `ArrayBuffer` Instances

`ArrayBuffer` instances inherit properties from the `ArrayBuffer` prototype object. `ArrayBuffer` instances each have an `[[ArrayBufferData]]` internal slot and an `[[ArrayBufferByteLength]]` internal slot.

`ArrayBuffer` instances whose `[[ArrayBufferData]]` is **null** are considered to be **detached** and all operators to access or modify data contained in the `ArrayBuffer` instance will fail.

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24.2 DataView Objects

24.2.1 Abstract Operations For `DataView` Objects

24.2.1.1 `GetViewValue (view, requestIndex, isLittleEndian, type)`

The abstract operation `GetViewValue` with arguments *view*, *requestIndex*, *isLittleEndian*, and *type* is used by functions on `DataView` instances to retrieve values from the view's buffer. It performs the following steps:

1. If `Type(view)` is not `Object`, throw a **TypeError** exception.
2. If *view* does not have a `[[DataView]]` internal slot, throw a **TypeError** exception.
3. Let *numberIndex* be `ToNumber(requestIndex)`.
4. Let *getIndex* be `ToInteger(numberIndex)`.
5. ReturnIfAbrupt(*getIndex*).
6. If *numberIndex* ≠ *getIndex* or *getIndex* < 0, throw a **RangeError** exception.
7. Let *isLittleEndian* be `ToBoolean(isLittleEndian)`.
- 8. Let *buffer* be the value of *view*'s `[[ViewedArrayBuffer]]` internal slot.**
- 9. If `IsDetachedBuffer(buffer)` is `true`, throw a **TypeError** exception.**
10. Let *viewOffset* be the value of *view*'s `[[ByteOffset]]` internal slot.
11. Let *viewSize* be the value of *view*'s `[[ByteLength]]` internal slot.
12. Let *elementSize* be the Number value of the Element Size value specified in [Table 46](#) for [Element Type](#) *type*.
13. If *getIndex* + *elementSize* > *viewSize*, throw a **RangeError** exception.
14. Let *bufferIndex* be *getIndex* + *viewOffset*.
15. Return `GetValueFromBuffer(buffer, bufferIndex, type, isLittleEndian)`.

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24.2.1.2 SetViewValue (view, requestIndex, isLittleEndian, type, value)

The abstract operation `SetViewValue` with arguments `view`, `requestIndex`, `isLittleEndian`, `type`, and `value` is used by functions on `DataView` instances to store values into the view's buffer. It performs the following steps:

1. If `Type(view)` is not `Object`, throw a `TypeError` exception.
2. If `view` does not have a `[[DataView]]` internal slot, throw a `TypeError` exception.
3. Let `numberIndex` be `ToNumber(requestIndex)`
4. Let `getIndex` be `ToInteger(numberIndex)`.
5. `ReturnIfAbrupt(getIndex)`.
6. If `numberIndex ≠ getIndex` or `getIndex < 0`, throw a `RangeError` exception.
7. Let `isLittleEndian` be `ToBoolean(isLittleEndian)`.
8. Let `buffer` be the value of `view`'s `[[ViewedArrayBuffer]]` internal slot.
9. If `IsDetachedBuffer(buffer)` is `true`, throw a `TypeError` exception.
10. Let `viewOffset` be the value of `view`'s `[[ByteOffset]]` internal slot.
11. Let `viewSize` be the value of `view`'s `[[ByteLength]]` internal slot.
12. Let `elementSize` be the Number value of the Element Size value specified in [Table 46](#) for [Element Type](#).
13. If `getIndex + elementSize > viewSize`, throw a `RangeError` exception.
14. Let `bufferIndex` be `getIndex + viewOffset`.
15. Return `SetValueInBuffer(buffer, bufferIndex, type, value, isLittleEndian)`.

NOTE The algorithms for `GetViewValue` and `SetViewValue` are identical except for their final steps.

24.2.2 The `DataView` Constructor

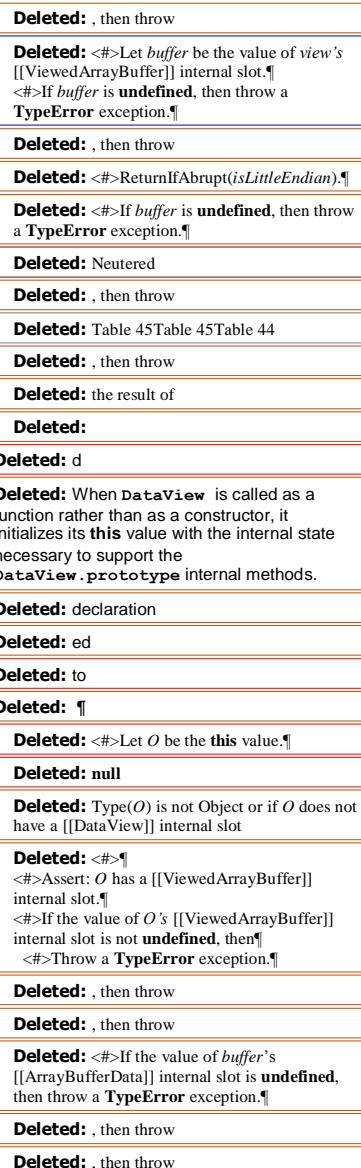
The `DataView` constructor is the `% DataView%` intrinsic object and the initial value of the `DataView` property of the global object. When called as a constructor it creates and initializes a new `DataView` object. `DataView` is not intended to be called as a function and will throw an exception when called in that manner.

The `DataView` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class [definition](#). Subclass constructors that intend to inherit the specified `DataView` behaviour must include a `super` call to the `DataView` constructor to [create and initialize subclass instances with the internal state necessary to support the `DataView.prototype` built-in methods](#).

24.2.2.1 `DataView (buffer [, byteOffset [, byteLength]])`

`DataView` called with arguments `buffer`, `byteOffset`, and `length` performs the following steps:

1. If `NewTarget` is `undefined`, throw a `TypeError` exception.
2. If `Type(buffer)` is not `Object`, throw a `TypeError` exception.
3. If `buffer` does not have an `[[ArrayBufferData]]` internal slot, throw a `TypeError` exception.
4. Let `numberOffset` be `ToNumber(byteOffset)`.
5. Let `offset` be `ToInteger(numberOffset)`.
6. `ReturnIfAbrupt(offset)`.
7. If `numberOffset ≠ offset` or `offset < 0`, throw a `RangeError` exception.
8. If `IsDetachedBuffer(buffer)` is `true`, throw a `TypeError` exception.
9. Let `bufferByteLength` be the value of `buffer`'s `[[ArrayBufferByteLength]]` internal slot.
10. If `offset > bufferByteLength`, throw a `RangeError` exception.
11. If `byteLength` is `undefined`, then
 - a. Let `viewByteLength` be `bufferByteLength - offset`.



12. Else,
 - a. Let *numberLength* be *ToNumber*(*byteLength*).
 - b. Let *viewLength* be *ToInteger* (*numberLength*).
 - c. ReturnIfAbrupt(*viewLength*).
 - d. If *numberLength* ≠ *viewLength* or *viewLength* < 0, throw a **RangeError** exception.
 - e. Let *viewByteLength* be *viewLength*.
 - f. If *offset*+*viewByteLength* > *bufferByteLength*, throw a **RangeError** exception.
13. Let *O* be *OrdinaryCreateFromConstructor*(*NewTarget*, "%**DataViewPrototype**%", «[[*DataView*]], [[ViewedArrayBuffer]], [[ByteLength]], [[ByteOffset]]»).
14. ReturnIfAbrupt(*O*).
15. Set *O*'s [[*DataView*]] internal slot to **true**.
16. Set *O*'s [[ViewedArrayBuffer]] internal slot to *buffer*.
17. Set *O*'s [[ByteLength]] internal slot to *viewByteLength*.
18. Set *O*'s [[ByteOffset]] internal slot to *offset*.
19. Return *O*.

24.2.3 Properties of the **DataView** Constructor

The value of the [[Prototype]] internal slot of the **DataView** constructor is the [intrinsic object %FunctionPrototype%](#) (19.2.3).

Besides the **length** property (whose value is 3), the **DataView** constructor has the following properties:

24.2.3.1 **DataView.prototype**

The initial value of **DataView.prototype** is the **DataView** prototype object (24.2.4).

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

24.2.4 Properties of the **DataView** Prototype Object

The value of the [[Prototype]] internal slot of the **DataView** prototype object is the [intrinsic object %ObjectPrototype%](#) (19.1.3). The **DataView** prototype object is an ordinary object. It does not have a [[*DataView*]], [[ViewedArrayBuffer]], [[ByteLength]], or [[ByteOffset]] internal slot.

24.2.4.1 **get DataView.prototype.buffer**

DataView.prototype.buffer is an accessor property whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *O* be the **this** value.
2. If *Type*(*O*) is not **Object**, throw a **TypeError** exception.
3. If *O* does not have a [[ViewedArrayBuffer]] internal slot throw a **TypeError** exception.
4. Let *buffer* be the value of *O*'s [[ViewedArrayBuffer]] internal slot.
5. Return *buffer*.

24.2.4.2 **get DataView.prototype.byteLength**

DataView.prototype.byteLength is an accessor property whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *O* be the **this** value.
2. If *Type*(*O*) is not **Object**, throw a **TypeError** exception.

Deleted: , then throw
Deleted: , then throw
Deleted: <#>If the value of *O*'s [[ViewedArrayBuffer]] internal slot is not **undefined**, then throw a **TypeError** exception.
Deleted: <#>**new DataView** (...*argumentsList*)
When **DataView** is called as part of a new expression it performs the following steps:
<#>Let *F* be the function object on which the **new** operator was applied.
<#>Let *argumentsList* be the *argumentsList* argument of the [[Construct]] internal method that was invoked by the **new** operator.
<#>Return the result of *Construct*(*F*, *argumentsList*).
If **DataView** is implemented as an ECMAScript function object, its [[Construct]] internal method will perform the above steps.
Deleted: Function prototype object

Deleted: The [[CreateAction]] of the **DataView** constructor identifies the following abstract operation:
The **DataView** CreateAction abstract operation when called with arguments *constructor* and *argumentsList* of performs the following steps:
<#>Let *obj* be *OrdinaryCreateFromConstructor*(*constructor*, "%**DataViewPrototype**%", «[[*DataView*]], [[ViewedArrayBuffer]], [[ByteLength]], [[ByteOffset]]»).
<#>Set the value of *obj*'s [[*DataView*]] internal slot to **true**.
<#>Return *obj*.
NOTE The value of the [[*DataView*]] internal slot is not used within this specification. The simple presence of that internal slot is used within the specification to identify objects created using this CreateAction.

Deleted: <#>**DataView** [@@create] ()
The @@create method of a **DataView** function object *F* performs the following steps:
<#>Let *F* be the **this** value.
<#>Let *obj* be the result of calling *OrdinaryCreateFromConstructor*(*F*, "%**DataViewPrototype**%", «[[*DataView*]], [[ViewedArrayBuffer]], [[ByteLength]], [[ByteOffset]]»).
<#>Set the value of *obj*'s [[*DataView*]] internal slot to **true**.
<#>Return *obj*.
...

Deleted: standard built-in Object prototype object

Comment [AWB1956]: Note this is identical to %TypedArray%.prototype.buffer and in theory could be the same function.

Deleted: <#>If *buffer* is **undefined**, then throw a **TypeError** exception.

3. If O does not have a `[[ViewedArrayBuffer]]` internal slot throw a **TypeError** exception.
4. Let $buffer$ be the value of O 's `[[ViewedArrayBuffer]]` internal slot.
- 5. If `IsDetachedBuffer(buffer)` is `true`, throw a **TypeError** exception.**
6. Let $size$ be the value of O 's `[[ByteLength]]` internal slot.
7. Return $size$.

Deleted: <#>If $buffer$ is `undefined`, then throw a **TypeError** exception.
Deleted: Neutered
Deleted: , then throw

24.2.4.3 `DataView.prototype.byteOffset`

`DataView.prototype.byteOffset` is an accessor property whose set accessor function is `undefined`. Its get accessor function performs the following steps:

1. Let O be the **this** value.
2. If `Type(O)` is not `Object`, throw a **TypeError** exception.
3. If O does not have a `[[ViewedArrayBuffer]]` internal slot throw a **TypeError** exception.
4. Let $buffer$ be the value of O 's `[[ViewedArrayBuffer]]` internal slot.
- 5. If `IsDetachedBuffer(buffer)` is `true`, throw a **TypeError** exception.**
6. Let $offset$ be the value of O 's `[[ByteOffset]]` internal slot.
7. Return $offset$.

Deleted: <#>If $buffer$ is `undefined`, then throw a **TypeError** exception.
Deleted: Neutered
Deleted: , then throw

24.2.4.4 `DataView.prototype.constructor`

The initial value of `DataView.prototype.constructor` is the [intrinsic object % DataView%](#),

Deleted: standard built-in `DataView` constructor

24.2.4.5 `DataView.prototype.getFloat32 (byteOffset [, littleEndian])`

When the `getFloat32` method is called with argument `byteOffset` and optional argument `littleEndian` the following steps are taken:

1. Let v be the **this** value.
2. If `littleEndian` is not present, let `littleEndian` be `false`.
3. Return the result of `GetViewValue(v, byteOffset, littleEndian, "Float32")`.

Deleted: ¶
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24.2.4.6 `DataView.prototype.getFloat64 (byteOffset [, littleEndian])`

When the `getFloat64` method is called with argument `byteOffset` and optional argument `littleEndian` the following steps are taken:

1. Let v be the **this** value.
2. If `littleEndian` is not present, let `littleEndian` be `false`.
3. Return the result of `GetViewValue(v, byteOffset, littleEndian, "Float64")`.

Deleted: , then let

24.2.4.7 `DataView.prototype.getInt8 (byteOffset)`

When the `getInt8` method is called with argument `byteOffset` the following steps are taken:

1. Let v be the **this** value.
2. Return the result of `GetViewValue(v, byteOffset, true, "Int8")`.

Deleted: `undefined`

24.2.4.8 `DataView.prototype.getInt16 (byteOffset [, littleEndian])`

When the `getInt16` method is called with argument `byteOffset` and optional argument `littleEndian` the following steps are taken:

1. Let v be the **this** value.

2. If *littleEndian* is not present, let *littleEndian* be **false**.
3. Return the result of `GetViewValue(v, byteOffset, littleEndian, "Int16")`.

Deleted: , then let

24.2.4.9 `DataView.prototype.getInt32 (byteOffset [, littleEndian])`

When the `getInt32` method is called with argument *byteOffset* and optional argument *littleEndian* the following steps are taken:

1. Let *v* be the **this** value.
2. If *littleEndian* is not present, let *littleEndian* be **undefined**.
3. Return the result of `GetViewValue(v, byteOffset, littleEndian, "Int32")`.

Deleted: , then let

24.2.4.10 `DataView.prototype.getUint8 (byteOffset)`

When the `getUint8` method is called with argument *byteOffset* the following steps are taken:

1. Let *v* be the **this** value.
2. Return the result of `GetViewValue(v, byteOffset, true, "Uint8")`.

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Deleted: **undefined**

24.2.4.11 `DataView.prototype.getUint16 (byteOffset [, littleEndian])`

When the `getUint16` method is called with argument *byteOffset* and optional argument *littleEndian* the following steps are taken:

1. Let *v* be the **this** value.
2. If *littleEndian* is not present, let *littleEndian* be **false**.
3. Return the result of `GetViewValue(v, byteOffset, littleEndian, "Uint16")`.

Deleted: , then let

24.2.4.12 `DataView.prototype.getUint32 (byteOffset [, littleEndian])`

When the `getUint32` method is called with argument *byteOffset* and optional argument *littleEndian* the following steps are taken:

1. Let *v* be the **this** value.
2. If *littleEndian* is not present, let *littleEndian* be **false**.
3. Return the result of `GetViewValue(v, byteOffset, littleEndian, "Uint32")`.

Deleted: , then let

24.2.4.13 `DataView.prototype.setFloat32 (byteOffset, value [, littleEndian])`

When the `setFloat32` method is called with arguments *byteOffset* and *value* and optional argument *littleEndian* the following steps are taken:

1. Let *v* be the **this** value.
2. If *littleEndian* is not present, let *littleEndian* be **false**.
3. Return the result of `SetViewValue(v, byteOffset, littleEndian, "Float32", value)`.

Deleted: , then let

24.2.4.14 `DataView.prototype.setFloat64 (byteOffset, value [, littleEndian])`

When the `setFloat64` method is called with arguments *byteOffset* and *value* and optional argument *littleEndian* the following steps are taken:

1. Let *v* be the **this** value.
2. If *littleEndian* is not present, let *littleEndian* be **false**.
3. Return the result of `SetViewValue(v, byteOffset, littleEndian, "Float64", value)`.

Deleted: , then let

24.2.4.15 DataView.prototype.setInt8 (byteOffset, value)

When the `setInt8` method is called with arguments `byteOffset` and `value` the following steps are taken:

1. Let `v` be the `this` value.
2. Return the result of `SetValue(v, byteOffset, true, "Int8", value)`.

Deleted: undefined

24.2.4.16 DataView.prototype.setInt16 (byteOffset, value [, littleEndian])

When the `setInt16` method is called with arguments `byteOffset` and `value` and optional argument `littleEndian` the following steps are taken:

1. Let `v` be the `this` value.
2. If `littleEndian` is not present, let `littleEndian` be `false`.
3. Return the result of `SetValue(v, byteOffset, littleEndian, "Int16", value)`.

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24.2.4.17 DataView.prototype.setInt32 (byteOffset, value [, littleEndian])

When the `setInt32` method is called with arguments `byteOffset` and `value` and optional argument `littleEndian` the following steps are taken:

1. Let `v` be the `this` value.
2. If `littleEndian` is not present, let `littleEndian` be `false`.
3. Return the result of `SetValue(v, byteOffset, littleEndian, "Int32", value)`.

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24.2.4.18 DataView.prototype.setUint8 (byteOffset, value)

When the `setUint8` method is called with arguments `byteOffset` and `value` the following steps are taken:

1. Let `v` be the `this` value.
2. Return the result of `SetValue(v, byteOffset, true, "Uint8", value)`.

Deleted: undefined

24.2.4.19 DataView.prototype.setUint16 (byteOffset, value [, littleEndian])

When the `setUint16` method is called with arguments `byteOffset` and `value` and optional argument `littleEndian` the following steps are taken:

1. Let `v` be the `this` value.
2. If `littleEndian` is not present, let `littleEndian` be `false`.
3. Return the result of `SetValue(v, byteOffset, littleEndian, "Uint16", value)`.

Deleted: , then let

24.2.4.20 DataView.prototype.setUint32 (byteOffset, value [, littleEndian])

When the `setUint32` method is called with arguments `byteOffset` and `value` and optional argument `littleEndian` the following steps are taken:

1. Let `v` be the `this` value.
2. If `littleEndian` is not present, let `littleEndian` be `false`.
3. Return the result of `SetValue(v, byteOffset, littleEndian, "Uint32", value)`.

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24.2.4.21 DataView.prototype[@@toStringTag]

The initial value of the `@@toStringTag` property is the string value `"DataView"`.

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }`.

24.2.5 Properties of DataView Instances

DataView instances are ordinary objects that inherit properties from the DataView prototype object. DataView instances each have a `[[DataView]]`, `[[ViewedArrayBuffer]]`, `[[ByteLength]]`, and `[[ByteOffset]]` internal slots.

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NOTE The value of the `[[DataView]]` internal slot is not used within this specification. The simple presence of that internal slot is used within the specification to identify objects created using the `DataView` constructor.

24.3 The JSON Object

The **JSON** object is a single ordinary object that contains two functions, `parse` and `stringify`, that are used to parse and construct JSON texts. The JSON Data Interchange Format is defined in ECMA-404. The JSON interchange format used in this specification is exactly that described by ECMA-404.

Conforming implementations of `JSON.parse` and `JSON.stringify` must support the exact interchange format described in this specification without any deletions or extensions to the format.

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The value of the `[[Prototype]]` internal slot of the JSON object is the `intrinsic object %ObjectPrototype%` (19.1.3). The value of the `[[Extensible]]` internal slot of the JSON object is set to `true`.

Deleted: standard built-in Object prototype object

The JSON object does not have a `[[Construct]]` internal method; it is not possible to use the JSON object as a constructor with the `new` operator.

The JSON object does not have a `[[Call]]` internal method; it is not possible to invoke the JSON object as a function.

24.3.1 JSON.parse (`text` [, `reviver`])

The `parse` function parses a JSON text (a JSON-formatted String) and produces an ECMAScript value. The JSON format is a subset of the syntax for ECMAScript literals, Array Initializers and Object Initializers. After parsing, JSON objects are realized as ECMAScript objects. JSON arrays are realized as ECMAScript Array instances. JSON strings, numbers, booleans, and null are realized as ECMAScript Strings, Numbers, Booleans, and `null`.

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The optional `reviver` parameter is a function that takes two parameters, `key` and `value`. It can filter and transform the results. It is called with each of the `key/value` pairs produced by the `parse`, and its return value is used instead of the original value. If it returns what it received, the structure is not modified. If it returns `undefined` then the property is deleted from the result.

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1. Let `JText` be `ToString(text)`.
2. ReturnIfAbrupt(`JText`).
3. Parse `JText` interpreted as UTF-16 encoded Unicode points (6.1.4) as a JSON text as specified in ECMA-404. Throw a **SyntaxError** exception if `JText` is not a valid JSON text as defined in that specification.
4. Let `scriptText` be the result of concatenating `"(`, `JText`, and `) ; "`.
5. Let `completion` be the result of parsing and evaluating `scriptText` as if it was the source text of an ECMAScript *Script*, but using the alternative definition of *DoubleStringCharacter* provided below. The extended PropertyDefinitionEvaluation semantics defined in B.3.1 must not be used during the evaluation.

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6. Let *unfiltered* be *completion*.*[[value]]*.
7. Assert: *unfiltered* will be either a primitive value or an object that is defined by either an *ArrayLiteral* or an *ObjectLiteral*.
8. If *IsCallable(reviver)* is **true**, then
 - a. Let *root* be *ObjectCreate(%ObjectPrototype%)*.
 - b. Let *rootName* be the empty String.
 - c. Let *status* be *CreateDataProperty(root, rootName, unfiltered)*.
 - d. Assert: *status* is **true**.
 - e. Return *Walk(root, rootName)*.
9. Else
 - a. Return *unfiltered*.

JSON allows Unicode code points U+2028 and U+2029 to directly appear in *String* literals without using an escape sequence. This is enabled by using the following alternative definition of *DoubleStringCharacter* when parsing *scriptText* in step 5:

```
DoubleStringCharacter ::=
  SourceCharacter but not one of " or \ or U+0000 through U+001F
  \ EscapeSequence
```

- The *SV* of *DoubleStringCharacter* :: *SourceCharacter but not one of " or \ or U+0000 through U+001F* is the UTF-16 Encoding (10.1.1) of the code point value of *SourceCharacter*.

NOTE The syntax of a valid JSON text is a subset of the ECMAScript *PrimaryExpression* syntax. Hence a valid JSON text is also a valid *PrimaryExpression*. Step 3 above verifies that *JText* conforms to that subset. When *scriptText* is parsed and evaluated as a *Script* the result will be either a String, Number, Boolean, or Null primitive value or an Object defined as if by an *ArrayLiteral* or *ObjectLiteral*.

24.3.1.1 Runtime Semantics: Walk Abstract Operation

The abstract operation *Walk* is a recursive abstract operation that takes two parameters: a *holder* object and the String *name* of a property in that object. *Walk* uses the value of *reviver* that was originally passed to the above parse function.

1. Let *val* be *Get(holder, name)*.
2. *ReturnIfAbrupt(val)*.
3. If *Type(val)* is *Object*, then
 - a. If *isArray(val)* is **true**, then
 - i. Set *I* to 0.
 - ii. Let *len* be the result of *ToLength(Get(val, "length"))*.
 - iii. *ReturnIfAbrupt(len)*.
 - iv. Repeat while *I < len*.
 1. Let *newElement* be *Walk(val, ToString(I))*.
 2. *ReturnIfAbrupt(newElement)*.
 3. If *newElement* is *undefined*, then
 - a. Let *status* be the result of calling the *[[Delete]]* internal method of *val* with *ToString(I)* as the argument.
 4. Else
 - a. Let *status* be *CreateDataProperty(val, ToString(I), newElement)*.
 - b. NOTE This algorithm intentionally does not throw an exception if status is **false**.
 5. *ReturnIfAbrupt(status)*.
 6. Add 1 to *I*.

- b. Else

Deleted: the result of the abstract operation
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Deleted: The abstract operation <i>Walk</i> is described below.
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Deleted: #>Let isArray be <i>isArray(val)</i> .#> #>ReturnIfAbrupt(isArray).#
Deleted: isArrayval is an exotic Array
Deleted: object
Deleted: Assert: len is not an abrupt completion and its value is a positive integer.
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Deleted: , <i>[[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true</i>

- i. Let *keys* be `EnumerableOwnNames(val)`.
- ii. `ReturnIfAbrupt(keys)`.
- iii. For each String *P* in *keys* do,
 1. Let *newElement* be `Walk(val, P)`.
 2. `ReturnIfAbrupt(newElement)`.
 3. If *newElement* is **undefined**, then
 - a. Let *status* be the result of calling the `[[Delete]]` internal method of *val* with *P* as the argument.
 4. Else
 - a. Let *status* be `CreateDataProperty(val, P, newElement)`.
 - b. NOTE This algorithm intentionally does not throw an exception if *status* is **false**.
 5. `ReturnIfAbrupt(status)`.
4. Return `Call(reviver, holder, <name, val>)`.

It is not permitted for a conforming implementation of `JSON.parse` to extend the JSON grammars. If an implementation wishes to support a modified or extended JSON interchange format it must do so by defining a different parse function.

NOTE In the case where there are duplicate name Strings within an object, lexically preceding values for the same key shall be overwritten.

24.3.2 `JSON.stringify (value [, replacer [, space]])`

The `stringify` function returns a String in UTF-16 encoded JSON format representing an ECMAScript value. It can take three parameters. The *value* parameter is an ECMAScript value, which is usually an object or array, although it can also be a String, Boolean, Number or **null**. The optional *replacer* parameter is either a function that alters the way objects and arrays are stringified, or an array of Strings and Numbers that acts as a white list for selecting the object properties that will be stringified. The optional *space* parameter is a String or Number that allows the result to have white space injected into it to improve human readability.

These are the steps in stringifying an object:

1. Let *stack* be an empty List.
2. Let *indent* be the empty String.
3. Let *PropertyList* and *ReplacerFunction* be **undefined**.
4. If `Type(replacer)` is Object, then
 - a. If `IsCallable(replacer)` is **true**, then
 - i. Let *ReplacerFunction* be *replacer*.
 - b. Else if `isArray(replacer)` is **true**, then
 - i. Let *PropertyList* be an empty List.
 - ii. `Let len be ToLength(Get(replacer, "length"))`.
 - iii. `ReturnIfAbrupt(len)`.
 - iv. `Let k be 0`.
 - v. `Repeat while k<len`.
 1. `Let v be Get(replacer, ToString(k))`.
 2. `ReturnIfAbrupt(v)`.
 3. Let *item* be **undefined**.
 4. If `Type(v)` is String, let *item* be *v*.
 5. Else if `Type(v)` is Number, let *item* be `ToString(v)`.
 6. Else if `Type(v)` is Object, then
 - a. If *v* has a `[[StringData]]` or `[[NumberData]]` internal slot, let *item* be `ToString(v)`.
 - b. `ReturnIfAbrupt(item)`.

Deleted: a List of String values consisting of the names of all the own properties of *val* whose `[[Enumerable]]` attribute is **true**. The ordering of the Strings is the same as that used by the `Object.keys` standard built-in function

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`PropertyDescriptor{[[Value]]}`:

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Deleted: <#>Let *replacerIsArray* be `isArray(replacer)`.¶<#>ReturnIfAbrupt(*replacerIsArray*).¶

Deleted: *replacerIsArray*

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Deleted: an exotic Array object

Deleted: *Value*

Deleted: <#>Let *len* be `ToLength(lenValue)`.¶

Deleted: <#>For each value *v* of a property of *replacer* that has an array index property name. The properties are enumerated in the ascending array index order of their names.¶

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7. If *item* is not **undefined** and *item* is not currently an element of *PropertyList*, then
- Append *item* to the end of *PropertyList*.
8. Let *k* be *k+1*.
5. If Type(*space*) is Object, then
- If *space* has a [[NumberData]] internal slot, then
 - Let *space* be ToNumber(*space*).
 - ReturnIfAbrupt(*space*).
 - Else if *space* has a [[StringData]] internal slot, then
 - Let *space* be ToString(*space*).
 - ReturnIfAbrupt(*space*).
6. If Type(*space*) is Number, then
- Let *space* be min(10, ToInteger(*space*)).
 - Set *gap* to a String containing *space* occurrences of code unit 0x0020 (SPACE). This will be the empty String if *space* is less than 1.
7. Else if Type(*space*) is String, then
- If the number of elements in *space* is 10 or less, set *gap* to *space* otherwise set *gap* to a String consisting of the first 10 elements of *space*.
8. Else
- Set *gap* to the empty String.
9. Let *wrapper* be ObjectCreate(%ObjectPrototype%).
10. Let *status* be CreateDataProperty(*wrapper*, the empty String, *value*).
11. Assert: *status* is true.
12. Return Str(the empty String, *wrapper*).

NOTE 1 JSON structures are allowed to be nested to any depth, but they must be acyclic. If *value* is or contains a cyclic structure, then the stringify function must throw a **TypeError** exception. This is an example of a value that cannot be stringified:

```
a = [];
a[0] = a;
my_text = JSON.stringify(a); // This must throw a TypeError.
```

NOTE 2 Symbolic primitive values are rendered as follows:

- The **null** value is rendered in JSON text as the String **null**.
- The **undefined** value is not rendered.
- The **true** value is rendered in JSON text as the String **true**.
- The **false** value is rendered in JSON text as the String **false**.

NOTE 3 String values are wrapped in QUOTATION MARK ("") code units. The code units " and \ are escaped with \ prefixes. Control characters code units are replaced with escape sequences \uHHHH, or with the shorter forms, \b (BACKSPACE), \f (FORM_FEED), \n (LINE_FEED), \r (CARRIAGE RETURN), \t (CHARACTER TABULATION).

NOTE 4 Finite numbers are stringified as if by calling `ToString(number)`. **Nan** and **Infinity** regardless of sign are represented as the String **null**.

NOTE 5 Values that do not have a JSON representation (such as **undefined** and functions) do not produce a String. Instead they produce the **undefined** value. In arrays these values are represented as the String **null**. In objects an unrepresentable value causes the property to be excluded from stringification.

NOTE 6 An object is rendered as an LEFT CURLY BRACKET followed by zero or more properties, separated with a COMMA, closed with a RIGHT CURLY BRACKET. A property is a quoted String representing the key or property name, a COLON, and then the stringified property value. An array is rendered as an opening LEFT SQUARE BRACKET followed by zero or more values, separated with a COMMA, closed with a RIGHT SQUARE BRACKET.

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24.3.2.1 Runtime Semantics: Str Abstract Operation

The abstract operation `Str(key, holder)` has access to `ReplacerFunction` from the invocation of the `stringify` method. Its algorithm is as follows:

1. Let `value` be `Get(holder, key)`.
Deleted: the result of
2. `ReturnIfAbrupt(value)`.
Deleted: the result of
3. If `Type(value)` is Object, then
 - a. Let `toJSON` be `Get(value, "toJSON")`.
Deleted: the result of calling the [[...all]] ...
 - b. `ReturnIfAbrupt(toJSON)`.
Deleted: the result of calling the [[...all]] ...
 - c. If `IsCallable(toJSON)` is true
 - i. Let `value` be `Call(toJSON, value, «key»)`.
Deleted: the result of calling the [[...all]] ...
 - ii. `ReturnIfAbrupt(value)`.
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4. If `ReplacerFunction` is not `undefined`, then
 - a. Let `value` be `Call(ReplacerFunction, holder, «key», value)`.
Deleted: ,
 - b. `ReturnIfAbrupt(value)`.
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5. If `Type(value)` is Object, then
 - a. If `value` has a `[[NumberData]]` internal slot, then
 - i. Let `value` be `ToNumber(value)`.
Deleted: ,
 - ii. `ReturnIfAbrupt(value)`.
Deleted: ,
 - b. Else if `value` has a `[[StringData]]` internal slot, then
 - i. Let `value` be `ToString(value)`.
Deleted: ,
 - ii. `ReturnIfAbrupt(value)`.
Deleted: ,
 - c. Else if `value` has a `[[BooleanData]]` internal slot, then
 - i. Let `value` be the value of the `[[BooleanData]]` internal slot of `value`.
Deleted: <#>If value is undefined, then throw, throw a `TypeError` exception.|| ...
6. If `value` is `null`, return `"null"`.
Deleted: then return
7. If `value` is `true`, return `"true"`.
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8. If `value` is `false`, return `"false"`.
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9. If `Type(value)` is String, return `Quote(value)`.
Deleted: the result of calling the abstract operation ... quote with argument ...
10. If `Type(value)` is Number, then
 - a. If `value` is finite, return `ToString(value)`.
Deleted: then
 - b. Else, return `"null"`.
Deleted: then
11. If `Type(value)` is Object, and `IsCallable(value)` is false, then
 - a. If `isArray(value)` is true, then
 - i. Return `JA(value)`.
Deleted: the result of calling the abstract operation ... A with argument ...
 - ii. Else, return `JO(value)`.
Deleted: the result of calling the abstract operation ... O with argument ...
12. Return `undefined`.

24.3.2.2 Runtime Semantics: Quote Abstract Operation

The abstract operation `Quote(value)` wraps a String value in QUOTATION MARK code units, and escapes certain other code units within it.

1. Let `product` be code unit `U+0022 (QUOTATION MARK)`.
Deleted: characters
2. For each code unit `C` in `value`
 - a. If `C` is `U+0022 (QUOTATION MARK)` or `U+005C (REVERSE SOLIDUS)`
 - i. Let `product` be the concatenation of `product` and code unit `U+005C (REVERSE SOLIDUS)`.
Deleted: 0x0022 ... +0022 (the Unicode double quotes)
 - ii. Let `product` be the concatenation of `product` and `C`.
Deleted: 0x0022
 - b. Else if `C` is `U+0008 (BACKSPACE)`, `U+000C (FORM FEED)`, `U+000A (LINE FEED)`, `U+000D (CARRIAGE RETURN)`, or `U+000B (LINE TABULATION)`
 - i. Let `product` be the concatenation of `product` and code unit `U+005C (REVERSE SOLIDUS)`.
Deleted: 0x005C ... +005C (THE UNICODE REVERSE SOLIDUS)

ii. Let *abbrev* be the string value corresponding to the value of *C* as follows:

<u>BACKSPACE</u>	" <u>b</u> "
<u>FORM FEED (FF)</u>	" <u>f</u> "
<u>LINE FEED (LF)</u>	" <u>n</u> "
<u>CARRIAGE RETURN (CR)</u>	" <u>r</u> "
<u>LINE TABULATION</u>	" <u>t</u> "

Formatted: Font: (Default) Times New Roman
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Deleted: 0x005C
Deleted: the Unicode backslash character
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Deleted: 0x0022
Deleted: the Unicode double quote character
Deleted: then

- iii. Let *product* be the concatenation of *product* and *abbrev*.
- c. Else if *C* has a code unit value less than U+0020 (SPACE).
- Let *product* be the concatenation of *product* and code unit U+005C (REVERSE SOLIDUS).
 - Let *product* be the concatenation of *product* and "u".
 - Let *hex* be the string result of converting the numeric code unit value of *C* to a String of four hexadecimal digits. Alphabetic hexadecimal digits are presented as lowercase Latin letters.
 - Let *product* be the concatenation of *product* and *hex*.
- d. Else
- Let *product* be the concatenation of *product* and *C*.
3. Let *product* be the concatenation of *product* and code unit U+0022 (QUOTATION MARK).
4. Return *product*.

24.3.2.3 Runtime Semantics: JO Abstract Operation

The abstract operation `JO(value)` serializes an object. It has access to the *stack*, *indent*, *gap*, and *PropertyList* of the invocation of the `stringify` method.

- If *stack* contains *value*, throw a **TypeError** exception because the structure is cyclical.
- Append *value* to *stack*.
- Let *stepback* be *indent*.
- Let *indent* be the concatenation of *indent* and *gap*.
- If *PropertyList* is not **undefined**, then
 - Let *K* be *PropertyList*.
- Else
 - Let *K* be EnumerableOwnNames(value).
- Let *partial* be an empty List.
- For each element *P* of *K*,
 - Let *strP* be `Str(P, value)`.
 - ReturnIfAbrupt(*strP*).
 - If *strP* is not **undefined**, then
 - Let *member* be `Quote(P)`.
 - Let *member* be the concatenation of *member* and the string ":".
 - If *gap* is not the empty String, then
 - Let *member* be the concatenation of *member* and code unit U+020 (SPACE).
 - Let *member* be the concatenation of *member* and *strP*.
 - Append *member* to *partial*.
- If *partial* is empty, then
 - Let *final* be "{}".
- Else
 - If *gap* is the empty String
 - Let *properties* be a String formed by concatenating all the element Strings of *partial* with each adjacent pair of Strings separated with code unit U+002C (COMMA). A comma is not inserted either before the first String or after the last String.
 - Let *final* be the result of concatenating "{", *properties*, and "}".
 - Else *gap* is not the empty String

Deleted: a List of Strings consisting of the keys of all the own properties of <i>value</i> whose <code>[<u>Enumerable</u>]</code> attribute is true and whose property key is a String value. The ordering of the Strings is the same as that used by the <code>Object.keys</code> standard built-in function.
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Deleted: the result of calling the abstract operation
Deleted: with argument
Deleted: 0x0020
Deleted: the Unicode space character

Deleted: 0x002C
Deleted: THE UNICODE
Deleted: character
Deleted: ¶

- i. Let *separator* be the result of concatenating code unit [U+002C \(COMMA\)](#), code unit [U+000A \(LINE FEED\)](#), and *indent*.
 - ii. Let *properties* be a String formed by concatenating all the element Strings of *partial* with each adjacent pair of Strings separated with *separator*. The *separator* String is not inserted either before the first String or after the last String.
 - iii. Let *final* be the result of concatenating " { ", code unit [U+000A \(LINE FEED\)](#), *indent*, *properties*, code unit [U+000A](#), *stepback*, and " } ".
11. Remove the last element of *stack*.
 12. Let *indent* be *stepback*.
 13. Return *final*.

24.3.2.4 Runtime Semantics: JA Abstract Operation

The abstract operation `JA(value)` serializes an array. It has access to the *stack*, *indent*, and *gap* of the invocation of the `stringify` method. The representation of arrays includes only the elements between zero and `array.length` – 1 inclusive. Properties whose keys are not array indexes are excluded from the stringification. An array is stringified as an [opening LEFT SQUARE BRACKET code point](#), elements separated by [COMMA](#), and a closing [RIGHT SQUARE BRACKET](#).

1. If *stack* contains *value*, throw a `TypeError` exception because the structure is cyclical.
2. Append *value* to *stack*.
3. Let *stepback* be *indent*.
4. Let *indent* be the concatenation of *indent* and *gap*.
5. Let *partial* be an empty List.
6. Let *len* be [ToLength](#)(`Get(value, "length")`).
7. [ReturnIfAbrupt](#)(*len*).
8. Let *index* be 0.
9. Repeat while *index* < *len*
 - a. Let *strP* be `Str(ToString(index), value)`.
 - b. [ReturnIfAbrupt](#)(*strP*).
 - c. If *strP* is [undefined](#), then
 - i. Append "null" to *partial*.
 - d. Else
 - i. Append *strP* to *partial*.
 - e. Increment *index* by 1.
10. If *partial* is empty, then
 - a. Let *final* be " [] ".
11. Else
 - a. If *gap* is the empty String, then
 - i. Let *properties* be a String formed by concatenating all the element Strings of *partial* with each adjacent pair of Strings separated with code unit [U+002C \(COMMA\)](#). A comma is not inserted either before the first String or after the last String.
 - ii. Let *final* be the result of concatenating " [", *properties*, and "] ".
 - b. Else
 - i. Let *separator* be the result of concatenating code unit [U+002C \(COMMA\)](#), code unit [U+000A \(LINE FEED\)](#), and *indent*.
 - ii. Let *properties* be a String formed by concatenating all the element Strings of *partial* with each adjacent pair of Strings separated with *separator*. The *separator* String is not inserted either before the first String or after the last String.
 - iii. Let *final* be the result of concatenating " [", code unit [U+000A \(LINE FEED\)](#), *indent*, *properties*, code unit [U+000A](#), *stepback*, and "] ".
12. Remove the last element of *stack*.

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Deleted: <#>Assert: <i>value</i> is a standard array object and hence its "length" property is a non-negative integer.¶
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13. Let *indent* be *stepback*.
14. Return *final*.

24.3.3 JSON [@@toStringTag]

The initial value of the `@@toStringTag` property is the string value "JSON".

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: true` }.

25 Control Abstraction Objects

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25.1 Iteration

25.1.1 Common Iteration Interfaces

An interface is a set of property keys whose associated values match a specific specification. Any object that provides all the properties as described by an interface's specification *conforms* to that interface. An interface is not represented by a distinct object. There may be many separately implemented objects that conform to any interface. An individual object may conform to multiple interfaces.

25.1.1.1 The *Iterable* Interface

The *Iterable* interface includes the following property:

Property	Value	Requirements
<code>@@iterator</code>	A zero arguments function that returns an object.	The function returns an object that conforms to the <i>Iterator</i> interface.

25.1.1.2 The *Iterator* Interface

The *Iterator* interface includes the following properties:

Property	Value	Requirements
<code>next</code>	A function that returns an object.	The function returns an object that conforms to the <i>IteratorResult</i> interface. If a previous call to the <code>next</code> method of an <i>Iterator</i> has returned an <i>IteratorResult</i> object whose <code>done</code> property is <code>true</code> , then all subsequent calls to the <code>next</code> method of that object must also return an <i>IteratorResult</i> object whose <code>done</code> property is <code>true</code> .

NOTE Arguments may be passed to the `next` function but their interpretation and validity is dependent upon the target *Iterator*. The `for-of` statement and other common users of *Iterators* do not pass any arguments, so *Iterators* that expect to be used in such a manner must be prepared to deal with being called with no arguments.

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25.1.1.3 The *IteratorResult* Interface

The *IteratorResult* interface includes the following properties:

Property	Value	Requirements
done	Either true or false .	This is the result status of an <i>iterator next</i> method call. If the end of the iterator was reached done is true . If the end was not reached done is false and a value is available. If a done property (either own or inherited does not exist), it is considered to have the value false .
value	Any ECMAScript language value.	If done is false , this is the current iteration element value. If done is true , this is the return value of the iterator, if it supplied one. If the iterator does not have a return value, value is undefined . In that case, the value property may be absent from the conforming object if it does not inherit an explicit value property.

25.1.2 The %IteratorPrototype% Object

The value of the `[[Prototype]]` internal slot of the `%IteratorPrototype%` object is the [intrinsic object `%ObjectPrototype%`](#) (19.1.3). The `%IteratorPrototype%` object is an ordinary object. The initial value of the `[[Extensible]]` internal slot of the `%IteratorPrototype%` object is **true**.

NOTE All objects defined in this specification that implement the Iterator interface also inherit from `%IteratorPrototype%`. ECMAScript code may also define objects that inherit from `%IteratorPrototype%`. The `%IteratorPrototype%` object provides a place where additional methods that are applicable to all iterator objects may be added.

The following expression is one way that ECMAScript code can access the `%IteratorPrototype%` object:

```
Object.getPrototypeOf(Object.getPrototypeOf([][Symbol.iterator]())))
```

25.1.2.1 `%IteratorPrototype% [@@iterator]()`

The following steps are taken:

1. Return the `this` value.

The value of the `name` property of this function is "`[Symbol.iterator]`".

25.2 GeneratorFunction Objects

Generator Function objects are constructor functions that are usually created by evaluating `GeneratorDeclaration`, `GeneratorExpression`, and `GeneratorMethod` syntactic productions. They may also be created by calling the `%GeneratorFunction%` intrinsic.

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Deleted: standard built-in Object prototype object

Deleted: Function prototype

Deleted: `GeneratorFunction` constructor

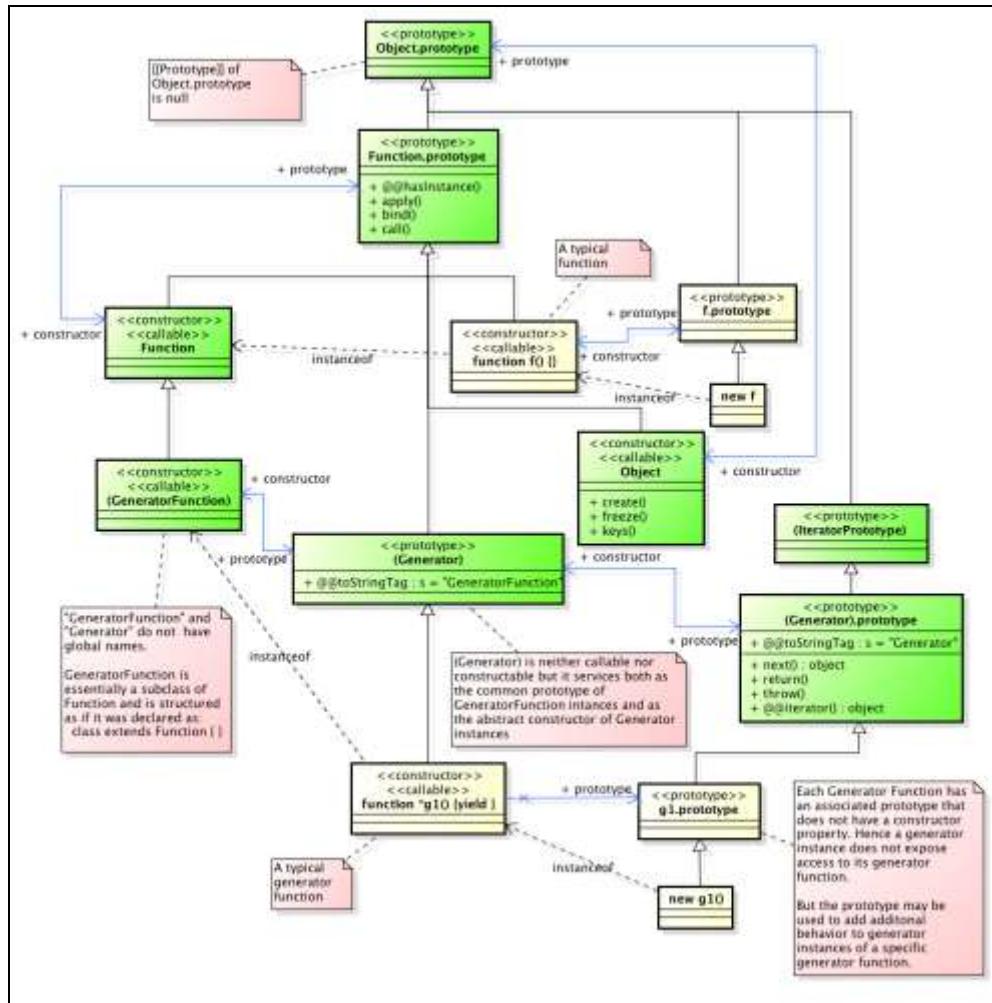


Figure 2 (Informative) — Generator Objects Relationships

25.2.1 The GeneratorFunction Constructor

The `GeneratorFunction` constructor is the `%GeneratorFunction%` intrinsic. When `GeneratorFunction` is called as a function rather than as a constructor, it creates and initializes a new `GeneratorFunction` object. Thus the function call `GeneratorFunction (...)` is equivalent to the object creation expression `new GeneratorFunction (...)` with the same arguments.

`GeneratorFunction` is designed to be subclassable. It may be used as the value of an `extends` clause of a class definition. Subclass constructors that intend to inherit the specified

Comment [AWB1557]: Before final publication we should try to get a vector graphics version of this diagram.

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Deleted: object and the value of the name `GeneratorFunction` exported from the built-in module "std:iteration"

Deleted: However, if the `this` value passed in the call is an Object with a [[ECMAScriptCode]] internal slot whose value is `undefined`, it initializes the `this` value using the argument values. . This permits `GeneratorFunction` to be used both as factory method and to perform constructor instance initialization.

GeneratorFunction behaviour must include a super call to the **GeneratorFunction** constructor to create and initialize subclass instances with the internal slots necessary for built-in GeneratorFunction behaviour. All **ECMAScript** syntactic forms for defining generator function objects create direct instances of **GeneratorFunction**. There is no syntactic means to create instances of **GeneratorFunction** subclasses.

25.2.1.1 GeneratorFunction (p1, p2, ..., pn, body)

The last argument specifies the body (executable code) of a generator function; any preceding arguments specify formal parameters.

When the **GeneratorFunction** function is called with some arguments $p_1, p_2, \dots, p_n, body$ (where n might be 0, that is, there are no “ p ” arguments, and where $body$ might also not be provided), the following steps are taken:

1. Let C be the active function object.
2. Let $args$ be the argumentsList that was passed to this function by [[Call]] or [[Construct]].
3. Return CreateDynamicFunction(C , NewTarget, "generator", $args$).

NOTE See NOTE for 19.2.1.1.

25.2.2 Properties of the GeneratorFunction Constructor

The **GeneratorFunction** constructor is a standard built-in function object that inherits from the **Function** constructor. The value of the [[Prototype]] internal slot of the **GeneratorFunction** constructor is the intrinsic object %Function%.

The value of the [[Extensible]] internal slot of the **GeneratorFunction** constructor is **true**.

The value of the name property of the GeneratorFunction is "GeneratorFunction".

The **GeneratorFunction** constructor has the following properties:

25.2.2.1 GeneratorFunction.length

This is a data property with a value of 1. This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **true** }.

25.2.2.2 GeneratorFunction.prototype

The initial value of **GeneratorFunction.prototype** is the intrinsic object %Generator%.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

25.2.3 Properties of the GeneratorFunction Prototype Object

The **GeneratorFunction** prototype object is an ordinary object. It is not a function object and does not have an [[ECMAScriptCode]] internal slot or any other of the internal slots listed in Table 28 or Table 49. In addition to being the value of the prototype property of the %GeneratorFunction% intrinsic and is itself the %Generator% intrinsic.

Deleted: may be subclassed and subclass constructors may perform a

Deleted: invocation of

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Deleted: <#>Let $argCount$ be the total number of arguments passed to this function invocation.
 <#>If P be the empty String.
 <#>If $argCount = 0$, let $bodyText$ be the empty String.
 <#>Else if $argCount = 1$, let $bodyText$ be that argument.
 <#>Else $argCount > 1$.
 <#>Let $firstArg$ be the first argument.
 <#>Let P be ToString(firstArg).
 <#>ReturnIfAbrupt(P).
 <#>Let k be 2.
 <#>Repeat, while $k < argCount$.
 <#>Let $nextArg$ be the k 'th argument.
 <#>Let $nextArgString$ be ToString(nextArg).
 <#>ReturnIfAbrupt($nextArgString$).
 <#>Let P be the result of concatenating the previous value of P , the String ", " (a comma), and $nextArgString$.
 <#>Increase k by 1.
 <#>Let $bodyText$ be the k 'th argument.
 <#>Let $bodyText$ be ToString(bodyText).
 <#>ReturnIfAbrupt($bodyText$).
 <#>Let $parameters$ be the result of parsing P , interpreted as UTF-16 encoded Unicode text as described in clause 6.1.40.1.1, using FormalParameters as the goal symbol. Throw a **SyntaxError** exception if the parse fails.
 <#>Let $funcBody$ be the result of parsing $bodyText$, interpreted as UTF-16 encoded Unicode text as described in clause 6.1.40.1.1, using FunctionBodyGeneratorBodyyield as the goal symbol. Throw a **SyntaxError** exception if the parse fails or if any static semantics errors are detected.
 <#>If IsSimpleParameterList of $parameters$ is **false** and any element of the BoundNames of $parameters$ also occurs in the VarDeclaredNames of $parameters$.

Deleted: <#>new GeneratorFunction (... argumentsList)

Deleted: Function

Deleted: The [[CreateAction]] of the **GeneratorFunction** constructor identifies the following abstract operation:
 ...

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Deleted: , the standard built-in **GeneratorFunction** prototype

Deleted: <#> GeneratorFunction[@create]()
 The @create method of an object F performs the following steps:
 ...

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The value of the `[[Prototype]]` internal slot of the `GeneratorFunction` prototype object is the `%FunctionPrototype%` intrinsic object. The initial value of the `[[Extensible]]` internal slot of the `GeneratorFunction` prototype object is `true`.

25.2.3.1 `GeneratorFunction.prototype.constructor`

The initial value of `GeneratorFunction.prototype.constructor` is the intrinsic object `%GeneratorFunction%`.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true` }.

25.2.3.2 `GeneratorFunction.prototype.prototype`

The value of `GeneratorFunction.prototype.prototype` is the `%GeneratorPrototype%` intrinsic object.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true` }.

25.2.3.3 `GeneratorFunction.prototype [@@toStringTag]`

The initial value of the `@@toStringTag` property is the string value `"GeneratorFunction"`.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true` }.

25.2.4 `GeneratorFunction` Instances

Every `GeneratorFunction` instance is an ECMAScript function object and has the internal slots listed in Table 28. The value of the `[[FunctionKind]]` internal slot for all such instances is `"generator"`.

Each `GeneratorFunction` instance has the following own properties:

25.2.4.1 `length`

The value of the `length` property is an integer that indicates the typical number of arguments expected by the `GeneratorFunction`. However, the language permits the function to be invoked with some other number of arguments. The behaviour of a `GeneratorFunction` when invoked on a number of arguments other than the number specified by its `length` property depends on the function.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true` }.

25.2.4.2 `prototype`

Whenever a `GeneratorFunction` instance is created another ordinary object is also created and is the initial value of the generator function's `prototype` property. The value of the `prototype` property is used to initialize the `[[Prototype]]` internal slot of a newly created Generator object before the generator function object is invoked as a constructor for that newly created object.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true` }.

NOTE Unlike function instances, the object that is the value of the a `GeneratorFunction`'s `prototype` property does not have a `constructor` property whose value is the `GeneratorFunction` instance.

Deleted: `<#> GeneratorFunction.prototype [@@create] ()`
 The `@@create` method of an object `F` performs the following steps:
`<#>Let obj be the this value.
 <#>Let obj be the result of calling OrdinaryCreateFromConstructor(F, "%GeneratorPrototype%", ([[GeneratorState]], [[GeneratorContext]])).
 <#>Return obj.`

The value of the `name` property of this function is `"Symbol.create"`.
 This property has the attributes { `[[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true` }.

Deleted: Table 26

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Deleted: Each `GeneratorFunction` instance is a constructor. The `[[CreateAction]]` of a `GeneratorFunction` instance identifies the following abstract operation:
 The `GeneratorFunction` instance `CreateAction` abstract operation when called with arguments `constructor` and `argumentsList` of performs the following steps:
`<#>Return OrdinaryCreateFromConstructor(constructor, "%GeneratorPrototype%", ([[GeneratorState]], [[GeneratorContext]])).`

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25.3 Generator Objects

A Generator object is an instance of a generator function and conforms to both the *Iterator* and *Iterable* interfaces.

Generator instances directly inherit properties from the object that is the value of the `prototype` property of the Generator function that created the instance. Generator instances indirectly inherit properties from the Generator Prototype intrinsic, %GeneratorPrototype%.

25.3.1 Properties of Generator Prototype

The Generator prototype object is the %GeneratorPrototype% intrinsic. It is also the initial value of the `prototype` property of the %Generator% intrinsic (the `GeneratorFunction.prototype`).

The Generator prototype is an ordinary object. It is not a Generator instance and does not have a `[[GeneratorState]]` internal slot.

The value of the `[[Prototype]]` internal slot of the Generator prototype object is the intrinsic object %IteratorPrototype% (25.1.2). The initial value of the `[[Extensible]]` internal slot of the Function prototype object is `true`.

All Generator instances indirectly inherit properties of the Generator prototype object.

25.3.1.1 Generator.prototype.constructor

The initial value of `Generator.prototype.constructor` is the intrinsic object %Generator%.

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }`.

25.3.1.2 Generator.prototype.next (value)

The `next` method performs the following steps:

1. Let `g` be the `this` value.
2. Return the result of `GeneratorResume(g, value)`.

25.3.1.3 Generator.prototype.return (value)

The `return` method performs the following steps:

1. Let `g` be the `this` value.
2. Let `C` be `Completion{[[type]]: return, [[value]]: value, [[target]]: empty}`.
3. Return `GeneratorResumeAbrupt(g, C)`.

25.3.1.4 Generator.prototype.throw (exception)

The `throw` method performs the following steps:

1. Let `g` be the `this` value.
2. Let `C` be `Completion{[[type]]: throw, [[value]]: exception, [[target]]: empty}`.
3. Return `GeneratorResumeAbrupt(g, C)`.

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Deleted: <#>If Type(generator) is not Object, then throw a <code>TypeError</code> exception. <#>If generator does not have a <code>[[GeneratorState]]</code> internal slot, then throw a <code>TypeError</code> exception. <#>Let <code>state</code> be the value of generator's <code>[[GeneratorState]]</code> internal slot. <#>Assert: generator also has a <code>[[GeneratorContext]]</code> internal slot.
Deleted: E
Deleted: <#>If state is "completed", then return <code>E</code> . <#>If state is neither "suspendedStart" nor "suspendedYield", then throw a <code>TypeError</code> exception. <#>If state is "suspendedStart" then, <#>Set generator's <code>[[GeneratorState]]</code> internal slot to "completed". <#>Once a generator enters the "completed" state it never leaves it and its associated execution context is never resumed. Any execution state associated with generator can be discarded at this point. <#>Return <code>E</code> . <#>Let <code>genContext</code> be the value of generator's <code>[[GeneratorContext]]</code> internal slot. <#>Let <code>methodContext</code> be the running execution context. <#>Suspend <code>methodContext</code> . <#>Set generator's <code>[[GeneratorState]]</code> internal slot to "executing". <#>Push <code>genContext</code> onto the execution context stack; <code>genContext</code> is now the running execution context. <#>Resume the suspended evaluation of <code>genContext</code> using <code>E</code> as the result of the operation that suspended it. Let <code>result</code> be the value returned by the resumed computation. <#>Assert: When we return here, <code>genContext</code> has already been removed from the execution context stack and <code>methodContext</code> is the currently running execution context.
Deleted: result

25.3.1.5 Generator.prototype [@@toStringTag]

The initial value of the @@toStringTag property is the string value "Generator".

This property has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.

Deleted: <#>Generator.prototype

[@@iterator] ()

The following steps are taken:

<#>Return the **this** value.

The value of the **name** property of this function is "[Symbol.iterator]".

25.3.2 Properties of Generator Instances

Generator instances are initially created with the internal slots described in [Table 49](#).

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Table 49 — Internal Slots of Generator Instances

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Internal Slot	Description
[[GeneratorState]]	The current execution state of the generator. The possible values are: undefined , "suspendedStart", "suspendedYield", "executing", and "completed".
[[GeneratorContext]]	The execution context that is used when executing the code of this generator.

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25.3.3 Generator Abstract Operations

25.3.3.1 GeneratorStart (generator, generatorBody)

The abstract operation GeneratorStart with arguments *generator* and *generatorBody* performs the following steps:

1. Assert: The value of *generator*'s [[GeneratorState]] internal slot is **undefined**.
2. Let *genContext* be the running execution context.
3. Set the Generator component of *genContext* to *generator*.
4. Set the code evaluation state of *genContext* such that when evaluation is resumed for that execution context the following steps will be performed:
 1. Let *result* be the result of evaluating *generatorBody*.
 2. Assert: If we return here, the generator either threw an exception or performed either an implicit or explicit return.
 3. Remove *genContext* from the execution context stack and restore the execution context that is at the top of the execution context stack as the running execution context.
 4. Set *generator*'s [[GeneratorState]] internal slot to "**completed**".
 5. Once a generator enters the "**completed**" state it never leaves it and its associated execution context is never resumed. Any execution state associated with *generator* can be discarded at this point.
 6. **If result is a normal completion, let *resultValue* be **undefined**.**
 7. **Else,**
 - a. **If *result*.[[type]] is return, let *resultValue* be *result*.[[value]].**
 - b. **Else, return *result*.**
 8. Return CreateIterResultObject(*resultValue*, true).
5. Set *generator*'s [[GeneratorContext]] internal slot to *genContext*.
6. Set *generator*'s [[GeneratorState]] internal slot to "suspendedStart".
7. Return NormalCompletion(*generator*).

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25.3.3.2 GeneratorValidate (generator)

The abstract operation GeneratorValidate with argument *generator* performs the following steps:

1. If Type(*generator*) is not Object, throw a **TypeError** exception.
2. If *generator* does not have a **[[GeneratorState]]** internal slot, throw a **TypeError** exception.
3. Assert: *generator* also has a **[[GeneratorContext]]** internal slot.
4. Let *state* be the value of *generator*'s **[[GeneratorState]]** internal slot.
5. If *state* is "executing", throw a **TypeError** exception.
6. Return *state*.

25.3.3.3 GeneratorResume (generator, value)

The abstract operation GeneratorResume with arguments *generator* and *value* performs the following steps:

1. Let *state* be GeneratorValidate(*generator*).
2. ReturnIfAbrupt(*state*).
3. If *state* is "completed", return CreateIterResultObject(**undefined**, true).
4. **Assert:** *state* is either "suspendedStart" or "suspendedYield".
5. Let *genContext* be the value of *generator*'s **[[GeneratorContext]]** internal slot.
6. Let *methodContext* be the running execution context.
7. Suspend *methodContext*.
8. Set *generator*'s **[[GeneratorState]]** internal slot to "executing".
9. Push *genContext* onto the execution context stack; *genContext* is now the running execution context.
10. Resume the suspended evaluation of *genContext* using NormalCompletion(*value*) as the result of the operation that suspended it. Let *result* be the value returned by the resumed computation.
11. Assert: When we return here, *genContext* has already been removed from the execution context stack and *methodContext* is the currently running execution context.
12. Return *result*.

25.3.3.4 GeneratorResumeAbrupt(generator, abruptCompletion)

The abstract operation GeneratorResumeAbrupt with arguments *generator* and *abruptCompletion* performs the following steps:

1. Let *state* be GeneratorValidate(*generator*).
2. ReturnIfAbrupt(*state*).
3. If *state* is "suspendedStart", then
 - a. Set *generator*'s **[[GeneratorState]]** internal slot to "completed".
 - b. Once a generator enters the "completed" state it never leaves it and its associated execution context is never resumed. Any execution state associated with *generator* can be discarded at this point.
 - c. Let *state* be "completed".
4. If *state* is "completed", then
 - a. If *abruptCompletion*.**[[type]]** is return, then
 - i. Return CreateIterResultObject(*abruptCompletion*.**[[value]]**, true).
 - b. Return *abruptCompletion*.
5. Assert: *state* is "suspendedYield".
6. Let *genContext* be the value of *generator*'s **[[GeneratorContext]]** internal slot.
7. Let *methodContext* be the running execution context.
8. Suspend *methodContext*.

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Deleted: <#>Let E be Completion{[[type]]: throw, [[value]]: <i>exception</i> , [[target]]: empty}.¶
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Deleted: , then throw a TypeError exception.
Deleted: <#>If <i>state</i> is "suspendedStart" then, <#>Set <i>generator</i> 's [[GeneratorState]] internal slot to "completed". <#>Once a generator enters the "completed" state it never leaves it and its associated execution context is never resumed. Any

9. Set *generator*'s `[[GeneratorState]]` internal slot to "executing".
10. Push *genContext* onto the execution context stack; *genContext* is now the running execution context.
11. Resume the suspended evaluation of *genContext* using *abruptCompletion* as the result of the operation that suspended it. Let *result* be the value returned by the resumed computation.
12. Assert: When we return here, *genContext* has already been removed from the execution context stack and *methodContext* is the currently running execution context.
13. Return *result*.

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25.3.3.5 GeneratorYield (*iterNextObj*)

The abstract operation *GeneratorYield* with argument *iterNextObj* performs the following steps:

1. Assert: *iterNextObj* is an Object that implements the *IteratorResult* interface.
2. Let *genContext* be the running execution context.
3. Assert: *genContext* is the execution context of a generator.
4. Let *generator* be the value of the Generator component of *genContext*.
5. Set the value of *generator*'s `[[GeneratorState]]` internal slot to "suspendedYield".
6. Remove *genContext* from the execution context stack and restore the execution context that is at the top of the execution context stack as the running execution context.
7. Set the code evaluation state of *genContext* such that when evaluation is resumed with a Completion *resumptionValue* the following steps will be performed:
 1. Return *resumptionValue*.
 2. NOTE: This returns to the evaluation of the *YieldExpression* production that originally called this abstract operation.
8. Return *NormalCompletion*(*iterNextObj*).
9. NOTE: This returns to the evaluation of the operation that had most previously resumed evaluation of *genContext*.

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25.4 Promise Objects

A Promise is an object that is used as a placeholder for the eventual results of a deferred (and possibly asynchronous) computation.

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Any Promise object is in one of three mutually exclusive states: *fulfilled*, *rejected*, and *pending*:

- A promise *p* is fulfilled if *p.then(f, r)* will immediately enqueue a *Job* to call the function *f*.
- A promise *p* is rejected if *p.then(f, r)* will immediately enqueue a *Job* to call the function *r*.
- A promise is pending if it is neither fulfilled nor rejected.

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A promise is said to be *settled* if it is not pending, i.e. if it is either fulfilled or rejected.

A promise is *resolved* if it is settled or if it has been "locked in" to match the state of another promise. Attempting to resolve or reject a resolved promise has no effect. A promise is *unresolved* if it is not resolved. An unresolved promise is always in the pending state. A resolved promise may be pending, fulfilled or rejected.

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25.4.1 Promise Abstract Operations

25.4.1.1 PromiseCapability Records

A PromiseCapability is a Record value used to encapsulate a promise object along with the functions that are capable of resolving or rejecting that promise object. PromiseCapability records are produced by the NewPromiseCapability abstract operation.

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PromiseCapability Records have the fields listed in [Table 50](#).

Table 50 — PromiseCapability Record Fields

Field Name	Value	Meaning
<code>[[Promise]]</code>	An object	An object that is usable as a promise.
<code>[[Resolve]]</code>	A function object	The function that is used to resolve the given promise object.
<code>[[Reject]]</code>	A function object	The function that is used to reject the given promise object.

25.4.1.1.1 IfAbruptRejectPromise (value, capability)

IfAbruptRejectPromise is a short hand for a sequence of algorithm steps that use a PromiseCapability record. An algorithm step of the form:

1. IfAbruptRejectPromise(*value*, *capability*).

means the same thing as:

1. If *value* is an abrupt completion,
 - a. Let *rejectResult* be Call(*capability*.`[[Reject]]`, *undefined*, *value*.`[[value]]`).
 - b. ReturnIfAbrupt(*rejectResult*).
 - c. Return *capability*.`[[Promise]]`.
2. Else if *value* is a Completion Record, let *value* be *value*.`[[value]].`

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25.4.1.2 PromiseReaction Records

The PromiseReaction is a Record value used to store information about how a promise should react when it becomes resolved or rejected with a given value. PromiseReaction records are created by the `then` method of the Promise prototype, and are used by a [PromiseReactionJob](#).

PromiseReaction records have the fields listed in [Table 51](#).

Table 51—PromiseReaction Record Fields

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Field Name	Value	Meaning
<code>[[Capabilities]]</code>	A PromiseCapability record	The capabilities of the promise for which this record provides a reaction handler.
<code>[[Handler]]</code>	A function object <u>or a</u> <u>String</u>	The function that should be applied to the incoming value, and whose return value will govern what happens to the derived promise. If <code>[[Handler]]</code> is "Identity" it is equivalent to a function that simply returns its first argument. If <code>[[Handler]]</code> is "Thrower" it is equivalent to a function that throws its first argument as an exception.

25.4.1.3 CreateResolvingFunctions (promise)

When `CreateResolvingFunctions` is performed with argument `promise`, the following steps are taken:

1. Let `alreadyResolved` be a new Record { `[[value]]: false` }.
2. Let `resolve` be a new built-in function object as defined in Promise Resolve Functions (25.4.1.4.2).
3. Set the `[[Promise]]` internal slot of `resolve` to `promise`.
4. Set the `[[AlreadyResolved]]` internal slot of `resolve` to `alreadyResolved`.
5. Let `reject` be a new built-in function object as defined in Promise Reject Functions (25.4.1.4.1).
6. Set the `[[Promise]]` internal slot of `reject` to `promise`.
7. Set the `[[AlreadyResolved]]` internal slot of `reject` to `alreadyResolved`.
8. Return a new Record { `[[Resolve]]: resolve, [[Reject]]: reject` }.

25.4.1.3.1 Promise Reject Functions

A promise reject function is an anonymous built-in function that has `[[Promise]]` and `[[AlreadyResolved]]` internal slots.

Deleted: `<#>AllocatePromise (constructor)`

The abstract operation `AllocatePromise` allocates a new promise object using the `constructor` argument. ¶

```
<#>Let obj be
OrdinaryCreateFromConstructor(constructor,
"PromisePrototype%", «[[PromiseState]],
[[PromiseConstructor]], [[PromiseResult]],
[[PromiseFulfillReactions]],
[[PromiseRejectReactions]]»).¶
<#>Set the value of obj's [[PromiseConstructor]] internal slot to constructor.¶
<#>Return obj.¶
```

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When a promise reject function `F` is called with argument `reason`, the following steps are taken:

1. Assert: `F` has a `[[Promise]]` internal slot whose value is an Object.
2. Let `promise` be the value of `F`'s `[[Promise]]` internal slot.
3. Let `alreadyResolved` be the value of `F`'s `[[AlreadyResolved]]` internal slot.
4. If `alreadyResolved.[[value]]` is true, return undefined.
5. Set `alreadyResolved.[[value]]` to true.
6. Return `RejectPromise(promise, reason)`.

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25.4.1.3.2 Promise Resolve Functions

A promise resolve function is an anonymous built-in function that has `[[Promise]]` and `[[AlreadyResolved]]` internal slots.

When a promise resolve function `F` is called with argument `resolution`, the following steps are taken:

1. Assert: `F` has a `[[Promise]]` internal slot whose value is an Object.
2. Let `promise` be the value of `F`'s `[[Promise]]` internal slot.
3. Let `alreadyResolved` be the value of `F`'s `[[AlreadyResolved]]` internal slot.
4. If `alreadyResolved.[[value]]` is true, return undefined.
5. Set `alreadyResolved.[[value]]` to true.

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6. If SameValue(*resolution*, *promise*) is **true**, then
 - a. Let *selfResolutionError* be a newly-created **TypeError** object.
 - b. Return RejectPromise(*promise*, *selfResolutionError*).
7. If Type(*resolution*) is not Object, then
 - a. Return FulfillPromise(*promise*, *resolution*).
8. Let *then* be Get(*resolution*, "then").
9. If *then* is an abrupt completion, then
 - a. Return RejectPromise(*promise*, *then*.[[value]]).
10. Let *then* be *then*.[[value]].
11. If IsCallable(*then*) is **false**, then
 - a. Return FulfillPromise(*promise*, *resolution*).
- 12. Perform EnqueueJob ("PromiseJobs", PromiseResolveThenableJob, <*promise*, *resolution*, *then*>)**
13. Return **undefined**.

25.4.1.4 FulfillPromise (*promise*, *value*)

When the FulfillPromise abstract operation is called with arguments *promise* and *value* the following steps are taken:

1. Assert: the value of *promise*'s [[PromiseState]] internal slot is "**pending**".
2. Let *reactions* be the value of *promise*'s [[PromiseFulfillReactions]] internal slot.
3. Set the value of *promise*'s [[PromiseResult]] internal slot to *value*.
4. Set the value of *promise*'s [[PromiseFulfillReactions]] internal slot to **undefined**.
5. Set the value of *promise*'s [[PromiseRejectReactions]] internal slot to **undefined**.
6. Set the value of *promise*'s [[PromiseState]] internal slot to "**fulfilled**".
7. Return TriggerPromiseReactions(*reactions*, *value*).

25.4.1.5 NewPromiseCapability (*C*)

The abstract operation NewPromiseCapability takes a constructor function, and attempts to use that constructor function in the fashion of the built-in **Promise** constructor to create a Promise object and extract its resolve and reject functions. The promise plus the resolve and reject functions are used to initialize a new PromiseCapability record which is returned as the value of this abstract operation.

1. If IsConstructor(*C*) is **false**, throw a **TypeError** exception.
- NOTE** *C* is assumed to be a constructor function that supports the parameter conventions of the **Promise** constructor (see 25.4.3.1).
3. Let *promiseCapability* be a new PromiseCapability { [[Promise]]: **undefined**, [[Resolve]]: **undefined**, [[Reject]]: **undefined** }.
4. Let *executor* be a new built-in function object as defined in GetCapabilitiesExecutor Functions (25.4.1.6.1).
5. Set the [[Capability]] internal slot of *executor* to *promiseCapability*.
6. Let *promise* be Construct(*constructor*, <*executor*>).
7. ReturnIfAbrupt(*promise*).
8. If IsCallable(*promiseCapability*.[[Resolve]]) is **false**, throw a **TypeError** exception.
9. If IsCallable(*promiseCapability*.[[Reject]]) is **false**, throw a **TypeError** exception.
10. **Set *promiseCapability*.[[Promise]] to *promise*.**
11. Return *promiseCapability*.

NOTE This abstract operation supports Promise subclassing, as it is generic on any constructor that calls a passed executor function argument in the same way as the Promise constructor. It is used to generalize static methods of the Promise constructor to any subclass.

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 <#>Let *resolvingFunctions* be CreateResolvingFunctions(*promise*).¶
 <#>Let *thenCallResult* be the result of calling the [[Call]] internal method of *then* passing *resolution* as the *thisArgument* and *resolvingFunctions*.[[Resolve]], *resolvingFunctions*.[[Reject]] as *argumentsList*.¶
 <#>If *thenCallResult* is an abrupt completion,¶
 Return the result of calling the [[Call]] internal method of *resolvingFunctions*.[[Reject]] passing *undefined* as the *thisArgument* and (*thenCallResult*.[[value]]) as *argumentsList*.

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Deleted: <#>If IsConstructor(*C*) is **false**, throw a **TypeError** exception.¶
 <#>Assert: *C* is a constructor function that supports the parameter conventions of the **Promise** constructor (see 25.4.3.1).¶

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Deleted: If Type(*constructorResult*) is Object and SameValue(*promise*, *constructorResult*) is **false**, then throw a **TypeError** exception.

25.4.1.5.1 GetCapabilitiesExecutor Functions

A GetCapabilitiesExecutor function is an anonymous built-in function that has a [[Capability]] internal slot.

When a GetCapabilitiesExecutor function *F* is called with arguments *resolve* and *reject* the following steps are taken:

1. Assert: *F* has a [[Capability]] internal slot whose value is a PromiseCapability Record.
2. Let *promiseCapability* be the value of *F*'s [[Capability]] internal slot.
3. If *promiseCapability*.[[Resolve]] is not **undefined**, **throw** a **TypeError** exception.
4. If *promiseCapability*.[[Reject]] is not **undefined**, **throw** a **TypeError** exception.
5. Set *promiseCapability*.[[Resolve]] to *resolve*.
6. Set *promiseCapability*.[[Reject]] to *reject*.
7. Return **undefined**.

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25.4.1.6 IsPromise (*x*)

The abstract operation IsPromise checks for the promise brand on an object.

1. If *Type(x)* is not *Object*, return **false**.
2. If *x* does not have a [[PromiseState]] internal slot, return **false**.
3. **Return true.**

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25.4.1.7 RejectPromise (*promise*, *reason*)

When the RejectPromise abstract operation is called with arguments *promise* and *reason* the following steps are taken:

1. Assert: the value of *promise*'s [[PromiseState]] internal slot is "**pending**".
2. Let *reactions* be the value of *promise*'s [[PromiseRejectReactions]] internal slot.
3. Set the value of *promise*'s [[PromiseResult]] internal slot to *reason*.
4. Set the value of *promise*'s [[PromiseFulfillReactions]] internal slot to **undefined**.
5. Set the value of *promise*'s [[PromiseRejectReactions]] internal slot to **undefined**.
6. Set the value of *promise*'s [[PromiseState]] internal slot to "**rejected**".
7. Return TriggerPromiseReactions(*reactions*, *reason*).

25.4.1.8 TriggerPromiseReactions (*reactions*, *argument*)

The abstract operation TriggerPromiseReactions takes a collection of functions to trigger in the next **Job**, and calls them, passing each the given argument. Typically, these reactions will modify a previously-returned promise, possibly calling in to a user-supplied handler before doing so.

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1. Repeat for each *reaction* in *reactions*, in original insertion order.
 - a. Perform **EnqueueJob("PromiseJobs", "PromiseReactionJob", reaction, argument)**.
2. Return **undefined**.

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25.4.2 Promise Jobs

25.4.2.1 PromiseReactionJob (reaction, argument)

The job PromiseReactionJob with parameters *reaction* and *argument* applies the appropriate handler to the incoming value, and uses the handler's return value to resolve or reject the derived promise associated with that handler.

1. Assert: *reaction* is a PromiseReaction Record.
2. Let *promiseCapability* be *reaction*.*[[Capabilities]]*.
3. Let *handler* be *reaction*.*[[Handler]]*.
4. If *handler* is "Identity", let *handlerResult* be NormalCompletion(*argument*).
5. Else if *handler* is "Thrower", let *handlerResult* be Completion{*[[type]]*: throw, *[[value]]*: *argument*, *[[target]]*: empty}.
6. Else, let *handlerResult* be Call(*handler*, undefined, *argument*).
7. If *handlerResult* is an abrupt completion, then
 - a. Let *status* be Call(*promiseCapability*.*[[Reject]]*, undefined, *handlerResult*.*[[value]]*).
 - b. NextJob *status*.
8. Let *handlerResult* be *handlerResult*.*[[value]]*.
9. Let *status* be Call(*promiseCapability*.*[[Resolve]]*, undefined, *handlerResult*).
10. NextJob *status*.

25.4.2.2 PromiseResolveThenableJob (promiseToResolve, thenable, then)

The job PromiseResolveThenableJob with parameters *promiseToResolve*, *thenable*, and *then* performs the following steps:

1. Let *resolvingFunctions* be CreateResolvingFunctions(*promiseToResolve*).
2. Let *thenCallResult* be Call(*then*, *thenable*, *resolvingFunctions*.*[[Resolve]]*, *resolvingFunctions*.*[[Reject]]*).
3. If *thenCallResult* is an abrupt completion,
 - a. Let *status* be Call(*resolvingFunctions*.*[[Reject]]*, undefined, *thenCallResult*.*[[value]]*).
 - b. NextJob *status*.
4. NextJob *thenCallResult*.

NOTE This Job uses the supplied thenable and its then method to resolve the given promise. This process must take place as a Job to ensure that the evaluation of the then method occurs after evaluation of any surrounding code has completed.

25.4.3 The Promise Constructor

The Promise constructor is the %Promise% intrinsic object and the initial value of the **Promise** property of the global object. When called as a constructor it creates and initializes a new Promise object. **Promise** is not intended to be called as a function and will throw an exception when called in that manner.

The **Promise** constructor is designed to be subclassable. It may be used as the value in an **extends** clause of a class definition. Subclass constructors that intend to inherit the specified **Promise** behaviour must include a **super** call to the **Promise** constructor to create and initialize the subclass instance with the internal state necessary to support the **Promise** and **Promise.prototype** built-in methods.

25.4.3.1 Promise (executor)

When the **Promise** function is called with argument *executor* the following steps are taken:

1. If *NewTarget* is **undefined**, throw a **TypeError** exception.
2. If *IsCallable(executor)* is **false**, **throw** a **TypeError** exception.
3. Let *promise* be *OrdinaryCreateFromConstructor(NewTarget, "%PromisePrototype%", «[[PromiseState]], [[PromiseConstructor]], [[PromiseResult]], [[PromiseFulfillReactions]], [[PromiseRejectReactions]]»).*
4. **ReturnIfAbrupt(promise).**
5. Set the value of *promise*'s [[PromiseConstructor]] internal slot to *NewTarget*.
6. Set *promise*'s [[PromiseState]] internal slot to "**pending**".
7. Set *promise*'s [[PromiseFulfillReactions]] internal slot to a new empty List.
8. Set *promise*'s [[PromiseRejectReactions]] internal slot to a new empty List.
9. Let *resolvingFunctions* be *CreateResolvingFunctions(promise)*.
10. Let *completion* be *Call(executor, undefined, «resolvingFunctions.[[Resolve]], resolvingFunctions.[[Reject]]»)*.
11. If *completion* is an abrupt completion, then
 - a. Let *status* be *Call(resolvingFunctions.[[Reject]], undefined, «completion.[[value]]»)*.
 - b. **ReturnIfAbrupt(status).**
12. **Return promise.**

NOTE The *executor* argument must be a function object. It is called for initiating and reporting completion of the possibly deferred action represented by this **Promise** object. The *executor* is called with two arguments: *resolve* and *reject*. These are functions that may be used by the *executor* function to report eventual completion or failure of the deferred computation. Returning from the *executor* function does not mean that the deferred action has been completed but only that the request to eventually perform the deferred action has been accepted.

The *resolve* function that is passed to an *executor* function accepts a single argument. The *executor* code may eventually call the *resolve* function to indicate that it wishes to resolve the associated **Promise** object. The argument passed to the *resolve* function represents the eventual value of the deferred action and can be either the actual fulfillment value or another **Promise** object which will provide the value if it is fulfilled.

The *reject* function that is passed to an *executor* function accepts a single argument. The *executor* code may eventually call the *reject* function to indicate that the associated **Promise** is rejected and will never be fulfilled. The argument passed to the *reject* function is used as the rejection value of the promise. Typically it will be an **Error** object.

The *resolve* and *reject* functions passed to an *executor* function by the **Promise** constructor have the capability to actually resolve and reject the associated promise. Subclasses may have different constructor behaviour that passes in customized values for *resolve* and *reject*.

25.4.4 Properties of the Promise Constructor

The value of the [[Prototype]] internal slot of the **Promise** constructor is the **intrinsic object %FunctionPrototype%** (19.2.3).

Besides the **length** property (whose value is 1), the **Promise** constructor has the following properties:

25.4.4.1 Promise.all (iterable)

The **all** function returns a new promise which is fulfilled with an array of fulfillment values for the passed promises, or rejects with the reason of the first passed promise that rejects. It resolves all elements of the passed iterable to promises as it runs this algorithm.

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Deleted: <#>If <i>promise</i> does not have a [[PromiseState]] internal slot, then throw a TypeError exception.¶ <#>If <i>promise</i> 's [[PromiseState]] internal slot is not undefined , then throw a TypeError exception.¶
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Deleted: <#>Return <i>InitializePromise(promise, executor)</i> .¶
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The abstract operation <i>InitializePromise</i> initializes a newly allocated <i>promise</i> object using an <i>executor</i> function.¶ <#>Assert: <i>promise</i> has a [[PromiseState]] internal slot and its value is undefined .¶ <#>Assert: <i>IsCallable(executor)</i> is true .¶ <#>Set <i>promise</i> 's [[PromiseState]] internal slot to " pending ".¶ <#>Set <i>promise</i> 's [[PromiseFulfillReactions]] internal slot to a new empty List.¶ <#>Set <i>promise</i> 's [[PromiseRejectReactions]] internal slot to a new empty List.¶ <#>Let <i>resolvingFunctions</i> be <i>CreateResolvingFunctions(promise)</i> .¶ <#>Let <i>completion</i> be the result of calling the [[Call]] internal method of (<i>executor</i> , with undefined , as <i>thisArgument</i> and « <i>resolvingFunctions.[[Resolve]], resolvingFunctions.[[Reject]]</i> ») as <i>argumentsList</i>).¶ <#>If <i>completion</i> is an abrupt completion, then ¶ <#>Let <i>status</i> be the result of calling the [[Call]] internal method of (<i>resolvingFunctions.[[Reject]]</i> , with undefined , as <i>thisArgument</i> and « <i>completion.[[value]]</i> ») as <i>argumentsList</i>).¶
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...

1. Let *C* be the **this** value.
2. If *Type(C)* is not *Object*, throw a **TypeError** exception.
3. Let *S* be *Get(C, @@species)*.
4. *ReturnIfAbrupt(S)*.
5. If *S* is neither **undefined** nor **null**, let *C* be *S*.
6. Let *promiseCapability* be *NewPromiseCapability(C)*.
7. *ReturnIfAbrupt(promiseCapability)*.
8. Let *iterator* be *GetIterator(iteratorable)*.
9. *IfAbruptRejectPromise(iterator, promiseCapability)*.
10. Let *result* be *PerformPromiseAll(iterator, C, promiseCapability)*.
11. If *result* is an abrupt completion,
 - a. Let *result* be *IteratorClose(iterator, result)*.
 - b. *IfAbruptRejectPromise(result, promiseCapability)*.
12. *Return result.[[value]]*.

Note: The **all** function requires its **this** value to be a constructor function that supports the parameter conventions of the **Promise** constructor.

25.4.4.1.1 PerformPromiseAll(iterator, constructor, resultCapability) Abstract Operation

When the *PerformPromiseAll* abstract operation is called with arguments *iterator*, *constructor*, and *resultCapability* the following steps are taken:

1. Assert: *iterator* is an object that supports the *Iterator* interface.
2. Assert: *constructor* is a constructor function.
3. Assert: *resultCapability* is a *PromiseCapability* record.
4. Let *values* be a new empty List.
5. Let *remainingElementsCount* be a new Record { [[value]]: 1 }.
6. Let *index* be 0.
7. Repeat,
 - a. Let *next* be *IteratorStep(iterator)*.
 - b. *ReturnIfAbrupt(next)*.
 - c. If *next* is **false**,
 - i. Set *remainingElementsCount.[[value]]* to *remainingElementsCount.[[value]] - 1*.
 - ii. If *remainingElementsCount.[[value]]* is 0,
 1. Let *valuesArray* be *CreateArrayFromList(values)*.
 2. Let *resolveResult* be *Call(resultCapability, [[Resolve]], undefined, valuesArray)*.
 3. If *resolveResult* is an abrupt completion, return *NormalCompletion(resolveResult)*.
 - iii. Return *resultCapability*.[[Promise]].
 - d. Let *nextValue* be *IteratorValue(next)*.
 - e. *ReturnIfAbrupt(nextValue)*.
 - f. Append **undefined** to *values*.
 - g. Let *nextPromise* be *Invoke(constructor, "resolve", nextValue)*.
 - h. *ReturnIfAbrupt(nextPromise)*.
 - i. Let *resolveElement* be a new built-in function object as defined in *Promise.all* Resolve Element Functions.
 - j. Set the [[AlreadyCalled]] internal slot of *resolveElement* to a new Record { [[value]]: false }.
 - k. Set the [[Index]] internal slot of *resolveElement* to *index*.
 - l. Set the [[Values]] internal slot of *resolveElement* to *values*.
 - m. Set the [[Capabilities]] internal slot of *resolveElement* to *resultCapability*.
 - n. Set the [[RemainingElements]] internal slot of *resolveElement* to *remainingElementsCount*.
 - o. Set *remainingElementsCount.[[value]]* to *remainingElementsCount.[[value]] + 1*.
 - p. Let *result* be *Invoke(nextPromise, "then", resolveElement, resultCapability, [[Reject]])*.

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- q. [ReturnIfAbrupt\(result\)](#).
 r. Set *index* to *index* + 1.

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25.4.4.1.2 Promise.all Resolve Element Functions

A Promise.all resolve element function is an anonymous built-in function that is used to resolve a specific Promise.all element. Each Promise.all resolve element function has **[[Index]]**, **[[Values]]**, **[[Capabilities]]**, **[[RemainingElements]]**, and **[[AlreadyCalled]]** internal slots.

When a Promise.all resolve element function *F* is called with argument *x*, the following steps are taken:

1. Let *alreadyCalled* be the value of *F*'s **[[AlreadyCalled]]** internal slot.
2. If *alreadyCalled*.**[[value]]** is **true**, return **undefined**.
3. Set *alreadyCalled*.**[[value]]** to **true**.
4. Let *index* be the value of *F*'s **[[Index]]** internal slot.
5. Let *values* be the value of *F*'s **[[Values]]** internal slot.
6. Let *promiseCapability* be the value of *F*'s **[[Capabilities]]** internal slot.
7. Let *remainingElementsCount* be the value of *F*'s **[[RemainingElements]]** internal slot.
8. Set *values*[*index*] to *x*.
9. Set *remainingElementsCount*.**[[value]]** to *remainingElementsCount*.**[[value]]** - 1.
10. If *remainingElementsCount*.**[[value]]** is 0,
 - a. Let *valuesArray* be **CreateArrayFromList(values)**.
 - b. Return **Call(promiseCapability, [[Resolve]], undefined, valuesArray)**.
11. Return **undefined**.

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<#>
<#>Let *next* be **IteratorStep(iterator)**.
<#>**IfAbruptRejectPromise(next, promiseCapability)**.
<#> If *next* is **false**, return *promiseCapability*.**[[Promise]]**.
<#> Let *nextValue* be **IteratorValue(next)**.
<#>**IfAbruptRejectPromise(nextValue, promiseCapability)**.
<#> Let *nextPromise* be **Invoke(C, "resolve", (nextValue))**.
<#>**IfAbruptRejectPromise(nextPromise, promiseCapability)**.
<#> Let *result* be **Invoke(nextPromise, "then", (promiseCapability.[[Resolve]], promiseCapability.[[Reject]])).
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25.4.4.2 Promise.prototype

The initial value of **Promise.prototype** is the Promise prototype object ([25.4.5](#)).

This property has the attributes { **[[Writable]]: false**, **[[Enumerable]]: false**, **[[Configurable]]: false** }.

25.4.4.3 Promise.race (iterable)

The **race** function returns a new promise which is settled in the same way as the first passed promise to settle. It resolves all elements of the passed iterable to promises as it runs this algorithm.

1. Let *C* be the **this** value.
2. If **Type(C)** is not **Object**, throw a **TypeError** exception.
3. Let *S* be **Get(C, @@species)**.
4. ReturnIfAbrupt(*S*).
5. If *S* is neither **undefined** nor **null**, let *C* be *S*.
6. Let *promiseCapability* be **NewPromiseCapability(C)**.
7. ReturnIfAbrupt(*promiseCapability*).
8. Let *iterator* be **GetIterator(iterable)**.
9. If **AbruptRejectPromise(iterator, promiseCapability)**.
10. Let *result* be **PerformPromiseRaceLoop(iterator, promiseCapability, C)**.
11. If *result* is an abrupt completion, then let *result* be **IteratorClose(iterator, result)**.
12. If **AbruptRejectPromise(result, promiseCapability)**.
13. Return *promiseCapability*.**[[Promise]]**.

NOTE 1 If the **iterable** argument is empty or if none of the promises in **iterable** ever settle then the pending promise returned by this method will never be settled

NOTE 2 The `race` function expects its `this` value to be a constructor function that supports the parameter conventions of the `Promise` constructor. It also expects that its `this` value provides a `resolve` method.

25.4.4.3.1 PerformPromiseRaceLoop(iterator, promiseCapability, C)

When the `PerformPromiseRaceLoop` abstract operation is called with arguments `iterator`, `promiseCapability`, and `C` the following steps are taken:

1. Repeat
 - a. Let `next` be `IteratorStep(iterator)`.
 - b. `ReturnIfAbrupt(next)`.
 - c. If `next` is `false`, return `promiseCapability.[[Promise]]`.
 - d. Let `nextValue` be `IteratorValue(next)`.
 - e. `ReturnIfAbrupt(nextValue)`.
 - f. Let `nextPromise` be `Invoke(C, "resolve", «nextValue»)`.
 - g. `ReturnIfAbrupt(nextPromise)`.
 - h. Let `result` be `Invoke(nextPromise, "then", «promiseCapability.[[Resolve]], promiseCapability.[[Reject]]»)`.
 - i. `ReturnIfAbrupt(result)`.

25.4.4.4 Promise.reject (r)

The `reject` function returns a new promise rejected with the passed argument.

1. Let `C` be the `this` value.
2. If `Type(C)` is not `Object`, throw a `TypeError` exception.
3. Let `S` be `Get(C, @@species)`.
4. `ReturnIfAbrupt(S)`.
5. If `S` is neither `undefined` nor `null`, let `C` be `S`.
6. Let `promiseCapability` be `NewPromiseCapability(C)`.
7. `ReturnIfAbrupt(promiseCapability)`.
8. Let `rejectResult` be `Call(promiseCapability.[[Reject]], undefined, «r»)`.
9. `ReturnIfAbrupt(rejectResult)`.
10. Return `promiseCapability.[[Promise]]`.

NOTE The `reject` function requires that its `this` value to be a constructor function that supports the parameter conventions of the `Promise` constructor.

25.4.4.5 Promise.resolve (x)

The `resolve` function returns either a new promise resolved with the passed argument, or the argument itself if the argument is a promise produced by this constructor.

1. Let `C` be the `this` value.
2. If `IsPromise(x)` is `true`.
 - a. Let `constructor` be the value of `x`'s `[[PromiseConstructor]]` internal slot.
 - b. If `SameValue(constructor, C)` is `true`, return `x`.
3. If `Type(C)` is not `Object`, throw a `TypeError` exception.
4. Let `S` be `Get(C, @@species)`.
5. `ReturnIfAbrupt(S)`.
6. If `S` is neither `undefined` nor `null`, let `C` be `S`.
7. Let `promiseCapability` be `NewPromiseCapability(C)`.
8. `ReturnIfAbrupt(promiseCapability)`.

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9. Let *resolveResult* be *Call(promiseCapability.[[Resolve]], undefined)*.
10. ReturnIfAbrupt(*resolveResult*).
11. Return *promiseCapability.[[Promise]]*.

NOTE The `resolve` function requires that its `this` value to be a constructor function that supports the parameter conventions of the `Promise` constructor.

25.4.4.6 `get Promise [@@species]`

`Promise[@@species]` is an accessor property whose set accessor function is `undefined`. Its `get` accessor function performs the following steps:

1. Return `this`.

The value of the `name` property of this function is "`get [Symbol.species]`".

NOTE Promise prototype methods normally use their `this` object's constructor to create a derived object. However, a subclass constructor may over-ride that default behaviour by redefining its `@@species` property.

25.4.5 Properties of the Promise Prototype Object

The value of the `[[Prototype]]` internal slot of the Promise prototype object is the [intrinsic object %ObjectPrototype%](#) (19.1.3). The Promise prototype object is an ordinary object. It does not have a `[[PromiseState]]` internal slot or any of the other internal slots of Promise instances.

25.4.5.1 `Promise.prototype.catch (onRejected)`

When the `catch` method is called with argument `onRejected` the following steps are taken:

1. Let *promise* be the `this` value.
2. Return *Invoke(promise, "then", undefined, onRejected)*.

25.4.5.2 `Promise.prototype.constructor`

The initial value of `Promise.prototype.constructor` is the [intrinsic object %Promise%](#).

25.4.5.3 `Promise.prototype.then (onFulfilled , onRejected)`

When the `then` method is called with arguments `onFulfilled` and `onRejected` the following steps are taken:

1. Let *promise* be the `this` value.
2. If `IsPromise(promise)` is `false`, throw a `TypeError` exception.
3. Let *C* be `SpeciesConstructor(promise, %Promise%)`.
4. ReturnIfAbrupt(*C*).
5. Let *resultCapability* be `NewPromiseCapability(C)`.
6. ReturnIfAbrupt(*resultCapability*).
7. Return `PerformPromiseThen(promise, onFulfilled, onRejected, resultCapability)`.

25.4.5.3.1 `PerformPromiseThen (promise, onFulfilled, onRejected, resultCapability)`

The abstract operation `PerformPromiseThen` performs the “`then`” operation on `promise` using `onFulfilled` and `onRejected` as its settlement actions. The result is `resultCapability`'s `promise`.

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The `@@create` method of a Promise function object *F* performs the following steps:
`<#>Let F be the this value.¶`

`<#>Return AllocatePromise(F).¶`

The value of the `name` property of this function is "`[Symbol.create]`".
This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.`

`<#>AllocatePromise (constructor) ¶`

The abstract operation `AllocatePromise` allocates a new promise object using the `constructor` argument.
`<#>Let obj be`

`OrdinaryCreateFromConstructor(constructor, "%PromisePrototype%", {[[PromiseState]], [[PromiseConstructor]], [[PromiseResult]], [[PromiseFulfillReactions]], [[PromiseRejectReactions]]}).¶`

`<#>Set the value of obj's [[PromiseConstructor]] internal slot to constructor.¶`

`<#>Return obj.¶`

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1. Assert: IsPromise(*promise*) is **true**.
2. Assert: *resultCapability* is a PromiseCapability record.
3. If *IsCallable*(*onFulfilled*) is **false**, then
 - a. Let *onFulfilled* be **"Identity"**.
4. If *IsCallable*(*onRejected*) is **false**, then
 - a. Let *onRejected* be **"Thrower"**.
5. Let *fulfillReaction* be the PromiseReaction { [[Capabilities]]: *resultCapability*, [[Handler]]: *onFulfilled* }.
6. Let *rejectReaction* be the PromiseReaction { [[Capabilities]]: *resultCapability*, [[Handler]]: *onRejected* }.
7. If the value of *promise*'s [[PromiseState]] internal slot is **"pending"**.
 - a. Append *fulfillReaction* as the last element of the List that is the value of *promise*'s [[PromiseFulfillReactions]] internal slot.
 - b. Append *rejectReaction* as the last element of the List that is the value of *promise*'s [[PromiseRejectReactions]] internal slot.
8. Else if the value of *promise*'s [[PromiseState]] internal slot is **"fulfilled"**.
 - a. Let *value* be the value of *promise*'s [[PromiseResult]] internal slot.
 - b. Perform *EnqueueJob*("PromiseJobs", *PromiseReactionJob*, *fulfillReaction*, *value*).
9. Else if the value of *promise*'s [[PromiseState]] internal slot is **"rejected"**.
 - a. Let *reason* be the value of *promise*'s [[PromiseResult]] internal slot.
 - b. Perform *EnqueueJob*("PromiseJobs", *PromiseReactionJob*, *rejectReaction*, *reason*).
10. Return *resultCapability*[[Promise]].

25.4.5.4 Promise.prototype [@@toStringTag]

The initial value of the @@toStringTag property is the string value **"Promise"**.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **true** }.

25.4.6 Properties of Promise Instances

Promise instances are ordinary objects that inherit properties from the Promise prototype object (the intrinsic, %PromisePrototype%). Promise instances are initially created with the internal slots described in Table 52.

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Deleted: <#>Identity Functions¶ <#>An identity function is an anonymous built-in function that when called with argument <i>x</i> , performs the following steps:¶ <#>Return <i>x</i> .¶ <#>Promise Resolution Handler Functions¶ <#>A promise resolution handler function is an anonymous built-in function that has the ability to handle a promise being resolved, by "unwrapping" any incoming values until they are no longer promises or thenables and can be passed to the appropriate fulfillment handler.¶
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Table 52 — Internal Slots of Promise Instances

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Internal Slot	Description
<code>[[PromiseState]]</code>	A string value that governs how a promise will react to incoming calls to its <code>then</code> method. The possible values are: <code>undefined</code> , <code>"pending"</code> , <code>"fulfilled"</code> , and <code>"rejected"</code> .
<code>[[PromiseConstructor]]</code>	The function object that was used to construct this promise. Checked by the <code>resolve</code> method of the <code>Promise</code> constructor.
<code>[[PromiseResult]]</code>	The value with which the promise has been fulfilled or rejected, if any. Only meaningful if <code>[[PromiseState]]</code> is not <code>"pending"</code> .
<code>[[PromiseFulfillReactions]]</code>	A List of <code>PromiseReaction</code> records to be processed when/if the promise transitions from the <code>"pending"</code> state to the <code>"fulfilled"</code> state.
<code>[[PromiseRejectReactions]]</code>	A List of <code>PromiseReaction</code> records to be processed when/if the promise transitions from the <code>"pending"</code> state to the <code>"rejected"</code> state.

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26 Reflection

26.1 The Reflect Object

The Reflect object is a single ordinary object.

The value of the `[[Prototype]]` internal slot of the Reflect object is the [intrinsic object %ObjectPrototype%](#), (19.1.3).

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The Reflect object is not a function object. It does not have a `[[Construct]]` internal method; it is not possible to use the Reflect object as a constructor with the `new` operator. The Reflect object also does not have a `[[Call]]` internal method; it is not possible to invoke the Reflect object as a function.

26.1.1 Reflect.apply (target, thisArgument, argumentsList)

When the `apply` function is called with arguments `target`, `thisArgument`, and `argumentsList` the following steps are taken:

1. If `IsCallable(target)` is `false`, throw a `TypeError` exception.
2. Let `args` be `CreateListFromArrayLike(argumentsList)`.
3. `ReturnIfAbrupt(args)`.
4. Perform the `PrepareForTailCall` abstract operation.
5. `Return Call(target, thisArgument, args)`.

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<#>ReturnIfAbrupt(`obj`).¶

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<#>ReturnIfAbrupt(`obj`).¶

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26.1.2 Reflect.construct (target, argumentsList [, newTarget])

When the `construct` function is called with arguments `target`, `argumentsList`, and `newTarget` the following steps are taken:

1. If `IsConstructor(target)` is `false`, throw a `TypeError` exception.
2. If `newTarget` is not present, let `newTarget` be `target`.

3. Else, if `IsConstructor(newTarget)` is `false`, throw a `TypeError` exception.
4. Let `args` be `CreateListFromArrayLike(argumentsList)`.
5. `ReturnIfAbrupt(args)`.
6. `Return Construct(target, args, newTarget)`.

26.1.3 `Reflect.defineProperty (target, propertyKey, attributes)`

When the `defineProperty` function is called with arguments `target`, `propertyKey`, and `attributes` the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. Let `key` be `ToPropertyKey(propertyKey)`.
3. `ReturnIfAbrupt(key)`.
4. Let `desc` be `ToPropertyDescriptor(attributes)`.
5. `ReturnIfAbrupt(desc)`.
6. Return the result of calling the `[[DefineOwnProperty]]` internal method of `target` with arguments `key`, and `desc`.

26.1.4 `Reflect.deleteProperty (target, propertyKey)`

When the `deleteProperty` function is called with arguments `target` and `propertyKey`, the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. Let `key` be `ToPropertyKey(propertyKey)`.
3. `ReturnIfAbrupt(key)`.
4. Return the result of calling the `[[Delete]]` internal method of `target` with argument `key`.

26.1.5 `Reflect.enumerate (target)`

When the `enumerate` function is called with argument `target` the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. Return the result of calling the `[[Enumerate]]` internal method of `target`.

26.1.6 `Reflect.get (target, propertyKey [, receiver])`

When the `get` function is called with arguments `target`, `propertyKey`, and `receiver` the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. Let `key` be `ToPropertyKey(propertyKey)`.
3. `ReturnIfAbrupt(key)`.
4. If `receiver` is not present, then
 - a. Let `receiver` be `target`.
5. Return the result of calling the `[[Get]]` internal method of `target` with arguments `key`, and `receiver`.

26.1.7 `Reflect.getOwnPropertyDescriptor (target, propertyKey)`

When the `getOwnPropertyDescriptor` function is called with arguments `target` and `propertyKey`, the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. Let `key` be `ToPropertyKey(propertyKey)`.

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Deleted: Let `obj` be `ToObject(target)`.

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3. ReturnIfAbrupt(key).
4. Let *desc* be the result of calling the [[GetOwnProperty]] internal method of *target* with argument *key*.
5. ReturnIfAbrupt(*desc*).
6. Return *FromPropertyDescriptor*(*desc*).

Deleted: *obj*

Deleted: the result of calling

26.1.8 Reflect.getPrototypeOf (target)

When the `getPrototypeOf` function is called with argument *target* the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. Return the result of calling the [[GetPrototypeOf]] internal method of *target*.

Deleted: , then throw

Deleted: Let *obj* be `ToObject(target)`.

Deleted: <#>`ReturnIfAbrupt(obj)`.

Deleted: *obj*

26.1.9 Reflect.has (target, propertyKey)

When the `has` function is called with arguments *target* and *propertyKey*, the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. Let *key* be `ToPropertyKey(propertyKey)`.
3. ReturnIfAbrupt(*key*).
4. Return the result of calling the [[HasProperty]] internal method of *target* with argument *key*.

Deleted: , then throw

Deleted: Let *obj* be `ToObject(target)`.

Deleted: <#>`ReturnIfAbrupt(obj)`.

Deleted: *obj*

26.1.10 Reflect.isExtensible (target)

When the `isExtensible` function is called with argument *target* the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. Return the result of calling the [[IsExtensible]] internal method of *target*.

Deleted: <#>`Reflect.hasOwn (target, propertyKey)`

When the `hasOwn` function is called with arguments *target* and *propertyKey*, the following steps are taken:

```
<#>Let obj be ToObject(target).
<#>ReturnIfAbrupt(obj).
<#>Let key be ToPropertyKey(propertyKey).
<#>ReturnIfAbrupt(key).
<#>Return the result of HasOwnProperty(obj, key).
```

Deleted: , then throw

Deleted: Let *obj* be `ToObject(target)`.

Deleted: <#>`ReturnIfAbrupt(obj)`.

Deleted: *obj*

Deleted: , then throw

Deleted: Let *obj* be `ToObject(target)`.

Deleted: <#>`ReturnIfAbrupt(obj)`.

Deleted: Return

Deleted: *obj*

Deleted: , then throw

Deleted: Let *obj* be `ToObject(target)`.

Deleted: <#>`ReturnIfAbrupt(obj)`.

Deleted: *obj*

Deleted: , then throw

Deleted: Let *obj* be `ToObject(target)`.

Deleted: <#>`ReturnIfAbrupt(obj)`.

Deleted: *obj*

26.1.11 Reflect.ownKeys (target)

When the `ownKeys` function is called with argument *target* the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. Let *keys* be the result of calling the [[OwnPropertyKeys]] internal method of *target*.
3. ReturnIfAbrupt(*keys*).
4. Return `CreateArrayFromList(keys)`.

26.1.12 Reflect.preventExtensions (target)

When the `preventExtensions` function is called with argument *target*, the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. Return the result of calling the [[PreventExtensions]] internal method of *target*.

Deleted: Let *obj* be `ToObject(target)`.

Deleted: <#>`ReturnIfAbrupt(obj)`.

26.1.13 Reflect.set (target, propertyKey, V [, receiver])

When the `set` function is called with arguments *target*, *V*, *propertyKey*, and *receiver* the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. Let *key* be `ToPropertyKey(propertyKey)`.
3. ReturnIfAbrupt(*key*).
4. If *receiver* is not present, then
 - a. Let *receiver* be *target*.

Deleted: , then throw

Deleted: Let *obj* be `ToObject(target)`.

Deleted: <#>`ReturnIfAbrupt(obj)`.

Deleted: *obj*

Deleted: , then throw

Deleted: Let *obj* be `ToObject(target)`.

Deleted: <#>`ReturnIfAbrupt(obj)`.

5. Return the result of calling the [[Set]] internal method of *target* with arguments *key*, *V*, and *receiver*.

Deleted: *obj*

26.1.14 Reflect.setPrototypeOf (target, proto)

When the `setPrototypeOf` function is called with arguments *target* and *protoKey*, the following steps are taken:

1. If `Type(target)` is not `Object`, throw a `TypeError` exception.
2. If `Type(proto)` is not `Object` and *proto* is not `null`, throw a `TypeError` exception.
3. Return the result of calling the [[SetPrototypeOf]] internal method of *target* with argument *proto*.

Deleted: , then throw

Deleted: Let *obj* be `ToObject(target)`.

Deleted: <#>`ReturnIfAbrupt(obj)`<||>

Deleted: , then throw

Deleted: *obj*

Deleted: <#>`Realm Objects`<||>

Deleted: <#>`The Reflect.Realm Constructor`<||>
The initialize value of `Reflect.Realm` is the %Realm% intrinsic object. `Reflect.Realm` is the constructor for Realm objects. When `Reflect.Realm` is called as a function rather than as a constructor, it initializes its `this` value with the internal state necessary to support the `Reflect.Realm.prototype` built-in methods.<||>

The `Reflect.Realm` constructor is designed to be subclassable. It may be used as the value in an `extends` clause of a class definition.

Subclass constructors that intend to inherit the specified Realm behaviour must include a `super` call to `Reflect.Realm`.<||>

<#>`Reflect.Realm ([options target , initializer handler])`<||>

When the `Reflect.Realm` function is called with optional arguments `options` *target* and `initializer` *handler* the following steps are taken:<||>
<#>Let *realmObject* be the this value.<||>
<#>If `Type(realmObject)` is not `Object` or *realmObject* does not have a [[RealmRecord]] internal slot, throw a `TypeError` exception.<||>
<#>If *realmObject* does not have a [[RealmRecord]] internal slot, throw a `TypeError` exception.<||>

Deleted: <#>`Loader Objects`<||>

Deleted: `Function`

Deleted: `d`

Deleted: The Proxy Constructor is a B

Deleted: `¶`

Deleted: The `Proxy` function is not intended to be directly called as a function. If it is called,<||>

Deleted: as part of a `new` expression it is a constructor: it creates and initializes a new

Deleted: `null`

Deleted: `¶`

Deleted: If `Proxy` is implemented as an ECMAScript function object, it most must hav...<||>

Deleted: `Function`

Deleted:

Deleted: 26.4.2.1.126.5.2.1

Deleted: the result of

26.2 Proxy Objects

26.2.1 The Proxy Constructor

The `Proxy` constructor is the %Proxy% intrinsic object and the initial value of the `Proxy` property of the global object. When called as a constructor it creates and initializes a new exotic proxy object. `Proxy` is not intended to be called as a function and will throw an exception when called in that manner.

`Proxy` The `Proxy` constructor may be used as the value in an `extends` clause of a class definition. Subclass constructors that intend to inherit the ability to create exotic proxy objects must include a `super` call to the `Proxy`.

26.2.1.1 Proxy (target, handler)

When `Proxy` is called with arguments *target* and *handler* performs the following steps:

1. If `NewTarget` is `undefined`, throw a `TypeError` exception.
2. Return `ProxyCreate(target, handler)`.

26.2.2 Properties of the Proxy Constructor

The value of the [[Prototype]] internal slot of the `Proxy` constructor is the intrinsic object %FunctionPrototype% (19.2.3).

Besides the `length` property (whose value is 2), the `Proxy` constructor has the following properties:

26.2.2.1 Proxy.revocable (target, handler)

The `Proxy.revocable` function is used to create a revocable Proxy object. When `Proxy.revocable` is called with arguments *target* and *handler* the following steps are taken:

1. Let *p* be `ProxyCreate(target, handler)`.
2. ReturnIfAbrupt(*p*).
3. Let *revoker* be a new built-in function object as defined in 26.2.2.1.1.
4. Set the [[RevokableProxy]] internal slot of *revoker* to *p*.
5. Let *result* be `ObjectCreate(%ObjectPrototype%)`.
6. `CreateDataProperty(result, "proxy", p)`.
7. `CreateDataProperty(result, "revoke", revoker)`.
8. Return *result*.

26.2.2.1.1 Proxy Revocation Functions

A Proxy revocation function is an anonymous function that has the ability to invalidate a specific Proxy object.

Each Proxy revocation function has a [[RevokableProxy]] internal slot.

When a Proxy revocation function, F , is called the following steps are taken:

1. Let p be the value of F 's [[RevokableProxy]] internal slot.
2. If p is **null**, return **undefined**.
3. Set the value of F 's [[RevokableProxy]] internal slot to **null**.
4. Assert: p is a Proxy object.
5. Set the [[ProxyTarget]] internal slot of p to **null**.
6. Set the [[ProxyHandler]] internal slot of p to **null**.
7. Return **undefined**.

Deleted: , then return

26.3 Module Namespace Objects

A Module Namespace Object is a module namespace exotic object that provides runtime property-based access to a module's exported bindings. There is no constructor function for Module Namespace Objects. Instead, such an object is created for each module that is imported by an *ImportDeclaration* that includes a *NameSpaceImport* (See 15.2.2).

Deleted: n

Deleted: r

In addition to the properties specified in 15.2.2 each Module Namespace Object has the own following properties:

26.3.1 @@toStringTag

The initial value of the @@toStringTag property is the string value "Module".

This property has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: true }.

26.3.2 [@@iterator]()

The following steps are taken:

1. Let N be the **this** value.
2. If **Type(N)** is not **Object**, throw a **TypeError** exception.
3. Return the result of calling the [[Enumerate]] internal method of N with no arguments.

Deleted: , then throw

The value of the **name** property of this function is "[Symbol.iterator]".

Annex A (informative)

Grammar Summary

A.1 Lexical Grammar

SourceCharacter ::
any Unicode code [point](#)

InputElementDiv ::
WhiteSpace
LineTerminator
Comment
Token
DivPunctuator
RightBracePunctuator

InputElementRegExp ::
WhiteSpace
LineTerminator
Comment
Token
RightBracePunctuator
RegularExpressionLiteral

InputElementTemplateTail ::
WhiteSpace
LineTerminator
Comment
Token
DivPunctuator
TemplateSubstitutionTail

WhiteSpace ::
<TAB>
<VT>
<FF>
<SP>
<NBSP>
<[ZWNBSP](#)>
<USP>

See [10.1](#)

See clause [11](#)

See clause [11](#)

See clause [11](#)

See [11.2](#)

Deleted: ¶
TODO: The Grammars in the Annex have not yet been updated for ES6. For now, see the grammars in the main body of the specification.¶

Deleted: clause 6
Deleted: unit
Deleted: 7

Deleted:
DivPunctuator
Deleted: ¶
Deleted: 7

Deleted: ..

Deleted: 7.2

Deleted: BOM



IdentifierStart ::

- UnicodeIDStart
- \$
- ＼ UnicodeEscapeSequence

See 11.6

IdentifierPart ::

- UnicodeIDContinue
- \$
- ＼ UnicodeEscapeSequence
- ⟨ZWNJ⟩
- ⟨ZWJ⟩

See 11.6

UnicodeIDStart::
any Unicode code point with the Unicode property “ID_Start” or
“Other_ID_Start”

See 11.6

UnicodeIDContinue::
any Unicode code point with the Unicode property “ID_Continue”, “Other_ID_Continue”, or
“Other_ID_Start”

See 11.6

ReservedWord ::

- Keyword*
- FutureReservedWord*
- NullLiteral*
- BooleanLiteral*

See 11.6.2

Keyword :: one of

<u>break</u>	<u>do</u>	<u>in</u>	<u>typeof</u>
<u>case</u>	<u>else</u>	<u>instanceof</u>	<u>var</u>
<u>catch</u>	<u>export</u>	<u>new</u>	<u>void</u>
<u>class</u>	<u>extends</u>	<u>return</u>	<u>while</u>
<u>const</u>	<u>finally</u>	<u>super</u>	<u>with</u>
<u>continue</u>	<u>for</u>	<u>switch</u>	<u>yield</u>
<u>debugger</u>	<u>function</u>	<u>this</u>	
<u>default</u>	<u>if</u>	<u>throw</u>	
<u>delete</u>	<u>import</u>	<u>try</u>	

See 11.6.2.1

FutureReservedWord ::

- enum
- await

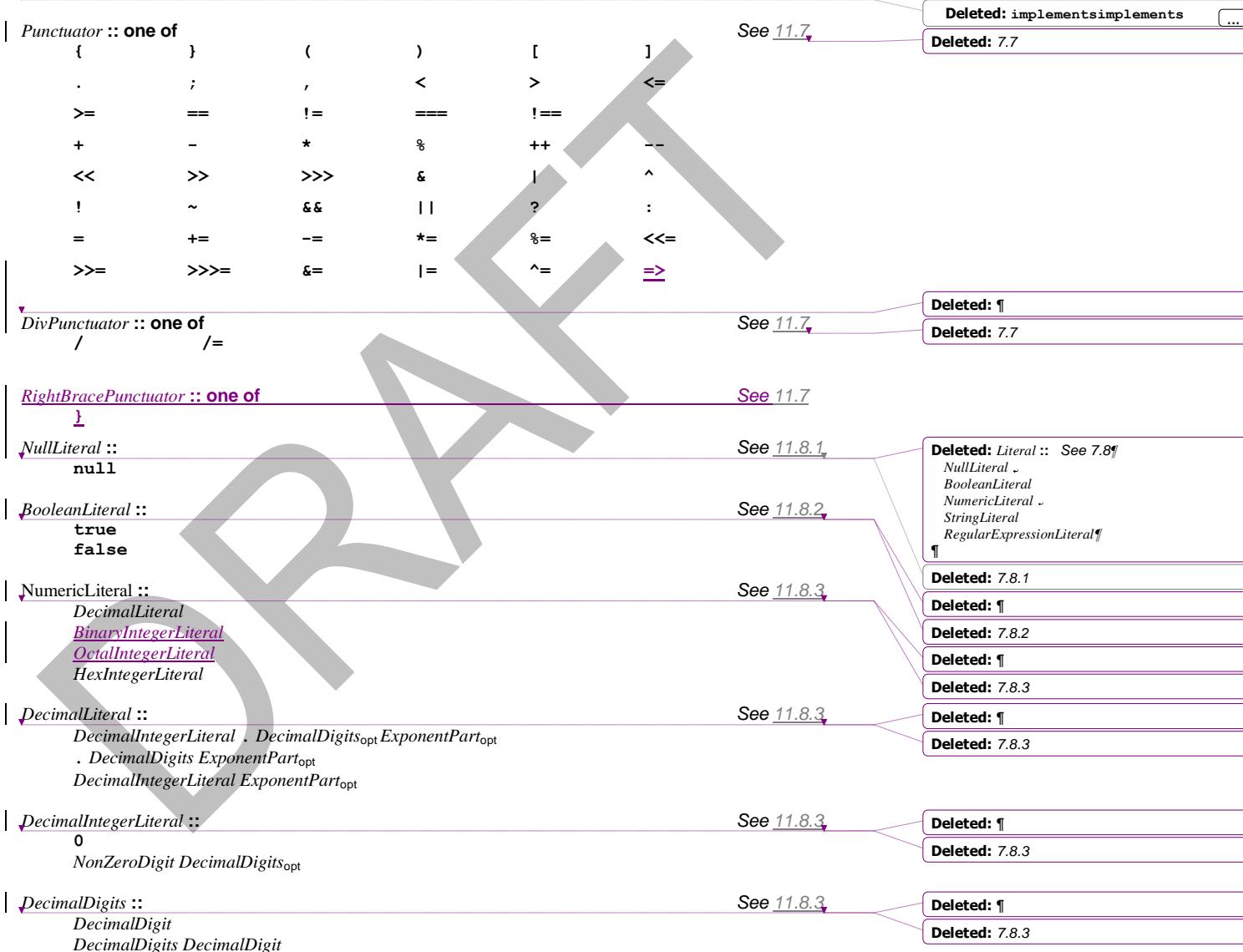
See 11.6.2.2

await is only treated as a *FutureReservedWord* when *Module* is the goal symbol of the syntactic grammar.

Deleted: ¶
Deleted: 7.6
Deleted: <i>UnicodeLetter</i>
Deleted: ¶
Deleted: 7.6
Deleted: <i>IdentifierStart</i>
Deleted: <i>UnicodeLetter</i>
Deleted: 7.6
Deleted: any character in the Unicode
Deleted: <i>UnicodeCombiningMark</i> ::.. See 7.6
Deleted: 7.6
Deleted:
Deleted: any character in the Unicode
Deleted: <i>UnicodeConnectorPunctuation</i> ::.. See 7.6
Deleted: 7.6.1
Deleted: ¶
Deleted: 7.6.1.1
Deleted: <i>break</i>
Deleted: <i>do</i> <i>do</i>
Deleted: <i>in</i> <i>instanceof</i>
Deleted: <i>typeof</i> <i>typeof</i>
Deleted: <i>case</i>
Deleted: <i>else</i> <i>else</i>
Deleted: <i>instanceof</i> <i>new</i>
Deleted: <i>var</i> <i>var</i>
Deleted: <i>catch</i>
Deleted: <i>export</i> <i>finally</i>
Deleted: <i>new</i> <i>return</i>
Deleted: <i>void</i> <i>void</i>
Deleted: <i>continue</i>
Deleted: <i>extends</i> <i>for</i>
Deleted: <i>return</i> <i>switch</i>
Deleted: <i>while</i> <i>while</i>
Deleted: <i>debugger</i>
Deleted: <i>finally</i> <i>function</i>
Deleted: <i>super</i> <i>this</i>
Deleted: <i>with</i> <i>with</i>
Deleted: <i>default</i>
Deleted: <i>for</i> <i>if</i>
Deleted: <i>switch</i> <i>throw</i>
Deleted: <i>yield</i>
Deleted: <i>delete</i>
Deleted: <i>function</i> <i>in</i>
Deleted: <i>this</i> <i>try</i>
Deleted: <i>delete</i>
Deleted: <i>import</i>
Deleted: <i>try</i>
Deleted: ¶
Deleted: one of ... <i>enum</i> ..
Deleted: <i>class</i>

The following tokens are also considered to be *FutureReservedWords* when parsing strict mode code (see 10.2.1).

implements
interface package
private protected
public



DecimalDigit :: one of

0 1 2 3 4 5 6 7 8 9

See 11.8.3

Deleted: ¶

Deleted: 7.8.3

NonZeroDigit :: one of

1 2 3 4 5 6 7 8 9

See 11.8.3

Deleted: ¶

Deleted: 7.8.3

ExponentPart ::

ExponentIndicator SignedInteger

See 11.8.3

Deleted: 7.8.3

ExponentIndicator :: one of

e E

See 11.8.3

Deleted: 7.8.3

SignedInteger ::

DecimalDigits
 + *DecimalDigits*
 - *DecimalDigits*

See 11.8.3

Deleted: ¶

Deleted: 7.8.3

BinaryIntegerLiteral ::

0b BinaryDigits
 0B BinaryDigits

See 11.8.3

BinaryDigits ::

BinaryDigit
 BinaryDigits BinaryDigit

See 11.8.3

BinaryDigit :: one of

0 1

See 11.8.3

Deleted: ¶

OctalIntegerLiteral ::

0o OctalDigits
 0O OctalDigits

See 11.8.3

OctalDigits ::

OctalDigit
 OctalDigits OctalDigit

See 11.8.3

OctalDigit :: one of

0 1 2 3 4 5 6 7

See 11.8.3

HexIntegerLiteral ::

0x HexDigits
 0X HexDigits

See 11.8.3

Deleted: ¶

Deleted: 7.8.3

Deleted: s

Deleted:
HexIntegerLiteral HexDigit

HexDigits ::

HexDigit
 HexDigits HexDigit

See 11.8.3

HexDigit :: one of

0 1 2 3 4 5 6 7 8 9 a b c d e f A B C D E F

See 11.8.3

Deleted: 7.8.3

<i>StringLiteral</i> ::	See 11.8.4	Deleted: 7.8.4
" <i>DoubleStringCharacters_{opt}</i> "		
' <i>SingleStringCharacters_{opt}</i> '		
<i>DoubleStringCharacters</i> ::	See 11.8.4	Deleted: 7.8.4
<i>DoubleStringCharacter DoubleStringCharacters_{opt}</i>		
<i>SingleStringCharacters</i> ::	See 11.8.4	Deleted: 7.8.4
<i>SingleStringCharacter SingleStringCharacters_{opt}</i>		
<i>DoubleStringCharacter</i> ::	See 11.8.4	Deleted: 7.8.4
<i>SourceCharacter but not one of " or \ or LineTerminator</i>		
\ <i>EscapeSequence</i>		
<i>LineContinuation</i>		
<i>SingleStringCharacter</i> ::	See 11.8.4	Deleted: 7.8.4
<i>SourceCharacter but not one of ' or \ or LineTerminator</i>		
\ <i>EscapeSequence</i>		
<i>LineContinuation</i>		
<i>LineContinuation</i> ::	See 11.8.4	Deleted: 7.8.4
\ <i>LineTerminatorSequence</i>		
<i>EscapeSequence</i> ::	See 11.8.4	Deleted: 7.8.4
<i>CharacterEscapeSequence</i>		
0 [lookahead & <i>DecimalDigit</i>]		
<i>HexEscapeSequence</i>		
<i>UnicodeEscapeSequence</i>		
<i>CharacterEscapeSequence</i> ::	See 11.8.4	Deleted: 7.8.4
<i>SingleEscapeCharacter</i>		
<i>NonEscapeCharacter</i>		
<i>SingleEscapeCharacter</i> :: one of	See 11.8.4	Deleted: 7.8.4
' " \ b f n r t v		
<i>NonEscapeCharacter</i> ::	See 11.8.4	Deleted: 7.8.4
<i>SourceCharacter but not one of EscapeCharacter or LineTerminator</i>		
<i>EscapeCharacter</i> ::	See 11.8.4	Deleted: ¶
<i>SingleEscapeCharacter</i>		Deleted: 7.8.4
<i>DecimalDigit</i>		
x		
u		
<i>HexEscapeSequence</i> ::	See 11.8.4	Deleted: 7.8.4
x <i>HexDigit HexDigit</i>		
<i>UnicodeEscapeSequence</i> ::	See 11.8.4	Deleted: ¶
u <i>Hex4Digits</i>		Deleted: 7.8.4
u{ <i>HexDigits</i> }		

<u>Hex4Digits ::</u>	See 11.8.4	
HexDigit HexDigit HexDigit HexDigit		Deleted: u
<u>RegularExpressionLiteral ::</u>	See 11.8.5	Deleted: ¶
/ RegularExpressionBody / RegularExpressionFlags		Deleted: 7.8.5
<u>RegularExpressionBody ::</u>	See 11.8.5	Deleted: ¶
RegularExpressionFirstChar RegularExpressionChars		Deleted: 7.8.5
<u>RegularExpressionChars ::</u>	See 11.8.5	Deleted: ¶
[empty] RegularExpressionChars RegularExpressionChar		Deleted: 7.8.5
<u>RegularExpressionFirstChar ::</u>	See 11.8.5	Deleted: ¶
RegularExpressionNonTerminator but not one of * or \ or / or [RegularExpressionBackslashSequence RegularExpressionClass		Deleted: 7.8.5
<u>RegularExpressionChar ::</u>	See 11.8.5	Deleted: ¶
RegularExpressionNonTerminator but not one of \ or / or [RegularExpressionBackslashSequence RegularExpressionClass		Deleted: 7.8.5
<u>RegularExpressionBackslashSequence ::</u>	See 11.8.5	Deleted: ¶
\ RegularExpressionNonTerminator		Deleted: 7.8.5
<u>RegularExpressionNonTerminator ::</u>	See 11.8.5	Deleted: ¶
SourceCharacter but not LineTerminator		Deleted: 7.8.5
<u>RegularExpressionClass ::</u>	See 11.8.5	Deleted: ¶
[RegularExpressionClassChars]		Deleted: 7.8.5
<u>RegularExpressionClassChars ::</u>	See 11.8.5	Deleted: ¶
[empty] RegularExpressionClassChars RegularExpressionClassChar		Deleted: 7.8.5
<u>RegularExpressionClassChar ::</u>	See 11.8.5	Deleted: ¶
RegularExpressionNonTerminator but not one of] or \ RegularExpressionBackslashSequence		Deleted: 7.8.5
<u>RegularExpressionFlags ::</u>	See 11.8.5	Deleted: ¶
[empty] RegularExpressionFlags IdentifierPart		Deleted: 7.8.5
<u>Template ::</u>	See 11.8.6	
NoSubstitutionTemplate TemplateHead		
<u>NoSubstitutionTemplate ::</u>	See 11.8.6	Deleted: ¶
` TemplateCharacters _{opt} `		
<u>TemplateHead ::</u>	See 11.8.6	Deleted: ¶
` TemplateCharacters _{opt} \$ {		

TemplateSubstitutionTail ::

See 11.8.6

TemplateMiddle
TemplateTail

TemplateMiddle ::

See 11.8.6

1 TemplateCharacters_{opt} \${ }

Deleted: 1

TemplateTail ::

See 11.8.6

1 TemplateCharacters_{opt} `

Deleted: 1

TemplateCharacters ::

See 11.8.6

TemplateCharacter TemplateCharacters_{opt}

TemplateCharacter ::

See 11.8.6

\$ [lookahead ≠ (]

Deleted: SourceCharacter but not one of ` or \ or \$ or LineTerminatorSequence

\ EscapeSequence

LineContinuation

LineTerminatorSequence

SourceCharacter but not one of ` or \ or \$ or LineTerminator

A.2 Expressions

IdentifierReference_[?yield] ::

See 12.1

Identifier
[~Yield] yield

BindingIdentifier_[?yield] ::

See 12.1

Identifier
[~Yield] yield

Deleted: [~Yield] yield ..

Deleted: r

LabelIdentifier_[?yield] ::

See 12.1

Identifier
[~Yield] yield

Deleted: 1

Identifier ::

See 12.1

IdentifierName but not ReservedWord

Deleted: 1

PrimaryExpression_[?yield] ::

See 12.2

this

IdentifierReference_[?yield]

Literal

ArrayLiteral_[?yield]

ObjectLiteral_[?yield]

FunctionExpression

ClassExpression

GeneratorExpression

RegularExpressionLiteral

TemplateLiteral_[?yield]

CoverParenthesizedExpressionAndArrowParameterList_[?yield]

CoverParenthesizedExpressionAndArrowParameterList_[?Yield] :

[See 12.2](#)

(Expression_[In, ?Yield])
()
(. . . BindingIdentifier_[?Yield])
(Expression_[In, ?Yield] , . . . BindingIdentifier_[?Yield])

When processing the production

PrimaryExpression_[?Yield] : CoverParenthesizedExpressionAndArrowParameterList_[?Yield]
the interpretation of CoverParenthesizedExpressionAndArrowParameterList is refined using the following grammar:

ParenthesizedExpression_[?Yield] :
(Expression_[In, ?Yield])

[See 12.2](#)

Literal :

NullLiteral
BooleanLiteral
NumericLiteral
StringLiteral

[See 12.2.3](#)

Deleted: 1

ArrayLiteral_[?Yield] :

[See 12.2.4](#)

[Elision_{opt}]
[ElementList_[?Yield]]
[ElementList_[?Yield] , Elision_{opt}]

ElementList_[?Yield] :

[See 12.2.4](#)

Elision_{opt} AssignmentExpression_[In, ?Yield]
Elision_{opt} SpreadElement_[?Yield]
ElementList_[?Yield] , Elision_{opt} AssignmentExpression_[In, ?Yield]
ElementList_[?Yield] , Elision_{opt} SpreadElement_[?Yield]

Elision :

[See 12.2.4](#)

Elision ,

SpreadElement_[?Yield] :

[See 12.2.4](#)

. . . AssignmentExpression_[In, ?Yield]
{ }
{ PropertyDefinitionList_[?Yield] }
{ PropertyDefinitionList_[?Yield] , }

ObjectLiteral_[?Yield] :

[See 12.2.5](#)

{ }
{ PropertyDefinitionList_[?Yield] }
{ PropertyDefinitionList_[?Yield] , }

PropertyDefinitionList_[?Yield] :

[See 12.2.5](#)

PropertyDefinition_[?Yield]
PropertyDefinitionList_[?Yield] , PropertyDefinition_[?Yield]

PropertyDefinition_[?Yield] :

[See 12.2.5](#)

IdentifierReference_[?Yield]
CoverInitializedName_[?Yield]
PropertyName_[?Yield] : AssignmentExpression_[In, ?Yield]
MethodDefinition_[?Yield]

<u>PropertyName</u> _[yield, GeneratorParameter] :	See 12.2.5
<u>LiteralPropertyName</u>	
[+GeneratorParameter] <u>ComputedPropertyName</u>	
[-GeneratorParameter] <u>ComputedPropertyName</u> _[?yield]	
<u>LiteralPropertyName</u> :	See 12.2.5
<u>IdentifierName</u>	
<u>StringLiteral</u>	
<u>NumericLiteral</u>	
<u>ComputedPropertyName</u> _[yield] :	See 12.2.5
[AssignmentExpression _[In, ?yield]]	
<u>CoverInitializedName</u> _[yield] :	See 12.2.5
<u>IdentifierReference</u> _[?yield] <u>Initializer</u> _[In, ?yield]	
<u>Initializer</u> _[In, Yield] :	See 12.2.5
= AssignmentExpression _[?In, ?yield]	
<u>TemplateLiteral</u> _[yield] :	See 12.2.8
<u>NoSubstitutionTemplate</u>	
<u>TemplateHead</u> Expression _[In, ?yield] [Lexical goal InputElementTemplateTail] <u>TemplateSpans</u> _[?yield]	
<u>TemplateSpans</u> _[yield] :	See 12.2.8
<u>TemplateTail</u>	
<u>TemplateMiddleList</u> _[?yield] [Lexical goal InputElementTemplateTail] <u>TemplateTail</u>	
<u>TemplateMiddleList</u> _[yield] :	See 12.2.8
<u>TemplateMiddle</u> Expression _[In, ?yield]	
<u>TemplateMiddleList</u> _[?yield] [Lexical goal InputElementTemplateTail] <u>TemplateMiddle</u> Expression _[In, ?yield]	
<u>MemberExpression</u> _[yield] :	See 12.3
[Lexical goal InputElementResExp] <u>PrimaryExpression</u> _[?yield]	
<u>MemberExpression</u> _[?yield] [Expression _[In, ?yield]]	
<u>MemberExpression</u> _[?yield] . IdentifierName	
<u>MemberExpression</u> _[?yield] . TemplateLiteral _[?yield]	
<u>SuperProperty</u> _[?yield]	
<u>MetaProperty</u> _{**}	
new MemberExpression _[?yield] Arguments _[?yield]	
<u>SuperProperty</u> _[yield] :	See 12.3
super [Expression _[In, ?yield]]	
super . IdentifierName	
<u>MetaProperty</u> _{**} :	See 12.3
new . target	
<u>NewExpression</u> _[yield] :	See 12.3
MemberExpression _[?yield]	
new NewExpression _[?yield]	

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 NewSuper

CallExpression_[?Yield] : See 12.3

MemberExpression_[?Yield] Arguments_[?Yield]

SuperCall_[?Yield]

CallExpression_[?Yield] Arguments_[?Yield]

CallExpression_[?Yield] Expression_[In, ?Yield]

CallExpression_[?Yield] . IdentifierName

CallExpression_[?Yield] TemplateLiteral_[?Yield]

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SuperCall_[?Yield] : See 12.3

super Arguments_[?Yield]

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Arguments_[?Yield] : See 12.3

()
{ ArgumentList_[?Yield]

ArgumentList_[?Yield] : See 12.3

AssignmentExpression_[In, ?Yield]
... AssignmentExpression_[In, ?Yield]
ArgumentList_[?Yield] , AssignmentExpression_[In, ?Yield]
ArgumentList_[?Yield] , ... AssignmentExpression_[In, ?Yield]

LeftHandSideExpression_[?Yield] : See 12.3

NewExpression_[?Yield]
CallExpression_[?Yield]

PostfixExpression_[?Yield] : See 12.4

LeftHandSideExpression_[?Yield]
LeftHandSideExpression_[?Yield] [no LineTerminator here] ++
LeftHandSideExpression_[?Yield] [no LineTerminator here] --

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UnaryExpression_[?Yield] : See 12.5

PostfixExpression_[?Yield]
delete UnaryExpression_[?Yield]
void UnaryExpression_[?Yield]
typeof UnaryExpression_[?Yield]
++ UnaryExpression_[?Yield]
-- UnaryExpression_[?Yield]
+ UnaryExpression_[?Yield]
- UnaryExpression_[?Yield]
~ UnaryExpression_[?Yield]
! UnaryExpression_[?Yield]

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MultiplicativeExpression_[?Yield] : See 12.6

UnaryExpression_[?Yield]
MultiplicativeExpression_[?Yield] MultiplicativeOperator UnaryExpression_[?Yield]

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MultiplicativeOperator : one of See 12.6

* / %

Deleted: MultiplicativeExpression_[?Yield] *
UnaryExpression_[?Yield]
MultiplicativeExpression_[?Yield] / UnaryExpression_[?Yield]
Deleted: %

AdditiveExpression_[?In, ?Yield] :

See 12.7

MultiplicativeExpression_[?Yield]
AdditiveExpression_[?Yield] + MultiplicativeExpression_[?Yield]
AdditiveExpression_[?Yield] - MultiplicativeExpression_[?Yield]

ShiftExpression_[?Yield] :

See 12.8

AdditiveExpression_[?Yield]
ShiftExpression_[?Yield] << AdditiveExpression_[?Yield]
ShiftExpression_[?Yield] >> AdditiveExpression_[?Yield]
ShiftExpression_[?Yield] >>> AdditiveExpression_[?Yield]

RelationalExpression_[?In, ?Yield] :

See 12.9

ShiftExpression_[?Yield]
RelationalExpression_[?In, ?Yield] < ShiftExpression_[?Yield]
RelationalExpression_[?In, ?Yield] > ShiftExpression_[?Yield]
RelationalExpression_[?In, ?Yield] <= ShiftExpression_[?Yield]
RelationalExpression_[?In, ?Yield] >= ShiftExpression_[?Yield]
RelationalExpression_[?In, ?Yield] instanceof ShiftExpression_[?Yield]
[+In] RelationalExpression_[?In, ?Yield] in ShiftExpression_[?Yield]

EqualityExpression_[?In, ?Yield] :

See 12.10

RelationalExpression_[?In, ?Yield]
EqualityExpression_[?In, ?Yield] === RelationalExpression_[?In, ?Yield]
EqualityExpression_[?In, ?Yield] != RelationalExpression_[?In, ?Yield]
EqualityExpression_[?In, ?Yield] === RelationalExpression_[?In, ?Yield]
EqualityExpression_[?In, ?Yield] !== RelationalExpression_[?In, ?Yield]

BitwiseANDExpression_[?In, ?Yield] :

See 12.11

EqualityExpression_[?In, ?Yield]
BitwiseANDExpression_[?In, ?Yield] & EqualityExpression_[?In, ?Yield]

BitwiseXORExpression_[?In, ?Yield] :

See 12.11

BitwiseANDExpression_[?In, ?Yield]
BitwiseXORExpression_[?In, ?Yield] ^ BitwiseANDExpression_[?In, ?Yield]

BitwiseORExpression_[?In, ?Yield] :

See 12.11

BitwiseXORExpression_[?In, ?Yield]
BitwiseORExpression_[?In, ?Yield] | BitwiseXORExpression_[?In, ?Yield]

LogicalANDExpression_[?In, ?Yield] :

See 12.12

BitwiseORExpression_[?In, ?Yield]
LogicalANDExpression_[?In, ?Yield] && BitwiseORExpression_[?In, ?Yield]

LogicalORExpression_[?In, ?Yield] :

See 12.12

LogicalANDExpression_[?In, ?Yield]
LogicalORExpression_[?In, ?Yield] || LogicalANDExpression_[?In, ?Yield]

ConditionalExpression_[?In, ?Yield] :

See 12.13

LogicalORExpression_[?In, ?Yield]
LogicalORExpression_[?In, ?Yield] ? AssignmentExpression_[?In, ?Yield] : AssignmentExpression_[?In, ?Yield]

AssignmentExpression_[In, Yield] :

- ConditionalExpression_[?In, ?Yield]
- [+Yield] YieldExpression_[?In]
- ArrowFunction_[?In, ?Yield]
- LeftHandSideExpression_[?Yield] = AssignmentExpression_[?In, ?Yield]
- LeftHandSideExpression_[?Yield] AssignmentOperator AssignmentExpression_[?In, ?Yield]

See 12.14

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AssignmentOperator : one of
 *= /= %= += -= <<= >>= >>>= &= ^= |=

See 12.14

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Expression_[In, Yield] :

- AssignmentExpression_[?In, ?Yield]
- Expression_[?In, ?Yield], AssignmentExpression_[?In, ?Yield]

See 12.15

A.3 Statements

Statement_[Yield, Return] :

- BlockStatement_[?Yield, ?Return]
- VariableStatement_[?Yield]
- EmptyStatement
- ExpressionStatement_[?Yield]
- IfStatement_[?Yield, ?Return]
- BreakableStatement_[?Yield, ?Return]
- ContinueStatement_[?Yield]
- BreakStatement_[?Yield]
- [+Return] ReturnStatement_[?Yield]
- WithStatement_[?Yield, ?Return]
- LabelledStatement_[?Yield, ?Return]
- ThrowStatement_[?Yield]
- TryStatement_[?Yield, ?Return]
- DebuggerStatement

See clause 13

Declaration_[Yield] :

- HoistableDeclaration_[?Yield]
- ClassDeclaration_[?Yield]
- LexicalDeclaration_[In, ?Yield]

See clause 13

HoistableDeclaration_[Yield, Default] :

- FunctionDeclaration_[?Yield, ?Default]
- GeneratorDeclaration_[?Yield, ?Default]

See clause 13

BreakableStatement_[Yield, Return] :

- IterationStatement_[?Yield, ?Return]
- SwitchStatement_[?Yield, ?Return]

See clause 13

BlockStatement_[Yield, Return] :

- Block_[?Yield, ?Return]

See 13.1

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Block_[Yield, Return] :

- { StatementList_{[?Yield, ?Return]opt} }

See 13.1

<u>StatementList_[?Yield, ?Return]</u> :	See 13.1
<u>StatementListItem_[?Yield, ?Return]</u>	
<u>StatementList_[?Yield, ?Return]</u> <u>StatementListItem_[?Yield, ?Return]</u>	
<u>StatementListItem_[?Yield, ?Return]</u> :	See 13.1
<u>Statement_[?Yield, ?Return]</u>	
<u>Declaration_[?Yield]</u>	
<u>LexicalDeclaration_[In, ?Yield]</u> :	See 13.2.1
<u>LetOrConst BindingList_[In, ?Yield] ;</u>	
<u>LetOrConst</u> :	See 13.2.1
<u>let</u>	
<u>const</u>	
<u>BindingList_[In, ?Yield]</u> :	See 13.2.1
<u>LexicalBinding_[?In, ?Yield]</u>	
<u>BindingList_[?In, ?Yield], LexicalBinding_[?In, ?Yield]</u>	
<u>LexicalBinding_[In, ?Yield]</u> :	See 13.2.1
<u>BindingIdentifier_[?Yield] Initializer_[?In, ?Yieldopt]</u>	
<u>BindingPattern_[?Yield] Initializer_[?In, ?Yield]</u>	
<u>VariableStatement_[?Yield]</u> :	See 13.2.2
<u>var VariableDeclarationList_[In, ?Yield] ;</u>	
<u>VariableDeclarationList_[In, ?Yield]</u> :	See 13.2.2
<u>VariableDeclaration_[In, ?Yield]</u>	
<u>VariableDeclarationList_[?In, ?Yield], VariableDeclaration_[?In, ?Yield]</u>	
<u>VariableDeclaration_[In, ?Yield]</u> :	See 13.2.2
<u>BindingIdentifier_[?Yield] Initializer_[?In, ?Yieldopt]</u>	
<u>BindingPattern_[?Yield] Initializer_[?In, ?Yield]</u>	
<u>BindingPattern_[?Yield, GeneratorParameter]</u> :	See 13.2.3
<u>ObjectBindingPattern_[?Yield, ?GeneratorParameter]</u>	
<u>ArrayBindingPattern_[?Yield, ?GeneratorParameter]</u>	
<u>ObjectBindingPattern_[?Yield, GeneratorParameter]</u> :	See 13.2.3
{ }	
{ <u>BindingPropertyList_[?Yield, ?GeneratorParameter]</u> }	
{ <u>BindingPropertyList_[?Yield, ?GeneratorParameter]</u> , }	
<u>ArrayBindingPattern_[?Yield, GeneratorParameter]</u> :	See 13.2.3
[<u>Elision_{opt} BindingRestElement_[?Yield, ?GeneratorParameteropt]</u>]	
[<u>BindingElementList_[?Yield, ?GeneratorParameter]</u>]	
[<u>BindingElementList_[?Yield, ?GeneratorParameter]</u> , <u>Elision_{opt} BindingRestElement_[?Yield, ?GeneratorParameteropt]</u>]	
<u>BindingPropertyList_[?Yield, GeneratorParameter]</u> :	See 13.2.3
<u>BindingProperty_[?Yield, ?GeneratorParameter]</u>	
<u>BindingPropertyList_[?Yield, ?GeneratorParameter], BindingProperty_[?Yield, ?GeneratorParameter]</u>	

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<u>BindingElementList_[?Yield, ?GeneratorParameter]</u> :	See 13.2.3
<u>BindingElisionElement_[?Yield, ?GeneratorParameter]</u>	
<u>BindingElementList_[?Yield, ?GeneratorParameter]</u> , <u>BindingElisionElement_[?Yield, ?GeneratorParameter]</u>	
<u>BindingElisionElement_[?Yield, ?GeneratorParameter]</u> :	See 13.2.3
<u>Elision_{opt}</u> <u>BindingElement_[?Yield, ?GeneratorParameter]</u>	
<u>BindingProperty_[?Yield, ?GeneratorParameter]</u> :	See 13.2.3
<u>SingleNameBinding_[?Yield, ?GeneratorParameter]</u>	
<u>PropertyName_[?Yield, ?GeneratorParameter]</u> : <u>BindingElement_[?Yield, ?GeneratorParameter]</u>	
<u>BindingElement_[?Yield, ?GeneratorParameter]</u> :	See 13.2.3
<u>SingleNameBinding_[?Yield, ?GeneratorParameter]</u>	
<u>[+GeneratorParameter] BindingPattern_[?Yield, ?GeneratorParameter] Initializer_[in, opt]</u>	
<u>[~GeneratorParameter] BindingPattern_[?Yield] Initializer_[in, ?Yield opt]</u>	
<u>SingleNameBinding_[?Yield, ?GeneratorParameter]</u> :	See 13.2.3
<u>[+GeneratorParameter] BindingIdentifier_[?Yield] Initializer_[in, opt]</u>	
<u>[~GeneratorParameter] BindingIdentifier_[?Yield] Initializer_[in, ?Yield opt]</u>	
<u>BindingRestElement_[?Yield, ?GeneratorParameter]</u> :	See 13.2.3
<u>[+GeneratorParameter] ... BindingIdentifier_[?Yield]</u>	
<u>[~GeneratorParameter] ... BindingIdentifier_[?Yield]</u>	
<u>EmptyStatement</u> :	See 13.3
;	
<u>ExpressionStatement_[?Yield]</u> :	See 13.4
<u>[lookahead $\notin \{\{, \text{function}, \text{class}, \text{let} \}$] Expression_[in, ?Yield] ;</u>	
<u>IfStatement_[?Yield, ?Return]</u> :	See 13.5
<u>if (Expression_[in, ?Yield]) Statement_[?Yield, ?Return] else Statement_[?Yield, ?Return]</u>	
<u>if (Expression_[in, ?Yield]) Statement_[?Yield, ?Return]</u>	
<u>IterationStatement_[?Yield, ?Return]</u> :	See 13.6
<u>do Statement_[?Yield, ?Return] while (Expression_[in, ?Yield]) ;_{opt}</u>	
<u>while (Expression_[in, ?Yield]) Statement_[?Yield, ?Return]</u>	
<u>for ([lookahead $\notin \{\text{let} \}$] Expression_[?Yield opt] ; Expression_[in, ?Yield opt] ; Expression_[in, ?Yield opt]) Statement_[?Yield, ?Return]</u>	
<u>for (var VariableDeclarationList_[?Yield] ; Expression_[in, ?Yield opt] ; Expression_[in, ?Yield opt]) Statement_[?Yield, ?Return]</u>	
<u>for (LexicalDeclaration_[?Yield] Expression_[in, ?Yield opt] ; Expression_[in, ?Yield opt]) Statement_[?Yield, ?Return]</u>	
<u>for ([lookahead $\notin \{\text{let} \}$] LeftHandSideExpression_[?Yield] in Expression_[in, ?Yield]) Statement_[?Yield, ?Return]</u>	
<u>for (var ForBinding_[?Yield] in Expression_[in, ?Yield]) Statement_[?Yield, ?Return]</u>	
<u>for (ForDeclaration_[?Yield] in Expression_[in, ?Yield]) Statement_[?Yield, ?Return]</u>	
<u>for ([lookahead $\neq \text{let}$] LeftHandSideExpression_[?Yield] of AssignmentExpression_[in, ?Yield]) Statement_[?Yield, ?Return]</u>	
<u>Statement_[?Yield, ?Return]</u>	
<u>for (var ForBinding_[?Yield] of AssignmentExpression_[in, ?Yield]) Statement_[?Yield, ?Return]</u>	
<u>for (ForDeclaration_[?Yield] of AssignmentExpression_[in, ?Yield]) Statement_[?Yield, ?Return]</u>	
<u>ForDeclaration_[?Yield]</u> :	See 13.6
<u>LetOrConst ForBinding_[?Yield]</u>	

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<u>ForBinding_[Yield]</u> :	See 13.6
<u>BindingIdentifier_[?Yield]</u>	
<u>BindingPattern_[?Yield]</u>	Deleted: 1
<u>ContinueStatement_[Yield]</u> :	See 13.7
<u>continue</u> ;	
<u>continue</u> [no LineTerminator here] <u>LabelIdentifier_[?Yield]</u> ;	
<u>BreakStatement_[Yield]</u> :	See 13.8
<u>break</u> ;	
<u>break</u> [no LineTerminator here] <u>LabelIdentifier_[?Yield]</u> ;	
<u>ReturnStatement_[Yield]</u> :	See 13.9
<u>return</u> ;	
<u>return</u> [no LineTerminator here] <u>Expression_[In, ?Yield]</u> ;	
<u>WithStatement_[Yield, Return]</u> :	See 13.10
<u>with</u> (<u>Expression_[In, ?Yield]</u>) <u>Statement_[?Yield, ?Return]</u>	
<u>SwitchStatement_[Yield, Return]</u> :	See 13.11
<u>switch</u> (<u>Expression_[In, ?Yield]</u>) <u>CaseBlock_[?Yield, ?Return]</u>	
<u>CaseBlock_[Yield, Return]</u> :	See 13.11
{ <u>CaseClause_{[?Yield, ?Return]opt}</u> }	
{ <u>CaseClause_{[?Yield, ?Return]opt}</u> <u>DefaultClause_[?Yield, ?Return]</u> <u>CaseClauses_{[?Yield, ?Return]opt}</u> }	
<u>CaseClauses_[Yield, Return]</u> :	See 13.11
<u>CaseClause_[?Yield, ?Return]</u>	
<u>CaseClauses_[?Yield, ?Return]</u> <u>CaseClause_[?Yield, ?Return]</u>	
<u>CaseClause_[Yield, Return]</u> :	See 13.11
<u>case</u> <u>Expression_[In, ?Yield]</u> : <u>StatementList_{[?Yield, ?Return]opt}</u>	
<u>DefaultClause_[Yield, Return]</u> :	See 13.11
<u>default</u> : <u>StatementList_{[?Yield, ?Return]opt}</u>	
<u>LabelledStatement_[Yield, Return]</u> :	See 13.12
<u>LabelIdentifier_[?Yield]</u> : <u>LabelledItem_[?Yield, ?Return]</u>	
<u>LabelledItem_[Yield, Return]</u> :	See 13.12
<u>Statement_[?Yield, ?Return]</u>	
<u>FunctionDeclaration_[?Yield]</u>	
<u>ThrowStatement_[Yield]</u> :	See 13.13
<u>throw</u> [no LineTerminator here] <u>Expression_[In, ?Yield]</u> ;	
<u>TryStatement_[Yield, Return]</u> :	See 13.14
<u>try</u> <u>Block_[?Yield, ?Return]</u> <u>Catch_[?Yield, ?Return]</u>	
<u>try</u> <u>Block_[?Yield, ?Return]</u> <u>Finally_[?Yield, ?Return]</u>	
<u>try</u> <u>Block_[?Yield, ?Return]</u> <u>Catch_[?Yield, ?Return]</u> <u>Finally_[?Yield, ?Return]</u>	

Catch_[Yield, Return] : See 13.14
 catch (CatchParameter_[?Yield]) Block_[?Yield, ?Return]

Finally_[Yield, Return] : See 13.14
 finally Block_[?Yield, ?Return]

CatchParameter_[Yield] : See 13.14
 BindingIdentifier_[?Yield]
 BindingPattern_[?Yield]

DebuggerStatement : See 13.15
 debugger ;

A.4 Functions and Classes

FunctionDeclaration_[Yield, Default] : See 14.1
 function BindingIdentifier_[?Yield] (FormalParameters) { FunctionBody }
 [+Default] function (FormalParameters) { FunctionBody }

FunctionExpression : See 14.1
 function BindingIdentifier_{opt} (FormalParameters) { FunctionBody }

StrictFormalParameters_[Yield, GeneratorParameter] : See 14.1
 FormalParameters_[?Yield, ?GeneratorParameter]

FormalParameters_[Yield, GeneratorParameter] : See 14.1
 [empty]
 FormalParameterList_[?Yield, ?GeneratorParameter]

FormalParameterList_[Yield, GeneratorParameter] : See 14.1
 FunctionRestParameter_[?Yield]
 FormalsList_[?Yield, ?GeneratorParameter]
 FormalsList_[?Yield, ?GeneratorParameter], FunctionRestParameter_[?Yield]

FormalsList_[Yield, GeneratorParameter] : See 14.1
 FormalParameter_[?Yield, ?GeneratorParameter]
 FormalsList_[?Yield, ?GeneratorParameter], FormalParameter_[?Yield, ?GeneratorParameter]

FunctionRestParameter_[Yield] : See 14.1
 BindingRestElement_[?Yield]

FormalParameter_[Yield, GeneratorParameter] : See 14.1
 BindingElement_[?Yield, ?GeneratorParameter]

FunctionBody_[Yield] : See 14.1
 FunctionStatementList_[?Yield]

FunctionStatementList_[Yield] : See 14.1
 StatementList_[?Yield, ReturnOpt]

ArrowFunction_[In, Yield] : See 14.2
 ArrowParameters_{[?Yield, [no LineTerminator here]]} => ConciseBody_[?In]

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ArrowParameters_[Yield] : See 14.2

BindingIdentifier_[?Yield]
CoverParenthesizedExpressionAndArrowParameterList_[?Yield]

ConciseBody_[In] : See 14.2

lookahead ≠ {} AssignmentExpression_[?In]
{ FunctionBody }

When the production

ArrowParameters_[Yield] : CoverParenthesizedExpressionAndArrowParameterList_[?Yield]

is recognized the following grammar is used to refine the interpretation of
CoverParenthesizedExpressionAndArrowParameterList:

ArrowFormalParameters_[Yield, GeneratorParameter] : See 14.2

(StrictFormalParameters_[?Yield, ?GeneratorParameter])

MethodDefinition_[Yield] : See 14.3

PropertyName_[?Yield] (StrictFormalParameters) { FunctionBody }
GeneratorMethod_[Yield]
get PropertyName_[?Yield] () { FunctionBody }
set PropertyName_[?Yield] (PropertySetParameterList) { FunctionBody }

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PropertySetParameterList : See 14.3

FormalParameter

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GeneratorMethod_[Yield] : See 14.4

* PropertyName_[?Yield] (StrictFormalParameters_[Yield, GeneratorParameter]) { GeneratorBody_[Yield] }

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GeneratorDeclaration_[Yield, Default] : See 14.4

function * BindingIdentifier_[?Yield] (FormalParameters_[Yield, GeneratorParameter]) { GeneratorBody_[Yield] }
[+Default] function * (FormalParameters_[Yield, GeneratorParameter]) { GeneratorBody_[Yield] }

GeneratorExpression : See 14.4

function * BindingIdentifier_[Yield, opt] (FormalParameters_[Yield, GeneratorParameter]) { GeneratorBody_[Yield] }

GeneratorBody_[Yield] : See 14.4

FunctionBody_[?Yield]

YieldExpression_[In] : See 14.4

yield
yield [no LineTerminator here] [Lexical goal InputElementRegExp] AssignmentExpression_[?In, Yield]
yield [no LineTerminator here] * [Lexical goal InputElementRegExp] AssignmentExpression_[?In, Yield]

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ClassDeclaration_[Yield, Default] : See 14.5

class BindingIdentifier_[?Yield] ClassTail_[?Yield]
[+Default] class ClassTail_[?Yield]

ClassExpression_[Yield, GeneratorParameter] : See 14.5

class BindingIdentifier_[?Yield, opt] ClassTail_[?Yield, ?GeneratorParameter]

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ClassTail_[?Yield,GeneratorParameter] : See 14.5
 [-GeneratorParameter] ClassHeritage_{[?Yield]opt} { ClassBody_{[?Yield]opt} }
 [+GeneratorParameter] ClassHeritage_{opt} { ClassBody_{opt} }

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ClassHeritage_[?Yield] : See 14.5
extends LeftHandSideExpression_[?Yield]

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ClassBody_[?Yield] : See 14.5
ClassElementList_[?Yield]

ClassElementList_[?Yield] : See 14.5
ClassElement_[?Yield]
ClassElementList_[?Yield] ClassElement_[?Yield]

ClassElement_[?Yield] : See 14.5
MethodDefinition_[?Yield]
static MethodDefinition_[?Yield]
i

A.5 Scripts and Modules

Script : See 15.1
ScriptBody_{opt}

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ScriptBody : See 15.1
StatementList

Module : See 15.2
ModuleBody_{opt}

ModuleBody : See 15.2
ModuleItemList

ModuleItemList : See 15.2
ModuleItem
ModuleItemList ModuleItem

ModuleItem : See 15.2
ImportDeclaration
ExportDeclaration
StatementList

ImportDeclaration : See 15.2.2
import ImportClause FromClause ;
import ModuleSpecifier ;

ImportClause : See 15.2.2
ImportedDefaultBinding
NameSpaceImport
NamedImports
ImportedDefaultBinding , NameSpaceImport
ImportedDefaultBinding , NamedImports

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ImportedDefaultBinding : [See 15.2.2](#)
ImportedBinding

NameSpaceImport : [See 15.2.2](#)
* as ImportedBinding

NamedImports : [See 15.2.2](#)
{ }
{ ImportsList }
{ ImportsList , }

FromClause : [See 15.2.2](#)
from ModuleSpecifier

ImportsList : [See 15.2.2](#)
ImportSpecifier
ImportsList , ImportSpecifier

ImportSpecifier : [See 15.2.2](#)
ImportedBinding
IdentifierName as ImportedBinding

ModuleSpecifier : [See 15.2.2](#)
StringLiteral

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ImportedBinding : [See 15.2.2](#)
BindingIdentifier

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ExportDeclaration : [See 15.2.3](#)
export * FromClause ;
export ExportClause FromClause ;
export ExportClause ;
export VariableStatement
export Declaration
export default HoistableDeclaration[Default]
export default ClassDeclaration[Default]
export default lookahead< { function, class }> AssignmentExpression[In] ;

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ExportClause : [See 15.2.3](#)
{ }
{ ExportsList }
{ ExportsList , }

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ExportsList : [See 15.2.3](#)
ExportSpecifier
ExportsList , ExportSpecifier

ExportSpecifier : [See 15.2.3](#)
IdentifierName
IdentifierName as IdentifierName

A.6 Number Conversions

<u>StringNumericLiteral</u> :::	<u>StrWhiteSpace_{opt}</u>	<u>StrWhiteSpace_{opt} StrNumericLiteral StrWhiteSpace_{opt}</u>	See 7.1.3.1
<u>StrWhiteSpace</u> :::	<u>StrWhiteSpaceChar</u>	<u>StrWhiteSpace_{opt}</u>	See 7.1.3.1
<u>StrWhiteSpaceChar</u> :::	<u>WhiteSpace</u>	<u>LineTerminator</u>	See 7.1.3.1
<u>StrNumericLiteral</u> :::	<u>StrDecimalLiteral</u>	<u>BinaryIntegerLiteral</u>	See 7.1.3.1
	<u>OctalIntegerLiteral</u>	<u>HexIntegerLiteral</u>	
<u>StrDecimalLiteral</u> :::	<u>StrUnsignedDecimalLiteral</u>	<u>+ StrUnsignedDecimalLiteral</u>	See 7.1.3.1
	<u>- StrUnsignedDecimalLiteral</u>		
<u>StrUnsignedDecimalLiteral</u> :::	<u>Infinity</u>	<u>DecimalDigits . DecimalDigits_{opt} ExponentPart_{opt}</u>	See 7.1.3.1
		<u>. DecimalDigits ExponentPart_{opt}</u>	
		<u>DecimalDigits ExponentPart_{opt}</u>	
<u>DecimalDigits</u> :::	<u>DecimalDigit</u>	<u>DecimalDigits DecimalDigit</u>	See 7.1.3.1
<u>DecimalDigit</u> :::	<u>one of</u>	<u>0 1 2 3 4 5 6 7 8 9</u>	See 7.1.3.1
<u>ExponentPart</u> :::	<u>ExponentIndicator</u>	<u>SignedInteger</u>	See 7.1.3.1
<u>ExponentIndicator</u> :::	<u>one of</u>	<u>e E</u>	See 7.1.3.1
<u>SignedInteger</u> :::	<u>DecimalDigits</u>	<u>+ DecimalDigits</u>	See 7.1.3.1
	<u>- DecimalDigits</u>		
<u>HexIntegerLiteral</u> :::	<u>0x HexDigit</u>	<u>0X HexDigit</u>	See 7.1.3.1
	<u>HexIntegerLiteral HexDigit</u>		

Deleted: Program : See clause 14¶
SourceElements_{opt}¶
 ¶ SourceElements : See clause 14¶
SourceElement
SourceElements SourceElement¶
 ¶ SourceElement : See clause 14¶
Statement
FunctionDeclaration¶

HexDigit :: one of

0 1 2 3 4 5 6 7 8 9 a b c d e f A B C D E F

See 7.1.3.1

All grammar symbols not explicitly defined by the *StringNumericLiteral* grammar have the definitions used in the Lexical Grammar for numeric literals (11.8.3)

Deleted: n

A.7 Universal Resource Identifier Character Classes

| *uri* ::=
 *uriCharacters*_{opt}

See 18.2.6.1

Deleted: 15.1.3

| *uriCharacters* ::=
 uriCharacter *uriCharacters*_{opt}

See 18.2.6.1

Deleted: 15.1.3

| *uriCharacter* ::=
 uriReserved
 uriUnescaped
 uriEscaped

See 18.2.6.1

Deleted: 15.1.3

| *uriReserved* :: one of
 ; / ? : @ & = + \$,

See 18.2.6.1

Deleted: 15.1.3

| *uriUnescaped* ::=
 uriAlpha
 DecimalDigit
 uriMark

See 18.2.6.1

Deleted: 15.1.3

| *uriEscaped* ::=
 % *HexDigit* *HexDigit*

See 18.2.6.1

Deleted: 15.1.3

| *uriAlpha* :: one of
 a b c d e f g h i j k l m n o p q r s t u v w x y z
 A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

See 18.2.6.1

Deleted: 15.1.3

| *uriMark* :: one of
 - _ . ! ~ * ' ()

See 18.2.6.1

Deleted: 15.1.3

A.8 Regular Expressions

*Pattern*_[?U] ::

See 21.2.1

*Disjunction*_[?U]

*Disjunction*_[?U] ::

See 21.2.1

*Alternative*_[?U]

*Alternative*_[?U] | *Disjunction*_[?U]

Alternative_[U] :: See 21.2.1
empty
Alternative_[?U] Term_[?U]

Term_[U] :: See 21.2.1
Assertion_[U]
Atom_[?U]
Atom_[?U] Quantifier

Assertion_[U] :: See 21.2.1
 $\begin{array}{c} \wedge \\ \exists \\ \backslash b \\ \backslash B \\ (\ ? = Disjunction_{[?U]}) \\ (\ ? ! Disjunction_{[?U]}) \end{array}$

Quantifier :: See 21.2.1
QuantifierPrefix
QuantifierPrefix ?

QuantifierPrefix :: See 21.2.1
 $\begin{array}{c} * \\ + \\ ? \\ \{ DecimalDigits \} \\ \{ DecimalDigits , \} \\ \{ DecimalDigits , DecimalDigits \} \end{array}$

Atom_[U] :: See 21.2.1
PatternCharacter
 $\begin{array}{c} \cdot \\ \backslash AtomEscape_{[?U]} \\ CharacterClass_{[?U]} \\ (\ Disjunction_{[?U]}) \\ (\ ? : Disjunction_{[?U]}) \end{array}$

SyntaxCharacter :: one of See 21.2.1
 $\begin{array}{c} ^ \$ \backslash . * + ? () [] \{ \} | \end{array}$

PatternCharacter :: See 21.2.1
SourceCharacter but not SyntaxCharacter

AtomEscape_[U] :: See 21.2.1
DecimalEscape
CharacterEscape_[?U]
CharacterClassEscape

CharacterEscape_[U] ::

See 21.2.1

ControlEscape

c ControlLetter

HexEscapeSequence

RegExpUnicodeEscapeSequence_[P|U]

IdentityEscape_[?U]

ControlEscape :: one of

f n r t v

See 21.2.1

ControlLetter :: one of

See 21.2.1

<u>a</u>	<u>b</u>	<u>c</u>	<u>d</u>	<u>e</u>	<u>f</u>	<u>g</u>	<u>h</u>	<u>i</u>	<u>j</u>	<u>k</u>	<u>l</u>	<u>m</u>	<u>n</u>	<u>o</u>	<u>p</u>	<u>q</u>	<u>r</u>	<u>s</u>	<u>t</u>	<u>u</u>	<u>v</u>	<u>w</u>	<u>x</u>	<u>y</u>	<u>z</u>
<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>I</u>	<u>J</u>	<u>K</u>	<u>L</u>	<u>M</u>	<u>N</u>	<u>O</u>	<u>P</u>	<u>Q</u>	<u>R</u>	<u>S</u>	<u>T</u>	<u>U</u>	<u>V</u>	<u>W</u>	<u>X</u>	<u>Y</u>	<u>Z</u>

RegExpUnicodeEscapeSequence_[U] ::

See 21.2.1

[+U] u LeadSurrogate \u TrailSurrogate

\u Hex4Digits

[+U] u{ HexDigits }

LeadSurrogate ::

See 21.2.1

Hex4Digits [match only if the SV of Hex4Digits is in the inclusive range 0xD800 to 0xDBFF]

Deleted: CV

TrailSurrogate ::

See 21.2.1

Hex4Digits [match only if the SV of Hex4Digits is in the inclusive range 0xDC00 to 0xDFFF]

Deleted: CV

IdentityEscape_[U] ::

See 21.2.1

[+U] SyntaxCharacter

[~U] SourceCharacter but not UnicodeIDContinue

DecimalEscape ::

See 21.2.1

DecimalIntegerLiteral [lookahead ≠ DecimalDigit]

CharacterClassEscape :: one of

See 21.2.1

d D s S w W

CharacterClass_[U] ::

See 21.2.1

[lookahead ≠ {^}] ClassRanges_[?U]]

[^ ClassRanges_[?U]]

ClassRanges_[U] ::

See 21.2.1

[empty]

NonemptyClassRanges_[?U]

NonemptyClassRanges_[U] ::

See 21.2.1

ClassAtom_[?U]

ClassAtom_[?U] NonemptyClassRangesNoDash_[?U]

ClassAtom_[?U] - ClassAtom_[?U] ClassRanges_[?U]

NonemptyClassRangesNoDash_[U] ::

See 21.2.1

ClassAtom_[?U]

ClassAtomNoDash_[?U] NonemptyClassRangesNoDash_[?U]

ClassAtomNoDash_[?U] - ClassAtom_[?U] ClassRanges_[?U]



ClassAtom_[U] :::

See 21.2.1

- ClassAtomNoDash_[?U]

ClassAtomNoDash_[U] :::

See 21.2.1

SourceCharacter but not one of \ or] or -

\ ClassEscape_[?U]

ClassEscape_[U] :::

See 21.2.1

DecimalEscape

b

t

f

CharacterEscape_[?U]

CharacterClassEscape

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Annex B (normative)

Additional ECMAScript Features for Web Browsers

Deleted:

The ECMAScript language syntax and semantics defined in this annex are required when the ECMAScript host is a web browser. The content of this annex is normative but optional if the ECMAScript host is not a web browser.

B.1 Additional Syntax

B.1.1 Numeric Literals

The syntax and semantics of 11.8.3 is extended as follows except that this extension is not allowed for strict mode code:

Syntax

NumericLiteral ::
DecimalLiteral
BinaryIntegerLiteral
OctalIntegerLiteral
HexIntegerLiteral
LegacyOctalIntegerLiteral

LegacyOctalIntegerLiteral ::
0 OctalDigit
LegacyOctalIntegerLiteral_ OctalDigit

DecimalIntegerLiteral ::
0
NonZeroDigit DecimalDigits_{opt}
NonOctalDecimalIntegerLiteral

NonOctalDecimalIntegerLiteral ::
0 NonOctalDigit
LegacyOctalLikeDecimalIntegerLiteral NonOctalDigit
NonOctalDecimalIntegerLiteral DecimalDigit

LegacyOctalLikeDecimalIntegerLiteral ::
0 OctalDigit
LegacyOctalLikeDecimalIntegerLiteral OctalDigit

NonOctalDigit :: one of
8 9

Deleted: 7

B.1.1.1 Static Semantics

- The MV of *LegacyOctalIntegerLiteral* :: *0 OctalDigit* is the MV of *OctalDigit*.

- The MV of *LegacyOctalIntegerLiteral* :: *LegacyOctalIntegerLiteral OctalDigit* is (the MV of *LegacyOctalIntegerLiteral* times 8) plus the MV of *OctalDigit*.
- The MV of *DecimalIntegerLiteral* :: *NonOctalDecimalIntegerLiteral* is the MV of *NonOctalDecimalIntegerLiteral*.
- The MV of *NonOctalDecimalIntegerLiteral* :: *0 NonOctalDigit* is the MV of *NonOctalDigit*.
- The MV of *NonOctalDecimalIntegerLiteral* :: *LegacyOctalLikeDecimalIntegerLiteral NonOctalDigit* is (the MV of *LegacyOctalLikeDecimalIntegerLiteral* times 10) plus the MV of *NonOctalDigit*.
- The MV of *NonOctalDecimalIntegerLiteral* :: *NonOctalDecimalIntegerLiteral DecimalDigit* is (the MV of *NonOctalDecimalIntegerLiteral* times 10) plus the MV of *DecimalDigit*.
- The MV of *LegacyOctalLikeDecimalIntegerLiteral* :: *0 OctalDigit* is the MV of *OctalDigit*.
- The MV of *LegacyOctalLikeDecimalIntegerLiteral* :: *LegacyOctalLikeDecimalIntegerLiteral OctalDigit* is (the MV of *LegacyOctalLikeDecimalIntegerLiteral* times 10) plus the MV of *OctalDigit*.
- The MV of *NonOctalDigit* :: *8* is 8.
- The MV of *NonOctalDigit* :: *9* is 9.

B.1.2 String Literals

Deleted:

The syntax and semantics of 11.8.4 is extended as follows except that this extension is not allowed for strict mode code:

Syntax

EscapeSequence ::
CharacterEscapeSequence
LegacyOctalEscapeSequence
HexEscapeSequence
UnicodeEscapeSequence

LegacyOctalEscapeSequence ::
OctalDigit [lookahead ≠ *OctalDigit*]
ZeroToThree OctalDigit [lookahead ≠ *OctalDigit*]
FourToSeven OctalDigit
ZeroToThree OctalDigit OctalDigit

Deleted: *DecimalDigit*

Deleted: *DecimalDigit*

ZeroToThree :: one of
 0 1 2 3

FourToSeven :: one of
 4 5 6 7

This definition of *EscapeSequence* is not used when parsing *TemplateCharacter* (11.8.6).

Deleted: ¶

B.1.2.1 Static Semantics

- The *SV* of *EscapeSequence* :: *LegacyOctalEscapeSequence* is the *SV* of the *LegacyOctalEscapeSequence*.
- The *SV* of *LegacyOctalEscapeSequence* :: *OctalDigit* is the code unit *whose* value is the MV of the *OctalDigit*.
- The *SV* of *LegacyOctalEscapeSequence* :: *ZeroToThree OctalDigit* is the code unit *whose* value is (8 times the MV of the *ZeroToThree*) plus the MV of the *OctalDigit*.
- The *SV* of *LegacyOctalEscapeSequence* :: *FourToSeven OctalDigit* is the code unit *whose* value is (8 times the MV of the *FourToSeven*) plus the MV of the *OctalDigit*.

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- The SV of LegacyOctalEscapeSequence :: ZeroToThree OctalDigit OctalDigit is the code unit whose value is (64 (that is, 8^2) times the MV of the ZeroToThree) plus (8 times the MV of the first OctalDigit) plus the MV of the second OctalDigit.
- The MV of ZeroToThree :: 0 is 0.
- The MV of ZeroToThree :: 1 is 1.
- The MV of ZeroToThree :: 2 is 2.
- The MV of ZeroToThree :: 3 is 3.
- The MV of FourToSeven :: 4 is 4.
- The MV of FourToSeven :: 5 is 5.
- The MV of FourToSeven :: 6 is 6.
- The MV of FourToSeven :: 7 is 7.

Deleted: CV

Deleted: character whose

B.1.3 HTML-like Comments

The syntax and semantics of 11.4 is extended as follows except that this extension is not allowed within module code:

Deleted: TODO See
<http://javascript.spec.whatwg.org/#comment-syntax>

Deleted: for

Syntax

Comment ::

MultiLineComment
SingleLineComment
SingleLineHTMLOpenComment
SingleLineHTMLCloseComment
SingleLineDelimitedComment

MultiLineComment ::

/* FirstCommentLine_{opt} LineTerminator MultiLineCommentChars_{opt} */ HTMLCloseComment_{opt}

FirstCommentLine ::

SingleLineDelimitedCommentChars

SingleLineHTMLOpenComment ::

<!-- SingleLineCommentChars_{opt}

SingleLineHTMLCloseComment ::

LineTerminatorSequence HTMLCloseComment

SingleLineDelimitedComment ::

/* SingleLineDelimitedCommentChars_{opt} */

HTMLCloseComment ::

WhiteSpaceSequence_{opt} SingleLineDelimitedCommentSequence_{opt} --> SingleLineCommentChars_{opt}

SingleLineDelimitedCommentChars ::

SingleLineNotAsteriskChar SingleLineDelimitedCommentChars_{opt}
 \ast SingleLinePostAsteriskCommentChars_{opt}

SingleLineNotAsteriskChar ::

SourceCharacter but not one of \ast or LineTerminator

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SingleLinePostAsteriskCommentChars ::

SingleLineNotForwardSlashOrAsteriskChar SingleLineDelimitedCommentChars_{opt}
* SingleLinePostAsteriskCommentChars_{opt}

SingleLineNotForwardSlashOrAsteriskChar ::

SourceCharacter but not one of / or * or LineTerminator

WhiteSpaceSequence ::

WhiteSpace WhiteSpaceSequence_{opt}

SingleLineDelimitedCommentSequence ::

SingleLineDelimitedComment WhiteSpaceSequence_{opt} SingleLineDelimitedCommentSequence_{opt}

Similar to a *MultiLineComment* that contains a line terminator code point, a *SingleLineHTMLCloseComment* is considered to be a *LineTerminator* for purposes of parsing by the syntactic grammar.

B.1.4 Regular Expressions Patterns

The syntax of 21.2.1 is modified and extended as follows. These changes introduce ambiguities that are broken by the ordering of grammar productions and by contextual information. When parsing using the following grammar, each alternative is considered only if previous production alternatives do not match.

This alternative pattern grammar and semantics only changes the syntax and semantics of BMP patterns. The following grammar extensions include productions parameterized with the [U] parameter. However, none of these extensions change the syntax of Unicode patterns recognized when parsing with the [U] parameter present on the goal symbol.

Syntax

Term_[U] ::
 [-U] ExtendedTerm
 [+U] Assertion_[U]
 [+U] Atom_[U]
 [+U] Atom_[U] Quantifier

ExtendedTerm ::
 Assertion
 AtomNoBrace Quantifier
 Atom
 QuantifiableAssertion Quantifier

AtomNoBrace ::
 PatternCharacterNoBrace
 ·
 \ AtomEscape
 CharacterClass
 (Disjunction)
 (? : Disjunction)

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Atom_[U] ::

PatternCharacter

\ AtomEscape_[?U]

CharacterClass_[?U]

(Disjunction_[?U]

(? : Disjunction_[?U])

PatternCharacterNoBrace ::

SourceCharacter but not one of

*^ \$ \ . * + ? () [] { } |*

Deleted: 1

PatternCharacter ::

SourceCharacter but not one of

*^ \$ \ . * + ? () [] |*

Deleted: 1

QuantifiableAssertion ::

(? = Disjunction)

(? ! Disjunction)

Assertion_[U] ::

^

\$

\ b

\ B

[+U] (? = Disjunction_[U])

[+U] (? ! Disjunction_[U])

[+U] QuantifiableAssertion

Deleted: ?

Deleted: ?

AtomEscape_[U] ::

[+U] DecimalEscape

[+U] CharacterEscape_[U]

[+U] CharacterClassEscape

[+U] DecimalEscape but only if the integer value of DecimalEscape is <= NCapturingParens

[+U] CharacterClassEscape

[+U] CharacterEscape

Deleted: [+U] CharacterEscape_[U]
Deleted: [+U] CharacterClassEscape

CharacterEscape_[U] ::

ControlEscape

c ControlLetter

HexEscapeSequence

RegExpUnicodeEscapeSequence_[?U]

[~U] LegacyOctalEscapeSequence

IdentityEscape_[?U]

IdentityEscape_[U] ::

[+U] SyntaxCharacter

[+U] SourceCharacter but not c

Deleted:
[~U] <ZWJ>
[~U] <ZWNJ>

NonemptyClassRanges_[U] ::
ClassAtom_[U]
ClassAtom_[U] NonemptyClassRangesNoDash_[U]
 $[+U] \text{ ClassAtom}_{[U]} - \text{ ClassAtom}_{[U]} \text{ ClassRanges}_{[U]}$
 $[-U] \text{ ClassAtomInRange} - \text{ ClassAtomInRange} \text{ ClassRanges}$

NonemptyClassRangesNoDash_[U] ::
ClassAtom_[U]
ClassAtomNoDash_[U] NonemptyClassRangesNoDash_[U]
 $[+U] \text{ ClassAtomNoDash}_{[U]} - \text{ ClassAtom}_{[U]} \text{ ClassRanges}_{[U]}$
 $[-U] \text{ ClassAtomNoDashInRange} - \text{ ClassAtomInRange} \text{ ClassRanges}$

ClassAtom_[U] ::
 $-$
ClassAtomNoDash_[U]

ClassAtomNoDash_[U] ::
SourceCharacter but not one of \ or] or -
 $\backslash \text{ ClassEscape}_{[U]}$

ClassAtomInRange ::
 $-$
ClassAtomNoDashInRange

ClassAtomNoDashInRange ::
SourceCharacter but not one of \ or] or -
 $\backslash \text{ ClassEscape}$ but only if *ClassEscape* evaluates to a *CharSet* with exactly one character
 $\backslash \text{ IdentityEscape}$

ClassEscape_[U] ::
 $[+U] \text{ DecimalEscape}$
 $[+U] \text{ CharacterEscape}_{[U]}$
 $[+U] \text{ CharacterClassEscape}_{[U]}$
 $[+U] \text{ DecimalEscape}$ but only if the integer value of *DecimalEscape* is $\leq N\text{CapturingParens}$
 b
 $[+U] \text{ CharacterClassEscape}_{[U]}$
 $[+U] \text{ CharacterEscape}_{[U]}$

Deleted: $[+U] \text{ CharacterEscape}_{[U]}$
 $[+U] \text{ CharacterClassEscape}_{[U]}$

B.1.4.1 Pattern Semantics

The semantics of 21.2.2 is extended as follows:

Within 21.2.2.5 reference to “*Atom* :: (*Disjunction*)” are to be interpreted as meaning “*Atom* :: (*Disjunction*) or *AtomNoBrace* :: (*Disjunction*)”.

Term (21.2.2.5) includes the following additional evaluation rule:

The production *Term* :: *QuantifiableAssertion* *Quantifier* evaluates the same as the production *Term* :: *Atom* *Quantifier* but with *QuantifiableAssertion* substituted for *Atom*.

Atom (21.2.2.8) evaluation rules for the *Atom* productions except for *Atom :: PatternCharacter* are also used for the *AtomNoBrace* productions, but with *AtomNoBrace* substituted for *Atom*. The following evaluation rule is also added:

The production *AtomNoBrace :: PatternCharacterNoBrace* evaluates as follows:

1. Let *ch* be the character represented by *PatternCharacterNoBrace*.
2. Let *A* be a one-element CharSet containing the character *ch*.
3. Call *CharacterSetMatcher(A, false)* and return its Matcher result.

CharacterEscape (21.2.2.10) includes the following additional evaluation rule:

The production *CharacterEscape :: LegacyOctalEscapeSequence* evaluates by evaluating the SV of the *LegacyOctalEscapeSequence* (see B.1.2) and returning its character result.

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ClassAtom (21.2.2.17) includes the following additional evaluation rules:

The production *ClassAtomInRange :: -* evaluates by returning the CharSet containing the one character *-*.

The production *ClassAtomInRange :: ClassAtomNoDashInRange* evaluates by evaluating *ClassAtomNoDashInRange* to obtain a CharSet and returning that CharSet.

ClassAtomNoDash (21.2.2.18) includes the following additional evaluation rules:

The production *ClassAtomNoDashInRange :: SourceCharacter but not one of \ or] or -* evaluates by returning a one-element CharSet containing the character represented by *SourceCharacter*.

The production *ClassAtomNoDashInRange :: \ ClassEscape but only if..., evaluates by evaluating ClassEscape to obtain a CharSet and returning that CharSet.*

The production *ClassAtomNoDashInRange :: \ IdentityEscape* evaluates by returning the character represented by *IdentityEscape*.

B.2 Additional Built-in Properties

When the ECMAScript host is a web browser the following additional properties of the standard built-in objects are defined.

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B.2.1 Additional Properties of the Global Object

B.2.1.1 escape (string)

The *escape* function is a property of the global object. It computes a new version of a String value in which certain code units have been replaced by a hexadecimal escape sequence.

For those code units being replaced whose value is U+00FF or less, a two-digit escape sequence of the form %xx is used. For those characters being replaced whose code unit value is greater than U+00FF, a four-digit escape sequence of the form %uxxxx is used.

Deleted: characters

Deleted: characters

Deleted: code unit

Deleted: 0xFF

Deleted: 0xFF

When the *escape* function is called with one argument *string*, the following steps are taken:

1. Let *string* be `ToString(string)`.
2. ReturnIfAbrupt(*string*).
3. Let *length* be the number of code units in *string*.
4. Let *R* be the empty string.
5. Let *k* be 0.
6. Repeat, while $k < \text{length}$.
 - a. Let *char* be the code unit (represented as a 16-bit unsigned integer) at *index k* within *string*.
 - b. If *char* is the code point of one of the 69 nonblank *code units in*
~~"ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123456789@*+-./"~~, then
 - i. Let *S* be a String containing the single *code unit* *char*.
 - c. Else if *char* ≥ 256 , then
 - i. Let *S* be a String containing six *code units* "%*wxyz*" where *wxyz* are *the code units of* the four hexadecimal digits encoding the value of *char*.
 - d. Else, *char* < 256
 - i. Let *S* be a String containing three *code units* "%*xy*" where *xy* are *the code units of* two hexadecimal digits encoding the value of *char*.
 - e. Let *R* be a new String value computed by concatenating the previous value of *R* and *S*.
 - f. Increase *k* by 1.
7. Return *R*.

NOTE The encoding is partly based on the encoding described in RFC 1738, but the entire encoding specified in this standard is described above without regard to the contents of RFC 1738. This encoding does not reflect changes to RFC 1738 made by RFC 3986.

B.2.1.2 unescape (string)

The `unescape` function is a property of the global object. It computes a new version of a String value in which each escape sequence of the sort that might be introduced by the `escape` function is replaced with the *code unit* that it represents.

When the `unescape` function is called with one argument *string*, the following steps are taken:

1. Let *string* be `ToString(string)`.
2. ReturnIfAbrupt(*string*).
3. Let *length* be the number of code units in *string*.
4. Let *R* be the empty String.
5. Let *k* be 0.
6. Repeat, while $k \neq \text{length}$.
 - a. Let *c* be the code unit at *index k* within *string*.
 - b. If *c* is %.
 - i. If $k \leq \text{length}-6$ and the code unit at *index k+1* within *string* is u and the four code units at *indices* $k+2, k+3, k+4$, and $k+5$ within *string* are all hexadecimal digits, then
 1. Let *c* be the code unit whose value is the integer represented by the four hexadecimal digits at *indices* $k+2, k+3, k+4$, and $k+5$ within *string*.
 2. Increase *k* by 5.
 - ii. Else if $k \leq \text{length}-3$ and the two code units at *indices* $k+1$ and $k+2$ within *string* are both hexadecimal digits, then
 1. Let *c* be the code unit whose value is the integer represented by two zeroes plus the two hexadecimal digits at *indices* $k+1$ and $k+2$ within *string*.
 2. Increase *k* by 2.
 - c. Let *R* be a new String value computed by concatenating the previous value of *R* and *c*.

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Deleted: position
Deleted: characters
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- d. Increase k by 1.
7. Return R .

B.2.2 Additional Properties of the Object.prototype Object

B.2.2.1 Object.prototype.__proto__

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`Object.prototype.__proto__` is an accessor property with attributes { `[[Enumerable]]: false, [[Configurable]]: true` }. The `[[Get]]` and `[[Set]]` attributes are defined as follows

B.2.2.1.1 get Object.prototype.__proto__

Deleted: ¶

The value of the `[[Get]]` attribute is a built-in function that requires no arguments. It performs the following steps:

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. `ReturnIfAbrupt(O)`.
3. Return the result of calling the `[[GetPrototypeOf]]` internal method of O .

B.2.2.1.2 set Object.prototype.__proto__

Deleted: ¶

The value of the `[[Set]]` attribute is a built-in function that takes an argument $proto$. It performs the following steps:

1. Let O be `RequireObjectCoercible(this value)`.
2. `ReturnIfAbrupt(O)`.
3. If `Type(proto)` is neither Object nor Null, `return undefined`.
4. If `Type(O)` is not Object, `return undefined`.
5. Let $status$ be the result of calling the `[[SetPrototypeOf]]` internal method of O with argument $proto$.
6. `ReturnIfAbrupt(status)`.
7. If $status$ is false, `throw` a `TypeError` exception.
8. Return `undefined`.

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B.2.3 Additional Properties of the String.prototype Object

B.2.3.1 String.prototype.substr (start, length)

The `substr` method takes two arguments, `start` and `length`, and returns a substring of the result of converting the `this` object to a String, starting from `index_start` and running for `length code units` (or through the end of the String if `length` is `undefined`). If `start` is negative, it is treated as $(sourceLength+start)$ where `sourceLength` is the length of the String. The result is a String value, not a String object. The following steps are taken:

1. Let O be `RequireObjectCoercible(this value)`.
2. Let S be `ToString(O)`.
3. `ReturnIfAbrupt(S)`.
4. Let $intStart$ be `ToInteger(start)`.
5. `ReturnIfAbrupt(intStart)`.
6. If `length` is `undefined`, let `end` be $+\infty$; otherwise let `end` be `ToInteger(length)`.
7. `ReturnIfAbrupt(end)`.
8. Let `size` be the number of `code units` in S .
9. If $intStart \leq 0$, let $intStart$ be $\max(size + intStart, 0)$.
10. Let `resultLength` be $\min(\max(end, 0), size - intStart)$.

Deleted: character

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Deleted: CheckObjectCoercible

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Deleted: is negative

Deleted: , then let

11. If *resultLength* ≤ 0, return the empty String "".
12. Return a String containing *resultLength* consecutive code units from *S* beginning with the code unit at *index* *intStart*.

Deleted: characters
Deleted: character
Deleted: position

The **length** property of the **substr** method is **2**.

NOTE The **substr** function is intentionally generic; it does not require that its **this** value be a String object. Therefore it can be transferred to other kinds of objects for use as a method.

B.2.3.2 String.prototype.anchor (name)

When the **anchor** method is called with argument *name*, the following steps are taken:

1. Let *S* be the **this** value.
2. Return CreateHTML(*S*, "a", "name", *name*).

B.2.3.2.1 CreateHTML (string, tag, attribute, value) Abstract Operation

Deleted: name

The abstract operation CreateHTML is called with arguments *string*, *tag*, *attribute*, and *value*. The arguments *tag* and *attribute* must be string values. The following steps are taken:

1. Let *str* be RequireObjectCoercible(*string*).
Deleted: CheckObjectCoercible
2. Let *S* be ToString(*str*).
Deleted: "
3. ReturnIfAbrupt(*S*).
Deleted: ¶
4. Let *p1* be the string value that is the concatenation of "<" and *tag*.
Deleted: code unit value 0x0022 QUOTATION MARK
5. If *attribute* is not the empty String, then
 - a. Let *V* be ToString(*value*).
Deleted: a single
 - b. ReturnIfAbrupt(*V*).
Deleted: =
 - c. Let *escapedV* be the string value that is the same as *V* except that each occurrence of the code unit U+0022 QUOTATION MARK in *V* has been replaced with the six code unit sequence "".
Deleted: 0x0022
 - d. Let *p1* be the string value that is the concatenation of the following string values:
 - The string value of *p1*
 - Code unit U+0020 (SPACE)
Deleted: 0x0020
 - The string value of *attribute*.
Deleted: a single
 - Code unit U+003D (EQUALS SIGN)
Deleted: =
 - Code unit U+0022 (QUOTATION MARK)
Deleted: 0x0022
 - The string value of *escapedV*
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 - Code unit U+0022 (QUOTATION MARK)
Deleted: QUATATION
6. Let *p2* be the string value that is the concatenation of *p1* and ">".
Deleted: a single =
7. Let *p3* be the string value that is the concatenation of *p2* and *S*.
Deleted: 0x0022
8. Let *p4* be the string value that is the concatenation of *p3*, "</", *tag*, and ">".
Deleted: a single QUATATION
9. Return *p4*.
Deleted: 0x0022

B.2.3.3 String.prototype.big ()

When the **big** method is called with no arguments, the following steps are taken:

1. Let *S* be the **this** value.
Deleted: p2
2. Return CreateHTML(*S*, "big", "", "").
Deleted: ¶

B.2.3.4 String.prototype.blink ()

When the **blink** method is called with no arguments, the following steps are taken:

1. Let S be the **this** value.
2. Return CreateHTML(S , "blink", "", "").

B.2.3.5 String.prototype.bold ()

When the **bold** method is called with no arguments, the following steps are taken:

1. Let S be the **this** value.
2. Return CreateHTML(S , "b", "", "").

B.2.3.6 String.prototype.fixed ()

When the **fixed** method is called with no arguments, the following steps are taken:

1. Let S be the **this** value.
2. Return CreateHTML(S , "tt", "", "").

B.2.3.7 String.prototype.fontcolor (color)

When the **fontcolor** method is called with argument $color$, the following steps are taken:

1. Let S be the **this** value.
2. Return CreateHTML(S , "font", "color", $color$).

B.2.3.8 String.prototype.fontSize (size)

When the **fontSize** method is called with argument $size$, the following steps are taken:

1. Let S be the **this** value.
2. Return CreateHTML(S , "font", "size", $size$).

B.2.3.9 String.prototype.italics ()

When the **italics** method is called with no arguments, the following steps are taken:

1. Let S be the **this** value.
2. Return CreateHTML(S , "i", "", "").

B.2.3.10 String.prototype.link (url)

When the **link** method is called with argument url , the following steps are taken:

1. Let S be the **this** value.
2. Return CreateHTML(S , "a", "href", url).

B.2.3.11 String.prototype.small ()

When the **small** method is called with no arguments, the following steps are taken:

1. Let S be the **this** value.
2. Return CreateHTML(S , "small", "", "").

B.2.3.12 String.prototype.strike ()

When the **strike** method is called with no arguments, the following steps are taken:

1. Let S be the **this** value.
2. Return CreateHTML(S , "**strike**", "", "").

B.2.3.13 String.prototype.sub ()

When the **sub** method is called with no arguments, the following steps are taken:

1. Let S be the **this** value.
2. Return CreateHTML(S , "**sub**", "", """).

B.2.3.14 String.prototype.sup ()

When the **sup** method is called with no arguments, the following steps are taken:

1. Let S be the **this** value.
2. Return CreateHTML(S , "**sup**", "", "").

B.2.4 Additional Properties of the Date.prototype Object

B.2.4.1 Date.prototype.getFullYear ()

NOTE The **getFullYear** method is preferred for nearly all purposes, because it avoids the "year 2000 problem."

When the **getFullYear** method is called with no arguments, the following steps are taken:

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is **NaN**, return **NaN**.
4. Return YearFromTime(LocalTime(t)) – 1900.

B.2.4.2 Date.prototype.setYear (year)

NOTE The **setFullYear** method is preferred for nearly all purposes, because it avoids the "year 2000 problem."

When the **setYear** method is called with one argument *year*, the following steps are taken:

1. Let t be LocalTime(this time value); but if this time value is **NaN**, let t be **+0**.
2. Let y be ToNumber(*year*).
3. [ReturnIfAbrupt\(y\)](#).
4. If y is **NaN**, set the **[[DateValue]]** internal slot of this Date object to **NaN** and return **NaN**.
5. If y is not **NaN** and $0 \leq \text{ToInteger}(y) \leq 99$, let yyyy be $\text{ToInteger}(y) + 1900$.
6. [Else](#), let yyyy be y .
7. Let d be $\text{MakeDay}(\text{yyyy}, \text{MonthFromTime}(t), \text{DateFromTime}(t))$.
8. Let date be $\text{UTC}(\text{MakeDate}(d, \text{TimeWithinDay}(t)))$.
9. Set the **[[DateValue]]** internal slot of this Date object to $\text{TimeClip}(\text{date})$.
10. Return the value of the **[[DateValue]]** internal slot of this Date object.

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Deleted: Otherwise

B.2.4.3 Date.prototype.toGMTString ()

NOTE The property `toUTCString` is preferred. The `toGMTString` property is provided principally for compatibility with old code. It is recommended that the `toUTCString` property be used in new ECMAScript code.

The Function object that is the initial value of `Date.prototype.toGMTString` is the same Function object that is the initial value of `Date.prototype.toUTCString`.

B.2.5 Additional Properties of the RegExp.prototype Object

B.2.5.1 RegExp.prototype.compile (pattern, flags)

When the `compile` method is called with arguments *pattern* and *flags*, the following steps are taken:

1. Let *O* be the `this` value.
2. If `Type(O)` is not `Object` or `Type(O)` is `Object` and *O* does not have a `[[RegExpMatcher]]` internal slot, then
 - a. Throw a `TypeError` exception.
3. If `Type(pattern)` is `Object` and *pattern* has a `[[RegExpMatcher]]` internal slot, then
 - a. If *flags* is not `undefined`, throw a `TypeError` exception.
 - b. Let *P* be the value of *pattern*'s `[[OriginalSource]]` internal slot.
 - c. Let *F* be the value of *pattern*'s `[[OriginalFlags]]` internal slot.
4. Else,
 - a. Let *P* be *pattern*.
 - b. Let *F* be *flags*.
5. Return `RegExpInitialize(O, P, F)`.

Deleted: <#>Let `extensible` be the result of calling the `[[IsExtensible]]` internal method of *O*.
 <#>`ReturnIfAbrupt(extensible)`.
 <#>If `extensible` is `false`, then throw a `TypeError` exception.

Deleted: <#>If the value of *pattern*'s `[[RegExpMatcher]]` internal slot is `undefined`, then throw a `TypeError` exception.

Deleted: , then throw

NOTE The `compile` method completely reinitializes the `this` object `RegExp` with a new pattern and flags. An implementation may interpret use of this method as an assertion that the resulting `RegExp` object will be used multiple times and hence is a candidate for extra optimization.

B.3 Other Additional Features

B.3.1 `proto` , Property Names in Object Initializers

The following Early Error rule is added to those in 12.2.5.1:

`ObjectLiteral : { PropertyDefinitionList }`,

and

`ObjectLiteral : { PropertyDefinitionList , }`,

- It is a Syntax Error if `PropertyNameList` of `PropertyDefinitionList` contains any duplicate entries for "`proto`" and at least two of those entries were obtained from productions of the form `PropertyDefinition :PropertyName :AssignmentExpression`.

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NOTE The List returned by `PropertyNameList` does not include string literal property names defined as using a `ComputedPropertyName`.

In 12.2.5.9, the `PropertyDefinitionEvaluation` algorithm for the production

`PropertyDefinition :PropertyName :AssignmentExpression`

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PropertyDefinition : PropertyName : AssignmentExpression

Deleted: ¶

1. Let *propKey* be the result of evaluating *PropertyName*.
2. ReturnIfAbrupt(*propKey*).
3. Let *exprValueRef* be the result of evaluating *AssignmentExpression*.
4. Let *propValue* be GetValue(*exprValueRef*).
5. ReturnIfAbrupt(*propValue*).
6. If *propKey* is the string value "__proto__" and if IsComputedPropertyKey(*propKey*) is **false**, then
 - a. If Type(*propValue*) is either Object or Null, then
 - i. Return the result of calling the [[SetPrototypeOf]] internal method of *object* with argument *propValue*.
 - b. Return NormalCompletion(empty).
7. If IsFunctionDefinitionof AssignmentExpression is **true**, then
 - a. Assert: *propValue* is an ECMAScript function object.
 - b. Let *referencesSuper* be the value of *propValue*'s [[NeedsSuper]] internal slot.
 - c. Let *thisMode* be the value of *propValue*'s [[ThisMode]] internal slot.
 - d. If *thisMode* is not lexical and *referencesSuper* is **true**, then
 - i. If *propValue*'s [[HomeObject]] internal slot is **undefined**, then
 1. Assert: *AssignmentExpression* is not a class definition whose constructor references super.
 2. Set the *propValue*'s [[HomeObject]] internal slot to *object*.
 - e. If IsAnonymousFunctionDefinition(*AssignmentExpression*) is **true**, then
 - i. Let *hasNameProperty* be HasOwnProperty(*propValue*, "name").
 - ii. ReturnIfAbrupt(*hasNameProperty*).
 - iii. If *hasNameProperty* is **false**, perform SetFunctionName(*propValue*, *propKey*).
8. Assert: *enumerable* is **true**.
9. Return CreateDataPropertyOrThrow(*object*, *propKey*, *propValue*).

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Deleted: <#>Set the *propValue*'s [[MethodName]] internal slot to *propKey*.¶

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Deleted: Assert: SetFunctionName will not return an abrupt completion.

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Deleted: <#>Let *desc* be the Property Descriptor{[[Value]]: *propValue*, [[Writable]]: **true**, [[Enumerable]]: **true**, [[Configurable]]: **true**}¶

Deleted: DefinePropertyOrThrow

Deleted: *desc*

B.3.2 Labelled Function Declarations

Prior to the Sixth Edition, the ECMAScript specification *LabelledStatement* did not allow for the association of a statement label with a *FunctionDeclaration*. However, a labelled *FunctionDeclaration* was an allowable extension for non-strict mode code and most browser-hosted ECMAScript implementations supported that extension. In the Sixth Edition, the grammar productions for *LabelledStatement* permits use of *FunctionDeclaration* as a *LabelledItem* but 13.12.1 includes an Early Error rule that produces a Syntax Error if that occurs. For web browser compatibility, that rule is modified with the addition of the underlined text:

LabelledItem : FunctionDeclaration

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- It is a Syntax Error if any strict mode source code matches this rule.

B.3.3 Block-Level Function Declarations Web Legacy Compatibility Semantics

Deleted: for Block-Level Function Declarations

Prior to the Sixth Edition, the ECMAScript specification did not define the occurrence of a *FunctionDeclaration* as an element of a *Block* statement's *StatementList*. However, support for that form of *FunctionDeclaration* was an allowable extension and most browser-hosted ECMAScript implementations permitted them. Unfortunately, the semantics of such declarations differ among those implementations. Because of these semantic differences, existing web ECMAScript code that uses *Block* level function declarations is only portable among browser implementation if the usage only depends upon the semantic intersection of all of the browser implementations for such declarations. The following are the use cases that fall within that intersection semantics:

1. A function is declared and only referenced within a single block
 - A function declaration with the name *f* is declared exactly once within the function code of an enclosing function *g* and that declaration is nested within a *Block*.
 - No other declaration of *f* that is not a `var` declaration occurs within the function code of *g*.
 - References to *f* occur within the *StatementList* of the *Block* containing the declaration of *f*.

2. A function is declared and possibly used within a single *Block* but also referenced by an inner function definition that is not contained within that same *Block*.
 - A function declaration with the name *f* is declared exactly once within the function code of an enclosing function *g* and that declaration is nested within a *Block*.
 - No other declaration of *f* that is not a `var` declaration occurs within the function code of *g*.
 - References to *f* may occur within the *StatementList* of the *Block* containing the declaration of *f*.
 - References to *f* occur within the function code of *g* that lexically follows the *Block* containing the declaration of *f*.

3. A function is declared and possibly used within a single block but also referenced within subsequent blocks.
 - A function declaration with the name *f* is declared exactly once within the function code of an enclosing function *g* and that declaration is nested within a *Block*.
 - No other declaration of *f* that is not a `var` declaration occurs within the function code of *g*.
 - References to *f* may occur within the *StatementList* of the *Block* containing the declaration of *f*.
 - References to *f* occur within another function *h* that is nested within *g* and no other declaration of *f* shadows the references to *f* from within *h*.
 - All invocations of *h* occur after the declaration of *f* has been evaluated.

The first use case is interoperable with the semantics of *Block* level function declarations provided by ECMA-262 Edition 6. Any pre-existing ECMAScript code that employs that use case will operate using the *Block* level function declarations semantics defined by clauses 9, 13, and 14 of this specification.

Sixth edition interoperability for the second and third use cases requires the following extensions to the clause 9 and [clause 14](#) semantics. These extensions are applied to each non-strict mode function *g* for each *FunctionDeclaration* *f* that is directly contained in the *StatementList* of a *Block*, *CaseClause*, or *DefaultClause* that is part of the function code of *g*.

1. Let *F* be String Value [of](#) the *BindingIdentifier* of *FunctionDeclaration* *f*.
2. If replacing the *FunctionDeclaration* *f* with a *VariableStatement* that has *F* as a *BindingIdentifier* would not produce any Early Errors for *g* and *F* is not an element of *BoundNames* of *FormalParameters* of *g*, then
 - a. During *FunctionDeclarationInstantiation* ([9.2.13](#)) for *g* perform the following steps immediately before performing step [27](#):
 - i. [NOTE](#) A var binding for *F* is only instantiated here if it is [neither](#) a *VarDeclaredName*, the name of a formal parameter, or another *FunctionDeclarations*.
 - ii. If [instantiatedVarNames](#) does not [contain](#) *F*, then
 1. Let *status* be the result of calling *varEnvRec*'s *CreateMutableBinding* concrete method passing *F* as the argument.
 2. [Assert:](#) *status* is never an abrupt completion.
 3. [Call the InitializeBinding concrete method of](#) *varEnvRec* with arguments *F* and [undefined](#).
 4. [Append](#) *F* to [instantiatedVarNames.](#)
 - b. In place of the *FunctionDeclaration* Evaluation algorithm provided in [14.1.23](#), perform the following steps to evaluate the *FunctionDeclaration* *f*:

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Deleted: <#>Let *alreadyDeclared* be the result of calling *env*'s *HasBinding* concrete method passing *F* as the argument.¶

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Deleted: *alreadyDeclared*

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Deleted: <#>NOTE The new binding is not initialized during Function Declaration Instantiation.¶

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1. Let *fenv* be the running execution context's VariableEnvironment.
2. Let *benv* be the running execution context's LexicalEnvironment.
3. Let *fobj* be the result of calling the GetBindingValue concrete method of *benv* with arguments *F* and **false**.
4. [ReturnIfAbrupt\(*fobj*\)](#).
5. [Let *status* be the result of calling *fenv*'s SetMutableBinding concrete method with arguments *F*, *fobj*, and **false**.](#)
6. [Assert: *status* is never an abrupt completion.](#)
7. Return NormalCompletion(empty).

If an ECMAScript implementation has a mechanism for reporting diagnostic warning messages, a warning should be produced for each function *g* whose function code contains a *FunctionDeclaration* for which steps 2.a [and 2.b](#) above will be performed.

B.3.4 FunctionDeclarations in IfStatement Statement Clauses

The following rules for *IfStatement* augment those in 13.5:

IfStatement[*Yield*, *Return*] :

```
if ( Expression[In, ?Yield] ) FunctionDeclaration[?Yield] else Statement[?Yield, ?Return]
if ( Expression[In, ?Yield] ) Statement[?Yield, ?Return] else FunctionDeclaration[?Yield]
if ( Expression[In, ?Yield] ) FunctionDeclaration[?Yield] else FunctionDeclaration[?Yield]
if ( Expression[In, ?Yield] ) FunctionDeclaration[?Yield]
```

The above rules are only applied when parsing non-strict mode code. If any non-strict code is matched by one of these rules subsequent processing of that code takes place as if each matching occurrence of *FunctionDeclaration*[?*Yield*] was the sole *StatementList* item of a *BlockStatement* occupying that position in the source code. The semantics of such a synthetic *BlockStatement* includes the web legacy compatibility semantics specified in B.3.3.

B.3.5 VariableStatements in Catch blocks

The content of subclause 13.14.1 is replaced with the following:

Catch : *catch* (*CatchParameter*) *Block*

- It is a Syntax Error if any element of the *BoundNames* of *CatchParameter* also occurs in the *LexicallyDeclaredNames* of *Block*.
- It is a Syntax Error if any element of the *BoundNames* of *CatchParameter* also occurs in the *VarDeclaredNames* of *Block*, unless that element is only bound by a *VariableStatement* or, the *VariableDeclarationList* of a *for* statement, or the *ForBinding* of a *for-in* statement.

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Deleted: <#> If the binding for *F* in *fenv* has not been initialized, then ¶

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Deleted: of *fenv*

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NOTE The *Block* of a *Catch* clause may contain *var* declarations that bind a name that is also bound by the *CatchParameter*. At runtime, such bindings are instantiated in the *VariableDeclarationEnvironment*. They do not shadow the same-named bindings introduced by the *CatchParameter* and hence the *Initializer* for such *var* declarations will assign to the corresponding catch parameter rather than the *var* binding. The relaxation of the normal static semantic rule does not apply to names only bound by *for-of* statements.

Annex C (informative)

The Strict Mode of ECMAScript

The strict mode restriction and exceptions

- **"implements", "interface", "let", "package", "private", "protected", "public", "static", and "yield" are reserved words** within strict mode code. (11.6.2.2).
- A conforming implementation, when processing strict mode code, may not extend the syntax of *NumericLiteral* (11.8.3) to include *LegacyOctalIntegerLiteral* as described in B.1.1.
- A conforming implementation, when processing strict mode code (see 10.2.1), may not extend the syntax of *EscapeSequence* to include *LegacyOctalEscapeSequence* as described in B.1.2.
- Assignment to an undeclared identifier or otherwise unresolvable reference does not create a property in the global object. When a simple assignment occurs within strict mode code, its *LeftHandSide* must not evaluate to an unresolvable Reference. If it does a **ReferenceError** exception is thrown (6.2.3.2). The *LeftHandSide* also may not be a reference to a data property with the attribute value `[[Writable]]:false`, to an accessor property with the attribute value `[[Set]]:undefined`, nor to a non-existent property of an object whose `[[Extensible]]` internal slot has the value **false**. In these cases a **TypeError** exception is thrown (12.14).
- The identifier **eval** or **arguments** may not appear as the *LeftHandSideExpression* of an Assignment operator (12.14) or of a *PostfixExpression* (12.14) or as the *UnaryExpression* operated upon by a Prefix Increment (12.5.7) or a Prefix Decrement (12.5.8) operator.
- Arguments objects for strict mode functions define non-configurable accessor properties named "**caller**" and "**callee**" which throw a **TypeError** exception on access (9.2.8).
- Arguments objects for strict mode functions do not dynamically share their array indexed property values with the corresponding formal parameter bindings of their functions. (9.4.4).
- For strict mode functions, if an arguments object is created the binding of the local identifier **arguments** to the arguments object is immutable and hence may not be the target of an assignment expression. (9.2.13).
- It is a **SyntaxError** if the IdentifierName **eval** or the IdentifierName **arguments** occurs as a *BindingIdentifier* within strict mode code (12.1.1).
- Strict mode eval code cannot instantiate variables or functions in the variable environment of the caller to eval. Instead, a new variable environment is created and that environment is used for declaration binding instantiation for the eval code (18.2.1).
- If **this** is evaluated within strict mode code, then the **this** value is not coerced to an object. A **this** value of **null** or **undefined** is not converted to the global object and primitive values are not converted to wrapper objects. The **this** value passed via a function call (including calls made using `Function.prototype.apply` and `Function.prototype.call`) do not coerce the passed this value to an object (8.3.2, 12.2.1, 19.2.3.1, 19.2.3.3).

Comment [AWB1858]: This entire section needs to be updated to include strict mode restrictions that apply to new ES6 features.

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Deleted: <#>It is a **SyntaxError** if strict mode code contains an *ObjectLiteral* with more than one definition of any data property (12.2.5.1).¶
<#>It is a **SyntaxError** if the Identifier "eval" or the Identifier "arguments" occurs as the Identifier in a *PropertySetParameterList* of a *PropertyDefinition* that is contained in strict code or if its *FunctionBody* is strict code (12.2.5.1).¶

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- When a `delete` operator occurs within strict mode code, a **SyntaxError** is thrown if its *UnaryExpression* is a direct reference to a variable, function argument, or function name (12.5.4).
- When a `delete` operator occurs within strict mode code, a **TypeError** is thrown if the property to be deleted has the attribute `{ [[Configurable]]:false }` (12.5.4).
- Strict mode code may not include a *WithStatement*. The occurrence of a *WithStatement* in such a context is a **SyntaxError** (13.10).
- It is a **SyntaxError** if a *TryStatement* with a *Catch* occurs within strict code and the *Identifier* of the *Catch* production is `eval` or `arguments` (13.14)
- **It is a SyntaxError if the same BindingIdentifier appears more than once in the FormalParameters of a strict mode function.** An attempt to create such a function using a `Function` or `Generator` constructor is a **SyntaxError** (14.1.2, 19.2.1, 25.2.1).
- An implementation may not extend, beyond that defined in this specification, the meanings within strict mode functions of properties named `caller` or `arguments` of function instances. ECMAScript code may not create or modify properties with these names on function objects that correspond to strict mode functions (9.2.1, 9.4.4).

Deleted: <#>It is a **SyntaxError** if a *VariableDeclaration* occurs within strict code and its *Identifier* is `eval` or `arguments` (13.2.2).¶

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Deleted: <#>It is a **SyntaxError** if the identifier `eval` or `arguments` appears within the *FormalParameters* of a strict mode `FunctionDeclaration` or `FunctionExpression` (12.1.1)¶

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Deleted: <#>It is a **SyntaxError** if the *IdentifierName eval* or the *IdentifierName arguments* occurs as It is a **SyntaxError** to use within strict mode code the identifiers `eval` or `arguments` as the *BindingIdentifier* of a `FunctionDeclaration`, or `FunctionExpression`, `GeneratorDeclaration`, or `GeneratorExpression` (12.1.1, 14.1,). Attempting to dynamically define such a strict mode function using the `Function` constructor (19.2.1) will throw a **SyntaxError** exception.¶

DRAFT

Annex D (informative)

Corrections and Clarifications with Possible Compatibility Impact

D.1 In Edition 6

9.1.4.2.1, 9.1.4.2.2: The 5th Edition moved the capture of the current array length prior to the integer conversion of the array index or new length value. However, the captured length value could become invalid if the conversion process has the side-effect of changing the array length. The 6th Edition specifies that the current array length must be captured after the possible occurrence of such side-effects.

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20.3.1.14: Previous editions permitted the TimeClip abstract operation to return either +0 or -0 as the representation of a 0 time value. The 6th Edition specifies that +0 always returned. This means that for the 6th Edition the time value of a Date object is never observably -0 and methods that return time values never return -0.

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20.3.1.15: If a time zone offset is not present, the local time zone is used. Edition 5.1 incorrectly stated that a missing time zone should be interpreted as "z".

20.3.4.36: If the year cannot be represented using the Date Time String Format specified in 20.3.1.15 a RangeError exception is thrown. Previous editions did not specify the behaviour for that case.

20.3.4.41: Previous editions did not specify the value returned by Date.prototype.toString when this time value is NaN. The 6th Edition specifies the result to be the String value is "Invalid Date".

21.2.3.1, 21.2.3.3.4: If any LineTerminator code points in the value of the source property of an RegExp instance must be expressed using an escape sequence, Edition 5.1 only required the escaping of "/".

21.2.5.6, 21.2.5.8: In previous editions, the specifications for `String.prototype.match` and `String.prototype.replace` was incorrect for cases where the pattern argument was a RegExp value whose `global` is flag set. The previous specifications stated that for each attempt to match the pattern, if `lastIndex` did not change it should be incremented by 1. The correct behaviour is that `lastIndex` should be incremented by one only if the pattern matched the empty string.

22.1.3.24, 22.1.3.24.1: Previous editions did not specify how a `NaN` value returned by a `comparefn` was interpreted by `Array.prototype.sort`. Edition 6 specifies that such as value is treated as if +0 was returned from the `comparefn`.

D.2 In Edition 5.1

Clause references in this list refer to the clause numbers used in Edition 5.1.

7.8.4: CV definitions added for `DoubleStringCharacter :: LineContinuation` and `SingleStringCharacter :: LineContinuation`.

10.2.1.1.3: The argument *S* is not ignored. It controls whether an exception is thrown when attempting to set an immutable binding.

10.2.1.2.2: In algorithm step 5, **true** is passed as the last argument to `[[DefineOwnProperty]]`.

10.5: Former algorithm step 5.e is now 5.f and a new step 5.e was added to restore compatibility with 3rd Edition when redefining global functions.

11.5.3: In the final bullet item, use of IEEE 754 round-to-nearest mode is specified.

12.6.3: Missing `ToBoolean` restored in step 3.a.ii of both algorithms.

12.6.4: Additional final sentences in each of the last two paragraphs clarify certain property enumeration requirements.

12.7, 12.8, 12.9: BNF modified to clarify that a `continue` or `break` statement without an *Identifier* or a `return` statement without an *Expression* may have a *LineTerminator* before the semi-colon.

12.14: Step 3 of algorithm 1 and step 2.a of algorithm 3 are corrected such that the value field of *B* is passed as a parameter rather than *B* itself.

15.1.2.2: In step 2 of algorithm, clarify that *S* may be the empty string.

15.1.2.3: In step 2 of algorithm clarify that `trimmedString` may be the empty string.

15.1.3: Added notes clarifying that ECMAScript's URI syntax is based upon RFC 2396 and not the newer RFC 3986. In the algorithm for `Decode`, a step was removed that immediately preceded the current step 4.d.vii.10.a because it tested for a condition that cannot occur.

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15.2.3.7: Corrected use of variable *P* in steps 5 and 6 of algorithm.

15.2.4.2: Edition 5 handling of `undefined` and `null` as `this` value caused existing code to fail. Specification modified to maintain compatibility with such code. New steps 1 and 2 added to the algorithm.

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15.3.3.3: Steps 5 and 7 of Edition 5 algorithm have been deleted because they imposed requirements upon the *argArray* argument that are inconsistent with other uses of generic array-like objects.

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15.4.3.12: In step 9.a, incorrect reference to `relativeStart` was replaced with a reference to `actualStart`.

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15.4.3.15: Clarified that the default value for `fromIndex` is the length minus 1 of the array.

15.4.3.18: In step 10 (corresponding to step 8 in 5.1) of the algorithm, `undefined` is now the specified return value.

15.4.3.22: In step 11.d.iii (corresponding to 9.c.ii in 5.1) the first argument to the `[[Call]]` internal method has been changed to `undefined` for consistency with the definition of `Array.prototype.reduce`.

15.4.5.1: In Algorithm steps 3.l.ii and 3.l.iii the variable name was inverted resulting in an incorrectly inverted test.

15.5.4.9: Normative requirement concerning canonically equivalent strings deleted from paragraph following algorithm because it is listed as a recommendation in NOTE 2.

15.5.4.14: In `split` algorithm step 11.a and 13.a, the positional order of the arguments to `SplitMatch` was corrected to match the actual parameter signature of `SplitMatch`. In step 13.a.iii.7.d, `lengthA` replaces `A.length`.

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15.5.5.2: In first paragraph, removed the implication that the individual character property access had "array index" semantics. Modified algorithm steps 3 and 5 such that they do not enforce "array index" requirement.

15.9.1.15: Specified legal value ranges for fields that lacked them. Eliminated "time-only" formats. Specified default values for all optional fields.

15.10.2.2: The step numbers of the algorithm for the internal closure produced by step 2 were incorrectly numbered in a manner that implied that they were steps of the outer algorithm.

15.10.2.6: In the abstract operation `IsWordChar` the first character in the list in step 3 is "a" rather than "A".

15.10.2.8: In the algorithm for the closure returned by the abstract operation `CharacterSetMatcher`, the variable defined by step 3 and passed as an argument in step 4 was renamed to `ch` in order to avoid a name conflict with a formal parameter of the closure.

15.10.6.2: Step 9.e was deleted because it performed an extra increment of `i`.

15.11.1.1: Removed requirement that the `message` `own` property is set to the empty String when the `message` argument is `undefined`.

15.11.1.2: Removed requirement that the `message` `own` property is set to the empty String when the `message` argument is `undefined`.

15.11.4.4: Steps 6-10 modified/added to correctly deal with missing or empty `message` property value.

15.11.1.2: Removed requirement that the `message` `own` property is set to the empty String when the `message` argument is `undefined`.

15.12.3: In step 10.b.iii of the `J4` abstract operation, the last element of the concatenation is "1".

B.2.1: Added to NOTE that the encoding is based upon RFC 1738 rather than the newer RFC 3986.

Annex C: An item was added corresponding to 7.6.12 regarding `FutureReservedWords` in strict mode.

D.3 In Edition 5

Clause references in this list refer to the clause numbers used in Edition 5.

Throughout: In the Edition 3 specification the meaning of phrases such as "as if by the expression `new Array()`" are subject to misinterpretation. In the Edition 5 specification text for all internal references and invocations of standard built-in objects and methods has been clarified by making it explicit that the intent

is that the actual built-in object is to be used rather than the current dynamically resolved value of the correspondingly identifier binding.

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11.8.1: ECMAScript generally uses a left to right evaluation order, however the Edition 3 specification language for the > and <= operators resulted in a partial right to left order. The specification has been corrected for these operators such that it now specifies a full left to right evaluation order. However, this change of order is potentially observable if side-effects occur during the evaluation process.

11.1.4: Edition 5 clarifies the fact that a trailing comma at the end of an *ArrayLiteral* does not add to the length of the array. This is not a semantic change from Edition 3 but some implementations may have previously misinterpreted this.

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11.2.3: Edition 5 reverses the order of steps 2 and 3 of the algorithm. The original order as specified in Editions 1 through 3 was incorrectly specified such that side-effects of evaluating *Arguments* could affect the result of evaluating *MemberExpression*.

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12.4: In Edition 3, an object is created, as if by `new Object()` to serve as the scope for resolving the name of the exception parameter passed to a `catch` clause of a `try` statement. If the actual exception object is a function and it is called from within the `catch` clause, the scope object will be passed as the `this` value of the call. The body of the function can then define new properties on its `this` value and those property names become visible identifiers bindings within the scope of the `catch` clause after the function returns. In Edition 5, when an exception parameter is called as a function, `undefined` is passed as the `this` value.

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Annex E (informative)

Additions and Changes That Introduce Incompatibilities with Prior Editions

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E.1 In the 6th Edition

7.1.3.1: In Edition 6, ToNumber applied to a String value now recognizes and converts *BinaryIntegerLiteral* and *OctalIntegerLiteral* numeric strings. In previous editions such strings were converted to NaN.

11: In Edition 6, Function calls are not allowed to return a Reference value.

12.2.5.1: In Edition 6, it is no longer an early error to have duplicate property names in Object Initializers.

12.14.1: In Edition 6, strict mode code containing an assignment to an immutable binding such as the function name of a *FunctionExpression* does not produce an early error. Instead it produces a runtime error.

13.4: In Edition 6, a *StatementListItem* beginning with the token `let` followed by the token `r` is the start of a *LexicalDeclaration*. In previous editions such a sequence would be the start of an *ExpressionStatement*.

13.6: In Edition 6, a terminating semi-colon is no longer required at the end of a do-while statement.

13.6: Prior to Edition 6, an *initialization* expression could appear as part of the *VariableDeclaration* that precedes the `in` keyword. The value of that expression was always discarded. In Edition 6, the *ForBind* in that same position does not allow the *occurrence* of such an *initializer*.

13.14: In Edition 6, it is an early error for a *Catch* clause to contain a `var` declaration for the same *Identifier* that appears as the *Catch* clause parameter. In previous editions, such a variable declaration would be instantiated in the enclosing variable environment but the declaration's *Initializer* value would be assigned to the *Catch* parameter.

14.3.9 In Edition 6, the function objects that are created as the values of the `[[Get]]` or `[[Set]]` attribute of accessor properties in an *ObjectLiteral* are not constructor functions and they do not have a *prototype* own property. In Edition 5, they were constructors and had a *prototype* property.

19.1.2.5: In Edition 6, if the argument to `Object.freeze` is not an object it is treated as if it was a non-extensible ordinary object with no own properties. In Edition 5, a non-object argument always causes a `TypeError` to be thrown.

19.1.2.6: In Edition 6, if the argument to `Object.getOwnPropertyDescriptor` is not an object an attempt is made to coerce the argument using `ToObject`. If the coercion is successful the result is used in place of the original argument value. In Edition 5, a non-object argument always causes a `TypeError` to be thrown.

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19.1.2.7: In Edition 6, if the argument to `object.getOwnPropertyNames` is not an object an attempt is made to coerce the argument using `ToObject`. If the coercion is successful the result is used in place of the original argument value. In Edition 5, a non-object argument always causes a `TypeError` to be thrown.

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19.1.2.9: In Edition 6, if the argument to `object.getPrototypeOf` is not an object an attempt is made to coerce the argument using `ToObject`. If the coercion is successful the result is used in place of the original argument value. In Edition 5, a non-object argument always causes a `TypeError` to be thrown.

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19.1.2.11: In Edition 6, if the argument to `Object.isExtensible` is not an object it is treated as if it was a non-extensible ordinary object with no own properties. In Edition 5, a non-object argument always causes a `TypeError` to be thrown.

19.1.2.12: In Edition 6, if the argument to `Object.isFrozen` is not an object it is treated as if it was a non-extensible ordinary object with no own properties. In Edition 5, a non-object argument always causes a `TypeError` to be thrown.

19.1.2.13: In Edition 6, if the argument to `Object.isSealed` is not an object it is treated as if it was a non-extensible ordinary object with no own properties. In Edition 5, a non-object argument always causes a `TypeError` to be thrown.

19.1.2.14: In Edition 6, if the argument to `Object.keys` is not an object an attempt is made to coerce the argument using `ToObject`. If the coercion is successful the result is used in place of the original argument value. In Edition 5, a non-object argument always causes a `TypeError` to be thrown.

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19.1.2.15: In Edition 6, if the argument to `Object.preventExtensions` is not an object it is treated as if it was a non-extensible ordinary object with no own properties. In Edition 5, a non-object argument always causes a `TypeError` to be thrown.

19.1.2.17: In Edition 6, if the argument to `Object.seal` is not an object it is treated as if it was a non-extensible ordinary object with no own properties. In Edition 5, a non-object argument always causes a `TypeError` to be thrown.

19.2.4.1: In Edition 6, the `length` property of function instances is configurable. In previous editions it was non-configurable.

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19.3.3: In Edition 6, the Boolean prototype object is not a Boolean instance. In previous editions it was a Boolean instance whose Boolean value was `false`.

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19.5.6.2: In Edition 6, the `[[Prototype]]` internal slot of a `NativeError` constructor is the `Error` constructor. In previous editions it was the `Function` prototype object.

20.1.3 In Edition 6, the Number prototype object is not a Number instance. In previous editions it was a Number instance whose number value was `+0`.

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20.3.4 In Edition 6, the Date prototype object is not a Date instance. In previous editions it was a Date instance whose TimeValue was `NaN`.

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22.1.3 In Edition 6, the Array prototype object is not an Array instance. In previous editions it was an Array instance with a length property whose value was `+0`.

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21.1.3 In Edition 6, the String prototype object is not a String instance. In previous editions it was a String instance whose String value was the empty string.

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21.1.3.22 and 21.1.3.24 In Edition 6, lowercase/uppercase conversion processing operates on code points. In previous editions such the conversion processing was only applied to individual code units. The only affected code points are those in the Deseret block of Unicode

21.1.3.25 In Edition 6, the `String.prototype.trim` method is defined to recognize white space code points that may exists outside of the Unicode BMP. However, as of Unicode 6.1 no such code points are defined. In previous editions such code points would not have been recognized as white space.

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21.2.3.1In Edition 6, If the `pattern` argument is a `RegExp` instance and the `flags` argument is not `undefined`, a new `RegExp` instance is created just like `pattern` except that `pattern`'s flags are replaced by the argument `flags`. In previous editions a `TypeError` exception was thrown when `pattern` was a `RegExp` instance and `flags` was not `undefined`.

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21.2.5 In Edition 6, the `RegExp` prototype object is not a `RegExp` instance. In previous editions it was a `RegExp` instance whose pattern is the empty string.

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21.2.5 In Edition 6, `source`, `global`, `ignoreCase`, and `multiline` are accessor properties defined on the `RegExp` prototype object. In previous editions they were data properties defined on `RegExp` instances.

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22.1.3 In Edition 6, the `Array` prototype object is not an `Array` instance. In previous editions it was an `Array` instance with a `length` property whose value was `+0`.

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E.2 In the 5th Edition

Clause references in this list refer to the clause numbers used in Edition 5 and 5.1.

7.1: Unicode format control `s` are no longer stripped from ECMAScript source text before processing. In Edition 5, if such a character appears in a `StringLiteral` or `RegularExpressionLiteral` the character will be incorporated into the literal where in Edition 3 the character would not be incorporated into the literal.

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7.2: Unicode character <`ZWNBSP`> is now treated as whitespace, and its presence in the middle of what appears to be an identifier could result in a syntax error which would not have occurred in Edition 3

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7.3: Line terminator characters that are preceded by an escape sequence are now allowed within a string literal token. In Edition 3 a syntax error would have been produced.

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7.8.5: Regular expression literals now return a unique object each time the literal is evaluated. This change is detectable by any programs that test the object identity of such literal values or that are sensitive to the shared side effects.

7.8.5: Edition 5 requires early reporting of any possible `RegExp` constructor errors that would be produced when converting a `RegularExpressionLiteral` to a `RegExp` object. Prior to Edition 5 implementations were permitted to defer the reporting of such errors until the actual execution time creation of the object.

7.8.5: In Edition 5 unescaped “`/`” characters may appear as a `CharacterClass` in a regular expression literal. In Edition 3 such a character would have been interpreted as the final character of the literal.

10.4.2: In Edition 5, indirect calls to the `eval` function use the global environment as both the variable environment and lexical environment for the eval code. In Edition 3, the variable and lexical environments of the caller of an indirect `eval` was used as the environments for the eval code.

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15.4.3: In Edition 5 all methods of `Array.prototype` are intentionally generic. In Edition 3 `toString` and `toLocaleString` were not generic and would throw a `TypeError` exception if applied to objects that were not instances of `Array`.

10.6: In Edition 5 the array indexed properties of argument objects that correspond to actual formal parameters are enumerable. In Edition 3, such properties were not enumerable.

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10.6: In Edition 5 the value of the `[[Class]]` internal slot of an arguments object is "`Arguments`". In Edition 3, it was "`Object`". This is observable if `toString` is called as a method of an arguments object.

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12.6.4: for-in statements no longer throw a `TypeError` if the `in` expression evaluates to `null` or `undefined`. Instead, the statement behaves as if the value of the expression was an object with no enumerable properties.

15: In Edition 5, the following new properties are defined on built-in objects that exist in Edition 3:

```
Object.getPrototypeOf, Object.getOwnPropertyDescriptor,
Object.getOwnPropertyNames, Object.create, Object.defineProperty,
Object.defineProperties, Object.seal, Object.freeze, Object.preventExtensions,
Object.isSealed, Object.isFrozen, Object.isExtensible, Object.keys,
Function.prototype.bind, Array.prototype.indexOf, Array.prototype.lastIndexOf,
Array.prototype.every, Array.prototype.some, Array.prototype.forEach,
Array.prototype.map, Array.prototype.filter, Array.prototype.reduce,
Array.prototype.reduceRight, String.prototype.trim, Date.now,
Date.prototype.toISOString, Date.prototype.toJSON.
```

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15: Implementations are now required to ignore extra arguments to standard built-in methods unless otherwise explicitly specified. In Edition 3 the handling of extra arguments was unspecified and implementations were explicitly allowed to throw a `TypeError` exception.

15.1.1: The value properties `NaN`, `Infinity`, and `undefined` of the Global Object have been changed to be read-only properties.

15.1.2.1: Implementations are no longer permitted to restrict the use of `eval` in ways that are not a direct call. In addition, any invocation of `eval` that is not a direct call uses the global environment as its variable environment rather than the caller's variable environment.

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15.1.2.2: The specification of the function `parseInt` no longer allows implementations to treat Strings beginning with a `0` as octal values.

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15.3.3.3: In Edition 3, a `TypeError` is thrown if the second argument passed to `Function.prototype.apply` is neither an array object nor an arguments object. In Edition 5, the second argument may be any kind of generic array-like object that has a valid `length` property.

15.3.3.3, 15.3.3.4: In Edition 3 passing `undefined` or `null` as the first argument to either `Function.prototype.apply` or `Function.prototype.call` causes the global object to be passed

to the indirectly invoked target function as the **this** value. If the first argument is a primitive value the result of calling ToObject on the primitive value is passed as the **this** value. In Edition 5, these transformations are not performed and the actual first argument value is passed as the **this** value. This difference will normally be unobservable to existing ECMAScript Edition 3 code because a corresponding transformation takes place upon activation of the target function. However, depending upon the implementation, this difference may be observable by host object functions called using **apply** or **call**. In addition, invoking a standard built-in function in this manner with **null** or **undefined** passed as the **this** value will in many cases cause behaviour in Edition 5 implementations that differ from Edition 3 behaviour. In particular, in Edition 5 built-in functions that are specified to actually use the passed **this** value as an object typically throw a **TypeError** exception if passed **null** or **undefined** as the **this** value.

15.3.4.2: In Edition 5, the **prototype** property of Function instances is not enumerable. In Edition 3, this property was enumerable.

15.5.5.2: In Edition 5, the individual characters of a String object's [[StringData]] may be accessed as array indexed properties of the String object. These properties are non-writable and non-configurable and shadow any inherited properties with the same names. In Edition 3, these properties did not exist and ECMAScript code could dynamically add and remove writable properties with such names and could access inherited properties with such names.

15.9.4.2: **Date.parse** is now required to first attempt to parse its argument as an ISO format string. Programs that use this format but depended upon implementation specific behaviour (including failure) may behave differently.

15.10.2.12: In Edition 5, \s now additionally matches <**ZWNBSP**>.

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15.10.4.1: In Edition 3, the exact form of the String value of the **source** property of an object created by the **RegExp** constructor is implementation defined. In Edition 5, the String must conform to certain specified requirements and hence may be different from that produced by an Edition 3 implementation.

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15.10.6.4: In Edition 3, the result of **RegExp.prototype.toString** need not be derived from the value of the **RegExp** object's **source** property. In Edition 5 the result must be derived from the **source** property in a specified manner and hence may be different from the result produced by an Edition 3 implementation.

15.11.2.1, 15.11.4.3: In Edition 5, if an initial value for the **message** property of an Error object is not specified via the **Error** constructor the initial value of the property is the empty String. In Edition 3, such an initial value is implementation defined.

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15.11.4.4: In Edition 3, the result of **Error.prototype.toString** is implementation defined. In Edition 5, the result is fully specified and hence may differ from some Edition 3 implementations.

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15.12: In Edition 5, the name **JSON** is defined in the global environment. In Edition 3, testing for the presence of that name will show it to be **undefined** unless it is defined by the program or implementation.

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