

Draft

Ecma/TC39/2013/0xx

Deleted: 2

Standard ECMA-262

6th Edition / Draft March 8, 2013

Draft

ECMAScript Language Specification

Report Errors and Issues at: <https://bugs.ecmascript.org>

Product: Draft for 6th Edition
Component: choose an appropriate one
Version: Rev 14, March 8, 2013 Draft

Standard

Rue du Rhône 114 CH-1204 Geneva T: +41 22 849 6000 F: +41 22 849 6001

DRAFT



COPYRIGHT PROTECTED DOCUMENT

Contents

	Page
Introduction.....	vii
1 Scope	1
2 Conformance.....	1
3 Normative references	1
4 Overview.....	1
4.1 Web Scripting.....	2
4.2 Language Overview	2
4.2.1 Objects.....	3
4.2.2 The Strict Variant of ECMAScript	4
4.3 Terms and definitions.....	4
5 Notational Conventions.....	7
5.1 Syntactic and Lexical Grammars	7
5.1.1 Context-Free Grammars	7
5.1.2 The Lexical and RegExp Grammars	8
5.1.3 The Numeric String Grammar	8
5.1.4 The Syntactic Grammar	8
5.1.5 The JSON Grammar	9
5.1.6 Grammar Notation	9
5.2 Algorithm Conventions	12
5.3 Static Semantic Rules	13
6 Source Text	14
7 Lexical Conventions	15
7.1 Unicode Format-Control Characters	16
7.2 White Space.....	16
7.3 Line Terminators.....	17
7.4 Comments	18
7.5 Tokens	19
7.6 Identifier Names and Identifiers	19
7.6.1 Reserved Words.....	20
7.7 Punctuators	21
7.8 Literals	22
7.8.1 Null Literals	22
7.8.2 Boolean Literals	22
7.8.3 Numeric Literals.....	22
7.8.5 Regular Expression Literals	25
7.8.6 Template Literal Lexical Components	26
7.8.4 String Literals.....	28
7.9 Automatic Semicolon Insertion	30
7.9.1 Rules of Automatic Semicolon Insertion	30
7.9.2 Examples of Automatic Semicolon Insertion.....	31
8 Types	32
8.1 ECMAScript Language Types	33
8.1.1 The Undefined Type.....	33
8.1.2 The Null Type	33
8.1.3 The Boolean Type	33
8.1.4 The String Type.....	33
8.1.5 The Number Type.....	33
8.1.6 The Object Type	34

8.2 ECMAScript Specification Types45
8.2.1 Data Blocks45
8.2.2 The List and Record Specification Type46
8.2.3 The Completion Record Specification Type46
8.2.4 The Reference Specification Type47
8.2.5 The Property Descriptor Specification Type49
8.2.6 The Lexical Environment and Environment Record Specification Types51
8.3 Ordinary Object Internal Methods and Internal Data Properties51
8.3.1 [[GetInheritance]] ()51
8.3.2 [[SetInheritance]] (V)51
8.3.3 [[HasIntegrity]] (Level)52
8.3.4 [[SetIntegrity]] (Level)52
8.3.5 [[HasOwnProperty]] (P)52
8.3.6 [[GetOwnProperty]] (P)52
8.3.7 [[DefineOwnProperty]] (P, Desc)52
8.3.8 [[HasProperty]](P)54
8.3.9 [[Get]] (P, Receiver)54
8.3.10 [[Set]] (P, V, Receiver)55
8.3.11 [[Delete]] (P)55
8.3.12 [[Enumerate]] ()55
8.3.13 [[OwnPropertyKeys]] ()56
8.3.14 ObjectCreate(proto, internalDataList) Abstract Operation56
8.3.15 Ordinary Function Objects56
8.4 Built-in Exotic Object Internal Methods and Data Fields59
8.4.1 Bound Function Exotic Objects59
8.4.2 Array Exotic Objects60
8.4.3 String Exotic Objects62
8.4.4 Exotic Symbol Objects64
8.4.5 Exotic Arguments Objects65
8.4.6 Indexed Delegation Exotic Objects66
8.4.7 Built-in Function Objects66
8.5 Proxy Object Internal Methods and Internal Data Properties67
8.5.1 [[GetInheritance]] ()67
8.5.3 [[HasIntegrity]] (Level)68
8.5.4 [[SetIntegrity]] (Level)68
8.5.5 [[HasOwnProperty]] (P)69
8.5.6 [[GetOwnProperty]] (P)70
8.5.7 [[DefineOwnProperty]] (P, Desc)70
8.5.8 [[HasProperty]] (P)71
8.5.9 [[Get]] (P, Receiver)72
8.5.10 [[Set]] (P, V, Receiver)72
8.5.11 [[Delete]] (P)73
8.5.12 [[Enumerate]] ()73
8.5.13 [[OwnPropertyKeys]] ()74
8.5.14 [[Call]] (thisArgument, argumentsList)74
8.5.15 [[Construct]] Internal Method74
9 Abstract Operations75
9.1 Type Conversion and Testing75
9.1.1 ToPrimitive75
9.1.2 ToBoolean76
9.1.3 ToNumber77
9.1.4 ToInteger79
9.1.5ToInt32: (Signed 32 Bit Integer)80
9.1.6ToUint32: (Unsigned 32 Bit Integer)80
9.1.7ToUint16: (Unsigned 16 Bit Integer)80
9.1.8ToString81
9.1.9ToObject82
9.1.10ToPropertyKey82
9.1.11ToPositiveInteger82

9.2	Testing and Comparison Operations	82
9.2.1	CheckObjectCoercible.....	82
9.2.2	IsCallable	83
9.2.3	SameValue(x, y)	83
9.2.4	SameValueZero(x, y).....	83
9.2.5	IsConstructor	84
9.2.6	IsPropertyKey.....	84
9.2.7	IsExtensible (O).....	84
9.3	Operations on Objects.....	84
9.3.1	Get (O, P)	84
9.3.2	Put (O, P, V, Throw).....	85
9.3.3	CreateOwnDataProperty (O, P, V).....	85
9.3.4	DefinePropertyOrThrow (O, P, desc)	85
9.3.5	DeletePropertyOrThrow (O, P)	85
9.3.6	HasProperty (O, P)	86
9.3.7	GetMethod (O, P).....	86
9.3.8	Invoke(O,P, [args])	86
9.3.9	SetIntegrityLevel (O, level)	86
9.3.10	TestIntegrityLevel (O, level)	87
9.3.11	CreateArrayFromList (elements)	87
9.3.12	OrdinaryHasInstance (C, O)	88
9.3.13	GetPrototypeOfConstructor (constructor, intrinsicDefaultProto)	88
9.3.13	OrdinaryCreateFromConstructor (constructor, intrinsicDefaultProto, internalDataList)	88
10	Executable Code and Execution Contexts.....	89
10.1	Types of Executable Code	89
10.1.1	Strict Mode Code	89
10.1.2	Non-ECMAScript Functions	90
10.2	Lexical Environments	90
10.2.1	Environment Records	90
10.2.2	Lexical Environment Operations	101
10.3	Code Realms	102
10.4	Execution Contexts.....	103
10.4.1	Identifier Resolution	104
10.4.2	GetThisEnvironment	104
10.4.3	This Resolution	104
10.4.4	GetGlobalObject.....	104
10.5	Declaration Binding Instantiation	105
10.5.1	Global Declaration Instantiation	105
10.5.2	Module Declaration Instantiation	106
10.5.3	Function Declaration Instantiation	106
10.5.4	Block Declaration Instantiation.....	108
10.5.5	Eval Declaration Instantiation	108
10.6	Arguments Object.....	108
11	Expressions.....	111
11.1	Primary Expressions	111
11.1.1	The this Keyword	112
11.1.2	Identifier Reference.....	112
11.1.3	Literals	112
11.1.4	Array Initialiser	113
11.1.5	Object Initialiser	116
11.1.6	Function Defining Expressions	119
11.1.7	Generator Comprehensions.....	120
11.1.8	Regular Expression Literals.....	120
11.1.9	Template Literals	120
11.1.10	The Grouping Operator	124
11.2	Left-Hand-Side Expressions	124
11.2.1	Property Accessors	126
11.2.2	The new Operator	127

11.2.3 Function Calls	127
11.2.4 The <code>super</code> Keyword.....	128
11.2.5 Argument Lists.....	130
11.2.6 Tagged Templates.....	131
11.3 Postfix Expressions.....	131
11.3.1 Postfix Increment Operator.....	132
11.3.2 Postfix Decrement Operator.....	132
11.4 Unary Operators.....	132
11.4.1 The <code>delete</code> Operator.....	133
11.4.2 The <code>void</code> Operator.....	133
11.4.3 The <code>typeof</code> Operator.....	134
11.4.4 Prefix Increment Operator.....	134
11.4.5 Prefix Decrement Operator.....	134
11.4.6 Unary + Operator.....	135
11.4.7 Unary - Operator.....	135
11.4.8 Bitwise NOT Operator (~)	135
11.4.9 Logical NOT Operator (!)	135
11.5 Multiplicative Operators	136
11.5.1 Applying the * Operator	136
11.5.2 Applying the / Operator	137
11.5.3 Applying the % Operator	137
11.6 Additive Operators.....	138
11.6.1 The Addition operator (+)	138
11.6.2 The Subtraction Operator (-)	138
11.6.3 Applying the Additive Operators to Numbers.....	139
11.7 Bitwise Shift Operators	139
11.7.1 The Left Shift Operator (<<)	139
11.7.2 The Signed Right Shift Operator (>>)	140
11.7.3 The Unsigned Right Shift Operator (>>>)	140
11.8 Relational Operators	141
11.8.1 Runtime Semantics	141
11.9 Equality Operators	144
11.9.1 Runtime Semantics	144
11.10 Binary Bitwise Operators	146
11.11 Binary Logical Operators	147
11.12 Conditional Operator (? :)	148
11.13 Assignment Operators	149
Static Semantics	149
Runtime Semantics.....	150
11.13.1 Destructuring Assignment	151
11.14 Comma Operator (,)	154
12 Statements and Declarations	155
Static Semantics	155
Runtime Semantics.....	155
12.1 Block	156
12.2 Declarations and the Variable Statement	159
12.2.1 Let and Const Declarations	159
12.2.2 Variable Statement	162
12.2.4 Destructuring Binding Patterns	164
12.3 Empty Statement	169
12.4 Expression Statement	169
12.5 The if Statement	169
12.6 Iteration Statements	170
12.6.1 The do-while Statement	171
12.6.2 The while Statement	171
12.6.3 The for Statement	172
12.6.4 The for-in and for-of Statements	173

12.7	The continue Statement	177
12.8	The break Statement	177
12.9	The return Statement	178
12.10	The with Statement	178
12.11	The switch Statement	179
12.12	Labelled Statements	183
12.13	The throw Statement	184
12.14	The try Statement	185
12.15	The debugger statement	187
13	Functions and Generators	187
13.1	Function Definitions	187
13.2	Arrow Function Definitions	193
13.3	Method Definitions	196
13.4	Generator Definitions	199
13.5	Class Definitions	200
13.6	Creating Function Objects and Constructors	205
13.7	Tail Position Calls	206
14	Scripts and Modules	207
14.1	Script	207
14.1.1	Directive Prologues and the Use Strict Directive	209
14.2	Modules	210
15	Standard Built-in ECMAScript Objects	210
15.1	The Global Object	211
15.1.1	Value Properties of the Global Object	211
15.1.2	Function Properties of the Global Object	212
15.1.3	URI Handling Function Properties	214
15.1.4	Constructor Properties of the Global Object	219
15.1.5	Other Properties of the Global Object	220
15.2	Object Objects	220
15.2.1	The Object Constructor Called as a Function	220
15.2.2	The Object Constructor	221
15.2.3	Properties of the Object Constructor	221
15.2.4	Properties of the Object Prototype Object	225
15.2.5	Properties of Object Instances	227
15.3	Function Objects	227
15.3.1	The Function Constructor Called as a Function	227
15.3.2	The Function Constructor	227
15.3.3	Properties of the Function Constructor	228
15.3.4	Properties of the Function Prototype Object	229
15.3.5	Properties of Function Instances	231
15.4	Array Objects	231
15.4.1	The Array Constructor Called as a Function	231
15.4.2	The Array Constructor	233
15.4.3	Properties of the Array Constructor	233
15.4.4	Properties of the Array Prototype Object	235
15.4.5	Properties of Array Instances	254
15.4.6	Array Iterator Object Structure	254
15.5	String Objects	256
15.5.1	The String Constructor Called as a Function	256
15.5.2	The String Constructor	256
15.5.3	Properties of the String Constructor	257
15.5.4	Properties of the String Prototype Object	258
15.5.5	Properties of String Instances	271
15.6	Boolean Objects	271
15.6.1	The Boolean Constructor Called as a Function	271
15.6.2	The Boolean Constructor	271
15.6.3	Properties of the Boolean Constructor	272

15.6.4 Properties of the Boolean Prototype Object	272
15.6.5 Properties of Boolean Instances	273
15.7 Number Objects	273
15.7.1 The Number Constructor Called as a Function	273
15.7.2 The Number Constructor	273
15.7.3 Properties of the Number Constructor	273
15.7.4 Properties of the Number Prototype Object	275
15.7.5 Properties of Number Instances	280
15.8 The Math Object	280
15.8.1 Value Properties of the Math Object	280
15.8.2 Function Properties of the Math Object	281
15.9 Date Objects	288
15.9.1 Overview of Date Objects and Definitions of Abstract Operations	288
15.9.2 The Date Constructor Called as a Function	293
15.9.3 The Date Constructor	294
15.9.4 Properties of the Date Constructor	295
15.9.5 Properties of the Date Prototype Object	296
15.9.6 Properties of Date Instances	304
15.10 RegExp (Regular Expression) Objects	304
15.10.1 Patterns	304
15.10.2 Pattern Semantics	307
15.10.3 The RegExp Constructor Called as a Function	318
15.10.4 The RegExp Constructor	320
15.10.5 Properties of the RegExp Constructor	320
15.10.6 Properties of the RegExp Prototype Object	321
15.10.7 Properties of RegExp Instances	328
15.11 Error Objects	328
15.11.1 The Error Constructor Called as a Function	328
15.11.2 The Error Constructor	329
15.11.3 Properties of the Error Constructor	329
15.11.4 Properties of the Error Prototype Object	329
15.11.5 Properties of Error Instances	330
15.11.6 Native Error Types Used in This Standard	330
15.11.7 <i>NativeError</i> Object Structure	331
15.12 The JSON Object	333
15.12.1 The JSON Grammar	333
15.12.2 <code>JSON.parse (text [, reviver])</code>	335
15.12.3 <code>JSON.stringify (value [, replacer [, space]])</code>	336
15.13 Binary Data Objects	341
15.13.1 The <code>BinaryData</code> Module	341
15.13.2 The <code>BinaryData.Type</code> Object	341
15.13.3 The <code>BinaryData.ArrayType</code> Object	341
15.13.4 The <code>BinaryData.StructType</code> Object	341
15.13.5 <code>ArrayBuffer</code> Objects	341
15.13.6 <code>TypedArray</code> Object Structures	345
15.13.7 <code>DataView</code> Objects	352
15.14 Map Objects	357
15.14.1 The <code>Map</code> Constructor Called as a Function	357
15.14.2 The <code>Map</code> Constructor	358
15.14.3 Properties of the <code>Map</code> Constructor	358
15.14.4 Properties of the <code>Map</code> Prototype Object	359
15.14.5 Properties of <code>Map</code> Instances	362
15.14.6 <code>Map</code> Iterator Object Structure	362
15.15 WeakMap Objects	363
15.15.1 The <code>WeakMap</code> Constructor Called as a Function	364
15.15.2 The <code>WeakMap</code> Constructor	365
15.15.3 Properties of the <code>WeakMap</code> Constructor	365
15.15.4 Properties of the <code>WeakMap</code> Prototype Object	365
15.15.5 Properties of <code>WeakMap</code> Instances	367

15.16 Set Objects	367
15.16.1 The Set Constructor Called as a Function	367
15.16.2 The Set Constructor	368
15.16.3 Properties of the Set Constructor	368
15.16.4 Properties of the Set Prototype Object	369
15.16.6 Properties of Set Instances	372
15.16.7 Set Iterator Object Structure	372
15.17 The Reflect Module	373
15.17.1 Exported Function Properties Reflecting the Essential Internal Methods	373
15.18 Proxy Objects	376
16 Errors	376
Annex A (informative) Grammar Summary	379
A.1 Lexical Grammar	379
A.2 Number Conversions	385
A.3 Expressions	386
A.4 Statements	390
A.5 Functions and Scripts	392
A.6 Universal Resource Identifier Character Classes	393
A.7 Regular Expressions	393
A.8 JSON	395
A.8.1 JSON Lexical Grammar	395
A.8.2 JSON Syntactic Grammar	396
Annex B (normative) Additional ECMAScript Features for Web Browsers	399
B.1 Additional Syntax	399
B.1.1 Numeric Literals	399
B.1.2 String Literals	399
B.2 Additional Properties	400
B.2.1 Additional Properties of the Global Object	400
B.2.2 Additional Properties of the String.prototype Object	401
B.2.3 Additional Properties of the Date.prototype Object	404
B.3 Other Additional Features	405
B.3.1 The __proto__ pseudo property	405
Annex C (informative) The Strict Mode of ECMAScript	407
Annex D (informative) Corrections and Clarifications with Possible Compatibility Impact	409
Annex E (informative) Additions and Changes that Introduce Incompatibilities with Prior Editions	413
In the 6 th Edition	413
In the 5 th Edition	413
Annex F (informative) Static Semantic Rule Cross Reference	417
Scrap Heap	419
8.3.10 [[Enumerate]] (includePrototype, onlyEnumerable)	420
10.5.3 Function Declaration Instantiation	421

DRAFT

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 internationalisation 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.

Since publication of the third edition, ECMAScript has 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. Although that work was not completed and not published¹ as the fourth edition of ECMAScript, it informs continuing evolution of the language. The fifth edition of ECMAScript (published as ECMA-262 5th edition) codifies de facto interpretations of the language specification that have become common among browser implementations and adds support for new features that have 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 has been fully aligned with the third edition of the international standard ISO/IEC 16262:2011.

This present sixth edition of the Standard.....

ECMAScript is a vibrant language and the evolution of the language is not complete. Significant technical enhancement will continue with future editions of this specification.

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

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.

"DISCLAIMER

This draft document may be copied and furnished to others, and derivative works that comment on or otherwise explain it or assist in its implementation may be prepared, copied, published, and distributed, in whole or in part, without restriction of any kind, provided that the above copyright notice and this section are included on all such copies and derivative works. However, this document itself may not be modified in any way, including by removing the copyright notice or references to Ecma International, except as needed for the purpose of developing any document or deliverable produced by Ecma International.

This disclaimer is valid only prior to final version of this document. After approval all rights on the standard are reserved by Ecma International.

The limited permissions are granted through the standardization phase and will not be revoked by Ecma International or its successors or assigns during this time.

This document and the information contained herein is provided on an "AS IS" basis and ECMA INTERNATIONAL DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY OWNERSHIP RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE."

DRAFT

ECMAScript Language Specification

1 Scope

This Standard defines the ECMAScript scripting language.

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 this Standard shall interpret characters 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.

Deleted: 3

Deleted: -1 with either UCS-2 or UTF-16 as the adopted encoding form, implementation level 3

Deleted: BMP subset

Deleted: 300

Deleted: If the adopted encoding form is not otherwise specified, it is presumed to be the UTF-16 encoding form.

A conforming implementation of ECMAScript is permitted to provide additional types, values, objects, properties, and functions beyond those described in this specification. In particular, a conforming implementation of ECMAScript is permitted to 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 is permitted to support program and regular expression syntax not described in this specification. In particular, a conforming implementation of ECMAScript is permitted to support program syntax that makes use of the "future reserved words" listed in 7.6.1.2 of this specification.

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.

ISO/IEC 9899:1996, Programming Languages – C, including amendment 1 and technical corrigenda 1 and 2

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

Deleted: ISO/IEC 10646-1:1993, *Information Technology – Universal Multiple-Octet Coded Character Set (UCS) plus its amendments and corrigenda*

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

Deleted: host

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.

A **scripting language** is a programming language that is used to manipulate, customise, 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. ECMAScript was originally designed to be used as a scripting language, but has become widely used as a general purpose programming language.

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 both as a general purpose programming language and 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.

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

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

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 customised 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 Language 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. An ECMAScript **object** is a collection of **properties** each with zero or more **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 change the value of 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**, and **String**; an object is a member of the remaining built-in type **Object**; and a function is a callable object. A function that is associated with an object via a property is 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, the **Object** object, the **Function** object, the **Array** object, the **String**

Deleted: can
Deleted: ,
Deleted: and t
Deleted: scripting

object, the **Boolean** object, the **Number** object, the **Math** object, the **Date** object, the **RegExp** object, the **JSON** object, and the **Error** objects **Error**, **EvalError**, **RangeError**, **ReferenceError**, **SyntaxError**, **TypeError** and **URIError**.

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.

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 does not use classes 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 initialises 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.

Comment [AWB101]: This description probably need to be tweaked in light of new features such as class declarations and explicit exposure of the [[Prototype]] property

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.

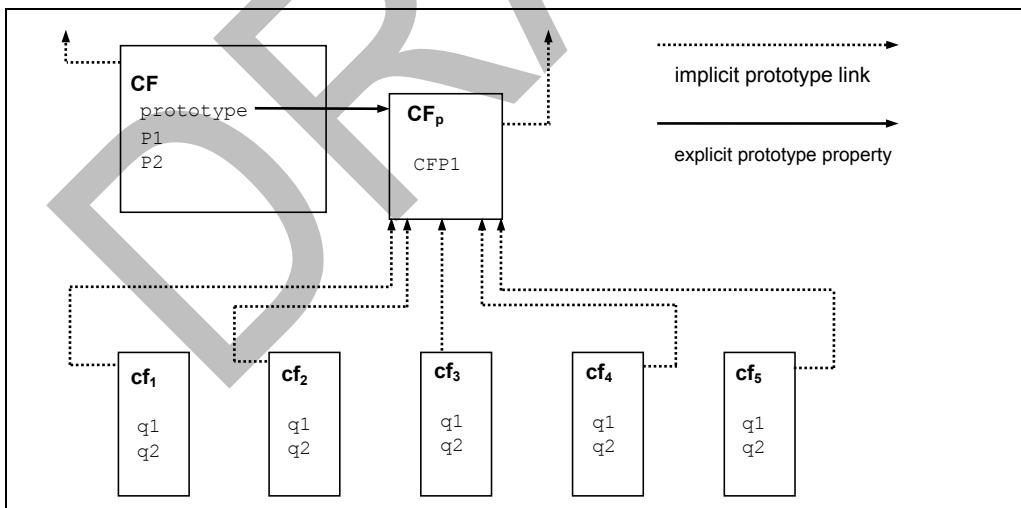


Figure 1 — Object/Prototype Relationships

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.

Deleted: and

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 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**.

4.2.2 The Strict Variant of ECMAScript

The ECMAScript Language recognises 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.

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 8 of this specification

4.3.2 primitive value

member of one of the types Undefined, Null, Boolean, Number, or String as defined in Clause 8

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 initialises 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 internal methods that must be supported by all ECMAScript objects.

Deleted: native

Deleted: in an ECMAScript implementation whose semantics are fully defined by this specification rather than by the host environment

4.3.7**exotic object**

object that has some alternative behaviour for one or more of the internal methods that must be supported by all ECMAScript objects.

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.

Deleted: NOTE Standard native objects are defined in this specification. Some native objects are built-in; others may be constructed during the course of execution of an ECMAScript program.||

Deleted: 7

Deleted: Every built-in object is a native object.

4.3.9**built-in object**

object supplied by an ECMAScript implementation, independent of the host environment, that is present at the start of the execution of an ECMAScript program

Deleted: 4.3.8||

host exotic object||
object that has some alternative behaviour for one or more of the internal methods that must be supported by all ECMAScript objects supplied by the host environment to complete the execution environment of ECMAScript||
NOTE Any object that is not a native ordinary object is a host exotic object.||

Deleted: 9

Deleted: 10

Deleted: 11

Deleted: 12

Deleted: 13

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**.

4.3.15

Boolean type

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

Deleted: 14

4.3.16

Boolean object

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

Deleted: 15

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.

Deleted: 16

4.3.18

String type

set of all possible String values

Deleted: 17

4.3.19

String object

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

Deleted: 18

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.

Deleted: 19

4.3.21

Number type

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

Deleted: 20

Deleted: s

4.3.22

Number object

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

Deleted: 21

4.3.23

Infinity

number value that is the positive infinite Number value

Deleted: 22

4.3.24

NaN

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

Deleted: 23

4.3.25**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.

Deleted: 24**Deleted:** is an instance of the standard built-in Function constructor and that**Deleted:** named**4.3.26****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.

Deleted: 25**4.3.27****property**

association between a name and a value that is a part of an object

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.

Deleted: 26**4.3.28****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.

Deleted: 27**4.3.29****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.

Deleted: 28**4.3.30****attribute**

internal value that defines some characteristic of a property

Deleted: 29**4.3.31****own property**

property that is directly contained by its object

Deleted: 30**4.3.32****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

Deleted: 31

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.

Deleted:

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

Deleted: one

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 7. This grammar has as its terminal symbols characters (Unicode code units) that conform to the rules for *SourceCharacter* defined in Clause 6. It defines a set of productions, starting from the goal symbol *InputElementDiv* or *InputElementRegExp*, that describe how sequences of such characters 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 (7.9). 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 15.10. This grammar also has as its terminal symbols the characters as defined by *SourceCharacter*. It defines a set of productions, starting from the goal symbol *Pattern*, that describe how sequences of characters 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 9.3.1.

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 and 14. 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 the goal symbol *Script*, that describe how sequences of tokens can form syntactically correct independent components of an ECMAScript programs.

When a stream of characters is to be parsed as an ECMAScript *script*, 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 *script* 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*, 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 11, 12, 13 and 14 is actually not a complete account of which token sequences are accepted as correct ECMAScript *scripts*. 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, certain token sequences that are described by the grammar are not considered acceptable if a terminator character appears in certain “awkward” places.

Deleted: Program

Deleted: program

Deleted: program

Deleted: Program

Deleted: programs

In certain cases in order to avoid ambiguities the syntactic grammar uses generalise productions that permit token sequences that are not valid ECMAScript scripts. For example, this technique is used in with 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 script is syntactically in error if the tokens in the stream of input elements cannot be parsed as a single instance of the supplemental goal symbol, with no tokens left over.

Deleted: program
Deleted: s
Deleted:
Deleted: such situations
Deleted: is
Deleted: program

5.1.5 The JSON Grammar

The JSON grammar is used to translate a String describing a set of ECMAScript objects into actual objects. The JSON grammar is given in 15.12.1.

The JSON grammar consists of the JSON lexical grammar and the JSON syntactic grammar. The JSON lexical grammar is used to translate character sequences into tokens and is similar to parts of the ECMAScript lexical grammar. The JSON syntactic grammar describes how sequences of tokens from the JSON lexical grammar can form syntactically correct JSON object descriptions.

Productions of the JSON lexical grammar are distinguished by having two colons “::” as separating punctuation. The JSON lexical grammar uses some productions from the ECMAScript lexical grammar. The JSON syntactic grammar is similar to parts of the ECMAScript syntactic grammar. Productions of the JSON syntactic grammar are distinguished by using one colon “:” as separating punctuation.

5.1.6 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* either exactly as written or using equivalent Unicode escape sequences (see clause 6). All terminal symbol characters specified in this way are to be understood as the appropriate Unicode character from the ASCII range, as opposed to any similar-looking characters from other Unicode ranges.

Deleted: program

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 :
Identifier Initialiser_{opt}

is a convenient abbreviation for:

VariableDeclaration :
Identifier
Identifier Initialiser

and that:

IterationStatement :
for (*ExpressionNoIn_{opt}* ; *Expression_{opt}* ; *Expression_{opt}*) *Statement*

is a convenient abbreviation for:

IterationStatement :
for (; *Expression_{opt}* ; *Expression_{opt}*) *Statement*
for (*ExpressionNoIn* ; *Expression_{opt}* ; *Expression_{opt}*) *Statement*

which in turn is an abbreviation for:

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

which in turn is an abbreviation for:

IterationStatement :
for (; ;) *Statement*
for (; ; *Expression*) *Statement*
for (; *Expression* ;) *Statement*
for (; *Expression* ; *Expression*) *Statement*
for (*ExpressionNoIn* ; ;) *Statement*
for (*ExpressionNoIn* ; ; *Expression*) *Statement*
for (*ExpressionNoIn* ; *Expression* ;) *Statement*
for (*ExpressionNoIn* ; *Expression* ; *Expression*) *Statement*

so the nonterminal *IterationStatement* actually has eight alternative right-hand sides.

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 braces. 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. 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*.

Deleted: program

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.

Deleted: program

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.

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

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 characters that could replace *IdentifierName* provided that the same sequence of characters could not replace *ReservedWord*.

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 character

Deleted: code unit

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 parameterised, 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 parameterised 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 non-terminal symbols of the production alternative as if they were parameters of the algorithm. When used in this manner, non-terminal symbols refer to the actual alternative definition that is matched when parsing the script source code.

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

Block :
{ *StatementList* }

Deleted: program

but there is no 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 the algorithm has an evaluation algorithm of the form:

Deleted: ra

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.

Deleted: When an algorithm is to produce a value as a result, the directive “return *x*” is used to indicate that the result of the algorithm is the value of *x* and that the algorithm should terminate. The notation *Result(n)* is used as shorthand for “the result of step *n*”. ¶

- b. Substep
 - i. Subsubstep.
 - ii. Subsubstep.
 - 1. Subsubsubstep
 - a Subsubsubsubstep

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 may assert 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.

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

The mathematical function $\text{sign}(x)$ yields 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 $\text{min}(x_1, x_2, \dots, x_n)$ yields the mathematically smallest 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 $\text{floor}(x)$ yields the largest integer (closest to positive infinity) that is not larger than x .

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

If an algorithm is defined to "throw an exception", execution of the algorithm is terminated and no result is returned. The calling algorithms are also terminated, until an algorithm step is reached that explicitly deals with the exception, using terminology such as "If an exception was thrown...". Once such an algorithm step has been encountered the exception is no longer considered to have occurred.

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 make up a valid ECMAScript script 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.

Deleted: program

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.

Deleted: Such algorithms may be parameterized.

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 non-terminal of the grammar that includes the associated production. The default definition of *Contains* is:

1. For each terminal and non-terminal 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 non-terminal, then
 - i. Let *contained* be the result of *Contains* for *sym* with argument *symbol*.
 - ii. If *contained* is **true**, return **true**.
2. Return **false**.

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 associate 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 can not be evaluated.

6 Source Text

Syntax

SourceCharacter ::=
any Unicode character

The ECMAScript code is expressed using Unicode, version 5.1 or later. ECMAScript source text is a sequence of Unicode characters. The phrase "Unicode character" refers to the abstract linguistic or typographical unit represented by a single Unicode scalar value. The actual encodings used to store and interchange ECMAScript source text is not relevant to this specification. Any well-defined encoding such as UTF-32 or UTF-16 may be used. Source text might even be externally represented using a non-Unicode character encoding. 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 an abstract Unicode character with a corresponding Unicode scalar value. Conforming ECMAScript implementations are not required to perform any normalisation of text, or behave as though they were performing normalisation of text.

The phrase "code point" refers to such a Unicode scalar value. "Unicode character" only refers to entities represented by single Unicode scalar values: the components of a combining character sequence are still individual "Unicode characters," even though a user might think of the whole sequence as a single character.

In string literals, regular expression literals, template literals and identifiers, any Unicode characters may also be expressed as a Unicode escape sequence that explicitly express a code point's numeric value. Within a comment, such an escape sequence is effectively ignored as part of the comment. Within other contexts, such an escape sequence contextually contributes one Unicode character.

NOTE 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 character 000a is line feed) and therefore the next Unicode character 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 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 a Unicode character to the literal and is never interpreted as a line terminator or as a quote mark that might terminate the string literal.

ECMAScript String values (8.4) are computational sequences of 16-bit integer values called "code units". ECMAScript language constructs that generate string values from *SourceCharacter* sequences use UTF-16 encoding to generate the code unit values.

Deleted: grammer

Deleted:

Deleted: I

Deleted: An

Deleted: Program

Deleted: static semantic

Deleted: used to

Deleted: a

Deleted: Program

Deleted: prior to the first evaluation of that *Program*

Comment [AW2]: Perhaps this should be somewhere else. Currently we don't have a section that enumerates all the steps in loading and evaluating a program.

Deleted: static semantic

Deleted: Program

Deleted: Static semantic rule violations are early (see clause 16) and reported in the same manner as syntax errors.

Deleted: ECMAScript source text is represented as a sequence of characters in the Unicode character encoding, version 3.0 or later. The text is expected to have been normalised to Unicode Normalization Form (canonical composition), as described in Unicode Technical Report #15. Conforming ECMAScript implementations are not required to perform any normalisation of text, or behave as though they were performing normalisation of text, themselves.

ECMAScript source text is assumed to be a sequence 16-bit code units for the purposes of this specification. Such a source text may include sequences of 16-bit code units that are not valid UTF-16 character encodings. If actual source text is encoded in a form other than 16-bit code units it must be processed as if it was first converted to UTF-16.¶

Deleted: code unit

Deleted: well defined

Deleted: source character

Deleted: s

Deleted: Throughout the rest of this document, the phrase "code unit" and the word "character" will be used to refer to a 16-bit unsigned value used to represent a single 16-bit unit of text. The phrase "Unicode character" will be used to refer to the abstract linguistic or typographical unit represented by a single Unicode scalar value.

Deleted: quasi

Deleted: (code unit)

Deleted: consisting

Deleted: of six characters, namely \u plus four

Deleted: Within a string literal or regular expression

Deleted: the

Deleted: to the identifier

Deleted: ¶

Formatted: Note

Deleted: NOTE Although this document sometimes

Deleted: String value of the

Static Semantics: UTF-16 Encoding

The UTF-16 Encoding of a numeric code point value, *cp*, is determined as follows:

1. Assert: $0 \leq cp \leq 0x10FFFF$
2. If $cp < 65535$, then return *cp*.
3. Let *cu1* be $\text{floor}((cp - 65536) / 1024) + 55296$. NOTE 55296 is 0xD800.
4. Let *cu2* be $((cp - 65536) \bmod 1024) + 56320$. NOTE 56320 is 0xDC00.
5. Return the code unit sequence consisting of *cu1* followed by *cu2*.

Deleted: determined

7 Lexical Conventions

The source text of an ECMAScript script 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 characters as the next input element.

Deleted: program

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.

Deleted: o

Deleted: There

Deleted: are two

Deleted: other

Deleted: Quasi

Deleted: Quasi

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 7.9); in examples such as the following:

```
a = b
/hi/g.exec(c).map(d);
```

where the first non-whitespace, non-comment character after a *LineTerminator* is slash (/) 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);
```

Comment [AWB93]: May need to also say something about TemplateSubstitution tail. Also need to consider with there are any ASI issues concerning it.

Syntax

InputElementDiv ::
WhiteSpace
LineTerminator
Comment
Token
DivPunctuator
RightBracePunctuator

InputElementRegExp ::
WhiteSpace
LineTerminator
Comment
Token
RightBracePunctuator
RegularExpressionLiteral

InputElementTemplateTail ::

WhiteSpace
LineTerminator
Comment
Token
DivPunctuator
TemplateSubstitutionTail

Deleted: Quasi

Deleted: Quasi

7.1 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.

<ZWNJ> and <ZWJ> are format-control characters that are used to make necessary distinctions when forming words or phrases in certain languages. In ECMAScript source text, <ZWNJ> and <ZWJ> may also be used in an identifier after the first character.

<BOM> 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. <BOM> characters intended for this purpose can sometimes also appear after the start of a text, for example as a result of concatenating files. <BOM> characters are treated as white space characters (see 7.2).

The special treatment of certain format-control characters outside of comments, string literals, and regular expression literals is summarised in Table 1.

Table 1 — Format-Control Character Usage

Code Point	Name	Formal Name	Usage
U+200C	Zero width non-joiner	<ZWNJ>	IdentifierPart
U+200D	Zero width joiner	<ZWJ>	IdentifierPart
U+FEFF	Byte Order Mark	<BOM>	Whitespace

7.2 White Space

White space characters are used to improve source text readability and to separate tokens (indivisible lexical units) from each other, but are otherwise insignificant. White space characters may occur between any two tokens and at the start or end of input. White space characters may occur within a StringLiteral, a RegularExpressionLiteral, a Template, or a TemplateSubstitutionTail, where they are considered significant characters forming part of a literal value. They may also occur within a Comment, but cannot appear within any other kind of token.

The ECMAScript white space characters are listed in Table 2.

Deleted: Unit

Deleted: Value

Deleted: \u

Deleted: \u

Deleted: \u

Deleted: also

Deleted: or

Deleted:

Deleted: Quasi

Deleted: Quasi

Deleted: (

Deleted: the

Deleted:)

Deleted: or

Table 2 — Whitespace Characters

Code Point	Name	Formal Name
U+0009	Tab	<TAB>
U+000B	Vertical Tab	<VT>
U+000C	Form Feed	<FF>
U+0020	Space	<SP>
U+00A0	No-break space	<NBSP>
U+FEFF	Byte Order Mark	<BOM>
Other category "Zs"	Any other Unicode "space separator"	<USP>

- Deleted: Unit
- Deleted: Value
- Deleted: \u
- Deleted: 3
- Deleted: 0

ECMAScript implementations must recognise all of the white space characters defined in Unicode 5.1. Later editions of the Unicode Standard may define other white space characters. ECMAScript implementations may recognise white space characters from later editions of the Unicode Standard.

Syntax

```
WhiteSpace ::=
    <TAB>
    <VT>
    <FF>
    <SP>
    <NBSP>
    <BOM>
    <USP>
```

Comment [AWB94]: Need to talk about line terminators in Templates

7.3 Line Terminators

Like white space characters, line terminator characters are used to improve source text readability and to separate tokens (indivisible lexical units) from each other. However, unlike white space characters, 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 (7.9). 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*.

- Deleted: Quasi
- Deleted: Quasi

A line terminator can occur within a *MultiLineComment* (7.4) but cannot occur within a *SingleLineComment*.

Line terminators are included in the set of white space characters that are matched by the \s class in regular expressions.

The ECMAScript line terminator characters are listed in Table 3.

Table 3 — Line Terminator Characters

Code Point	Name	Formal Name
U+000A	Line Feed	<LF>
U+000D	Carriage Return	<CR>
U+2028	Line separator	<LS>
U+2029	Paragraph separator	<PS>

- Deleted: Unit
- Deleted: Value
- Deleted: \u
- Deleted: \u
- Deleted: \u
- Deleted: \u
- Deleted: character
- Deleted: character

Only the Unicode characters in Table 3 are treated as line terminators. Other new line or line breaking Unicode characters are treated as white space but not as line terminators. 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 ≠ <LF>]
- <LS>
- <PS>
- <CR> <LF>

7.4 Comments

Comments can be either single or multi-line. Multi-line comments cannot nest.

Because a single-line comment can contain any Unicode character except a *LineTerminator* character, and because of the general rule that a token is always as long as possible, a single-line comment always consists of all characters 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 recognised 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 7.9).

Comments behave like white space and are discarded except that, if a *MultiLineComment* contains a line terminator character, then the entire comment is considered to be a *LineTerminator* for purposes of parsing by the syntactic grammar.

Syntax

Comment ::

- MultiLineComment*
- SingleLineComment*

MultiLineComment ::

- /* *MultiLineCommentChars*_{opt} */

MultiLineCommentChars ::

- MultiLineNotAsteriskChar* *MultiLineCommentChars*_{opt}
- * *PostAsteriskCommentChars*_{opt}

PostAsteriskCommentChars ::

- MultiLineNotForwardSlashOrAsteriskChar* *MultiLineCommentChars*_{opt}
- * *PostAsteriskCommentChars*_{opt}

MultiLineNotAsteriskChar ::

- SourceCharacter **but not ***

MultiLineNotForwardSlashOrAsteriskChar ::

- SourceCharacter **but not one of / or ***

SingleLineComment ::

- // *SingleLineCommentChars*_{opt}

SingleLineCommentChars ::

- SingleLineCommentChar* *SingleLineCommentChars*_{opt}

*SingleLineCommentChar ::
SourceCharacter but not LineTerminator*

7.5 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.

7.6 Identifier Names and Identifiers

IdentifierName, *Identifier*, 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* and *Identifier* is an *IdentifierName* that is not a *ReservedWord* (see 7.6.1). The Unicode identifier grammar is based on character properties specified by the Unicode Standard. The Unicode characters 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 recognise identifier characters defined in later editions of the Unicode Standard.

NOTE 1 This standard specifies specific character additions: The dollar sign (`u+0024`) and the underscore (`u+005f`) are permitted anywhere in an *IdentifierName*, and the characters zero width non-joiner (`U+200C`) and zero width joiner (`U+200D`) are permitted anywhere after the first character of an *IdentifierName*.

Unicode escape sequences are permitted in an *IdentifierName*, where they contribute a single Unicode character to the *IdentifierName*. The code point of the contributed character is expressed by the *HexDigits* of the *UnicodeEscapeSequence* (see 7.8.4). The `\` preceding the *UnicodeEscapeSequence* and the `u` and `{ }` characters, if they appear, do not contribute characters to the *IdentifierName*. A *UnicodeEscapeSequence* cannot be used to put a character into an *IdentifierName* that would otherwise be illegal. In other words, if a `\ UnicodeEscapeSequence` sequence were replaced by the Unicode character it contributes, the result must still be a valid *IdentifierName* that has the exact same sequence of characters as the original *IdentifierName*. All interpretations of *IdentifierName* within this specification are based upon their actual characters regardless of whether or not an escape sequence was used to contribute any particular characters.

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 units (in other words, conforming ECMAScript implementations are only required to do bitwise comparison on *IdentifierName* values).

NOTE 2 If maximal portability is a concern, programmers should only employ the identifier characters that were defined in Unicode 3.0.

Syntax

Identifier ::

- IdentifierName but not ReservedWord*

IdentifierName ::

- IdentifierStart*
- IdentifierName IdentifierPart*

Deleted: Quasi

Deleted: and

Deleted: Quasi

Deleted: Identifier,

Deleted: Identifier Names

Deleted: grammar given in the "Identifiers" section of chapter 5 of the Unicode standard

Deleted: An

Deleted: both normative and informative

Deleted: categories

Deleted: 3

Formatted: Note

Deleted: (\$)

Deleted: ()

Deleted: also

Deleted: ,

Deleted: as computed by the CV of the

Deleted: es

Deleted: a

Deleted: its

Deleted: *UnicodeEscapeSequence's CV*

Deleted: identifiers

Deleted: The intent is that the incoming source text has been converted to normalised form C before it reaches the compiler.

Formatted: Note

Deleted: ECMAScript implementations may recognise identifier characters defined in later editions of the Unicode Standard.

Comment [AWB95]: Norbert suggests changing this to 5.1.0. Would be really be better for "portability"?

IdentifierStart ::

UnicodeIDStart

\$

 └ UnicodeEscapeSequence

IdentifierPart ::

UnicodeIDContinue

\$

 └ UnicodeEscapeSequence

<ZWNJ>

<ZWJ>

UnicodeIDStart ::

any Unicode character with the Unicode property "ID_Start"

UnicodeIDContinue ::

any Unicode character with the Unicode property "ID_Continue"

The definitions of the nonterminal UnicodeEscapeSequence is given in 7.8.4

Static Semantics: StringValue

Identifier :: IdentifierName but not ReservedWord

1. Return the StringValue of IdentifierName.

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 (clause 6) each code point.

7.6.1 Reserved Words

A reserved word is an IdentifierName that cannot be used as an Identifier.

Syntax

ReservedWord ::

Keyword

FutureReservedWord

NullLiteral

BooleanLiteral

The ReservedWord definitions are specified as literal sequences of Unicode characters. However, any Unicode character in a ReservedWord can also be expressed by a \ UnicodeEscapeSequence that expresses that same Unicode character's code point. Use of such escape sequences does not change the meaning of the ReservedWord.

7.6.1.1 Keywords

The following tokens are ECMAScript keywords and may not be used as Identifiers in ECMAScript programs.

Deleted: UnicodeLetter

Deleted: IdentifierStart

Deleted: Identifier

Deleted:
UnicodeCombiningMark .
UnicodeDigit
UnicodeConnectorPunctuation

Deleted: UnicodeLetter

Deleted: in

Deleted: categories

Deleted: Uppercase letter (Lu)

Deleted: , "Lowercase letter (Ll)", "Titlecase letter (Lt)"
"Modifier letter (Lm)", "Other letter (Lo)", or "Letter number (Ni)"

Deleted: Start

Deleted: UnicodeCombiningMark

Deleted: in

Deleted: categories

Deleted: Non-spacing mark (Mn)

Deleted: or "Combining spacing mark (Mc)"

Deleted: UnicodeDigit ::¶
any character in the Unicode category "Decimal number (Nd)"¶
UnicodeConnectorPunctuation ::¶
any character in the Unicode category "Connector punctuation (Pc)"¶

Deleted:

Deleted: Semantics¶

The String value of the production

Deleted: is determined as follows:

Deleted:

Deleted: v

Deleted: consisting

Deleted: The String value of IdentifierName is determined follows:

Deleted: characters

Deleted: a

Deleted: and

Syntax

Keyword :: one of

break	delete	<u>import</u>	this
case	do	in	throw
catch	<u>else</u>	instanceof	try
<u>class</u>	<u>export</u>	<u>let</u>	typeof
<u>continue</u>	finally	new	var
<u>const</u>	for	return	void
debugger	function	<u>super</u>	while
default	if	switch	with

7.6.1.2 Future Reserved Words

The following words are used as keywords in proposed extensions and are therefore reserved to allow for the possibility of future adoption of those extensions.

Syntax

FutureReservedWord :: one of

enum	extends

The following tokens are also considered to be *FutureReservedWords* when they occur within strict mode code (see 10.1.1). The occurrence of any of these tokens within strict mode code in any context where the occurrence of a *FutureReservedWord* would produce an error must also produce an equivalent error:

implements	private	public	yield
interface	package	protected	static

Comment [AWB86]: It isn't clear that extends actually needs to be reserved. It's only usage is highly contextual.

Deleted: class

Deleted: super

Deleted: const

Deleted: export

Deleted: import

Comment [AWB87]: Move to keywords

Deleted: let

7.7 Punctuators

Syntax

Punctuator :: one of

{	()	[]	:
...	;	,	<	>	<=
>=	==	!=	==	!==	
+	-	*	%	++	--
<<	>>	>>>	&		^
!	~	&&		?	:
=	+=	-=	*=	%=	<<=
>>=	>>>=	&=	=	^=	=>

DivPunctuator :: one of

/ /=

RightBracePunctuator ::

}

Deleted: }

7.8 Literals

7.8.1 Null Literals

Syntax

NullLiteral ::
 null

7.8.2 Boolean Literals

Syntax

BooleanLiteral ::
 true
 false

7.8.3 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*

ExponentIndicator :: one of
 e E

SignedInteger ::
 DecimalDigits
 + *DecimalDigits*
 - *DecimalDigits*

BinaryIntegerLiteral ::
 0b *BinaryDigit*
 0B *BinaryDigit*
 BinaryIntegerLiteral *BinaryDigit*

Deleted: Syntax

Literal ::||
 NullLiteral
 ValueLiteral .||
 ||
 ValueLiteral ::||
 BooleanLiteral
 NumericLiteral
 StringLiteral
 RegularExpressionLiteral||

Deleted: Semantics

The value of the null literal *null* is the sole value of the Null type, namely *null*.||

Deleted: Semantics

The value of the Boolean literal *true* is a value of the Boolean type, namely *true*.||
The value of the Boolean literal *false* is a value of the Boolean type, namely *false*.||

Comment [AWB78]: 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 [AWB79]: The various Digit productions could be refactored to have less redundancy

BinaryDigit :: one of

0 1

OctalIntegerLiteral ::

0o OctalDigit

0O OctalDigit

OctalIntegerLiteral 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 10.1.1), must not extend the syntax of NumericLiteral to include OctalIntegerLiteral as described in B.1.1.

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 characters in DecimalDigits.
- 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 characters in DecimalDigits and e is the MV of ExponentPart.
- The MV of DecimalLiteral :: . DecimalDigits is the MV of DecimalDigits times 10^{-n} , where n is the number of characters in DecimalDigits.
- The MV of DecimalLiteral :: . DecimalDigits ExponentPart is the MV of DecimalDigits times 10^{e-n} , where n is the number of characters in DecimalDigits and e is the MV of ExponentPart.
- 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.

Deleted:

Deleted: *IntegerLiteral*

Deleted: *source character*

- 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 characters in *DecimalDigits*.
- 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 *BinaryDigit* is the MV of *BinaryDigit*.
- The MV of *BinaryIntegerLiteral* :: 0B *BinaryDigit* is the MV of *BinaryDigit*.
- The MV of *BinaryIntegerLiteral* :: *BinaryIntegerLiteral BinaryDigit* is (the MV of *BinaryIntegerLiteral* times 2) plus the MV of *BinaryDigit*.
- The MV of *OctalIntegerLiteral* :: 0o *OctalDigit* is the MV of *OctalDigit*.
- The MV of *OctalIntegerLiteral* :: 0O *OctalDigit* is the MV of *OctalDigit*.
- The MV of *OctalIntegerLiteral* :: *OctalIntegerLiteral OctalDigit* is (the MV of *OctalIntegerLiteral* times 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* times 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 8.5), 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.

Deleted:

Deleted: <#>The MV of *NumericLiteral* :: *BinaryIntegerLiteral* is the MV of *BinaryIntegerLiteral*.
 <#>The MV of *BinaryDigit* :: 0 is 0.
 <#>The MV of *BinaryDigit* :: 1 is 1.
 <#>The MV of *BinaryIntegerLiteral* :: 0ob *BinaryDigit* is the MV of *BinaryDigit*.
 <#>The MV of *BinaryIntegerLiteral* :: 0OB *BinaryDigit* is the MV of *BinaryDigit*.
 <#>The MV of *BinaryIntegerLiteral* :: *BinaryIntegerLiteral BinaryDigit* is (the MV of *BinaryIntegerLiteral* times 2) plus the MV of *BinaryDigit*.
 <#>The MV of *NumericLiteral* :: *OctalIntegerLiteral* is the MV of *OctalIntegerLiteral*.
 <#>The MV of *OctalDigit* :: 0 is 0.
 <#>The MV of *OctalDigit* :: 1 is 1.
 <#>The MV of *OctalDigit* :: 2 is 2.
 <#>The MV of *OctalDigit* :: 3 is 3.
 <#>The MV of *OctalDigit* :: 4 is 4.
 <#>The MV of *OctalDigit* :: 5 is 5.
 <#>The MV of *OctalDigit* :: 6 is 6.
 <#>The MV of *OctalDigit* :: 7 is 7.
 <#>The MV of *OctalIntegerLiteral* :: 0o *OctalDigit* is the MV of *OctalDigit*.
 <#>The MV of *OctalIntegerLiteral* :: 0O *OctalDigit* is the MV of *OctalDigit*.
 <#>The MV of *OctalIntegerLiteral* :: *OctalIntegerLiteral OctalDigit* is (the MV of *OctalIntegerLiteral* times 8) plus the MV of *OctalDigit*.
Deleted: *HexIntegerLiteral*
Deleted: *HexIntegerLiteral*
Deleted: *HexIntegerLiteral*

7.8.5 Regular Expression Literals

NOTE A regular expression literal is an input element that is converted to a `RegExp` object (see 15.10) 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 15.10.4) or calling the `RegExp` constructor as a function (15.10.3).

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 (15.10.1).

An implementation may extend the ECMAScript Regular Expression grammar defined in 15.10.1, 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 characters `//` start a single-line comment. To specify an empty regular expression, use: `/(?:)/`.

Deleted: A conforming implementation, when processing strict mode code (see 10.1.1), must not extend the syntax of `NumericLiteral` to include `OctalIntegerLiteral` described in B.1.1.¶

Deleted: 7.8.4 String Literals¶

NOTE A string literal is zero or more Unicode characters code points enclosed in single or double quotes. Unicode Each characterscode points may also be be represented by an escape sequence. All characters may appear literally in a string literal except for the closing quote character, backslash, carriage return, line separator, paragraph separator, and line feed. Any character may appear in the form of an escape sequence. String literals evaluate to ECMAScript String values. When generating these string values Unicode characterscode points are UTF-16 encoded as defined in clause 6. Code points belonging to Basic Multilingual Plane are encoded as a single code unit element of the string. All other Unicode characterscode points are encodedd using UTF-16 as two code unit elements of the string.

Syntax¶

```
StringLiteral ::¶
" DoubleStringCharactersopt "
' SingleStringCharactersopt '¶
DoubleStringCharacters ::¶
DoubleStringCharacter DoubleStringCharacters
SingleStringCharacters ::¶
SingleStringCharacter SingleStringCharactersopt
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 .
o [lookahead & DecimalDigit]
HexEscapeSequence .
UnicodeEscapeSequence¶
A conforming implementation, when processing strict mode code (see 10.1.1), must not extend the syntax of EscapeSequence to include OctalEscapeSequence 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¶
```

Formatted: Note

Deleted: Strings of characters

Deleted: passed uninterpreted to the regular expression constructor, which interprets them according to its own, grammar.

Deleted: regular expression constructor's grammar

Static Semantics: BodyText

RegularExpressionLiteral :: / RegularExpressionBody / RegularExpressionFlags

1. Return the source code that was recognized as RegularExpressionBody.

Static Semantics: FlagText

RegularExpressionLiteral :: / RegularExpressionBody / RegularExpressionFlags

1. Return the source code that was recognized as RegularExpressionFlags.

7.8.6 Template Literal Lexical Components

Syntax

Template ::

NoSubstitutionTemplate
 TemplateHead

NoSubstitutionTemplate ::

 ` TemplateCharacters_{opt} `

TemplateHead ::

 ` TemplateCharacters_{opt} \${

TemplateSubstitutionTail ::

TemplateMiddle
 TemplateTail

TemplateMiddle ::

 } TemplateCharacters_{opt} \${

TemplateTail ::

 } TemplateCharacters_{opt} `

TemplateCharacters ::

TemplateCharacter TemplateCharacters_{opt}

TemplateCharacter ::

SourceCharacter but not one of ` \ or \ or \$
 \$ lookahead ∈ { }
 \ EscapeSequence
 LineContinuation

Static Semantics: TV's and TRV's

A template literal component is interpreted as a sequence of Unicode characters. The Template Value (TV) of a literal component is described in terms of code unit values (CV, 7.8.4) contributed by the various parts of the template literal component. As part of this process, some Unicode characters within the Template component are interpreted as having a mathematical value (MV, 7.8.3). In determining a TV, escape sequences are replaced by the code unit of the Unicode characters 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.

Deleted: Semantics¶

A regular expression literal evaluates to a value of Object type that is an instance of the standard built-in constructor RegExp. This value is determined in two steps: first, the characters comprising the regular expression's RegularExpressionBody and RegularExpressionFlags production expansions are collected uninterpreted into two Strings Pattern and Flags, respectively. Then each time the literal is evaluated, a new object is created as if by the expression new RegExp(Pattern, Flags) where RegExp is the standard built-in constructor with the same name. The newly constructed object becomes the value of the RegularExpressionLiteral. If the call to new RegExp would generate an error as specified in 15.10.4.1, the error must be treated as an early error (Clause 16).¶

Deleted: Quasi...template

Deleted: 7.9

Deleted: Quasi

Deleted: FullQuasi...oSubstitutionTemplate

Deleted: FullQuasi

Deleted: Quasi

Deleted: Quasi

Deleted: Quasi

Deleted: Quasi...emplateMiddle

Deleted: Quasi

Deleted: Quasi

Deleted: Quasi

Deleted: Quasi...emplateCharacter Quasi

Deleted: Quasi

Comment [AWB910]: Note that the original proposal allowed \$IdentifierName to be used as a substitution without {} around the name..

Line terminations characters are simply handled as literal SourceCharacters. I find this troublesome. Shouldn't we have some sort of normalizations of line terminators. Otherwise, the actual characters in a multi-line template are at the mercy of the authors editor/OS.

Deleted: QV...V's and RQV

Deleted: quasi...emplate literal component is interpre

Deleted: QV...V and QRV...RV of FullQuasi

Deleted: QV...V and QRV...RV of Quasi

Deleted: QV...V and QRV...RV of Quasi

Deleted: r

Deleted: QV...V and QRV...RV of Quasi

- The TV of *NoSubstitutionTemplate* :: ` *TemplateCharacters* ` is the TV of *TemplateCharacters*. Deleted: QV...V of
- The TV of *TemplateHead* :: ` *TemplateCharacters* \$ { is the TV of *TemplateCharacters*. Deleted: QV...V of Quasi...emplateHead :: `
- The TV of *TemplateMiddle* :: } *TemplateCharacters* \$ { is the TV of *TemplateCharacters*. Deleted: QV...V of Quasi...emplateMiddle :: }
- The TV of *TemplateTail* :: } *TemplateCharacters* ` is the TV of *TemplateCharacters*. Deleted: QV...V of Quasi...emplateTail :: }
- The TV of *TemplateCharacter* :: *TemplateCharacter* is the TV of *TemplateCharacter*. Deleted: QV...V of Quasi...emplateCharacter
- 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. Deleted: QV...V of Quasi...emplateCharacters
- The TV of *TemplateCharacter* :: *SourceCharacter* but not one of ` or \ or \$ is the UTF-16 Encoding (clause 6) of the code point value of *SourceCharacter*. Deleted: QV...V of Quasi
- The TV of *TemplateCharacter* :: \$ [lookahead \notin {1} is the code unit value 0x0024. Deleted: QV...V of Quasi
- The TV of *TemplateCharacter* :: \ *EscapeSequence* is the CV of *EscapeSequence*. Deleted: QV...V of Quasi
- The TV of *TemplateCharacter* :: *LineContinuation* is the TV of *LineContinuation*. Deleted: QV...V of Quasi...emplateCharacter
- The TV of *LineContinuation* :: \ *LineTerminatorSequence* is the empty code unit sequence. Deleted: QV
- The TRV of *NoSubstitutionTemplate* :: ` *TemplateCharacters* ` is the TRV of *TemplateCharacters*. Deleted: QRV...RV of
- The TRV of *TemplateHead* :: ` *TemplateCharacters* \$ { is the TRV of *TemplateCharacters*. Deleted: QRV...RV of Quasi...emplateHead :: `
- The TRV of *TemplateMiddle* :: } *TemplateCharacters* \$ { is the TRV of *TemplateCharacters*. Deleted: QRV...RV of Quasi...emplateMiddle :: }
- The TRV of *TemplateTail* :: } *TemplateCharacters* ` is the TRV of *TemplateCharacters*. Deleted: QRV...RV of Quasi...emplateTail :: }
- The TRV of *TemplateCharacter* :: *TemplateCharacter* is the TRV of *TemplateCharacter*. Deleted: QRV...RV of
- 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. Deleted: QRV...RV of
- The TRV of *TemplateCharacter* :: *SourceCharacter* but not one of ` or \ or \$ is the UTF-16 Encoding (clause 6) of the code point value of *SourceCharacter*. Deleted: QRV...RV of Quasi
- The TRV of *TemplateCharacter* :: \$ [lookahead \notin {1} is the code unit value 0x0024. Deleted: QRV...RV of Quasi
- The TRV of *TemplateCharacter* :: \ *EscapeSequence* is the sequence consisting of the code unit value 0x005C followed by the code units of TRV of *EscapeSequence*. Deleted: QRV...RV of Quasi...emplateCharacter
- The TRV of *TemplateCharacter* :: *LineContinuation* is the TRV of *LineContinuation*. Deleted: QRV...RV of Quasi...emplateCharacter
- The TRV of *EscapeSequence* :: *CharacterEscapeSequence* is the TRV of the *CharacterEscapeSequence*. Deleted: QRV...RV of EscapeSequence ::
- The TRV of *EscapeSequence* :: 0 [lookahead \notin *DecimalDigit*] is the code unit value 0x0030. Deleted: QRV
- The TRV of *EscapeSequence* :: *HexEscapeSequence* is the TRV of the *HexEscapeSequence*. Deleted: QRV...RV of EscapeSequence ::
- The TRV of *EscapeSequence* :: *UnicodeEscapeSequence* is the TRV of the *UnicodeEscapeSequence*. Deleted: C...RV of EscapeSequence ::
- The TRV of *CharacterEscapeSequence* :: *SingleEscapeCharacter* is the TRV of the *SingleEscapeCharacter*. Deleted: QRV...RV of CharacterEscapeSequence ::
- The TRV of *CharacterEscapeSequence* :: *NonEscapeCharacter* is the CV of the *NonEscapeCharacter*. Deleted: QRV
- The TRV of *SingleEscapeCharacter* :: one of ' " \ b f n r t v is the CV of the *SourceCharacter* that is that single character. Deleted: QRV
- 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*. Deleted: QRV...RV of HexEscapeSequence ::
- The TRV of *UnicodeEscapeSequence* :: u *HexDigit HexDigit HexDigit HexDigit* is the sequence consisting of code unit value 0x0075 followed by TRV of the first *HexDigit* followed by the TRV of the second *HexDigit* followed by TRV of the third *HexDigit* followed by the TRV of the fourth *HexDigit*. Deleted: QRV...RV of UnicodeEscapeSequence ::
- 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. Deleted: QRV...RV of UnicodeEscapeSequence ::
- The TRV of *HexDigits* :: *HexDigit* is the TRV of *HexDigit*. Deleted: QRV...RV of HexDigits :: HexDigit
- The TRV of *HexDigits* :: *HexDigits HexDigit* is the sequence consisting of TRV of *HexDigits* followed by TRV of *HexDigit*. Deleted: QRV...RV of HexDigits :: HexDigits
- The TRV of a *HexDigit* is the CV of the *SourceCharacter* that is that *HexDigit*. Deleted: QRV
- The TRV of *LineContinuation* :: \ *LineTerminatorSequence* is the sequence consisting of the code unit value 0x005C followed by the code units of TRV of *LineTerminatorSequence*. Deleted: QRV...RV of LineContinuation :: \
- The TRV of *LineTerminatorSequence* :: <LF> is the code unit value 0x000A. Deleted: QRV
- The TRV of *LineTerminatorSequence* :: <CR> [lookahead \notin <LF>] is the code unit value 0x000D. Deleted: QRV
- The TRV of *LineTerminatorSequence* :: <LS> is the code unit value 0x2028. Deleted: QRV

- 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 0x000D followed by the code unit value 0x000A.

NOTE TV excludes the code units of *LineContinuation* while TRV includes them.

Deleted: QRV

Deleted: QRV

Deleted: QV

Deleted: QRV

7.8.4 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 characters may appear literally in a string literal except for the closing quote character, backslash, carriage return, line separator, paragraph separator, and line feed. Any character 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 clause 6. 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 ::
 " *DoubleStringCharacters*_{opt} "
 ' *SingleStringCharacters*_{opt} '

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 10.1.1), must not extend the syntax of *EscapeSequence* to include *OctalEscapeSequence* 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 HexDigit HexDigit HexDigit HexDigit

u{ HexDigits }

The definition of the nonterminal *HexDigit* is given in 7.8.3. *SourceCharacter* is defined in clause 6.

NOTE A line terminator character cannot appear in a string literal, except as part of a *LineContinuation* to produce the empty character sequence. The correct way to cause a line terminator character to be part of the String value of a string literal is to use an escape sequence such as `\n` or `\u000A`.

Static Semantics

Static Semantics: Early Errors

UnicodeEscapeSequence :: u{ HexDigits }

- It is a Syntax Error if the MV of *HexDigits* > 1114111.

Static Semantics: SV's and CV'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 (CV) contributed by the various parts of the string literal. As part of this process, some Unicode characters within the string literal are interpreted as having a mathematical value (MV), as described below or in 7.8.3.

- 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* *DoubleStringCharacters* is a sequence of one or two code units that is the CV of *DoubleStringCharacter*.
- The SV of *DoubleStringCharacters* :: *DoubleStringCharacter* *DoubleStringCharacters* is a sequence of one or two code units that is the CV of *DoubleStringCharacter* followed by all the code units in the SV of *DoubleStringCharacters* in order.
- The SV of *SingleStringCharacters* :: *SingleStringCharacter* *SingleStringCharacters* is a sequence of one or two code units that is the CV of *SingleStringCharacter*.
- The SV of *SingleStringCharacters* :: *SingleStringCharacter* *SingleStringCharacters* is a sequence of one or two code units that is the CV of *SingleStringCharacter* followed by all the code units in the SV of *SingleStringCharacters* in order.
- The SV of *LineContinuation* :: \ *LineTerminatorSequence* is the empty code unit sequence.
- The CV of *DoubleStringCharacter* :: *SourceCharacter* but not one of " or \ or *LineTerminator* is the UTF-16 Encoding (clause 6) of the code point value of *SourceCharacter*.
- The CV of *DoubleStringCharacter* :: \ *EscapeSequence* is the CV of the *EscapeSequence*.
- The CV of *DoubleStringCharacter* :: *LineContinuation* is the empty character sequence.
- The CV of *SingleStringCharacter* :: *SourceCharacter* but not one of ' or \ or *LineTerminator* is the UTF-16 Encoding (clause 6) of the code point value of *SourceCharacter*.
- The CV of *SingleStringCharacter* :: \ *EscapeSequence* is the CV of the *EscapeSequence*.
- The CV of *SingleStringCharacter* :: *LineContinuation* is the empty character sequence.

- The CV of *EscapeSequence* :: *CharacterEscapeSequence* is the CV of the *CharacterEscapeSequence*.
- The CV of *EscapeSequence* :: 0 [lookahead \notin *DecimalDigit*] is the code unit value 0.
- The CV of *EscapeSequence* :: *HexEscapeSequence* is the CV of the *HexEscapeSequence*.
- The CV of *EscapeSequence* :: *UnicodeEscapeSequence* is the CV of the *UnicodeEscapeSequence*.
- The CV of *CharacterEscapeSequence* :: *SingleEscapeCharacter* is the character whose code unit value is determined by the *SingleEscapeCharacter* according to:

Field Code Changed

Table 4 — String Single Character Escape Sequences

Escape Sequence	Code Unit Value	Name	Symbol
\b	0x0008	backspace	<BS>
\t	0x0009	horizontal tab	<HT>
\n	0x000A	line feed (new line)	<LF>
\v	0x000B	vertical tab	<VT>
\f	0x000C	form feed	<FF>
\r	0x000D	carriage return	<CR>
\"	0x0022	double quote	"
\'	0x0027	single quote	'
\\\	0x005C	backslash	\

- The CV of *CharacterEscapeSequence* :: *NonEscapeCharacter* is the CV of the *NonEscapeCharacter*.
- The CV of *NonEscapeCharacter* :: *SourceCharacter* but not one of *EscapeCharacter* or *LineTerminator* is the UTF-16 Encoding (clause 6) of the code point value of *SourceCharacter*.
- The CV 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 CV of *UnicodeEscapeSequence* :: u 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 CV of *UnicodeEscapeSequence* :: u{ *HexDigits* } is the UTF-16 Encoding (clause 6) of the MV of *HexDigits*.

7.9 Automatic Semicolon Insertion

Deleted:

Certain ECMAScript statements (empty statement, variable statement, expression statement, `do-while` 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.

7.9.1 Rules of Automatic Semicolon Insertion

There are three basic rules of semicolon insertion:

- When, as the *script* 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 }.
- When, as the *script* 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*, then a semicolon is automatically inserted at the end of the input stream.

Deleted: program

Deleted: program

Deleted: Program

3. When, as the `script` 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.

Deleted: program

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 12.6.3).

NOTE The following are the only restricted productions in the grammar:

```

PostfixExpression :
  LeftHandSideExpression [no LineTerminator here] ++
  LeftHandSideExpression [no LineTerminator here] --

ContinueStatement :
  continue [no LineTerminator here] Identifier ;

BreakStatement :
  break [no LineTerminator here] Identifier ;

ReturnStatement :
  return [no LineTerminator here] Expression ;

ThrowStatement :
  throw [no LineTerminator here] Expression ;

```

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`, or `throw` token is encountered and a *LineTerminator* is encountered before the next token, a semicolon is automatically inserted after the `continue`, `break`, `return`, or `throw` 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 should start on the same line as the `return` or `throw` token.

An `Identifier` in a `break` or `continue` statement should be on the same line as the `break` or `continue` token.

7.9.2 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 parenthesised 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.

8 Types

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.

Deleted: 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, Number, and Object.||

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, Property Identifier, Lexical Environment, and Environment Record, and D 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.¶

8.1 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, Number, and Object. An ECMAScript language value is a value that is characterized by an ECMAScript language type.

8.1.1 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**.

8.1.2 The Null Type

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

8.1.3 The Boolean Type

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

8.1.4 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 Normalised Form C, string literals are guaranteed to also be normalised, 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 *c1* is in the range 0xD800 to 0xDBFF and the second code unit *c2* is in the range 0xDC00 to 0xDFFF, is a surrogate pair and is interpreted as a code point with the value $(c1 - 0xD800) \times 0x400 + (c2 - 0xDC00) + 0x10000$.
- 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.

8.1.5 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

Deleted: Unicode
Deleted: (see Clause 6)
Deleted: position
Deleted: position

Deleted: <#> When a String contains actual textual data, each element is considered to be a single UTF-16 code unit. Whether or not this is the actual storage format of a String, the characters within a String are numbered by their initial code unit element position as though they were represented using UTF-16. All operations on Strings (except as otherwise stated) treat them as sequences of undifferentiated 16-bit unsigned integers; they do not ensure the resulting String is in normalized form, nor do they ensure language-sensitive results.¶

Deleted: The intent is that textual data coming into the execution environment from outside (e.g., user input, text read from a file or received over the network, etc.) be converted to Unicode Normalized Form C before the running program sees it. Usually this would occur at the same time incoming text is converted from its original character encoding to Unicode (and would impose no additional overhead). Since it is recommended that

Deleted: be

Deleted: (if source text is guaranteed to be normalized)

between various Not-a-Number values, but such behaviour is implementation-dependent; to ECMAScript code, all NaN values are indistinguishable from each other.

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 normalised, 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 denormalised, 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” mode.)

Some ECMAScript operators deal only with integers in the range -2^{31} through $2^{31}-1$, inclusive, or in the range 0 through $2^{32}-1$, inclusive. These operators accept any value of the Number type but first convert each such value to one of 2^{32} integer values. See the descriptions of the `ToInt32` and `ToUInt32` operators in 9.5 and 9.6, respectively.

8.1.6 The Object Type

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

Deleted: named

Deleted: named

Deleted: , or an internal property

- A *data property* associates a *key value* with an ECMAScript language value and a set of Boolean attributes.
- A *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.

~~Deleted: named~~~~Deleted: name~~~~Deleted: named~~~~Deleted: name~~

Properties are identified using key values. A key value is either an ECMAScript String value or an Exotic Symbol object (8.4.3).

~~Deleted: y~~~~Deleted: ECMAScript~~~~Comment [AWB1211]: TODO, section reference~~~~Deleted: ????~~~~Deleted: An internal property has no name and is not directly accessible via ECMAScript language operators. Internal properties exist purely for specification purposes. ¶~~~~Deleted: named (non-internal)~~~~Deleted: put~~~~Deleted: accessible~~~~Deleted: properites~~~~Deleted: objects~~~~Deleted: semanjtics~~~~Deleted: object are~~~~Deleted: ,~~~~Deleted: named~~~~Deleted: named~~~~Deleted: name~~~~Deleted: Named~~~~Deleted: reading~~~~Deleted: Put~~~~Deleted: P~~~~Deleted: or [[DefineOwnProperty]]~~~~Deleted: for~~~~Deleted: named~~~~Deleted: name~~

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.

8.1.6.1 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 5.

Table 5 — Attributes of a Data Property

Attribute Name	Value Domain	Description
[[Value]]	Any ECMAScript language type	The value retrieved by a get access of the property.
[[Writable]]	Boolean	If false , attempts by ECMAScript code to change the property's [[Value]] attribute using [[Set]] will not succeed.
[[Enumerable]]	Boolean	If true , the property will be enumerated by a for-in enumeration (see 12.6.4). Otherwise, the property is said to be non-enumerable.
[[Configurable]]	Boolean	If false , attempts to delete the property, change the property to be an accessor property, or change its attributes (other than [[Value]], or changing [[Writable]] to false) will fail.

An accessor property associates a *key value* with the attributes listed in Table 6.

Table 6 — Attributes of an Accessor Property

Attribute Name	Value Domain	Description
[[Get]]	Object or Undefined	If the value is an Object it must be a function Object. The function's [[Call]] internal method (8.6.2) is called with an empty arguments list to retrieve the property value each time a get access of the property is performed.
[[Set]]	Object or Undefined	If the value is an Object it must be a function Object. The function's [[Call]] internal method (8.6.2) 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 [[Set]] internal method may, but is not required to, have an effect on the value returned by subsequent calls to the property's [[Get]] internal method.
[[Enumerable]]	Boolean	If true, the property is to be enumerated by a for-in enumeration (see 12.6.4). Otherwise, the property is said to be non-enumerable.
[[Configurable]]	Boolean	If false, attempts to delete the property, change the property to be a data property, or change its attributes will fail.

If the initial values of a property's attributes are not explicitly specified by this specification, the default value defined in Table 7 is used.

Table 7 — Default Attribute Values

Attribute Name	Default Value
[[Value]]	undefined
[[Get]]	undefined
[[Set]]	undefined
[[Writable]]	false
[[Enumerable]]	false
[[Configurable]]	false

8.1.6.2 Object Internal Methods and Internal Data Properties

The actual semantics of ECMAScript objects 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 methods are identified within this specification using names enclosed in double square brackets [[]]. Internal method names are polymorphic. This means that different ECMAScript 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.

Internal data properties correspond to internal state that is associated with objects and used by various ECMAScript specification algorithms. Depending upon the specific internal data property such state may consist of values of any ECMAScript language type or of specific ECMA specification type values. Unless explicitly specified otherwise, internal data properties are allocated as part of the process of creating an ECMAScript object and may not be dynamically added to ECMAScript objects. Unless specified otherwise, the initial value of an internal data property is the value **undefined**.

Deleted: Named

Deleted: return

Deleted: P

Deleted: P

Deleted: n

Deleted: is

Deleted: for a named property

Deleted: Properties and

Deleted: This specification uses various internal properties to define the semantics of object values.

Deleted: properties

Deleted: An

Deleted: as if it produced and operated upon internal properties in the manner described here

Deleted: .

Deleted: The names of i

Deleted: properties

Deleted: are

Deleted: When

Deleted: uses an

Deleted: property

Deleted: and the object does not implement the indicated internal property

Table 8 summarises the essential internal methods used by this specification that are applicable to all ECMAScript objects. 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 8 and other similar tables describes the invocation pattern for each internal method. The invocation pattern always includes a parenthesised 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 8 augmented by the following additional names. "any" means the value may be any ECMAScript language type. "primitive" means Undefined, Null, Boolean, String, or Number. An internal method implicitly returns a Completion Record as described in 8.8. In addition to its parameters, an internal method always has access to the object upon which it is invoked as a method.

Deleted: The
Deleted: properties
Field Code Changed
Deleted:
Deleted: Value Type Domain
Deleted: s
Deleted: the following
Deleted: define
Deleted: the types of values associated with internal properties
Deleted: The type names refer to the types defined in Clause 8 augmented by the following additional names. "any" means the value may be any ECMAScript language type. "primitive" means Undefined, Null, Boolean, String, or Number. "SpecOp" means the internal method, an implementation provided procedure defined by an abstract operation specification. "SpecOp" is followed a
Deleted: "SpecOp"

DRAFT

Table 8 — Essential Internal Methods

Internal Method	Signature	Description
<code>[[GetInheritance]]</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. an object.
<code>[[SetInheritance]]</code>	<code>(Object or Null)→Boolean</code>	Associate with an 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>[[HasIntegrity]]</code>	<code>(String)→Boolean</code>	Determine whether the property structure of an object is fixed to at least the specified level. The argument is one of the values "nonextensible", "sealed", or "frozen".
<code>[[SetIntegrity]]</code>	<code>(String)→Boolean</code>	Restrict the mutability of an object's properties to that which is allowed for the specified integrity level. The argument is one of the values "nonextensible", "sealed", or "frozen". Returns <code>true</code> indicating that the operation was completed successfully or <code>false</code> indicating that the operation was not successful. The integrity level of an object may be raised but may not be lower.
<code>[[HasOwnProperty]]</code>	<code>(propertyKey) → Boolean</code>	Returns a Boolean value indicating whether the object already has an own property whose key is <code>propertyKey</code> .
<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 the object already has either an own or inherited property whose key is <code>propertyKey</code> .
<code>[[Set]]</code>	<code>(propertyKey,value,Receiver) → Boolean</code>	Try to set the value of an object's property identified by <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> indicating that the property value was set or <code>false</code> indicating that it could not be set.
<code>[[Delete]]</code>	<code>(propertyKey) → Boolean</code>	Removes the own property identified by the <code>propertyKey</code> parameter from the 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 was not present.
<code>[[DefineOwnProperty]]</code>	<code>(propertyKey,PropertyDescriptor) → Boolean</code>	Creates or alters the named own property to have the state described by a Property Descriptor. Returns <code>true</code> indicating that the property was successfully created/updated or <code>false</code> indicating that the property could not be created or updated.
<code>[[Enumerate]]</code>	<code>()→Object</code>	Returns an iterator object over the string values of the keys of the enumerable properties of the object.
<code>[[OwnPropertyKeys]]</code>	<code>()→Object</code>	Returns an iterator object that produces all of the own property keys for the object except those that are private Symbols.

Table 9 summarises additional essential internal methods that must be supported by all objects that may be called as functions.

Table 9 — Additional Essential Internal Methods of Function Objects

Internal Method	Signature	Description
[[Call]]	(any, a List of any) → any or Reference	Executes code associated with the object. Invoked via a function call expression. The arguments to the internal method are a this value and a list containing the arguments passed to the function by a call expression. Objects that implement this internal method are callable . Only callable objects that are host objects may return Reference values.
[[Construct]]	(a List of any) → Object	Creates an object. Invoked via the new operator. The arguments to the internal are the arguments passed to the new operator. Objects that implement this internal method are called constructors .

Deleted:
Deleted: The
Deleted: Table 9
Deleted: the
Deleted: properties
Deleted: used by this specification that are only applicable to some ECMAScript objects
Deleted: .
Deleted: **Value Type Domain**
Comment [AWB912]: Hopefully we can eliminate functions returning References

8.1.6.3 Invariants of the Essential Internal Methods

Current this section is just a bunch of material merged together from the ES5 spec. and from the wiki Proxy pages. It need to be completely reworked.

The intent is that it lists all invariants of the Essential Internal Methods. This includes both invariants that are enforced for Proxy objects and other invariants that may not be enforced.

Deleted: ¶
Deleted: 2

Definitions:

- The **target** of an internal method is the object the internal method is called upon.
- A **sealed** property is a non-configurable own property of a target.
- A **frozen** property is a non-configurable non-writable own property of a target.
- A **new** property is a property that does not exist on a non-extensible target.
- Two property descriptors **desc1** and **desc2** for a property key value are incompatible if:
 - desc1** is produced by calling **[[GetOwnPropertyDescriptor]]** of **target** with **key**, and
 - Calling **[[DefineOwnProperty]]** of **target** with arguments **key** and **desc2** would throw a **TypeError** exception.

Exotic objects may define additional constraints upon their **[[Set]]** internal method behavior. If possible, exotic objects should not allow **[[Set]]** operations in situations where this definition of **[[CanPut]]** returns **false**.

Deleted: P
Comment [AWB1213]: Need to decide what replaces this when CanPut goes away
Deleted: P

[[GetInheritance]]

Every **[[Prototype]]** chain must have finite length (that is, starting from any object, recursively accessing the **[[Prototype]]** internal **data** property must eventually lead to a **null** value).

getOwnPropertyDescriptor

Non-configurability invariant: cannot return incompatible descriptors for sealed properties

Non-extensibility invariant: must return **undefined** for new properties

Invariant checks:

if trap returns **undefined**, check if the property is configurable

if property exists on target, check if the returned descriptor is compatible

if returned descriptor is non-configurable, check if the property exists on the target and is also non-configurable

defineProperty

Non-configurability invariant: cannot succeed (return true) for incompatible changes to sealed properties

Non-extensibility invariant: must reject (return **false**) for new properties

Invariant checks:

on success, if property exists on target, check if existing descriptor is compatible with argument descriptor

on success, if argument descriptor is non-configurable, check if the property exists on the target and is also non-configurable

getOwnPropertyNames

Non-configurability invariant: must report all sealed properties

Non-extensibility invariant: must not list new property names

Invariant checks:

check whether all sealed target properties are present in the trap result

If the target is non-extensible, check that no new properties are listed in the trap result

deleteProperty

Non-configurability invariant: cannot succeed (return true) for sealed properties

Invariant checks:

on success, check if the target property is configurable

getPrototypeOf

Invariant check: check whether the target's prototype and the trap result are identical (according to the `egal` operator)

freeze | seal | preventExtensions

Invariant checks:

on success, check if `isFrozen(target)`, `isSealed(target)` or `!isExtensible(target)`

isFrozen | isSealed | isExtensible

Invariant check: check whether the boolean trap result is equal to `isFrozen(target)`, `isSealed(target)` or `isExtensible(target)`

hasOwn

Non-configurability invariant: cannot return **false** for sealed properties

Non-extensibility invariant: must return **false** for new properties

Invariant checks:

if **false** is returned, check if the target property is configurable

if **false** is returned, the property does not exist on target, and the target is non-extensible, throw a `TypeError`

has

Non-configurability invariant: cannot return **false** for sealed properties

Invariant checks:

if **false** is returned, check if the target property is configurable

get

Non-configurability invariant: cannot return inconsistent values for frozen data properties, and must return **undefined** for sealed accessors with an **undefined** getter

Invariant checks:

if property exists on target as a data property, check whether the target property's value and the trap result are identical (according to the `egal` operator)

if property exists on target as an accessor, and the accessor's `get` attribute is **undefined**, check whether the trap result is also **undefined**.

set

Non-configurability invariant: cannot succeed (return `true`) for frozen data properties or sealed accessors with an **undefined** setter

Invariant checks:

on success, if property exists on target as a data property, check whether the target property's value and the update value are identical (according to the `egal` operator)

on success, if property exists on target as an accessor, check whether the accessor's `set` attribute is not **undefined**

keys

Non-configurability invariant: must report all enumerable sealed properties

Non-extensibility invariant: must not list new property names

Invariant checks:

Check whether all enumerable sealed target properties are listed in the trap result

If the target is non-extensible, check that no new properties are listed in the trap result

enumerate

Non-configurability invariant: must report all enumerable sealed properties

Invariant checks:

Check whether all enumerable sealed target properties are listed in the trap result

NOTE This specification defines no ECMAScript language operators or built-in functions that permit a program to modify an object's `[[Prototype]]` internal properties or to change the value of `[[Extensible]]` from `false` to `true`. Implementation specific extensions that modify `[[Prototype]]` or `[[Extensible]]` must not violate the invariants defined in the preceding paragraph.

Unless otherwise specified, the standard ECMAScript objects are ordinary objects and behave as described in 8.3. Some standard objects are exotic objects and have behaviour defined in 8.4.

Exotic objects may implement internal methods in any manner unless specified otherwise; for example, one possibility is that `[[Get]]` and `[[Set]]` for a particular exotic object indeed fetch and store property values but `[[HasOwnProperty]]` always generates `false`. However, if any specified manipulation of an exotic object's internal properties is not supported by an implementation, that manipulation must throw a `TypeError` exception when attempted.

Comment [AWB1214]: These are placeholders based upon the proxy trap invariants. We need to provide new versions all the the essential internal methods.

Deleted: Clause 8.12 provides the algorithm that defined the default behaviour for the internal methods in Table 8. An *ordinary object* is an object that uses all of these default algorithms. An *exotic object* is an object that uses some other algorithm to provide alternative behaviour for one or more of these internal methods. The descriptions in these tables indicate their behaviour for native ECMAScript objects, unless stated otherwise in this document for particular kinds of native ECMAScript objects. ¶

Deleted: Host objects may support these internal properties with any implementation-dependent behaviour as long as it is consistent with the specific host object restrictions stated in this document. ¶

Deleted: The "Value Type Domain" column in the following tables define the types of values associated with internal properties. The type names refer to the types defined in Clause 8 augmented by the following additional names: "*any*" means the value may be any ECMAScript language type. "*primitive*" means Undefined, Null, Boolean, String, or Number. "*SpecOp*" means the internal property is an internal method, an implementation provided procedure defined by an abstract operation specification. "*SpecOp*" is followed by a list of descriptive parameter names. If a parameter name is the same as a type name then the name describes the type of the parameter. If a "*SpecOp*" returns a value, its parameter list is followed by the symbol "`-`" and the type of the returned value.

Comment [AWB1215]: No longer true because of Proxies.

Deleted: Every object (including host objects) must implement all of the internal properties.

Formatted: Strikethrough

Formatted: Strikethrough

Deleted: `[[Class]]` or

Deleted: `[[Class]]`,

Deleted: The value of the `[[Class]]` internal property is defined by this specification for every object.

Deleted: common internal methods of native objects

Deleted: `12`

Deleted: Array objects have a slightly different implementation of the `[[DefineOwnProperty]]` internal method.

Deleted: `]`

Deleted: Host

Deleted: these

Deleted: `P`

Deleted: `Put`

Deleted: `P`

Deleted: host

Deleted: host

The `[[GetOwnProperty]]` internal method of all objects must conform to the following invariants for each property of the object:

- If a property is described as a data property and it may return different values over time, then either or both of the `[[Writable]]` and `[[Configurable]]` attributes must be `true` even if no mechanism to change the value is exposed via the other internal methods.
- If a property is described as a data property and its `[[Writable]]` and `[[Configurable]]` are both `false`, then the `SameValue` (according to 9.12) must be returned for the `[[Value]]` attribute of the property on all calls to `[[GetOwnProperty]]`.
- If the attributes other than `[[Writable]]` may change over time or if the property might disappear, then the `[[Configurable]]` attribute must be `true`.
- If the `[[Writable]]` attribute may change from `false` to `true`, then the `[[Configurable]]` attribute must be `true`.
- If the result of calling an object's `[[IsExtensible]]` internal method has been observed by ECMAScript code to be `false`, then if a call to `[[GetOwnProperty]]` describes a property as non-existent all subsequent calls must also describe that property as non-existent.

Deleted: host

Deleted: host

The `[[DefineOwnProperty]]` internal method of all objects must not permit the addition of a new property to an object if the `[[Extensible]]` internal method of that object has been observed by ECMAScript code to be `false`.

If the result of calling the `[[IsExtensible]]` internal method of an object has been observed by ECMAScript code to be `false` then it must not subsequently become `true`.

8.1.6.4 Well-Known Symbols and Intrinsics

Well-known symbols are built-in exotic symbol objects (8.4.4) 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 (10.3) and the value of their `[[Private]]` internal data property (forward ref) is `false`.

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 10.

Table 10—Well-known Symbols

Specification Name	Value and Purpose
<code>@@create</code>	A method used to allocate an object. Called from the <code>[[Construct]]</code> internal method.
<code>@@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>@@isRegExp</code>	A Boolean value that if true indicates that an object may be used as a regular expression.
<code>@@iterator</code>	A method that returns the default iterator for an object. Called by the semantics of the <code>for-of</code> statement.
<code>@@ToPrimitive</code>	A method that converts an object to a corresponding primitive value. Called by the <code>ToPrimitive</code> abstract operation.
<code>@@toStringTag</code>	A string 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> .

Deleted: value

Deleted: of

Deleted: the

Deleted: host

Deleted: property

Deleted: host

Deleted: host

Deleted: that

Deleted: property

Deleted: host

Deleted: property

Deleted: that

Deleted: host

Deleted: 3

Deleted: Table 10Table 11

Deleted: 10

Deleted: 1011

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

Deleted: f

Deleted: specific

Within this specification a reference such as %name% means the intrinsic object, associated with the current Code Realm, corresponding to the name. Determine of the current Code Realmand its intrinsics is described in 10.3. The well-known intrinics are listed in Table 11.

DRAFT

Table 11.— Well-known Intrinsic Objects

Deleted: 1125

Intrinsic Name	ECMAScript Language Association
%Object%	The initial value of the global object property named "Object".
%ObjectPrototype%	The initial value of the "prototype" data property of the intrinsic %Object%.
%ObjProto_toString%	The initial value of the "toString" data property of the intrinsic %ObjectPrototype%.
%Function%	The initial value of the global object property named "Function".
%FunctionPrototype%	The initial value of the "prototype" data property of the intrinsic %Function%.
%Array%	The initial value of the global object property named "Array".
%ArrayPrototype%	The initial value of the "prototype" data property of the intrinsic %Array%.
%ArrayIteratorPrototype%	The prototype object used for iterator objects created by the CreateArrayIterator abstract operation.
%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%	The initial value of the global object property named "WeakMap".
%WeakMapPrototype%	The initial value of the "prototype" data property of the intrinsic %WeakMap%.
%Set%	The initial value of the global object property named "Set".
%SetPrototype%	The initial value of the "prototype" data property of the intrinsic %Set%.
%SetIteratorPrototype%	The prototype object used for iterator objects created by the CreateSetIterator abstract operation
%StopIteration%	
%ErrorPrototype%	
%EvalErrorPrototype%	
%RangePrototype%	
%ReferenceErrorPrototype%	
%SyntaxErrorPrototype%	
%TypeErrorPrototype%	
%URIErrorPrototype%	
???	

Comment [AWB1216]: This needs to be per engine not per Realm. Also, perhaps it can be a Symbol.

Comment [AWB1217]: TODO more to comeTODO

8.2 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.

Deleted: Table — Internal Properties Only
Defined for Some Objects¶
Internal Property

Comment [AWB918]: Hopefully we can eliminate functions returning References

Deleted: Property Identifier,

Deleted: ¶

8.2.1 Data Blocks

This section is a placeholder for describing the Data Block internal type. The following material is verbatim from the the Binary Data ES wiki proposal. The material has not yet been reviewed or integrated with the rest of this spec.

This spec introduces a new, spec-internal block datatype, intuitively representing a contiguously allocated block of binary data. Blocks are not ECMAScript language values and appear only in the program store (aka heap).

A block is one of:

- a number-block
- an array-block[t, n]
- a struct-block[t1, ..., tn]

A number-block is one of:

- an unsigned-integer; i.e., one of uint8, uint16, uint32, or uint64
- a signed-integer; i.e., one of int8, int16, int32, or int64
- a floating-point; i.e., one of float32 or float64

A uintk is an integer in the range [0, 2^k). An intk is an integer in the range [-2^{k-1}, 2^{k-1}). A floatk is a floating-point number representable as a k-bit IEE754 value.

An array-block[t, n] is an ordered sequence of n blocks of homogeneous block type t. Each element of the array is stored at an independently addressable location in the program store, and multiple Data objects may contain references to the element.

A struct-block[t1, ..., tn] is an ordered sequence of n blocks of heterogeneous types t1 to tn, respectively. Each field of the struct is stored at an independently addressable location in the program store, and multiple Data objects may contain references to the field.

The spec also introduces a datatype of Data objects, which are ECMAScript objects that encapsulate references to block data in the program store. Every Data object has the following properties:

[[Class]] = "Data"

[[Value]] : reference[block] – a reference to a block in the program store

[[DataType]] : reference[Type] – a reference to a Type object describing this object's data block

8.2.2 The List and Record Specification Type

The List type is used to explain the evaluation of argument lists (see 11.2.4) in new expressions, in function calls, and in other algorithms where a simple list of values is needed. Values of the List type are simply ordered sequences of values. These sequences may be of any length.

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]].

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: Property Descriptor {[[Value]]: 42, [[Writable]]: false, [[Configurable]]: true}.

8.2.3 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 12.

Table 12 — Completion Record Fields

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

The term "abrupt completion" refers to any completion with a [[type]] value other than normal.

8.2.3.1 NormalCompletion

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

1. Return NormalCompletion(argument).

Is a short hand that is defined as follows:

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

8.2.3.2 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:

Deleted: 7

Deleted: aggregations

Deleted: the

Deleted: type

Deleted: a

Deleted: at

Deleted: .

Deleted: F

Deleted: ,

Deleted: fields

Deleted: why

Deleted: D

Deleted: D

Deleted: D

Deleted: F

Deleted: aggregations

Deleted: 8

Deleted: ie

Deleted: Table 12Table 10Table 11

Deleted: 1210

Deleted: .8

Deleted: 1

Deleted: I

Deleted: y

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.

8.2.3.3 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**}.

8.2.3.4 ReturnIfAbrupt

Algorithms steps that say

1. ReturnIfAbrupt(**argument**).

mean the same things as:

1. If **argument** is an abrupt completion, then return **argument**.

2. Else if **argument** is a Completion Record, then let **argument** be **argument.[[value]]**.

8.2.4 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.

A **Reference** is a resolved name 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 Number, or an environment record (10.2.1). A **base** value of **undefined** indicates that the **Reference** could not be resolved to a binding. The **referenced name** is a String.

A Super Reference is a Reference that is used to represent 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.

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.
- GetThisValue(V). Returns the **thisValue** component of the reference V.
- IsStrictReference(V). Returns the **strict reference flag** component of the reference V.
- HasPrimitiveBase(V). Returns **true** if the **base** value is a Boolean, String, or Number.
- IsPropertyReference(V). Returns **true** if either the **base** value is an object or HasPrimitiveBase(V) is **true**; otherwise returns **false**.

Deleted: the String

Deleted: s

Deleted: {**[[type]]: normal, [[value]]: String**}

Deleted: ,**[[target]]:empty**

Deleted: }

Deleted: argument

Deleted: 8.8.2 NormalCompletion¶

The abstract operation NormalCompletion with a single **argument**, such as:
The abstraction operation NormalValue with a single **argument** is a short hand that is defined as follows:
as follows:
¶

<#> If **argument** is not a Completion Record, return **argument**.¶

<#> If **argument** is an abrupt completion, return **argument**.¶

<#> Return **argument.[[value]]**.¶

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

<#> Return NormalCompletion(**argument**).¶

Is a short hand that is defined as follows:
¶

<#> Return Completion {**[[type]]: normal, [[value]]: argument, [[target]]:empty**}.¶

Deleted: 8

Deleted: 8

Deleted: ,

Deleted: ,

Deleted: ,

Deleted: .¶

Deleted: 7

Deleted: 9

Deleted: and

Deleted: .

Deleted: The behaviour of assignment could instead, be explained entirely in terms of a case analysis on the syntactic form of the left-hand operand of an assignment operator, but for operational difficulty: function calls are permitted to return references. This possibility is admitted purely for the sake of host objects. No built-in ECMAScript function defined by this specification returns a reference and there is no provision for a user-defined function to return a reference. (Another reason not to use a syntactic case analysis is that it would be lengthy and awkward, affecting many parts of the specification.)

Deleted: reference

- IsUnresolvableReference(V). Returns **true** if the *base* value is **undefined** and **false** otherwise.
- IsSuperReference(V). Returns **true** if this reference has a *thisValue* component.

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

8.2.4.1 GetValue (V)

1. ReturnIfAbrupt(V).
2. If Type(V) is not Reference, return V.
3. Let *base* be the result of calling GetBase(V).
4. If IsUnresolvableReference(V), throw a **ReferenceError** exception.
5. If IsPropertyReference(V), then
 - If HasPrimitiveBase(V) is **true**, then
 - Assert: In this case, *base* will never be **null** or **undefined**.
 - Set *base* to ToObject(*base*).
 - 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.
 - Return the result of calling the GetBindingValue (see 10.2.1) concrete method of *base* passing GetReferencedName(V) and IsStrictReference(V) as arguments.

NOTE The object that may be created in step 5.a.ii is not accessible outside of the above method. An implementation might choose to avoid the actual creation of the object.

8.2.4.2 PutValue (V, W)

1. ReturnIfAbrupt(V).
2. ReturnIfAbrupt(W).
3. If Type(V) is not Reference, throw a **ReferenceError** exception.
4. Let *base* be the result of calling GetBase(V).
5. If IsUnresolvableReference(V), then
 - If IsStrictReference(V) is **true**, then
 - Throw **ReferenceError** exception.
 - Let *globalObj* be the result of the abstract operation **GetGlobalObject**.
 - Return the result of calling **Put(globalObj, GetReferencedName(V), W, false)**.
6. Else if IsPropertyReference(V), then
 - If HasPrimitiveBase(V) is **true**, then
 - Assert: In this case, *base* will never be **null** or **undefined**.
 - Set *base* to ToObject(*base*).
 - Let *succeeded* be the result of calling the **[[Set]]** internal method of *base* passing GetReferencedName(V), W, and GetThisValue(V) as arguments.
 - ReturnIfAbrupt(*succeeded*).
 - If *succeeded* is **false** and IsStrictReference(V) is **true**, then throw a **TypeError** exception.
 - Return.
7. Else *base* must be a reference whose base is an environment record. So,
 - Return the result of calling the **SetMutableBinding** (10.2.1) concrete method of *base*, passing GetReferencedName(V), W, and IsStrictReference(V) as arguments.
8. Return.

NOTE The object that may be created in step 6.a.ii is not accessible outside of the above algorithm. An implementation might choose to avoid the actual creation of that transient object.

8.2.4.3 GetThisValue (V)

1. ReturnIfAbrupt(V).
2. If Type(V) is not Reference, return V.
3. If IsUnresolvableReference(V), throw a **ReferenceError** exception.
4. If IsSuperReference(V), then
 - Return the value of the *thisValue* component of the reference V.
5. Return GetBase(V).

Deleted: 7

Deleted: 9

Deleted: <#>Let *V* be NormalValue(*V*).¶

Deleted: false...rue, then

Deleted: let *get* be the **[[Get]]** internal method of *base*, otherwise let...ToObject(*base*)*get* be the special **[[Get]]**

Deleted: <#>If IsSuperReference(*V*) is **false**, then ¶<#>Return the result of calling the *get* as an internal method using of *base* as its *this* value, and passing GetReferencedName(*V*) for the argument.¶<#>Else,¶

Deleted: *get* as an

Deleted: P

Deleted: ...*base* must be an environment record..

Deleted: The following **[[Get]](P [, accessorThisValue])** internal method is used by **GetValue** when *V* is a proper reference with a primitive base value. It is called using *base* as the value the internal method is called upon to *this* value and with property name *P* as its argument. The following steps are taken:¶

<#>Let *O* be ToObject(*base*).¶

<#>Let *desc* be the result of calling the **[[GetProperty]]** internal method of *O* with property name *P*.¶

<#>If *desc* is **undefined**, return **undefined**.¶

<#>If *desc* is **true**, return *desc*.**[[Value]]**.¶<#>Otherwise, *IsAccessorDescriptor(desc)* must be **true** so let *getter* be *desc*.**[[Get]]** (see 8.10).¶

<#>If *getter* is **undefined**, return **undefined**.¶<#>If the *accessorThisValue* argument is not present, let *accessorThisValue* be *base*.¶<#>Return the result of calling the **[[Call]]** internal method *getter* providing *accessorThisValue* as *thisArgument* the *this* value and providing an empty List no as *argumentsList*.¶

Deleted: 7

Deleted: 9

Deleted: <#>Let *V* be NormalValue(*V*).¶

Deleted: ion

Deleted: Call

Deleted: the **[[...ut]]** internal method of... ...lobalObj the

Deleted: false

Deleted: <#> let *put* be the **[[Put]]** internal method of *base*

Deleted: Call

Deleted: the

Deleted: put

Deleted: P

Deleted: as an

Deleted: using ...*f**base* as its *this* value, and

Deleted: for the property name... *W* for the value

Deleted:)

Deleted: for the *Throw* flag

Deleted: Call

Deleted: The following **[[Put]]** internal method is used

Deleted: 9

8.2.5 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 composed of named fields where each field's name is an attribute name and its value is a corresponding attribute value as specified in 8.1.6.1. In addition, any field may be present or absent.

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 8.1.6.1 Table 5 or Table 6.

A Property Descriptor may be derived from an ECMAScript 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.

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

8.2.5.1 IsAccessorDescriptor (Desc)

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

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

8.2.5.2 IsDataDescriptor (Desc)

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

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

8.2.5.3 IsGenericDescriptor (Desc)

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

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

8.2.5.4 FromPropertyDescriptor (Desc)

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

The following algorithm assumes that `Desc` is a fully populated Property Descriptor, such as that returned from `[[GetOwnProperty]]` (see 8.12.1).

1. If `Desc` is **undefined**, then return **undefined**.
2. If `Desc` has an `[[Origin]]` field, then return `Desc.[[Origin]]`.

Deleted: 8.8 The List Specification Type

The List type is used to explain the evaluation of argument lists (see 11.2.4) in new expressions, in function calls, and in other algorithms where a simple list of values is needed. Values of the List type are simply ordered sequences of values. These sequences may be of any length.¶

8.9 The Completion Specification Type

The Completion type is used to explain the behaviour of statements (`break`, `continue`, `return` and `throw`) that perform nonlocal transfers of control. Values of the Completion type are triples of the form `(type, value, target)`, where `type` is one of `normal`, `break`, `continue`, `return`, or `throw`, `value` is any ECMAScript language value or empty, and `target` is any ECMAScript identifier or empty. If `cv` is a completion value then `cv.type`, `cv.value`, and `cv.target` may be used to directly refer to its constituent values.¶

The term "abrupt completion" refers to an completion with a type other than normal.¶

Deleted: 10

Deleted: and Property Identifier

Deleted: s

Deleted: named

Deleted: records

Deleted: For notational convenience within this specification, an object literal-like syntax can be used to define a property descriptor value. For example, Property Descriptor `{[[Value]]: 42, [[Writable]]: false, [[Configurable]]: true}` defines a data property descriptor. 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 Property Descriptor. For example, if D is a property descriptor then `D.[[Value]]` is shorthand for "the field of D named `[[Value]]`".¶

The Property Identifier type is used to associate a property name with a Property Descriptor. Values of the Property Identifier type are pairs of the form `(name, descriptor)`, where name is a String and descriptor is a Property Descriptor value.¶

Deleted: 10

Deleted: 10

Deleted: 10

Deleted: 10

3. Let *obj* be the result of the abstract operation `ObjectCreate` with the intrinsic object `%ObjectPrototype%` as its argument.
4. Assert: *obj* is an extensible ordinary object with no own properties.
5. If *Desc* has a `[[Value]]` field, then
 - a. Call `OrdinaryDefineOwnProperty` with arguments *obj*, `"value"`, and Property Descriptor `[[Value]]`: $\{[[Value]]: Desc.[[Value]], [[Writable]]: \text{true}, [[Enumerable]]: \text{true}, [[Configurable]]: \text{true}\}$
6. If *Desc* has a `[[Writable]]` field, then
 - a. Call `OrdinaryDefineOwnProperty` with arguments *obj*, `"writable"`, and Property Descriptor `[[Value]]`: $\{[[Value]]: Desc.[[Writable]], [[Writable]]: \text{true}, [[Enumerable]]: \text{true}, [[Configurable]]: \text{true}\}$
7. If *Desc* has a `[[Get]]` field, then
 - a. Call `OrdinaryDefineOwnProperty` with arguments *obj*, `"get"`, and Property Descriptor `[[Value]]`: $\{[[Value]]: Desc.[[Set]], [[Writable]]: \text{true}, [[Enumerable]]: \text{true}, [[Configurable]]: \text{true}\}$
8. If *Desc* has a `[[S]]` field, then
 - a. Call `OrdinaryDefineOwnProperty` with arguments *obj*, `"set"`, and Property Descriptor `[[Value]]`: $\{[[Value]]: Desc.[[Set]], [[Writable]]: \text{true}, [[Enumerable]]: \text{true}, [[Configurable]]: \text{true}\}$
9. If *Desc* has a `[[Enumerable]]` field, then
 - a. Call `OrdinaryDefineOwnProperty` with arguments *obj*, `"enumerable"`, and Property Descriptor `[[Value]]`: $\{[[Value]]: Desc.[[Enumerable]], [[Writable]]: \text{true}, [[Enumerable]]: \text{true}, [[Configurable]]: \text{true}\}$
10. If *Desc* has a `[[Configurable]]` field, then
 - a. Call `OrdinaryDefineOwnProperty` with arguments *obj*, `"configurable"`, and Property Descriptor `[[Value]]`: $\{[[Value]]: Desc.[[Configurable]], [[Writable]]: \text{true}, [[Enumerable]]: \text{true}, [[Configurable]]: \text{true}\}$
11. Return *obj*.

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

Deleted: ion

Deleted: (15.2)

Deleted: creating a new object as if by the expression `new Object()` where `Object` is the standard built-in constructor with that name

Deleted: If `IsDataDescriptor(Desc)` is `true`

Deleted: the `[[...rinaryDefineOwnProperty]]` internal

Deleted: the `[[...efineOwnProperty with arguments]]`

Deleted: Else, `IsAccessorDescriptor(Desc)` must be `true`

Deleted: so

Deleted: the `[[...efineOwnProperty with arguments]]`

Deleted: Get

Deleted: the `[[...efineOwnProperty with arguments]]`

Deleted: the `[[...efineOwnProperty with arguments]]`

Deleted: the `[[...efineOwnProperty with arguments]]`

Deleted: 10

12. Return *desc*.

8.2.5.6 CompletePropertyDescriptor (Desc, LikeDesc)

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

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

8.2.6 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 Clause 10.

8.3 Ordinary Object Internal Methods and Internal Data Properties

Sections 8.3-8.5 will eventually be subsections of a new toplevel section that follow the current section 10

All ordinary objects have an internal data property called [[Prototype]]. The value of this property 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 ECMAScript object has a Boolean-valued [[Extensible]] internal data property that controls whether or not properties may be added to the object. If the value of the [[Extensible]] internal data property is **false** then additional properties may not be added to the object. In addition, if [[Extensible]] is **false** the value of [[Prototype]] internal data properties of the object may not be modified. Once the value of an object's [[Extensible]] internal data property has been set to **false** it may not be subsequently changed to **true**.

In the following algorithm descriptions, assume *O* is an ordinary ECMAScript object, *P* is a property key value, *V* is any ECMAScript language value, *Desc* is a Property Description record, and *B* is a Boolean flag.

8.3.1 [[GetInheritance]] ()

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

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

8.3.2 [[SetInheritance]] (V)

When the [[SetInheritance]] internal method of *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 *extensible* be the value of the [[Extensible]] internal data property of *O*.
3. If *extensible* is **false**, then return **false**.

Deleted: Record

Deleted: Record

Deleted: Record

Deleted:)

Deleted: *d*

Deleted: 11

Deleted: 12

Deleted: Algorithms for

Comment [AWB1219]: TODO

Deleted: Whether or not an object can have an object as its [[Prototype]] depends on the implementation. Every [[Prototype]] chain must have finite length (that is, starting from any object, recursively accessing the [[Prototype]] internal property must eventually lead to a native value).

Deleted: Named *d*

Deleted: *put*

Deleted: Named *a*

Deleted: *put*

Deleted: named

Deleted: named

Deleted: ¶

Deleted: native

Deleted: String

Deleted: Throw

Deleted: *r*

4. Set the value of the `[[Prototype]]` internal data property of O to V .
5. Return `true`.

8.3.3 `[[HasIntegrity]] (Level)`

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

1. Assert: $Level$ is one of `"nonextensible"`, `"sealed"`, or `"frozen"`.
2. If $Level$ is `"nonextensible"`, then
 - a. Return the value of the `[[Extensible]]` internal data property of O
3. Return the result of `TestIntegrityLevel(O , Level)`.

Deleted: `IsExtensible`

Deleted:

Deleted: `IsExtensible`

8.3.4 `[[SetIntegrity]] (Level)`

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

1. Assert: $Level$ is one of `"nonextensible"`, `"sealed"`, or `"frozen"`.
2. Set the value of the `[[Extensible]]` internal data property of O to `false`.
3. If $Level$ is not `"nonextensible"`, then
 - a. Return the result of `SetIntegrityLevel(O , Level)`.
4. Return `true`.

Deleted: the value of the `[[Extensible]]` internal data property of O

Deleted: `1`

Deleted: `PreventExtensions`

Deleted: `PreventExtensions`

Deleted: `<#>Assert: Type(B) is Boolean.`

Deleted: `NormalCompletion(empty)`

8.3.5 `[[HasOwnProperty]] (P)`

When the `[[HasOwnProperty]]` internal method of O is called 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 `false`.
3. Return `true`.

Deleted: P is a valid property key, either a String or a Symbol Object

8.3.6 `[[GetOwnProperty]] (P)`

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

1. Return the result of `OrdinaryGetOwnProperty` with arguments O and P .

Deleted: `12`

Deleted: `1`

Deleted: `name`

8.3.6.1 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 .

Deleted: P is a valid property key, either a String or a Symbol Object

Deleted: `<#>ReturnIfAbrupt(O)`

Deleted: `n't`

Deleted: `name`

Deleted: `named`

8.3.7 `[[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:

Deleted: However, if O is a String object it has a more elaborate `[[GetOwnProperty]]` internal method defined in 15.5.5.2.

1. Return the result of OrdinaryDefineOwnProperty with arguments *O*, *P*, and *Desc*.

8.3.7.1 OrdinaryDefineOwnProperty (*O*, *P*, *Desc*)

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

1. Let *current* be the result of calling OrdinaryGetOwnProperty with arguments *O* and *P*.
2. Let *extensible* be the value of the [[Extensible]] internal data property of *O*.
3. Return the result of ValidateAndApplyPropertyDescriptor with arguments *O*, *P*, *extensible*, *Desc*, and *current*.

8.3.7.2 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 the result of ValidateAndApplyPropertyDescriptor with arguments **undefined**, **undefined**, *Extensible*, *Desc*, and *Current*.

8.3.7.3 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 preformed.

Deleted: t

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**, then return **false**.
 - b. Assert: *extensible* is **true**.
 - c. If IsGenericDescriptor(*Desc*) or IsDataDescriptor(*Desc*) is **true**, then
 - i. If *O* is not **undefined**, then 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**, then 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 (9.12).
 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**, then 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**, then 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**, then 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
 - 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 attribute field of $Desc$ that is present, set the correspondingly named 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**.

8.3.8 **[[HasProperty]](P)**

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

1. Assert: **IsPropertyKey(P)** is **true**.
2. Let $hasOwn$ be the result of calling **[[HasOwnProperty]]** internal method of O with argument P .
3. **ReturnIfAbrupt(hasOwn)**.
4. If $hasOwn$ is **false**, then
 - a. Let $parent$ be the result of calling the **[[GetInheritance]]** internal method of O .
 - b. **ReturnIfAbrupt(parent)**.
 - c. If $parent$ is not **null**, then
 - i. Return the result of calling the **[[HasProperty]]** internal method of $parent$ with argument P .
5. **Return hasOwn**.

8.3.9 **[[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 **[[GetInheritance]]** internal method of O .
 - b. **ReturnIfAbrupt(parent)**.
 - c. If $parent$ is **null**, then 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 the result of calling the **[[Call]]** internal method of $getter$ with $Receiver$ as the **thisArgument** and an empty List as $argumentsList$.

Deleted: However, if O has an **[[BuiltInBrand]]** internal data property whose value is **BuiltinArray** O also has a more elaborate **[[DefineOwnProperty]]** internal method defined in 15.4.5.1.

Deleted: 10

Comment [AWB1220]: Replaced with **ToPrimitive** changes and possible call to **@@ToPrimitive** method

Deleted: 8.3.11 **[[DefaultValue]](hint)**

When the **[[DefaultValue]]** internal method of O is called with **hint String**, the following steps are taken:

```

    // Let toString be the result of Get(O, "toString").
    // ReturnIfAbrupt(toString).
    // If IsCallable(toString) is true then:
    //   Let str be the result of calling the [[Call]] internal method of toString, with  $O$  as thisArgument and an empty List as argumentsList.
    //   ReturnIfAbrupt(str).
    //   If str is a primitive value, return str.
    //   Let valueOf be the result of Get(O, "valueOf").
    //   ReturnIfAbrupt(valueOf).
    //   If IsCallable(valueOf) is true then:
    //     Let val be the result of calling the [[Call]] internal method of valueOf, with  $O$  as thisArgument and an empty argument List.
    //     ReturnIfAbrupt(val).
    //     If val is a primitive value, return val.
    //     Throw a TypeError exception.
  
```

When the **[[DefaultValue]]** internal method of O is called with **hint Number**, the following steps are taken:

```

    Let valueOf be the result of Get(O, "valueOf").
    ReturnIfAbrupt(valueOf).
  
```

Deleted: 7

Deleted: Get

Deleted: desc

Deleted: desc

Deleted: desc

Deleted: undefined

Deleted: false

Deleted: 7

Deleted: P

Deleted: P

Deleted: name

Deleted: P

Deleted: ,

Deleted: P is a valid property key, either a String or a Symbol Object

Deleted: the **[[]**

Deleted: OrdinaryGetOwnProperty

Deleted: **]]** internal method of

Deleted: s

Deleted: O with property name and

Deleted: return **undefined**.

Deleted: P

Deleted: s

Deleted: targetThis

8.3.10 [[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 [[GetInheritance]] 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. If Type(Receiver) is not Object, return false.
 - ii. Return the result of performing CreateOwnDataProperty(Receiver, P, V).
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 Property Descriptor {[[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 the result of performing CreateOwnProperty(Receiver, P, V).
6. If IsAccessorDescriptor(ownDesc) is true, then
 - a. Let setter be ownDesc.[[Set]].
 - b. If setter is undefined, return false.
 - c. Let setterResult be the result of calling the [[Call]] internal method of setter providing Receiver as thisArgument and a new List containing V as argumentsList.
 - d. ReturnIfAbrupt(setterResult).
 - e. Return true.

8.3.11 [[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. If desc is undefined, then return true.
4. If desc.[[Configurable]] is true, then
 - a. Remove the own property with name P from O.
 - b. Return true.
5. Return false.

8.3.12 [[Enumerate]] ()

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

1. Return an Iterator object (reference xxxx) whose next method iterates over all the keys of enumerable property keys of O. The mechanics and order of enumerating the properties is not specified but must conform to the rules specified below.

Enumerated properties do not include properties whose property key is a Symbol. Properties of the object being enumerated may be deleted during enumeration. If a property that has not yet been visited during

Deleted: 8
Deleted: Put]
Deleted: P
Deleted: Throw
Deleted: Put
Deleted: P
Deleted: and Boolean flag Throw
Deleted: P is a valid property key, either a String or a Symbol.
Deleted: <#>If the result of calling the [[CanPut]] internal method of O is false, then throw a ReferenceError exception.
Deleted: Ordinary[[GetOwnProperty]] internal method of O.
Deleted: [] internal method of O.
Deleted: s...O with argument and receiver.
Deleted: desc
Deleted: P
Deleted: s
Deleted: <#>Let newDesc be the Property Descriptor {[[Value]]: V}.
Deleted: SameValue(O, Receiver)...is not true.
Deleted: the [[DefineOwnProperty]] internal method of O.
Deleted: Ordinary[[GetOwnProperty]] internal method of O.
Deleted: JJJ internal method of O.
Deleted: OO passing , ..., receiver.
Deleted: ...valueDesc, and Throw as argument.
Deleted: O and ...receiver are different values.
Deleted: <#>If Type(Receiver) is not Object, then throw a TypeError exception.
Deleted: <#>Let desc be the result of calling the [[GetOwnProperty]] internal method of O with argument P.
Deleted: desc
Deleted: desc
Deleted: which cannot be undefined.
Deleted: <#>If accessorThisValue is not present, then throw a ReferenceError exception.
Deleted: Else create a named data property named accessorThisValue.
Comment [AWB621]: Need to decide what to do with accessorThisValue.
Comment [AWB622]: TODO replace with accessorThisValue.
Deleted: Let newDesc be the Property Descriptor {[[Value]]: V}.
Deleted: 8.3.9 [[HasProperty]] (P)¶
Deleted: 8.12.5 [[Put]] (P, V, Throw, ¶)
Deleted: Return.¶
Deleted: 8.12.6 [[HasProperty]] (P)¶
Deleted: 12....7
Deleted: 9
Deleted: , Throw
Deleted: name ...ey P and the Boolean flag Throw.
Deleted: P is a valid property key, either a String or a Symbol.
Deleted: <#>ReturnIfAbrupt(O).¶
Deleted: the [[GetOwnProperty]] internal method of O.
Deleted: OrdinaryGetOwnProperty internal method of O.
Deleted: [] internal method of O.
Deleted: s...O with property name and receiver.
Deleted: <#>Else if Throw, then throw a ReferenceError exception.
Comment [AWB623]: TODO.
Comment [AWB624]: TODO: Finish this up.
Deleted: 8.3.910 [[DefineOwnProperty]] (P, V, Throw, ¶)
Deleted: 1
Comment [AWB625]: TODO.

enumeration is deleted, then it will not be visited. If new properties are added to the object being enumerated during enumeration, the newly added properties are not guaranteed to be visited in the active enumeration. A property name must not be visited more than once in any enumeration.

Enumerating the properties of an object includes enumerating properties of its prototype, and the prototype of the prototype, and so on, recursively; but a property of a prototype is not enumerated if it is “shadowed” because some previous object in the prototype chain has a property with the same name. The values of `[[Enumerable]]` attributes are not considered when determining if a property of a prototype object is shadowed by a previous object on the prototype chain.

The following is an informative algorithm that conforms to these rules

1. Let `obj` be `O`.
2. Let `proto` be the result of calling the `[[GetInheritance]]` internal method of `O` with no arguments.
3. ReturnIfAbrupt(`proto`).
4. If `proto` is the value `null`, then
 - a. Let `propList` be a new empty List.
5. Else
 - a. Let `propList` be the result of calling the `[[Enumerate]]` internal method of `proto`.
6. ReturnIfAbrupt(`propList`).
7. For each `name` that is the property key of an own property of `O`
 - a. If `Type(name)` is `String`, then
 - i. Let `desc` be the result of calling `OrdinaryGetOwnProperty` with arguments `O` and `name`.
 - ii. If `name` is an element of `propList`, then remove `name` as an element of `propList`.
 - iii. If `desc.Enumerable` is `true`, then add `name` as an element of `propList`.
8. Order the elements of `propList` in an implementation defined order.
9. Return `propList`.

8.3.13 `[[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`
 - a. If `P` is not a private `Symbol`, then
 - i. Add `P` as the last element of `keys`.
3. Return `MakeListIterator(keys)`.

8.3.14 `ObjectCreate(proto, internalDataList)` 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 `internalDataList` is a List of the names of internal data property names that should be defined as part of the object. If the list is not provided, an empty List is used. It performs the following steps:

1. If `proto` was not provided, let `proto` be the intrinsic `%ObjectPrototype%`.
2. Let `obj` be a newly created ECMAScript object with an internal data property for each name in `internalDataList`.
3. Set `obj`'s essential internal methods to the default ordinary object definitions specified in 8.3.
4. Set the `[[Prototype]]` internal data property of `obj` to `proto`.
5. Set the `[[Extensible]]` internal data property of `obj` to `true`.
6. Return `obj`.

8.3.15 Ordinary Function Objects

Ordinary function objects encapsulate parameterised ECMAScript code closed over a lexical environment and support the dynamic evaluation of that code. An ordinary function object is an ordinary object and has the same internal data properties and (except as noted below) the same internal methods as other ordinary objects.

Comment [AWB626]: TODO: Finish this up, and turn into iterator definition include a next method.

The algorithm is also confused about `[[Enumerate]]` call on proto returning a list or iterator. See https://bugs.ecmascript.org/show_bug.cgi?id=944

Deleted: 8.123.112 `[[IterateKeys]]()`

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

```
<#>Let result be a new empty List.  
<#>If Type(O) is not Object, return result.  
<#>For each own property key P of O  
<#>If Type(P) is String, then  
<#>Let desc be the result of calling OrdinaryGetOwnProperty with arguments O and P.  
<#>If desc.Enumerable is true, then  
<#>Add P as the last element of result.  
<#>Return result.  
<#>Let itr be the result of performing Invoke with argument %iterator%, O and an empty argument List.  
<#>Return itr.
```

If an implementation defines a specific order of enumeration for the for-in statement, that same enumeration order must be used in step 5 of this algorithm.

Deleted: `result`

Deleted: <#>If `Type(O)` is not Object, return `result`.

Deleted: `result`

Comment [AWB1327]: TODO: need to define, return an iterator object over the elements of an internal list.

Deleted: `result`

Deleted: 8.3.14 `[[Freeze]]()`

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

```
<#>Return the result of MakeObjectSecure(O, true).
```

8.3.15 `[[Seal]]()`

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

```
<#>Return the result of MakeObjectSecure(O, false).
```

8.3.16 `[[IsFrozen]]()`

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

```
<#>Return the result of TestIfSecureObject(O, true).
```

8.3.17 `[[IsSealed]]()`

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

```
<#>Return the result of TestIfSecureObject(O, false).
```

Deleted: 8

Deleted: optional

Deleted: 9

Deleted: z

Ordinary function objects have the additional internal data properties listed in Table 13. They also have a `[[BuiltInBrand]]` internal data property whose value is `BuiltinFunction`.

Ordinary function objects provide alternative definitions for the `[[Get]]` and `[[GetOwnProperty]]` internal methods. These alternatives prevent the value of strict mode function from being revealed as the value of a function object property named "caller". These alternative definitions exist sole 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 these alternative internal methods for ordinary function objects.

Deleted: P

Table 13 -- Internal Data Properties of Ordinary Function Objects

Internal Data Property	Type	Description
<code>[[Scope]]</code>	<code>Lexical Environment</code>	The Lexical Environment that the function was closed over. Is used as the outer environment when evaluating the code of the function.
<code>[[FormalParameters]]</code>	<code>Parse Node</code>	The root parse node of the source code that defines the function's formal parameter list.
<code>[[Code]]</code>	<code>Parse Node</code>	The root parse node of the source code that defines the function's body.
<code>[[Realm]]</code>	<code>Realm Record</code>	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>	<code>(lexical, strict, global)</code>	Defines how <code>this</code> references are interpreted within the formal parameters and code body of the function. <code>lexical</code> means that <code>this</code> refers to the <code>this</code> value of a lexically enclosing function. <code>strict</code> means that the <code>this</code> value is used exactly as provided by an invocation of the function. <code>global</code> means that a <code>this</code> value of <code>undefined</code> is interpreted as a reference to the global object.
<code>[[Strict]]</code>	<code>Boolean</code>	<code>true</code> if this is a strict mode function, <code>false</code> if this is not a strict mode function.
<code>[[Home]]</code>	<code>Object</code>	If the function uses <code>super</code> , this is the object whose <code>[[GetInheritance]]</code> provides the object where <code>super</code> property lookups begin. Not present for functions that don't reference <code>super</code> .
<code>[[MethodName]]</code>	<code>String or Symbol</code>	If the function uses <code>super</code> , this is the property keys that is used for unqualified references to <code>super</code> . Not present for functions that don't reference <code>super</code> .

Ordinary function objects all have the `[[Call]]`, `[[Get]]` and `[[GetOwnProperty]]` internal methods defined here. Ordinary functions that are also constructors in addition have the `[[Construct]]` internal method.

Deleted: P

8.3.15.1 `[[Call]]` Internal Method

The `[[Call]]` internal method for an ordinary 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, then Suspend `callerContext`.
3. Let `calleeContext` be a new ECMAScript Code execution context.
4. Let `calleeRealm` be the value of F 's `[[Realm]]` internal data property.
5. Set `calleeContext`'s Realm `calleeRealm`.
6. Let `thisMode` be the value of F 's `[[ThisMode]]` internal data property.
7. If `thisMode` is `lexical`, then
 - a. Let `localEnv` be the result of calling `NewDeclarativeEnvironment` passing the value of the `[[Scope]]` internal data property of F as the argument.
8. Else,

Deleted: 9

- a. If *thisMode* is strict, set *thisValue* to *thisArgument*.
- b. Else
 - i. if *thisArgument* is null or undefined, then
 1. Set *thisValue* to *calleeRealm*.[[globalThis]].
 - ii. Else if Type(*thisArgument*) is not Object, set the *thisValue* to ToObject(*thisArgument*).
 - iii. Else set the *thisValue* to *thisArgument*.
 - c. Let *localEnv* be the result of calling NewFunctionEnvironment passing *F* and *thisValue* as the arguments.
9. Set the LexicalEnvironment of *calleeContext* to *localEnv*.
10. Set the VariableEnvironment of *calleeContext* to *localEnv*.
11. Push *calleeContext* on to the execution context stack; *calleeContext* is now the running execution context.
12. Let *status* be the result of performing Function Declaration Instantiation using the function *F*, *argumentsList* and *localEnv* as described in [10.5.3].
13. 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*.
14. Let *result* be the result of evaluating the *FunctionBody* that is the value of *F*'s [[Code]] internal data property.
15. Remove *calleeContext* from the execution context stack and restore *callerContext* as the running execution context.
16. Return *result*.

NOTE Most ordinary functions use a Function Environment Record as their LexicalEnvironment. Ordinary functions that are arrow functions use a Declarative Environment Record as their LexicalEnvironment.

8.3.15.2 [[Construct]] Internal Method

The [[Construct]] internal method for an ordinary Function object *F* is called with a single parameter *argumentsList* which is a possibly empty List of ECMAScript language values. The following steps are taken:

1. Return the result of OrdinaryConstruct(*F*, *argumentsList*).

8.3.15.2.1 OrdinaryConstruct (*F*, *argumentsList*)

When the abstract operation OrdinaryConstruct is called with Object *F* and List *argumentsList* the following steps are taken:

1. Let *creator* be the result of Get(*F*, @@create).
2. ReturnIfAbrupt(*creator*).
3. If *creator* is not undefined, then
 - a. If IsCallable(*creator*) is false, then throw a **TypeError** exception.
 - b. Let *obj* be the result of calling the [[Call]] internal method of *creator* with arguments *F* and an empty List.
4. Else *creator* is undefined so fall back to object creation defaults
 - a. Let *obj* be the result of calling OrdinaryCreateFromConstructor(*F*, "%ObjectPrototype%").
5. ReturnIfAbrupt(*obj*).
6. Let *result* be the result of calling the [[Call]] internal method of *F*, providing *obj* and *argumentsList* as the arguments.
7. ReturnIfAbrupt(*result*).
8. If Type(*result*) is Object then return *result*.
9. Return *obj*.

8.3.15.3 [[Get]] (*P*, *Receiver*)

When the [[Get]] internal method of ordinary function object *F* is called with property key *P* and ECMAScript language value *Receiver* the following steps are taken:

1. Let *v* be the result of calling the default ordinary object [[Get]] internal method (8.3.7) on *F* passing *P* and *Receiver* as arguments.
2. ReturnIfAbrupt(*v*).
3. If *P* is "caller" and *v* is a strict mode Function object, return null.

Comment [AWB 328]: May need to update section number

Deleted: <#>If *result.type* is return then return NormalCompletion(*result.[[value]]*).¶

Deleted: 9

Deleted: with arguments

Deleted: and

Deleted: 9

Deleted: , fallBackProto

Comment [AWB1429]: At Jan 29, 2012 TC39 serve people suggest that this fall back was unnecessary complexity and that it should this throw. However, that means that a ordinary function whose __proto__ is set undefined will throw if newed. I'm not sure that is desirable. It's a breaking change for the reality web.

Deleted: <#>Let *proto* be the result of Get(*F*, "prototype").¶

<#>ReturnIfAbrupt(*proto*).¶

<#>If Type(*proto*) is Object, let *obj* be the result of the abstract operation ObjectCreate with argument *proto*.¶

<#>Else, let *obj* be the result of the abstract operation ObjectCreate.¶

Deleted: NormalCompletion(

Deleted:)

Deleted: 9

Deleted: P

Deleted: P

Deleted: P

Deleted: undefined

4. Return v .

8.3.19.4 [[GetOwnProperty]] (P)

When the $[[GetOwnProperty]]$ internal method of ordinary function object F is called with property key P , the following steps are taken:

1. Let v be the result of calling the default ordinary object $[[GetOwnProperty]]$ internal method (8.3.6) on F passing P as the argument.
2. ReturnIfAbrupt(v).
3. If $\text{IsDataDescriptor}(v)$ is **true**, then
 - a. If P is "**caller**" and $v.[[Value]]$ is a strict mode Function object, then
 - i. Set $v.[[Value]]$ to **null**.
4. Return v .

Deleted: `undefined`

Deleted: $v.[[Value]]$

8.4 Built-in Exotic Object Internal Methods and Data Fields

This specification defines several kinds of built-in exotic objects. These objects generally behave similar to ordinary objects except for a few specific situations. The following exotic objects use the ordinary object internal methods except where it is explicitly specified otherwise below:

Deleted: `t`

Deleted: `at`

8.4.1 Bound Function Exotic Objects

A *bound function* is an exotic object that wraps another function object. A bound function is callable (it has $[[Call]]$ and $[[Construct]]$ internal methods). Calling a bound function generally results in a call of its wrapped function.

Bound function objects do not have the internal data properties of ordinary function objects defined in Table 13. Instead they have the internal data properties defined in Table 14. They also have a $[[BuiltinBrand]]$ internal data property whose value is **BuiltinFunction**.

Table 14 – Internal Data Properties of Exotic Bound Function Objects

Deleted: 1412

Internal Data Property	Type	Description
$[[BoundTargetFunction]]$	Callable Object	The wrapped function object.
$[[BoundThis]]$	Any	The value that is always passed as the this value when calling the wrapped function.
$[[BoundArguments]]$	List of Any	A list of values that whose elements are used as the first arguments to any call to the wrapped function.

Deleted: P

Unlike ordinary function objects, bound function objects do not use alternative definitions of the $[[Get]]$ and $[[GetOwnProperty]]$ internal methods. Bound function objects provide all of the essential internal methods as specified in 8.3. However, they use the following definitions for the essential internal methods of function objects.

8.4.1.1 [[Call]]

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 $boundArgs$ be the value of F 's $[[BoundArguments]]$ internal data property.
2. Let $boundThis$ be the value of F 's $[[BoundThis]]$ internal data property.
3. Let $target$ be the value of F 's $[[BoundTargetFunction]]$ internal data property.
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 the result of calling the $[[Call]]$ internal method of $target$ providing $boundThis$ as $thisArgument$ and providing $args$ as $argumentsList$.

8.4.1.2 [[Construct]]

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 $ExtraArgs$, the following steps are taken:

1. Let $target$ be the value of F 's `[[BoundTargetFunction]]` internal data property.
2. If $target$ has no `[[Construct]]` internal method, a `TypeError` exception is thrown.
3. Let $boundArgs$ be the value of F 's `[[BoundArguments]]` internal data property.
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 $ExtraArgs$ in the same order.
5. Return the result of calling the `[[Construct]]` internal method of $target$ providing $args$ as the arguments.

8.4.1.3 BoundFunctionCreate Abstract Operation

The abstract operation `BoundFunctionCreate` with arguments $targetFunction$, $boundThis$ and $boundArgs$ is used to specify the creation of new Object objects. It performs the following steps:

1. Let $proto$ be the intrinsic `%FunctionPrototype%`.
2. Let obj be a newly created ECMAScript object.
3. Set obj 's essential internal methods to the default ordinary object definitions specified in 8.3.
4. Set the `[[Call]]` internal method of obj as described in 8.4.1.1.
5. Set the `[[Construct]]` internal method of obj as described in 8.4.1.2.
6. Set the `[[Prototype]]` internal data property of obj to $proto$.
7. Set the `[[Extensible]]` internal data property of obj to `true`.
8. Set the `[[BoundTargetFunction]]` internal data property of obj to $targetFunction$.
9. Set the `[[BoundThis]]` internal data property of obj to the value of $boundThis$.
10. Set the `[[BoundArguments]]` internal data property of obj to $boundArgs$.
11. Add the `[[BuiltinBrand]]` internal data property with value `BuiltinFunction` to obj .
12. Return obj .

8.4.2 Array Exotic Objects

An `Array` object is an exotic object that gives special treatment to a certain class of property names. A property name P (in the form of a String value) is an `array index` if and only if `ToString(ToUint32(P))` is equal to P and `ToUint32(P)` is not equal to $2^{32}-1$. A property whose property name is an array index is also called an `element`. Every `Array` object has a `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 property whose name is an array index; whenever a property of an `Array` object is created or changed, other properties are adjusted as necessary to maintain this invariant. Specifically, whenever a property is added whose name is an array index, the `length` property is changed, if necessary, to be one more than the numeric value of that array index; and whenever the `length` property is changed, every property whose name is an array index whose value is not smaller than the new length is automatically 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.

Exotic `Array` objects have the same internal data properties as ordinary objects. They also have an `[[ArrayInitializationState]]` internal data property.

Exotic `Array` objects always have a non-configurable property named "`length`".

Exotic `Array` objects provide alternative definitions for the `[[Set]]` and `[[DefineOwnProperty]]` internal methods. Except for these two internal methods, exotic `Array` objects provide all of the other essential internal methods as specified in 8.3.

8.4.2.1 [[DefineOwnProperty]] (P , $Desc$)

When the `[[DefineOwnProperty]]` internal method of an exotic `Array` object A is called with property P , and Property Descriptor $Desc$ the following steps are taken:

1. Assert: `IsPropertyKey(P)` is `true`.

Deleted: the

Deleted: F

Deleted: Array objects

Deleted: Exotic `Array` objects have the same internal data properties as ordinary objects. They also have a `[[BuiltinBrand]]` internal data property whose value is `BuiltinArray`.¶

Deleted: P

Deleted: 8.4.2.1 `[[SetP]] (P , V , $Receiver$)`

When the `[[SetP]]` internal method of an exotic `Array` object O is called with property key P , value V , and ECMAScript language value $Receiver$, the following steps are taken:¶

<#>Assert: P is a valid property key, either a String or a Symbol Object.¶

<#>Let $ownDesc$ be the result of calling `OrdinaryGetOwnProperty` with arguments O and P .¶

<#>Return `IfAbrupt(ownDesc)`.¶

<#>If $desc$ is `undefined`, then¶

<#>Let $parent$ be the result of calling the `[[GetInheritance]]` internal method of O .¶

<#>Return `IfAbrupt(parent)`.¶

<#>If $parent$ is not `null`, then¶

<#>Return the result of calling the `[[SetP]]` internal method of $parent$ with arguments P , V , and $Receiver$.¶

<#>Else,¶

<#>If `Type(Receiver)` is not `Object`, return `false`.¶

<#>Return the result of performing `CreateOwnDataProperty(Receiver, P, V)`.¶

<#>If `IsDataDescriptor(ownDesc)` is `true`, then¶

<#>If $ownDesc.[[Writable]]$ is `false`, return `false`.¶

<#>If `SameValue(O, Receiver)` is `true`, then¶

<#>Let $valueDesc$ be the Property Descriptor `{[[Value]]: V}`.¶

<#>If P is `"length"`, then¶

<#>Return the result of calling `ArraySetLength` with arguments O , and $valueDesc$.¶

<#>Else,¶

<#>Return the result of calling `OrdinaryDefineOwnProperty` with arguments O , P , and $valueDesc$.¶

<#>Else O and $Receiver$ are different values,¶

<#>If `Type(Receiver)` is not `Object`, return `false`.¶

<#>Return the result of performing `CreateOwnDataProperty(Receiver, P, V)`.¶

<#>If `IsAccessorDescriptor(desc)` is `true`, then¶

<#>Let $setter$ be $desc.[[Set]]$.¶

<#>If $setter$ is `undefined`, return `false`.¶

<#>Let $setterResult$ be the result of calling the `[[Call]]` internal method of $setter$ providing $Receiver$ as `thisArgument` and a List containing V as `argumentsList`.¶

<#>Return `IfAbrupt(setterResult)`.¶

<#>Return `true`.¶

NOTE . This algorithm differs from the ordinary object `[[SetP]]` algorithm only in the handling of properties with the name "length" in step 5.b.ii.1.¶

Deleted: 2

Deleted: P is a valid property key, either a String or a Symbol Objec

2. If P is "`length`", then
 - a. Return the result of calling `ArraySetLength` with arguments A , and $Desc$.
3. Else if P is an array index, then
 - a. 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.
 - b. Let $oldLen$ be $oldLenDesc.[[Value]]$.
 - c. Let $index$ be `ToUint32(P)`.
 - d. ReturnIfAbrupt($index$).
 - e. If $index > oldLen$ and $oldLenDesc.[[Writable]]$ is `false`, then return `false`.
 - f. Let $succeeded$ be the result of calling `OrdinaryDefineOwnProperty` passing A , P , and $Desc$ as arguments.
 - g. ReturnIfAbrupt($succeeded$).
 - h. If $succeeded$ is `false`, then return `false`.
 - i. If $index > oldLen$
 - i. Set $oldLenDesc.[[Value]]$ to $index + 1$.
 - ii. Let $succeeded$ be the result of calling `OrdinaryDefineOwnProperty` passing A , "`length`", and $oldLenDesc$ as arguments.
 - iii. ReturnIfAbrupt($succeeded$).
 - j. Return `true`.
4. Return the result of calling `OrdinaryDefineOwnProperty` passing A , P , and $Desc$ as arguments.

Deleted: Reject i

8.4.2.3 ArrayCreate Abstract Operation

The abstract operation `ArrayCreate` with argument `length` (a positive integer or `undefined`) and optional argument `proto` is used to specify the creation of new exotic Array objects. It performs the following steps:

1. If the `proto` argument was not passed, then let `proto` be the intrinsic object `%ArrayPrototype%`.
2. Let A be a newly created `Array` exotic object.
3. Set A 's essential internal methods to the default ordinary object definitions specified in 8.3.
4. Set the `[[DefineOwnProperty]]` internal method of A as specified in 8.4.2.1.
5. Set the `[[Prototype]]` internal data property of A to `proto`.
6. Set the `[[Extensible]]` internal data property of A to `true`.
7. If `length` is not `undefined`, then
 - a. Set the `[[ArrayInitializationState]]` internal data property of A to `true`.
8. Else
 - a. Set the `[[ArrayInitializationState]]` internal data property of A to `false`.
 - b. Let `length` be 0.
9. Call `OrdinaryDefineOwnProperty` with arguments A , "`length`" and Property Descriptor `{[[Value]]: length, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: false}`.
10. Return A .

Deleted: ECMAScript**Deleted:** <#>Set the `[[SetP]]` internal method as specified in 8.4.2.1.**Deleted:** 2**Deleted:** the intrinsic object `%ArrayPrototype%`**Deleted:** <#>Set the `[[BuiltInBrand]]` internal property of A to the value `BuiltinArray`.¶**Deleted:** 0**Deleted:** 3

8.4.2.4 ArraySetLength Abstract Operation

When the abstract operation `ArraySetLength` is called with an exotic Array object A , and Property Descriptor $Desc$ the following steps are taken:

1. If the `[[Value]]` field of $Desc$ is absent, then
 - a. Return the result of calling `OrdinaryDefineOwnProperty` passing A , "`length`", and $Desc$ as arguments.
2. Let $newLenDesc$ be a copy of $Desc$.
3. Let $newLen$ be `ToUint32($Desc.[[Value]]$)`.
4. If $newLen$ is not equal to `ToNumber($Desc.[[Value]]$)`, throw a `RangeError` exception.
5. Set $newLenDesc.[[Value]]$ to $newLen$.
6. 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.
7. Let $oldLen$ be $oldLenDesc.[[Value]]$.
8. If $newLen > oldLen$, then

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.¶
 <#>Let $oldLen$ be $oldLenDesc.[[Value]]$.¶

Comment [AWB1430]: Note that if `[[Value]]` is an object this sequence will call its `valueOf` method twice. That seems undesirable, but it's the legacy behaviour going back to at least E

Comment [AWB1431]: See bug https://bugs.ecmascript.org/show_bug.cgi?id=200 for why these two lines moved.

- a. Return the result of calling OrdinaryDefineOwnProperty passing A , `"length"`, and $newLenDesc$ as arguments.
9. If $oldLenDesc.[[Writable]]$ is `false`, then return `false`.
10. If $newLenDesc.[[Writable]]$ is absent or has the value `true`, let $newWritable$ be `true`.
11. 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`.
12. Let $succeeded$ be the result of calling OrdinaryDefineOwnProperty passing A , `"length"`, and $newLenDesc$ as arguments.
13. ReturnIfAbrupt($succeeded$).
14. If $succeeded$ is `false`, return `false`.
15. 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. ReturnIfAbrupt($succeeded$).
 - 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 the result of calling OrdinaryDefineOwnProperty passing A , `"length"`, and $newLenDesc$ as arguments.
 - iv. ReturnIfAbrupt($succeeded$).
 - v. Return `false`.
16. If $newWritable$ is `false`, then
 - a. Call OrdinaryDefineOwnProperty passing A , `"length"`, and Property Descriptor $\{[[Writable]]: false\}$ as arguments. This call will always return `true`.
17. Return `true`.

8.4.3 String Exotic Objects

A `String` object is an exotic object that encapsulates a `String` value and exposes virtual array index 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 data properties as ordinary objects. They also have a `[[StringData]]` internal data property.

Deleted: and a `[[BuiltInBrand]]` internal data property whose value is `BuiltinStringWrapper`

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 8.3.

8.4.3.1 `[[HasOwnProperty]](P)`

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

1. Assert: `IsPropertyKey(P)` is `true`.
2. Let has be the result of calling the ordinary object `[[HasOwnProperty]]` internal method (8.3.5) on O with argument P .
3. ReturnIfAbrupt(has).
4. If has is `true`, then return `true`.
5. Let $index$ be `ToInteger(P)`.
6. ReturnIfAbrupt($index$).
7. Let $absIntIndex$ be `ToString(abs(index))`.
8. ReturnIfAbrupt($absIntIndex$).
9. If `SameValue(absIntIndex, P)` is `false` return `false`.
10. Let str be the `String` value of the `[[StringData]]` internal property of O .

Deleted: Assert: P is a valid property key, either a `String` or `Symbol` Object.

11. Let `len` be the number of elements in `str`.
12. If `len < index`, return `false`.
13. Return `true`.

8.4.3.2 `[[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 the result of `OrdinaryGetOwnProperty(S, P)`.
3. **ReturnIfAbrupt(desc)**.
4. If `desc` is not `undefined` return `desc`.
5. Let `index` be `ToInteger(P)`.
6. **ReturnIfAbrupt(index)**.
7. Let `absIntIndex` be `ToString(abs(index))`.
8. **ReturnIfAbrupt(absIntIndex)**.
9. If `SameValue(absIntIndex, P)` is `false` return `undefined`.
10. Let `str` be the String value of the `[[StringData]]` internal data property of `S`.
11. Let `len` be the number of elements in `str`.
12. If `len ≤ index`, return `undefined`.
13. Let `resultStr` be a String value of length 1, containing one code unit from `str`, specifically the code unit at position `index`, where the first (leftmost) element in `str` is considered to be at position 0, the next one at position 1, and so on.
14. Return a Property Descriptor { `[[Value]]: resultStr, [[Enumerable]]: true, [[Writable]]: false, [[Configurable]]: false }.`

8.4.3.3 `[[DefineOwnProperty]] (P, Desc)`

When the `[[DefineOwnProperty]]` internal method of an exotic String object `O` is called with property `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. Let `extensible` be the value of the `[[Extensible]]` internal data property of `O`.
3. Return the result of `ValidateAndApplyPropertyDescriptor` with arguments `O, P, extensible, Desc, and current`.

NOTE This algorithm differs from the ordinary object `OrdinaryDefineOwnProperty` abstract operation algorithm only in invocation of `[[GetOwnProperty]]` in step 1.

8.4.3.4 `[[Enumerate]] ()`

When the `[[Enumerate]]` internal method of an exotic String object `O` is called the following steps are taken:

8.4.3.5 `[[OwnPropertyKeys]] ()`

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

8.4.6.6 StringCreate Abstract Operation

The abstract operation `StringCreate` with argument `prototype` (is used to specify the creation of new exotic String objects. It performs the following steps:

1. Let `A` be a newly created String exotic object.
2. Set `A`'s essential internal methods to the default ordinary object definitions specified in 8.3.
3. Set the `[[HasOwnProperty]]` internal method of `A` as specified in 8.4.3.1.
4. Set the `[[GetOwnProperty]]` internal method of `A` as specified in 8.4.3.2.
5. Set the `[[DefineOwnProperty]]` internal method of `A` as specified in 8.4.3.3.
6. Set the `[[Enumerate]]` internal method of `A` as specified in 8.4.3.4.

Deleted: `P` is a valid property key, either a String or a Symbol Object

Deleted: calling the default `[[GetOwnProperty]]` internal method (8.12.1) on

Deleted: with argument

Deleted: `ToString(abs(ToInteger(P)))` is not the same value as

Deleted: ,

Deleted: <#>Let `index` be `ToInteger(P)`.¶

Deleted: ¶

<#>8.4.3.3 `[[GetP]] (P, Receiver)`
When the `[[GetP]]` internal method of exotic String object `O` is called with property key `P` and ECMAScript language value `Receiver` the following steps are taken:
Assert: `P` is a valid property key, either a String or Symbol Object.¶

Let `desc` be the result of calling the `[[GetOwnProperty]]` internal method of `O` with argument `P`.¶

ReturnIfAbrupt(desc).¶

If `desc` is `undefined`, then¶

Let `parent` be the result of calling the `[[GetInheritance]]` internal method of `O`.¶

ReturnIfAbrupt(parent).¶

If `parent` is `null`, then return `undefined`.¶

Return the result of calling the `[[GetP]]` internal methods of `parent` with arguments `P` and `Receiver`. If `IsDataDescriptor(desc)` is `true`, return `desc.[[Value]]`.¶

Otherwise, `IsAccessorDescriptor(desc)` must be `true`, so, let `getter` be `desc.[[Get]]`.¶

If `getter` is `undefined`, return `undefined`.¶

Return the result of calling the `[[Call]]` internal method of `getter` with `targetThis` as the `thisArgument` and an empty List as `argumentsList`.¶

NOTE This algorithm differs from the ordinary object `[[SetP]]` algorithm only in invocation of `[[GetOwnProperty]]` in step 2.

Deleted: 8.4.3.4 `[[Delete]] (P)`¶

When the `[[Delete]]` internal method of exotic String object `O` is called with property name `P` the following steps are taken:
¶

<#>Assert: `P` is a valid property key, either a String or a Symbol Object.¶

<#>Let `desc` be the result of calling the `[[GetOwnProperty]]` internal method of `O` with argument `P`.¶

<#>If `desc` is `undefined`, then return `true`.¶

Deleted: 5

Deleted: Let `extensible` be the result of calling the `[[GetIsExtensible]]` internal method of `O`.

Deleted: and `[[IsExtensible]]` in step 2

Comment [AWB1232]: TODO

Deleted: 6

Deleted: ¶
8.4.3.7 `[[Keys]] ()`

Comment [AWB1233]: TODO

Deleted: When the `[[Keys]]` internal method of an exotic String object `O` is called the following steps are taken:
¶

Deleted: 8

Comment [AWB1334]: TODO

7. Set the `[[OwnPropertyKeys]]` internal method of *A* as specified in 8.4.3.5.
8. Set the `[[Prototype]]` internal data property of *A* to `prototype`.
9. Set the `[[Extensible]]` internal data property of *A* to `true`.
10. Return *A*.

8.4.4 Exotic Symbol Objects

A `Symbol` object is an exotic object that may be used as a property key. Symbol exotic objects are unique in that they are always immutable and never observably reference any other object.

Deleted: n

Exotic String objects have a single internal data properties named `[[Private]]` that is set when the object is created and never modified.

Deleted: the

Exotic Symbol objects provide alternative definitions for all of the essential internal methods.

8.4.4.1 `[[GetInheritance]]()`

When the `[[GetInheritance]]` internal method of an exotic Symbol object *O* is called the following steps are taken:

1. Return `null`.

8.4.4.2 `[[SetInheritance]](V)`

When the `[[SetInheritance]]` internal method of an exotic Symbol 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`.

8.4.4.3 `[[HasIntegrity]](Level)`

When the `[[HasIntegrity]]` internal method of an exotic Symbol object *O* is called the following steps are taken:

1. Assert: *Level* is one of "nonextensible", "sealed", or "frozen".
2. Return `true`.

Deleted: `[[IsExtensible]]()`

Deleted: IsExtensible

Deleted: false

8.4.4.4 `[[SetIntegrity]](Level)`

When the `[[SetIntegrity]]` internal method of an exotic Symbol object *O* is called the following steps are taken:

1. Assert: *Level* is one of "nonextensible", "sealed", or "frozen".
2. Return `true`.

Deleted: PreventExtensions

Deleted: NormalCompletion(empty)

8.4.4.5 `[[HasOwnProperty]](P)`

When the `[[HasOwnProperty]]` internal method of an exotic Symbol object *O* is called with property key *P*, the following steps are taken:

1. Return `false`.

Deleted: ,

8.4.4.6 `[[GetOwnProperty]](P)`

When the `[[GetOwnProperty]]` internal method of an exotic Symbol object *O* is called with property key *P*, the following steps are taken:

1. Return `undefined`.

8.4.4.7 [[DefineOwnProperty]] (P, Desc)

When the `[[DefineOwnProperty]]` internal method of an exotic Symbol object O is called with property key P and property descriptor $Desc$, the following steps are taken:

1. Return `false`.

8.4.4.8 [[HasProperty]] (P)

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

1. Return `false`.

8.4.4.9 [[Get]] (P, Receiver)

When the `[[Get]]` internal method of an exotic Symbol 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 P is `"toString"`, then
 - a. Let ctx be the running execution context.
 - b. Let $ctxRealm$ be ctx 's Realm component.
 - c. Return $ctxRealm.[[intrinsic]].%ObjProto_toString %$.
3. Return `undefined`.

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

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

1. Return `false`.

8.4.4.11 [[Delete]] (P)

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

1. Assert: `IsPropertyKey(P)` is `true`.
2. Return `true`.

8.4.4.12 [[Enumerate]] ()

When the `[[Enumerate]]` internal method of an exotic Symbol object O is called the following steps are taken:

1. Return an Iterator object (reference xxxx) whose next method immediately throws `%StopIteration%` and forms no other action..

8.4.4.13 [[OwnPropertyKeys]] ()

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

1. Return an Iterator object (reference xxxx) whose next method immediately throws `%StopIteration%` and forms no other action..

8.4.5 Exotic Arguments Objects

An `arguments object` is an exotic object whose array index properties map to the formal parameters bindings of an invocation of a non-strict function.

Deleted: 7

Deleted: P

Deleted: P

Deleted: P is a valid property key, either a String or a Symbol Object

Deleted: 8

Deleted: P

Deleted: P

Deleted: 9

Deleted: P is a valid property key, either a String or a Symbol Object

Deleted: 8.4.4.10 [[DefineOwnProperty]] (Desc)|

When the `[[DefineOwnProperty]]` internal method of an exotic Symbol object O is called with property key P and property descriptor $Desc$ the following steps are taken:
 <#>Return false.|

Deleted: 1

Comment [AWB635]: TODO

Deleted: 8.4.4.12 [[Keys]] ()|

When the `[[Keys]]` internal method of an exotic Symbol object O is called the following steps are taken:
 <#>Return a new empty List.|

Comment [AWB636]: TODO

Deleted: Return a new empty List.

Comment [AWB1237]: Possibly unnecessary

Comment [AWB1238]: Possibly unnecessary

Comment [AWB1239]: Possibly unnecessary

Comment [AWB1240]: Possibly unnecessary

Deleted: 8.4.4.14 [[Freeze]] ()|

When the `[[Freeze]]` internal method of an exotic Symbol object O is called the following steps are taken:
 <#>Return true.|

8.4.4.145 [[Seal]] ()|

When the `[[Seal]]` internal method of an exotic Symbol object O is called the following steps are taken:
 <#>Return true.|

8.4.4.16 [[IsFrozen]] ()|

When the `[[IsFrozen]]` internal method of an exotic Symbol object O is called the following steps are taken:
 <#>Return true.|

8.4.4.17 [[IsSealed]] ()|

When the `[[IsSealed]]` internal method of an exotic Symbol object O is called the following steps are taken:
 <#>Return true.|

Deleted: invocation

Exotic arguments objects have the same internal data properties as ordinary objects. They also have a `[[ParameterMap]]` internal data property and a `[[BuiltinBrand]]` internal data property whose value is `BuiltinArguments`.

Deleted: s

Exotic arguments 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 8.3.

Comment [AWB1241]: TODO move arguments internal methods here.

8.4.6 Indexed Delegation Exotic Objects

A *Indexed Delegation object* is an exotic object that delegates `[[Get]]` and `[[Set]]` handling of array index property keys to methods of the object.

Deleted: 5

Deleted: Typed

Deleted: Array

Indexed Delegation objects initially have the same internal data properties as ordinary objects.

Comment [AWB1342]: Issue: does the `TypedArray` spec./`WEBIDL` specs require that such indexed properties show up using `[[GetOwnProperty]]`, `keys`, etc? If so, some more internal method over-rides will be needed.

Exotic Indexed Delegation objects provide alternative definitions for the following internal methods. All of the other exotic Indexed Delegation object essential internal methods that are not defined below are as specified in 8.3.

Deleted: P

Deleted: P

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

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

1. If `SameValue(O, Receiver)` is `true` and *P* is an array index, then
 - a. Let *args* be a new List containing *P*.
 - b. Return the result of `Invoke(O, @@elementGet, args)`.
2. Return the result of calling the default ordinary object `[[Get]]` internal method (8.3.7) on *O* passing *P* and *Receiver* as arguments.

Deleted: P

Deleted: P

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

When the `[[Set]]` internal method of an exotic indexed delegation object *O* is called with property key *P*, value *V*, and ECMAScript language value *Receiver*, the following steps are taken:

1. If `SameValue(O, Receiver)` is `true` and *P* is an array index, then
 - a. Let *args* be a new List containing *P* and *V*.
 - b. Return the result of `ToBoolean(Invoke(O, @@elementSet, args))`.
2. Return the result of calling the default ordinary object `[[Set]]` internal method (8.3.7) on *O* passing *P*, *V*, and *Receiver* as arguments.

Deleted: index

Comment [AWB1343]: If we make this a private symbol that is not exposed, then it is just a specification device. If we make it an exposed symbol (whether private or not) it becomes a ES programmer extension point.

Deleted:)

Deleted: P

Deleted: P

Deleted: P

Deleted: index

Comment [AWB1344]: If we make this a private symbol that is not exposed, then it is just a specification device. If we make it an exposed symbol (whether private or not) it becomes a ES programmer extension point.

Deleted: P

Deleted: (

8.4.6.3 `IndexedDelegatorCreate` Abstract Operation

The abstract operation `IndexedDelegatorCreate` with argument `prototype` is used to specify the creation of new exotic Indexed Delegation objects. It performs the following steps:

11. Let *A* be a newly created ECMAScript object.
12. Set *A*'s essential internal methods to the default ordinary object definitions specified in 8.3.
13. Set the `[[Get]]` internal method of *A* as specified in 8.4.6.1.
14. Set the `[[Set]]` internal method of *A* as specified in 8.4.6.2.
15. Set the `[[Prototype]]` internal data property of *A* to `prototype`.
16. Set the `[[Extensible]]` internal data property of *A* to `true`.
17. Return *A*.

Deleted: P

Deleted: P

8.4.7 Built-in Function Objects

The function objects specified in Clause 15 may be implemented as either ordinary function objects 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 be that specified for each one in Clause 15.

Deleted: 6

If an implementation provided exotic object is used, the object must have the ordinary object behaviour specified in 8.3 except for `[[Get]]` and `[[GetOwnProperty]]` which must be as specified in 8.3.19. All such exotic function objects also have `[[Prototype]]` and `[[Extensible]]` internal data properties and a `[[BuiltinBrand]]` internal data property whose value is `BuiltinFunction`.

Deleted: s
Deleted: non-function
Deleted: P

`[[Call]]` and `[[Construct]]`

Comment [AWB1245]: TODO: need to talk about `[[Call]]` and `[[Construct]]` behaviour of chapter 15 native functions.

8.5 Proxy Object Internal Methods and Internal Data Properties

A proxy object is an exotic object whose essential internal methods are partially implemented using ECMAScript code. Every proxy objects has an internal data property called `[[ProxyHandler]]`. The value of `[[ProxyHandler]]` is always an object, called the proxy's *handler object*. Methods 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 data property called `[[ProxyTarget]]` whose value is either an object or the `null` value. This object is called the proxy's *target object*.

Deleted: usually

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.

Deleted: s

The `[[ProxyHandler]]` and `[[ProxyTarget]]` internal data properties 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 `[[ProxyHandler]]` internal data property is set to a special revoked proxy handler object and its `[[ProxyTarget]]` internal data property is set to `null`.

Deleted: that

Deleted: An ECMAScript implementation must be robust in the presence of such violations.

Because proxy permit arbitrary ECMAScript code to be used to implement internal methods, it is possible to define a proxy object whose handler methods violates the invariants defined in 8.1.6.2. Some of the internal method invariants defined in 8.1.6.2 are essential integrity invariants. These invariants are explicitly enforced by the proxy 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, `Desc` is a Property Description record, and `B` is a Boolean flag.

Deleted: proxy

8.5.1 `[[GetInheritance]]()`

When the `[[GetInheritance]]` 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 data property of `O`.
2. Let `target` be the value of the `[[ProxyTarget]]` internal data property of `O`.
3. Let `trap` be the result of `GetMethod(handler, "getPrototypeOf")`.
4. ReturnIfAbrupt(`trap`).
5. If `trap` is `undefined`, then
 - a. Return the result of calling the `[[GetInheritance]]` internal method of `target`.
6. Let `handlerProto` be the result of calling the `[[Call]]` internal method of `trap` with `handler` as the `this` value and a new List containing `target`.
7. ReturnIfAbrupt(`handlerProto`).
8. Let `targetProto` be the result of calling the `[[GetInheritance]]` internal method of `target`.
9. ReturnIfAbrupt(`targetProto`).
10. If `SameValue(handlerProto, targetProto)` is `false`, then throw a `TypeError` exception.
11. Return `handlerProto`.

Deleted: `trapResult`

NOTE `[[GetInheritance]]` for proxy objects enforces the following invariant:

- `[[GetInheritance]]` applied to the proxy object must return the same value as `[[GetInheritance]]` applied to the proxy object's target object.

Deleted: `handler`

8.5.2 [[SetInheritance]] (V)

When the [[SetInheritance]] 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 data property of O .
3. Let $target$ be the value of the [[ProxyTarget]] internal data property of O .
4. Let $trap$ be the result of GetMethod($handler$, "setPrototypeOf").
5. ReturnIfAbrupt($trap$).
6. If $trap$ is undefined, then
 - a. Return the result of calling the [[SetInheritance]] internal method of $target$ with argument V .
7. Let $trapResult$ be the result of calling the [[Call]] internal method of $trap$ with $handler$ as the this value and a new List containing $target$ and V .
8. ReturnIfAbrupt($trapResult$).
9. Let $trapResult$ be ToBoolean($trapResult$).
10. Let $targetProto$ be the result of calling the [[GetInheritance]] internal method of $target$.
11. ReturnIfAbrupt($targetProto$).
12. If $trapResult$ is true and SameValue(V , $targetProto$) is false, then throw a **TypeError** exception.
13. Return $trapResult$.

NOTE [[SetInheritance]] for proxy objects enforces the following invariant:

- [[SetInheritance]] may only return true if the argument value is now the valued return for [[GetInheritance]] applied to the proxy object's target object.

8.5.3 [[HasIntegrity]] (Level)

When the [[HasIntegrity]] internal method of an exotic Proxy object O is called the following steps are taken:

1. Assert: $Level$ is one of "nonextensible", "sealed", or "frozen".
2. Let $handler$ be the value of the [[ProxyHandler]] internal data property of O .
3. Let $target$ be the value of the [[ProxyTarget]] internal data property of O .
4. If $Level$ is "nonextensible", then let $trapName$ be "isExtensible".
5. Else if $Level$ is "sealed", then let $trapName$ be "isSealed".
6. Else $Level$ is "frozen", so let $trapName$ be "isFrozen".
7. Let $trap$ be the result of GetMethod($handler$, $trapName$).
8. ReturnIfAbrupt($trap$).
9. If $trap$ is undefined, then
 - a. Return the result of calling the [[HasIntegrity]] internal method of $target$ with argument $Level$.
10. Let $trapResult$ be the result of calling the [[Call]] internal method of $trap$ with $handler$ as the this value and a new List containing $target$.
11. ReturnIfAbrupt($trapResult$).
12. Let $booleanTrapResult$ be ToBoolean($trapResult$).
13. Let $targetResult$ be the result of calling the [[HasIntegrity]] internal method of $target$ with argument $Level$.
14. ReturnIfAbrupt($targetResult$).
15. If SameValue($booleanTrapResult$, $targetResult$) is false, then throw a **TypeError** exception.
16. Return $booleanTrapResult$.

NOTE [[HasIntegrity]] for proxy objects enforces the following invariant:

- [[HasIntegrity]] applied to the proxy object must return the same value as [[HasIntegrity]] applied to the proxy object's target object with the same argument.

8.5.4 [[SetIntegrity]] (Level)

When the [[SetIntegrity]] internal method of an exotic Proxy object O is the following steps are taken:

1. Assert: $Level$ is one of "nonextensible", "sealed", or "frozen".
2. Let $handler$ be the value of the [[ProxyHandler]] internal data property of O .
3. Let $target$ be the value of the [[ProxyTarget]] internal data property of O .

Deleted: proxy

Deleted: <#>Let $getProtoTrap$ be the result of GetMethod($handler$, "getPrototypeOf").
 <#>ReturnIfAbrupt($getProtoTrap$).
 <#>If $getProtoTrap$ is undefined, then
 <#>Return $trapResult$.
 <#>Let $getProtoResult$ be the result of calling $getProtoTrap$ with $handler$ as the this value and a new List containing $target$.
 <#>ReturnIfAbrupt($getProtoResult$).
Deleted: $getProtoResult$

Deleted: After a

Deleted: call, [[GetInheritance]] applied to the proxy object must

Deleted: the same value as

Deleted: handler

Deleted: IsExtensible

Deleted:

Deleted: IsExtensible

Deleted: proxy

Deleted: "isExtensible"

Deleted: IsExtensible

Deleted: proxyIsExtensible

Deleted: targetIsExtensible

Deleted: IsExtensible

Deleted: targetIsExtensible

Deleted: proxyIsExtensible

Deleted: IsExtensible

Deleted: IsExtensible

Deleted: IsExtensible

Deleted: handler

Deleted: PreventExtensions

Deleted: PreventExtensions

Deleted: proxy

4. If *Level* is "nonextensible", then let *trapName* be "preventExtensions".
5. Else if *Level* is "sealed", then let *trapName* be "seal".
6. Else *Level* is "frozen", so let *trapName* be "freeze".
7. Let *trap* be the result of GetMethod(*handler*, *trapName*).
8. ReturnIfAbrupt(*trap*).
9. If *trap* is undefined, then
 - a. Return the result of calling the [[SetIntegrity]] internal method of *target* with argument *Level*.
10. Let *trapResult* be the result of calling the [[Call]] internal method of *trap* with *handler* as the this value and a new List containing *target*.
11. ReturnIfAbrupt(*trapResult*).
12. Let *booleanTrapResult* be ToBoolean(*trapResult*).
13. Let *targetResult* be the result of calling the [[HasIntegrity]] internal method of *target* with argument *Level*.
14. ReturnIfAbrupt(*targetResult*).
15. If SameValue(*booleanTrapResult*, *targetResult*) is false, then throw a **TypeError** exception.
16. Return *booleanTrapResult*.

NOTE [[SetIntegrity]] for proxy objects enforces the following invariant:

- [[SetIntegrity]] applied to the proxy object must return the same value as [[HasIntegrity]] applied to the proxy object's target object with the same argument.

8.5.5 [[HasOwnProperty]] (P)

When the [[HasOwnProperty]] 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 data property of *O*.
3. Let *target* be the value of the [[ProxyTarget]] internal data property of *O*.
4. Let *trap* be the result of GetMethod(*handler*, "hasOwn").
5. ReturnIfAbrupt(*trap*).
6. If *trap* is undefined, then
 - a. Return the result of calling the [[HasOwnProperty]] internal method of *target* with argument *P*.
7. Let *trapResult* be the result of calling the [[Call]] internal method of *trap* with *handler* as the this value and a new List containing *target* and *P*.
8. ReturnIfAbrupt(*trapResult*).
9. Let *success* be ToBoolean(*trapResult*).
10. If *success* 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, then throw a **TypeError** exception.
 - ii. Let *extensibleTarget* be the result of calling the [[IsExtensible]] internal method of *target*.
 - iii. ReturnIfAbrupt(*extensibleTarget*).
 - iv. If ToBoolean(*extensibleTarget*) is false, then throw a **TypeError** exception.
11. Else *success* is true.
 - a. Let *extensibleTarget* be the result of IsExtensible(*target*).
 - b. ReturnIfAbrupt(*extensibleTarget*).
 - c. If ToBoolean(*extensibleTarget*) is true, then return *success*.
 - d. Let *targetDesc* be the result of calling the [[GetOwnProperty]] internal method of *target* with argument *P*.
 - e. ReturnIfAbrupt(*targetDesc*).
 - f. If *targetDesc* is undefined, then throw a **TypeError** exception.
12. Return *success*.

NOTE [[HasOwnProperty]] 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 a own property of the target object and the target object is not extensible.

Deleted: "preventExtensions"

Deleted: PreventExtensions

Deleted: <#>Let *isTrap* be the result of GetMethod(*handler*, "isExtensible").
 <#>ReturnIfAbrupt(*isTrap*).
 <#>If *isTrap* is undefined, then
 <#>Return NormalCompletion(empty).
 <#>Let *isTrapResult* be the result of calling *isTrap* with *handler* as the this value and a new List containing *target*.
 <#>ReturnIfAbrupt(*isTrapResult*).
 <#>Let *proxysExtensible* be ToBoolean(*isTrapResult*).
 <#>

Deleted: *targetIsExtensible*

Deleted: *IsExtensible*

Deleted: *targetIsExtensible*

Deleted: SameValue(*proxyIsExtensible*, *targetIsExtensible*) is false

Deleted: NormalCompletion(empty)

Deleted: PreventExtensions

Deleted: After a

Deleted: [[PreventExtensions]] call, [[IsExtensible]] applied to the proxy object must return the same value as [[IsExtensible]] applied to the proxy object's handler object.

Deleted: proxy

Deleted: *P* is a valid property key, either a String or a Symbol Object

Deleted: <#>If *targetDesc* is undefined, then

Deleted: calling the [[

Deleted:]] internal method of

Deleted: false

Deleted: throw a **TypeError** exception

- A property cannot be reported as existent, if it does not exists as a own property of the target object and the target object is not extensible.

8.5.6 [[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 data property of O .
3. Let $target$ be the value of the [[ProxyTarget]] internal data property of O .
4. Let $trap$ be the result of GetMethod($handler$, "getOwnPropertyDescriptor").
5. ReturnIfAbrupt($trap$).
6. If $trap$ is undefined, then
 - a. Return the result of calling the [[GetOwnProperty]] internal method of $target$ with argument P .
7. Let $trapResultObj$ be the result of calling the [[Call]] internal method of $trap$ with $handler$ as the this value and a new List containing $target$ and P .
8. ReturnIfAbrupt($trapResultObj$).
9. If Type($trapResultObj$) is neither Object or Undefined, then throw a TypeError exception.
10. Let $targetDesc$ be the result of calling the [[GetOwnProperty]] internal method of $target$ with argument P .
11. ReturnIfAbrupt($targetDesc$).
12. If $trapResultObj$ is undefined, then
 - a. If $targetDesc$ is undefined, then return undefined.
 - b. If $targetDesc$.[[Configurable]] is false, then throw a TypeError exception.
 - c. Let $extensibleTarget$ be the result of IsExtensible($target$).
 - d. ReturnIfAbrupt($extensibleTarget$).
 - e. If ToBoolean($extensibleTarget$) is false, then throw a TypeError exception.
 - f. Return undefined.
13. Let $extensibleTarget$ be the result of IsExtensible($target$).
14. ReturnIfAbrupt($extensibleTarget$).
15. Set $extensibleTarget$ to ToBoolean($extensibleTarget$).
16. Let $resultDesc$ be ToPropertyDescriptor($trapResultObj$).
17. ReturnIfAbrupt($resultDesc$).
18. Call CompletePropertyDescriptor($resultDesc$, $targetDesc$).
19. Let $valid$ be the result of IsCompatiblePropertyDescriptor($extensibleTarget$, $resultDesc$, $targetDesc$).
20. If $valid$ is false, then throw a TypeError exception.
21. If $resultDesc$.[[Configurable]] is false, then
 - i. If $targetDesc$ is undefined or $targetDesc$.[[Configurable]] is true, then
 - i. Throw a TypeError exception.
22. Return $resultDesc$.

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 a own property of the target object and the target object is not extensible.
- A property cannot be reported as existent, if it does not exists as a 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 a 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.

8.5.7 [[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 data property of O .
3. Let $target$ be the value of the [[ProxyTarget]] internal data property of O .

Deleted: proxy

Deleted: Assert: P is a valid property key, either a String or Symbol Object.

Deleted: u

Deleted: calling the [[

Deleted:]] internal method of

Deleted:

Deleted: calling the [[

Deleted:]] internal method of

Deleted:

Comment [AWB1246]: Note the result descriptor defaults are set to the values in the targetDesc (if there one) rather than the normal defaults. This is a change from the wiki spec.

Deleted: a

Deleted: not

Deleted: and

Comment [AWB1247]: The resultDesc carries a reference to the original descriptor returned by the trap copy is not made and missing attribute properties are added to it.

This is a change from the wiki spec.

4. Let *trap* be the result of *GetMethod(handler, "defineProperty")*.
5. *ReturnIfAbrupt(trap)*.
6. If *trap* is **undefined**, then
 - a. Return the result of calling the **[[DefineOwnProperty]]** internal method of *target* with arguments *P* and *Desc*.
7. Let *descObj* be *FromPropertyDescriptor(Desc)*.
8. NOTE If *Desc* was originally generated from an object using *ToPropertyDescriptor*, then *descObj* will be that original object.
9. Let *trapResult* be the result of calling the **[[Call]]** internal method of *trap* with *handler* as the **this** value and a new List containing *target*, *P*, and *descObj*.
10. *ReturnIfAbrupt(trapResult)*.
11. If *ToBoolean(trapResult)* is **false**, then return **false**.
12. Let *targetDesc* be the result of calling the **[[GetOwnProperty]]** internal method of *target* with argument *P*.
13. *ReturnIfAbrupt(targetDesc)*.
14. Let *extensibleTarget* be the result of *IsExtensible(target)*.
15. *ReturnIfAbrupt(extensibleTarget)*.
16. Set *extensibleTarget* to *ToBoolean(extensibleTarget)*.
17. If *targetDesc* is **undefined**, then
 - a. If *extensibleTarget* is **false**, then throw a **TypeError** exception.
 - b. If *Desc.[[Configurable]]* is **false**, then throw a **TypeError** exception.
18. Else *targetDesc* is not **undefined**,
 - a. If *IsCompatiblePropertyDescriptor(extensibleTarget, Desc, targetDesc)* is **false**, then throw a **TypeError** exception.
 - b. If *Desc.[[Configurable]]* is **false** and *targetDesc.[[Configurable]]* is **true**, then throw a **TypeError** exception.
19. Return **true**.

NOTE **[[GetOwnProperty]]** 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 exist 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 applying the property descriptor of the property to the target object using **[[DefineOwnProperty]]** will not throw an exception.

Deleted: calling the **[[**
Deleted: **]]** internal method of

8.5.8 **[[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 data property of *O*.
3. Let *target* be the value of the **[[ProxyTarget]]** internal data property of *O*.
4. Let *trap* be the result of *GetMethod(handler, "has")*.
5. *ReturnIfAbrupt(trap)*.
6. If *trap* is **undefined**, then
 - a. Return the result of calling the **[[HasProperty]]** internal method of *target* with argument *P*.
7. Let *trapResult* be the result of calling the **[[Call]]** internal method of *trap* with *handler* as the **this** value and a new List containing *target* and *P*.
8. *ReturnIfAbrupt(trapResult)*.
9. Let *success* be *ToBoolean(trapResult)*.
10. If *success* 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**, then throw a **TypeError** exception.
 - ii. Let *extensibleTarget* be the result of *IsExtensible(target)*.
 - iii. *ReturnIfAbrupt(extensibleTarget)*.
 - iv. If *ToBoolean(extensibleTarget)* is **false**, then throw a **TypeError** exception.
11. Return *success*.

Deleted: calling the **[[**
Deleted: **]]** internal method of

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 a own property of the target object and the target object is not extensible.

8.5.9 [[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 data property of O.
3. Let target be the value of the [[ProxyTarget]] internal data property of O.
4. Let trap be the result of GetMethod(handler, "get").
5. ReturnIfAbrupt(trap).
6. If trap is undefined, then
 - a. Return the result of calling the [[Get]] internal method of target with arguments P and Receiver.
7. Let trapResult be the result of calling the [[Call]] internal method of trap with handler as the this value and a new List containing target, P, and Receiver.
8. ReturnIfAbrupt(trapResult).
9. Let targetDesc be the result of calling the [[GetOwnProperty]] internal method of target with argument P.
10. ReturnIfAbrupt(targetDesc).
11. 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, then 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, then throw a TypeError exception.
12. Return trapResult.

NOTE [[GetProperty]] 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 corresponding target object property is non-configurable accessor property that has undefined as its [[Get]] attribute.

Deleted: 7

Deleted: P

Deleted: P

Deleted: proxy

Deleted: Assert: P is a valid property key, either a String or Symbol Object

Deleted: P

8.5.10 [[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 data property of O.
3. Let target be the value of the [[ProxyTarget]] internal data property of O.
4. Let trap be the result of GetMethod(handler, "set").
5. ReturnIfAbrupt(trap).
6. If trap is undefined, then
 - a. Return the result of calling the [[Set]] internal method of target with arguments P, V, and Receiver.
7. Let trapResult be the result of calling the [[Call]] internal method of trap with handler as the this value and a new List containing target, P, V, and Receiver.
8. ReturnIfAbrupt(trapResult).
9. If ToBoolean(trapResult) is false, then return false.
10. Let targetDesc be the result of calling the [[GetOwnProperty]] internal method of target with argument P.
11. ReturnIfAbrupt(targetDesc).
12. 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, then throw a TypeError exception.

Deleted: .

Deleted: P

Deleted: P

Deleted: proxy

Deleted: Assert: P is a valid property key, either a String or Symbol Object

Deleted: P

- b. If `IsAccessorDescriptor(targetDesc)` and `targetDesc.[[Configurable]]` is `false`, then
 - i. If `targetDesc.[[Set]]` is `undefined`, then throw a `TypeError` exception.

13. Return `true`.

NOTE `[[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.

8.5.11 `[[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 data property of `O`.
3. Let `target` be the value of the `[[ProxyTarget]]` internal data property of `O`.
4. Let `trap` be the result of `GetMethod(handler, "deleteProperty")`.
5. `ReturnIfAbrupt(trap)`.
6. If `trap` is `undefined`, then
 - a. Return the result of calling the `[[Delete]]` internal method of `target` with argument `P`.
7. Let `trapResult` be the result of calling the `[[Call]]` internal method of `trap` with `handler` as the `this` value and a new List containing `target` and `P`.
8. `ReturnIfAbrupt(trapResult)`.
9. If `ToBoolean(trapResult)` is `false`, then return `false`.
10. Let `targetDesc` be the result of calling the `[[GetOwnProperty]]` internal method of `target` with argument `P`.
11. `ReturnIfAbrupt(targetDesc)`.
12. If `targetDesc` is `undefined`, then return `true`.
13. If `targetDesc.[[Configurable]]` is `false`, then throw a `TypeError` exception.
14. 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.

8.5.12 `[[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 data property of `O`.
2. Let `target` be the value of the `[[ProxyTarget]]` internal data property of `O`.
3. Let `trap` be the result of `GetMethod(handler, "enumerate")`.
4. `ReturnIfAbrupt(trap)`.
5. If `trap` is `undefined`, then
 - a. Return the result of calling the `[[Enumerate]]` internal method of `target`.
6. Let `trapResult` be the result of calling the `[[Call]]` internal method of `trap` with `handler` as the `this` value and a new List containing `target`.
7. `ReturnIfAbrupt(trapResult)`.
8. If `Type(trapResult)` is not `Object`, then throw a `TypeError` exception.

TODO: we may need to add a lot of additional invariant checking here according to the wiki spec. But maybe it really isn't necessary. Tomvc response: I think it may be possible to waive the extra invariant checks for `[[Enumerate]]`. It's not a crucial primitive. My reasoning is that `[[Enumerate]]` deals with both own and inherited properties, and we don't really enforce any invariants on inherited properties. So I guess it's ok if the invariants for `[[Enumerate]]` are weakened.

Do note that this is a bit inconsistent with the way we treat internal methods like `[[HasProperty]]`, `[[GetProperty]]` and `[[SetProperty]]`: these also deal with own and inherited properties, but still enforce invariants on own properties.

9. Return `trapResult`.

NOTE `[[Enumerate]]` for proxy objects enforces the following invariants:

- The result of `[[Enumerate]]` must be an `Object`.

Deleted: P

Deleted: o

Deleted: 9

Deleted: proxy

Deleted: Assert: `P` is a valid property key, either a String or a Symbol Object.

Deleted: d

Deleted: 8.5.10 `[[DefineOwnProperty]](P, Desc)`

When the `[[DefineOwnProperty]]` internal method of proxy object `O` is called with property key `P` and property descriptor `Desc`, the following steps are taken:¹¹

<#> Assert: `P` is a valid property key, either a String or a Symbol Object.¹¹

<#> Let `handler` the value of the `[[ProxyHandler]]` internal data property of `O`.¹¹

<#> Let `target` the value of the `[[ProxyTarget]]` internal data property of `O`.¹¹

<#> Let `trap` be the result of `GetMethod(handler, "defineProperty")`.¹¹

<#> ReturnIfAbrupt(`trap`).¹¹

<#> If `trap` is `undefined`, then¹¹

<#> Return the result of calling the `[[DefineOwnProperty]]` internal method of `target` with arguments `P` and `Desc`.¹¹

<#> Let `descObj` be `FromPropertyDescriptor(Desc)`.¹¹

<#> NOTE If `Desc` was originally generated from an object using `ToPropertyDescriptor`, the `descObj` will be that original object.¹¹

<#> Let `trapResult` be the result of calling `trap` with `handler` as the `this` value and a new List containing `target`, `P`, and `descObj`.¹¹

<#> ReturnIfAbrupt(`trapResult`).¹¹

<#> If `ToBoolean(trapResult)` is `false`, then return `false`.¹¹

<#> Let `targetDesc` be the result of calling the `[[GetOwnProperty]]` internal method of `target` with argument `P`.¹¹

<#> ReturnIfAbrupt(`targetDesc`).¹¹

<#> Let `extensibleTarget` be the result of calling `[[IsExtensible]]` internal method of `target`.¹¹

<#> ReturnIfAbrupt(`extensibleTarget`).¹¹

<#> Set `extensibleTarget` to `Boolean(extensibleTarget)`.¹¹

<#> If `targetDesc` is `undefined`, then¹¹

<#> If `extensibleTarget` is `false`, then throw a `TypeError` exception.¹¹

<#> If `Desc.[[Configurable]]` is `false`, then throw a `TypeError` exception.¹¹

<#> Else `targetDesc` is not `undefined`.¹¹

<#> If `IsComitableDescriptor(extensibleTarget, Desc, targetDesc)` is `false`, then throw a `TypeError` exception.¹¹

<#> If `Desc.[[Configurable]]` is `false` and `targetDesc.[[Configurable]]` is `true`, then throw a `TypeError` exception.¹¹

<#> Return `true`.¹¹

Deleted: 1

Deleted: of

Deleted: proxy

Comment [AWB1248]: TODO.

8.5.13 [[OwnPropertyKeys]]()

When the [[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 data property of O .
2. Let $target$ be the value of the [[ProxyTarget]] internal data property of O .
3. Let $trap$ be the result of GetMethod($handler$, "ownKeys").
4. ReturnIfAbrupt($trap$).
5. If $trap$ is **undefined**, then
 - a. Return the result of calling the [[OwnPropertyKeys]] internal method of $target$.
6. Let $trapResult$ be the result of calling the [[Call]] internal method of $trap$ with $handler$ as the **this** value and a new List containing $target$.
7. ReturnIfAbrupt($trapResult$).
8. If Type($trapResult$) is not Object, then throw a **TypeError** exception.
9. **TODO:** we may need to add a lot of additional invariant checking here according to the wiki spec. But maybe it really isn't necessary.
10. Return $trapResult$.

NOTE [[OwnPropertyKeys]] for proxy objects enforces the following invariants:

- The result of [[OwnPropertyKeys]] must be an Object.

8.5.14 [[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 data property of O .
2. Let $target$ be the value of the [[ProxyTarget]] internal data property of O .
3. Let $trap$ be the result of GetMethod($handler$, "apply").
4. ReturnIfAbrupt($trap$).
5. If $trap$ is **undefined**, then
 - a. Return the result of calling the [[Call]] internal method of $target$ with arguments $thisArgument$ and $argumentsList$.
6. Let $argArray$ be the result of CreateArrayFromList($argumentsList$).
7. Return the result of calling the [[Call]] internal method of $trap$ with $handler$ as the **this** value and a new List containing $target$, $thisArgument$, and $argArray$.

NOTE An Proxy exotic object only has a [[Call]] internal method if the initial value of its [[ProxyTarget]] internal data property is an object that has a [[Call]] internal method.

8.5.15 [[Construct]] Internal Method

The [[Construct]] internal method of an exotic Proxy object O is called with a single parameter $argumentsList$ which is a possibly empty List of ECMAScript language values. The following steps are taken:

1. Let $handler$ be the value of the [[ProxyHandler]] internal data property of O .
2. Let $target$ be the value of the [[ProxyTarget]] internal data property of O .
3. Let $trap$ be the result of GetMethod($handler$, "construct").
4. ReturnIfAbrupt($trap$).
5. If $trap$ is **undefined**, then
 - a. Return the result of calling the [[Construct]] internal method of $target$ with argument $argumentsList$.
6. Let $argArray$ be the result of CreateArrayFromList($argumentsList$).
7. Return the result of calling $trap$ with $handler$ as the **this** value and a new List containing $target$ and $argArray$.

NOTE An Proxy exotic object only has a [[Construct]] internal method if the initial value of its [[ProxyTarget]] internal data property is an object that has a [[Construct]] internal method.

Comment [AWB1249]: TODO

Deleted: 8.5.12 [[Keys]]()

When the [[Keys]] internal method of proxy object O is called the following steps are taken:

```
<#>Let  $handler$  the value of the [[ProxyHandler]] internal data property of  $O$ .
<#>Let  $target$  the value of the [[ProxyTarget]] internal data property of  $O$ .
<#>Let  $trap$  be the result of GetMethod( $handler$ , "keys").
<#>ReturnIfAbrupt( $trap$ ).
<#>If  $trap$  is undefined, then
<#>Return the result of calling the [[Keys]] internal method of  $target$ .
<#>Let  $trapResult$  be the result of calling  $trap$  with  $handler$  as the this value and a new List containing  $target$ .
<#>ReturnIfAbrupt( $trapResult$ ).
<#>If Type( $trapResult$ ) is not Object, then throw a TypeError exception.
<#>TODO: we may need to add a lot of additional invariant checking here according to the wiki spec. But maybe it really isn't necessary.
<#>Return  $trapResult$ .
```

NOTE [[Keys]] for proxy objects enforces the following invariants:

<#>The result of [[Keys]] must be an Object.

Deleted: proxy

Deleted: geto

Deleted: Property

Deleted: Names

Comment [AWB1250]: TODO

Deleted: 8.5.14 [[Freeze]]()

When the [[Freeze]] internal method of an exotic Proxy object O is called the following steps are taken:

```
<#>Return the result of MakeObjectSecure( $O$ , false).
```

8.5.15 [[Seal]]()

When the [[Seal]] internal method of an exotic Proxy object O is called the following steps are taken:

```
<#>Return the result of MakeObjectSecure( $O$ , false).
```

8.5.16 [[IsFrozen]]()

When the [[IsFrozen]] internal method of an exotic Proxy object O is called the following steps are taken:

```
<#>Return the result of TestIfSecureObject( $O$ , true).
```

8.5.17 [[IsSealed]]()

When the [[IsSealed]] internal method of an exotic Proxy object O is called the following steps are taken:

```
<#>Return the result of TestIfSecureObject( $O$ , false).
```

Deleted: 8

Deleted: 9

Deleted: v

9 Abstract Operations

These operations are not a part of the ECMAScript language; they are defined here to solely to aid the specification of the semantics of the ECMAScript Language. Other, more specialized abstract operations are defined throughout this specification.

9.1 Type Conversion and Testing

The ECMAScript language implicitly performs automatic type conversion as needed. To clarify the semantics of certain constructs it is useful to define a set of conversion abstract operations. The conversion abstract operations are polymorphic; that is, they can accept a value of any ECMAScript language type, but not of specification types.

9.1.1 ToPrimitive

The abstract operation `ToPrimitive` takes an input `argument` and an optional argument `PreferredType`. The abstract operation `ToPrimitive` converts its `input` argument to a non-Object type. If an object is capable of converting to more than one primitive type, it may use the optional hint `PreferredType` to favour that type. Conversion occurs according to Table 15:

Table 15.— `ToPrimitive` Conversions

Input Type	Result
Completion Record	If <code>argument</code> is an abrupt completion, return <code>argument</code> . Otherwise return <code>ToPrimitive(argument.[[value]])</code> also passing the optional hint <code>PreferredType</code> .
Undefined	Return <code>argument</code> (no conversion).
Null	Return <code>argument</code> (no conversion).
Boolean	Return <code>argument</code> (no conversion).
Number	Return <code>argument</code> (no conversion).
String	Return <code>argument</code> (no conversion).
Object	Perform the steps following this table.

When the `InputType` is Object, the following steps are taken:

1. If `PreferredType` was not passed, let `hint` be "`default`".
2. Else if `PreferredType` is `String`, let `hint` be "`string`".
3. Else `PreferredType` is `Number`, let `hint` be "`number`".
4. Let `exoticToPrim` be the result of `Get(argument, @@ToPrimitive)`.
5. ReturnIfAbrupt(`exoticToPrim`).
6. If `exoticToPrim` is not `undefined`, then
 - a. If `IsCallable(exoticToPrim)` is `false`, then throw a `TypeError` exception.
 - b. Let `result` be the result of calling the `[[Call]]` internal method of `exoticToPrim`, with `argument` as `thisArgument` and a List containing `hint` as `argumentsList`.
 - c. ReturnIfAbrupt(`result`).
 - d. If `result` is an ECMAScript language value and `Type(result)` is not `Object`, then return `result`.
 - e. Else, throw a `TypeError` exception.
7. If `hint` is "`default`" then, let `hint` be "`number`".
8. Return the result of `OrdinaryToPrimitive(argument, hint)`.

When the `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 `tryFirst` be "`toString`".

Deleted: runtime system

Deleted: These abstract operations are not part of the language; they are defined here to aid the specification of the semantics of the language

Deleted:

Deleted: Table 15Table 13Table 12

Deleted: 151312

Deleted: The result equals

Deleted:

Deleted: the `input` argumen

Deleted: t

Deleted: The result equals

Deleted: the `input` argument

Deleted: following

Deleted: given

Deleted: :||

<#>Let `default` be the result of calling the `[[DefaultValue]]` internal method of `argument`, passing the optional hint `PreferredType`.¶

<#>Return `ToPrimitive(default)`.¶

Return a default value for the Object. The default value of an object is retrieved by calling the `[[DefaultValue]]` internal method of the object, passing the optional hint `PreferredType`. The behaviour of the `[[DefaultValue]]` internal method is defined by this specification for all native ECMAScript objects in 8.12.8.

Deleted: O

Deleted: `toString`

Deleted: O

Deleted: be

Deleted: O

Deleted: s

- b. Let *trySecond* be "valueOf".
4. Else,
- a. Let *tryFirst* be "valueOf".
 - b. Let *trySecond* be "toString".
5. Let *first* be the result of Get(*O*, *tryFirst*).
6. ReturnIfAbrupt(*first*).
7. If IsCallable(*first*) is true then,
- a. Let *result* be the result of calling the [[Call]] internal method of *first*, with *O* as *thisArgument* and an empty List as *argumentsList*.
 - b. ReturnIfAbrupt(*result*).
 - c. If *result* is an ECMAScript language value and Type(*result*) is not Object, then return *result*.
 - d. Else, throw a **TypeError** exception.
8. Let *second* be the result of Get(*O*, *trySecond*).
9. ReturnIfAbrupt(*second*).
10. If IsCallable(*second*) is true then,
- a. Let *result* be the result of calling the [[Call]] internal method of *second*, with *O* as *thisArgument* and an empty argument list.
 - b. ReturnIfAbrupt(*result*).
 - c. If *result* is an ECMAScript language value and Type(*result*) is not Object, then return *result*.
11. 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 15.9.6) over-ride the default ToPrimitive behaviour. Date objects treat no hint as if the hint were String.

9.1.2 ToBoolean

The abstract operation ToBoolean converts its *argument* to a value of type Boolean according to [Table 16](#):

Table 16 — ToBoolean Conversions

Argument Type	Result
Completion Record	If <i>argument</i> is an abrupt completion, return the argument. Otherwise return ToBoolean(<i>argument</i> .[[value]])
Undefined	Return false
Null	Return false
Boolean	Return the input argument (no conversion).
Number	Return false if the argument is +0, -0, or NaN; otherwise return true.
String	Return false if the argument is the empty String (its length is zero); otherwise return true.
Object	Return true

Deleted: First

Deleted: 161413

Deleted: The result equals

Deleted: The result is

Deleted: the result is

Deleted: The result is

Deleted: the result is

9.1.3 ToNumber

The abstract operation ToNumber converts its *argument* to a value of type Number according to [Table 17](#):

Table 17. — ToNumber Conversions

Argument Type	Result
Completion Record	If <i>argument</i> is an abrupt completion, return <i>argument</i> . Otherwise return <code>ToNumber(argument.[[value]])</code>
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 note below.
Object	Apply the following steps: 1. Let <i>primValue</i> be <code>ToPrimitive(argument, hint Number)</code> . 2. Return <code>ToNumber(primValue)</code> .

9.1.3.1 ToNumber Applied to the String Type

ToNumber applied to Strings applies the following grammar to the input String. If the grammar cannot interpret the String as an expansion of *StringNumericLiteral*, then the result of ToNumber is **NaN**.

Syntax

```

StringNumericLiteral ::=
  StrWhiteSpaceopt
  StrWhiteSpaceopt StrNumericLiteral StrWhiteSpaceopt

StrWhiteSpace ::=
  StrWhiteSpaceChar StrWhiteSpaceopt

StrWhiteSpaceChar ::=
  WhiteSpace
  LineTerminator

StrNumericLiteral ::=
  StrDecimalLiteral
  HexIntegerLiteral

StrDecimalLiteral ::=
  StrUnsignedDecimalLiteral
  + StrUnsignedDecimalLiteral
  - StrUnsignedDecimalLiteral

StrUnsignedDecimalLiteral ::=
  Infinity
  DecimalDigits . DecimalDigitsopt ExponentPartopt
  . DecimalDigits ExponentPartopt
  DecimalDigits ExponentPartopt

DecimalDigits ::=
  DecimalDigit
  DecimalDigits DecimalDigit

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

```

Deleted: Table 17Table 15Table 14

Deleted: 171514

Deleted:

Deleted: The result is

Deleted: the

Deleted: The result is

Deleted: the

Deleted: The result equals

Deleted: the *input*

Deleted: *input*

ExponentPart ::::
ExponentIndicator *SignedInteger*

ExponentIndicator :::: **one of**
e **E**

SignedInteger ::::
DecimalDigits
+ *DecimalDigits*
- *DecimalDigits*

HexIntegerLiteral ::::
0x *HexDigit*
0X *HexDigit*
HexIntegerLiteral *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

NOTE Some differences should be noted between the syntax of a *StringNumericLiteral* and a *NumericLiteral* (see 7.8.3):

- A *StringNumericLiteral* may be preceded and/or followed by 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 be preceded by + 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*.

Runtime Semantics

The conversion of a String to a Number value is similar overall to the determination of the Number value for a numeric literal (see 7.8.3), 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 in full. 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 of *StringNumericLiteral* :::: [empty] is 0.
- The MV of *StringNumericLiteral* :::: *StrWhiteSpace* is 0.
- The MV of *StringNumericLiteral* :::: *StrWhiteSpace*_{opt} *StrNumericLiteral* *StrWhiteSpace*_{opt} is the MV of *StrNumericLiteral*, no matter whether white space is present or not.
- The MV of *StrNumericLiteral* :::: *StrDecimalLiteral* is the MV of *StrDecimalLiteral*.
- The MV of *StrNumericLiteral* :::: *HexIntegerLiteral* is the MV of *HexIntegerLiteral*.
- The MV of *StrDecimalLiteral* :::: *StrUnsignedDecimalLiteral* is the MV of *StrUnsignedDecimalLiteral*.
- The MV of *StrDecimalLiteral* :::: + *StrUnsignedDecimalLiteral* is the MV of *StrUnsignedDecimalLiteral*.
- The MV of *StrDecimalLiteral* :::: - *StrUnsignedDecimalLiteral* is the negative of the MV of *StrUnsignedDecimalLiteral*. (Note that if the MV of *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 *StrUnsignedDecimalLiteral*:::: **Infinity** is 10^{10000} (a value so large that it will round to +∞).
- The MV of *StrUnsignedDecimalLiteral*:::: *DecimalDigits* . is the MV of *DecimalDigits*.
- The MV of *StrUnsignedDecimalLiteral*:::: *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 characters in the second *DecimalDigits*.
- The MV of *StrUnsignedDecimalLiteral*:::: *DecimalDigits* . *ExponentPart* is the MV of *DecimalDigits* times 10^e , where *e* is the MV of *ExponentPart*.
- The MV of *StrUnsignedDecimalLiteral*:::: *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 characters in the second *DecimalDigits* and *e* is the MV of *ExponentPart*.

- The MV of *StrUnsignedDecimalLiteral::: DecimalDigits* is the MV of *DecimalDigits* times 10^{-n} , where *n* is the number of characters in *DecimalDigits*.
- The MV of *StrUnsignedDecimalLiteral::: DecimalDigits ExponentPart* is the MV of *DecimalDigits* times 10^{e-n} , where *n* is the number of characters in *DecimalDigits* and *e* is the MV of *ExponentPart*.
- The MV of *StrUnsignedDecimalLiteral::: DecimalDigits* is the MV of *DecimalDigits*.
- The MV of *StrUnsignedDecimalLiteral::: DecimalDigits ExponentPart* is the MV of *DecimalDigits* times 10^e , where *e* is the MV of *ExponentPart*.
- 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* is 0.
- The MV of *DecimalDigit :::: 1 or of HexDigit :::: 1* is 1.
- The MV of *DecimalDigit :::: 2 or of HexDigit :::: 2* is 2.
- The MV of *DecimalDigit :::: 3 or of HexDigit :::: 3* is 3.
- The MV of *DecimalDigit :::: 4 or of HexDigit :::: 4* is 4.
- The MV of *DecimalDigit :::: 5 or of HexDigit :::: 5* is 5.
- The MV of *DecimalDigit :::: 6 or of HexDigit :::: 6* is 6.
- The MV of *DecimalDigit :::: 7 or of HexDigit :::: 7* is 7.
- The MV of *DecimalDigit :::: 8 or of HexDigit :::: 8* is 8.
- The MV of *DecimalDigit :::: 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 *HexIntegerLiteral :::: 0x HexDigit* is the MV of *HexDigit*.
- The MV of *HexIntegerLiteral :::: 0X HexDigit* is the MV of *HexDigit*.
- The MV of *HexIntegerLiteral :::: HexIntegerLiteral HexDigit* is (the MV of *HexIntegerLiteral* times 16) plus the MV of *HexDigit*.

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 character 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 8.5), unless the literal includes a *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.

9.1.4 ToInteger

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

1. Let *number* be the result of calling *ToNumber* on the input argument.
2. ReturnIfAbrupt(*number*).

3. If *number* is NaN, return +0.
4. If *number* is +0, -0, +∞, or -∞, return *number*.
5. Return the result of computing sign(*number*) × floor(abs(*number*)).

9.1.5 ToInt32: (Signed 32 Bit Integer)

The abstract operation ToInt32 converts its 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 the result of calling ToNumber on the input argument.
2. ReturnIfAbrupt(*number*).
3. If *number* is NaN, +0, -0, +∞, or -∞, return +0.
4. Let *int* be sign(*number*) × floor(abs(*number*)).
5. Let *int32bit* be *int* modulo 2^{32} .
6. If *int32bit* is greater than or equal to 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(ToInt32(*x*)) is equal to ToInt32(*x*) for all values of *x*. (It is to preserve this latter property that +∞ and -∞ are mapped to +0.)
- ToInt32 maps -0 to +0.

9.1.6 ToUint32: (Unsigned 32 Bit Integer)

The abstract operation ToUint32 converts its 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 the result of calling ToNumber on the input argument.
2. ReturnIfAbrupt(*number*).
3. If *number* is NaN, +0, -0, +∞, or -∞, return +0.
4. Let *int* be sign(*number*) × floor(abs(*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 +∞ and -∞ are mapped to +0.)
- ToUint32 maps -0 to +0.

9.1.7 ToUint16: (Unsigned 16 Bit Integer)

The abstract operation ToUint16 converts its 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 the result of calling ToNumber on the input argument.
2. ReturnIfAbrupt(*number*).
3. If *number* is NaN, +0, -0, +∞, or -∞, return +0.
4. Let *int* be sign(*number*) × floor(abs(*number*)).
5. Let *int16bit* be *int* modulo 2^{16} .
6. Return *int16bit*.

NOTE Given the above definition of ToUint16:

- The substitution of 2^{16} for 2^{32} in step 4 is the only difference between ToUint32 and ToUint16.
- ToUint16 maps -0 to +0.

Deleted: posInt

Deleted: *

Deleted: posInt

Deleted: ; that is, a finite integer value *k* of Number type with positive sign and less than 2^{32} in magnitude such that the mathematical difference of posInt int and *k* is mathematically an integer multiple of 2^{32}

Deleted: ion

Deleted: posInt

Deleted: posInt

Deleted: ; that is, a finite integer value *k* of Number type with positive sign and less than 2^{32} in magnitude such that the mathematical difference of posInt int and *k* is mathematically an integer multiple of 2^{32}

Deleted: 5

Deleted: posInt

Deleted: posInt

Deleted: ; that is, a finite integer value *k* of Number type with positive sign and less than 2^{16} in magnitude such that the mathematical difference of posInt int and *k* is mathematically an integer multiple of 2^{16}

9.1.8 ToString

The abstract operation `ToString` converts its *argument* to a value of type `String` according to [Table 18](#):

Table 18 — ToString Conversions

Argument Type	Result
Completion Record	If <i>argument</i> is an abrupt completion, return <i>argument</i> . Otherwise return <code>ToPrimitive(argument.[[value]])</code>
Undefined	" <code>undefined</code> "
Null	" <code>null</code> "
Boolean	If <i>argument</i> is <code>true</code> , then return " <code>true</code> ". If <i>argument</i> is <code>false</code> , then return " <code>false</code> ".
Number	See 9.8.1.
String	Return <i>argument</i> (no conversion)
Object	Apply the following steps: 1. Let <i>primValue</i> be <code>ToPrimitive(argument, hint String)</code> . 2. Return <code>ToPrimitive(primValue)</code> .

Deleted: Table 18Table 16Table 15

Deleted: 181615

Deleted: the
Deleted: the result is
Deleted: the
Deleted: the result is
Deleted: the input
Deleted: input

9.1.8.1 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`".
2. If *m* is `+0` or `-0`, return the `String` "`0`".
3. If *m* is less than zero, return the `String` concatenation of the `String` "`-`" and `ToString(-m)`.
4. If *m* is `+∞`, return the `String` "`Infinity`".
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.
6. If $k \leq n \leq 21$, return the `String` consisting of the *k* digits of the decimal representation of *s* (in order, with no leading zeroes), followed by $n-k$ occurrences of the character '`0`'.
7. If $0 < n \leq 21$, return the `String` consisting of the most significant *n* digits of the decimal representation of *s*, followed by a decimal point '`.`', followed by the remaining $k-n$ digits of the decimal representation of *s*.
8. If $-6 < n \leq 0$, return the `String` consisting of the character '`0`', followed by a decimal point '`.`', followed by $-n$ occurrences of the character '`0`', followed by the *k* digits of the decimal representation of *s*.
9. Otherwise, if *k* = 1, return the `String` consisting of the single digit of *s*, followed by lowercase character '`e`', followed by a plus sign '`+`' or minus sign '`-`' according to whether *n*-1 is positive or negative, followed by the decimal representation of the integer `abs(n-1)` (with no leading zeroes).
10. Return the `String` consisting of the most significant digit of the decimal representation of *s*, followed by a decimal point '`.`', followed by the remaining *k*-1 digits of the decimal representation of *s*, followed by the lowercase character '`e`', followed by a plus sign '`+`' or minus sign '`-`' according to whether *n*-1 is positive or negative, followed by the decimal representation of the integer `abs(n-1)` (with no leading zeroes).

Deleted: infinity

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 `ToNumber(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.

Deleted: <http://cm.bell-labs.com/netlib/fp/dtoa.c.gz>
Deleted: http://cm.bell-labs.com/netlib/fp/g_fmt.c.gz

9.1.9 ToObject

The abstract operation `ToObject` converts its *argument* to a value of type `Object` according to [Table 19](#):

Table 19.—ToObject Conversions

Deleted: [Table 19](#)[Table 17](#)[Table 16](#)
Deleted: [191716](#)

Argument Type	Result
Completion Record	If <i>argument</i> is an abrupt completion, return <i>argument</i> . Otherwise return <code>ToObject(<i>argument</i>[[value]])</code> .
Undefined	Throw a <code>TypeError</code> exception.
Null	Throw a <code>TypeError</code> exception.
Boolean	Return a new Boolean object whose <code>[[BooleanData]]</code> internal <code>data</code> property is set to the value of <i>argument</i> . See 15.6 for a description of Boolean objects.
Number	Return a new Number object whose <code>[[NumberData]]</code> internal <code>data</code> property is set to the value of <i>argument</i> . See 15.7 for a description of Number objects.
String	Return a new String object whose <code>[[StringData]]</code> internal <code>data</code> property is set to the value of <i>argument</i> . See 15.5 for a description of String objects.
Object	Return <i>argument</i> (no conversion).

Deleted: Create
Deleted: PrimitiveValue
Deleted: the
Deleted: Create
Deleted: PrimitiveValue
Deleted: the
Deleted: Create
Deleted: PrimitiveValue
Deleted: the
Deleted: The result is
Deleted: the input

9.1.10 ToPropertyKey

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

1. `ReturnIfAbrupt(argument)`.
2. If `Type(argument)` is `Object`, then
 - a. If *argument* is an exotic `Symbol` object, then
 - i. Return *argument*.
3. `Return ToString(argument)`.

Deleted: has a `[[NativeBrand]]` internal property whose value is `NativePrivateName`
Deleted: String

9.1.11 ToPositiveInteger

The abstract operation `ToInteger` converts its argument to an integral numeric value. This abstract operation functions as follows:

1. Let *number* be the result of calling `ToNumber` on the input *argument*.
2. `ReturnIfAbrupt(number)`.
3. If *number* is `NaN`, return `+0`.
4. If *number* is $+\infty$, or $-\infty$, return *number*.
5. If *number* < 0 , return `+0`.
6. Return the result of computing `floor(number)`.

Deleted: i

Deleted: 0

9.2 Testing and Comparison Operations

9.2.1 CheckObjectCoercible

The abstract operation `CheckObjectCoercible` throws an error if its argument is a value that cannot be converted to an `Object` using `ToObject`. It is defined by [Table 20](#):

Deleted: [Table 20](#)[Table 18](#)[Table 17](#)

Table 20 — CheckObjectCoercible Results

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

9.2.2 IsCallable

The abstract operation `IsCallable` determines if its *argument*, which must be an ECMAScript language value or a Completion Record, is a callable function Object according to Table 21:

Table 21 — IsCallable Results

Argument Type	Result
Completion Record	If <i>argument</i> is an abrupt completion, return <i>argument</i> . Otherwise return <code>IsCallable(argument.[[value]])</code>
Undefined	Return false .
Null	Return false .
Boolean	Return false .
Number	Return false .
String	Return false .
Object	If <i>argument</i> has a [[Call]] internal method, then return true , otherwise return false .

9.2.3 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 `Type(x)` is `String`, then
 - a. If *x* and *y* are exactly the same sequence of code units (same length and same code units in corresponding positions) return **true**; otherwise, return **false**.
8. If `Type(x)` is `Boolean`, then
 - a. If *x* and *y* are both **true** or both **false**, then return **true**; otherwise, return **false**.
9. Return **true** if *x* and *y* are the same `Object` value. Otherwise, return **false**.

9.2.4 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 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 **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 Type(*x*) is **String**, then
 - a. If *x* and *y* are exactly the same sequence of code units (same length and same code units in corresponding positions) return **true**; otherwise, return **false**.
8. If Type(*x*) is **Boolean**, then
 - a. If *x* and *y* are both **true** or both **false**, then return **true**; otherwise, return **false**.
9. Return **true** if *x* and *y* are the same **Object** value. Otherwise, return **false**.

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

Formatted: Note

Deleted: 4

Deleted: Callable

Deleted: value

9.2.5 IsConstructor

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

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

Deleted: 5

9.2.6 IsPropertyKey

The abstract operation **IsPropertyKey** determine if its *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 **Object** and *argument* is an exotic **Symbol** object, return **true**.
4. Return **false**.

9.2.7 IsExtensible (O)

The abstract operation **IsExtensible** is used to determine whether additional properties can be added to an object. A Boolean value is return. The operation is called with argument *O* where *O* is the object. This abstract operation performs the following steps:

1. Assert: Type(*O*) is **Object**.
2. Let *notExtensible* be the result of calling the **[[HasIntegrity]]** internal method of *globalObject* with argument "**nonextensible**".
3. ReturnIfAbrupt(*notExtensible*).
4. If *notExtensible* is **true**, then return **false**; else return **true**.

Deleted: Property Access

9.3 Operations on Objects

9.3.1 Get (O, P)

The abstract operation **Get** is used to retrieve the value of an 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:

Deleted: ,

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.

9.3.2 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, then throw a **TypeError** exception.
7. Return $success$.

9.3.3 CreateOwnProperty (O, P, V)

The abstract operation CreateOwnProperty 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 new value for the property. This abstract operation performs the following steps:

1. Assert: Type(O) is Object.
2. Assert: IsPropertyKey(P) is true.
3. Assert: O does not have an own property whose key is P .
4. Let $notExtensible$ be the result of calling the [[HasIntegrity]] internal method of O with argument "nonextensible".
5. ReturnIfAbrupt($notExtensible$).
6. If $notExtensible$ is true, then return false.
7. Let $newDesc$ be the Property Descriptor {[[Value]]: V , [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}.
8. Return the result of calling the [[DefineOwnProperty]] internal method of O passing P and $newDesc$ as arguments.

9.3.4 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 can not 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:

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, then throw a **TypeError** exception.
6. Return $success$.

9.3.5 DeletePropertyOrThrow (O, P)

The abstract operation Put 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.

Deleted: Either

Deleted: Type

Deleted: String

Deleted: or Type(O) is Object and O is a Symbol object

Deleted: P

Deleted: n

Deleted: ,

Deleted: Either Type(P) is String or Type(O) is Object and O is a Symbol object

Deleted: P

Deleted: ,

Deleted: Either Type(P) is String or Type(O) is Object and O is a Symbol object

Deleted: e

Deleted: Get

Deleted: Is

Deleted: Extensible

Deleted: e

Deleted: e

Deleted: false

Deleted: record

Deleted: s

Deleted: Either Type(P) is String or Type(O) is Object and O is a Symbol object

Deleted: ,

Deleted: Either Type(P) is String or Type(O) is Object and O is a Symbol object

4. ReturnIfAbrupt(success).
5. If success is false, then throw a **TypeError** exception.
6. Return success.

9.3.6 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 return. 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* argument *P*.

9.3.7 GetMethod (O, P)

The abstract operation **GetMethod** is used to get the value of an 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:

1. Assert: Type(*O*) is Object.
2. Assert: IsPropertyKey(*P*) is true.
3. Let *func* be the result of calling the [[Get]] internal method of *O* passing *P* and *O* as the arguments.
4. ReturnIfAbrupt(*func*).
5. If *func* is undefined, then return undefined.
6. If IsCallable(*func*) is false, then throw a **TypeError** exception.
7. Return *func*.

9.3.8 Invoke(O,P,[args])

The abstract operation **Invoke** is used to call a method property of an object. The operation is called with arguments *P*, *O*, and optionally *args* where *P* is the property key, *O* serves as both the lookup point for the property and the **this** value of the call, and *args* is the list of arguments values passed to the method. If *args* 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 *args* was not passed, then let *args* be a new empty List.
3. Let *obj* be ToObject(*O*).
4. ReturnIfAbrupt(*obj*).
5. Let *func* be the result of GetMethod(*obj*, *P*).
6. ReturnIfAbrupt(*func*).
7. If *func* is undefined, throw a **TypeError** exception.
8. Return the result of calling the [[Call]] internal method of *func* passing *O* as **thisArgument** and *args* as **argumentsList**.

9.3.9 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 *keys* be the result of calling [[OwnPropertyKeys]] internal method of *O*.
4. ReturnIfAbrupt(*keys*).
5. Let *pendingException* be undefined.
6. If *level* is "sealed", then
 - a. Repeat for each element *k* of *keys*.
 - i. Let *status* be the result of DefinePropertyOrThrow(*O*, *k*, PropertyDescriptor { [[Configurable]]: false }).
 - ii. If *status* is an Abrupt Completion, then

Deleted: ,
Deleted: Either Type(<i>P</i>) is String or Type(<i>O</i>) is Object and is a Symbol object
Deleted: <#>Let <i>obj</i> be <i>O</i> . <#>Repeat, <#>If <i>obj</i> is null, then return false. <#>If Type(<i>obj</i>) is not Object, then throw a TypeError exception. <#>Let <i>has</i> be the result of calling the [[HasOwnProperty]] internal method of <i>obj</i> argument <i>P</i> . <#>ReturnIfAbrupt(<i>has</i>). <#>If <i>has</i> is true, return <i>has</i> . <#>Set <i>obj</i> to the result of calling the [[GetInheritance]] internal method of <i>obj</i> .
Deleted: IfAbrupt(<i>obj</i>).
Deleted: ,
Deleted: Either Type(<i>P</i>) is String or Type(<i>O</i>) is Object and is a Symbol object
Deleted: <i>P</i>
Deleted:
Deleted: <i>V</i>
Deleted: 1
Deleted: ,
Deleted: Invoke
Deleted: ion
Deleted: abstract
Deleted: ,
Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: passing
Deleted: as
Deleted: the argument
Deleted: IsCallable(
Deleted:)
Deleted: false
Deleted: the this value
Deleted: argument list
Deleted: MakeObjectSecure
Deleted: immutable
Deleted: MakeObjectSecure
Deleted: If the Boolean argument immutable is true all own data properties are also made non-writable.
Deleted: ,
Deleted: <#>Assert: Type(<i>immutable</i>) is Boolean.
Deleted: immutable
Deleted: false

1. If *pendingException* is **undefined**, then set *pendingException* to *status*.
7. Else *level* is "**frozen**".
 - a. Repeat for each element *k* of *keys*.
 - i. Let *status* be the result of calling the **[[GetOwnProperty]]** internal method of *O* with *k*.
 - ii. If *status* is an Abrupt Completion, then
 1. If *pendingException* is **undefined**, then set *pendingException* to *status*.
 - iii. Else
 1. Let *currentDesc* be *status*.**[[value]]**.
 2. If *currentDesc* is not **undefined**, then
 - a. If *IsAccessorDescriptor*(*currentDesc*) is **true**, then
 - i. Let *desc* be **PropertyDescriptor**{**[[Configurable]]**: **false**}.
 - b. Else
 - i. Let *desc* be **PropertyDescriptor** **[[Configurable]]**: **false**, **[[Writable]]**: **false**.
 - c. Let *status* be the result of **DefinePropertyOrThrow**(*O*, *k*, *desc*).
 - d. If *status* is an Abrupt Completion, then
 - i. If *pendingException* is **undefined**, then set *pendingException* to *status*.
 8. If *pendingException* is not **undefined**, then return *pendingException*.
 9. Return the result of calling the **[[PreventExtensions]]** internal method of *O*.

9.3.10 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**.
2. Assert: *level* is either "**sealed**" or "**frozen**".
3. Let *status* be the result of **IsExtensible**(*O*).
4. ReturnIfAbrupt(*status*).
5. If *status* is **true**, then return **false**.
6. NOTE If the object is extensible, none of its properties are examined.
7. Let *keys* be the result of calling **[[OwnPropertyKeys]]** internal method of *O*.
8. ReturnIfAbrupt(*keys*).
9. Let *pendingException* be **undefined**.
10. Let *configurable* be **false**.
11. Let *writable* be **false**.
12. Repeat for each element *k* of *keys*.
 - a. Let *status* be the result of calling the **[[GetOwnProperty]]** internal method of *O* with *k*.
 - b. If *status* is an Abrupt Completion, then
 - i. If *pendingException* is **undefined**, then set *pendingException* to *status*.
 - ii. Let *configurable* be **true**.
 - c. Else
 - i. Let *currentDesc* be *status*.**[[value]]**.
 - ii. If *currentDesc* is not **undefined**, then
 1. Set *configurable* to *configurable* logically ored with *currentDesc*.**[[Configurable]]**.
 2. If *IsDataDescriptor*(*currentDesc*) is **true**, then
 - a. Set *writable* to *writable* logically ored with *currentDesc*.**[[Writable]]**.
13. If *pendingException* is not **undefined**, then return *pendingException*.
14. If *level* is "**frozen**" and *writable* is **true**, then return **false**.
15. If *configurable* is **true**, then return **false**.
16. Return **true**.

9.3.11 CreateArrayFromList (*elements*)

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

1. Assert: *elements* is a List whose elements are all ECMA Script language values.

Comment [AWB1451]: TODO: don't freeze private symbol properties.

Deleted: *TestIfSecureObject*

Deleted: *immutable*

Deleted: *TestIfSecureObject*

Deleted: If the Boolean argument *immutable* is **true** a check is also made to determine whether all own data properties are non-writable.

Deleted: ,

Deleted: <#>Assert: **Type**(*immutable*) is Boolean.

Deleted: calling the **[[**

Deleted: *Get*

Deleted: **]]** internal method of

Deleted:

Deleted: <#>If *immutable* is **false**, then

Deleted: *immutable*

Deleted: *true*

Deleted: ,

2. Let *array* be the result of the abstract operation *ArrayCreate* with argument *O*.
3. Let *n* be 0.
4. For each element *e* of *elements*
 - a. Call *CreateOwnProperty*(*array*, *ToString(n)*, *e*).
 - b. Assert: the call in step 4.a will never result in an abrupt completion.
 - c. Increment *n* by 1.
5. Return *array*.

9.3.12 OrdinaryHasInstance (C, O)

The abstract operation *OrdinaryHasInstance* implements the default algorithm for determining if an object *O* inherits from the inheritance path used 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 data property, then
 - a. Let *BC* be the value of *C*'s *[[BoundTargetFunction]]* internal data property.
 - b. Return the result of *instanceofOperator(O, BC)* (see 11.8).
3. If *Type(O)* is not *Object*, return **false**.
4. Let *P* be the result of *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 *[[GetInheritance]]* 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**.

Deleted: ,

Deleted: the

Deleted: O

Deleted: abstract operation

Deleted:) with *C* and *O* as arguments

Deleted: an

9.3.13 GetPrototypeOfConstructor (constructor, intrinsicDefaultProto)

The abstract operation *GetPrototypeOfConstructor* 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:

1. Assert: *intrinsicProto* 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. If *IsConstructor(constructor)* is **false**, then throw a **TypeError** exception.
3. Let *proto* be the result of *Get(constructor, "prototype")*.
4. *ReturnIfAbrupt(proto)*.
5. If *Type(proto)* is not *Object*, then
 - a. If *constructor* has a *[[Realm]]* internal data property, let *realm* be *F*'s *[[Realm]]*.
 - b. Else
 - i. Let *ctx* be the running execution context.
 - ii. Let *realm* be *ctx*'s *Realm*.
 - c. Let *proto* be *realm*'s intrinsic object named *intrinsicDefaultProto*.
6. Return *proto*.

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. This accounts for the possibility that a built-in @@create method from a different Code Realm might be installed on *constructor*.

9.3.13 OrdinaryCreateFromConstructor (constructor, intrinsicDefaultProto, internalDataList)

The abstract operation *OrdinaryCreateFromConstructor* creates an ordinary object whose *[[Prototype]]* value is retrieved from a constructor's *prototype* property, if it exists. Otherwise the supplied default is used for *[[Prototype]]*. The optional *internalDataList* is a List of the names of internal data property names that should 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: *intrinsicProto* 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 the result of `GetPrototypeOfFromConstructor(constructor, intrinsicDefaultProto)`.
3. ReturnIfAbrupt(*proto*).
4. Return the result of the abstract operation `ObjectCreate(proto, internalDataList)`.

10 Executable Code and Execution Contexts

10.1 Types of Executable Code

There are five types of ECMAScript executable 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 *FunctionBody*, *ConciseBody*, *ClassBody*, or *ModuleBody*.
- *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 `[[Code]]` internal data property (see 13.6) of function and generator objects. 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 *FunctionBody*, *ConciseBody*, or *ClassBody*.
- *Generator code* is source text that is parsed to supply the value of the `[[Code]]` internal data property (see 13.5) of generator objects. The generator code of a particular generator does not include any source text that is parsed as the function code of a nested *FunctionBody*, *ConciseBody*, or *ClassBody*. All generator code is also considered to be function code, but only function code that is defined within a generator is generator code.
- *Module code* is source text that is parse 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 *FunctionBody*, *ConciseBody*, *ClassBody*, or *ModuleBody*.

NOTE Function code is generally provided as the bodies of Function Definitions (13.1), Arrow Function Definitions (13.2), Method Definitions (13.3) and Generator Definitions (13.4). Function code is also derived from the last argument to the Function constructor (15.3). Generator code is provided as the bodies of Generator Definitions 13.4 and Generator Expressions (11.????).

10.1.1 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 three types of ECMAScript code are referred to as 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).
- Module code is always strict code.
- All code contained in a *ClassBody* is 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 15.1.2.1.1) to the eval function that is contained in strict mode code.

Deleted: <#> If `Type(constructor)` is not Object then throw a `TypeError` exception. ¶

<#> Let *proto* be the result of `Get(constructor, "prototype")`. ¶

<#> ReturnIfAbrupt(*proto*). ¶

<#> If `Type(proto)` is not Object, then ¶

<#> If *constructor* has a `[[Realm]]` internal data property, let *realm* be *F*'s `[[Realm]]`. ¶

<#> Else, ¶

<#> Let *ctx* be the running execution context. ¶

<#> Let *realm* be *ctx*'s `[[Realm]]`. ¶

<#> Let *proto* be *realm*'s intrinsic object named `intrinsicDefaultProto`. ¶

Deleted: with argument

Deleted:

Deleted: NOTE If *constructor* does not supply a `[[Prototype]]` value, the default value that is used is obtained from the Co Realm of the *constructor* function rather than from the running execution context. This accounts for the possibility that a built-in @@create method from a different Code Realm might be installed on *constructor*. ¶

Deleted: three

Deleted: Program

Deleted: Program

Deleted: Program

Deleted: Program

Comment [AWB752]: TODO: may need an additional reference to the `[[Code]]` of a generator.

Deleted: 5

Deleted: as part of a *FunctionBody*.

Deleted: *FunctionBody*

Deleted: part

Deleted: function or generator

Deleted: *FunctionBody*

Deleted: Function code also denotes the source text supplied when using the built-in *Function* object as a constructor. More precisely, the last parameter provided to the *Function* constructor is converted to a String and treated as the *FunctionBody*. If more than one parameter is provided to the *Function* constructor, all parameters except the last one are converted to Strings and concatenated together, separated by commas. The resulting String is interpreted as the *FormalParameterList* for the *FunctionBody* defined by the last parameter. The function code for a particular instantiation of a *Function* does not include any source text that is parsed as part of a nested *FunctionBody*.

Comment [AWB1153]: TODO

Deleted: Program

- Function code that is part of a *FunctionDeclaration*, *FunctionExpression*, or accessor *PropertyDefinition* is strict function code if its *FunctionDeclaration*, *FunctionExpression*, or *PropertyDefinition* is contained in strict mode code or if the function code begins with a Directive Prologue that contains a Use Strict Directive.
- 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.

Deleted: *PropertyAssignment*

Deleted: *PropertyAssignment*

10.1.2 Non-ECMAScript Functions

An ECMAScript implementation may support the evaluation of 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.

Deleted: ¶

Deleted: <#> Unless specified otherwise, extended code (10.21.12) is also considered strict mode code.¶

10.2 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.

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.

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

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.

10.2.1 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*

Deleted: 10.1.2 Extended Code¶

Extended code is any any code contained in an ECMAScript Program syntactic unit that contains occurrences of lexical or syntactic productions defined subsequent to the Fifth Edition of the ECMAScript specification. Code is interpreted as extended code in the following situations:¶

<#> Global code is extended global code if it is contained in an ECMAScript Program syntactic unit that has been designated as an extended Program unit in an implementation defined manner or if ???¶

<#> Eval code is extended eval code if the call to eval is a direct call (see 15.1.2.1) to the eval function that is contained in extended mode code or if it begins with ???¶

<#> Function code that is part of a *FunctionDeclaration*, *FunctionExpression*, or accessor *PropertyAssignment* is extended function code if its *FunctionDeclaration*, *FunctionExpression*, or *PropertyAssignment* is contained in extended mode code or if the function code begins with ???¶

<#> 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 ???¶

The term "strict code" includes is used to designate both actual strict mode code and extended code while the term "extended code" is used only to mean actual extended code.

Deleted: *WithStatement*

Deleted: execution

Deleted: the

Deleted: *Program* and

are specializations that are used for specifically for *Script* global declarations and for top-level declarations within funtions.

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 are a subclass of declarative environment record. The abstract class includes the abstract specification methods defined in Table 22. These abstract methods have distinct concrete algorithms for each of the concrete subclasses.

Deleted: two

Deleted: and

Deleted: Table 22Table 20Table 19

Deleted: 222019

Table 22.— Abstract Methods of Environment Records

Method	Purpose
HasBinding(N)	Determine if an environment record has a binding for an identifier. Return true if it does and false if it does not. The String value <i>N</i> is the text of the identifier.
CreateMutableBinding(N, D)	Create a new <u>but uninitialised mutable</u> binding in an environment record. The String value <i>N</i> is the text of the bound name. If the optional Boolean argument <i>D</i> is true the binding is may be subsequently deleted.
CreateImmutableBinding(N)	<u>Create a new but uninitialised immutable binding in an environment record. The String value N is the text of the bound name.</u>
InitializeBinding(N,V)	<u>Set the value of an already existing but uninitialised binding in an environment record. The String value N is the text of the bound name. V is the value for the binding and is a value of any ECMAScript language type.</u>
SetMutableBinding(N,V, S)	Set the value of an already existing mutable binding in an environment record. The String value <i>N</i> is the text of the bound name. <i>V</i> is the value for the binding and may be a value of any ECMAScript language type. <i>S</i> is a Boolean flag. If <i>S</i> is true and the binding cannot be set throw a TypeError exception. <i>S</i> is used to identify strict mode references.
GetBindingValue(N,S)	Returns the value of an already existing binding from an environment record. The String value <i>N</i> is the text of the bound name. <i>S</i> is used to identify strict mode references. If <i>S</i> is true and the binding does not exist or is uninitialised throw a ReferenceError exception.
DeleteBinding(N)	Delete a binding from an environment record. The String value <i>N</i> is the text of the bound name. If a binding for <i>N</i> 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 .

Deleted: CreateVarBinding(N, D)

Deleted: ImplicitThisValue

Deleted: Returns the value to use as the this value on calls to function objects that are obtained as binding values from this environment record.

10.2.1.1 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.

10.2.1.1.1 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. If it does not have such a binding, return `false`.

10.2.1.1.2 CreateMutableBinding (N, D)

The concrete Environment Record method `CreateMutableBinding` for declarative environment records creates a new mutable binding for the name `N` that is uninitialised. 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.

Deleted: to the value `undefined`
Deleted:

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 uninitialised. If `D` is `true` record that the newly created binding may be deleted by a subsequent `DeleteBinding` call.
4. Return `NormalCompletion(empty)`

Deleted: and
Deleted: set its bound value to `undefined`

10.2.1.1.3 CreateImmutableBinding (N)

The concrete Environment Record method `CreateImmutableBinding` for declarative environment records creates a new immutable binding for the name `N` that is uninitialised. A binding must not already exist in this environment record for `N`.

Comment [AWB54]: This probably needs a `D` option argument, just like `createMutableEnvironment`

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 uninitialised.

10.2.1.1.4 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 uninitialised binding for `N` must already exist.

1. Let `envRec` be the declarative environment record for which the method was invoked.
2. Assert: `envRec` must have an uninitialised 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 initialised.

Deleted: 3

10.2.1.1.5 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` must already exist. 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. Assert: `envRec` must have a binding for `N`.
3. If the binding for `N` in `envRec` is a mutable binding, change its bound value to `V`.
4. Else if binding for `N` in `envRec` has not yet been initialized throw a `ReferenceError` exception.
5. Else this must be an attempt to change the value of an immutable binding so if `S` is `true` throw a `TypeError` exception.
6. Return `NormalCompletion(empty)`.

Deleted: if

Deleted: `undefined`

10.2.1.1.6 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`. The binding must already exist. If `S` is `true` and the binding is an uninitialised immutable binding throw a `ReferenceError` exception.

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 uninitialised binding, then
 - a. If `S` is `false`, return the value `undefined`, otherwise throw a `ReferenceError` exception.
4. Else
 - a. Return the value currently bound to `N` in `envRec`.

10.2.1.1.7 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`.

10.2.1.1.8 HasThisBinding ()

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

1. Return `false`.

10.2.1.1.9 HasSuperBinding ()

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

1. Return `false`.

10.2.1.1.10 WithBaseObject()

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

1. Return `undefined`.

10.2.1.2 Object Environment Records

Each object environment record is associated with an object called its *binding object*. An object environment record binds the set of identifier names that directly correspond to the property names of its binding object. Property names that are not 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 (12.10) 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.

Deleted: 4

Deleted: immutable

Deleted: ,

Deleted: return

Deleted: 5

Deleted: is

Deleted: 10.2.1.1.6 CreateVarBinding (N,
The concrete Environment Record method CreateVarBinding for declarative environment records performs the same action as the CreateMutableBinding concrete method of the same environment Record.||

Let `envRec` be the declarative environment record for which the method was invoked.
Return the result of calling `envRec`'s CreateMutableBinding concrete method w arguments `N` and `D`.||

Deleted: 7

Deleted: 8

Deleted: 6

Deleted: 9

Deleted: ImplicitThisValue

Deleted: ImplicitThisValue

Comment [AWB55]: This probably needs a option argument, just like createMutableEnvironment

Deleted: 10.2.1.1.710 CreateImmutableBinding (N)||

The concrete Environment Record method CreateImmutableBinding for declarative environment records creates a new immutable binding for the name `N` that is initialised to the value `undefined`. A binding must not already exist in this environment record for `N`.||

Let `envRec` be the declarative environment record for which the method was invoked.
Assert: `envRec` does not already have a binding for `N`.||

Create an immutable binding in `envRec` and record that it is uninitialised.||

10.2.1.1.811 InitializeImmutableBinding (N,V)||

The concrete Environment Record method InitializeImmutableBinding 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 uninitialised immutable binding for `N` must already exist.||

Let `envRec` be the declarative environment record for which the method was invoked.
Assert: `envRec` must have an uninitialised immutable binding for `N`.||

Set the bound value for `N` in `envRec` to `V`.||

Deleted: be configured to

Deleted: This capability is used to specify the behaviour of With Statement (12.10) induced bindings.

Deleted: provideThis

Deleted: provideThis

10.2.1.2.1 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. Return the result of `HasProperty(bindings, N)`.

10.2.1.2.2 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 initialises it to the value `undefined`. A property named *N* must not already exist in the binding object. 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`.

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

10.2.1.2.3 CreateImmutableBinding (N)

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

10.2.1.2.4 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 uninitialised binding for *N* must already exist.

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

10.2.1.2.5 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 the result of `Put(bindings, N, V, and S)`.

10.2.1.2.6 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 the result of `HasProperty(bindings, N)`.

Deleted: calling
Deleted: the `[[HasProperty]]` internal method of
Deleted: , passing
Deleted: as the property name

Deleted: calling the `[[HasProperty]]` internal method of
Deleted: passing
Deleted: as the property name
Deleted: ,
Deleted:
Deleted: Call
Deleted: the
Deleted: `[[DefineOwnProperty]]` internal method of
Deleted: passing
Deleted: ,
Deleted: , and true as arguments
Comment [AWB56]: This probably needs a *D* option argument, just like `createMutableEnvironment`
Deleted: 1
Deleted: 1

Deleted: 3

Deleted: should

Deleted: Call
Deleted: calling the `[[`
Deleted: `]]` internal method of
Deleted:
Deleted: with arguments
Deleted: 4
Deleted: calling the `[[HasProperty]]` internal method of
Deleted: passing
Deleted: as the property name

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 the result of `Get(bindings, N)`.

10.2.1.2.7 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.

10.2.1.2.8 HasThisBinding ()

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

1. `Return false.`

10.2.1.2.9 HasSuperBinding ()

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

1. `Return false.`

10.2.1.2.10 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`.

10.2.1.3 Function Environment Records

A function environment record is a declarative environment record that is used to represent the outermost scope of a function that provides a `this` binding. In addition to its identifier bindings, a function environment record contains the `this` value used within its scope. If such a function 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 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`.

Methods environment records support all of Declarative Environment Record methods listed in Table 22 and share the same specifications for all of those methods except for `HasThisBinding` and `HasSuperBinding`. In addition, declarative environment records support the methods listed in Table 23:

Table 23.— Additional Methods of Function Environment Records

Method	Purpose
<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> binding. If the value is <code>Empty</code> , return <code>undefined</code> .

- Deleted:** calling the `[[Delete]]` internal method of
Deleted: `N`
Deleted: passing
Deleted: for the argument
Deleted: `5`
- Deleted:** ,
Deleted: and `false`
Deleted: `s`
- Deleted:** 10.2.1.12.6 CreateVarBinding (`N` and `D`)
The concrete Environment Record method `CreateVarBinding` for object environment records performs the same action as the `CreateMutableBinding` concrete method of the same environment Record.
Let `envRec` be the declarative environment record for which the method was invoked.
Return the result of calling `envRec`'s `CreateMutableBinding` concrete method with arguments `N` and `D`. ¶
- Deleted:** 7
Deleted: 8
Deleted: 6
Deleted: 9
Deleted: `ImplicitThisValue`
Deleted: `ImplicitThisValue`
Deleted: `provideThis`
Deleted: `provideThis`
Deleted: 4
Deleted: `Method`
Deleted: `method`
Deleted: `method`
Deleted: `method`
Deleted: `Method`
Deleted: and Table 20
Deleted: those
Deleted: `j`
Deleted:
Deleted: Table 23Table 21Table 20
Deleted: Table 21
Deleted: 2321202021
Deleted: `Method`
Deleted: `Home`
Deleted: `Object`
Deleted: `value`
Deleted: `of`

<u>GetMethodName()</u>	Return the value of this environment record's <i>MethodName</i> binding.
------------------------	--------------------------------------------------------------------------

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

10.2.1.3.1 HasThisBinding ()

Function Environment Records always provide a *this* binding.

1. Return **true**.

10.2.1.3.2 HasSuperBinding ()

1. If this environment record's *HomeObject* has the value *Empty*, then return **false**. Otherwise, return **true**.

10.2.1.3.3 GetThisBinding ()

1. Return the value of this environment record's *thisValue*.

10.2.1.3.4 GetSuperBase ()

1. Let *home* be the value of this environment record's *HomeObject*.
2. If *home* has the value *Empty*, then return **undefined**.
3. Assert *Type(home)* is *Object*.
4. Return the result of calling *home*'s *[[GetInheritance]]* internal method.

10.2.1.3.5 GetMethodName ()

1. Return the value of this environment record's *MethodName*.

10.2.1.4 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 (10.3). A global environment provides the bindings for built-in globals (15.1), 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 *thisValue*. The object environment record component of a global environment record contains the bindings for all built-in globals (15.1) and all bindings introduced by a *FunctionDeclaration* 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* or *VariableStatement* 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 state components listed in Table 24 and the additional methods listed in Table 25.

Deleted: Method

Deleted: Regular

Deleted: Method

Deleted: HomeObject

Deleted: this environment record's *HomeObject*

Deleted:

Deleted: Otherwise, r

Deleted: value

Deleted: of

Deleted: Prototype

Deleted: property

Deleted: *HomeObject* value

Deleted: is

Deleted: of a

Deleted: Program

Deleted: If such a function references *super*.

Deleted: Program

Deleted: All ECMAScript *Program* productions that are processed in a specific Realm (10.3) share the same global environment record..

Deleted: composit

Deleted: Table 24Table 22Table 21

Deleted: Table 25Table 23Table 22

Table 24 -- Components of Global Environment Records

Component	Purpose
<u>ObjectEnvironment</u>	A Object Environment Record whose base object is the global object. Contains global built-in bindings as well as bindings for <i>FunctionDeclaration</i> or <i>VariableStatement</i> declarations in global code for the associated Realm.
<u>DeclarativeEnvironment</u>	A Declarative Environment Record that contains bindings for all declarations in global for the associated Realm code except for <i>FunctionDeclaration</i> and <i>VariableStatement</i> declarations.
<u>VarNames</u>	A List containing the string names bound by <i>FunctionDeclaration</i> or <i>VariableStatement</i> declarations in global code for the associated Realm.

Deleted: 242221

Deleted: o

Deleted: r

Table 25 — Additional Methods of Global Environment Records

Method	Purpose
<u>GetThisBinding()</u>	Return the value of this environment record's <i>this</i> binding.
<u>HasVarDeclaration (N)</u>	Determines if the argument identifier has a binding in this environment record that was created using a <i>VariableStatement</i> or a <i>FunctionDeclaration</i> .
<u>HasLexicalDeclaration (N)</u>	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> .
<u>CanDeclareGlobalVar (N)</u>	Determines if a corresponding <i>CreateGlobalVarBinding</i> call would succeed if called for the same argument <i>N</i> .
<u>CanDeclareGlobalFunction (N)</u>	Determines if a corresponding <i>CreateGlobalFunctionBinding</i> call would succeed if called for the same argument <i>N</i> .
<u>CreateGlobalVarBinding(N, D)</u>	Used to create global <i>var</i> bindings in the <i>ObjectEnvironmentComponent</i> of the environment record. The binding will be a mutable binding. The corresponding global object property will have attribute values appropriate for a <i>var</i> . 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 <i>true</i> the binding may be subsequently deleted. This is logically equivalent to <i>CreateMutableBinding</i> but it allows <i>var</i> declarations to receive special treatment.
<u>CreateGlobalFunctionBinding(N, V, D)</u>	Used to create and initialize global <i>function</i> bindings in the <i>ObjectEnvironmentComponent</i> of the environment record. The binding will be a mutable binding. The corresponding global object property will have attribute values appropriate for a <i>function</i> . The String value <i>N</i> is the text of the bound name. If the optional Boolean argument <i>D</i> is <i>true</i> the binding may be subsequently deleted. This is logically equivalent to <i>CreateMutableBinding</i> followed by a <i>SetMutableBinding</i> but it allows function declarations to receive special treatment.

Deleted: 252322

Deleted: or

Deleted: or

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

10.2.1.4.1 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`'s DeclarativeEnvironment.
3. If the result of calling `DclRec`'s HasBinding concrete method with argument `N` is `true`, return `true`.
4. Let `ObjRec` be `envRec`'s ObjectEnvironment.
5. Return the result of calling `ObjRec`'s HasBinding concrete method with argument `N`.

Deleted: n

Deleted: n

10.2.1.4.2 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 DeclarativeEnvironment. A binding for `N` must not already exist in the DeclarativeEnvironment. 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`'s DeclarativeEnvironment.
3. Assert: `DclRec` does not already have a binding for `N`.
4. Create a mutable binding in `DclRec` 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.
5. Return `NormalCompletion(empty)`.

Deleted: or

Deleted: and

10.2.1.4.3 CreateImmutableBinding (N)

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`.

Comment [AWB57]: This probably needs a `D` option argument, just like `createMutableEnvironment`

1. Let `envRec` be the global 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.

10.2.1.4.4 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.

1. Let `envRec` be the global environment record for which the method was invoked.
2. Let `DclRec` be `envRec`'s DeclarativeEnvironment.
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. Let `ObjRec` be `envRec`'s ObjectEnvironment.
5. If the result of calling `ObjRec`'s HasBinding concrete method with argument `N` is `true`, then
 - a. Set the bound value for `N` in `envRec` to `V`.
 - b. Record that the binding for `N` in `envRec` has been initialized.

Deleted: n

Deleted: the

Deleted: Declarative

Deleted: n

10.2.1.4.5 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 declarative environment record for which the method was invoked.
2. Let `DclRec` be `envRec`'s DeclarativeEnvironment.
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`'s ObjectEnvironment.
5. Return the result of calling the `SetMutableBinding` concrete method of `ObjRec` with arguments `N`, `V`, and `S`.

Deleted: n

Deleted: Declarative

10.2.1.4.6 GetBindingValue(N,S)

The concrete Environment Record method `GetBindingValue` for global environment records simply returns the value of its bound identifier whose name is the value of the argument `N`. If `S` is `true` and the binding is an uninitialised 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`.

1. Let `envRec` be the declarative environment record for which the method was invoked.
2. Let `DclRec` be `envRec`'s `DeclarativeEnvironment`.
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`'s `ObjectEnvironment`.
5. Return the result of calling the `GetBindingValue` concrete method of `ObjRec` with arguments `N`, and `S`.

Deleted: n

Deleted: V;

Deleted: Declarative

Deleted: V;

10.2.1.4.7 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 declarative environment record for which the method was invoked.
2. Let `DclRec` be `envRec`'s `DeclarativeEnvironment`.
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`'s `ObjectEnvironment`.
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 `DclRec` with argument `N`.
 - b. `ReturnIfAbrupt(status)`.
 - c. If `status` is `true`, then
 - i. Let `varNames` be `envRec`'s `VarNames` List.
 - ii. If `N` is an element of `varNames`, then remove that element from the `varNames`.
 - d. Return `status`.
6. Return `true`.

Deleted: n

Deleted: n

10.2.1.4.8 HasThisBinding ()

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

1. Return `true`.

10.2.1.4.9 HasSuperBinding ()

1. Return `false`.

10.2.1.4.10 WithBaseObject()

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

1. Return `undefined`.

10.2.1.4.11 GetThisBinding ()

2. Let `envRec` be the global environment record for which the method was invoked.
3. Let `ObjRec` be `envRec`'s `ObjectEnvironment`.
4. Let `bindings` be the binding object for `ObjRec`.
5. Return `bindings`.

10.2.1.4.12 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`'s `VarNames` List.
3. If `varDeclaredNames` contains the value of `N`, return `true`.
4. Return `false`.

10.2.1.4.13 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`'s `DeclarativeEnvironment`.
3. Return the result of calling `DclRec`'s `HasBinding` concrete method with argument `N`.

10.2.1.4.14 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`'s `ObjectEnvironment`.
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 the result of `IsExtensible(bindings)`.
6. Return `extensible`.

Deleted: <#>If the result of calling the [[GetIsExtensible] internal propertymethod of `bindings` is `true`, return `true`.>

Deleted: `false`

10.2.1.4.15 CanDeclareGlobalFunction (N)

The concrete environment record method `CanDeclareGlobalVar` 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`'s `ObjectEnvironment`.
3. Let `globalObject` be the binding object for `ObjRec`.
4. Let `extensible` be the result of `IsExtensible(globalObject)`.
5. Return `IfAbrupt(extensible)`.
6. If the result of calling `ObjRec`'s `HasBinding` concrete method with argument `N` is `false`, then return `extensible`.
7. Let `existingProp` be the result of calling the [[GetOwnProperty]] internal method of `globalObject` with argument `N`.
8. If `existingProp` is `undefined`, then return `extensible`.
9. If `existingProp.[[Configurable]]` is `true`, then return `true`.
10. If `IsDataDescriptor(existingProp)` is `true` and `existingProp` has attribute values `{[[Writable]]: true, [[Enumerable]]: true}`, then return `true`.
11. Return `false`.

Deleted: `value`

Deleted: calling of the [[GetIsExtensible]] internal propertymethod of

10.2.1.4.16 CreateGlobalVarBinding (N, D)

The concrete Environment Record method `CreateVarBinding` 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.

Comment [AWB1158]: Carry over from ES5, but perhaps unnecessary

1. Let *envRec* be the declarative environment record for which the method was invoked.
2. Let *ObjRec* be *envRec*'s ObjectEnvironment.
3. Assert: The result of calling *envRec*'s *CanDeclareGlobalVar* concrete method with argument *N* is **true**.
4. If the result of calling *ObjRec*'s *HasBinding* concrete method with argument *N* is **false**, then
 - a. Call the *CreateMutableBinding* concrete method of *ObjRec* with arguments *N* and *D*.
5. Let *varDeclaredNames* be *envRec*'s VarNames List.
6. If *varDeclaredNames* does not contain the value of *N*, then
 - a. Append *N* to *varDeclaredNames*.
7. Return.

Deleted: n

Deleted: s

10.2.1.4.17 CreateGlobalFunctionBinding (N, V, D)

The concrete Environment Record method *CreateFunctionBinding* 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 declarative environment record for which the method was invoked.
2. Let *ObjRec* be *envRec*'s ObjectEnvironment.
3. Assert: The result of calling *envRec*'s *CanDeclareGlobalFunction* concrete method with argument *N* is **true**.
4. Let *globalObject* be the binding object for *ObjRec*.
5. Let *existingProp* be the result of calling the *[[GetOwnProperty]]* internal method of *globalObject* with argument *N*.
6. If *existingProp* is **undefined** or *existingProp.[[Configurable]]* is **true**, then
 - a. Call the *[[DefineOwnProperty]]* internal method of *globalObject* passing *N* and Property Descriptor *{[[Value]]: V, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: D}* as arguments.
7. Else,
 - a. Call the *[[DefineOwnProperty]]* internal method of *globalObject* passing *N* and Property Descriptor *{[[Value]]: V}* as arguments.
8. NOTE The assertion in step 3 means that the above *[[DefineOwnProperty]]* calls will never return **false** or an abrupt completion.
9. Let *varDeclaredNames* be *envRec*'s VarNames List.
10. If *varDeclaredNames* does not contain the value of *N*, then
 - a. Append *N* to *varDeclaredNames*.
11. Return.

Deleted: n

Deleted: ,

Deleted: , and false

Deleted: ,

Deleted: ,

Deleted: , and false

Comment [AWB1259]: TODO: need to reconsider this? May not be true if the global object can be a Proxy.

Deleted: s

Deleted: ¶

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

10.2.2 Lexical Environment Operations

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

10.2.2.1 GetIdentifierReference (lex, name, strict)

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(N)* concrete method of *envRec* passing *name* as the argument *N*.
4. 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*.
5. Else
 - a. Let *outer* be the value of *lex*'s outer environment reference.
 - b. Return the result of calling *GetIdentifierReference* passing *outer*, *name*, and *strict* as arguments.

Deleted: n

Deleted: identifier

Deleted: mode

Deleted: mode

10.2.2.2 NewDeclarativeEnvironment (E)

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 .

10.2.2.3 NewObjectEnvironment (O, E)

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 be $envRec$.
4. Set the outer lexical environment reference of env to E .
5. Return env .

10.2.2.4 NewFunctionEnvironment (F, T)

When the abstract operation `NewFunctionEnvironment` is called with an ECMAScript function Object F and a ECMAScript value T as arguments, the following steps are performed:

1. Assert: F 's `thisMode` is not lexical.
2. Let env be a new Lexical Environment.
3. Let $envRec$ be a new Function environment record containing containing no bindings.
4. Set $envRec$'s `thisValue` to T .
5. If F has a `[[HomeObject]]` internal data property, then
 - a. Set $envRec$'s `HomeObject` to the value of F 's `[[HomeObject]]` internal data property.
 - b. Set $envRec$'s `MethodName` to the value of F 's `[[MethodName]]` internal data property.
6. Else
 - a. Set $envRec$'s `HomeObject` to Empty.
7. Set env 's environment record to be $envRec$.
8. Set the outer lexical environment reference of env to the value of F 's `[[Scope]]` internal data property.
9. Return env .

10.3 Code Realms

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

A Realm is specified as a Record with the fields specified in Table 26:

Table 26 — 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 ECMAScript object	The global object for this Realm
<code>[[GlobalEnv]]</code>	A ECMAScript environment	The global environment for this Realm
<code>[[Loader]]</code>	any ECMAScript identifier or empty	The Loader object that can associate ECMAScript code with this Realm

Deleted: Method

Deleted: Object

Deleted: method

Deleted:

Deleted: <#>If F 's `[[ThisMode]]` internal data property is lexical, then ¶

Deleted: home

Comment [AWB860]: Other possible terms that have been discussed are "Home" and "Island". We still need get final agreement on terminology.

Deleted: following

Deleted: t

The intrinsic objects associated with a code Realm include the well-known intrinsics listed in Table 11 and additional intrinsics specified by Table 27.

Table 27.— Additional Intrinsic Objects with Realm Specific Bindings

Intrinsic Name	ECMAScript Language Association
???	???
???	???

10.4 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 the state components listed in Table 28.

Table 28.—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.
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 latter 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.

Execution contexts for ECMAScript code have the additional state components listed in Table 29.

Table 29.—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 VariableStatements 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. The value of the VariableEnvironment component never changes while the value of the LexicalEnvironment component may change during execution of code within an execution context.

- Deleted:** are
- Deleted:** Within this specification a reference such as %name% means the value with this intrinsic name in the [[intrinsics]] record of the Realm of the running execution context.
- Deleted:** 2725
- Deleted:** %Object%
- Deleted:** The initial value of the global object property named "Object".
- Comment [AWB1361]:** This is where we should list all the per realm intrinsics that do T have %names%
- Deleted:** %ObjectPrototype%
- Deleted:** The initial value of the "prototype" data property of the intrinsic %Object%.
- Deleted:** %ObjProto_toString%
- Deleted:** 10.2.3 The Global Environment The global environment is a unique Lexical Environment which is created before any
- Deleted:** 3
- Deleted:** n
- Deleted:** When control is transferred to
- Deleted:** to
- Deleted:** At any point in time, there is at most
- Deleted:** t
- Deleted:** and
- Deleted:** In addition, e
- Deleted:**
- Deleted:** Execution Context
- Deleted:** ECMAScript
- Deleted:** PreviousContext
- Deleted:** within which the associated
- Deleted:** code is evaluated
- Deleted:** LexicalEnvironment
- Deleted:** ThisBinding
- Deleted:** The code evaluation state
- Deleted:** current
- Deleted:** current
- Deleted:** current
- Deleted:** ECMAScript
- Deleted:** current
- Deleted:** ECMAScript
- Deleted:** of
- Deleted:** current
- Deleted:** changes
- Deleted:** to
- Deleted:** current
- Deleted:** Table 29Table 27Table 25Table 24
- Deleted:** 2927252624

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.

Deleted: and “ThisBinding”

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

10.4.1 Identifier Resolution

Identifier resolution is the process of determining the binding of an IdentifierName using the LexicalEnvironment of the running execution context. During execution of ECMAScript code, Identifier Resolution 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, then let strict be **true**, else let strict be **false**.
3. Return the result of calling GetIdentifierReference abstract operation passing env, the StringValue of IdentifierName, and strict as arguments.

The result of evaluating an identifier is always a value of type Reference with its referenced name component equal to the Identifier String.

Deleted: 3

Deleted: the syntactic production PrimaryExpression : Identifier is evaluated

10.4.2 GetThisEnvironment

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

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**, then return envRec.
 - d. Let outer be the value of lex’s outer environment reference.
 - e. Let lex be outer.

NOTE The loop in step 4 will always terminate because the list of environment always end with the global environment which has a this binding.

Deleted: a

Deleted: function

Deleted:

Deleted: v

Deleted: containing the same sequence of characters as

Deleted: Identifier

Deleted: 3

Deleted: It starts search with the LexicalEnvironment of the current execution context.

Deleted: current

10.4.3 This Resolution

The abstract operation ThisResolution is the process of determining the binding of the keyword this using the LexicalEnvironment of the running execution context. ThisResolution performs the following steps:

1. Let env be the result of performing the GetThisEnvironment abstract operation.
2. Return the result of calling the GetThisBinding concrete method of env.

Deleted: 3

Deleted: 4

Deleted: current

10.4.4 GetGlobalObject

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

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

10.5 Declaration Binding Instantiation

10.5.1 Global Declaration Instantiation

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.

Global Declaration Instantiation is performed as follows using arguments *script*, *env*, and *deletableBindings*. *script* is the *ScriptBody* that for which the execution context is being established. *env* is the global environment record in which bindings are to be created. *deletableBindings* is *true* if the bindings that are created should be deletable.

1. Let *strict* be *IsStrict* of *script*.
2. Let *lexNames* be the LexicallyDeclaredNames of *script*.
3. Let *varNames* be the VarDeclaredNames of *script*.
4. For each *name* in *lexNames*, do
 - a. If the result of calling *env*'s *HasVarDeclaration* concrete method passing *name* as the argument is *true*, throw a *SyntaxError* exception.
 - b. If the result of calling *env*'s *HasLexicalDeclaration* concrete method passing *name* as the argument is *true*, throw a *SyntaxError* exception.
5. For each *name* in *varNames*, do
 - a. If the result of calling *env*'s *HasLexicalDeclaration* concrete method passing *name* as the argument is *true*, throw a *SyntaxError* exception.
6. Let *varDeclarations* be the VarScopedDeclarations of *script*.
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 a *FunctionDeclaration* then
 - i. NOTE If there are multiple *FunctionDeclarations* for the same name, the last declaration is used.
 - ii. Let *fn* be the sole element of the *BoundNames* of *d*.
 - iii. If *fn* is not an element of *declaredFunctionNames*, then
 1. Let *fnDefinable* be the result of calling *env*'s *CanDeclareGlobalFunction* concrete method passing *fn* as the argument.
 2. If *fnDefinable* is *false*, throw *TypeError* exception.
 3. Append *fn* to *declaredFunctionNames*.
 4. Append *d* to *functionsToInitialize*.
10. Let *declaredVarNames* be an empty List.
11. For each *d* in *varDeclarations*, do
 - a. If *d* is a *VariableStatement* 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 *env*'s *CanDeclareGlobalVar* concrete method passing *vn* and *deletableBindings* as the arguments.
 - b. If *vnDefinable* is *false*, throw *TypeError* exception.
 - c. If *vn* is not an element of *declaredVarNames*, then
 - i. Append *vn* to *declaredVarNames*.
 12. NOTE: No abnormal terminations occur after this algorithm step.
 13. For each *FunctionDeclaration* *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. Call *env*'s *CreateGlobalFunctionBinding* concrete method passing *fn*, *fo*, and *deletableBindings* as the arguments.
 14. For each String *vn* in *declaredVarNames*, in list order do
 - a. Call *env*'s *CreateGlobalVarBinding* concrete method passing *vn* and *deletableBindings* as the argument.
 15. Let *lexDeclarations* be the LexicallyScopedDeclarations of *script*.
 16. 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

Deleted: 10.4 Establishing an Execution Context¶

Evaluation of global code or code using the *eval* function (15.1.2.1) establishes and enters a new execution context. Every invocation of an ECMAScript code function (13.2.1) also establishes and enters a new execution context, even if a function is calling itself recursively. Every return exit from an execution context exits the execution context. A thrown exception may also exit one or more execution contexts.¶

When control enters an execution context, the execution context's *ThisBinding* is set to its *VariableEnvironment* and initial *LexicalEnvironment* are defined, and declaration binding instantiation (10.5) is performed. The exact manner in which the actions occur depend on the type of code being entered.¶

10.4.1 Entering Global Code¶

The following steps are performed when control enters the execution context for global code:¶

Initialise the execution context using the global code as described in 10.4.1.1.¶

Perform Declaration Binding Instantiation described in 10.5 using the global code.¶

10.4.1.1 Initial Global Execution Context¶

The following steps are performed to initialise a global execution context for ECMAScript code C:¶

Set the *VariableEnvironment* to the Global Environment.¶

Set the *LexicalEnvironment* to the Global Environment.¶

Set the *ThisBinding* to the global object.¶

10.4.2 Entering Eval Code¶

The following steps are performed when control enters the execution context for eval code:¶

Deleted: 10.5 Declaration Binding Instantiation¶

Comment [AWB62]: It may make sense to split eval code out into a separate subsection.

Deleted: Every execution context has an associated *VariableEnvironment*. Variables and functions declared in ECMAScript code

Deleted: Base Code

Deleted: Top-Level

Deleted: non-function code

Deleted: that is base code

Deleted: VariableEnvironment

Deleted: top-level

Deleted: level variable, constant, or function

Deleted: Top-level Declaration Instantiation base code is performed as follows: ¶

Deleted: true else let *strict* be false

Deleted: *code*

Deleted: configurableBindings

Deleted: *f*

Deleted: *Y*

Deleted: *code*

- i. If IsConstantDeclaration of *d* is **true**, then
 1. Call *env*'s `CreateImmutableBinding` concrete method passing *dn* as the argument.
 - ii. Else,
 1. Call *env*'s `CreateMutableBinding` concrete method passing *dn* and **false** as the arguments.
17. Return `NormalCompletion(empty)`

NOTE Early errors specified in 14.1 prevent name conflicts between function/var declarations and let/const/class/module declarations as well as redeclaration of let/const/class/module 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 Global Declaration Instantiation. If any such errors are detected, no bindings are instantiated for the script.

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, and module declarations.

10.5.2 Module Declaration Instantiation

10.5.3 Function Declaration Instantiation

This version reflects the consensus as of the Sept. 2012 TC39 meeting. However, it now appears that the binding semantics of formal parameters is like to change again.

NOTE When an execution context is established for evaluating function code a new Declarative Environment Record is created and bindings for each formal parameter, and each function level variable, constant, or function declared in the function are instantiated in the environment record. Formal parameters and functions are initialized as part of this process. All other bindings are initialized during execution of the function code.

Function Declaration Instantiation 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 declarative environment record in which bindings are to be created.

1. Let *code* be the value of the `[[Code]]` internal data property of *func*.
2. Let *strict* be the value of the `[[Strict]]` internal data property of *func*.
3. Let *formals* be the value of the `[[FormalParameters]]` internal data property of *func*.
4. Let *parameterNames* be the `BoundNames` of *formals*.
5. Let *varDeclarations* be the `VarScopedDeclarations` of *code*.
6. Let *functionsToInitialize* be an emptyList.
7. Let *argumentsObjectNotNeeded* be **false**.
8. For each *d* in *varDeclarations*, in reverse list order do
 - a. If *d* is a `FunctionDeclaration` then
 - i. NOTE If there are multiple `FunctionDeclarations` for the same name, the last declaration is used.
 - ii. Let *fn* be the sole element of the `BoundNames` of *d*.
 - iii. If *fn* is "**arguments**", then let *argumentsObjectNotNeeded* be **true**.
 - iv. Let *alreadyDeclared* be the result of calling *env*'s `HasBinding` concrete method passing *fn* as the argument.
 - v. If *alreadyDeclared* is **false**, then
 1. Let *status* be the result of calling *env*'s `CreateMutableBinding` concrete method passing *fn* as the argument.
 2. Assert: *status* is never an `Abrupt Completion`.
 3. Append *d* to *functionsToInitialize*.
9. For each String *paramName* in *parameterNames*, do

Comment [AWB63]: The exact details of declaration instantiation for module code still need to be worked out.

Deleted: If *code* is `function code`, then

- Let *func* be the function whose `[[Call]]` internal method initiated execution of *code*. Let *names* be the value of *func*'s `[[FormalParameters]]` internal property.
- Let *argCount* be the number of elements in *args*.
- Let *n* be the number 0.
- For each String *argName* in *names*, in list order do
 - Let *n* be the current value of *n* plus 1.
 - If *n* is greater than *argCount*, let *v* be undefined otherwise let *v* be the value of the *n*'th element of *args*.
 - Let *argAlreadyDeclared* be the result of calling *env*'s `HasBinding` concrete method passing *argName* as the argument.
 - If *argAlreadyDeclared* is false, then
 - call *Call env*'s `CreateMutableBinding` concrete method passing *argName* as the argument.
 - Call *env*'s `InitializeBinding` concrete method passing *argName*, and undefined as the arguments.
 - Call *env*'s `SetMutableBinding` concrete method passing *argName*, *v*, and *strict* as the arguments.

Deleted: For each `FunctionDeclaration` *f* in *code*, in source text order do

- Let *fn* be the Identifier in `FunctionDeclaration` *f*.
- Let *fo* be the result of performing `Instantiate FunctionDeclaration` for instantiating `FunctionDeclaration` *f* described in Clause 13.
- Let *funcAlreadyDeclared* be the result of calling *env*'s `HasBinding` concrete method passing *fn* as the argument.
- If *funcAlreadyDeclared* is false, then
 - call *Call env*'s `CreateMutableVarBinding` concrete method passing *fn* and *configurableBindings* as the arguments.
 - Call *env*'s `InitializeBinding` concrete method passing *fn*, and undefined as the arguments.
 - Else if *env* is the environment record component of the global environment then
 - Let *go* be the global object.
 - Let *existingProp* be the resulting of calling the `[[GetOwnProperty]]` internal method of *go* with argument *fn*.
 - If *existingProp* is undefined or *existingProp* `.[[Configurable]]` is true, then
 - Call the `[[DefineOwnProperty]]` internal method of *go* passing *fn*, `Property Descriptor` `{[[Value]]: undefined, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: configurableBindings }`, and *true* as arguments.
 - Else if *IsAccessorDescriptor*(*existingProp*) or *existingProp* does not have attribute values `{[[Writable]]: true, [[Enumerable]]: true}`, then
 - Throw a `TypeError` exception.
 - Let *status* be the result of calling *Call env*'s `SetMutableBinding` concrete method passing *fn*, *fo*, and *strict* as the arguments.
 - ReturnIfAbrupt(*status*).

Deleted: Extended Code Top-Level

Deleted: ¶

Deleted: be

Deleted: `FormalParameterList`

Deleted: List

Deleted: `FormalParameterList`

Deleted: *arg*

Deleted: in list order

- a. Let `alreadyDeclared` be the result of calling `env`'s `HasBinding` concrete method passing `paramName` as the argument.
- b. NOTE Duplicate parameter names can only occur in non-strict functions. Parameter names that are the same as function declaration names do not get initialized to `undefined`.
- c. If `alreadyDeclared` is `false`, then
 - i. If `paramName` is "`arguments`", then let `argumentsObjectNotNeeded` be `true`.
 - ii. Let `status` be the result of calling `env`'s `CreateMutableBinding` concrete method passing `paramName` as the argument.
 - iii. Assert: `status` is never an Abrupt Completion
 - iv. Call `env`'s `InitializeBinding` concrete method passing `paramName`, and `undefined` as the arguments.
10. NOTE If there is a function declaration or formal parameter with the name "`arguments`" then an argument object is not created.
11. If `argumentsObjectNotNeeded` is `false`, then
 - a. If `strict` is `true`, then
 - i. Call `env`'s `CreateImmutableBinding` concrete method passing the String "`arguments`" as the argument.
 - b. Else,
 - i. Call `env`'s `CreateMutableBinding` concrete method passing the String "`arguments`" as the argument.
12. Let `varNames` be the `VarDeclaredNames` of `code`.
13. For each String `varName` in `varNames`, in list order do
 - a. Let `alreadyDeclared` be the result of calling `env`'s `HasBinding` concrete method passing `varName` as the argument.
 - b. NOTE A `VarDeclaredNames` is only instantiated and initialised here if it is not also the name of a formal parameter or a `FunctionDeclarations`.
 - c. If `alreadyDeclared` is `false`, then
 - i. Call `env`'s `CreateMutableBinding` concrete method passing `varName` as the argument.
14. Let `lexDeclarations` be the `LexicalDeclarations` of `code`.
15. For each element `d` in `lexDeclarations` do
 - a. NOTE A lexically declared name can not be the same as a function declaration, formal parameter, or a var name. 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. Call `env`'s `CreateImmutableBinding` concrete method passing `dn` as the argument.
 - ii. Else,
 1. Call `env`'s `CreateMutableBinding` concrete method passing `dn` and `false` as the arguments.
16. For each `FunctionDeclaration` `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. Call `env`'s `SetMutableBinding` concrete method passing `fn`, `fo`, and `false` as the arguments.
17. NOTE Function declarations are initialised prior to parameter initialisation so that default value expressions may reference them. It is not extended code. "`arguments`" is not initialised until after parameter initialisation.
18. Let `ao` be the result of `InstantiateArgumentsObject` with argument `argumentsList`.
19. NOTE If `argumentsObjectNotNeeded` is `true` then the value of `ao` is not directly observable to ECMAScript code and need not actually exist. In that case, its use in the above steps is strictly as a device for specifying formal parameter initialisation semantics.
20. Let `formalStatus` be the result of performing Binding Initialisation for `formals` with `ao` and `undefined` as arguments.
21. ReturnIfAbrupt(`formalStatus`).
22. If `argumentsObjectNotNeeded` is `false`, then
 - a. If `strict` is `true`, then
 - i. Perform the abstract operation `CompleteStrictArgumentsObject` with argument `ao`.
 - b. Else,
 - i. Perform the abstract operation `CompleteMappedArgumentsObject` with arguments `ao`, `func`, `formals`, and `env`.
 - c. Call `env`'s `InitializeBinding` concrete method passing "`arguments`" and `ao` as arguments.
23. Return `NormalCompletion(empty)`.

Deleted: `arg`
Deleted: Normal
Deleted: code
Deleted: Call
Deleted: `arg`
Deleted: `ReturnIfAbrupt(status)`.
Deleted: <#>If `strict` is `false`, then||
Deleted: `arg`

Comment [AWB764]: TODO: don't create arguments binding for arrow functions (and perhaps for concise methods)

Deleted: M

Comment [AWB665]: TODO This is no longer true and needs to be taken into account

Deleted: <#>Let `declarations` be the `LexicalDeclarations` of `code`.||
<#>If `strict` is `true`, then||
<#>Let `ao` be the result of `CreateStrictArgumentsObject` with argument `argumentsList`.||
<#>Let `formalStatus` be the result of `Performing Binding Initialization` for `formals` with `ao` and `env` as arguments.||
<#>Else,||
<#>Let `names` be `BoundNames` of `formals`.||
<#>NOTE Because `F` is a none strict function it is not extended code. Hence `formals` does not contain the names of any destructive `BindingProperties`, rest parameters, or parameters with default value initialisers.||
<#>Let `ao` be the result of performing the abstract operation `CreateMappedArgumentsObject` with arguments `func`, `names`, `env`, and `argumentsList`.||
<#>Let `formalStatus` be the result of performing `Perform Binding Initialization` for `formals` with `ao` and `undefined` as arguments.||
<#>NOTE Binding initialisation for `formals` is performed prior to instantiating a

Deleted: `argumentsAlreadyDeclared`
Deleted: initialization

Comment [AWB766]: TODO: don't create arguments binding for arrow functions (and perhaps for concise methods)

Deleted: <#>Let `hasArgumentsObject` be the Boolean negation of `argumentsAlreadyDeclared`.

Deleted: `argumentsAlreadyDeclared`
Deleted: 0

Deleted: <#>Call `env`'s `CreateImmutableBinding` concrete method passing the String "`arguments`".

Deleted: 0

Deleted: <#>Call `env`'s `CreateMutableBinding` concrete method passing the String "`arguments`".

Deleted: <#>Let `varNames` be the `VarDeclaredNames` of `code`.||
Deleted: .

Deleted: `hasArgumentsObject`

10.5.4 Block Declaration Instantiation

NOTE When a *Block* or *CaseBlock* production is evaluated a new Declarative Environment Record is created and bindings for each block scoped variable, constant, or function declared in the block are instantiated in the environment record.

Block Declaration Instantiation 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 LexicalDeclarations 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* as the argument.
 - ii. Else,
 1. Call *env*'s CreateMutableBinding concrete method passing *dn* and **false** as the arguments.
 - b. For each *FunctionDeclaration* *f* in *declarations*, in list order 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. Call *env*'s InitializeBinding concrete method passing *fn*, and *fo* as the arguments.

10.5.5 Eval Declaration Instantiation

10.6 Arguments Object

When *function code* is evaluated, an arguments object is created unless (as specified in 10.5) the identifier **arguments** occurs as an *Identifier* in the function's *FormalParameterList* or occurs as the *BindingIdentifier* of a *FunctionDeclaration* contained in the outermost *StatementList* of the function code.

The abstract operation *InstantiateArgumentsObject* called with an argument *args* performs the following steps:

1. Let *len* be the number of elements in *args*.
2. Let *obj* be the result of the abstract operation *ObjectCreate* with the intrinsic object %ObjectPrototype% as its argument.
3. Add the **[[BuiltInBrand]]** internal data property to *obj* with value **BuiltinArguments**.
4. Call the **[[DefineOwnProperty]]** internal method on *obj* passing **"length"** and the Property Descriptor **{[[Value]]: len, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true}** as arguments.
5. Let *indx* = *len* - 1.
6. Repeat while *indx* > 0.
 - a. Let *val* be the element of *args* at 0-originated list position *indx*.
 - b. Call the **[[DefineOwnProperty]]** internal method on *obj* passing *ToString(indx)* and the Property Descriptor **{[[Value]]: val, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}** as arguments.
 - c. Let *indx* = *indx* - 1.
7. Return *obj*.

The abstract operation *CompleteStrictArgumentsObject* called with argument *obj* which must have been previously created by the abstract operation *InstantiateArgumentsObject*. The following steps are performed:

1. Perform the *AddRestrictedFunctionProperties* abstract operation with argument *obj*.
2. Return.

The abstract operation *CompleteMappedArgumentsObject* is called with object *obj*, object *func*, grammar production *formals*, and environment record *env*. *obj* must have been previously created by the abstract operation *InstantiateArgumentsObject*. The following steps are performed:

1. Let *len* be the result of *Get(obj, "length")*.
2. Let *mappedNames* be an empty List.
3. Let *numberOfNonRestFormals* be *NumberOfParameters* of *formals*.

Comment [AWB767]: Jan 19 meeting notes: Current tentative decision is to support let, const, and local functions in nonstrict ES5 in the same way as in strict ES6. Fallback to either specifying limited cases or doing the ES5 nonstrict status quo (i.e. syntax error + Clause 13).

Deleted: contained in extended code

Deleted: <#>Assert: parameterNames has no duplicate

Deleted: a *ConstDeclaration*

Deleted: *FunctionDeclaration*

Deleted: Instantiate Function Declaration

Deleted: instantiating *FunctionDeclaration*

Deleted: as described in Clause 13

Deleted: <#>Call *env*'s *CreateMutableBinding* concrete

Deleted: ¶

Deleted: For each *LetDeclaration* and *ConstDeclaration*

Deleted: control enters an execution context for

Comment [AWB 268]: Additional modification to this

Deleted: *VariableDeclaration* or

Deleted: *Function*

Deleted: *D*

Deleted: *NativeBrand*

Deleted: *NativeArguments*

Deleted: ,

Deleted: , and *false*

Deleted: ,

Deleted: , and *false*

Deleted: *CreateStrictArgumentsObject*

Deleted: *list args*

Deleted: *ion*

Deleted: performs *t*

Deleted: <#>Let *len* be the number of elements in *args*.

Deleted: *or*

Deleted: <#>Call the **[[DefineOwnProperty]]** internal

Deleted: *obj*

Deleted: *Create*

Deleted: *List*

Deleted: *names*

Deleted: *ion*

Deleted: , and argument list *args*

Deleted: performs the following steps

Deleted: number of elements in

Deleted: calling the **[[**

Deleted: **]]** internal method of

Deleted: with

Deleted: argument

Deleted: . *args*.

Deleted: <#>Let *obj* be the result of the abstraction

4. Let *map* be the result of the abstract operation *ObjectCreate* with the intrinsic object `%ObjectPrototype%` as its argument.
5. Let *idx* = *len* - 1.
6. Repeat while *idx* ≥ 0.
 - a. If *idx* is less than the *numberOfNonRestFormals*, then
 - i. Let *param* be *getParameter* of *formals* with argument *idx*.
 - ii. If *param* is a *BindingIdentifier*, then
 1. Let *name* be the sole element of *BoundNames* of *param*.
 2. If *name* is not an element of *mappedNames*, then
 - a. Add *name* as an element of the list *mappedNames*.
 - b. Let *g* be the result of calling the *MakeArgGetter* abstract operation with arguments *name* and *env*.
 - c. Let *p* be the result of calling the *MakeArgSetter* abstract operation with arguments *name* and *env*.
 - d. Call the *[[DefineOwnProperty]]* internal method of *map* passing *ToString(idx)* and the Property Descriptor `{[[Set]]: p, [[Get]]: g, [[Configurable]]: true}` as arguments.
 - b. Let *idx* = *idx* - 1
 7. If *mappedNames* is not empty, then
 - a. Set the *[[ParameterMap]]* internal data property of *obj* to *map*.
 - b. Set the *[[Get]]*, *[[GetOwnProperty]]*, *[[DefineOwnProperty]]*, and *[[Delete]]* internal methods of *obj* to the definitions provided below.
 8. Call the *[[DefineOwnProperty]]* internal method on *obj* passing `"callee"` and the Property Descriptor `{[[Value]]: func, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true}` as arguments.
 9. Return *obj*.

The abstract operation *MakeArgGetter* called with String *name* and environment record *env* creates a function object that when executed returns the value bound for *name* in *env*. It performs the following steps:

1. Let *bodyText* be the result of concatenating the Strings `"return "`, *name*, and `";"`.
2. Let *body* be the result of parsing *bodyText* using *FunctionBody* as the goal symbol.
3. Let *parameters* be a *FormalParameterList* : [empty] production.
4. Return the result of calling the abstract operation *FunctionCreate* using *Normal* as the kind, *parameters* as *FormalParameterList*, *body* for *FunctionBody*, *env* as *Scope*, and *true* for *Strict*.

The abstract operation *MakeArgSetter* called with String *name* and environment record *env* creates a function object that when executed sets the value bound for *name* in *env*. It performs the following steps:

1. Let *paramText* be the String *name* concatenated with the String `"_arg"`.
2. Let *parameters* be the result of parsing *paramText* using *FormalParameterList* as the goal symbol.
3. Let *bodyText* be the String `"<name> = <param>;"` with `<name>` replaced by the value of *name* and `<param>` replaced by the value of *paramText*.
4. Let *body* be the result of parsing *bodyText* using *FunctionBody* as the goal symbol.
5. Return the result of calling the abstract operation *FunctionCreate* using *Normal* as the kind, *parameters* as *FormalParameterList*, *body* for *FunctionBody*, *env* as *Scope*, and *true* for *Strict*.

The *[[Get]]* internal method of an arguments object for a non-strict mode function with formal parameters when called with a property name *P* performs the following steps:

1. Let *args* be the arguments object.
2. Let *map* be the value of the *[[ParameterMap]]* internal data property of the arguments object.
3. Let *isMapped* be the result of calling the *[[GetOwnProperty]]* internal method of *map* passing *P* as the argument.
4. If the value of *isMapped* is *undefined*, then
 - a. Let *v* be the result of calling the default *ordinary object* *[[Get]]* internal method (8.12.3) on *args* passing *P* and *args* as the arguments.
 - b. If *P* is `"caller"` and *v* is a strict mode Function object, throw a *TypeError* exception.
 - c. Return *v*.
5. Else *map* contains a formal parameter mapping for *P*.
 - a. Return the result of calling *Get(map, P)*.

Deleted: >=
Deleted: <#>Let <i>val</i> be the element of <i>args</i> at originated list position <i>idx</i> . <#>Call the <i>[[DefineOwnProperty]]</i> internal method on <i>obj</i> passing <i>ToString(idx)</i> , the <i>pProto</i> <i>dDescriptor</i> <code>{[[Value]]: val, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}</code> , and <i>false</i> as arguments. Deleted: number of elements in <i>names</i>
Deleted: <i>name</i>
Deleted: the element
Deleted: <i>names</i>
Deleted: at 0-originated list position
Deleted: ,
Deleted: , and <i>false</i>
Deleted: <i>P</i>
Deleted: ,
Deleted: <i>p</i>
Deleted: <i>d</i>
Deleted: , and <i>false</i>
Deleted: The abstract operation <i>InstantiateArgumentsObject</i> called with an argument <i>len</i> performs the following steps: <#>Let <i>obj</i> be the result of creating a new ECMAScript object. <#>Set all the internal methods of <i>obj</i> as specified in 8.12. <#>Set Add the <i>[[ClassIsArgumentsNativeBranch]]</i> internal property of <i>obj</i> with value <i>NativeArguments</i> to <code>"Arguments"</code> . <#>Let <i>Object</i> be the standard built-in Object constructor (15.2.2). <#>Set the <i>[[Prototype]]</i> internal property of <i>obj</i> to the standard built-in Object prototype object (15.2.4). <#>Call the <i>[[DefineOwnProperty]]</i> internal method on <i>obj</i> passing <code>"length"</code> , the Property Descriptor <code>{[[Value]]: len, [[Writable]]: true}</code> .
Deleted: creating a function object as described
Deleted: no <i>FormalParameterList</i>
Deleted: creating a function object as described
Deleted: a List containing the single String
Deleted: <i>param</i>
Comment [AWB1269]: TODO: keep
Deleted: <i>P</i>
Deleted:
Deleted: the arguments object
Deleted: ,
Deleted: so
Deleted: the <i>[[</i>
Deleted: <i>]]</i> internal method of
Deleted: passing
Deleted: as the argument

The `[[GetOwnProperty]]` internal method of an arguments object for a non-strict mode function with formal parameters when called with a property name P performs the following steps:

1. Let $desc$ be the result of calling the default `[[GetOwnProperty]]` internal method (8.12.1) on the arguments object passing P as the argument.
2. If $desc$ is `undefined` then return $desc$.
3. Let map be the value of the `[[ParameterMap]]` internal `data` property of the arguments object.
4. Let $isMapped$ be the result of calling the `[[GetOwnProperty]]` internal method of map passing P as the argument.
5. If the value of $isMapped$ is not `undefined`, then
 - a. Set $desc.[[Value]]$ to the result of calling `Get(map, P)`.
6. Return $desc$.

The `[[DefineOwnProperty]]` internal method of an arguments object for a non-strict mode function with formal parameters when called with a property name P and Property Descriptor $Desc$ performs the following steps:

1. Let map be the value of the `[[ParameterMap]]` internal `data` property of the arguments object.
2. Let $isMapped$ be the result of calling the `[[GetOwnProperty]]` internal method of map passing P as the argument.
3. Let $allowed$ be the result of calling the default `[[DefineOwnProperty]]` internal method (8.3.9) on the arguments object passing P and $Desc$ as the arguments.
4. `ReturnIfAbrupt(allowed)`.
5. If $allowed$ is `false`, then return `false`.
6. If the value of $isMapped$ is not `undefined`, 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. Assert: the follow Put call will always succeed because formal parameters mapped by argument objects are always writable.
 2. Call `Put(map, P, Desc.[[Value]], false)`.
 - 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.
7. Return `true`.

The `[[Delete]]` internal method of an arguments object for a non-strict mode function with formal parameters when called with a property key P performs the following steps:

1. Let map be the value of the `[[ParameterMap]]` internal `data` property of the arguments object.
2. Let $isMapped$ be the result of calling the `[[GetOwnProperty]]` internal method of map passing P as the argument.
3. Let $result$ be the result of calling the default `[[Delete]]` internal method for ordinary objects (8.3.10) on the arguments object passing P as the argument.
4. If $result$ is `true` and the value of $isMapped$ is not `undefined`, then
 - a. Call the `[[Delete]]` internal method of map passing P as the argument.
5. Return $result$.

NOTE 1 For non-strict mode functions the array index (defined in 15.4) 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 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. The "callee" property has a more specific meaning for non-

Deleted: the <code>[[</code>
Deleted: <code>]]</code> internal method of
Deleted: passing
Deleted: as the argument
Deleted: ,
Deleted: , and Boolean flag <code>Throw</code>
Deleted: 12
Deleted: ,
Deleted: , and <code>false</code>
Deleted: 1 If <code>Throw</code> is <code>true</code> then throw a <code>TypeError</code> exception, otherwise
Deleted: , and <code>false</code>
Deleted: s
Deleted: the <code>[[</code>
Deleted: <code>]]</code> internal method of
Deleted:
Deleted: passing
Deleted: and <code>Throw</code>
Deleted: as the arguments
Deleted: and <code>false</code>
Deleted: s
Deleted: name
Deleted: and Boolean flag <code>Throw</code>
Deleted: 12
Deleted: 7
Deleted: and <code>Throw</code>
Deleted: s
Deleted: , and <code>false</code>
Deleted: s
Deleted: named

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.

11 Expressions

11.1 Primary Expressions

Syntax

PrimaryExpression :

- this
- Identifier
- Literal
- ArrayInitialiser
- ObjectLiteral
- FunctionExpression
- ClassExpression
- GeneratorExpression
- GeneratorComprehension
- RegularExpressionLiteral
- TemplateLiteral
- CoverParenthesizedExpressionAndArrowParameterList

CoverParenthesizedExpressionAndArrowParameterList :

- (Expression)
- ()
- (... Identifier)
- (Expression , ... Identifier)

Supplemental Syntax

When processing the production PrimaryExpression : CoverParenthesizedExpressionAndArrowParameterList the following grammar is used to refine the interpretation of CoverParenthesizedExpressionAndArrowParameterList.

ParenthesizedExpression :

- (Expression)

Static Semantics

Static Semantics: CoveredParenthesizedExpression

CoverParenthesizedExpressionAndArrowParameterList : (Expression)

1. Return the result of parsing the lexical token stream matched by

CoverParenthesizedExpressionAndArrowParameterList using ParenthesizedExpression as the goal symbol.

Static Semantics: IsValidSimpleAssignmentTarget

PrimaryExpression :

- this
- Literal
- ArrayInitialiser
- ObjectLiteral
- FunctionExpression
- ClassExpression
- GeneratorExpression
- GeneratorComprehension
- RegularExpressionLiteral
- TemplateLiteral

Deleted: ArrayLiteral

Deleted: [Lexical goal InputElementRegExp]

Deleted: Quasi

Deleted: (Expression)

Deleted: FormalParameterList

Deleted: Static Semantics: Early Errors

PrimaryExpression :
CoverParenthesizedExpressionAndArrowParameterList

<#> 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 the

CoveredParenthesizedExpression of

CoverParenthesizedExpressionAndArrowParameterList.
¶

1. Return false.

PrimaryExpression : Identifier

1. If this *PrimaryExpression* is contained in strict code and StringValue of *Identifier* is "eval" or "arguments", then return **false**.
2. Return **true**.

PrimaryExpression : CoverParenthesizedExpressionAndArrowParameterList

1. Let *expr* be *CoverParenthesizedExpression* of *CoverParenthesizedExpressionAndArrowParameterList*.
2. Return *IsValidSimpleAssignmentTarget* of *expr*.

11.1.1 The `this` Keyword

Runtime Semantics: Evaluation

PrimaryExpression : `this`

1. Return the result of calling the *ThisResolution* abstract operation.

11.1.2 Identifier Reference

Runtime Semantics: Evaluation

PrimaryExpression : Identifier

1. Let *ref* be the result of performing Identifier Resolution as specified in 10.4.1 using the *IdentifierName* corresponding to *Identifier*.
2. Return *ref*.

NOTE: The result of evaluating an *Identifier* is always a value of type Reference.

11.1.3 Literals

Syntax

Literal :

NullLiteral
 ValueLiteral

ValueLiteral :

BooleanLiteral
 NumericLiteral
 StringLiteral

Runtime Semantics

Runtime Semantics: Evaluation

Literal : NullLiteral

1. Return **null**.

ValueLiteral : BooleanLiteral

1. Return **false** if *BooleanLiteral* is the token *BooleanLiteral :: false*
2. Return **true** if *BooleanLiteral* is the token *BooleanLiteral :: true*

Deleted: <#>Let *env* be the result of performing the *GetThisEnvironment* abstract operation.¶

Deleted: *GetThisBinding*

Deleted: concrete method of *env*

Deleted: The `this` keyword evaluates to Return the value of the *ThisBinding* of the current execution context.¶

Comment [AWB870]: It may make sense to define some of the static semantic rules related static name resolution

Deleted: 3

Deleted: An *Identifier* is evaluated by performing Identifier Resolution as specified in 10.3.1 using the *IdentifierName* corresponding to *Identifier*.

Deleted: Reference

Deleted:
RegularExpressionLiteral

ValueLiteral : NumericLiteral

1. Return the number whose value is MV of *NumericLiteral* as defined in 7.8.3.

ValueLiteral : StringLiteral

1. Return the string whose elements are the SV of *StringLiteral* as defined in 7.8.4.

11.1.4 Array Initialiser

Syntax

ArrayInitialiser :

ArrayLiteral
ArrayComprehension

11.1.4.1 Array Literal

NOTE An *ArrayLiteral* is an expression describing the initialisation 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 initialiser 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 :

[*Elision*_{opt}]
[*ElementList*]
[*ElementList*, *Elision*_{opt}]

ElementList :

*Elision*_{opt} *AssignmentExpression*
*Elision*_{opt} *SpreadElement*
ElementList, *Elision*_{opt} *AssignmentExpression*
ElementList, *Elision*_{opt} *SpreadElement*

Elision :

'
Elision,

SpreadElement :

... *AssignmentExpression*

Static Semantics

Static Semantics: Elision Width

Elision :

1. Return the numeric value 1.

Elision : *Elision*,

1. Let preceding be the Elision Width of *Elision*.

Deleted: character

Deleted: A *Literal* is evaluated as described in 7.8.

Deleted: *SealedArrayInitialiser* :
ArrayInitialiser
ArrayInitialiser

Deleted: array initialiser

Deleted: written in a form of a literal. It is

Deleted: ,

Deleted: ... *AssignmentExpression*

Deleted: ... *AssignmentExpression*

Deleted: ...

Deleted: *ArrayComprehension* :
Expression ComprehensionForList
Expression ComprehensionForList if (Expression)
ComprehensionForList :
ComprehensionFor
ComprehensionForList ComprehensionFor
ComprehensionFor :
for (*LeftHandSideExpression* of *Expression*)

Deleted: 11.1.4.1

Deleted: Static Semantics: Early Errors

The static semantics of the production *SpreadElementElementList* : *Elision*_{opt} ... *AssignmentExpression* are:
<#> It is a Syntax Error if the source code parsed with this production is not extended code.

Deleted: *ElementList* : *ElementList*, *Elision*_{opt} *AssignmentExpression*
<#> It is a Syntax Error if the source code parsed with this production is not extended code.

Deleted: *Elision* : [empty] ¶
<#> Return the numeric value 0 ¶

2. Return preceding+1.

Runtime Semantics

Deleted: 11.1.4.2

Runtime Semantics: Array Accumulation

With parameters *array* and *nextIndex*.

ElementList : *Elision_{opt}* *AssignmentExpression*

1. Let *padding* be the Elision Width 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. Call the **[[DefineOwnProperty]]** internal method of *array* with arguments
`Tostring(ToUint32(nextIndex+padding))` and the Property Descriptor { **[[Value]]**: *initValue*, **[[Writable]]**: **true**, **[[Enumerable]]**: **true**, **[[Configurable]]**: **true** }.
6. Assert: the above call to **[[DefineOwnProperty]]** will never return **false** or an abrupt completion value.
7. Return *nextIndex+padding+1*.

Deleted: *opt*

Deleted: If *initValue* is an abrupt completion, return *initValue*.

Deleted:,

Deleted:, and false

ElementList : *Elision_{opt}* *SpreadElement*

1. Let *padding* be the Elision Width of *Elision*; if *Elision* is not present, use the numeric value zero.
2. Return the result of performing Array Accumulation for *SpreadElement* with arguments *array* and *nextIndex+padding*.

Deleted: *opt*

ElementList : *ElementList* , *Elision_{opt}* *AssignmentExpression*

1. Let *postIndex* be the result of performing Array Accumulation for *ElementList* with arguments *array* and *nextIndex*.
2. ReturnIfAbrupt(*postIndex*).
3. Let *padding* be the Elision Width 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. Call the **[[DefineOwnProperty]]** internal method of *array* with arguments
`Tostring(ToUint32(postIndex+padding))` and the Property Descriptor { **[[Value]]**: *initValue*, **[[Writable]]**: **true**, **[[Enumerable]]**: **true**, **[[Configurable]]**: **true** }.
8. Assert: the above call to **[[DefineOwnProperty]]** will never return **false** or an abrupt completion value.
9. Return *postIndex+padding+1*.

Deleted: If *postIndex* is an abrupt completion, return *postIndex*

Deleted: *opt*

Deleted: If *initValue* is an abrupt completion, return *initValue*

Deleted: (

Deleted:, and false

ElementList : *ElementList* , *Elision_{opt}* *SpreadElement*

1. Let *postIndex* be the result of performing Array Accumulation for *ElementList* with arguments *array* and *nextIndex*.
2. ReturnIfAbrupt(*postIndex*).
3. Let *padding* be the Elision Width of *Elision*; if *Elision* is not present, use the numeric value zero.
4. Return the result of performing Array Accumulation for *SpreadElement* with arguments *array* and *postIndex+padding*.

Deleted: If *postIndex* is an abrupt completion, return *postIndex*

Deleted: Let *pad* be the result of evaluating *Elision_{opt}*; if no present, use the numeric value zero.

Deleted: ...

Comment [AW71]: Note that the value the spread operator is applied to is coerced to an Object.

Deleted: If *spreadObj* is an abrupt completion, return *spreadObj*

Deleted: the **[**

Deleted: **]** internal method of

Deleted:

Deleted: with argument

Deleted: "

Deleted: "

9. Repeat, while $n < spreadLen$

- a. Let $exists$ be the result of `HasProperty(spreadObj, ToString(n))`.
- b. `ReturnIfAbrupt(exists)`.
- c. If $exists$ is **true** then.
 - i. Let v be the result of calling the `[[Get]]` internal method of $spreadObj$ passing `ToString(n)` as the argument.
 - ii. `ReturnIfAbrupt(v)`.
 - iii. Call the `[[DefineOwnProperty]]` internal method of $array$ with arguments `ToString(ToUint32(nextIndex))` and Property Descriptor `{[[Value]]: v, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
 - iv. Assert: the above call to `[[DefineOwnProperty]]` will never return **false** or an abrupt completion value.
- d. Let $n = n + 1$.
- e. Let $nextIndex = nextIndex + 1$.

10. `Return nextIndex`.

NOTE `[[DefineOwnProperty]]` 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]]`.

Runtime Semantics: Evaluation

ArrayLiteral : [$Elision_{opt}$]

1. Let $array$ be the result of the abstract operation `ArrayCreate` with argument 0.
2. Let pad be the `Elision Width of Elision`; if `Elision` is not present, use the numeric value zero.
3. Call `Put(array, "length", pad, false)`.
4. Return $array$.

ArrayLiteral : [$ElementList$]

1. Let $array$ be the result of the abstract operation `ArrayCreate` with argument 0.
2. Let len be the result of performing `Array Accumulation` for `ElementList` with arguments $array$ and 0.
3. `ReturnIfAbrupt(len)`.
4. Call `Put(array, "length", len, false)`.
5. Return $array$.

ArrayLiteral : [$ElementList$, $Elision_{opt}$]

1. Let $array$ be the result of the abstract operation `ArrayCreate` with argument 0.
2. Let len be the result of performing `Array Accumulation` for `ElementList` with arguments $array$ and 0.
3. `ReturnIfAbrupt(len)`.
4. Let $padding$ be the `Elision Width of Elision`; if `Elision` is not present, use the numeric value zero.
5. Call `Put(array, "length", ToUint32(padding+len), false)`.
6. Return $array$.

11.1.4.2 Array Comprehension

Syntax

ArrayComprehension :

[$Comprehension$]

Comprehension :

$ComprehensionQualification$ $AssignmentExpression$

ComprehensionQualification :

$ComprehensionFor$ $ComprehensionQualifierList_{opt}$

Deleted: calling the `[[HasProperty]]` internal method of `...spreadObj` with

Comment [AW72]: Note that indices wrap. For example consider:

[..., ..., { 4294967293: "x", length: Math.pow(2,32)-2}]

Deleted: ...and Property Descriptor `{[[Value]]: ..., [[Writable]]: ..., [[Enumerable]]: ..., [[Configurable]]: ...}`

Deleted: Put

Deleted: P

Deleted: The production `...rrayLiteral`:

Deleted: ion

Deleted: (15.4)

Deleted: the result of creating a new object as if the expression `new Array()` where `Array` the standard built-in constructor with that name

Deleted: result of evaluating

Deleted: opt

Deleted: ; if not present, use the numeric value zero

Deleted: the `[[...ut]]` internal method of `...rrayLiteral`:

Deleted: The production `...rrayLiteral`:

Deleted: ion

Deleted: (15.4)

Deleted: the result of creating a new object as if the expression `new Array()` where `Array` the standard built-in constructor with that name

Deleted: Return the `...et` len be the result of

Deleted: If len is an abrupt completion, return len

Deleted: the `[[...ut]]` internal method of `...rrayLiteral`:

Deleted: The production `...rrayLiteral`:

Deleted: ion

Deleted: (15.4)

Deleted: the result of creating a new object as if the expression `new Array()` where `Array` the standard built-in constructor with that name

Deleted: <#>Let $array$ be the result of evaluating `ElementList`.

Deleted: If len is an abrupt completion, return len

Deleted: Let pad be the `Elision Width of result` evaluating `Elisionopt`; if not present, use the numeric value zero.

Deleted: <#>Let len be the result of calling the `[[Get]]` internal method of $array$ with argument `"length"`.

Deleted: the `[[...ut]]` internal method of `...rrayLiteral`:

Deleted: [$AssignmentExpression$ $ComprehensionForList$]

Deleted:)

Deleted:

ComprehensionQualifierList :
ComprehensionQualifier
ComprehensionQualifierList ComprehensionQualifier

ComprehensionQualifier :
ComprehensionFor
ComprehensionIf

ComprehensionFor :
for (ForBinding of AssignmentExpression)

ComprehensionIf:
if (AssignmentExpression)

ForBinding :
BindingIdentifier
BindingPattern

Runtime Semantics

Runtime Semantics: Binding Initialisation

With arguments *value* and *environment*.

NOTE undefined is passed for *environment* to indicate that a PutValue operation should be used to assign the initialisation value. This is the case for `var` statements formal parameter lists of non-strict functions. In those cases a lexical binding is hosted and preinitialized prior to evaluation of its initializer.

ForBinding : BindingPattern

1. Let *obj* be `ToObject(value)`.
2. ReturnIfAbrupt(*obj*).
3. Return the result of performing Binding Initialisation for *BindingPattern* passing *obj* and *environment* as the arguments.

Runtime Semantics: Evaluation

ToDo

11.1.5 Object Initialiser

NOTE An object initialiser is an expression describing the initialisation 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 braces. The values need not be literals; they are evaluated each time the object initialiser is evaluated.

Syntax

ObjectLiteral :
{ }
{ PropertyDefinitionList }
{ PropertyDefinitionList , }

PropertyDefinitionList :
PropertyName
PropertyNameAndValueList

Deleted: *For*
Deleted: *For*
Deleted:
Deleted: *For*
Deleted: *For*
Deleted: (*LeftHandSideExpression*
Deleted: *Expression*
Deleted:)
Deleted: *Static Semantics*
Static Semantics: *Bound Names*
ForBinding : BindingIdentifier
<#>Return the Bound Names of *BindingIdentifier*.
ForBinding : BindingPattern
<#>Return the Bound Names of *BindingPattern*.

Deleted: *Runtime Semantics: Binding Initialisation*
With arguments *value* and *environment*.
NOTE undefined is passed for *environment* to indicate that a PutValue operation should be used to assign the initialisation value. This is the case for `var` statements formal parameter lists of non-strict functions. In those cases a lexical binding is hosted and preinitialized prior to evaluation of its initializer.
ForBinding : BindingIdentifier
<#>Perform Binding Initialisation for *BindingIdentifier* passing *value* and *env* as the arguments.
ForBinding : BindingPattern
<#>Perform Binding Initialisation for *BindingPattern* passing *value* and *env* as the arguments.

Comment [AWB1173]:

Deleted: *ArrayComprehensionLiteral : [ElementList]*
Let array be the result of the abstraction operation `ArrayCreate` (15.4) with argument 0.
Let len be result of performing Array Accumulation for *ElementList* with arguments *array* and 0.
ReturnIfAbrupt(len) If len is an abrupt completion, return len.
Call the `[[Put]]` internal method of *array* with arguments "length", len, and false.
Return *array*.

Deleted: The production *ElementList : Elision_{opt} AssignmentExpression* is evaluated as follows:
Let array be the result of creating a new object as is by the expression `new Array()` where `Array` is the standard built-in constructor with that name.
Let firstIndex be the result of evaluating *Elision*; if present, use the numeric value zero.
Let initResult be the result of evaluating *AssignmentExpression*.
Let initValue be `GetValue(initResult)`.
Call the `[[DefineOwnProperty]]` internal method of *array* with arguments `ToString(firstIndex)`, the Property Descriptor { `[[Value]]`: *initValue*, `[[Writable]]`: true, `[[Enumerable]]`: true, `[[Configurable]]`: true}, and `false`.

Deleted: *PropertyNameAndValueList*
Deleted: *PropertyNameAndValueList*
Deleted: *PropertyNameAndValueList*
Deleted: *PropertyAssignment*
Deleted: *PropertyNameAndValueList*
Deleted: *PropertyAssignment*

PropertyDefinition :

IdentifierName
CoverInitialisedName
PropertyName : AssignmentExpression
MethodDefinition

PropertyName :

IdentifierName
StringLiteral
NumericLiteral

CoverInitialisedName :

IdentifierName Initialiser

Initialiser :

= AssignmentExpression

NOTE 1 MethodDefinition is defined in 13.3.

NOTE 2 In certain contexts, ObjectLiteral is used as a cover grammar for a more restricted secondary grammar. The CoverInitialisedName 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.

Static SemanticsStatic Semantics: Early Errors

In addition to describe an actual object initialiser the ObjectLiteral productions are used as a cover grammar for ObjectAssignmentPattern (11.13.1). When ObjectLiteral appears in a context where ObjectAssignmentPattern is required, the following Early Error rules are **not** applied.

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:
 1. 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.
 2. 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.

PropertyDefinition : MethodDefinition

- It is a Syntax Error if ReferencesSuper of MethodDefinition is true.

PropertyDefinition : IdentifierName

- It is a Syntax Error if IdentifierName is a ReservedWord.

PropertyDefinition : CoverInitialisedName

- 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 (11.13.1). It can not occur in an actual object initialiser.

Deleted: PropertyAssignment

Deleted:

```
PropertyName ( FormalParameterList ) {
  FunctionBody }
* PropertyName ( FormalParameterList ) {
  FunctionBody }
  get PropertyName ( ) { FunctionBody }
  set PropertyName ( PropertySetParameterList ) { FunctionBody }
```

Deleted: PropertySetParameterList ¶
BindingIdentifier
BindingPattern ¶

Deleted: Identifier ¶
Semantics ¶

Deleted: 11.1.5.1

Deleted: PropertyNameAndValueList :
PropertyNameAndValueList , PropertyAssignment

Deleted: a

Deleted: property definition

Deleted: property definition

Deleted: i

Comment [AWB874]: The currently prevailing position in TC39 is that use of super should not be allowed in object literals. This restriction is arbitrary in the sense that the runtime semantics would work.

Deleted: i

Static Semantics: Contains

With parameter *symbol*.

PropertyDefinition : MethodDefinition

1. If *symbol* is MethodDefinition, return true.
2. Return false.

NOTE Static semantic rules that depend upon substructure generally do not look into function definitions.

PropertyName : 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.

Static Semantics: IsValidSimpleAssignmentTarget

PrimaryExpression : Literal

1. Return false.

Static Semantics: PropName

PropertyDefinition : IdentifierName

1. Return StringValue of IdentifierName.

PropertyDefinition : PropertyName : AssignmentExpression

1. Return PropName of PropertyName.

PropertyName : StringLiteral

1. Return a String value whose characters are the SV of the StringLiteral.

PropertyName : NumericLiteral

1. Let *nbr* be the result of forming the value of the NumericLiteral.
2. Return ToString(*nbr*).

Static Semantics: PropertyNameList

PropertyDefinitionList : PropertyDefinition

1. Return a new List containing PropName of PropertyDefinition.

PropertyDefinitionList : PropertyDefinitionList , PropertyDefinition

1. Let *list* be PropertyNameList of PropertyDefinitionList.
2. Append PropName of PropertyDefinition to the end of *list*.
3. Return *list*.

Deleted: <#>It is a Syntax Error if this production is contained in strict code, *PropertyName* is the production *PropertyAssignment : PropertyName : AssignmentExpression*, and *PropertyDefinitionList(PropName of PropertyAssignment) of PropertyNameAndValueList* is not the empty List.
 <#>It is a Syntax Error if *PropertyAssignment* is the production *PropertyAssignment : IdentifierName and PropertyDefinitionList(PropName of PropertyAssignment) of PropertyNameAndValueList* is not the empty List.
 <#>It is a Syntax Error if *PropertyAssignment* is the production *PropertyAssignment : PropertyName (FormalParameterList) { FunctionBody } and PropertyDefinitionList(PropName of PropertyAssignment) of PropertyNameAndValueList* is not the empty List.
 <#>It is a Syntax Error if *PropertyAssignment* is the production *PropertyAssignment : * PropertyName (FormalParameterList) { FunctionBody } and PropertyDefinitionList(PropName of PropertyAssignment) of PropertyNameAndValueList* is not the empty List.
 <#>It is a Syntax Error if *PropertyAssignment* is the production *PropertyAssignment : get PropertyName () and PropertyDefinitionList (PropName of PropertyAssignment) of PropertyNameAndValueList* includ a production of the form *PropertyAssignment : PropertyName : AssignmentExpression*.
 <#>It is a Syntax Error if *PropertyAssignment* is the production *PropertyAssignment : set PropertyName (PropertySetParameterList) { FunctionBody } and PropertyDefinitionList (PropName of PropertyAssignment) of PropertyNameAndValueList* includ a production of the form *PropertyAssignment : PropertyName : AssignmentExpression*.
 <#>It is a Syntax Error if *PropertyAssignment* is the production *PropertyAssignment : get PropertyName ()*

Deleted: *PropertyDefinition : MethodDefinition ¶*

Deleted:

Deleted:

Deleted: NOTE: Static semantic rules that depend upon substructure generally do not look into function definitions.

Deleted: **Static Semantics: ExpectedArgumentCount**
PropertySetParameterList : BindingIdentifier ¶
 <#>Return 1.
PropertySetParameterList : BindingPattern ¶

Deleted: *PropertyAssignment*

Deleted:

Deleted: *PropertyAssignment*

Deleted: *PropertyDefinition : MethodDefinition ¶*
 <#>Return PropName of MethodDefinition.¶

Deleted: *PropertyAssignment : PropertyName (FormalParameterList) { FunctionBody } ¶*
 <#>Return PropName of PropertyName.¶

Deleted: *PropertyName : IdentifierName ¶*
 <#>Return PropName(of IdentifierName).¶

Deleted: the

Deleted: s

Comment [AWB1075]: Issue: static semantic rules probably should call ToString (a runtime operation).

Runtime Semantics

Runtime Semantics: Evaluation

ObjectLiteral : { }

1. Return a new object created as if by the expression `new Object()` where `Object` is the standard built-in constructor with that name.

ObjectLiteral :

```
{ PropertyDefinitionList }
{ PropertyDefinitionList , }
```

1. Let `obj` be the result of the abstract operation `ObjectCreate` with the intrinsic object `%ObjectPrototype%` as its argument.
2. Let `status` be the result of performing `Property Definition Evaluation` of `PropertyDefinitionList` with argument `obj`.
3. `ReturnIfAbrupt(status)`.
4. Return `obj`.

Runtime Semantics: Property Definition Evaluation

With parameter `object`.

PropertyDefinitionList : PropertyDefinitionList , PropertyDefinition

1. Let `status` be the result of performing `Property Definition Evaluation` of `PropertyDefinitionList` with argument `object`.
2. `ReturnIfAbrupt(status)`.
3. Return the result of performing `Property Definition Evaluation` of `PropertyDefinition` with argument `object`.

PropertyDefinition : IdentifierName

1. Let `propName` be `StringValue` of `IdentifierName`.
2. Let `exprValue` be the result of performing `Identifier Resolution` as specified in 10.3.1 using `IdentifierName`.
3. Let `propValue` be `GetValue(exprValue)`.
4. `ReturnIfAbrupt(propValue)`.
5. Let `desc` be the `Property Descriptor` `{[[Value]]: propValue, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
6. Return the result of `DefinePropertyOrThrow(object, propName, desc)`.

PropertyDefinition :PropertyName : AssignmentExpression

1. Let `propName` be `PropName` of `PropertyName`.
2. Let `exprValue` be the result of evaluating `AssignmentExpression`.
3. Let `propValue` be `GetValue(exprValue)`.
4. `ReturnIfAbrupt(propValue)`.
5. Let `desc` be the `Property Descriptor` `{[[Value]]: propValue, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
6. Return the result of `DefinePropertyOrThrow(object, propName, desc)`.

11.1.6 Function Defining Expressions

See 13.1 for `PrimaryExpression : FunctionExpression`.

See 13.4 for `PrimaryExpression : GeneratorExpression`.

See 13.5 for `PrimaryExpression : ClassExpression`.

Deleted: 11.1.5.2
Deleted: The production <code>...ObjectLiteral : { }</code>
Deleted: <code>PropertyNameAndValueList...ropertyDefinitionList</code>
Deleted: <code>ObjectLiteral : { }</code>
Deleted: <code>ion</code>
Deleted: (15.2)
Deleted: creating a new object as if by the expression <code>new Object()</code>
Deleted: <code>P</code>
Deleted: <code>success</code>
Deleted: <code>D</code>
Deleted: <code>PropertyNameAndValueList</code>
Deleted: If <code>successstatus</code> is an abrupt completion
Deleted: the result of evaluating
Deleted: The production
Deleted: The production
Deleted: <code>PropertyNameAndValueList...ropertyDefinitionList</code>
Deleted:
Deleted: <#>Let <code>obj</code> be the result of evaluating
Deleted: <#>Let <code>previous</code> be the result of calling
Deleted: <code>success</code>
Deleted: Performing <code>Property Definition</code>
Deleted: <code>PropertyNameAndValueList</code>
Deleted: Call the <code>[[DefineOwnProperty]]</code> internal
Deleted: If <code>successstatus</code> is an abrupt completion
Deleted: Performing <code>Property Definition</code>
Deleted: <code>PropertyAssignment</code>
Deleted: Return <code>obj</code> .
Deleted: <code>! </code>
Deleted: The production
Deleted: <code>PropertyAssignment</code>
Deleted: is evaluated as follows:
Deleted: <code>PropName(</code>
Deleted: <code>)</code>
Deleted: as the <code>Identifier</code>
Deleted: If <code>propValue</code> is an abrupt completion,
Deleted: Call
Deleted: calling the
Deleted: <code>,</code>
Deleted: and
Deleted: <code>, and false</code>
Deleted: <#>Return <code>Property Identifier</code>
Deleted: The production
Deleted: <code>PropertyAssignment</code>
Deleted: is evaluated as follows:
Deleted: the result of evaluating
Deleted: <code>(...of PropertyName)</code>
Deleted: If <code>propValue</code> is an abrupt completion,
Deleted: calling <code>Call the [[...efineOwn...roperty]]</code>
Deleted: <code>,</code>
Deleted: and
Deleted: <code>, and false</code>
Deleted: Return <code>Property Identifier (propName)</code>
Comment [AWB676]: Need a actual
Deleted: <code>PropertyDefinition : MethodDefinition</code>
Deleted: <code>PropertyAssignment : PropertyName</code>

11.1.7 Generator Comprehensions

Syntax

GeneratorComprehension :

(Comprehension)

11.1.8 Regular Expression Literals

Syntax

See 7.8.5.

Static Semantics

Static Semantics: Early Errors

PrimaryExpression : *RegularExpressionLiteral*

- It is a Syntax Error if *BodyText* of *RegularExpressionLiteral* can not be recognized using the goal symbol *Pattern* of the ECMAScript RegExp grammar specified in 15.10.
- It is a Syntax Error if *FlagText* of *RegularExpressionLiteral* contains any character other than "g", "i", "m", "u", or "y", or if it contains the same character more than once.

Runtime Semantics

Runtime Semantics: Evaluation

PrimaryExpression : *RegularExpressionLiteral*

1. A regular expression literal evaluates to a value of the *Object* type that is an instance of the standard built-in constructor *RegExp*. This value is determined in two steps: first, the characters comprising the regular expression's *RegularExpressionBody* and *RegularExpressionFlags* production expansions are collected uninterpreted into two Strings *Pattern* and *Flags*, respectively. Then each time the literal is evaluated, a new object is created as if by the expression `new RegExp(Pattern, Flags)` where *RegExp* is the standard built-in constructor with that name. The newly constructed object becomes the value of the *RegularExpressionLiteral*.

11.1.9 Template Literals

Syntax

TemplateLiteral :

NoSubstitutionTemplate
TemplateHead *Expression* [Lexical goal *InputElementTemplateTail*] *TemplateSpans*

TemplateSpans :

TemplateTail
TemplateMiddleList [Lexical goal *InputElementTemplateTail*] TemplateTail

TemplateMiddleList :

TemplateMiddle *Expression*
TemplateMiddleList [Lexical goal *InputElementTemplateTail*] *TemplateMiddle Expression*

Static Semantics

Static Semantics: TemplateStrings

With parameter *raw*.

Deleted: Runtime Semantics: Evaluation
PrimaryExpression : *FunctionExpression*
 Return the result of evaluating *FunctionExpression*

Deleted: (*Expression* *ComprehensionForList*)
Deleted:
Deleted: *Expression*
Deleted: *ForList* **if** (*Expression*
Deleted:)

Comment [AWB877]: Should convert to a multistep algorithm and breakout a static semantic rule for the error

Deleted: *Quasi*

Deleted: *Quasi*
Deleted: *FullQuasi*
Deleted: *Quasi*
Deleted: *QuasiMiddleList_{opt}* [Lexical goal *InputElementQuasiTail*]
Deleted: *Quasi*
Deleted: *Tail*
Deleted: *Quasi*
Deleted: [Lexical goal *InputElementQuasiTail*] *Quasi*
Deleted: *Quasi*
Deleted: *Quasi*
Deleted: *Quasi*
Deleted: *QuasiStrings*

TemplateLiteral : NoSubstitutionTemplate

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*.

Deleted: Quasi...emplateLiteral : FullQuasi

TemplateLiteral : TemplateHead Expression [Lexical goal InputElementTemplateTail] 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*.

Deleted: Quasi...emplateLiteral :

Deleted: QV...V of FullQuasi

Deleted:

Deleted: QRV...RV of FullQuasi

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*.

Deleted: Quasi...emplateLiteral...pans :

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*.

Deleted: <#>Let head be the QV of QuasiHead

Deleted: <#>Let head be the QRV of QuasiHead

Deleted: <#>Let middle be QuasiStrings of QuasiMiddleList with argument raw.¶

Deleted: Quasi...emplateMiddleList : [Lexical

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: Quasi...emplateMiddleList :

Deleted: QuasiStrings...emplateStrings of Quasi

Deleted: QV...V of Quasi

Deleted: QRV...RV of Quasi

TemplateMiddleList : TemplateMiddleList [Lexical goal InputElementTemplateTail] 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: QRV...RV of Quasi

Runtime Semantics

Runtime Semantics: ArgumentListEvaluation

TemplateLiteral : NoSubstitutionTemplate

1. Let *siteObj* be the result of the abstract operation *GetTemplateCallSite* passing this *TemplateLiteral* production as the argument.

Deleted: Quasi...emplateLiteral : FullQuasi

Deleted: the

Deleted: ion

Deleted: Quasi...emplateCallSite passing this

2. Return a List containing the one element which is *siteObj*.

TemplateLiteral : *TemplateHead Expression* [Lexical goal *InputElementTemplateTail*] *TemplateSpans*

1. Let *siteObj* be the result of the abstract operation *GetTemplateCallSite* passing this *TemplateLiteral* production as the argument.
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.

Runtime Semantics: *GetTemplateCallSite* Abstract Operation

The abstract operation *GetTemplateCallSite* is called with a grammar production, *templateLiteral*, as an argument. It performs the following steps:

1. If a call site object for the source code corresponding to *templateLiteral* has already been created by a previous call to this abstract operation, then return that call site object.
2. Let *cookedStrings* be *TemplateStrings* of *templateLiteral* with argument **false**.
3. Let *rawStrings* be *TemplateStrings* of *templateLiteral* with argument **true**.
4. Let *count* be the number of elements in the List *cookedStrings*.
5. Let *siteObj* be the result of the abstract operation *ArrayCreate* with argument *count*.
6. Let *rawObj* be the result of the abstract operation *ArrayCreate* with argument *count*.
7. Let *index* be **0**.
8. Repeat while *index* < *count*
 - a. Let *prop* be *ToString(index)*.
 - b. Let *cookedValue* be the string value at 0-based position *index* of the List *cookedStrings*.
 - c. Call the *[[DefineOwnProperty]]* internal method of *siteObj* with arguments *prop* and Property Descriptor *{[[Value]]: cookedValue, [[Writable]]: false, [[Configurable]]: false}*.
 - d. Let *rawValue* be the string value at 0-based position *index* of the List *rawStrings*.
 - e. Call the *[[DefineOwnProperty]]* internal method of *rawObj* with arguments *prop* and Property Descriptor *{[[Value]]: rawValue, [[Writable]]: false, [[Configurable]]: false}*.
 - f. Let *index* be *index+1*.
9. Call the *[[Freeze]]* internal method of *rawObj*.
10. Call the *[[DefineOwnProperty]]* internal method of *siteObj* with arguments **"raw"** and Property Descriptor *{[[Value]]: rawObj, [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false}*.
11. Call the *[[Freeze]]* internal method of *siteObj*.
12. 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.
13. *Return siteObj*.

NOTE 1 The creation of a call site object cannot result in an abrupt completion.

NOTE 2 Each *TemplateLiteral* in the program code is associated with a unique *Template call site object* that is used in the evaluation of tagged Templates (11.2.6). The same call site object is used each time a specific tagged Template is evaluated. Whether call site 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.

Runtime Semantics: SubstitutionEvaluation

TemplateSpans : *TemplateTail*

1. *Return an empty List*.

TemplateSpans : *TemplateMiddleList* [Lexical goal *InputElementTemplateTail*] *TemplateTail*

1. *Return the result of SubstitutionEvaluation of TemplateMiddleList*.

Deleted: *QuasiLiteral* : *QuasiHead Expression* [Lexical goal *InputElementQuasiTail*] *QuasiTail*
*<#>*Let *siteObj* be the the result of the abstraction operation *GetQuasiCallSite* passing this *QuasiLiteral* production as the argument.
*<#>*Let *firstSub* be the result of evaluating *Expression*. ¶
*<#>*ReturnIfAbrupt(*sub*).¶

Deleted: *Quasi*
Deleted: *QuasiMiddleList*
Deleted: *Quasi*
Deleted: *Quasi*
Deleted: *Tail*
Deleted: *the*
Deleted: *ion*
Deleted: *Quasi*
Deleted: *Quasi*
Deleted: *MiddleList*
Deleted: *Quasi*
Deleted: *quasi*
Deleted: *quasi*
Deleted: *QuasiStrings*
Deleted: *quasi*
Deleted: *QuasiStrings*
Deleted: *quasi*
Deleted: *Object*
Deleted: abstract operation with argument
Deleted: ,
Deleted: , and false
Deleted: value
Deleted: ,
Deleted: , and false
Deleted: Object
Deleted: abstract operation with argument
Deleted: *quasi*
Deleted: *n*
Deleted: *Quasi*
Deleted: *Quasi*
Deleted: *Quasi*
Deleted: *Quasi*
Deleted: *Quasi*

TemplateMiddleList : TemplateMiddle Expression

1. Let *sub* be the result of evaluating *Expression*.
2. ReturnIfAbrupt(*sub*).
3. Return a List containing only *sub*.

Deleted: Quasi...emplateMiddleList : [Lexical

Deleted: middle

TemplateMiddleList : TemplateMiddleList [Lexical goal InputElementTemplateTail] 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*.

Deleted: Quasi...emplateMiddleList :

Deleted: Quasi

Deleted: list

Runtime Semantics: Evaluation
TemplateLiteral : NoSubstitutionTemplate

1. Return the string value whose elements are the TV of *NoSubstitutionTemplate* as defined in 7.8.6.

Deleted: Quasi...emplateLiteral : FullQuasi

Deleted: QV...V of FullQuasi

Deleted: Quasi...emplateLiteral :

Deleted: QV...V of Quasi

Comment [AWB978]: Note that the conversion semantics are like `String.prototype.concat` rather than the `+` operator.

Deleted: <#>Let *tail* be the QV of *QuasiTail* as defined in 7.8.6.¶

Deleted: Quasi...emplateLiteral...pans :

Comment [AWB979]: Note that the conversion semantics are like `String.prototype.concat` rather than the `+` operator.

Deleted: <#>Let *head* be the QV of *QuasiHead* as defined in 7.8.6.¶
 <#>Let *sub* be the result of evaluating *Expression*.¶
 <#>Let *first* be `ToString(sub)`.¶
 <#>ReturnIfAbrupt(*first*).¶
 <#>Let *rest* be the result of evaluating *QuasiMiddleList*.¶

Deleted: rest

Deleted: QV...V of Quasi

Deleted: code units

Deleted: followed by the elements of *first* followed by the code units of *rest*

Deleted: code units

Deleted: Quasi...emplateMiddleList : [Lexical

Deleted: QV...V of Quasi

Comment [AWB980]: Note that the conversion semantics are like `String.prototype.concat` rather than the `+` operator.

Deleted: Quasi...emplateMiddleList :

Deleted: Quasi

Deleted: QV...V of Quasi

Comment [AWB981]: Note that the conversion semantics are like `String.prototype.concat` rather than the `+` operator.

TemplateSpans : TemplateTail

1. Let *tail* be the TV of *TemplateTail* as defined in 7.8.6.
2. Return the string whose elements are the code units of *tail*.

TemplateSpans : TemplateMiddleList [Lexical goal InputElementTemplateTail] TemplateTail

1. Let *head* be the result of evaluating *TemplateMiddleList*.
2. ReturnIfAbrupt(*head*).
3. Let *tail* be the TV of *TemplateTail* as defined in 7.8.6.
4. Return the string whose elements are the elements of *head* followed by the elements of *tail*.

TemplateMiddleList : TemplateMiddle Expression

1. Let *head* be the TV of *TemplateMiddle* as defined in 7.8.6.
2. Let *sub* be the result of evaluating *Expression*.
3. Let *middle* be `ToString(sub)`.
4. ReturnIfAbrupt(*middle*).
5. Return the sequence of characters consisting of the code units of *head* followed by the elements of *middle*.

TemplateMiddleList : TemplateMiddleList [Lexical goal InputElementTemplateTail] 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 7.8.6.
4. Let *sub* be the result of evaluating *Expression*.
5. Let *last* be `ToString(sub)`.
6. ReturnIfAbrupt(*last*).

7. Return the sequence of characters consisting of the elements of *rest* followed by the code units of *middle* followed by the elements of *last*.

11.1.10 The Grouping Operator

Static Semantics: Early Errors

PrimaryExpression : CoverParenthesizedExpressionAndArrowParameterList

- 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 the CoveredParenthesizedExpression of CoverParenthesizedExpressionAndArrowParameterList.

Static Semantics: IsValidSimpleAssignmentTarget

PrimaryExpression : CoverParenthesizedExpressionAndArrowParameterList

1. Let *expr* be CoveredParenthesizedExpression of CoverParenthesizedExpressionAndArrowParameterList.
2. Return IsValidSimpleAssignmentTarget of *expr*.

ParenthesizedExpression : (Expression)

1. Return IsValidSimpleAssignmentTarget of Expression.

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 parenthesised expressions.

11.2 Left-Hand-Side Expressions

Syntax

MemberExpression :
[Lexical goal InputElementRegExp] PrimaryExpression
MemberExpression [Expression]
MemberExpression . IdentifierName
MemberExpression TemplateLiteral
super [Expression]
super . IdentifierName
new super Arguments_{opt}
new MemberExpression Arguments

NewExpression :

MemberExpression
new NewExpression

Deleted: ComprehensionForList ·||
 ComprehensionFor
 ComprehensionForList ComprehensionFor·||
 ComprehensionFor ·||
 for (LeftHandSideExpression of Expression)

Deleted: The production PropertyName : IdentifierName is evaluated as follows:
 Return the String value containing the same sequence of characters as the IdentifierName).||
 The production PropertyName : StringLiteral is evaluated as follows:
 Return the SV of the StringLiteral.||
 The production PropertyName : NumericLiteral is evaluated as follows:
 Let *nbr* be the result of forming the value of the NumericLiteral.||
 Return ToString(nbr).||

Deleted: 6

Deleted: 7

Deleted: 8

Deleted: The production

Deleted: PrimaryExpression

Deleted: is evaluated as follows:

Deleted: FunctionExpression

Deleted: Quasi

Deleted: MemberExpression <| TriangleLiteral

Deleted: MemberExpression <| SealedArrayLiteral
 MemberExpression <| SealedObjectLiteral
 MemberExpression <| FunctionExpression
 MemberExpression <| ValueLiteral

CallExpression :

- MemberExpression Arguments*
- super Arguments*
- CallExpression Arguments*
- CallExpression [Expression]*
- CallExpression . IdentifierName*
- CallExpression TemplateLiteral*

Arguments :

- ()*
- (ArgumentList)*

ArgumentList :

- AssignmentExpression*
- ... AssignmentExpression*
- ArgumentList , AssignmentExpression*
- ArgumentList , ... AssignmentExpression*

LeftHandSideExpression :

- NewExpression*
- CallExpression*

Static Semantics

Static Semantics: Contains

With parameter symbol.

MemberExpression : MemberExpression . IdentifierName

1. If *MemberExpression* 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**.

MemberExpression : 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**.

MemberExpression : new super

1. If *symbol* is the *ReservedWord* **super**, return **true**.
2. If *symbol* is the *ReservedWord* **new**, return **true**.
3. Return **false**.

MemberExpression : new super Arguments

Deleted: Quasi

Deleted:
CallExpression <| TriangleLiteral

Deleted: TriangleLiteral :
SealedArrayLiteral
SealedObjectLiteral
FunctionExpression
ArrowFunction
ValueLiteral

Deleted: c

Deleted:
Deleted:

Deleted:
Deleted:

Deleted: c

Deleted:
Deleted:

1. If `symbol` is the ReservedWord `super`, return `true`.
2. If `symbol` is the ReservedWord `new`, return `true`.
3. Return the result of `Arguments Contains symbol`.

Static Semantics: IsValidSimpleAssignmentTarget

CallExpression :

CallExpression [Expression]
CallExpression . IdentifierName

MemberExpression :

MemberExpression [Expression]
MemberExpression . IdentifierName
super [Expression]
super . IdentifierName

1. Return `true`.

CallExpression :

MemberExpression Arguments
super Arguments
CallExpression Arguments
CallExpression TemplateLiteral

NewExpression : new NewExpression

MemberExpression :

new super Arguments_{opt}
new MemberExpression Arguments

1. Return `false`.

11.2.1 Property Accessors

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 a string literal containing the same sequence of characters after processing of Unicode escape sequences as the `IdentifierName`.

Deleted: Static Semantics: IsValidAssignmentPattern

LeftHandSideExpression : NewExpression
<#>If the source code corresponding to `NewExpression` can be parsed as `ArrayLiteral`, then
<#>If the source code corresponding to `NewExpression` can be parsed as `ObjectLiteral`, then return `false`.
<#>If the source code corresponding to `NewExpression` can be parsed using `AssignmentPattern` (11.13.1) as the goal symbol, return `true`.
<#>Return `false`.
LeftHandSideExpression : CallExpression
<#>Return `false`.

Deleted: MemberExpression Arguments
super Arguments
CallExpression Arguments

Comment [AWB1082]: These are false, because we disallow host functions returning reference values.

Deleted: CallExpression : CallExpression TemplateLiteral

Deleted: MemberExpression : new MemberExpression Arguments

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 *by* be *CheckObjectCoercible(baseValue)*.
8. *ReturnIfAbrupt(by)*.
9. Let *propertyNameString* be *ToString(propertyNameValue)*.
10. 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**.
11. Return a value of type Reference whose base value is *by* and whose referenced name is *propertyNameString*, and whose strict reference flag is *strict*.

CallExpression : CallExpression [Expression]

Is evaluated in exactly the same manner as *MemberExpression : MemberExpression [Expression]*, except that the contained *CallExpression* is evaluated in step 1.

11.2.2 The new Operator

Runtime Semantics: Evaluation

NewExpression : new NewExpression

1. Let *ref* be the result of evaluating *NewExpression*.
2. Let *constructor* be *GetValue(ref)*.
3. *ReturnIfAbrupt(constructor)*.
4. If *Type(constructor)* is not Object, throw a **TypeError** exception.
5. If *constructor* does not implement the [[Construct]] internal method, throw a **TypeError** exception.
6. Return the result of calling the [[Construct]] internal method on *constructor*, with an empty List as the argument.

MemberExpression : new MemberExpression Arguments

1. Let *ref* be the result of evaluating *MemberExpression*.
2. Let *constructor* be *GetValue(ref)*.
3. *ReturnIfAbrupt(constructor)*.
4. Let *argList* be the result of evaluating *Arguments*, producing an internal List of argument values (11.2.4).
5. *ReturnIfAbrupt(argList)*.
6. If *Type(constructor)* is not Object, throw a **TypeError** exception.
7. If *constructor* does not implement the [[Construct]] internal method, throw a **TypeError** exception.
8. Return the result of calling the [[Construct]] internal method on *constructor*, passing *argList* as the argument.

11.2.3 Function Calls

Runtime Semantics: Evaluation

CallExpression : MemberExpression Arguments

1. Let *ref* be the result of evaluating *MemberExpression*.
2. If this *CallExpression* is in a tail position (13.7) then let *tailCall* be **true**, otherwise let *tailCall* be **false**.
3. Return the result of the abstract operation *EvaluateCall* with arguments *ref*, *Arguments*, and *tailCall*.

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *baseValue* is an abrupt completion, return *baseValue*

Deleted: If *propertyNameValue* is an abrupt completion, return *propertyNameValue*

Deleted: Call

Deleted: If the result of

Deleted:

Deleted: *CheckObjectCoercible(baseValue)*

Deleted: is an abrupt completion, return that result

Deleted: contained in

Deleted: *baseValue*

Deleted: mode

Deleted: The production

Deleted: is

Deleted: ,

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *constructor* is an abrupt completion, return *constructor*

Deleted: , providing no arguments (that is,

Deleted: list

Deleted: of

Comment [AWB983]: TODO probably need to do something about new operators in tail position.

Deleted: arguments)

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *constructor* is an abrupt completion, return *constructor*

Deleted: list

Deleted: If *argList* is an abrupt completion, return *argList*

Deleted: providing the list

Deleted: values

Comment [AWB784]: TODO: tail calls.

Jan 19 meeting notes: Tentative decision is to support tail calls in strict mode only.

Deleted: The production

Deleted: is evaluated as follows:

Deleted:

Deleted: and

CallExpression : CallExpression Arguments

1. Let *ref* be the result of evaluating *CallExpression*.
2. If this *CallExpression* is in a tail position (13.7) then let *tailCall* be **true**, otherwise let *tailCall* be **false**.
3. Return the result of the abstract operation *EvaluateCall* with arguments *ref.Arguments*, and *tailCall*.

Runtime Semantics: EvaluateCall Abstract Operation

The abstract operation *EvaluateCall* takes as arguments a value *ref*, and 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. Let *argList* be the result of performing ArgumentListEvaluation of arguments.
4. ReturnIfAbrupt(argList).
5. If *Type(func)* is not Object, throw a **TypeError** exception.
6. If *IsCallable(func)* is **false**, throw a **TypeError** exception.
7. 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)*.
8. Else *Type(ref)* is not Reference,
 - a. Let *thisValue* be **undefined**.
9. If *tailPosition* is **true**, then
 - a. Let *leafContext* be the running execution context.
 - b. Suspend leafContext.
 - c. Pop *leafContext* from the execution context context stack. The execution context now on the top of the stack becomes the running execution context, however it remains in its suspended state.
 - d. Assert: leafContext has no further use. It will never be activated as the running execution context.
10. Let *result* be the result of calling the **[[Call]]** internal method on *func*, passing *thisValue* as the *thisArgument* and *argList* as the *argumentsList*.
11. Assert: If tailPosition is true, the above call will not return here, but instead evaluation will continue with the resumption of leafCallerContext as the running execution context.
12. Assert: Type(result) is an ECMAScript language type.
13. Return result.

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 1 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.

11.2.4 The super Keyword

Static Semantics

Static Semantics: Early Errors

MemberExpression :

- super [Expression]*
- super . IdentifierName*
- new super Arguments_{opt}*

CallExpression : super Arguments

- It is a Syntax Error if the source code parsed with this production is global code that is not eval code.

- Deleted:**
Deleted: and
Deleted:
Deleted: Reference,
Deleted: <#>Let *ref* be the result of evaluating *MemberExpression*.
Deleted: If *func* is an abrupt completion, return *func*
Deleted: evaluating
Deleted: *Arguments*
Deleted: , producing an internal list of argument values (see 11.2.4)
Deleted: If *argList* is an abrupt completion, return *argList*
Deleted: *GetBase*
Deleted: ImplicitThisValue
Deleted: ,
Deleted: .
Deleted: <#>Let *leafCallerContext* be *leafContext*'s PreviousContext.
Deleted: Make *leafCallerContext* t
Comment [AWB985]: Is this really true. Need to think about whether generators may impact this assertion.
Deleted: Return
Deleted: providing
Deleted: as the *this* value
Deleted: providing the list
Deleted: argument values
Deleted: .
Deleted: a
Deleted: The This production *CallExpression : CallExpression Arguments* is evaluated in exactly the same manner, as *CallExpression : MemberExpression Arguments* except that the contained *CallExpression* is evaluated in step 1.¶
Deleted: NOTE 2 The returned result will never be of type Reference if *func* is an native ordinary ECMAScript object. Whether calling an host exotic object can return value of type Reference is implementation-dependent. If a value of type Reference is returned, it must be a non-strict Property Reference.¶
Deleted: 3
Deleted: <#>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 eval code that is also global code and the source code is not being processed by a direct call eval that is contained in function code.¶
Deleted: <#>It is a Syntax Error if the source code parsed with this production is not extended code.¶
Deleted: code

- It is a Syntax Error if the source code parsed with this production is eval code and the source code is not being processed by a direct call to eval that is contained in function code.

Runtime Semantics: Evaluation

MemberExpression : super [Expression]

- Let *propertyNameReference* be the result of evaluating *Expression*.
- Let *propertyNameValue* be *GetValue(propertyNameReference)*.
- Let *propertyKey* be *ToPropertyKey(propertyNameValue)*.
- 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**.
- Return the result of *MakeSuperReference(propertyKey, strict)*.

MemberExpression : super . IdentifierName

- Let *propertyKey* be *StringValue of IdentifierName*.
- 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**.
- Return the result of *MakeSuperReference(propertyKey, strict)*.

MemberExpression : new super Arguments_{opt}

- 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**.
- Let *ref* be the result of *MakeSuperReference(undefined, strict)*.
- Let *constructor* be *GetValue(ref)*.
- ReturnIfAbrupt(*constructor*).
- If *Arguments* is present, then
 - Let *argList* be the result of evaluating *Arguments*, producing an internal List of argument values (11.2.4).
 - ReturnIfAbrupt(*argList*).
- Else
 - Let *argList* be a new empty List.
- If *Type(constructor)* is not *Object*, throw a **TypeError** exception.
- If *constructor* does not implement the **[[Construct]]** internal method, throw a **TypeError** exception.
- Return the result of calling the **[[Construct]]** internal method on *constructor*, passing *argList* as the argument.

CallExpression : super Arguments

- 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**.
- Let *ref* be the result of *MakeSuperReference(undefined, strict)*.
- ReturnIfAbrupt(*ref*).
- If this *CallExpression* is in a tail position (13.7) then let *tailCall* be **true**, otherwise let *tailCall* be **false**.
- Return the result of the abstract operation *EvaluateCall* with arguments *ref*, *Arguments*, and *tailCall*.

Runtime Semantics: Abstract Operation MakeSuperReference(propertyKey, strict)

- Let *env* be the result of performing the *GetThisEnvironment* abstract operation.
- If the result of calling the *HasSuperBinding* concrete method of *env* is **false**, then throw a **ReferenceError** exception.
- Let *actualThis* be the result of calling the *GetThisBinding* concrete method of *env*.
- Let *baseValue* be the result of calling the *GetSuperBase* concrete method of *env*.
- Let *bv* be *CheckObjectCoercible(baseValue)*.
- ReturnIfAbrupt(*bv*).
- If *propertyKey* is *undefined*, then
 - Let *propertyKey* be the result of calling the *GetMethodName* concrete method of *env*.

Deleted: that is also global code

Deleted: <#> It is a Syntax Error if the source code parsed with this production is not extended code.¶

Deleted: <#> Let *env* be the result of performing the *GetThisEnvironment* abstract operation.¶

<#> If the result of calling the *HasSuperBinding* concrete method of *env* is **false**, then throw a **ReferenceError** exception.¶

<#> Let *actualThis* be the result of calling the *GetThisBinding* concrete method of *env*.¶

<#> Let *baseValue* be the result of calling the *GetHomeObjectSuperBase* concrete method of *env*.

Deleted: <#> Let *baseReference* be the result of evaluating *MemberExpression*.¶

<#> Let *baseValue* be *GetValue(baseReference)*.

Deleted: <#> ReturnIfAbrupt(*CheckObjectCoercible(baseValue).Call*)

Deleted: *NameString*

Deleted: *String*

Deleted: a value of type Reference that is a Super Reference whose base value is *baseValue* and, whose referenced name is *propertyNameStringKey*, whose *thisValue* is *actualThis*, and whose strict moderefence flag is *strict*

Deleted: <#> Let *env* be the result of performing the *GetThisEnvironment* abstract operation.¶

<#> If the result of calling the *HasSuperBinding* concrete method of *env* is **false**, then throw a **ReferenceError** exception.¶

<#> Let *actualThis* be the result of calling the *GetThisBinding* concrete method of *env*.¶

<#> Let *baseValue* be the result of calling the *GetSuperBaseHomeObject* concrete method of *env*.

<#> ReturnIfAbrupt(*CheckObjectCoercible(baseValue)*).¶

Deleted:

Deleted: a value of type Reference that is a Super Reference whose base value is *baseValue*, whose referenced name is *propertyKey*, whose *thisValue* is *actualThis*, and whose strict moderefence flag is *strict*

Deleted: <#> Let *env* be the result of performing the *GetThisEnvironment* abstract operation.¶

<#> If the result of calling the *HasSuperBinding* concrete method of *env* is **false**, then throw a **ReferenceError** exception.¶

<#> Let *actualThis* be the result of calling the *GetThisBinding* concrete method of *env*.¶

<#> Let *baseValue* be the result of calling the *GetSuperBaseHomeObject* concrete method of *env*.

<#> ReturnIfAbrupt(*CheckObjectCoercible(baseValue)*).¶

<#> Let *propertyKey* be the result of calling the *GetMethodName* concrete method of *env*.¶

Deleted: be a value of type Reference that is a Super Reference whose base value is *baseValue*, whose referenced name is *propertyKey*, whose *thisValue*

Deleted:

Deleted: and

8. Return a value of type Reference that is a Super Reference whose base value is *by*, whose referenced name is *propertyKey*, whose *thisValue* is *actualThis*, and whose strict reference flag is *strict*.

11.2.5 Argument Lists

The evaluation of an argument list produces a List of values (see 8.7).

Runtime Semantics

Runtime Semantics: ArgumentListEvaluation

Arguments : ()

1. Return an empty List.

ArgumentList : AssignmentExpression

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

1. Let *list* be an empty List.
2. Let *spreadRef* be the result of evaluating *AssignmentExpression*.
3. Let *spreadValue* be *GetValue(spreadRef)*.
4. Let *spreadObj* be *ToObject(spreadValue)*.
5. *ReturnIfAbrupt(spreadObj)*.
6. Let *lenVal* be the result of calling *Get(spreadObj, "length")*.
7. Let *spreadLen* be *ToUint32(lenVal)*.
8. *ReturnIfAbrupt(spreadLen)*.
9. Let *n* = 0.
10. Repeat, while *n < spreadLen*
 - a. Let *nextArg* be the result of calling *Get(spreadObj, ToString(n))*.
 - b. *ReturnIfAbrupt(nextArg)*.
 - c. Append *nextArg* as the last element of *list*.
 - d. Let *n* = *n+1*.
11. Return *list*.

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. Return a List whose length is one greater than the length of *precedingArgs* and whose items are the items of *precedingArgs*, in order, followed at the end by *arg* which is the last item of the new list.

ArgumentList : ArgumentList , ... AssignmentExpression

1. Let *precedingArgs* be an empty List.
2. Let *spreadRef* be the result of evaluating *AssignmentExpression*.
3. Let *spreadValue* be *GetValue(spreadRef)*.
4. Let *spreadObj* be *ToObject(spreadValue)*.
5. *ReturnIfAbrupt(spreadObj)*.
6. Let *lenVal* be the result of calling *Get(spreadObj, "length")*.
7. Let *spreadLen* be *ToUint32(lenVal)*.

Deleted: 4
Deleted: 8
Deleted: 11.2.45.1 Static Semantics¶
Static Semantics: Early Errors¶
The production <i>Arguments</i> : () is evaluated as follows:¶
Return an empty List.¶
The production <i>Arguments</i> : (<i>ArgumentList</i>) is evaluated as follows:¶
Return the result of evaluating <i>ArgumentList</i> .¶
The production <i>ArgumentList</i> : <i>AssignmentExpression</i> evaluated as follows:¶
Deleted: Evaluation
Deleted: The production
Deleted: is evaluated as follows:
Deleted: The production <i>Arguments</i> : (<i>ArgumentList</i>)
Deleted: The production
Deleted: is evaluated as follows:
Deleted: If <i>arg</i> is an abrupt completion, return <i>arg</i>
Deleted: ...
Comment [AW86]: Note that the value the spread
Deleted: If <i>spreadObj</i> is an abrupt completion, return
Deleted: the [[
Deleted:]] internal method of
Deleted:
Deleted: with argument
Deleted: "
Deleted: "
Deleted: the [[
Deleted:]] internal method of
Deleted: passing
Deleted:
Deleted: as the argument
Deleted: The production
Deleted: is evaluated as follows:
Deleted: If <i>precedingArgs</i> is an abrupt completion, return
Deleted: If <i>arg</i> is an abrupt completion, return <i>arg</i>
Deleted: The production
Deleted: ...
Deleted: is evaluated as follows:
Comment [AW87]: Note that the value the spread
Deleted: If <i>spreadObj</i> is an abrupt completion, return
Deleted: the [[
Deleted:]] internal method of
Deleted:
Deleted: with argument
Deleted: "
Deleted: "

8. ReturnIfAbrupt(spreadLen).
9. Let $n = 0$.
10. Repeat, while $n < spreadLen$
 - a. Let nextArg be the result of calling `Get(spreadObj, ToString(n))`.
 - b. ReturnIfAbrupt(nextArg).
 - c. Append nextArg as the last element of precedingArgs.
 - d. Let $n = n + 1$.
11. Return precedingArgs.

11.2.6 Tagged Templates

Runtime Semantics

Runtime Semantics: Evaluation

MemberExpression : MemberExpression TemplateLiteral

1. Let tagRef be the result of evaluating MemberExpression.
2. If this MemberExpression is in a tail position (13.7) then let tailCall be true, otherwise let tailCall be false.
3. Return the result of the abstract operation EvaluateCall with arguments tagRef, TemplateLiteral, and tailCall.

CallExpression : CallExpression TemplateLiteral

1. Let tagRef be the result of evaluating CallExpression.
2. If this CallExpression is in a tail position (13.7) then let tailCall be true, otherwise let tailCall be false.
3. Return the result of the abstract operation EvaluateCall with arguments tagRef, TemplateLiteral, and tailCall.

11.3 Postfix Expressions

Syntax

PostfixExpression :
LeftHandSideExpression
LeftHandSideExpression [no LineTerminator here] ++
LeftHandSideExpression [no LineTerminator here] --

Static Semantics

Static Semantics: Early Errors

PostfixExpression :

LeftHandSideExpression [no LineTerminator here] ++
LeftHandSideExpression [no LineTerminator here] --

- It is an early Reference Error if IsValidSimpleAssignmentTarget of LeftHandSideExpression is false.

Static Semantics: IsValidSimpleAssignmentTarget

PostfixExpression :

LeftHandSideExpression [no LineTerminator here] ++
LeftHandSideExpression [no LineTerminator here] --

1. Return false.

Deleted: the [[]]] internal method of
Deleted: passing
Deleted: as the argument
Deleted: Quasi

Deleted: The runtime semantics of production
CallExpression : CallExpression QuasiTemplateLiteral
is identical to that of MemberExpression : MemberExpression QuasiTemplateLiteral,
but with evaluation of CallExpression substituted for the evaluation of MemberExpression.
Deleted: Quasi
Deleted: Quasi

Deleted: PostfixExpression :
LeftHandSideExpression
LeftHandSideExpression [no LineTerminator here] ++
LeftHandSideExpression [no LineTerminator here] --
<#> It is a Syntax Error if the derived
LeftHandSideExpression is PrimaryExpression :
ObjectLiteral and
ContainsNonObjectLiteralProductions of
ObjectLiteral is true.
<#> It is a Syntax Error if the derived
LeftHandSideExpression is PrimaryExpression :
(Expression) and Expression derived a
production that if used in place of
LeftHandSideExpression would produce a Syntax
Error according to these rules. This rule is
recursively applied.
Deleted: It is a Syntax Error if the
PostfixExpression is contained in strict code and
LeftHandSideExpression is the Identifier eval or
the Identifier arguments.

Deleted: ¶
<#> It is a Syntax Error if the
AssignmentExpression is contained in extended
code and the LeftHandSideExpression is a Literal
or a FunctionExpression.¶
<#> It is a Syntax Error if the
AssignmentExpression is contained in extended
code and the LeftHandSideExpression is an
Identifier that does not statically resolve to a
declarative environment record binding or if the
resolved binding is an immutable binding.¶
It is a Syntax Error if the LeftHandSideExpression
is PrimaryExpression : (Expression) and
Expression derived a production that if used in
place of LeftHandSideExpression that would
produce a Syntax Error according to these rules.
This rule is recursively applied.

11.3.1 Postfix Increment Operator

Runtime Semantics: Evaluation

PostfixExpression : LeftHandSideExpression [no LineTerminator here] ++

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 11.6.3).
5. Let *status* be *PutValue*(*lhs*, *newValue*).
6. *ReturnIfAbrupt*(*status*).
7. Return *oldValue*.

11.3.2 Postfix Decrement Operator

Runtime Semantics: Evaluation

PostfixExpression : LeftHandSideExpression [no LineTerminator here] --

1. Let *lhs* be the result of evaluating *LeftHandSideExpression*.
2. Let *oldValue* be *ToNumber*(*GetValue*(*lhs*)).
3. Let *newValue* be the result of subtracting the value **1** from *oldValue*, using the same rules as for the **-** operator (11.6.3).
4. Let *status* be *PutValue*(*lhs*, *newValue*).
5. *ReturnIfAbrupt*(*status*).
6. Return *oldValue*.

11.4 Unary Operators

Syntax

```
UnaryExpression :
  PostfixExpression
  delete UnaryExpression
  void UnaryExpression
  typeof UnaryExpression
  ++ UnaryExpression
  -- UnaryExpression
  + UnaryExpression
  - UnaryExpression
  ~ UnaryExpression
  ! UnaryExpression
```

Static Semantics

Static Semantics: Early Errors

UnaryExpression :

++ UnaryExpression
-- UnaryExpression

- It is an early Reference Error if *IsValidSimpleAssignmentTarget* of *UnaryExpression* is **false**.

Static Semantics: IsValidSimpleAssignmentTarget

Deleted: The production

Deleted: is evaluated as follows:

Deleted: <#>Throw a **SyntaxError** exception if the following conditions are all true:
 <#>*Type*(*lhs*) is Reference is **true**
 <#>*IsStrictReference*(*lhs*) is **true**
 <#>*Type*(*GetBase*(*lhs*)) is Environment Record
 <#>*GetReferencedName*(*lhs*) is either "**eval**" or "**arguments**"

Deleted: If *oldValue* is an abrupt completion, return *oldValue*.

Deleted: Call

Deleted: If

Deleted: The production

Deleted: is evaluated as follows:

Deleted: <#>Throw a **SyntaxError** exception if the following conditions are all true:
 <#>*Type*(*lhs*) is Reference is **true**
 <#>*IsStrictReference*(*lhs*) is **true**
 <#>*Type*(*GetBase*(*lhs*)) is Environment Record
 <#>*GetReferencedName*(*lhs*) is either "**eval**" or "**arguments**"

Deleted: If Call

Deleted: *UnaryExpression :*
delete UnaryExpression

<#>
++ UnaryExpression
-- UnaryExpression
 <#>It is a Syntax Error if the *UnaryExpression* is contained in strict code and the derived *UnaryExpression* is the Identifier **eval** or the Identifier **arguments**.
 <#>It is a Syntax Error if the *UnaryExpression* is contained in extended code and the derived *UnaryExpression* is a **Literal** or a **FunctionExpression**.
 <#>It is a Syntax Error if the *UnaryExpression* is contained in extended code and the derived *UnaryExpression* is an **Identifier** that does not statically resolve to a declarative environment record binding or the resolved binding is an immutable binding.

<#>It is a Syntax Error if the derived *UnaryExpression* is a **PrimaryExpression**:
(CoverParenthesizedExpressionAndArrowParameterList Expression)
 and *Expression* derives a production that if used in place of *LeftHandSideUnaryExpression* would produce a Syntax Error according to these rules. This rule is recursively applied.

UnaryExpression :

- delete UnaryExpression
- void UnaryExpression
- typeof UnaryExpression
- ++ UnaryExpression
- UnaryExpression
- + UnaryExpression
- UnaryExpression
- ~ UnaryExpression
- ! UnaryExpression

1. Return false.

11.4.1 The delete Operator

Static Semantics: Early Errors

UnaryExpression : delete UnaryExpression

- It is a Syntax Error if the UnaryExpression is contained in strict code and the derived UnaryExpression is PrimaryExpression : Identifier.
- It is a Syntax Error if the derived UnaryExpression is PrimaryExpression : CoverParenthesizedExpressionAndArrowParameterList and derives a production that is used in place of UnaryExpression would produce a Syntax Error according to these rules. This rule is recursively applied.

Deleted: derives an
Deleted: that statically resolves to a environment record

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. If IsStrictReference(ref) is true, then throw a SyntaxError exception.
 - b. Return true.
5. If IsPropertyReference(ref) is true, then
 - a. If IsSuperReference(ref), then 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, then throw a TypeError exception.
 - e. Return true.
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.

Deleted: The production
Deleted: is evaluated as follows:
Deleted: If ref is an abrupt completion, return undefined.
Deleted: Else, r
Deleted: Return
Deleted: and IsStrictReference(ref)
Deleted: s
Deleted: t
Deleted: ,
Deleted: so
Deleted: <#> If IsStrictReference(ref) is true, throw a SyntaxError exception.

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.

11.4.2 The void Operator

Runtime Semantics: Evaluation

UnaryExpression : void UnaryExpression

Deleted: The production
Deleted: is evaluated as follows:

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.

Deleted: Call

Deleted: <#>ReturnIfAbrupt(*exprref*).If *ref* is an abrupt completion, return *ref*.¶

11.4.3 The `typeof` Operator

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".
 - b. Let *val* be GetValue(*val*).
3. ReturnIfAbrupt(*val*).
4. Return a String determined by Type(*val*) according to [Table 30](#).

Deleted: The production

Deleted: is evaluated as follows:

Table 30—`typeof` Operator Results

Type of <i>val</i>	Result
Undefined	"undefined"
Null	"object"
Boolean	"boolean"
Number	"number"
String	"string"
Object (ordinary and does not implement [[Call]])	"object"
Object (implements [[Call]])	"function"
Object (exotic and does not implement [[Call]])	Implementation-defined unless explicitly specified. May not be "undefined", "boolean", "number", or "string".

Deleted: If *val* is an abrupt completion, return *val*.

Deleted: [Table 30](#)[Table 28](#)[Table 26](#)

Deleted: 302826

11.4.4 Prefix Increment Operator

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. Let *newValue* be the result of adding the value 1 to *oldValue*, using the same rules as for the + operator (see 11.6.3).
5. Let *status* be PutValue(*expr*, *newValue*).
6. ReturnIfAbrupt(*status*).
7. Return *newValue*.

Deleted: native

Deleted: native or host and does

Deleted:

Deleted: host

Deleted: except m

11.4.5 Prefix Decrement Operator

Runtime Semantics: Evaluation

UnaryExpression : `--` *UnaryExpression*

Deleted: The production

Deleted: is evaluated as follows:

Deleted: <#>Throw a `SyntaxError` exception if the following conditions are all true.¶
 <#>Type(*expr*) is Reference is **true**¶
 <#>IsStrictReference(*expr*) is **true**¶
 <#>Type(GetBase(*expr*)) is Environment Record¶
 <#>GetReferencedName(*expr*) is either "eval" or "arguments"¶

Deleted: If *oldValue* is an abrupt completion, return *oldValue*.

Deleted: If

Deleted: Call

Deleted: The production

Deleted: is evaluated as follows:

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 11.6.3).
5. *Let status be PutValue(expr, newValue)*.
6. *ReturnIfAbrupt(status)*.
7. Return *newValue*.

11.4.6 Unary + Operator

NOTE The unary **+** operator converts its operand to Number type.

Runtime Semantics: Evaluation

UnaryExpression : + UnaryExpression

1. Let *expr* be the result of evaluating *UnaryExpression*.
2. Return *ToNumber*(*GetValue*(*expr*)).

11.4.7 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**.

Deleted: <#> Throw a **SyntaxError** exception if the following conditions are all true:
 <#> *Type*(*expr*) is Reference and *IsStrictReference*(*expr*) is **true**
 <#> *Type*(*GetBase*(*expr*)) is Environment Record
 <#> *GetReferencedName*(*expr*) is either "**eval**" or "arguments"

Deleted: If *oldValue* is an abrupt completion, return *oldValue*.

Deleted: Call

Deleted: If

Deleted: The production

Deleted: is evaluated as follows:

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.

Deleted: Note that negating

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *oldValue* is an abrupt completion, return *oldValue*.

11.4.8 Bitwise NOT Operator (**~**)

Runtime Semantics: Evaluation

UnaryExpression : ~ UnaryExpression

1. Let *expr* be the result of evaluating *UnaryExpression*.
2. Let *oldValue* be *ToInt32*(*GetValue*(*expr*)).
3. *ReturnIfAbrupt*(*oldValue*)
4. Return the result of applying bitwise complement to *oldValue*. The result is a signed 32-bit integer.

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *oldValue* is an abrupt completion, return *oldValue*.

11.4.9 Logical NOT Operator (**!**)

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**.

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *oldValue* is an abrupt completion, return *oldValue*.

11.5 Multiplicative Operators

Syntax

MultiplicativeExpression :

UnaryExpression
*MultiplicativeExpression * UnaryExpression*
MultiplicativeExpression / UnaryExpression
MultiplicativeExpression % UnaryExpression

Static Semantics: IsValidSimpleAssignmentTarget

MultiplicativeExpression :

*MultiplicativeExpression * UnaryExpression*
MultiplicativeExpression / UnaryExpression
MultiplicativeExpression % UnaryExpression

1. Return **false**.

Runtime Semantics: Evaluation

The production *MultiplicativeExpression* : *MultiplicativeExpression* @ *UnaryExpression*, where @ stands for one of the operators in the above definitions, is evaluated as follows:

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 specified operation (*, /, or %) to *lnum* and *rnum*. See the Notes below 11.5.1, 11.5.2, 11.5.3.

11.5.1 Applying the * Operator

The * operator performs multiplication, producing the product of its operands. Multiplication is commutative. Multiplication is not always associative in ECMAScript, because of finite precision.

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 or 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.

Deleted: Semantics¶

Deleted: lval

Deleted: If *leftValue* is an abrupt completion, return *leftValue*.

Deleted: leftNum

Deleted: n

Deleted: If *leftNum* is an abrupt completion, return *leftNum*.

Deleted: rightNum

Deleted: n

Deleted: If *rightNum* is an abrupt completion, return *rightNum*.

Deleted: leftNum

Deleted: rightNum

11.5.2 Applying the / Operator

The / operator 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:

- 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.

11.5.3 Applying the % Operator

The % operator yields the remainder of its operands from an implied division; the left operand is the dividend and the right operand is the divisor.

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.

11.6 Additive Operators

Syntax

AdditiveExpression :
MultiplicativeExpression
AdditiveExpression + MultiplicativeExpression
AdditiveExpression - MultiplicativeExpression

Static Semantics: IsValidSimpleAssignmentTarget

AdditiveExpression :
AdditiveExpression + MultiplicativeExpression
AdditiveExpression - MultiplicativeExpression

1. Return **false**.

11.6.1 The Addition operator (+)

NOTE The addition operator either performs string concatenation or numeric addition.

Formatted: Note

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. Return the String that is the result of concatenating *ToString(lprim)* followed by *ToString(rprim)*
12. Return the result of applying the addition operation to *ToNumber(lprim)* and *ToNumber(rprim)*. See the Note below 11.6.3.

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: If *rval* is an abrupt completion, return *rval*.

Deleted: If *lprim* is an abrupt completion, return *lprim*.

Deleted: If *rprim* is an abrupt completion, return *rprim*.

NOTE 1 No hint is provided in the calls to *ToPrimitive* in steps 5 and 6. All standard ECMAScript 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.

Deleted: native

Deleted: Host

Deleted: 5

11.6.2 The Subtraction Operator (-)

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 *lnum* be *ToNumber(lval)*.

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: If *rval* is an abrupt completion, return *rval*.

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 11.6.3.

Deleted: If `lnum` is an abrupt completion, return `lnum`.

Deleted: If `rnum` is an abrupt completion, return `rnum`.

11.6.3 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.

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 $a + (-b)$.

11.7 Bitwise Shift Operators

Syntax

ShiftExpression :

```

AdditiveExpression
ShiftExpression << AdditiveExpression
ShiftExpression >> AdditiveExpression
ShiftExpression >>> AdditiveExpression

```

Static Semantics: IsValidSimpleAssignmentTarget

ShiftExpression :

```

ShiftExpression << AdditiveExpression
ShiftExpression >> AdditiveExpression
ShiftExpression >>> AdditiveExpression

```

1. Return `false`.

11.7.1 The Left Shift Operator (`<<`)

NOTE Performs a bitwise left shift operation on the left operand by the amount specified by the right operand.

Formatted: Note

Runtime Semantics: Evaluation

ShiftExpression : ShiftExpression << AdditiveExpression

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 *ToUpper32(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.

11.7.2 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.

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: If *rval* is an abrupt completion, return *rval*.

Deleted: *n*

Deleted: If *lnum* is an abrupt completion, return *lnum*.

Deleted: *n*

Deleted: If *rnum* is an abrupt completion, return *rnum*.

Runtime Semantics: Evaluation

ShiftExpression : ShiftExpression >> AdditiveExpression

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 *ToUpper32(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.

11.7.3 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.

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: If *rval* is an abrupt completion, return *rval*.

Deleted: *n*

Deleted: If *lnum* is an abrupt completion, return *lnum*.

Deleted: *n*

Deleted: If *rnum* is an abrupt completion, return *rnum*.

Runtime Semantics: Evaluation

ShiftExpression : ShiftExpression >>> AdditiveExpression

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*)**

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: If *rval* is an abrupt completion, return *rval*.

Deleted: *n*

Deleted: If *lnum* is an abrupt completion, return *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.

Deleted: *n*

Deleted: If *rnum* is an abrupt completion, return *rnum*.

11.8 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.

Formatted: Note

Syntax

RelationalExpression :

```

ShiftExpression
RelationalExpression < ShiftExpression
RelationalExpression > ShiftExpression
RelationalExpression <= ShiftExpression
RelationalExpression >= ShiftExpression
RelationalExpression instanceof ShiftExpression
RelationalExpression in ShiftExpression

```

RelationalExpressionNoIn :

```

ShiftExpression
RelationalExpressionNoIn < ShiftExpression
RelationalExpressionNoIn > ShiftExpression
RelationalExpressionNoIn <= ShiftExpression
RelationalExpressionNoIn >= ShiftExpression
RelationalExpressionNoIn instanceof ShiftExpression

```

The semantics of the *RelationalExpressionNoIn* productions are the same as the *RelationalExpression* productions except that the contained *RelationalExpressionNoIn* is used in place of the contained *RelationalExpression*.

Deleted: evaluated in

Deleted: manner

Deleted: evaluated instead

NOTE The "NoIn" variants are needed to avoid confusing the *in* operator in a relational expression with the *in* operator in a *for* statement.

Static Semantics: IsValidSimpleAssignmentTarget

RelationalExpression :

```

RelationalExpression < ShiftExpression
RelationalExpression > ShiftExpression
RelationalExpression <= ShiftExpression
RelationalExpression >= ShiftExpression
RelationalExpression instanceof ShiftExpression
RelationalExpression in ShiftExpression

```

1. `Return false`.

Deleted: Semantics

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.

The *RelationalExpressionNoIn* productions are evaluated in the same manner as the *RelationalExpression* productions except that the contained *RelationalExpressionNoIn* is evaluated instead of the contained *RelationalExpression*.

11.8.1 Runtime Semantics

Runtime Semantics: The Abstract Relational Comparison Algorithm

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 the result of calling *ToPrimitive(x, hint Number)*.
 - b. [ReturnIfAbrupt\(px\)](#)
 - c. Let *py* be the result of calling *ToPrimitive(y, hint Number)*.
 - d. [ReturnIfAbrupt\(py\)](#)
4. Else the order of evaluation needs to be reversed to preserve left to right evaluation
 - a. Let *py* be the result of calling *ToPrimitive(y, hint Number)*.
 - b. [ReturnIfAbrupt\(py\)](#)
 - c. Let *px* be the result of calling *ToPrimitive(x, hint Number)*.
 - d. [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 character at position *k* within *px* is different from the character at position *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 for the character at position *k* within *px*.
 - e. Let *n* be the integer that is the code unit value for the character at position *k* within *py*.
 - f. If *m < n*, return **true**. Otherwise, return **false**.
6. Else
 - a. Let *nx* be the result of calling *ToNumber(px)*. Because *px* and *py* are primitive values evaluation order is not important.
 - b. Let *ny* be the result of calling *ToNumber(py)*.
 - c. If *nx* is **NaN**, return **undefined**.
 - d. If *ny* is **NaN**, return **undefined**.
 - e. If *nx* and *ny* are the same Number value, return **false**.
 - f. If *nx* is **+0** and *ny* is **-0**, return **false**.
 - g. If *nx* is **-0** and *ny* is **+0**, return **false**.
 - h. If *nx* is **+∞**, return **false**.
 - i. If *ny* is **+∞**, return **true**.
 - j. If *ny* is **-∞**, return **false**.
 - k. If *nx* is **-∞**, return **true**.
 - l. 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 3 differs from step 7 in the algorithm for the addition operator + (11.6.1) 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 normalised 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.

Runtime Semantics: Evaluation

RelationalExpression : *RelationalExpression* < *ShiftExpression*

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)*.

Deleted: If *x* is an abrupt completion, return *x*.

Deleted: If *y* is an abrupt completion, return *y*.

Deleted: If *px* is an abrupt completion, return *px*.

Deleted: If *py* is an abrupt completion, return *py*.

Deleted: If *py* is an abrupt completion, return *py*.

Deleted: If *px* is an abrupt completion, return *px*.

Deleted: If it is not the case that

Deleted: both *Type(px)* is String and *Type(py)* is String, f

Deleted: <#>Else, both *px* and *py* are Strings, ¶

<#>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.) ¶

<#>If *px* is a prefix of *py*, return **true**. ¶

<#>Let *k* be the smallest nonnegative integer such that the character at position *k* within *px* is different from the character at position *k* within *py*. (There must be such a *k*, for neither String is a prefix of the other.) ¶

<#>Let *m* be the integer that is the code unit value for the character at position *k* within *px*. ¶

<#>Let *n* be the integer that is the code unit value for the character at position *k* within *py*. ¶

<#>If *m < n*, return **true**. Otherwise, return **false**. ¶

Deleted: 11.8.1 The Less-than Operator (<) ¶ The production

Deleted: is evaluated as follows:

Deleted: If *lval* is an abrupt completion, return *lval*.

6. Let r be the result of performing abstract relational comparison $lval < rval$. (see 11.8.5)
7. **ReturnIfAbrupt(r)**
8. If r is **undefined**, return **false**. Otherwise, return r .

RelationalExpression : RelationalExpression > ShiftExpression

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 .

Deleted: 11.8.2 *The Greater-than Operator*
The production

Deleted: is evaluated as follows:

Deleted: If $lval$ is an abrupt completion, return $lval$.

Deleted: . (see 11.8.5).

RelationalExpression : RelationalExpression <= ShiftExpression

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 **true** or **undefined**, return **false**. Otherwise, return **true**.

Deleted: 11.8.3 *The Less-than-or-equal Operator (<=)*
The production

Deleted: is evaluated as follows:

Deleted: If $lval$ is an abrupt completion, return $lval$.

Deleted: . (see 11.8.5).

RelationalExpression : RelationalExpression >= ShiftExpression

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 $lval < rval$.
7. **ReturnIfAbrupt(r)**
8. If r is **true** or **undefined**, return **false**. Otherwise, return **true**.

Deleted: 11.8.4 *The Greater-than-or-equal Operator (>=)*
The production

Deleted: is evaluated as follows:

Deleted: If $lval$ is an abrupt completion, return $lval$.

Deleted: (see 11.8.5)

RelationalExpression: RelationalExpression instanceof ShiftExpression

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. **ReturnIfAbrupt(rval)**
7. **Return the result of instanceofOperator(lval, rval)**.

Deleted: is evaluated as follows:

Deleted: If $lval$ is an abrupt completion, return $lval$.

Deleted: If $rval$ is an abrupt completion, return $rval$.

Deleted: <#>If *Type(rval)* is not Object, throw **TypeError** exception.
<#>If *rval* does not have a *[[HasInstance]]* internal method, throw a **TypeError** exception.

Deleted: calling the

Deleted: calling the *[[HasInstance]]* internal method of

Deleted: r

Deleted: with argument

Deleted: and

Deleted: *hal*

Deleted: HasI

Deleted: ,

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 *Type(C)* is not Object, throw a **TypeError** exception.
2. Let *instOfHandler* be the result of *GetMethod(C.@@hasInstance)*.
3. **ReturnIfAbrupt(instOfHandler)**.
4. If *instOfHandler* is not **undefined**, then
 - a. Return the result of calling the *[[Call]]* internal method of *instOfHandler* passing C as *thisArgument* and a new List containing O as *argumentsList*.
5. If *IsCallable(C)* is **false**, then throw a **TypeError** exception.
6. **Return the result of *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 `@@hasInstance` it is assumed that it implements the default `instanceof` semantics.

Formatted: Note

RelationalExpression : RelationalExpression in ShiftExpression

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. ReturnIfAbrupt(`rval`)
7. If `Type(rval)` is not `Object`, throw a `TypeError` exception.
8. Return the result of `HasProperty(rval, ToPropertyKey(lval))`.

11.9 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 :

RelationalExpression
`EqualityExpression == RelationalExpression`
`EqualityExpression != RelationalExpression`
`EqualityExpression === RelationalExpression`
`EqualityExpression !== RelationalExpression`

EqualityExpressionNoIn :

RelationalExpressionNoIn
`EqualityExpressionNoIn == RelationalExpressionNoIn`
`EqualityExpressionNoIn != RelationalExpressionNoIn`
`EqualityExpressionNoIn === RelationalExpressionNoIn`
`EqualityExpressionNoIn !== RelationalExpressionNoIn`

The semantics of the `EqualityExpressionNoIn` productions are the same as the `EqualityExpression` productions except that the contained `EqualityExpressionNoIn` and `RelationalExpressionNoIn` are used in place of the contained `EqualityExpression` and `RelationalExpression`, respectively.

Static Semantics: IsValidSimpleAssignmentTarget

EqualityExpression :

`EqualityExpression == RelationalExpression`
`EqualityExpression != RelationalExpression`
`EqualityExpression === RelationalExpression`
`EqualityExpression !== RelationalExpression`

1. Return false.

11.9.1 Runtime Semantics

Runtime Semantics: The Abstract Equality Comparison Algorithm

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 the same as `Type(y)`, then
 - a. Return the result of performing strict equality comparison algorithm `x === y`.

Deleted: 11.8.7 The `in` operator
The production

Deleted: is evaluated as follows:

Deleted: If `lval` is an abrupt completion, return `lval`.

Deleted: of calling the `[[HasProperty]]` internal method of

Deleted: with argument

Deleted: `ToString`

Formatted: Note

Deleted:
`EqualityExpression [no LineTerminator here] is RelationalExpression`
`EqualityExpression [no LineTerminator here] isnt RelationalExpression`

Deleted:
`EqualityExpression [no LineTerminator here] is RelationalExpression`
`EqualityExpression [no LineTerminator here] isnt RelationalExpression`

Deleted: Semantics
The result of evaluating an equality operator is always type Boolean, reflecting whether the relationship named by the operator holds between its two operands.

Deleted: evaluated in

Deleted: manner

Deleted: evaluated instead

Deleted:
`EqualityExpression [no LineTerminator here] is RelationalExpression`
`EqualityExpression [no LineTerminator here] isnt RelationalExpression`

Deleted: 1

Deleted: <#>`ReturnIfAbrupt(x)`.If `x` is an abrupt completion, return `x`.
<#>`ReturnIfAbrupt(y)`.If `y` is an abrupt completion, return `y`

2. If x is **null** and y is **undefined**, return **true**.
3. If x is **undefined** and y is **null**, return **true**.
4. If $\text{Type}(x)$ is **Number** and $\text{Type}(y)$ is **String**,
return the result of the comparison $x == \text{ToNumber}(y)$.
5. If $\text{Type}(x)$ is **String** and $\text{Type}(y)$ is **Number**,
return the result of the comparison $\text{ToNumber}(x) == y$.
6. If $\text{Type}(x)$ is **Boolean**, return the result of the comparison $\text{ToNumber}(x) == y$.
7. If $\text{Type}(y)$ is **Boolean**, return the result of the comparison $x == \text{ToNumber}(y)$.
8. If $\text{Type}(x)$ is either **String** or **Number** and $\text{Type}(y)$ is **Object**,
return the result of the comparison $x == \text{ToPrimitive}(y)$.
9. If $\text{Type}(x)$ is **Object** and $\text{Type}(y)$ is either **String** or **Number**,
return the result of the comparison $\text{ToPrimitive}(x) == y$.
10. Return **false**.

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**.

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 **String** values that are canonically equal according to the Unicode standard could test as unequal. In effect this algorithm assumes that both **String**s are already in normalised form.

Runtime Semantics: The Strict Equality Comparison Algorithm

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

1. If $\text{Type}(x)$ is different from $\text{Type}(y)$, return **false**.
2. If $\text{Type}(x)$ is **Undefined**, return **true**.
3. If $\text{Type}(x)$ is **Null**, return **true**.
4. If $\text{Type}(x)$ 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 $\text{Type}(x)$ is **String**, then
 - a. If x and y are exactly the same sequence of characters (same length and same characters in corresponding positions), return **true**.
 - b. Else, return **false**.
6. If $\text{Type}(x)$ 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 **Object** value, return **true**.
8. Return **false**.

Deleted: <#> If $\text{Type}(x)$ is **Undefined**, return **true**.
 <#> If $\text{Type}(x)$ is **Null**, return **true**.
 <#> If $\text{Type}(x)$ is **Number**, then
 <#> If x is **NaN**, return **false**.
 <#> If y is **NaN**, return **false**.
 <#> If x is the same **Number** value as y , return **true**.
 <#> If x is **+0** and y is **-0**, return **true**.
 <#> If x is **-0** and y is **+0**, return **true**.
 <#> Return **false**.
 <#> If $\text{Type}(x)$ is **String**, then return **true** if x and y are exactly the same sequence of characters (same length and same characters in corresponding positions). Otherwise, return **false**.
 <#> If $\text{Type}(x)$ is **Boolean**, return **true** if x and y are both **true** or both **false**. Otherwise, return **false**.
 <#> Return **true** if x and y refer to the same **object** value. Otherwise, return **false**.

Deleted: <#>ReturnIfAbrupt(x).If x is an abrupt completion, return x .
 <#>ReturnIfAbrupt(y).If y is an abrupt completion, return y .

Deleted: return **true** i
Deleted: ; otherwise
Deleted: return **true** i
Deleted: ;
Deleted: otherwise
Deleted: Return **true** i
Deleted: refer to
Deleted: object
Deleted: .
Deleted: Otherwise, r

NOTE This algorithm differs from the SameValue Algorithm (9.12) in its treatment of signed zeroes and NaNs.

Runtime Semantics: Evaluation

EqualityExpression : EqualityExpression == 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 *algorithm rval == lval*.

Deleted: 11.9.1 The Equals Operator (==)
The production

Deleted: is evaluated as follows:

Deleted: If *lval* is an abrupt completion, return *lval*.

EqualityExpression : EqualityExpression != 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 *algorithm rval == lval*.
8. If *r* is **true**, return **false**. Otherwise, return **true**.

Deleted: (see 11.9.3).

Deleted: 11.9.2 The Does-not-equals Operator (!=)
The production

Deleted: is evaluated as follows:

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: If *rval* is an abrupt completion, return *rval*.

Deleted: (see 11.9.3).

EqualityExpression : EqualityExpression === 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 the strict equality comparison *algorithm rval === lval*.

Deleted: 11.9.4 The Strict Equals Operator (===)
The production

Deleted: is evaluated as follows:

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: (See 11.9.6)

Deleted: 11.9.5 The Strict Does-not-equal Operator
(!==)
The production

Deleted: is evaluated as follows:

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: (See 11.9.6)

Deleted: <#>ReturnIfAbrupt(*r*).¶

Deleted: *EqualityExpression : EqualityExpression [no LineTerminator here] is RelationalExpression ¶*
<#>Let *lref* be the result of evaluating *EqualityExpression*.
<#>Let *lval* be *GetValue(lref)*.¶
<#>ReturnIfAbrupt(*lval*).If *lval* is an abrupt completion, return *lval*.¶

<#>Let *rref* be the result of evaluating *RelationalExpression*.
<#>Let *rval* be *GetValue(rref)*.¶

<#>If *rval* is an abrupt completion, return *rval*.¶

<#>Return the result of performing *SavmeValue(rval, lval)*.

EqualityExpression : EqualityExpression [no LineTerminator here] isnt RelationalExpression ¶

<#>Let *lref* be the result of evaluating *EqualityExpression*.
<#>Let *lval* be *GetValue(lref)*.¶

<#>ReturnIfAbrupt(*lval*).If *lval* is an abrupt completion, return *lval*.¶

<#>Let *rref* be the result of evaluating *RelationalExpression*.
<#>Let *rval* be *GetValue(rref)*.¶

<#>Let *r* be the result of performing *SavmeValue(rval, lval)*.
<#>ReturnIfAbrupt(*r*).¶

<#>If *r* is **true**, return **false**. Otherwise, return **true**.¶

11.10 Binary Bitwise Operators

Syntax

BitwiseANDExpression :
EqualityExpression
BitwiseANDExpression & EqualityExpression

BitwiseANDExpressionNoIn :
EqualityExpressionNoIn
BitwiseANDExpressionNoIn & EqualityExpressionNoIn

BitwiseXORExpression :

BitwiseANDExpression

BitwiseXORExpression \wedge *BitwiseANDExpression*

BitwiseXORExpressionNoIn :

BitwiseANDExpressionNoIn

BitwiseXORExpressionNoIn \wedge *BitwiseANDExpressionNoIn*

BitwiseORExpression :

BitwiseXORExpression

BitwiseORExpression $|$ *BitwiseXORExpression*

BitwiseORExpressionNoIn :

BitwiseXORExpressionNoIn

BitwiseORExpressionNoIn $|$ *BitwiseXORExpressionNoIn*

Static Semantics: IsValidSimpleAssignmentTarget

BitwiseANDExpression : *BitwiseANDExpression & EqualityExpression*

BitwiseXORExpression : *BitwiseXORExpression* \wedge *BitwiseANDExpression*

BitwiseORExpression : *BitwiseORExpression* $|$ *BitwiseXORExpression*

1. Return false.

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 $\text{GetValue}(lref)$.
3. ReturnIfAbrupt($lval$).
4. Let $rref$ be the result of evaluating B .
5. Let $rval$ be $\text{GetValue}(rref)$.
6. ReturnIfAbrupt($rval$).
7. Let $lnum$ be $\text{ToInt32}(lval)$.
8. ReturnIfAbrupt($lnum$).
9. Let $rnum$ be $\text{ToInt32}(rval)$.
10. ReturnIfAbrupt($rnum$).
11. Return the result of applying the bitwise operator $@$ to $lnum$ and $rnum$. The result is a signed 32 bit integer.

Deleted: Semantics¶

Deleted: If $lval$ is an abrupt completion, return $lval$.

Deleted: If $rval$ is an abrupt completion, return $rval$.

Deleted: If $lnum$ is an abrupt completion, return $lnum$.

Deleted: If $rnum$ is an abrupt completion, return $rnum$.

11.11 Binary Logical Operators

Syntax

LogicalANDExpression :

BitwiseORExpression

LogicalANDExpression $\&\&$ *BitwiseORExpression*

LogicalANDExpressionNoIn :

BitwiseORExpressionNoIn

LogicalANDExpressionNoIn $\&\&$ *BitwiseORExpressionNoIn*

LogicalORExpression :

LogicalANDExpression

LogicalORExpression $||$ *LogicalANDExpression*

LogicalORExpressionNoIn :

LogicalANDExpressionNoIn

LogicalORExpressionNoIn $||$ *LogicalANDExpressionNoIn*

The semantics of the *LogicalANDExpressionNoIn* and *LogicalORExpressionNoIn* productions are the same manner as the *LogicalANDExpression* and *LogicalORExpression* productions except that the contained *LogicalANDExpressionNoIn*, *BitwiseORExpressionNoIn* and *LogicalORExpressionNoIn* are used in place of the contained *LogicalANDExpression*, *BitwiseORExpression* and *LogicalORExpression*, respectively.

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.

Deleted: evaluated in

Deleted: evaluated instead

Static Semantics: IsValidSimpleAssignmentTarget

LogicalANDExpression : *LogicalANDExpression* `&&` *BitwiseORExpression*
LogicalORExpression : *LogicalORExpression* `||` *LogicalANDExpression*

1. Return `false`.

Runtime Semantics: Evaluation

LogicalANDExpression : *LogicalANDExpression* `&&` *BitwiseORExpression*

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)*.

Deleted: Semantics¶
The production

Deleted: is evaluated as follows:

Deleted: *lval*

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: *lvalToBoolean(lval)*

LogicalORExpression : *LogicalORExpression* `||` *LogicalANDExpression*

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)*.

Deleted: The production

Deleted: is evaluated as follows:

Deleted: *lval*

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: *lvalToBoolean(lval)*

11.12 Conditional Operator (`? :`)

Syntax

ConditionalExpression :
LogicalORExpression
LogicalORExpression `? AssignmentExpression` `:` *AssignmentExpression*

ConditionalExpressionNoIn :
LogicalORExpressionNoIn
LogicalORExpressionNoIn `? AssignmentExpression` `:` *AssignmentExpressionNoIn*

The semantics of the *ConditionalExpressionNoIn* production is the same as the *ConditionalExpression* production except that the contained *LogicalORExpressionNoIn*, *AssignmentExpression* and *AssignmentExpressionNoIn* are used in place of the contained *LogicalORExpression*, first *AssignmentExpression* and second *AssignmentExpression*, respectively.

NOTE The grammar for a *ConditionalExpression* in ECMAScript is a little bit 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.

Deleted: The *LogicalANDExpressionNoIn* and *LogicalORExpressionNoIn* productions are evaluated the same manner as the *LogicalANDExpression* and *LogicalORExpression* productions except that the contained *LogicalANDExpressionNoIn*, *BitwiseORExpressionNoIn* and *LogicalORExpressionNoIn* are evaluated instead of the contained *LogicalANDExpression*, *BitwiseORExpression* and *LogicalORExpression*, respectively.¶

NOTE The value produced by a `&&` or `||` operator not necessarily of type Boolean. The value produced will always be the value of one of the two operand expressions.¶

Deleted: evaluated in

Deleted: manner

Deleted: evaluated instead

Static Semantics: IsValidSimpleAssignmentTarget

ConditionalExpression : LogicalORExpression ? AssignmentExpression : AssignmentExpression

1. Return false.

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*).

11.13 Assignment Operators

Syntax

AssignmentExpression :

```

  ConditionalExpression
  YieldExpression
  ArrowFunction
  LeftHandSideExpression = AssignmentExpression
  LeftHandSideExpression AssignmentOperator AssignmentExpression

```

AssignmentExpressionNoIn :

```

  ConditionalExpressionNoIn
  YieldExpression
  ArrowFunction
  LeftHandSideExpression = AssignmentExpressionNoIn
  LeftHandSideExpression AssignmentOperator AssignmentExpressionNoIn

```

AssignmentOperator : one of

*= /= %= += -= <<= >>= >>>= &= ^= |=

The semantics of the *AssignmentExpressionNoIn* productions are the same manner as the *AssignmentExpression* productions except that the contained *ConditionalExpressionNoIn* and *AssignmentExpressionNoIn* are used in place of the contained *ConditionalExpression* and *AssignmentExpression*, respectively.

Static Semantics

Static Semantics: Early Errors

AssignmentExpression : *LeftHandSideExpression* = *AssignmentExpression*

- 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 *LeftHandSideExpression* is an *Identifier* that can be statically determined to always resolve to a declarative environment record binding and the resolved binding is an immutable binding.
- It is an early Reference Error if *LeftHandSideExpression* is neither an *ObjectLiteral* nor an *ArrayLiteral* and *IsValidSimpleAssignmentTarget* of *LeftHandSideExpression* is false.

Deleted: Semantics¶
The production

Deleted: is evaluated as follows:

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: *ToBoolean*(*GetValue*(*lref*))

Deleted: Supplemental Syntax¶
In certain circumstances when processing the production *AssignmentExpression* :
LeftHandSideExpression = *AssignmentExpression* the following grammar is used to refine the interpretation of *LeftHandSideExpression*.¶
AssignmentPattern :¶
ObjectAssignmentPattern
ArrayAssignmentPattern ¶
ObjectAssignmentPattern :¶
{ } .
{ *AssignmentPropertyList* }
{ *AssignmentPropertyList* , } ¶
ArrayAssignmentPattern :¶
[*Elision*_{opt} *AssignmentRestElement*_{opt}]
[*AssignmentElementList* , *Elision*_{opt} *AssignmentRestElement*_{opt}]
AssignmentPropertyList :¶
AssignmentProperty
AssignmentPropertyList ,
AssignmentProperty ¶
AssignmentElementList :¶
*Elision*_{opt} *AssignmentElement*
AssignmentElementList , *Elision*_{opt}
AssignmentElement ¶
AssignmentProperty :¶
Identifier
PropertyName : *LeftHandSideExpression*
AssignmentElement :¶
LeftHandSideExpression ¶
AssignmentRestElement :¶
... *LeftHandSideExpression* ¶

Deleted: *AssignmentExpression* :¶
LeftHandSideExpression = *AssignmentExpression*
LeftHandSideExpression *AssignmentOperator* *AssignmentExpression* ¶
<#>Semantics¶
<#>11.13.1 Simple Assignment (=)¶
*<#>*The static semantics of *AssignmentExpression* : *LeftHandSideExpression* *AssignmentExpression* are.¶
*<#>*It is a Syntax Error if the *AssignmentExpression* is contained in strict code and the *LeftHandSideExpression* is the *Identifier eval* or the *Identifier arguments*.¶
*<#>*It is a Syntax Error if the *AssignmentExpression* is contained in extended code and the *LeftHandSideExpression* is the *Identifier this* or the *Identifier super*.¶
*<#>*It is a Syntax Error if the *AssignmentExpression* is contained in extended code and the *LeftHandSideExpression* is a *Literal* or a *FunctionExpression*.¶
*<#>*It is a Syntax Error if the *AssignmentExpression* is contained in extended code and the *LeftHandSideExpression* is an *Identifier* that can be does not statically determined to always resolves to a declarative environment record binding orand if the resolved binding is an immutable binding.¶

Deleted: the

AssignmentExpression : LeftHandSideExpression AssignmentOperator AssignmentExpression

- It is a Syntax Error if the *LeftHandSideExpression* is an *Identifier* that can be statically determined to always resolve to a declarative environment record binding and the resolved binding is an immutable binding.
- It is an early Reference Error if *IsValidSimpleAssignmentTarget* of *LeftHandSideExpression* is false.

Static Semantics: IsValidSimpleAssignmentTarget

AssignmentExpression :
YieldExpression
ArrowFunction
LeftHandSideExpression = AssignmentExpression
LeftHandSideExpression AssignmentOperator AssignmentExpression

1. Return false.

Runtime Semantics

Runtime Semantics: Evaluation

AssignmentExpression : LeftHandSideExpression = AssignmentExpression

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. Let *status* be *PutValue(lref, rval)*.
 - f. ReturnIfAbrupt(status).
 - g. Return *rval*.
2. Let *AssignmentPattern* be the parse of the source code corresponding to *LeftHandSideExpression* using *AssignmentPattern* as the goal symbol.
3. Let *lref* be the result of evaluating *AssignmentExpression*.
4. Let *rval* be *ToObject(GetValue(rref))*.
5. ReturnIfAbrupt(rval).
6. Let *status* be the result of performing Destructuring Assignment Evaluation of *AssignmentPattern* using *rval* as the argument.
7. ReturnIfAbrupt(status).
8. Return *rval*.

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 *operator* be the @ where *AssignmentOperator* is @=.
8. Let *r* be the result of applying operator @ to *lval* and *rval*.
9. Let *status* be *PutValue(lref, r)*.
10. ReturnIfAbrupt(status).
11. Return *r*.

NOTE When an assignment occurs within strict mode code, it is an runtime error if *lref* in step 1.e of the first algorithm or step 9 of the second algorithm is an unresolved 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.

Deleted: <#>It is a Syntax Error if the *AssignmentExpression* is contained in extended code and *IsValidAssignmentPattern* of the *LeftHandSideExpression* is an *ObjectLiteral* or an *ArrayLiteral* and the source code corresponding to *LeftHandSideExpression* cannot be parsed using *AssignmentPattern* as the goal symboltrue.¶

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *lref* is an abrupt completion, return *lref*.

Deleted: <#>Throw a *SyntaxError* exception if the following conditions are all true:¶
 <#> *Type(lref)* is Reference is true¶
 <#> *IsStrictReference(lref)* is true¶
 <#> *Type(GetBase(lref))* is Environment Record¶
 <#> *GetReferencedName(lref)* is either "eval" or "arguments"¶

Deleted: Call

Deleted: If the result of

Deleted: <#>If this is not extended code, throw a *ReferenceError* exception.¶

Deleted: If *rval* is an abrupt completion, return *rval*.

Deleted: P

Deleted: Evaluate

Deleted: *obj* parameter

Deleted: If *status* is an abrupt completion, return *rval*.

Deleted:

where *AssignmentOperator* is @= and @ represents one of the operators indicated above

Deleted: If *lval* is an abrupt completion, return *lval*.

Deleted: If *rval* is an abrupt completion, return *rval*.

Deleted: <#>Throw a *SyntaxError* exception if the

Deleted: If the result of

Deleted: Call

Deleted: is an abrupt completion, return that result

Deleted: ¶

Formatted: Note

Deleted: its *LeftHandSide* must not evaluate to an

Deleted: d

Deleted:

Deleted: must not be

Deleted: an

Deleted: does

Deleted: upon assignment

Deleted: whose

Deleted: where calling its

Deleted: [[

Deleted: Get

Deleted:]] internal property method

Deleted: has

Deleted: ¶

11.13.1 Destructuring Assignment

Deleted: .1

Supplemental Syntax

In certain circumstances when processing the production *AssignmentExpression* : *LeftHandSideExpression* = *AssignmentExpression* the following grammar is used to refine the interpretation of *LeftHandSideExpression*.

AssignmentPattern :

ObjectAssignmentPattern
ArrayAssignmentPattern

ObjectAssignmentPattern :

{ }
{ *AssignmentPropertyList* }
{ *AssignmentPropertyList* , }

ArrayAssignmentPattern :

[*Elision_{opt}* *AssignmentRestElement_{opt}*]
[*AssignmentElementList*]
[*AssignmentElementList* , *Elision_{opt}* *AssignmentRestElement_{opt}*]

AssignmentPropertyList :

AssignmentProperty
AssignmentPropertyList , *AssignmentProperty*

AssignmentElementList :

Elision_{opt} *AssignmentElement*
AssignmentElementList , *Elision_{opt}* *AssignmentElement*

AssignmentProperty :

Identifier *Initialiser_{opt}*
PropertyName : *AssignmentElement*

AssignmentElement :

DestructuringAssignmentTarget *Initialiser_{opt}*

AssignmentRestElement :

... *DestructuringAssignmentTarget*

Deleted: *LeftHandSideExpression*

Deleted: *LeftHandSideExpression*

Deleted: ...

Deleted: *LeftHandSideExpression*

Static Semantics

Static Semantics: Early Errors

AssignmentProperty : *Identifier* *Initialiser_{opt}*

- It is a Syntax Error if *Identifier* is the *Identifier eval* or the *Identifier arguments*.
- It is a Syntax Error if *Identifier* does not statically resolve to a declarative environment record binding or if the resolved binding is an immutable binding.

Deleted: *PropertyName*

Deleted: :

Deleted: *LeftHandSideExpression*

Deleted: <#>It is a Syntax Error if *Identifier* the *Identifier this* or the *Identifier super*.¹

Comment [AW88]: This part probably does need to be here if 11.1.2 has this as a static semantic for extended code.

DestructuringAssignmentTarget : *LeftHandSideExpression*

- It is a Syntax Error *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* of *LeftHandSideExpression* is *false*.
- It is a Syntax Error if the *LeftHandSideExpression* is an *Identifier* that can be statically determined to always resolve to a declarative environment record binding and the resolved binding is an immutable binding.
- It is a Syntax Error if *LeftHandSideExpression* is the *Identifier eval* or the *Identifier arguments*.
- It is a Syntax Error if *IsInvalidAssignmentPattern* of *LeftHandSideExpression* is *true*.
- It is a Syntax Error if the *LeftHandSideExpression* is
CoverParenthesizedExpressionAndArrowParameterList : (Expression),
 and *Expression* derived a production that would produce a Syntax Error according to these rules. This rule is recursively applied.

Runtime Semantics

Runtime Semantics: Destructuring Assignment Evaluation

with parameter *obj*

ObjectAssignmentPattern : { }

and

ArrayAssignmentPattern :

[]
[Elision]

1. Return NormalCompletion(empty).

AssignmentPropertyList : AssignmentPropertyList , AssignmentProperty

1. Let *status* be the result of performing Destructuring Assignment Evaluation for *AssignmentPropertyList* using *obj* as the argument.
2. ReturnIfAbrupt(*status*).
3. Return the result of performing Destructuring Assignment Evaluation for *AssignmentProperty* using *obj* as the argument.

AssignmentProperty : Identifier Initialiser_{opt}

1. Let *P* be StringValue of *Identifier*.
2. Let *v* be the result of calling *Get(obj, P)*.
3. ReturnIfAbrupt(*v*).
4. If *Initialiser_{opt}* is present and *v* is *undefined*, then
 - a. Let *defaultValue* be the result of evaluating *Initialiser*.
 - b. Let *v* be *ToObject*(*GetValue(defaultValue)*).
5. ReturnIfAbrupt(*v*).
6. Let *lref* be the result of performing Identifier Resolution(10.3.1) with the *IdentifierName* corresponding to *Identifier*.
7. Return *PutValue(lref, v)*.

AssignmentProperty : PropertyName : AssignmentElement

1. Let *name* be PropName of *PropertyName*.
2. Return the result of performing Keyed Destructuring Assignment Evaluation of *AssignmentElement* with *obj* and *name* as the arguments.

ArrayAssignmentPattern : [Elision_{opt} AssignmentRestElement]

1. Let *skip* be the Elision Width of *Elision*; if *Elision* is not present, use the numeric value zero.
2. Return the result of performing Indexed Destructuring Assignment Evaluation of *AssignmentRestElement* with *obj* and *skip* as the arguments.

- Deleted:** *AssignmentElement : LeftHandSideExpression*
- Comment [AW89]:** This part probably doesn't need to be here.
- Deleted:** <#>It is a Syntax Error if
- Deleted:** It is a Syntax Error if the *LeftHandSideExpression*
- Deleted:** *PrimaryExpression ... (Expression)*
- Deleted:** *AssignmentRestElement : ...*
- Deleted:** The supplemental production
- Deleted:** The supplemental production
- Deleted:** ,the production *ArrayAssignmentPattern : []*
- Deleted:** *ObjectAssignmentPattern : []*
- Deleted:** The supplemental production
- Deleted:** is evaluated with the parameter *obj* as follows
- Deleted:** Perform
- Deleted:** of
- Deleted:** Evaluate
- Deleted:** with
- Deleted:** using ...*bj* as the *obj* parameter
- Deleted:** If *status* is an abrupt completion,
- Deleted:** Perform
- Deleted:** of Evaluate *AssignmentProperty*
- Deleted:** with
- Deleted:** using ...*bj* as the *obj* ...rgumentparameter
- Deleted:** The supplemental production
- Deleted:**
- Deleted:** <#>Let *exists* be the result of calling the *[[Has]]* internal method of ...*bj* with argument *key*.
- Deleted:** <#>Else ¶
- Deleted:** *v*
- Deleted:** Else,
- Deleted:** <#> Let *v* be *undefined*.¶
- Deleted:** using
- Deleted:** Call
- Deleted:** ¶
- Deleted:** The static semantics of the supplemental
- Deleted:** *LeftHandSideExpression*
- Deleted:** is evaluated with the parameter *obj* as follows
- Deleted:** the result of evaluating ...*ropName* of
- Deleted:** Indexed
- Deleted:** <#>Let *v* be the result of calling the *[[Get]]* internal method of ...*bj* with argument *key*.
- Deleted:** The supplemental production
- Deleted:**
- Deleted:** is evaluated with the parameter *obj* as follows
- Deleted:** If *Elision* is present, then let *skip* be the result of calling the *[[Elision]]* internal method of ...*bj* with argument *width*.
- Deleted:** Perform
- Deleted:** Evaluate ...*AssignmentRestElement* with *obj* using *skip* as the arguments.
- Deleted:** 0
- Deleted:** index ...rgumentsparameter...¶

ArrayAssignmentPattern : [AssignmentElementList]

1. Return the result of performing Indexed Destructuring Assignment Evaluation of *AssignmentElementList* using *obj* and 0 as the arguments.

ArrayAssignmentPattern : [AssignmentElementList , Elision_{opt} AssignmentRestElement_{opt}]

1. Let *lastIndex* be the result of performing Indexed Destructuring Assignment Evaluation of *AssignmentElementList* using *obj* and 0 as the arguments.
2. ReturnIfAbrupt(*lastIndex*).
3. Let *skip* be the Elision Width of *Elision*; if *Elision* is not present, use the numeric value zero.
4. If *AssignmentRestElement* is present, then return the result of performing Indexed Destructuring Assignment Evaluation of *AssignmentRestElement* with *obj* and *lastIndex+skip* as the arguments.
5. Return *lastIndex*.

Runtime Semantics: Indexed Destructuring Assignment Evaluation

with parameters *obj* and *index*

AssignmentElementList : Elision_{opt} AssignmentElement

1. Let *skip* be the Elision Width of *Elision*; if *Elision* is not present, use the numeric value zero.
2. Let *name* be *ToString(index+skip)*.
3. Let *status* be the result of performing Keyed Destructuring Assignment Evaluation of *AssignmentElement* with *obj* and *name* as the arguments.
4. ReturnIfAbrupt(*status*).
5. Return *index+skip+1*.

AssignmentElementList : AssignmentElementList , Elision_{opt} AssignmentElement

1. Let *listNext* be the result of performing Indexed Destructuring Assignment Evaluation of *AssignmentElementList* using *obj* as the *obj* parameter and *index* as the *index* parameter.
2. Let *skip* be the Elision Width of *Elision*; if *Elision* is not present, use the numeric value zero.
3. ReturnIfAbrupt(*listNext*).
4. Let *name* be *ToString(listNext+skip)*.
5. Let *status* be the result of performing Keyed Destructuring Assignment Evaluation of *AssignmentElement* with *obj* and *name* as the arguments.
6. ReturnIfAbrupt(*status*).
7. Return *listNext+skip+1*.

AssignmentRestElement : ... DestructuringAssignmentTarget

1. Let *lref* be the result of evaluating *DestructuringAssignmentTarget*.
2. ReturnIfAbrupt(*lref*).
3. Let *lenVal* be the result of *Get(obj, "length")*.
4. Let *len* be *ToInt32(lenVal)*.
5. ReturnIfAbrupt(*len*).
6. Let *A* be the result of the abstract operation *ArrayCreate* with argument 0.
7. Let *n=0*.
8. Repeat, while *index < len*
 - a. Let *P* be *ToString(index)*.
 - b. Let *exists* be the result of *HasProperty(obj, P)*.
 - c. ReturnIfAbrupt(*exists*).
 - d. If *exists* is *true*, then
 - i. Let *v* be the result of *Get(obj, ToString(index))*.
 - ii. ReturnIfAbrupt(*len*).
 - iii. Call the *[[DefineOwnProperty]]* internal method of *A* with arguments *ToString(n)* and *PropertyDescriptor* *{[[Value]]: v, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}*.
 - e. Let *n = n+1*.

Deleted: <#>Perform Indexed Destructuring

Deleted: The supplemental production

Deleted: *AssignmentPropertyList*

Deleted:

Deleted: <#>is evaluated with the parameter

Deleted: *index*

Deleted: evaluating ...*AssignmentElementList*

Deleted: If *lastIndex* is an abrupt completion,

Deleted: If *Elision* is present, then let *skip* be the

Deleted: perform

Deleted: evaluate ...*AssignmentRestElement* with

Deleted: *i*

Deleted: *index* ...*argumentsparameter* ...*1*

Deleted: The supplemental production

Deleted: is evaluated with the parameters o

Deleted: If *Elision* is present, then let *skip* be the

Deleted: Perform

Deleted: Indexed

Deleted: Evaluate

Deleted: Let *index* be the result of evaluating

Deleted: using ...*bj* as the *obj* parameter

Deleted: *index+skip*

Deleted: *index* ...*argumentsparameter*

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

Deleted: +*skip*

Deleted: *1*

Deleted: The supplemental production

Deleted: is evaluated with the parameters o

Deleted: e...*istNextnd*

Deleted: evaluating

Deleted: *tRes*

Deleted: If *Elision* is present, then let *skip* be the

Deleted: If *listNext* is an abrupt completion, return

Deleted: Let *index* be the result of evaluating

Deleted: Perform

Deleted: Indexed

Deleted: Evaluate ...*AssignmentElement* with us

Deleted: *e*

Deleted: *listNextnd+ski*

Deleted: *p*

Deleted: *index* ...*argumentsparameter*

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

Deleted: i...*istNextnd*

Deleted: *1*

Deleted: The supplemental production

Deleted: The supplemental production

Deleted: ...

Deleted: *LefHandSideExpression*

Deleted: is evaluated with the parameters o

Deleted: *LeftHandSideExpression*

Deleted: If *lref* is an abrupt completion,

Deleted: calling the *[...et()]* internal method of

Deleted: t

Deleted: If *len* is an abrupt completion, return l

Deleted: ion

f. Let $index = index + 1$.
 9. Return $\text{PutValue}(lref, A)$.

Deleted: Call

Deleted: ¶

Runtime Semantics: Keyed Destructuring Assignment Evaluation

with parameters obj and $propertyName$

AssignmentElement : DestructuringAssignmentTarget Initialiser_{opt}

1. Let v be the result of $\text{Get}(obj, propertyName)$.
2. ReturnIfAbrupt(v).
3. If $Initialiser_{\text{opt}}$ is present and v is **undefined**, then
 - a. Let $defaultValue$ be the result of evaluating $Initialiser$.
 - b. Let v be $\text{GetValue}(defaultValue)$.
4. If $DestructuringAssignmentTarget$ is an *ObjectLiteral* or an *ArrayLiteral* then
 - a. Let $AssignmentPattern$ be the parse of the source code corresponding to $DestructuringAssignmentTarget$ using $AssignmentPattern$ as the goal symbol.
 - b. Let $vObj$ be $\text{ToObject}(v)$.
 - c. ReturnIfAbrupt($vObj$).
 - d. Return the result of performing Destructuring Assignment Evaluation of $AssignmentPattern$ with $vObj$ as the argument.
5. ReturnIfAbrupt(v).
6. Let $lref$ be the result of evaluating $DestructuringAssignmentTarget$.
7. Return $\text{PutValue}(lref, v)$.

Deleted: LeftHandSideExpression

Deleted: calling the [[

Deleted:]]

Deleted: internal method of

Deleted: with argument

Deleted: v

Deleted: LeftHandSideExpression

Deleted: LeftHandSideExpression

11.14 Comma Operator (,)

Syntax

Expression :

AssignmentExpression
 Expression , AssignmentExpression

ExpressionNoIn :

AssignmentExpressionNoIn
 ExpressionNoIn , AssignmentExpressionNoIn

The semantics of the *ExpressionNoIn* production is the same manner as the *Expression* production except that the contained *ExpressionNoIn* and *AssignmentExpressionNoIn* are used in place of the contained *Expression* and *AssignmentExpression*, respectively.

Deleted: evaluated in

Deleted: evaluated instead

Static Semantics: IsValidSimpleAssignmentTarget

Expression : Expression , AssignmentExpression

1. Return **false**.

Runtime Semantics: Evaluation

Expression : Expression , AssignmentExpression

1. Let $lref$ be the result of evaluating *Expression*.
2. ReturnIfAbrupt($\text{GetValue}(lref)$).
3. Let $rref$ be the result of evaluating *AssignmentExpression*.
4. Return $\text{GetValue}(rref)$.

NOTE GetValue must be called even though its value is not used because it may have observable side-effects.

Deleted: Semantics¶

The production

Deleted: is evaluated as follows:

Deleted: Call

Deleted: If the result of

Deleted:

Deleted: is an abrupt completion, return that result

Deleted: .

12 Statements and Declarations

Syntax

Statement :

BlockStatement
VariableStatement
EmptyStatement
ExpressionStatement
IfStatement
BreakableStatement
ContinueStatement
BreakStatement
ReturnStatement
WithStatement
LabelledStatement
ThrowStatement
TryStatement
DebuggerStatement

Declaration :

FunctionDeclaration
GeneratorDeclaration
ClassDeclaration
LexicalDeclaration

BreakableStatement :

IterationStatement
SwitchStatement

Static Semantics

Static Semantics: VarDeclaredNames

Statement :

EmptyStatement
ExpressionStatement
ContinueStatement
BreakStatement
ReturnStatement
ThrowStatement
DebuggerStatement

1. Return a new empty List.

Runtime Semantics

Runtime Semantics: Labelled Evaluation

With argument *labelSet*.

BreakableStatement : IterationStatement

1. Let *stmtResult* be the result of performing Labelled Evaluation of *IterationStatement* with argument *labelSet*.
2. If *stmtResult*.[[type]] is *break* and *stmtResult*.[[target]] is *empty*, then
 - a. If *stmtResult*.[[value]] is *empty*, then let *stmtResult* be NormalCompletion(*undefined*).
 - b. Else, let *stmtResult* be NormalCompletion(*stmtResult*.[[value]])
3. Return *stmtResult*.

Deleted: *IterationStatement*

Deleted:
SwitchStatement

Deleted: *LetDeclaration*
Const

Deleted: 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. 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.[¶]

Deleted: **Static Semantics: BoundNames**
The BoundNames of the *Declaration* production are determined as follows:[¶]
<#> Return the BoundNames of the single non-terminal symbol that is the right hand side of the production.[¶]

Deleted: The VarDeclaredNames of the productions:
Statement : EmptyStatement
Statement : ExpressionStatement
Statement : ContinueStatement
Statement : BreakStatement
Statement : ReturnStatement
Statement : ThrowStatement
Statement : DebuggerStatement
is determined as follows:[¶]

Deleted: Statement :[¶]
BlockStatement
VariableStatement
IterationStatement
WithStatement
LabelledStatement
SwitchStatement
TryStatement
The VarDeclaredNames of the productions:
Statement : BlockStatement
Statement : IfStatement
Statement : IterationStatement
Statement : WithStatement
Statement : LabelledStatement
Statement : SwitchStatement
Statement : TryStatement
is determined as follows:[¶]

Return the VarDeclaredNames of the single non-terminal symbol that is the right hand side of the production.[¶]
The VarDeclaredNames of the production *Statement : VariableStatement* is determined as follows:[¶]
Return the BoundNames of *VariableStatement*.[¶]

Deleted: L

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**, then 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*.

Runtime Semantics: Evaluation

BreakableStatement :
IterationStatement
SwitchStatement

1. Let *newLabelSet* be a new empty List.
2. Return the result of performing Labelled Evaluation of this *BreakableStatement* with argument *newLabelSet*.

12.1 Block

Syntax

BlockStatement :
Block

Block :
{ *StatementList*_{opt} }

StatementList :
StatementListItem
StatementList StatementListItem

StatementListItem :
Statement
Declaration

Static Semantics

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*.

Static Semantics: LexicalDeclarations

StatementList : *StatementList* *StatementListItem*

1. Let *declarations* be LexicalDeclarations of *StatementList*.
2. Append to *declarations* the elements of the LexicalDeclarations of *StatementListItem*.
3. Return *declarations*.

StatementListItem : *Statement*

1. Return a new empty List.

StatementListItem : *Declaration*

Deleted: L

Deleted: s

Comment [AWB 390]: Need to have an evalution semantics in section 13 for *FunctionDeclaration*

Deleted: The *Statement* productions are all evaluated as follows||

<#>Return the result of evaluating the single non-terminal symbol that is the right hand side of the production.||
The *Declaration* productions are all evaluated as as follows||

<#>Return the result of evaluating the single non-terminal symbol that is the right hand side of the production.||
NOTE The result of evaluating a *Statement* or *Declaration* is always a Completion value.||

Deleted: The BoundNames of the *Declaration*

productions are determined as follows:||
Return the BoundNames of the single non-terminal symbol that is the right hand side of the production.
The *Declaration* productions are all evaluated as as follows||
Return the result of evaluating the single non-terminal symbol that is the right hand side of the production.||

Deleted: NOTE Several widely used implementations of ECMAScript are known to support the use of *FunctionDeclaration* as a *Statement*. However there are significant and irreconcilable variations among the implementations in the semantics applied to such *FunctionDeclarations*. Because of these irreconcilable differences, the use of a *FunctionDeclaration* as a *Statement* results in code that is not reliably portable among implementations. It is recommended that ECMAScript implementations either disallow this usage of *FunctionDeclaration* or issue a warning when such a usage is encountered. Future editions of ECMAScript may define alternative portable means for declaring functions in a *Statement* context.||

Deleted: <#>It is a Syntax Error if *StatementList* includes a *StatementListItem* : *Declaration* production whose *Declaration* is a *Declaration* : *FunctionDeclaration* production and the source code matching this *Block* production is not contained in extended code.||

Deleted: i

Deleted: *StatementList* : *StatementListItem* ¶

<#>Return the LexicalDeclarations of *StatementListItem*.¶

Deleted: names

1. Return a new List containing *Declaration*.

Static Semantics: LexicallyDeclaredNames

Block : {}

1. Return a new empty List.

StatementList : StatementList StatementListItem

1. Let *names* be LexicallyDeclaredNames of *StatementList*.
2. Append to *names* the elements of the LexicallyDeclaredNames of *StatementListItem*.
3. Return *names*.

StatementListItem : Statement

1. Return a new empty List.

StatementListItem : Declaration

1. Return the BoundNames of *Declaration*.

Static Semantics: TopLevelLexicallyDeclaredNames

StatementList : StatementList StatementListItem

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.

StatementListItem : Declaration

1. If *Declaration* is *Declaration : FunctionDeclaration*, then return a new empty List.
2. Return the BoundNames of *Declaration*.

NOTE At the top level of a function, or script, function declarations are treated like var declarations rather than like lexical declarations.

Deleted: return

Deleted: The VarDeclaredNames of the production *BlockStatement : Block* is determined as follows:
 <#>Return the VarDeclaredNames of *Block*.
 The production *BlockStatement : Block* is evaluated as follows:
 <#>Return the result of evaluating *Block*.

Deleted: The LexicallyDeclaredNames of the production

Deleted: is determined as follows:

Deleted: *Block : { StatementList }*
 <#>Return the LexicallyDeclaredNames of *StatementListItem*.
StatementList : StatementListItem ¶
 <#>Return the LexicallyDeclaredNames of *StatementListItem*. ¶

Static Semantics: TopLevelLexicallyScopedDeclarations

StatementList : StatementList StatementListItem

1. Let *declarations* be TopLevelLexicallyScopedDeclarations of *StatementList*.
2. Append to *declarations* the elements of the TopLevelLexicallyScopedDeclarations of *StatementListItem*.
3. Return *declarations*.

StatementListItem : Statement

1. Return a new empty List.

StatementListItem : Declaration

1. If *Declaration* is *Declaration : FunctionDeclaration*, then return a new empty List.
2. Return a new List containing *Declaration*.

Deleted: ..

Static Semantics: TopLevelVarDeclaredNames

StatementList : StatementList StatementListItem

1. Let *names* be TopLevelVarDeclaredNames of *StatementList*.
2. Append to *names* the elements of the TopLevelVarDeclaredNames of *StatementListItem*.
3. Return *names*.

StatementListItem : Declaration

1. If *Declaration* is *Declaration : FunctionDeclaration*, then return the LexicallyDeclaredNames of *Declaration*.
2. Return a new empty List.

StatementListItem : Statement

1. Return VarDeclaredNames of *Statement*.

NOTE At the top level of a function or script, inner function declarations are treated like var declarations.

Static Semantics: TopLevelVarScopedDeclarations

StatementList : StatementList StatementListItem

1. Let *declarations* be TopLevelVarScopedDeclarations of *StatementList*.
2. Append to *declarations* the elements of the TopLevelVarScopedDeclarations of *StatementListItem*.
3. Return *declarations*.

StatementListItem : Statement

1. If *Statement* is *Statement : VariableStatement*, then return a new List containing *VariableStatement*.
2. Return a new empty List.

StatementListItem : Declaration

1. If *Declaration* is *Declaration : FunctionDeclaration*, then return a new List containing *Declaration*.
2. Return a new empty List.

Static Semantics: VarDeclaredNames

Block : { }

1. Return a new empty List.

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

2. Return a new empty List.

Runtime Semantics

Runtime Semantics: Evaluation

Block : { }

1. Return NormalCompletion(**undefined**)

Deleted: BlockStatement : Block ¶
<#>Return the VarDeclaredNames of Block.¶
Deleted: The VarDeclaredNames of the production
Deleted: is determined as follows:
Deleted: Block : { StatementList } ¶
<#>Return the VarDeclaredNames of StatementList.¶
StatementList : StatementListItem ¶
<#>Return the VarDeclaredNames of StatementListItem.¶
Deleted: StatementListItem : Statement ¶
<#>Return the VarDeclaredNames of Statement.¶
Deleted: BlockStatement : Block ¶
<#>Return the result of evaluating Block.¶
Deleted: The production
Deleted: is evaluated as follows:
Comment [AWB1391]: Breaking change: completion reform
Comment [AWB1392]: TODO, need to verify that under completion reform empty blocks evaluate to undefined.
Deleted: normal,
Deleted: empty
Deleted: , empty

Block : { *StatementList* }

1. Let `oldEnv` be the running execution context's LexicalEnvironment.
 2. Let `blockEnv` be the result of calling `NewDeclarativeEnvironment` passing `oldEnv` as the argument.
 3. Perform Block Declaration Instantiation using `StatementList` and `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 s_1 be the result of evaluating *StatementList*.
 2. [ReturnIfAbrupt\(\$s_1\$ \)](#).
 3. Let s be the result of evaluating *StatementListItem*.
 4. If $s_{\llbracket \text{type} \rrbracket}$ is throw, [return \$s\$](#) .
 5. If $s_{\llbracket \text{value} \rrbracket}$ is empty, let $V = s_{\llbracket \text{target} \rrbracket}$, otherwise let $V = s_{\llbracket \text{value} \rrbracket}$.
 6. Return [Completion](#) { $\llbracket \text{type} \rrbracket$: $s_{\llbracket \text{type} \rrbracket}$, $\llbracket \text{value} \rrbracket$: V , $\llbracket \text{target} \rrbracket$: $s_{\llbracket \text{target} \rrbracket}$ }.

NOTE Steps 4 and 5 of the above algorithm ensure that the value of a *StatementList* is the value of the last value producing Statement 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;")
```

12.2 Declarations and the Variable Statement

12.2.1 Let and Const Declarations

NOTE A `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 `Initialiser` is assigned the value of its `Initialiser`'s `AssignmentExpression` when the `LexicalBinding` is evaluated, not when the variable is created. If a `LexicalBinding` in a `let` declaration does not have an `Initialiser` the variable is assigned the value `undefined` when the `LexicalBinding` is evaluated.

Syntax

LexicalDeclaration :

LetOrConst BindingList ;

LexicalDeclarationNoIn :

LetOrConst BindingListNoIn

LetOrConst:

let
const

BindingList :

LexicalBinding
BindingList , LexicalBinding

BindingListNoIn :

LexicalBindingNoIn
BindingListNoIn, LexicalBindingNoIn

© Ecma International 2012

159

LexicalBinding :
 BindingIdentifier Initialiser_{opt}
 BindingPattern Initialiser

LexicalBindingNoIn :
 BindingIdentifier InitialiserNoIn_{opt}
 BindingPattern InitialiserNoIn

BindingIdentifier :
 Identifier

InitialiserNoIn :
 = AssignmentExpressionNoIn

The semantics of the LexicalDeclarationNoIn, BindingListNoIn, LexicalBindingNoIn and InitialiserNoIn productions are the same as the LexicalDeclaration, BindingList, LexicalBinding and Initialiser productions except that the contained BindingListNoIn, LexicalBindingNoIn, InitialiserNoIn and AssignmentExpressionNoIn are used in place of the contained BindingList, LexicalBinding, Initialiser and AssignmentExpression, respectively.

Static Semantics

Static Semantics: Early Errors

LexicalBinding : BindingIdentifier

- It is a Syntax Error if IsConstantDeclaration of the LexicalDeclaration containing this production is true.

BindingIdentifier : Identifier

- It is a Syntax Error if the BindingIdentifier is contained in strict code and if the Identifier is eval or arguments.

Static Semantics: BoundNames

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.

LexicalBinding : BindingIdentifier Initialiser_{opt}

1. Return the BoundNames of BindingIdentifier.

LexicalBinding : BindingPattern Initialiser

1. Return the BoundNames of BindingPattern.

BindingIdentifier : Identifier

1. Return a new List containing the StringValue of Identifier.

Static Semantics: IsConstantDeclaration

LexicalDeclaration : LetOrConst BindingList ;

Deleted: Let

Deleted: Let

Deleted: Initialiser :
= AssignmentExpression_{opt}

Deleted: Let

Deleted: NOTE A let declaration defines variables that are scoped to the current execution context's LexicalEnvironment. Let variables are created when their containing Lexical Environment is instantiated but may not be accessed in any way until the variable's LetBinding is executed. A variable defined by a LetBinding with an Initialiser is assigned the value of its Initialiser's AssignmentExpression when the LetBinding is executed, not when the variable is created. If a LetBinding does not have an Initialiser the variable is assigned the value undefined when LetBinding is executed.||

Deleted: if the BindingIdentifier

Comment [AWB896]: Consider disallowing undefined

Deleted: Semantics¶

Deleted: The static semantics of the production

Deleted: Bound Names

Deleted: The BoundNames of the production

Deleted: Let

Deleted: let LetBindingList

Deleted: is determined as follows:

Deleted: Bound Names

Deleted: Let

Deleted: LetBindingList : LetLexicalBinding ¶

Deleted: Let

Deleted: Let

Deleted: Let

Deleted: N

Deleted:

Deleted: Let

Deleted: of

Deleted: Bound Names

Deleted: Let

Deleted: Let

Deleted: Bound Names

Deleted: Let

Deleted: Bound Names

Deleted: Let

1. Return IsConstantDeclaration of LetOrConst.

LetOrConst: let

1. Return false.

LetOrConst: const

1. Return true.

Runtime Semantics

Runtime Semantics: Binding Initialisation

With arguments value and environment.

NOTE undefined is passed for environment to indicate that a PutValue operation should be used to assign the initialisation value. This is the case for var statements formal parameter lists of non-strict functions. In those cases a lexical binding is hosted and preinitialized prior to evaluation of its initializer.

BindingIdentifier : Identifier

1. If environment is not undefined, then
 - a. Let name be StringValue of Identifier.
 - b. Let env be the environment record component of environment.
 - c. Call the InitializeBinding concrete method of env passing name and value as the arguments.
 - d. Return NormalCompletion(undefined).
2. Else
 - a. Let lhs be the result of evaluating Identifier as described in 11.1.2.
 - b. Return PutValue(lhs, value).

Runtime Semantics: Evaluation

LexicalDeclaration : LetOrConst BindingList ;

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.

LexicalBinding : BindingIdentifier ;

1. Let env be the running execution context's LexicalEnvironment.
2. Return the result of performing BindingInitialisation 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 Initialiser ;

1. Let rhs be the result of evaluating Initialiser.
2. Let value be GetValue(rhs).
3. ReturnIfAbrupt(value).
4. Let env be the running execution context's LexicalEnvironment.

Deleted: ... <u>BindingList</u>
Deleted: ... <u>BindingList</u>
Deleted: <u>false</u>
Deleted: <u>RuntimeStatic Semantics: String Value</u>
Deleted: <u>BindingIdentifier</u> : <u>Identifier</u> ¶
Deleted: <u>Return the String Value of Identifier.</u> ¶
Deleted: <u>Initialization</u>
Deleted: <u>enviornment</u>
Deleted: <u>initialization</u>
Deleted: <u>the</u>
Deleted: <u>BindingIdentifier</u> <u>BindingIdentifier</u> <u>Identifier</u> ¶
<#>P <u>Return the result of performing BindingInitialisation</u> Initialisation for Identifier passing value and env as the arguments. ¶
Token: <u>Identifier</u> ¶
Deleted: <u>enviornment</u>
Deleted:
Deleted: <u>enviornment</u>
Deleted: <u>environment</u> ...assing name Identifier
Deleted: <u>Value</u>
Deleted: <u>Call</u>
Deleted: <u>The production</u>
Deleted: <u>LetDeclaration</u> ... <u>LetOrConst</u> <u>let</u> <u>Let</u>
Deleted: <u>is evaluated as follows:</u>
Deleted: <u>Evaluate Let</u>
Deleted: <u>If next is an abrupt completion, return next</u>
Deleted: <u>(normal, ...mpty, empty)</u>
Deleted: <u>LetBindingList</u> : <u>LetLexicalBinding</u> is evaluated as follows: ¶
Deleted: <u>Let...indingList</u> : <u>Let...indingList</u> , <u>Let</u>
Deleted: <u>is evaluated as follows:</u>
Deleted: <u>Evaluate Let</u>
Deleted: <u>If next is an abrupt completion, return</u>
Deleted: <u>Evaluate Let</u>
Deleted: <u>Let</u>
Deleted: <u>is evaluated as follows:</u>
Deleted: <u>running</u>
Deleted: <u>current</u>
Deleted: <u>Perform ...inding Initialization</u>
Deleted: <u>e</u>
Deleted: <u>The production</u>
Deleted: <u>Let</u>
Deleted: <u>is evaluated as follows:</u>
Deleted: <u>If value is an abrupt completion, return</u>
Deleted: <u>running</u>
Deleted: <u>current</u>

5. Return the result of performing *Binding Initialisation* for *BindingIdentifier* passing *value* and *env* as the arguments.

LexicalBinding : BindingPattern Initialiser

1. Let *rhs* be the result of evaluating *Initialiser*.
2. Let *value* be *ToObject(GetValue(rhs))*.
3. ReturnIfAbrupt(*value*).
4. Let *env* be the running execution context's *LexicalEnvironment*.
5. Return the result of performing *Binding Initialisation* for *BindingPattern* using *value* and *env* as the arguments.

12.2.2 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 initialised to *undefined* when created. Within the scope of any *VariableEnvironemnt* a common *Identifier* may appear in more than one *VariableDeclaration* but those declarations collective define only one variable. A variable defined by a *VariableDeclaration* with an *Initialiser* is assigned the value of its *Initialiser*'s *AssignmentExpression* when the *VariableDeclaration* is executed, not when the variable is created.

Syntax

VariableStatement :
var *VariableDeclarationList* ;

VariableDeclarationList :
VariableDeclaration
VariableDeclarationList, *VariableDeclaration*

VariableDeclarationListNoIn :
VariableDeclarationNoIn
VariableDeclarationListNoIn, *VariableDeclarationNoIn*

VariableDeclaration :
*BindingIdentifier Initialiser*_{opt}
BindingPattern Initialiser

VariableDeclarationNoIn :
*BindingIdentifier InitialiserNoIn*_{opt}
BindingPattern InitialiserNoIn

The semantics of the *VariableDeclarationListNoIn*, *VariableDeclarationNoIn* and *InitialiserNoIn* productions are the same as the *VariableDeclarationList*, *VariableDeclaration* and *Initialiser* productions except that the contained *VariableDeclarationListNoIn*, *VariableDeclarationNoIn*, *InitialiserNoIn* and *AssignmentExpressionNoIn* are used in of the contained *VariableDeclarationList*, *VariableDeclaration*, *Initialiser* and *AssignmentExpression*, respectively.

Static Semantics

Static Semantics: BoundNames

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 Initialiser*_{opt}

Deleted: Perform
Deleted: Initialization
Deleted: <i>Let</i>
Deleted: is evaluated as follows:
Deleted: <i>rval</i>
Deleted: If <i>rval</i> is an abrupt completion, return
Deleted:
Deleted: <i>rval</i>
Deleted: running
Deleted: current
Deleted: Perform
Deleted: Initialization
Deleted: Evaluate
Deleted: <i>rval</i>
Deleted: as the <i>obj</i> parameter
Deleted: <i>environment</i> parameter
Deleted: <i>BindingIdentifier</i> : <i>Identifier</i> is evaluated as follows: Return the result of evaluating <i>Identifier</i> as described 11.1.2.¶
Deleted: The production <i>Initialiser</i> := <i>AssignmentExpression</i> is evaluated as follows: Return the result of evaluating <i>AssignmentExpression</i> .¶
Deleted: The <i>LetBindingListNoIn</i> , <i>LetBindingNoIn</i> and <i>InitialiserNoIn</i> productions are evaluated in the same manner as the <i>LetBindingList</i> , <i>LetBinding</i> and <i>Initialiser</i> productions except that the contained <i>LetBindingListNoIn</i> , <i>LetBindingNoIn</i> , <i>InitialiserNoIn</i> and <i>AssignmentExpressionNoIn</i> are evaluated instead of the contained <i>LetBindingList</i> , <i>LetBinding</i> , <i>Initialiser</i> and <i>AssignmentExpression</i> , respectively.¶
Deleted: 12.2.2 Const Declaration¶
NOTE A <i>const</i> declaration defines read-only variables that are scoped to the current execution context's <i>LexicalEnvironment</i> . Constant variables are created when their containing <i>Lexical Environment</i> is instantiated but may not be accessed in any way until the variable's <i>ConstBinding</i> is executed. A variable defined by a <i>ConstBinding</i> is assigned the value of its <i>Initialiser</i> 's <i>AssignmentExpression</i> when the <i>ConstBinding</i> is executed, not when the variable is created.¶
Syntax¶
ConstDeclaration :¶
<i>const</i> <i>ConstBindingList</i> ;¶
ConstBindingList :¶
<i>ConstBinding</i> <i>ConstBinding List</i> , <i>ConstBinding</i> ¶
Deleted: 3
Deleted: current
Deleted: ¶
Deleted: NOTE A <i>var</i> statement declares variables that are scoped to the current execution context's ¶
Deleted: Static Semantics: Early Errors¶
<i>VariableDeclaration</i> : <i>BindingPattern Initialiser</i> ¶
Deleted: The <i>BoundNames</i> of the production <i>VariableStatement</i> : <i>var</i> <i>VariableDeclarationList</i> ; is

1. Return the BoundNames of *BindingIdentifier*.

VariableDeclaration : BindingPattern Initialiser

1. Return the BoundNames of *BindingPattern*.

Runtime Semantics

Runtime Semantics: Binding Initialisation

With arguments *value* and *environment*.

NOTE *undefined* is passed for *environment* to indicate that a PutValue operation should be used to assign the initialisation value. This is the case for *var* statements formal parameter lists of non-strict functions. In those cases a lexical binding is hosted and preinitialized prior to evaluation of its initializer.

VariableDeclaration : BindingIdentifier

1. Return the result of performing Binding Initialisation for *BindingIdentifier* passing *value* and *undefined* as the arguments.

VariableDeclaration : BindingIdentifier Initialiser

1. Return the result of performing Binding Initialisation for *BindingIdentifier* passing *value* and *undefined* as the arguments.

VariableDeclaration : BindingPattern Initialiser

1. Return the result of performing Binding Initialisation for *BindingPattern* passing *value* and *undefined* as the arguments.

Runtime Semantics: Evaluation

VariableStatement : var VariableDeclarationList ;

1. Let *next* be the result of evaluating *VariableDeclarationList*.
2. ReturnIfAbrupt(*next*).
3. Return NormalCompletion(*empty*).

VariableDeclarationList : VariableDeclarationList , VariableDeclaration

1. Let *next* be the result of evaluating *VariableDeclarationList*.
2. ReturnIfAbrupt(*next*).
3. Return the result of evaluating *VariableDeclaration*.

VariableDeclaration : BindingIdentifier

1. Return NormalCompletion(*empty*).

VariableDeclaration : BindingIdentifier Initialiser

1. Let *rhs* be the result of evaluating *Initialiser*.
2. Let *value* be *GetValue(rhs)*.
3. ReturnIfAbrupt(*value*).
4. Return the result of performing Binding Initialisation for *BindingIdentifier* passing *value* and *undefined* as the arguments.

NOTE If a *VariableDeclaration* is nested within a *with* statement and the *Identifier* in the *VariableDeclaration* is the same as a property name of the binding object of the *with* statement's object environment record, then step 3 will assign *value* to the property instead of to the *VariableEnvironment* binding of the *Identifier*.

Deleted: the

Deleted: The production

Deleted: is evaluated as follows:

Deleted: Evaluate

Deleted: If *next* is an abrupt completion, return *next*

Deleted: (normal,

Deleted: *y*, empty)

Deleted: The BoundNames of the production *VariableDeclarationList : VariableDeclaration* is determined as follows:
*<#>*Return BoundNames of *VariableDeclaration*

Deleted: The production

VariableDeclarationList : VariableDeclaration is evaluated as follows:
*<#>*Return the result of evaluating Evaluate *VariableDeclaration*.
<#>

Deleted: The BoundNames of the production *VariableDeclarationList : VariableDeclaration* is determined as follows:
*<#>*Let *names* be BoundNames of *VariableDeclarationList*.
*<#>*Append to *names* the elements of BoundNames of *VariableDeclaration*.
*<#>*Return *names*.
The production

Deleted: is evaluated as follows:

Deleted: Evaluate

Deleted: If *next* is an abrupt completion, return *next*

Deleted: Evaluate

Deleted: The BoundNames of the production *VariableDeclaration : BindingIdentifier Initialiser* is determined as follows:
*<#>*Return the BoundNames of *BindingIdentifier*.
The production

Deleted: is evaluated as follows:

Deleted: the String value of *BindingIdentifier*

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If *value* is an abrupt completion, return *value*

Deleted: Perform

Deleted: Initialization

Deleted: NOTE 1 The String value of a *VariableDeclaration* is used in the evaluation of for-in statements (12.6.4).
<#>

Deleted: 2

Deleted: 4

VariableDeclaration : BindingPattern Initialiser

2. Let *rhs* be the result of evaluating *Initialiser*.
3. Let *rval* be *ToObject*(*GetValue*(*rhs*)).
4. ReturnIfAbrupt(*rval*).
5. Return the result of performing Binding Initialisation for *BindingPattern* passing *rval* and *undefined* as arguments.

12.2.4 Destructuring Binding Patterns

Syntax

BindingPattern :
ObjectBindingPattern
ArrayBindingPattern

ObjectBindingPattern :

{ }
{ BindingPropertyList }
{ BindingPropertyList , }

ArrayBindingPattern :

[Elision_{opt} BindingRestElement_{opt}]
[BindingElementList]
[BindingElementList , Elision_{opt} BindingRestElement_{opt}]

BindingPropertyList :

BindingProperty
BindingPropertyList , BindingProperty

BindingElementList :

Elision_{opt} BindingElement
BindingElementList , Elision_{opt} BindingElement

BindingProperty :

SingleNameBinding
PropertyName : BindingElement

BindingElement :

SingleNameBinding
BindingPattern Initialiser_{opt}

SingleNameBinding :

BindingIdentifier Initialiser_{opt}

BindingRestElement :

... BindingIdentifier

Static Semantics

Static Semantics: Early Errors

BindingPattern : ObjectBindingPattern

- It is a Syntax Error if the *BoundNames* of *ObjectBindingPattern* contains the string “*eval*” or the string “*arguments*”.

BindingPattern : ArrayBindingPattern

Deleted: The static semantics of the production *VariableDeclaration : BindingPattern Initialiser* are:
<#>It is a Syntax Error if the source code matching this production is not contained in extended code.
The *BoundNames* of the production *VariableDeclaration BindingPattern Initialiser* is determined as follows:
<#>Return the *BoundNames* of *BindingPattern*.
The production

Deleted: is evaluated as follows:

Deleted: *ToObject*(

Deleted:)

Deleted: If *rval* is an abrupt completion, return *rval*

Deleted: Perform

Deleted: Initialization

Deleted: Evaluate

Deleted: using

Deleted: as the *obj* parameter

Deleted: the *environment* parameter

Deleted: The *VariableDeclarationListNoIn*, *VariableDeclarationNoIn* and *InitialiserNoIn* productions are evaluated in the same manner as the *VariableDeclarationList*, *VariableDeclaration* and *Initialiser* productions except that the contained *VariableDeclarationListNoIn*, *VariableDeclarationNoIn*, *InitialiserNoIn* and *AssignmentExpressionNoIn* are evaluated instead of the contained *VariableDeclarationList*, *VariableDeclaration*, *Initialiser* and *AssignmentExpression*, respectively.
Deleted: VariableStatement :
var *VariableDeclarationList* ;
VariableDeclarationList :
VariableDeclaration
VariableDeclarationList , *VariableDeclaration*;
VariableDeclarationListNoIn :
VariableDeclarationNoIn
VariableDeclarationListNoIn , *VariableDeclarationNoIn*;
VariableDeclaration :
*Identifier Initialiser*_{opt};
VariableDeclarationNoIn :
*Identifier InitialiserNoIn*_{opt};
Initialiser :
= *AssignmentExpression*
InitialiserNoIn :
= *AssignmentExpressionNoIn*

Comment [AW97]: The destructuring wiki page argues for allowing empty binding patterns. I'm not really convinced.

Comment [AW98]: See above comment about empty binding patterns.

Comment [AW99]: See above comment about empty binding patterns.

Deleted: *Identifier*

Deleted: *PropertyName* : *SingleNameBinding*

Deleted: *PropertyName* : *BindingPattern Initialiser*_{opt}

Deleted: *Identifier* .

Deleted: ...

Deleted: *Identifier*

Deleted: Bound Names

Deleted: *Object*

- It is a Syntax Error if the *BoundNames* of *ArrayBindingPattern* contains the string “`eval`” or the string “`arguments`”.

Static Semantics: *BoundNames*

ObjectBindingPattern : { }

- Return an empty List.

ArrayBindingPattern : [*Elision*_{opt}]

- Return an empty List.

ArrayBindingPattern : [*Elision*_{opt} *BindingRestElement*]

- Return the *BoundNames* of *BindingRestElement*.

ArrayBindingPattern : [*BindingElementList* , *Elision*_{opt}]

- Return the *BoundNames* of *BindingElementList*.

ArrayBindingPattern : [*BindingElementList* , *Elision*_{opt} *BindingRestElement*]

- Let *names* be *BoundNames* of *BindingElementList*.
- Append to *names* the elements of *BoundNames* of *BindingRestElement*.
- Return *names*.

BindingPropertyList : *BindingPropertyList* , *BindingProperty*

- Let *names* be *BoundNames* of *BindingPropertyList*.
- Append to *names* the elements of *BoundNames* of *BindingProperty*.
- Return *names*.

BindingElementList : *Elision*_{opt} *BindingElement*

- Return *BoundNames* of *BindingElement*.

BindingElementList : *BindingElementList* , *Elision*_{opt} *BindingElement*

- Let *names* be *BoundNames* of *BindingElementList*.
- Append to *names* the elements of *BoundNames* of *BindingElement*.
- Return *names*.

BindingProperty : *PropertyName* : *BindingElement*

- Return the *BoundNames* of *BindingElement*.

SingleNameBinding : *BindingIdentifier* *Initialiser*_{opt}

- Return the *BoundNames* of *BindingIdentifier*.

BindingElement : *BindingPattern* *Initialiser*_{opt}

- Return the *BoundNames* of *BindingPattern*.

Static Semantics: *HasInitialiser*

BindingElement : *BindingPattern*

Deleted: *Bound Names*

Deleted: *Bound Names*

Deleted: *Semantics*¶

Deleted: A variable statement declares variables that are created as defined in 10.5. Variables are initialised to `undefined` when created. A variable with an *Initialiser* is assigned the value of its *AssignmentExpression* when the *VariableStatement* is executed, not when the variable is created.¶ **Semantics**¶

The production *VariableStatement* : var *VariableDeclarationList* ; is evaluated as follows:¶

<#> Evaluate *VariableDeclarationList*.¶

<#> Return (normal, empty, empty).¶

The production *VariableDeclarationList* : *VariableDeclaration* is evaluated as follows:¶

<#> Evaluate *VariableDeclaration*.¶

The production *VariableDeclarationList* : *VariableDeclaration* , *VariableDeclaration* is evaluated as follows:¶

<#> Evaluate *VariableDeclarationList*.¶

<#> Evaluate *VariableDeclaration*.¶

The production *VariableDeclaration* : *Identifier* is evaluated as follows:¶

<#> Return a String value containing the same sequence of characters as in the *Identifier*.¶

The production *VariableDeclaration* : *Identifier* *Initialiser* is evaluated as follows:¶

<#> Let *lhs* be the result of evaluating *Identifier* as described in 11.1.2.¶

<#> Let *rhs* be the result of evaluating *Initialiser*.¶

<#> Let *value* be GetValue(*rhs*).¶

<#> Call PutValue(*lhs*, *value*).¶

Deleted: The *BoundNames* of the production *BindingPattern* : *ObjectBindingPattern* is determined as follows:¶

Comment [AW100]: The destructuring wiki page argues for allowing empty binding patterns but I'm not really convinced.

Deleted: *ObjectBindingPattern* :¶ { *BindingPropertyList* }¶ { *BindingPropertyList* , } ¶

Deleted: *List*

Deleted: *ArrayBindingPattern* :¶ [*BindingElementList*] ¶

<#> Return the *BoundNames* of *BindingElementList*.¶

Deleted: *BindingPropertyList* : *BindingProperty* ¶

<#> Return *BoundNames* of *BindingProperty*.¶

Deleted: *BindingProperty* : *SingleNameBinding* ¶

<#> Return the *BoundNames* of *SingleNameBinding*.¶

Deleted: *BindingElement* : *SingleNameBinding* ¶

<#> Return the *BoundNames* of *SingleNameBinding*.¶

Deleted: *BindingRestElement* : ... *BindingIdentifier* ¶

<#> Return the *BoundNames* of *BindingIdentifier*.¶

Deleted: *BindingElement* : *SingleNameBinding* ¶

<#> Return HasInitializer of *SingleNameBinding*.¶

1. Return **false**.

BindingElement : BindingPattern Initialiser

1. Return **true**.

SingleNameBinding : BindingIdentifier Initialiser

1. Return **false**.

SingleNameBinding : BindingIdentifier Initialiser

1. Return **true**.

Runtime Semantics

Runtime Semantics: Binding Initialisation

With parameters *value* and *environment*.

NOTE When **undefined** is passed for *environment* it indicates that a PutValue operation should be used to assign the initialisation 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. Assert: Type(*value*) is Object
2. Return the result of performing Binding Initialisation for *ObjectBindingPattern* using *value* and *environment* as arguments.

BindingPattern : ArrayBindingPattern

1. Assert: Type(*value*) is Object
2. Return the result of performing Indexed Binding Initialisation for *ArrayBindingPattern* using *value*, *0*, and *environment* as arguments.

ObjectBindingPattern : { }

1. Return NormalCompletion(empty).

BindingPropertyList : BindingPropertyList , BindingProperty

1. Let *status* be the result of performing Binding Initialisation for *BindingPropertyList* using *value* and *environment* as arguments.
2. ReturnIfAbrupt(*status*).
3. Return the result of performing Binding Initialisation for *BindingProperty* using *value* and *environment* as arguments.

BindingProperty : SingleNameBinding

1. Let *name* be the string that is the only element of BoundNames of *SingleNameBinding*.
2. Return the result of performing Keyed Binding Initialisation for *SingleNameBinding* using *value*, *environment*, and *name* as the arguments.

BindingProperty : PropertyName : BindingElement

1. Let *P* be the PropName of *PropertyName*.
2. Return the result of performing Keyed Binding Initialisation for *BindingElement* using *value*, *environment*, and *P* as arguments.

Deleted: Initialization

Deleted: environment

Deleted: initialization

Deleted: the

Deleted: The production

Deleted: If *value* is neither of **null** or **undefined**, then

Deleted: <#>Let *obj* be ToObject(*value*).¶

Deleted: is evaluated with parameters *value* and *env* as

Deleted: Perform ...inding Initialisation

Deleted: *value* as the

Deleted: *obj*

Deleted: parameter ...nd *env* as the ...nvironment paramet

Deleted: The BoundNames of the production

Deleted: If *value* is neither of **null** or **undefined**, then

Deleted: <#>Let *array* be ToObject(*value*).¶

Deleted: <#>Let *lenValue* be the result of calling the [[Get]]

Deleted: <#>Else,¶

Deleted: <#>Let *arrayLength* be 0.¶

Deleted: is evaluated with parameters *value* and *env* as

Deleted: Perform ...ndexed Binding Initialisation

Deleted: Evaluate ...rayBindingPattern using *value*

Deleted: *array*

Deleted:

Deleted: *arrayLength*, **undefined**

Deleted: as the *obj* parameter ...nd *env* as the ...nvironment

Deleted: The BoundNames of the production

Formatted

Deleted: is evaluated

Deleted: with parameters *value* and *env* as follows:¶

Deleted: Return

Comment [AW101]: The destructuring wiki page

Deleted: *ObjectBindingPattern* :¶

Deleted: The BoundNames of the production

Deleted: The production *BindingPropertyList* :

Deleted: The BoundNames of the production

Deleted: with parameters *obj* and *env* as follows:¶

Deleted: *next*

Deleted: Perform ...inding Initialisation

Deleted: Evaluate ...indingPropertyList using *obj...alue*

Deleted: *next*

Deleted: If *next* is an abrupt completion, return *next*

Deleted: Perform ...inding Initialisation

Deleted: Evaluate ...indingProperty using *obj...alue* as

Deleted: Perform ...yed Binding Initialisation

Deleted: Perform ...yed Binding Initialisation

Deleted: Evaluate

Runtime Semantics: Indexed Binding Initialisation

With parameters *array*, *nextIndex*, and *environment*.

NOTE When **undefined** is passed for *environment* it indicates that a PutValue operation should be used to assign the initialisation 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.

ArrayBindingPattern : [*Elision_{opt}*]

1. Return NormalCompletion(empty).

ArrayBindingPattern: [*Elision_{opt}* *BindingRestElement*]

1. Let *nextIndex* be the Elision Width of *Elision*; if *Elision* is not present, use the numeric value zero.
2. Return the result of performing Indexed Binding Initialisation for *BindingRestElement* using *array*, *nextIndex*, and *environment* as arguments.

ArrayBindingPattern: [*BindingElementList*]

1. Return the result of performing Indexed Binding Initialisation for *BindingElementList* using *array*, *nextIndex*, and *environment* as arguments.

ArrayBindingPattern: [*BindingElementList* , *Elision_{opt}*]

1. Return the result of performing Indexed Binding Initialisation for *BindingElementList* using *array*, *nextIndex*, and *environment* as arguments.

ArrayBindingPattern: [*BindingElementList* , *Elision_{opt}* *BindingRestElement*]

1. Let *next* be the result of performing Indexed Binding Initialisation for *BindingElementList* using *array*, *nextIndex*, and *environment* as arguments.
2. ReturnIfAbrupt(*next*).
3. Let *skip* be the Elision Width of *Elision*; if *Elision* is not present, use the numeric value zero.
4. Return the result of performing Indexed Binding Initialisation for *BindingRestElement* using *array*, *next+skip*, and *environment* as arguments.

BindingElementList : *Elision_{opt}* *BindingElement*

1. Let *skip* be the Elision Width of *Elision*; if *Elision* is not present, use the numeric value zero.
2. Let *status* be the result of performing Indexed Binding Initialisation for *BindingElement* using *array*, *nextIndex+skip*, and *environment* as arguments.
3. ReturnIfAbrupt(*status*).
4. Return *nextIndex+skip+1*.

BindingElementList : *BindingElementList* , *Elision_{opt}* *BindingElement*

1. Let *listNext* be the result of performing Indexed Binding Initialisation for *BindingElementList* using *array*, *nextIndex*, and *environment* as arguments.
2. ReturnIfAbrupt(*listNext*).
3. Let *skip* be the Elision Width of *Elision*; if *Elision* is not present, use the numeric value zero.
4. Let *status* be the result of performing Indexed Binding Initialisation for *BindingElement* using *array*, *listNext+skip*, and *environment* as arguments.
5. ReturnIfAbrupt(*status*).
6. Return *listNext+skip+1*.

BindingElement : *SingleNameBinding*

Deleted: Initialization
Deleted: <i>arrayLength</i> ,
Deleted: initialization
Deleted: the
Deleted: Return
Deleted: If <i>Elision</i> is present, then let <i>nextIndex</i>
Deleted: Perform ...ndexed Binding Initializati
Deleted: <i>arrayLength</i> ,
Deleted: Perform ...ndexed Binding Initializati
Deleted: Perform ...ndexed Binding Initializati
Deleted: 0,
Deleted: <i>index</i>
Deleted: Initialization
Deleted: ,
Deleted: 0
Deleted: <i>index</i>
Deleted: If <i>index</i> is an abrupt completion, return
Deleted: If <i>Elision</i> is present, then let <i>skip</i> be the
Deleted: Perform ...ndexed Binding Initializati
Deleted: <i>arrayLength</i> ,
Deleted: <i>index</i>
Deleted: The BoundNames of the production
Deleted: with the parameters <i>obj</i> , <i>env</i> , and
Deleted: If <i>Elision</i> is present, then let <i>skip</i> be the
Deleted: <i>next</i>
Deleted: Perform ...ndexed Binding Initializati
Deleted: Evaluate ...ndingElement using
Deleted: <i>arrayLength</i> ,
Deleted: <i>Deleted:</i>
Deleted: <i>env</i> as the <i>env</i> parameter, and <i>index+skip</i>
Deleted: <i>next</i>
Deleted: If <i>next</i> is an abrupt completion, return
Deleted: <i>index</i>
Deleted: The BoundNames of the production
Deleted: is evaluated with the parameters o
Deleted: Initialization
Deleted: <i>obj</i>
Deleted: <i>arrayLength</i> ,
Deleted: as the <i>obj</i> parameter, <i>env</i> as the <i>env</i>
Deleted: <i>next</i>
Deleted: If <i>next</i> is an abrupt completion, return
Deleted: If <i>Elision</i> is present, then let <i>skip</i> be the
Deleted: Evaluate
Deleted: <i>next</i>
Deleted: Perform ...ndexed Binding Initializati
Deleted: <i>obj...array</i> as the <i>obj</i> parameter
Deleted: <i>arrayLength</i> ,
Deleted: <i>env</i> as the <i>env</i> parameter
Deleted: ,
Deleted: and ...istNext+skip , and environment
Deleted: <i>listNext</i>
Deleted: If <i>listNext</i> is an abrupt completion, ret
Deleted: <i>listNext</i>
Deleted: 1
Deleted: The BoundNames of the production

1. Return the result of performing Keyed Binding Initialisation for *SingleNameBinding* using *array*, *environment*, and *ToString(nextIndex)* as the arguments.

BindingElement : BindingPattern Initialiser_{opt}

1. Let *P* be *ToString(nextIndex)*.
2. Let *v* be the result of *Get(array, P)*.
3. ReturnIfAbrupt(*v*).
4. If *Initialiser_{opt}* is present and *v* is *undefined*, then
 - a. Let *defaultValue* be the result of evaluating *Initialiser*.
 - b. Let *v* be *ToObject(GetValue(defaultValue))*.
5. ReturnIfAbrupt(*v*).
6. Return the result of performing Binding Initialisation for *BindingPattern* passing *v* and *environment* as arguments.

BindingRestElement : ... BindingIdentifier

2. Let *A* be the result of the abstract operation *ArrayCreate* with argument 0.
3. Let *lenVal* be the result of *Get(array, "length")*.
4. Let *arrayLength* be *ToInt32(lenVal)*.
5. ReturnIfAbrupt(*arrayLength*).
6. Let *n*=0.
7. Let *index* = *nextIndex*.
8. Repeat, while *index* < *arrayLength*
 - a. Let *P* be *ToString(index)*.
 - b. Let *exists* be the result of *HasProperty(array, P)*.
 - c. ReturnIfAbrupt(*exists*).
 - d. If *exists* is *true*, then
 - i. Let *v* be the result of *Get(array, P)*.
 - ii. ReturnIfAbrupt(*v*).
 - iii. Call the *[[DefineOwnProperty]]* internal method of *A* with arguments *ToString(n)* and *PropertyDescriptor* {*[[Value]]*: *v*, *[[Writable]]*: *true*, *[[Enumerable]]*: *true*, *[[Configurable]]*: *true*}
 - e. Let *n* = *n*+1.
 - f. Let *index* = *index*+1.
9. Return the result of performing Binding Initialisation for *BindingIdentifier* using *A* and *environment* as arguments.

Runtime Semantics: Keyed Binding Initialisation

With parameters *obj*, *environment*, and *propertyName*.

NOTE When *undefined* is passed for *environment* it indicates that a *PutValue* operation should be used to assign the initialisation 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 Initialiser_{opt}

1. Let *v* be the result of *Get(obj, propertyName)*.
2. ReturnIfAbrupt(*v*).
3. If *Initialiser_{opt}* is present and *v* is *undefined*, then
 - a. Let *defaultValue* be the result of evaluating *Initialiser*.
 - b. Let *v* be *ToObject(GetValue(defaultValue))*.
4. ReturnIfAbrupt(*v*).
5. Return the result of performing Binding Initialisation for *BindingPattern* passing *v* and *environment* as arguments.

SingleNameBinding : BindingIdentifier Initialiser_{opt}

1. Let *v* be the result of *Get(obj, propertyName)*.

- Deleted:** <#>If *nextIndex* ≥ *arrayLength*, then ¶
- Deleted:** with the parameters *obj*, *env* and *index* as ¶
- Deleted:** Perform ...keyed Binding Initialisation ¶
- Deleted:** Evaluate ¶
- Deleted:** *P, obj...ray, environment*, and *ToString(env* ¶
- Deleted:** The BoundNames of the production ¶
- Deleted:** <#>If *nextIndex* ≥ *arrayLength*, then ¶
- Deleted:** <#>Let *exists* be the result of calling the ¶
- Deleted:** with the parameters *obj*, *env* and *index* as ¶
- Deleted:** <#>If *exists* is *true*, then ¶
- Deleted:** calling the *[[...et]]*... internal method of ¶
- Deleted:** *obj* ¶
- Deleted:** with argument ¶
- Deleted:** passing *P* as the argument ¶
- Deleted:** <#>Else ¶
- Deleted:** <#>Let *v* be the result of evaluating *Initialiser*. ¶
- Deleted:** If *v* is an abrupt completion, return *v*. ¶
- Deleted:** Perform ...inding Initialisation ¶
- Deleted:** Evaluate ...indingPattern passing *v v ...nd* ¶
- Deleted:** ... ¶
- Deleted:** ion ¶
- Deleted:** (15.4) ¶
- Deleted:** a new array object created as if by the expression ¶
- Deleted:** calling the *[[...et]]*... internal method of ...rray w ¶
- Deleted:** If *arrayLength* is an abrupt completion, return ¶
- Deleted:** calling the *[[HasProperty]]* internal method of ¶
- Deleted:** calling the *[[...et]]*... internal method of ...rray ¶
- Deleted:** If *v* is an abrupt completion, return *v* ¶
- Deleted:** , ¶
- Deleted:** .[[value]] ¶
- Deleted:** , and false ¶
- Deleted:** Perform ...inding Initialisation ¶
- Deleted:** *array* ¶
- Deleted:** Initialization ¶
- Deleted:** initialization ¶
- Deleted:** the ¶
- Deleted:** *BindingElement: SingleNameBinding* ¶
- Deleted:** <#>Let *exists* be the result of calling the ¶
- Deleted:** calling the *[[...et]]*... internal method of ...bj wi ¶
- Deleted:** <#>Else ¶
- Deleted:** *v* ¶
- Deleted:** <#>Else, ¶
- Deleted:** If *v* is an abrupt completion, return *v*. ¶
- Deleted:** Perform ...inding Initialisation ¶
- Deleted:** <#>Let *exists* be the result of calling the ¶
- Deleted:** calling the *[[...et]]* internal method of... ...bj

2. ReturnIfAbrupt(*v*).
3. If *Initialiser_{opt}* is present and *v* is **undefined**, then
 - a. Let *defaultValue* be the result of evaluating *Initialiser*.
 - b. Let *v* be *GetValue(defaultValue)*.
4. ReturnIfAbrupt(*v*).
5. Return the result of performing Binding Initialisation for *BindingIdentifier* passing *v* and *environment* as arguments.

12.3 Empty Statement

Syntax

EmptyStatement :

;

Runtime Semantics

Runtime Semantics: Evaluation

EmptyStatement : ;

1. Return NormalCompletion(empty).

12.4 Expression Statement

Syntax

ExpressionStatement :

[lookahead $\notin \{\{, \text{function}, \text{class}\}\}] \text{Expression} ;$

NOTE An *ExpressionStatement* cannot start with an opening curly brace 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*.

Runtime Semantics

Runtime Semantics: Evaluation

ExpressionStatement : [lookahead $\notin \{\{, \text{function}, \text{class}\}\}] \text{Expression} ;$

1. Let *exprRef* be the result of evaluating *Expression*.
2. Let *value* be *GetValue(exprRef)*.
3. ReturnIfAbrupt(*value*).
4. Return NormalCompletion(*value*).

12.5 The if Statement

Syntax

IfStatement :

if (*Expression*) *Statement* **else** *Statement*
if (*Expression*) *Statement*

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**.

Static Semantics: VarDeclaredNames

IfStatement : **if** (*Expression*) *Statement* **else** *Statement*

- Deleted:** <#>Else ¶
- Deleted:** v
- Deleted:** <#>Else, ¶
<#> Let v be **undefined**. ¶
- Deleted:** If v is an abrupt completion, return v.
- Deleted:** Perform
- Deleted:** Initialization
- Deleted:** enviornment
- Deleted:** The BoundNames of the production
BindingRestElement : ... *BindingIdentifier* ¶
determined as follows: ¶
Return the BoundNames of *BindingIdentifier*
- Deleted:** The BoundNames of the production
BindingRestElement : ... *Identifier* is
determined as follows: ¶
Return BoundNames of *BindingElement*. ¶
- Deleted:** The production *BindingRestElement* ... *BindingIdentifier* is evaluated with the
parameters *obj*, *env*, and *index* as follows: ¶
Let *lenVal* be the result of calling the [[Get]]
internal method of *obj* with argument
"length". ¶
Let *len* be *ToUint32(lenVal)*. ¶
Let *A* be a new array object created as if by
the expression *new Array()* where *Array* is the standard built-in constructor with the
name. ¶
Let *n*=0; ¶
Repeat, while *index* < *len* ¶
Let *P* be *ToString(index)*. ¶
Let *exists* be the result of calling the
[[HasProperty]] internal method of *obj* with
argument *P*. ¶
If *exists* is true, then ¶
Let *v* be the result of calling the [[Get]]
internal method of *obj* passing *P* as the
argument. ¶
Call the [[DefineOwnProperty]] internal
method of *A* with arguments *ToString(n)*,
Property Descriptor {[[Value]]: *v*,
[[Writable]]: true, [[Enumerable]]: true,
[[Configurable]]: true}, and *false*. ¶
Let *n* = *n*+1. ¶
Let *index* = *index*+1. ¶
- Deleted:** Semantics ¶
The production
- Deleted:** is evaluated as follows:
- Deleted:** (normal,
- Deleted:** , empty).
- Deleted:** might
- Deleted:** Semantics ¶
The production
- Deleted:** is evaluated as follows:
- Deleted:** If *value* is an abrupt completion, return
value
- Deleted:** (normal, *GetValue(exprRef)*)
- Deleted:** , empty
- Deleted:** Semantics ¶
The VarDeclaredNames of the production
- Deleted:** is determined as follows:

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`.

IfStatement : if (Expression) Statement

1. Return the `VarDeclaredNames` of `Statement`.

Runtime Semantics

Runtime Semantics: Evaluation

IfStatement : if (Expression) Statement else Statement

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`.

IfStatement : if (Expression) Statement

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`.

12.6 Iteration Statements

Syntax

IterationStatement :

```

do Statement while ( Expression )
while ( Expression ) Statement
for ( ExpressionNoInOpt ; ExpressionOpt ; ExpressionOpt ) Statement
for ( var VariableDeclarationListNoIn ; ExpressionOpt ; ExpressionOpt ) Statement
for ( LexicalDeclarationNoIn ; ExpressionOpt ; ExpressionOpt ) Statement
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

```

ForDeclaration :

LetOrConst ForBinding

NOTE 1 *ForBinding* is defined in 11.1.4.2.

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If `exprValue` is an abrupt completion, return `exprValue`

Deleted: `ToBoolean(GetValue(exprRef))`

Deleted: Return

Deleted: Return

Comment [AWB6102]: Breaking change from ES5 completion reform

Deleted: The `VarDeclaredNames` of the production *IfStatement : if (Expression) Statement* is determined as follows:
 ↪ Return the `VarDeclaredNames` of `Statement`.
 The production

Deleted: is evaluated as follows:

Deleted: If `exprValue` is an abrupt completion, return `exprValue`

Deleted: `ToBoolean(GetValue(exprRef))`

Comment [AWB6103]: Breaking change from ES5 completion reform

Deleted: return

Deleted: (normal, empty)

Deleted: , empty).

Comment [AWB6104]: Breaking change from ES5 completion reform

Deleted: ↪ Return the result of evaluating `Statement`.

Deleted: ;

Comment [AWB6105]: 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: `BindingIdentifier`

Deleted: `VariableDeclarationNoIn`

Deleted: `ForVarDeclaration`

Deleted: `ForVarDeclaration : ↪ BindingPattern VariableDeclarationNoIn`

NOTE 2 A semicolon is not required after a `do-while` statement.

Runtime Semantics

Runtime Semantics: LoopContinues Abstract Operation

The abstract operation `LoopContinues` with arguments `completion` and `labelSet` is defined by the following step:

1. If `completion.[[type]]` is `normal`, then return `true`.
2. If `completion.[[type]]` is not `continue`, then return `false`.
3. If `completion.[[target]]` is `empty`, then return `true`.
4. If `completion.[[target]]` is an element of `labelSet`, then return `true`.
5. Return `false`.

NOTE Within the `Statement` part of an `IterationStatement` a `ContinueStatement` may be used to begin a new iteration.

12.6.1 The `do-while` Statement

Static Semantics: VarDeclaredNames

IterationStatement : do Statement while (Expression)

1. Return the `VarDeclaredNames` of `Statement`.

Runtime Semantics

Runtime Semantics: Labelled Evaluation

With argument `labelSet`.

IterationStatement : do Statement while (Expression)

1. Let `V = undefined`.
2. Repeat
 - a. Let `stmt` be the result of evaluating `Statement`.
 - b. If `stmt.[[value]]` is not `empty`, let `V = stmt.[[value]]`.
 - c. If `stmt` is an abrupt completion and `LoopContinues(stmt,labelSet)` is `false`, return `stmt`.
 - d. Let `exprRef` be the result of evaluating `Expression`.
 - e. Let `exprValue` be `ToBoolean(GetValue(exprRef))`.
 - f. If `exprValue` is `false`, Return `NormalCompletion(V)`.
 - g. Else if `exprValue` is not `true`, then
 - i. Assert: `exprValue` is an abrupt completion.
 - ii. If `LoopContinues(exprValue,labelSet)` is `false`, return `exprValue`.

12.6.2 The `while` Statement

Static Semantics: VarDeclaredNames

IterationStatement : while (Expression) Statement

1. Return the `VarDeclaredNames` of `Statement`.

Runtime Semantics

Runtime Semantics: Labelled Evaluation

With argument `labelSet`.

IterationStatement : while (Expression) Statement

Comment [AWB6106]: Note that this is technically a breaking change from ES5, however it is made to match web reality.

Deleted: ForBinding .
BindingIdentifier
BindingPattern ¶

Formatted: Note

Deleted: Within the `Statement` part of an `IterationStatement` a `ContinueStatement` may be used to begin a new iteration. This semantic is defined using t

Deleted: The

Deleted: loopContinues

Deleted: be

Deleted: s

Deleted: The `VarDeclaredNames` of the production

Deleted: ;

Deleted: is determined as follows:

Deleted: Runtime Semantics: Evaluation

Deleted: The production

Deleted: ;

Deleted: is evaluated as follows:

Comment [AWB6107]: Breaking change: completion reform

Deleted: empty

Deleted: <#>Let `iterating` be `true`.¶

Deleted: ;

Deleted: while `iterating` is true

Deleted: <#>If `stmt.type` is not `continue` or `stmt.target` is not in the current label set, then
<#>If `stmt.type` is `break` and `stmt.target` is in the current label set, return `(normal, V, empty)`.¶

Deleted: loopContinues

Deleted: `ToBoolean(GetValue(exprRef))`

Deleted: set `iterating` to false

Comment [AWB6108]: Break/continue/return in the expression works normally (future for d {} or block lambda expressions)

Deleted: a Completion Record

Deleted: loopContinues

Deleted: Return `(normal, V, empty)`;¶

Deleted: The `VarDeclaredNames` of the production

Deleted: `Statement` is determined as follows:

Deleted: Runtime Semantics: Evaluation

Deleted: The production

Deleted: is evaluated as follows:

1. Let $V = \text{undefined}$.
2. Repeat
 - a. Let $exprRef$ be the result of evaluating *Expression*.
 - b. Let $exprValue$ be $\text{ToBoolean}(\text{GetValue}(exprRef))$.
 - c. If $exprValue$ is **false**, return *NormalCompletion*(V).
 - d. If $exprValue$ is **not true**, then
 - i. Assert: $exprValue$ is an abrupt completion.
 - ii. If $\text{LoopContinues}(exprValue, \text{labelSet})$ is **false**, return $exprValue$.
 - e. Let $stmt$ be the result of evaluating *Statement*.
 - f. If $stmt[\text{value}]$ is not **empty**, let $V = stmt[\text{value}]$.
 - g. If $\text{LoopContinues}(stmt, \text{labelSet})$ is **false**, return $stmt$.

12.6.3 The `for` Statement

Static Semantics

Static Semantics: VarDeclaredNames

IterationStatement : **for** (*ExpressionNoIn* ; *Expression_{opt}* ; *Expression_{opt}*) *Statement*

1. Return the *VarDeclaredNames* of *Statement*.

IterationStatement : **for** (**var** *VariableDeclarationListNoIn* ; *Expression_{opt}* ; *Expression_{opt}*) *Statement*

1. Let *names* be *BoundNames* of *VariableDeclarationListNoIn*.
2. Append to *names* the elements of the *VarDeclaredNames* of *Statement*.
3. Return *names*.

IterationStatement : **for** (*LexicalDeclarationNoIn* ; *Expression_{opt}* ; *Expression_{opt}*) *Statement*

1. Return the *VarDeclaredNames* of *Statement*.

Runtime Semantics

Runtime Semantics: Labelled Evaluation

With argument *labelSet*.

IterationStatement : **for** (*ExpressionNoIn* ; *Expression_{opt}* ; *Expression_{opt}*) *Statement*

1. If *ExpressionNoIn* is present, then
 - a. Let $exprRef$ be the result of evaluating *ExpressionNoIn*.
 - b. Let $exprValue$ be $\text{GetValue}(exprRef)$.
 - c. If $\text{LoopContinues}(exprValue, \text{labelSet})$ is **false**, return $exprValue$.
2. Return the result of performing For Body Evaluation with the first *Expression* as the *testExpr* argument, the second *Expression* as the *incrementExpr* argument, *Statement* as the *stmt* argument, and with *labelSet*.

IterationStatement : **for** (**var** *VariableDeclarationListNoIn* ; *Expression_{opt}* ; *Expression_{opt}*) *Statement*

1. Let *varDcl* be the result of evaluating *VariableDeclarationListNoIn*.
2. If $\text{LoopContinues}(\text{varDcl}, \text{labelSet})$ is **false**, return *varDcl*.
3. Return the result of performing For Body Evaluation with the first *Expression* as the *testExpr* argument, the second *Expression* as the *incrementExpr* argument, *Statement* as the *stmt* argument, and with *labelSet*.

IterationStatement : **for** (*LexicalDeclarationNoIn* ; *Expression_{opt}* ; *Expression_{opt}*) *Statement*

1. Let *oldEnv* be the running execution context's *LexicalEnvironment*.
2. Let *loopEnv* be the result of calling *NewDeclarativeEnvironment* passing *oldEnv* as the argument.
3. Let *isConst* be the result of performing *IsConstantDeclaration* of *LexicalDeclarationNoIn*.

Comment [AWB6109]: ES5 breaking change: completion reform

Deleted: empty

Deleted: $\text{ToBoolean}(\text{GetValue}(exprRef))$

Deleted: (normal,

Deleted: , empty

Comment [AWB6110]: Break/continue/return in the expression works normally (future for do {} or block lambda expressions)

Deleted: Else i

Deleted: a Completion Record

Deleted: loopContinues

Deleted: <#>If *stmt.type* is not continue or|| *stmt.target* is not in the current label set, then¶
<#>If *stmt.type* is break and *stmt.target* is in the current label set, then¶
<#>Return (normal, *V*, empty).¶

Deleted: *stmt* is an abrupt completion

Deleted: loopContinues

Comment [AWB 3111]: The lexical scoping of for iteration variables still needs to be taken care of

Deleted: The *VarDeclaredNames* of the production

Deleted: is determined as follows:

Deleted: Runtime Semantics: Evaluation¶

Deleted: The production

Deleted: is evaluated as follows:

Deleted: .

Deleted: Call

Deleted: (This value is not used but the call may have side effects.)

Deleted: loopContinues

Deleted: increment

Deleted: testExpr

Comment [AWB6112]: ES5 breaking change: Completion reform

Deleted: The abstraction operation For Body Evaluation with arguments *testExpr*, *incrementExpr*, and *labelSet* is performed as follows:¶
<#>Let *V* = **undefined**,empty.¶
<#>Repeat¶

Deleted: loopContinues

Deleted: incrementExpr

Deleted: testExpr

Comment [AWB6113]: A final decision has not yet

Deleted: <#>Evaluate *VariableDeclarationListNoIn*.¶

Deleted: running

Deleted: current

Deleted: the

Deleted: d

4. For each element *dn* of the *BoundNames* of *LexicalDeclarationNoIn* do
 - a. If *isConst* is **true**, then
 - i. Call *loopEnv*'s *CreateImmutableBinding* concrete method passing *dn* as the argument.
 - b. Else,
 - i. Call *loopEnv*'s *CreateMutableBinding* concrete method passing *dn* and **false** as the arguments.
5. Set the *running execution context's LexicalEnvironment* to *loopEnv*.
6. Let *forDcl* be the result of evaluating *LexicalDeclarationNoIn*.
7. If *LoopContinues(forDcl,labelSet)* is **false**, then
 - a. Set the *running execution context's LexicalEnvironment* to *oldEnv*.
 - b. Return *forDcl*.
8. Let *bodyResult* be the result of performing For Body Evaluation with the first *Expression* as the *testExpr* argument, the second *Expression* as the *incrementExpr* argument, *Statement* as the *stmt* argument, and with *labelSet*.
9. Set the *running execution context's LexicalEnvironment* to *oldEnv*.
10. Return *bodyResult*.

Runtime Semantics: For Body Evaluation Abstract Operation

The abstract operation For Body Evaluation with arguments *testExpr*, *incrementExpr*, *stmt*, and *labelSet* is performed as follows:

1. Let *V* = **undefined**.
2. Repeat
 - a. If *testExpr* is not **[empty]**, then
 - i. Let *testExprRef* be the result of evaluating *testExpr*.
 - ii. Let *testExprValue* be *ToBoolean(GetValue(testExprRef))*.
 - iii. If *testExprValue* is **false**, return *NormalCompletion(V)*.
 - iv. Else if *LoopContinues(testExprValue,labelSet)* is **false**, return *testExprValue*.
 - b. Let *result* be the result of evaluating *stmt*.
 - c. If *result.[value]* is not **empty**, let *V* = *result.[value]*.
 - d. If *LoopContinues(result,labelSet)* is **false**, return *result*.
 - e. 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*.

12.6.4 The `for-in` and `for-of` Statements

Static Semantics

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 the *LeftHandSideExpression* is an *Identifier* that can be statically determined to always resolve to a declarative environment record binding and the resolved binding is an immutable binding.
- It is a Syntax Error if *LeftHandSideExpression* is neither an *ObjectLiteral* nor an *ArrayLiteral* and *IsValidSimpleAssignmentTarget* of *LeftHandSideExpression* is **false**.

Deleted: running
Deleted: current
Deleted: loopContinues
Deleted: varDcl
Deleted: running
Deleted: current
Deleted: varDcl
Deleted: increment
Deleted: testExpr
Deleted: running
Deleted: current

Comment [AWB6114]: ES5 breaking change: Completion reform

Deleted:,

- It is a Syntax Error if the LeftHandSideExpression is CoverParenthesizedExpressionAndArrowParameterList : (Expression) and Expression derived a production that would produce a Syntax Error according to these rules. This rule is recursively applied.

IterationStatement :

for (ForDeclaration in Expression) Statement
for (ForDeclaration of AssignmentExpression) Statement

- It is a Syntax Error if any element of the BoundNames of ForDeclaration also occurs in the VarDeclaredNames of Statement.

Static Semantics: BoundNames

ForDeclaration : LetOrConst ForBinding

1. Return the BoundNames of ForBinding.

Static Semantics: VarDeclaredNames

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.

IterationStatement : for (ForDeclaration in Expression) Statement

1. Return the VarDeclaredNames of Statement.

IterationStatement : for (LeftHandSideExpression of AssignmentExpression) Statement

1. Return the VarDeclaredNames of Statement.

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.

Runtime Semantics

Runtime Semantics: Binding Instantiation

With arguments value and environment.

ForDeclaration : LetOrConst ForBinding

1. For each element name of the BoundNames of ForBinding do
 - a. If IsConstantDeclaration of LetOrConst is false, then
 - i. Call environment's CreateMutableBinding concrete method with argument name.

Deleted: <#>It is a Syntax Error if the IterationStatement is contained in strict code and LeftHandSideExpression is the Identifier eval or the Identifier arguments.¶

<#>It is a Syntax Error if the LeftHandSideExpression is an Identifier that statically resolves to a declarative environment record binding and the resolved binding is an immutable binding.¶

Deleted: <#>It is a Syntax Error if the LeftHandSideExpression is PrimaryExpression: (Expression) and Expression derived a production that would produce a Syntax Error according to these rules. This rule is recursively applied.¶

<#>It is a Syntax Error if isValidAssignmentPattern of LeftHandSideExpression is true.It is a Syntax Error if the LeftHandSideExpression is an ObjectLiteral or an ArrayLiteral and the source code corresponding to LeftHandSideExpression cannot be parsed using AssignmentPattern as the goal symbol.¶

Deleted: Lexically Declared Names

Deleted: Var Declared Names

Deleted: Bound Names

Deleted: ForVarDeclaration : BindingPattern ¶
 <#>Return the Bound Names of BindingPattern.¶
ForVarDeclaration : VariableDeclarationNoIn ¶
 <#>Return the Bound Names of VariableDeclarationNoIn.¶

Deleted: Bound Names

Deleted: ForBinding : BindingIdentifier ¶
 <#>Return the Bound Names of BindingIdentifier.¶
ForDeclaration : BindingPattern ¶
 <#>Return the Bound Names of BindingPattern.¶

Deleted: Var Declared Names

Deleted: The VarDeclaredNames of the production

Deleted: is determined as follows:

Deleted: Var Declared Names

Deleted: VariableDeclarationNoIn

Deleted: BindingIdentifier

Deleted: Bound Names

Deleted: Variable

Deleted: BindingIdentifier

Deleted: DeclarationNoIn

Deleted: Var Declared Names

Deleted: Var Declared Names

Deleted: ForVarDeclaration

Deleted: Bound Names

Deleted: ForVarDeclaration

Deleted: Var Declared Names

Deleted: Var Declared Names

Deleted: Bound Names

- b. Else,
 1. Call *environment*'s `CreateImmutableBinding` concrete method with argument *name*.
2. Return the result of performing Binding Initialisation for *ForBinding* passing *value* and *environment* as the arguments.

Deleted: Perform

Runtime Semantics: Labelled Evaluation

With argument *labelSet*.

IterationStatement : `for (LeftHandSideExpression in Expression) Statement`

1. Let *keyResult* be the result of performing For In/Of Expression Evaluation with *Statement*, *enumerate*, and *labelSet*.
2. `ReturnIfAbrupt(keyResult)`.
3. Return the result of performing For In/Of Body Evaluation with *LeftHandSideExpression*, *Statement*, *keyResult*, *assignment*, and *labelSet*.

IterationStatement : `for (var ForBinding in Expression) Statement`

1. Let *keyResult* be the result of performing For In/Of Expression Evaluation with *Statement*, *enumerate*, and *labelSet*.
2. `ReturnIfAbrupt(keyResult)`.
3. Return the result of performing For In/Of Body Evaluation with *ForBinding*, *Statement*, *keyResult*, *varBinding*, and *labelSet*.

IterationStatement : `for (ForDeclaration in Expression) Statement`

1. Let *keyResult* be the result of performing For In/Of Expression Evaluation with *Statement*, *enumerate*, and *labelSet*.
2. `ReturnIfAbrupt(keyResult)`.
3. Return the result of performing For In/Of Body Evaluation with *ForDeclaration*, *Statement*, *keyResult*, *lexicalBinding*, and *labelSet*.

IterationStatement : `for (LeftHandSideExpression of AssignmentExpression) Statement`

1. Let *keyResult* be the result of performing For In/Of Expression Evaluation with *AssignmentExpression*, *iterate*, and *labelSet*.
2. `ReturnIfAbrupt(keyResult)`.
3. Return the result of performing For In/Of Body Evaluation with *LeftHandSideExpression*, *Statement*, *keyResult*, *assignment*, and *labelSet*.

IterationStatement : `for (var ForBinding of AssignmentExpression) Statement`

1. Let *keyResult* be the result of performing For In/Of Expression Evaluation with *AssignmentExpression*, *iterate*, and *labelSet*.
2. `ReturnIfAbrupt(keyResult)`.
3. Return the result of performing For In/Of Body Evaluation with *ForBinding*, *Statement*, *keyResult*, *varBinding*, and *labelSet*.

IterationStatement : `for (ForDeclaration of AssignmentExpression) Statement`

1. Let *keyResult* be the result of performing For In/Of Expression Evaluation with *AssignmentExpression*, *iterate*, and *labelSet*.
2. `ReturnIfAbrupt(keyResult)`.
3. Return the result of performing For In/Of Body Evaluation with *ForDeclaration*, *Statement*, *keyResult*, *lexicalBinding*, and *labelSet*.

Deleted: Runtime Semantics: Binding Initialisation¶

With arguments *value* and *environment*.¶
NOTE `undefined` is passed for *environment* indicate that a PutValue operation should be used to assign the initialisation value. This is the the case for `var` statements formal parameter lists of non-strict functions. In those cases a lexical binding is hosted and preinitialized prior to evaluation of its initialiser.
ForVarDeclaration : BindingPattern ¶
<#>Perform Binding Initialisation for *BindingPattern* passing *value* and *env* as the arguments.¶

ForVarDeclaration : VariableDeclarationNoIn ¶
<#>Perform Binding Initialisation for *VariableDeclarationNoIn* passing *value* and *env* as the arguments.¶

ForBinding : BindingIdentifier ¶
<#>Perform Binding Initialisation for *BindingIdentifier* passing *value* and *env* as the arguments.¶

ForBinding : BindingPattern ¶
<#>Perform Binding Initialisation for *BindingPattern* passing *value* and *env* as the arguments.¶

Deleted: Runtime Semantics: Evaluation¶

Deleted: The production

Deleted: is evaluated as follows:

Deleted: .[[value]]

Deleted: *BindingIdentifier*

Deleted: *BindingIdentifier*

Deleted: .[[value]]

Deleted: .[[value]]

Deleted: *ForDeclaration*

Deleted: *Statement*

Deleted: .[[value]]

Deleted: *BindingIdentifier*

Deleted: *Statement*

Deleted: *BindingIdentifier*

Deleted: .[[value]]

Deleted: *Statement*

Deleted: .[[value]]

Deleted: *ForDeclaration*

Runtime Semantics: For In/Of Expression Evaluation Abstract Operation

The abstract operation For In/Of Expression Evaluation is called with arguments *expr*, *iterationKind*, and *labelSet*. The value of *iterationKind* is either **enumerate** or **iterate**.

1. Let *exprRef* be the result of evaluating the production that is *expr*.
2. Let *exprValue* be GetValue(*exprRef*).
3. If *exprValue* is an abrupt completion.
 - a. If LoopContinues(*exprValue.labelSet*) is **false**, then return *exprValue*.
 - b. Else, return Completion {[[type]]: break, [[value]]: empty, [[target]]: empty}.
4. If *exprValue.[[value]]* is **null** or **undefined**, return Completion {[[type]]: break, [[value]]: empty, [[target]]: empty}.
5. Let *obj* be ToObject(*exprValue*).
6. If *iterationKind* is **enumerate**, then
 - a. Let *keys* be the result of calling the **[[Enumerate]]** internal method of *obj* with no arguments.
7. Else,
 - a. Assert *iterationKind* is **iterate**.
 - b. Let *keys* be the result of performing **Invoke** with arguments *obj*, **%Iterator%**, and an empty List.
8. If *keys* is an abrupt completion, then
 - a. If LoopContinues(*exprValue.labelSet*) is **false**, then return *exprValue*.
 - b. Assert: *keys.[[type]]* is **continue**.
 - c. Return Completion {[[type]]: break, [[value]]: empty, [[target]]: empty}.
9. Return *keys*.

Runtime Semantics: For In/Of Body Evaluation Abstract Operation

The abstract operation For In/Of Body Evaluation is called with arguments *lhs*, *stmt*, *keys*, *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 *noArgs* be an empty List.
3. Let *V* = **undefined**.
4. Repeat
 - a. Let *next* be the result of **Invoke(keys, "next")**.
 - b. If **IteratorComplete(next)** is **true**, then return **NormalCompletion(V)**.
 - c. If LoopContinues(*next.labelSet*) is **false**, then return *next*.
 - d. If *next* is an abrupt completion, then let *status* be *next*.
 - e. Else,
 - i. Assert *next.[[type]]* is **normal**.
 - ii. Let *nextValue* be *next.[[value]]*.
 - iii. If *lhsKind* is **assignment**, then
 1. Assert: *lhs* is a **LeftHandSideExpression**.
 2. If *lhs* is neither an **ObjectLiteral** nor an **ArrayLiteral** then
 - a. Let *lhsRef* be the result of evaluating *lhs* (it may be evaluated repeatedly).
 - b. Let *status* be the result of performing **PutValue(lhsRef, nextValue)**.
 3. Else
 - a. Let *AssignmentPattern* be the parse of the source code corresponding to *lhs* using *AssignmentPattern* as the goal symbol.
 - b. Let *rval* be **ToObject(nextValue)**.
 - c. If *rval* is an abrupt completion, then let *status* be *rval*.
 - d. Else, let *status* be the result of performing **Destructuring Assignment Evaluation** of *AssignmentPattern* using *rval* as the argument.
 - iv. Else if *lhsKind* is **varBinding**, then
 1. Assert: *lhs* is a **ForBinding**.
 2. Let *status* be the result of performing **Binding Initialisation** for *lhs* passing *nextValue* and **undefined** as the arguments.
 - v. Else,
 1. Assert *lhsKind* is **lexicalBinding**.
 2. Assert: *lhs* is a **ForDeclaration**.

Deleted: ion

Deleted: is performed as follows:

Deleted: Expression

Deleted: then return

Deleted: loopContinues

Comment [AWB6115]: Note a continue in the initial expression is just like a break

Comment [AWB6116]: Completion value reform

Deleted: undefined,

Comment [AWB6117]: Completion value reform

Deleted: undefined,

Deleted:

Deleted:

Deleted: (normal, empty, empty)

Deleted: arguments true and true

Comment [AWB6118]: Notation for private names known to the implementation

Comment [AWB6119]: Break/continue in the expression works normally (future for do {} or block lambda expressions)

Deleted: <#>Let *keys* be the result of calling the **[[Iterate]]** internal method of *obj*.
|

Deleted: LoopContinues

Comment [AWB6120]: Note a continue in the initial expression is just like a break

Comment [AWB6121]: Completion value reform

Deleted: undefined,

Deleted: ion

Deleted: is performed as follows:

Deleted: running

Deleted: current

Comment [AWB6122]: Completion value reform

Deleted:)

Deleted: empty

Deleted: performing

Deleted: with arguments

Deleted: , *keys*, and an empty arguments List

Comment [AWB7123]: TODO: need to define

Deleted: loopContinues

Deleted: <#>Let *P* be the name of the next property of *obj* whose **[[Enumerable]]** attribute is **true**. If there is no such property, return (normal, *V*, empty).¶

Deleted: the **LeftHandSideExpression**

Deleted: Call

Deleted: *P*

Comment [AWB6124]: ToDo, update this to return a completion value

Deleted: ForDeclaration

3. Let *iterationEnv* be the result of calling `NewDeclarativeEnvironment` passing *oldEnv* as the argument.
4. Perform Binding Instantiation for *lhs* passing *nextValue* and *iterationEnv* as arguments.
5. Let *status* be `NormalCompletion(empty)`.
6. Set the running execution context's LexicalEnvironment to *iterationEnv*.
- vi. If *status.[[type]]* is `normal`, then
 1. Let *status* be the result of evaluating *stmt*.
 2. If *status.[[type]]* is `normal` and *status.[[value]]* is not empty, then
 - a. Let *V* = *status.[[value]]*.
- vii. Set the running execution context's LexicalEnvironment to *oldEnv*.
- viii. If *status* is an abrupt completion and `LoopContinues(status.labelSet)` is `false`, then return *status*.

Comment [AWB11125]: Need to understand why result of previous step is ignored. See b811

Deleted: running

Deleted: current

Deleted: *stmt*

Deleted: *Statement*

Deleted: If *stmt.value* is not empty, *V*

Deleted: *stmt*

Deleted: running

Deleted: current

Deleted: `loopContinues`

Deleted: <#>If *stmt.type* is `break` and *stmt.target* is in the current label set, return (`normal`, *V*, *empty*)
<#>If *stmt.type* is not `continue` or *stmt.target* is in the current label set, then
<#>If *stmt* is an abrupt completion, return *stmt*.¶

Deleted: The `VarDeclaredNames` of the production
`for (var VariableDeclarationNoIn in Expression) Statement`
 is determined as follows:¶
 Let names be `BoundNames` of `VariableDeclarationNoIn`.¶
 Append to names the elements of the `VarDeclaredNames` of `Statement`.¶
 Return *names*.¶

Deleted: The production
`IterationStatement : for (var VariableDeclarationNoIn in Expression) Statement`
 is evaluated as follows:¶
 Let *varName* be the result of evaluating `VariableDeclarationNoIn`.¶
 Let *exprRef* be the result of evaluating the `Expression`.¶
 Let *exprValue* be `GetValue(exprRef)`.¶
 If *exprValue* is null or undefined, return (`normal`, `empty`, `empty`).¶
 Let *obj* be `ToObject(exprValue)`.¶
 Let *V* = `empty`.¶
 Repeat¶

Deleted: Semantics¶

Deleted: A program is considered syntactically incorrect if either of the following is true:¶

Deleted: The program contains a `continue` statement without the optional *Identifier*, where

Deleted: The program contains a `continue` statement with the optional *Identifier*, where

Deleted: label set

Deleted: A `ContinueStatement` without an *Identifier* is evaluated as follows:¶

Deleted: (

Deleted:).

Deleted: A `ContinueStatement` with the optional *Identifier* is evaluated as follows:¶

Deleted: (

Deleted:).

12.7 The continue Statement

Syntax

`ContinueStatement :`
 `continue ;`
 `continue [no LineTerminator here] Identifier ;`

Static Semantics

Static Semantics: Early Errors

`ContinueStatement : continue ;`

- It is a Syntax Error if this production is not nested, directly or indirectly (but not crossing function boundaries), within an `IterationStatement`.

`ContinueStatement : continue [no LineTerminator here] Identifier ;`

- It is a Syntax Error if *Identifier* does not appear in the `CurrentLabelSet` of an enclosing (but not crossing function boundaries) `IterationStatement`.

Runtime Semantics

Runtime Semantics: Evaluation

`ContinueStatement : continue ;`

1. Return `Completion {[[type]]: continue, [[value]]: empty, [[target]]: empty}`.

`ContinueStatement : continue [no LineTerminator here] Identifier ;`

1. Return `Completion {[[type]]: continue, [[value]]: empty, [[target]]: Identifier}`.

12.8 The break Statement

Syntax

`BreakStatement :`
 `break ;`
 `break [no LineTerminator here] Identifier ;`

Static Semantics

Static Semantics: Early Errors

BreakStatement : break ;

- It is a Syntax Error if this production, not nested, directly or indirectly (but not crossing function boundaries), within an *IterationStatement* or a *SwitchStatement*.

BreakStatement : break [no LineTerminator here] Identifier ;

- It is a Syntax Error if *Identifier* does not appear in the *CurrentLabelSet* of an enclosing (but not crossing function boundaries) *Statement*.

Runtime Semantics

Runtime Semantics: Evaluation

BreakStatement : break ;

1. Return Completion {[[type]]: break, [[value]]: empty, [[target]]: empty}.

BreakStatement : break [no LineTerminator here] Identifier ;

1. Return Completion {[[type]]: break, [[value]]: empty, [[target]]: *Identifier*}.

12.9 The return Statement

Syntax

```
ReturnStatement :
  return ;
  return [no LineTerminator here] Expression ;
```

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*.

Static Semantics

Static Semantics: Early Errors

- It is a Syntax Error if a *return* statement is not within a *FunctionBody*.

Runtime Semantics

Runtime Semantics: Evaluation

ReturnStatement : return ;

1. Return Completion {[[type]]: return, [[value]]: **undefined**, [[target]]: empty}.

ReturnStatement : return [no LineTerminator here] 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}.

12.10 The with Statement

Syntax

```
WithStatement :
  with ( Expression ) Statement
```

Deleted: Semantics

A program is considered syntactically incorrect if either the following is true:¹¹

Deleted: The program contains a **break** statement without the optional *Identifier*, which is

Deleted: The program contains a **break** statement with the optional *Identifier*, where

Deleted: label set

Deleted: A *BreakStatement* without an *Identifier* is evaluated as follows:¹¹

Deleted: (

Deleted:).

Deleted: A *BreakStatement* with an *Identifier* is evaluated as follows:¹¹

Deleted: (

Deleted:).

Deleted: <#>Semantics¹¹

Deleted: An ECMAScript program is considered syntactically incorrect if it contains

Deleted: that

Deleted: 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*.

Deleted: A *ReturnStatement* is evaluated as follows:¹¹ If the *Expression* is not present, r

Deleted: (

Deleted:).

Comment [AWB9126]: TODO If *exprRef* is a Reference that invokes a getter we probably should find a way to specify that the get call is handled as a tail call.

Deleted: If *exprValue* is an abrupt completion, return *exprValue*

Deleted: (

Deleted: *GetValue*(

Deleted: *exprRef*)

Deleted:).

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.

Deleted: current

Static Semantics

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.

Static Semantics: VarDeclaredNames

WithStatement : with (Expression) Statement

1. Return the VarDeclaredNames of Statement.

Runtime Semantics

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 the result of calling `NewObjectEnvironment` passing `obj` and `oldEnv` as the arguments.
6. Set the `withEnvironment` flag of `newEnv` 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.

Deleted: Semantics
The static semantics of the production

Deleted: are:

Deleted: static

Deleted: The VarDeclaredNames of the production

Deleted: is determined as follows:

Deleted: The production

Deleted: is evaluated as follows:

Deleted: If `obj` is an abrupt completion, return a

Deleted: `j`

Deleted: `running`

Deleted: `current`

Deleted: `provideThis`

Deleted: `running`

Deleted: `current`

Deleted: but if an exception is thrown during the evaluation, let `C` be `(throw, V, empty)`, where `V` is the exception. (Execution now proceeds as if no exception were thrown.)

Deleted: `running`

Deleted: `current`

Deleted: 12.10.1 Strict Mode Restrictions
Strict mode code may not include a `WithStatement`. The occurrence of a `WithStatement` in such a context is treated as a `SyntaxError`.

12.11 The switch Statement

Syntax

SwitchStatement :
 switch (Expression) CaseBlock

CaseBlock :
 { CaseClauses_{opt} }
 { CaseClauses_{opt} DefaultClause CaseClauses_{opt} }

CaseClauses :
 CaseClause
 CaseClauses CaseClause

CaseClause :
 case Expression : StatementList_{opt}

DefaultClause :
 default : StatementList_{opt}

Static Semantics

Static Semantics: Early Errors

CaseBlock : { CaseClauses }

- It is a Syntax Error if the LexicallyDeclaredNames of CaseClauses contains any duplicate entries.
- It is a Syntax Error if any element of the LexicallyDeclaredNames of CaseClauses also occurs in the VarDeclaredNames of CaseClauses.

Deleted: are:

Deleted: i

Static Semantics: LexicalDeclarations

CaseBlock : {}

1. Return a new empty List.

CaseBlock : { CaseClauses_{opt} DefaultClause CaseClauses_{opt} }

1. If the first CaseClauses is present, let declarations be the LexicalDeclarations of the first CaseClauses.
2. Else let declarations be a new empty List.
3. Append to declarations the elements of the LexicalDeclarations 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 LexicalDeclarations of the second CaseClauses.

Deleted: CaseClause : case Expression : StatementList
 <#> It is a Syntax Error if StatementList includes a StatementListItem : FunctionDeclaration production and no source code matching this CaseClause production is contained in extended code.¶

Deleted: CaseBlock : { CaseClauses } ¶
 <#> Return the LexicalDeclarations of CaseClauses.¶

Deleted: LexicallyDeclaredNames

Deleted: names

Deleted: names

Deleted: the

Deleted: lyDeclaredNames

Deleted: CaseClauses : CaseClause ¶
 <#> Return the LexicalDeclarations of CaseClause.¶

Deleted: names

CaseClauses : CaseClauses CaseClause

1. Let declarations be LexicalDeclarations of CaseClauses.
2. Append to declarations the elements of the LexicalDeclarations of CaseClause.
3. Return declarations.

CaseClause : case Expression : StatementList_{opt}

1. If the StatementList is present, return the LexicalDeclarations of StatementList.
2. Else return a new empty List.

DefaultClause : default : StatementList_{opt}

1. If the StatementList is present, return the LexicalDeclarations of StatementList.
2. Else return a new empty List.

Static Semantics: LexicallyDeclaredNames

CaseBlock : {}

1. Return a new empty List.

CaseBlock : { CaseClauses_{opt} DefaultClause CaseClauses_{opt} }

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.

Deleted: CaseBlock : { CaseClauses } ¶
 <#> Return the LexicallyDeclaredNames of CaseClauses.¶

Deleted: the

CaseClauses : CaseClauses CaseClause

1. Let names be LexicallyDeclaredNames of CaseClauses.

Deleted: CaseClauses : CaseClause ¶
 <#> Return the LexicallyDeclaredNames of CaseClause.¶

2. Append to *names* the elements of the LexicallyDeclaredNames of *CaseClause*.
3. Return *names*.

CaseClause : case Expression : StatementList_{opt}

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.

Static Semantics: VarDeclaredNames

SwitchStatement : switch (Expression) CaseBlock

1. Return the VarDeclaredNames of *CaseBlock*.

CaseBlock : { }

1. Return a new empty List.

CaseBlock : { CaseClauses_{opt} DefaultClause CaseClauses_{opt} }

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*.

CaseClause : case Expression : StatementList_{opt}

1. If the *StatementList* is present, return the VarDeclaredNames of *StatementList*.
2. Else return a new empty List.

DefaultClause : default : StatementList_{opt}

1. If the *StatementList* is present, return the VarDeclaredNames of *StatementList*.
2. Else return a new empty List.

Runtime Semantics

Runtime Semantics: Case Block Evaluation

With argument *input*.

CaseBlock : { CaseClauses_{opt} }

1. Let *V* = undefined.
2. Let *A* be the list of *CaseClause* items in source text order.
3. Let *searching* be **true**.

Deleted: Semantics
The VarDeclaredNames of the production

Deleted: is determined as follows:

Deleted: *CaseBlock : { CaseClauses } ¶*
<#>Return the VarDeclaredNames of *CaseClauses*

Deleted: the

Deleted: *CaseClauses : CaseClause ¶*
<#>Return the VarDeclaredNames of *CaseClause*

Deleted: **Runtime Semantics: Evaluation**
The production *SwitchStatement : switch (Expression) CaseBlock* is evaluated as follows:
<#>Let *exprRef* be the result of evaluating *Expression*.
<#>Let *oldEnv* be the running execution context's LexicalEnvironment.
<#>Let *blockEnv* be the result of calling *NewDeclarativeEnvironment* passing *oldEnv* as the argument.
<#>Perform Block Declaration Instantiation using *CaseBlock* and *blockEnv*.
<#>Let *R* be the result of evaluating *CaseBlock*, passing *GetValue(exprRef)* as a parameter.
<#>Set the running execution context's LexicalEnvironment to *oldEnv*.
<#>If *R.type* is *break* and *R.target* is in the current label set, return (*normal*, *R.value*, *empty*).
<#>Return *R*.
NOTE No matter how control leaves the *SwitchStatement* the LexicalEnvironment is always restored to its former state.

Deleted: The production

Deleted: is given an input parameter, *input*, and is evaluated as follows:

Comment [AWB6127]: ES5 breaking change: completion reform

Deleted: empty

4. Repeat, while *searching* is **true**
- Let *C* be the next *CaseClause* in *A*. If there is no such *CaseClause*, return *NormalCompletion(V)*.
 - Let *clauseSelector* be the result of evaluating *C*.
 - ReturnIfAbrupt(clauseSelector)*
 - If *input* is equal to *clauseSelector* as defined by the *Strict Equality Comparison Algorithm (11.9.1)*, then
 - Set *searching* to **false**.
 - If *C* has a *StatementList*, then
 - Evaluate *C*'s *StatementList* and let *R* be the result.
 - ReturnIfAbrupt(R)*
 - Let *V* = *R.[[value]]*.
5. Repeat
- Let *C* be the next *CaseClause* in *A*. If there is no such *CaseClause*, return *NormalCompletion(V)*.
 - If *C* has a *StatementList*, then
 - Evaluate *C*'s *StatementList* and let *R* be the result.
 - If *R.[[value]]* is not **empty**, then let *V* = *R.[[value]]*.
 - If *R* is an abrupt completion, then return *Completion {[[type]]: R.[[type]], [[value]]: V, [[target]]: R.[[target]]}*.

CaseBlock : { *CaseClauses*_{opt} *DefaultClause* *CaseClauses*_{opt} }

- Let *V* = **undefined**.
- Let *A* be the list of *CaseClause* items in the first *CaseClauses*, in source text order.
- Let *found* be **false**.
- Repeat letting *C* be in order each *CaseClause* in *A*
 - If *found* is **false**, then
 - Let *clauseSelector* be the result of *Case Selector Evaluation of C*.
 - If *clauseSelector* is an abrupt completion, then
 - If *clauseSelector.[[value]]* is **empty**, then return *Completion {[[type]]: clauseSelector.[[type]], [[value]]: undefined, [[target]]: clauseSelector.[[target]]}*.
 - Else, return *clauseSelector*.
 - If *input* is equal to *clauseSelector* as defined by the *Strict Equality Comparison Algorithm (11.9.1)*, then set *found* to **true**.
 - If *found* is **true**, then
 - Evaluate *CaseClause C* and let *R* be the result.
 - If *R.[[value]]* is not **empty**, then let *V* = *R.[[value]]*.
 - If *R* is an abrupt completion, then return *Completion {[[type]]: R.[[type]], [[value]]: V, [[target]]: R.[[target]]}*.
- Let *foundInB* be **false**.
- If *found* is **false**, then
 - Let *B* be a new list of the *CaseClause* items in the second *CaseClauses*, in source text order.
 - Repeat, letting *C* be in order each *CaseClause* in *B*.
 - If *foundInB* is **false**, then
 - Let *clauseSelector* be the result of *Case Selector Evaluation of C*.
 - If *clauseSelector* is an abrupt completion, then
 - If *clauseSelector.[[value]]* is **empty**, then return *Completion {[[type]]: clauseSelector.[[type]], [[value]]: undefined, [[target]]: clauseSelector.[[target]]}*.
 - Else, return *clauseSelector*.
 - If *input* is equal to *clauseSelector* as defined by the *Strict Equality Comparison Algorithm (11.9.1)*, then set *foundInB* to **true**.
 - If *foundInB* is **true**, then
 - Evaluate *CaseClause C* and let *R* be the result.
 - If *R.[[value]]* is not **empty**, then let *V* = *R.[[value]]*.
 - If *R* is an abrupt completion, then return *Completion {[[type]]: R.[[type]], [[value]]: V, [[target]]: R.[[target]]}*.
- If *foundInB* is **true**, then return *NormalCompletion(V)*.
- Evaluate *DefaultClause* and let *R* be the result.
- If *R.[[value]]* is not **empty**, then let *V* = *R.[[value]]*.
- If *R* is an abrupt completion, then return *Completion {[[type]]: R.[[type]], [[value]]: V, [[target]]: R.[[target]]}*.
- Let *B* be a new list of the *CaseClause* items in the second *CaseClauses*, in source text order.

- Deleted:** (normal,
- Deleted:** , empty
- Deleted:** If *clauseSelector* is an abrupt completion, return *clauseSelector*
- Deleted:** *i*
- Deleted:** *6*
- Deleted:** === operator
- Deleted:** *r*
- Deleted:** If *R* is an abrupt completion, then return *R*
- Deleted:** (normal,
- Deleted:** , empty
- Deleted:** (
- Deleted:**).
- Deleted:** The production
- Deleted:** is given an input parameter, *input*, and is evaluated as follows:
 - Comment [AWB6128]:** ES5 breaking change: completion reform
 - Deleted:** empty.
 - Deleted:** <#>Let *B* be the list of *CaseClause* items in the second *CaseClauses*, in source text order.¶
 - Deleted:** evaluating
 - Deleted:** Comparision
 - Deleted:** *6*
 - Deleted:** === operator
 - Deleted:** <#>If *C* has a *StatementList*, then¶
 - Deleted:** 's *StatementList*
 - Deleted:** (
 - Deleted:**).
 - Deleted:** while *foundInB* is **false** and all elements of *B* have not been processed
 - Deleted:** <#>Let *C* be the next *CaseClause* in *B*. ¶
 - Deleted:** evaluating
 - Deleted:** .
 - Deleted:** Comparision
 - Deleted:** *6*
 - Deleted:** === operator
 - Deleted:** *1*
 - Deleted:** S
 - Deleted:** If *C* has a *StatementList*,
 - Deleted:** *C*'s *StatementList*
 - Deleted:** (
 - Deleted:**).
 - Deleted:** <#>If *foundInB* is **false** and the *DefaultClause* has a *StatementList*, then¶
 - Deleted:** the
 - Deleted:** 's *StatementList*
 - Deleted:** (*R.type*, *V*, *R.target*)

12. Repeat, letting C be in order each *CaseClause* in B (NOTE this is another complete iteration of the second *CaseClauses*)

- b. Evaluate *CaseClause* C , and let R be the result.
- c. If $R.[[value]]$ is not empty, then let $V = R.[[value]]$.
- d. If R is an abrupt completion, then return Completion{[[type]]: $R.[[type]]$, [[value]]: V , [[target]]: $R.[[target]]$ }.

13. Return NormalCompletion(V).

Deleted: Note

Deleted: that if step 7.a.i has been performed the loop does not start at the beginning of B

Deleted: <#>Let C be the next *CaseClause* in B . If there is no such *CaseClause*, return NormalCompletion((normal, V , empty).¶<#>If C has a *StatementList*, then ¶

Deleted: 's *StatementList*

Deleted: return ($R.type$, V , $R.target$)

Runtime Semantics: Case Selector Evaluation

CaseClause : **case** *Expression* : *StatementList*_{opt}

1. Let $exprRef$ be the result of evaluating *Expression*.
2. Return GetValue($exprRef$).

NOTE *Case Selector Evaluation* 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.

Deleted: Evaluating

Deleted: *CaseClause*

Runtime Semantics: Evaluation

SwitchStatement : **switch** (*Expression*) *CaseBlock*

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 the result of calling NewDeclarativeEnvironment passing $oldEnv$ as the argument.
6. Perform Block Declaration Instantiation using *CaseBlock* and $blockEnv$.
7. Let R be the result of performing Case Block Evaluation of *CaseBlock* with argument $switchValue$.
8. Set the running execution context's LexicalEnvironment to $oldEnv$.
9. Return R .

Deleted: If $switchValue$ is an abrupt completion return $switchValue$

Deleted: running

Deleted: current

Deleted: running

Deleted: current

Deleted: <#>If $R.[[type]]$ is break and $R.[[target]]$ is in *CurrentLabelSet*, return NormalCompletion($R.[[value]]$).¶

Deleted: [empty]

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: The production

Deleted: opt

Deleted: is evaluated as follows:

Deleted: [empty]

CaseClause : **case** *Expression* : *StatementList*

1. Return the result of evaluating *StatementList*.

DefaultClause : **default**:

1. Return NormalCompletion(empty).

DefaultClause : **default**: *StatementList*

1. Return the result of evaluating *StatementList*.

12.12 Labelled Statements

Syntax

LabelledStatement :
 Identifier : *Statement*

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

Deleted: Let $exprRef$ be the result of evaluating *Expression*.¶
Return GetValue($exprRef$).¶
NOTE Evaluating *CaseClause* 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.¶

Deleted: Semantics¶

other than the introduction of a label to a *label set*. 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.

Static Semantics

Static Semantics: Early Errors

- It is a Syntax Error if a *LabelledStatement* is enclosed by a *LabelledStatement* with the same *Identifier* as the enclosed *LabelledStatement*. This does not apply to a *LabelledStatement* appearing within the body of a *FunctionDeclaration* and a *LabelledStatement* that encloses, directly or indirectly, the *FunctionDeclaration*.

Deleted: An ECMAScript program is considered syntactically incorrect if it contains

Deleted: that

Deleted: label

Deleted: labels

Deleted: that

Deleted: is

Deleted: nested

Deleted: ,

Deleted: within

Deleted: a labelled statement

Deleted: The VarDeclaredNames of the production *DefaultCase*

Deleted: *t* is determined as follows:

Static Semantics: VarDeclaredNames

LabelledStatement : *Identifier* : *Statement*

1. Return the VarDeclaredNames of *Statement*.

Runtime Semantics

Runtime Semantics: Labelled Evaluation

With argument *labelSet*.

LabelledStatement : *Identifier* : *Statement*

1. Let *label* be the StringValue of *Identifier*.
2. Let *newLabelSet* be a new List containing *label* and the elements of *labelSet*.
3. If *Statement* is either *LabelledStatement* or *BreakableStatement*, then
 - a. Let *stmtResult* be the result of performing Labelled Evaluation of *Statement* with argument *newLabelSet*.
4. Else,
 - a. Let *stmtResult* be the result of evaluating *Statement*.
5. If *stmtResult*.[[type]] is **break** and *stmtResult*.[[target]] is the same value as *label*, then
 - a. Let *result* be NormalCompletion(*stmtResult*.[[value]]).
6. Else,
 - a. Let *result* be *stmtResult*.
7. Return *result*.

Deleted:

Deleted: *I*

Runtime Semantics: Evaluation

LabelledStatement : *Identifier* : *Statement*

3. Let *newLabelSet* be a new empty List.
4. Return the result of performing Labelled Evaluation of this *LabelledStatement* with argument *newLabelSet*.

Deleted: The production *Identifier* : *Statement* is evaluated by adding *Identifier* to the label set of *Statement* and then evaluating *Statement*. If the *LabelledStatement* itself has a non-empty label set, these labels are also added to the label set of *Statement* before evaluating it. the result of evaluating *Statement* is (**break**, *V*, *L*) where is equal to *Identifier*, the production results in (**normal**, **empty**).¶

Deleted: Prior to the evaluation of a *LabelledStatement* the contained *Statement* is regarded as possessing empty label set, unless it is an *IterationStatement* or *SwitchStatement*, in which case it is regarded as possessing a label set consisting of the single element, **empty**.¶

12.13 The **throw** Statement

Syntax

ThrowStatement :

throw [no LineTerminator here] *Expression* ;

Runtime Semantics: Evaluation

The production *ThrowStatement* : **throw** [no LineTerminator here] *Expression* ; is evaluated as follows:

Deleted: Semantics¶

1. Let *exprRef* be the result of evaluating *Expression*.
2. Let *exprValue* be *GetValue(exprRef)*.
3. ReturnIfAbrupt(*exprValue*).
4. Return *Completion* {[[type]]: *throw*, [[value]]: *GetValue(exprRef)*, [[target]]: *empty* }.

12.14 The `try` Statement

Syntax

TryStatement :

```
try Block Catch
try Block Finally
try Block Catch Finally
```

Catch :

```
catch ( CatchParameter ) Block
```

Finally :

```
finally Block
```

CatchParameter :

```
BindingIdentifier
BindingPattern
```

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 *Identifier* is bound to that exception.

Deleted: Identifier

Formatted: Note

Static Semantics

Static Semantics: Early Errors

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*.

Deleted: the code that matches this production is contained in extended code and

Comment [AWB129]: Note that this is a new restriction that does not exist in ES5

Deleted: Static Semantics: *BoundNames*

```
CatchParameter: BindingIdentifier ¶
<#>Return the BoundNames of BindingIdentifier
CatchParameter: BindingPattern ¶
<#>Return the BoundNames of BindingPattern.
```

Deleted: Semantics¶
The *VarDeclaredNames* of the production

Deleted: is determined as follows:

Static Semantics: *VarDeclaredNames*

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*.

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*.

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*.

Catch : catch (CatchParameter) Block

1. Return the VarDeclaredNames of *Block*.

Runtime Semantics

Runtime Semantics: Binding Initialisation

With arguments *value* and *environment*.

NOTE *undefined* is passed for *environment* to indicate that a PutValue operation should be used to assign the initialisation value. This is the case for *var* statements formal parameter lists of non-strict functions. In those cases a lexical binding is hosted and preinitialized prior to evaluation of its initializer.

CatchParameter: BindingPattern

4. Let *exceptionObj* be *ToObject(value)*.
5. ReturnIfAbrupt(*exceptionObj*)
6. Return the result of performing Binding Initialisation for *BindingPattern* passing *exceptionObj* and *environment* as the arguments.

Runtime Semantics: Catch Clause Evaluation

with parameter *thrownValue*

Catch : catch (CatchParameter) Block

1. Let *oldEnv* be the running execution context's LexicalEnvironment.
2. Let *catchEnv* be the result of calling *NewDeclarativeEnvironment* passing *oldEnv* as the argument.
3. For each element *argName* of the *BoundNames* of *CatchParameter*, do
 - a. Call the *CreateMutableBinding* concrete method of *catchEnv* passing *argName* as the argument.
4. Let *status* be the result of performing Binding Initialisation for *CatchParameter* passing *thrownValue* and *catchEnv* as arguments.
5. ReturnIfAbrupt(*status*)
6. Set the running execution context's LexicalEnvironment to *catchEnv*.
7. Let *B* be the result of evaluating *Block*.
8. Set the running execution context's LexicalEnvironment to *oldEnv*.
9. Return *B*.

NOTE No matter how control leaves the *Block* the LexicalEnvironment is always restored to its former state.

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 Catch Clause Evaluation of *Catch* with parameter *B*.[[value]].

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*.

TryStatement : try Block Catch Finally

1. Let *B* be the result of evaluating *Block*.

Deleted: Finally : finally *Block* ¶
Return the VarDeclaredNames of *Block*.¶

Deleted: Initialization

Deleted: environment

Deleted: initialization

Deleted: the

Deleted: CatchParameter: BindingIdentifier¶
<#>PerformReturn the result of performing Binding
InitializationInitialisation for *BindingIdentifier* passing *value*
and *enviornmentenvironment* as the arguments.¶

Comment [AWB10130]: Catching a thrown null or undefined with a destructuring parameter rethrows a TypeError. Does this make sense?

Deleted: Perform

Deleted: Initialization

Deleted: enviornment

Deleted: running

Deleted: current

Deleted: Perform

Deleted: Initialization

Deleted: g

Deleted: If an exception was thrown in the preceding step
return (*throw*, *V*, empty) where *V* is the exception. (Execution
now proceeds as if no exception were thrown.)*status* is an
abrupt completion, then return *status*

Deleted: running

Deleted: current

Deleted: running

Deleted: current

Deleted: The production

Deleted: is evaluated as follows:

Deleted: evaluating

Deleted: The production

Deleted: is evaluated as follows:

Deleted: The production

Deleted: is evaluated as follows:

2. If $B.[[type]]$ is `throw`, then
 - a. Let C be the result of performing Catch Clause Evaluation 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 .

12.15 The `debugger` statement

Syntax

`DebuggerStatement :`

`debugger ;`

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.

The production `DebuggerStatement : debugger ;` is evaluated as follows:

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 $result$.

13 Functions and Generators

13.1 Function Definitions

Syntax

`FunctionDeclaration :`

`function BindingIdentifier (FormalParameterList) { FunctionBody }`

`FunctionExpression :`

`function BindingIdentifieropt (FormalParameterList) { FunctionBody }`

`FormalParameterList :`

`[empty]`

`FunctionRestParameter`

`FormalsList`

`FormalsList , FunctionRestParameter`

`FormalsList :`

`FormalParameter`

`FormalsList , FormalParameter`

`FunctionRestParameter :`

`... BindingIdentifier`

`FormalParameter :`

`BindingElement`

`FunctionBody :`

`StatementListopt`

Deleted: evaluating

Deleted:,

Deleted: The production `Catch : catch (IdentifierCatchParameter) Block` is evaluated with parameter C as follows:
Let C be the parameter that has been passed to this production.
Let $oldEnv$ be the running execution context's LexicalEnvironment.
Let $catchEnv$ be the result of calling `NewDeclarativeEnvironment` passing $oldEnv$ as the argument.

For each element $argName$ of the `BoundNames` of `CatchParameter`, do
Call the `CreateMutableBinding` concrete method of `catchEnv` passing $argName$ the `Identifier` String value as the argument.
Call the `Evaluate` `CatchParameter` `SetMutableBinding` using concrete method of `catchEnv` passing the `Identifier`, C and `catEnv`, and `false` as arguments. Note that the last argument is immaterial in this situation.
If an exception was thrown in the preceding step, return `(throw, V, empty)` where V is the exception. (Execution now proceeds as if exception were thrown.)
Set the running execution context's LexicalEnvironment to `catchEnv`.
Let B be the result of evaluating `Block`.
Set the running execution context's LexicalEnvironment to `oldEnv`.
Return B .

NOTE No matter how control leaves the `Block` the LexicalEnvironment is always restored to its former state.
The `VarDeclaredNames` of the production `Finally : finally Block` is determined as follows:
Return the `VarDeclaredNames` of `Block`.

Deleted: The production `Finally : finally Block` is evaluated as follows:
Return the result of evaluating `Block`.

Deleted: The `BoundNames` of the production `CatchParameter : BindingIdentifier` is

Deleted: Semantics

Deleted: Runtime Semantics: Evaluation

Deleted: (normal,

Deleted: , empty

Deleted: `opt`

Deleted: `opt`

Deleted: ... `Identifier`

Deleted: ... `Identifier`

Deleted: `FormalParameterList`

Deleted: `Identifier`

Deleted: `FormalParameterList`

Deleted: `Identifier`

Deleted: `BindingIdentifier Initialiseropt`

Deleted: `Pattern`

Deleted: `Initialiseropt`

Deleted: `SourceElementsopt`

Static Semantics

Static Semantics: Early Errors

FunctionDeclaration : **function** BindingIdentifier (*FormalParameterList*) { *FunctionBody* }

and

FunctionExpression : **function** BindingIdentifier_{opt} (*FormalParameterList*) { *FunctionBody* }

- It is a Syntax Error if IsSimpleParameterList of *FormalParameterList* is **true** and any element of the BoundNames of *FormalParameterList* also occurs in the VarDeclaredNames of *FunctionBody*.
- It is a Syntax Error if IsSimpleParameterList of *FormalParameterList* is **false** and BoundNames of *FormalParameterList* contains any duplicate elements.
- It is a Syntax Error if IsSimpleParameterList of *FormalParameterList* is **false** and BoundNames of *FormalParameterList* contains either "eval" or "arguments".
- It is a Syntax Error if the source code matching this production is strict code and BoundNames of *FormalParameterList* contains any duplicate elements.
- It is a Syntax Error if any element of the BoundNames of *FormalParameterList* also occurs in the LexicallyDeclaredNames of *FunctionBody*.
- It is a Syntax Error if *FunctionBody* Contains *YieldExpression*.

NOTE The LexicallyDeclaredNames of a *FunctionBody* does not include identifiers bound using var or function declarations. Simple parameter lists bind identifiers as VarDeclaredNames. Parameter lists that contain destructuring patterns, default value initialisers, or a rest parameter bind identifiers as LexicallyDeclaredNames. Multiple occurrences of the same Identifier in a *FormalParameterList* is only allowed for non-strict functions with simple parameter lists.

FunctionBody : 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*.

FormalParameter : BindingElement

- It is a Syntax Error if *BindingElement* Contains *YieldExpression*.

Static Semantics: BoundNames

FunctionDeclaration : **function** BindingIdentifier (*FormalParameterList*) { *FunctionBody* }

1. Return the BoundNames of *BindingIdentifier*.

FormalParameterList : [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*.

Static Semantics: Contains

Deleted: NOTE The identifier of a rest parameter is specified as an *Identifier* rather than a *BindingIdentifier* because it may be the identifier arguments..¶

Deleted: Semantics¶

Deleted: <#>It is a Syntax Error if the source code matching this production is extended code and the BoundNames of *BindingIdentifier* also occurs in the VarDeclaredNames of *FunctionBody*.¶

<#>It is a Syntax Error if the source code matching this production is extended code and the BoundNames of *BindingIdentifier* also occurs in the LexicallyDeclaredNames of *FunctionBody*.¶

Deleted: <#>It is a Syntax Error if the source code matching this production is extended code and any element of the LexicallyDeclaredNames of *FormalParameterList* also occurs in the VarDeclaredNames of *FunctionBody*.¶

Deleted: the source code matching this production is extended code and

Deleted: Lexically

Deleted: s

Deleted: s

Deleted: the source code matching this production is extended code and

Deleted: BoundNames

Deleted: i

Deleted: the source code matching this production is extended code and

Deleted: *FormalParameterList* : *FormalsList*¶

<#>It is a Syntax Error if *FormalParameterList* Contains *YieldExpression*.¶

<#>It is a Syntax Error if BoundNames of *FormalsList* contains any duplicate elements and either *FormalsList* Contains *BindingPattern* or *FormalsList* Contains *Initialiser*.

<#>It is a Syntax Error if BoundNames of *FormalsList* contains either "eval" or "arguments" and either *FormalsList* Contains *BindingPattern* or *FormalsList* Contains *Initialiser*.

FormalParameterList : *FormalsList* , *FunctionRestParameter*

<#>It is a Syntax Error if BoundNames of *FormalsList* contains any duplicate elements.

<#>It is a Syntax Error if BoundNames of *FormalsList* contains the any element String Value of the BoundName of *IdentifierFunctionRestParameter*.

FormalsList : *FormalsList* , *FormalParameter* ¶

<#>It is a Syntax Error if the source code matching this production is strict code and BoundNames of *FormalsList* contains any element which is also contained in BoundNames of *FormalParameter*.

FunctionRestParameter : ... *BindingIdentifier* ¶

<#>It is a Syntax Error if the String Value of the sole element of the BoundNames of *BindingIdentifier* is eval arguments.

Deleted: <#>It is a Syntax Error if the source code parsed with this production is not extended code.¶

<#>It is a Syntax Error if *Identifier* is "eval"¶

Deleted: *FormalParameterList* : *FunctionRestParameter*

<#>Return the BoundNames of *FunctionRestParameter*.

Deleted: *FormalParameterList* : ... *BindingIdentifier* ¶

<#>Return the BoundNames String Value of *BindingIdentifier*.

With parameter symbol.

FunctionDeclaration : function BindingIdentifier (FormalParameterList) { FunctionBody }

1. Return **false**.

FunctionExpression : function BindingIdentifier_{opt} (FormalParameterList) { FunctionBody }

1. Return **false**.

NOTE Static semantic rules that depend upon substructure generally do not look into function definitions.

Static Semantics: ExpectedArgumentCount

FormalParameterList :

[empty]
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 Initialiser. 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 HasInitialiser of FormalParameter is **false** return 0
2. Return 1.

FormalsList : FormalsList , FormalParameter

1. Let *count* be the ExpectedArgumentCount of *FormalsList*.
2. If HasInitialiser of *FormalsList* is **true** or HasInitialiser of FormalParameter is **true**, then return *count*.
3. Return *count*+1.

Static Semantics: HasInitialiser

FormalsList : FormalsList , FormalParameter

1. If HasInitialiser of *FormalsList* is **true**, then return **true**.
2. Return HasInitialiser of FormalParameter.

Static Semantics: IsConstantDeclaration

FunctionDeclaration : function BindingIdentifier (FormalParameterList) { FunctionBody }

1. Return **false**.

Static Semantics: IsSimpleParameterList

FormalParameterList : [empty]

1. Return **true**.

Deleted: ¶

Deleted: *FormalsList*

Deleted: are

Deleted: *FormalsList* : *FormalParameter* ¶
<#>Return HasInitialiser of FormalParameter ¶

Deleted: *FormalParameter* : *BindingElement* ¶
<#>Return HasInitialiser of BindingElement ¶

FormalParameterList : FunctionRestParameter

1. Return **false**.

FormalParameterList : FormalsList , FunctionRestParameter

1. Return **false**.

FormalsList : FormalsList , FormalParameter

1. If IsSimpleParameterList of *FormalsList* is **false**, return **false**.
 2. Return IsSimpleParameterList of *FormalParameter*.

FormalParameter : BindingElement

1. If HasInitialiser of *BindingElement* is **true**, return **false**.
 2. If *FormalParameter* Contains *BindingPattern* is **true**, return **false**.
 3. Return **true**.

Static Semantics: IsStrict

FunctionBody : StatementList_{opt}

1. If this *FunctionBody* is contained in strict code or if *StatementList* is strict code, then return **true**.
 Otherwise, return **false**.

Deleted:

Comment [AWB10131]: Need a better definition

Deleted: ¶

Static Semantics: LexicallyDeclaredNames

FunctionDeclaration : function BindingIdentifier (FormalParameterList) { FunctionBody }

1. Return the BoundNames of *BindingIdentifier*.

FunctionBody : [empty]

1. Return an empty List.

FunctionBody : StatementList

1. Return TopLevelLexicallyDeclaredNames of *StatementList*.

Static Semantics: VarDeclaredNames

FunctionDeclaration : function BindingIdentifier (FormalParameterList) { FunctionBody }

1. Return an empty List.

FunctionBody : [empty]

1. Return an empty List.

FunctionBody : StatementList

1. Return TopLevelVarDeclaredNames of *StatementList*.

Deleted: *FunctionBody : StatementList* ¶

<#>Return the LexicallyDeclaredNames of *StatementList*. ¶

Runtime Semantics

Runtime Semantics: Binding Initialisation

With parameters *value* and *environment*

Deleted: *FunctionBody : StatementList* ¶
 Return the VarDeclaredNames of *StatementList*. ¶

Deleted: Initialization

Deleted: environment

Deleted: and optional parameter *index*

NOTE When **undefined** is passed for *environment* it indicates that a PutValue operation should be used to assign the initialisation 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.

FormalParameterList : [empty]

1. Return NormalCompletion(empty).

FormalParameterList : *FunctionRestParameter*

1. Return the result of performing Indexed Binding Initialisation for *FunctionRestParameter* using *value*, 0, and *environment* as the arguments.

FormalParameterList : *FormalsList*

1. Return the result of performing Indexed Binding Initialisation for *FormalsList* using *value*, 0, and *environment* as the arguments.

FormalParameterList : *FormalsList* , *FunctionRestParameter*

1. Let *restIndex* be the result of performing Indexed Binding Initialisation for *FormalsList* using *value*, 0, and *environment* as the arguments.
2. ReturnIfAbrupt(*restIndex*).
3. Return the result of performing Indexed Binding Initialisation for *FunctionRestParameter* using *value*, *restIndex*, and *environment* as the arguments.

Runtime Semantics: Indexed Binding Initialisation

With parameters *array*, *nextIndex*, and *environment*.

FormalsList : *FormalParameter*

1. Let *status* be the result of performing Indexed Binding Initialisation for *FormalParameter* using *array*, *nextIndex*, and *environment* as the arguments.
2. ReturnIfAbrupt(*status*).
3. Return *nextIndex* + 1.

FormalsList : *FormalsList* , *FormalParameter*

1. Let *lastIndex* be the result of performing Indexed Binding Initialisation for *FormalsList* using *array*, *nextIndex*, and *environment* as the arguments.
2. ReturnIfAbrupt(*lastIndex*).
3. Let *status* be the result of performing Indexed Binding Initialisation for *FormalParameter* using *array*, *lastIndex*, and *environment* as the arguments.
4. ReturnIfAbrupt(*status*).
5. Return *lastIndex* + 1.

FunctionRestParameter : . . . *BindingIdentifier*

1. Assert: *array* is a well formed arguments object and hence it has a valid integer valued "length" property.
2. Let *status* be the result of Get(*array*, "length").
3. Let *argumentsLength* be *status*.[[value]].
4. Let *A* be the result of the abstract operation *ArrayCreate* with argument 0.
5. Let *n*=0.
6. Repeat, while *nextIndex* < *argumentsLength*
 - a. Let *P* be *ToString*(*nextIndex*).
 - b. Assert: *array* is a well formed arguments object, hence it must have a property *P*.
 - c. Let *v* be the result of Get(*array*, *P*).

Deleted: initialization

Deleted: the

Deleted: Perform...return the result of performing

Deleted: *lenValue*,

Deleted: .||
Return.

Deleted: <#>Asset: *value* is a new created arguments object and hence it has a valid integer valued "length" property.¶
<#>Let *lenValue* be the result of calling the [[Get]] internal method of *value* with argument "length".

Deleted: Perform ...ndexed Binding Initializati

Deleted: *lenValue*,

Deleted: <#>Return.¶

Deleted: Initialization

Deleted: *lenValue*,

Deleted: Perform ...ndexed Binding Initializati

Deleted: *lenValue*,

Deleted: <#>Return.¶

Deleted: *arrayLength*,

Deleted: Perform ...inding Initializati

Deleted: *value*

Deleted: *env*, and

Deleted: *i*

Deleted: *i*

Deleted: Initialization

Deleted: *value*...*array*, *lenValue*,

Deleted: Perform...et *status* be the result of

Deleted: *value*...*array*, *lenValue*,

Deleted: *argumentsLength*

Deleted: calling the [[...et]] internal method of

Deleted: *value*

Deleted: with argument

Deleted: *argumentsLength*

Deleted: ion

Deleted: (15.4)

Deleted: a new array object created as if by the expression **new Array()** where **Array** is the standard built-in constructor with that name

Deleted: *arrayLength*

Deleted: calling the [[...et()]] internal method of

- d. Call the `[[DefineOwnProperty]]` internal method of *A* with arguments `ToString(n)` and `PropertyDescriptor` `{[[Value]]: v, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
- e. Let $n = n + 1$.
- f. Let $nextIndex = nextIndex + 1$.
7. Return the result of performing `BindingInitialisation` for `BindingIdentifier` using *A* and *environment* as arguments.

Runtime Semantics: InstantiateFunctionObject

With parameter *scope*.

FunctionDeclaration : `function BindingIdentifier (FormalParameterList) { FunctionBody }`

1. If the `FunctionDeclaration` is contained in strict code or if its `FunctionBody` is strict code, then let `strict` be `true`. Otherwise let `strict` be `false`.
2. Let *F* be the result of performing the `FunctionCreate` abstract operation with arguments `NormalFormalParameterList, FunctionBody, scope, and strict`.
3. Perform the abstract operation `MakeConstructor` with argument *F*.
4. Return *F*.

Runtime Semantics: Evaluation

FunctionDeclaration : `function BindingIdentifier (FormalParameterList) { FunctionBody }`

1. Return `NormalCompletion(empty)`.

FunctionExpression : `function (FormalParameterList) { FunctionBody }`

1. If the `FunctionExpression` is contained in strict code or if its `FunctionBody` is strict code, then let `strict` be `true`. Otherwise let `strict` be `false`.
2. Let *scope* be the `LexicalEnvironment` of the running execution context.
3. Let *closure* be the result of performing the `FunctionCreate` abstract operation with arguments `NormalFormalParameterList, FunctionBody, scope, and strict`.
4. Perform the abstract operation `MakeConstructor` with argument *closure*.
5. Return *closure*.

FunctionExpression : `function BindingIdentifier (FormalParameterList) { FunctionBody }`

1. If the `FunctionExpression` is contained in strict code or if its `FunctionBody` is strict code, then let `strict` be `true`. Otherwise let `strict` be `false`.
2. Let *funcEnv* be the result of calling `NewDeclarativeEnvironment` passing the running execution context's `LexicalEnvironment` as the argument.
3. Let *envRec* be *funcEnv*'s environment record.
4. Let *name* be `StringValue` of `BindingIdentifier`.
5. Call the `CreateImmutableBinding` concrete method of *envRec* passing *name* as the argument.
6. Let *closure* be the result of performing the `FunctionCreate` abstract operation with arguments `NormalFormalParameterList, FunctionBody, funcEnv, and strict`.
7. Perform the abstract operation `MakeConstructor` with argument *closure*.
8. Call the `InitializeBinding` concrete method of *envRec* passing *name* and *closure* as the arguments.
9. Return `NormalCompletion(closure)`.

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.

FunctionBody : `StatementListopt`

Deleted: ,
Deleted: , and false
Deleted: Perform
Deleted: Initialization
Deleted: <code>FormalParameter : BindingElement</code> ¶ ¶Return the result of performing <code>PerformIndexedBindInitialization</code> for <code>BindingElement</code> using <code>array, arrayLength, nextIndex, and environment</code> as the arguments.
Deleted: Instantiate Function Declaration
Deleted: ¶Let <code>scope</code> be the <code>LexicalEnvironment</code> of the running current execution context. ¶
Deleted: ing
Deleted: The production
Deleted: opt
Deleted: . is instantiated as follows during Declaration Binding instantiation (10.5):
Deleted: (normal, empty, empty).
Deleted: Return the result of creating a new <code>Function</code> object as specified in 13.2 with parameters specified by <code>FormalParameterList_{opt}</code> and body specified by <code>FunctionBody</code> . Pass in the <code>VariableEnvironment</code> of the running execution context as the <code>Scope</code> . Pass in <code>true</code> as the <code>Strict</code> flag if the <code>FunctionDeclaration</code> is contained in strict code or if its <code>FunctionBody</code> is strict code.
Deleted: The production
Deleted: opt
Deleted: . is evaluated as follows:
Deleted: current
Deleted: ing
Deleted: the result of creating a new <code>Function</code> object as specified in 13.2 with parameters specified by <code>FormalParameterList_{opt}</code> and body specified by <code>FunctionBody</code> . Pass in the <code>LexicalEnvironment</code> of the running execution context as the <code>Scope</code> . Pass in <code>true</code> as the <code>Strict</code> flag if the <code>FunctionDeclaration</code> is contained in strict code or if its <code>FunctionBody</code> is strict code.
Deleted: opt
Deleted: running
Deleted: current
Deleted:
Deleted: the String value of <code>BindingIdentifier</code>
Deleted: ¶Let <i>closure</i> be the result of creating a new
Deleted: ing
Deleted: Immutable
Deleted: the String value of <code>Identifier</code>
Deleted: Value
Deleted: The production
Deleted: Source
Deleted: Elements
Deleted: is evaluated as follows:

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) of its *StatementList* contains a Use Strict Directive or if any of the conditions in 10.1.1 apply. If the code of this *FunctionBody* is strict mode code, *StatementList* is evaluated in the following steps as strict mode code. Otherwise, *StatementList* is evaluated in the following steps as non-strict mode code.
2. If *StatementList* is not present, then return NormalCompletion(***undefined***).
3. Let *result* be the result of evaluating *StatementList*.
4. If *result*.[[type]] is return then return NormalCompletion(*result*.[[value]])
5. ReturnIfAbrupt(*result*).
6. Return NormalCompletion(***undefined***).

13.2 Arrow Function Definitions

Syntax

ArrowFunction :
ArrowParameters => *ConciseBody*

ArrowParameters :
BindingIdentifier
CoverParenthesizedExpressionAndArrowParameterList

ConciseBody :
_[lookahead $\notin \{ \{ \} \}$] *AssignmentExpression*
_{ *FunctionBody* _}

Supplemental Syntax

When processing the production *ArrowParameters* : *CoverParenthesizedExpressionAndArrowParameterList* the following grammar is used to refine the interpretation of *CoverParenthesizedExpressionAndArrowParameterList*.

ArrowFormalParameterList :
₍ *FormalParameterList* ₎

Static Semantics

Static Semantics: Early Errors

ArrowFunction : *ArrowParameters* => *ConciseBody*

- It is a Syntax Error if *IsSimpleParameterList* of *ArrowParameters* is **true** and any element of the *BoundNames* of *ArrowParameters* also occurs in the *VarDeclaredNames* of *ConciseBody*.
- It is a Syntax Error if *IsSimpleParameterList* of *ArrowParameters* is **false** and *BoundNames* of *ArrowParameters* contains any duplicate elements.
- It is a Syntax Error if *IsSimpleParameterList* of *ArrowParameters* is **false** and *BoundNames* of *ArrowParameters* contains either "eval" or "arguments".
- It is a Syntax Error if the source code matching this production is strict code and *BoundNames* of *ArrowParameters* contains any duplicate elements.
- It is a Syntax Error if any element of the *BoundNames* of *ArrowParameters* also occurs in the *LexicallyDeclaredNames* of *ConciseBody*.
- It is a Syntax Error if *ConciseBody* Contains *YieldExpression*.

ArrowParameters : *BindingIdentifier*

- It is a Syntax Error if the *StringValue* of the sole element of the *BoundNames* of *BindingIdentifier* is **eval** or **arguments**.

ArrowParameters : *CoverParenthesizedExpressionAndArrowParameterList*

Deleted: part of a *FunctionDeclaration* or *FunctionExpression* that is
Deleted: *SourceElements*
Deleted: *SourceElements*
Deleted: *SourceElements*
Deleted: *Source*
Deleted: *Elements*
Deleted: return the
Deleted: *SourceElements*
Deleted: *Else r*
Deleted: normal,
Deleted: , empty

Deleted: (*ArrowFormalParameterList*)
Deleted: *ArrowFormalParameterList* :
_[empty]
FunctionRestParameter .
CoverFormalsList
CoverFormalsList , *FunctionRestParameter* |

Deleted: *CoverFormalsList* :
_{||}
Expression ||
Supplemental Syntax ||
When processing the production
CoverFormalsList : *Expression* the *FormalsList*
production is used to further restrict the
source code that matches *Expression*. ||
ArrowFormalParameterList :
_{||}
FormalParameterList ||
Deleted: *ConciseBody*
Deleted: *FormalParameterList*

Deleted: <**#**> It is a Syntax Error if any
element of the LexicallyDeclaredNames of
ConciseBody
ConciseBody also occurs in the
VarDeclaredNames of *ConciseBody*
ConciseBody

Deleted: *ConciseBody*

Deleted: *ConciseBody*

Deleted:

Deleted: *ArrowFormalParameterList* :
CoverFormalsList , *FunctionRestParameter* ||
<**#**> It is a Syntax Error if *BoundNames* of
CoverFormalsList contains any element which
also contained in *BoundNames* of
FunctionRestParameter. ||
Deleted: *CoverFormalsList*
Deleted: *Expression*

- It is a Syntax Error if the lexical token sequence matched by *CoverParenthesizedExpressionAndArrowParameterList* cannot be parsed with no tokens left over using *ArrowFormalParameterList* as the goal symbol.

Deleted: source code

Deleted: corresponding to

Deleted: Expression

Deleted: *FormalsList*

Deleted: <#>All Early Errors rules for *FormalParameterList* and its derived productions *FormalsList* also apply to the Covered *FormalsList* of *CoverParenthesizedExpressionAndArrowParameterList*.¶

Static Semantics: BoundNames

ArrowParameters : *CoverParenthesizedExpressionAndArrowParameterList*

- Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList*.
- Return the *BoundNames* of *formals*.

Deleted: *ArrowParameters* : *BindingIdentifier*¶

<#>Return the *BoundNames* of *BindingIdentifier*.¶
ArrowParameters : (*ArrowFormalParameterList*)¶
<#>Return the *BoundNames* of *ArrowFormalParameterList*

Deleted: *ArrowFormalParameterList* : [empty]¶

<#>Return an empty List.¶

ArrowFormalParameterList : *FunctionRestParameter*¶

<#>Return the *BoundNames* of *FunctionRestParameter*.¶

ArrowFormalParameterList : *CoverFormalsList*¶

<#>Return the *BoundNames* of *CoverFormalsList*.¶

ArrowFormalParameterList : *CoverFormalsList* , *FunctionRestParameter*¶

<#>Let *names* be *BoundNames* of *CoverFormalsList*.¶
<#>Append to *names* the *BoundNames* of *FunctionRestParameter*.¶

<#>Return *names*.¶

CoverFormalsList : *Expression* ¶

<#>Return the *BoundNames* of *CoveredFormalsList* of *Expression*.¶

Deleted: *ConciseBody*

Deleted: *s*

Deleted: *s*

Deleted: NOTE Static semantic rules that depend upon substructure generally do not look into function definitions. This *Contains* is used to detect *yield* and *super* usage within an *ArrowFunction*.¶

Deleted:

Deleted: *CoverFormalsList* : *Expression*¶

Deleted: source code

Deleted: corresponding to

Deleted: Expression

Deleted: *FormalsList*

Static Semantics: Contains

With parameter *symbol*.

ArrowFunction : *ArrowParameters* => *ConciseBody*

- If *symbol* is neither *super* or *this*, then return *false*.
- If *ArrowParameters* Contains *symbol* is *true*, return *true*;
- 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*.

ArrowParameters : *CoverParenthesizedExpressionAndArrowParameterList*

- Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList*.
- Return *formals* Contains *symbol*.

Static Semantics: CoveredFormalsList

CoverParenthesizedExpressionAndArrowParameterList :

(*Expression*)
()
(. . . *Identifier*)
(*Expression* , . . . *Identifier*)

- Return the result of parsing the lexical token stream matched by *CoverParenthesizedExpressionAndArrowParameterList* using *ArrowFormalParameterList* as the goal symbol.

Deleted: *ArrowParameters* : (*ArrowFormalParameterList*)¶
<#>Return the *ExpectedArgumentCount* of *ArrowFormalParameterList*.¶

Deleted: *ArrowFormalParameterList* : [empty]

FunctionRestParameter¶

<#>Return 0.¶

ArrowFormalParameterList : ¶

CoverFormalsList

CoverFormalsList , *FunctionRestParameter*¶

Deleted: *CoveredFormalsList* of *CoverFormalsList*

Static Semantics: ExpectedArgumentCount

ArrowParameters : *BindingIdentifier*

- Return 1.

ArrowParameters : *CoverParenthesizedExpressionAndArrowParameterList*

- Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList*.
- Return the *ExpectedArgumentCount* of *formals*.

Static Semantics: IsSimpleParameterList

ArrowParameters : *BindingIdentifier*

- Return *true*.

ArrowParameters : *CoverParenthesizedExpressionAndArrowParameterList*

1. Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList*.
2. Return the *IsSimpleParameterList* of *formals*.

Static Semantics: LexicallyDeclaredNames

ConciseBody : [lookahead ≠ { { : } }] *AssignmentExpression*

1. Return an empty List.

Runtime Semantics

Runtime Semantics: Binding Initialisation

With parameters *value* and *environment*.

NOTE When **undefined** is passed for *environment* it indicates that a *PutValue* operation should be used to assign the initialisation 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. Return the result of performing Binding Initialisation for *BindingIdentifier* using *value* and *environment* as the arguments.

ArrowParameters : *CoverParenthesizedExpressionAndArrowParameterList*

1. Let *formals* be *CoveredFormalsList* of *CoverParenthesizedExpressionAndArrowParameterList*.
2. Return the result of performing Binding initialisation of *formals* with arguments *value* and *environment*.

Runtime Semantics: Evaluation

ArrowFunction : *ArrowParameters* => *ConciseBody*

1. Let *strict* be **true**.
2. Let *scope* be the *LexicalEnvironment* of the running execution context.
3. Let *closure* be the result of performing the *FunctionCreate* abstract operation with arguments *Arrow*, *ArrowParameters*, *ConciseBody*, *scope*, and *strict*.
4. Return *closure*.

NOTE Even though an *ArrowFunction* may contain references to **super**, the *FunctionCreate* call in step 3 is not passed the optional *homeObject* and *methodName* parameters. 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*.

ConciseBody : [lookahead ≠ { { : } }] *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 10.1.1 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. If *exprValue*.[[type]] is return then return *NormalCompletion(result, [[value]])*.
 5. *ReturnIfAbrupt(exprValue)*.
 6. Return *NormalCompletion(exprValue)*.

NOTE In the absence of extensions to this specification, the test in step 4 will never be **true**.

Deleted: *ConciseBody*

Deleted: *ConciseBody* : { *FunctionBody*
Return the *LexicallyDeclaredNames* of *FunctionBody*.
Static Semantics: VarDeclaredNames
ConciseBody : [lookahead ≠ { { : } }] *AssignmentExpression* ||
Return the *VarDeclaredNames* of *AssignmentExpression*.||
ConciseBody : { *FunctionBody* }||
Return the *VarDeclaredNames* of *FunctionBody*.||

Deleted: and optional parameter *index*

Deleted: *Indexed*

Deleted: , *lenValue*

Deleted: ,

Deleted: 0,

Deleted: *ro*

Deleted: *z*

Deleted: and optional argument *index*, if index was passed to this routine

Deleted: *ArrowParameters* : (*ArrowFormalParameterList*)||
<#>Return the result of performing Binding Initialisation for *ArrowFormalParameterList* using *value*, *environment* as the arguments. Also pass the optional argument *index* if it is present.||

Deleted: *ArrowFormalParameterList* : [empty]
<#>Return *NormalCompletion(empty)*.||
ArrowFormalParameterList : *FunctionRestParameter*||
<#>Return the result of performing Indexed Binding Initialisation for *FunctionRestParameter* using *value*, *lenValue*, 0, and *environment* as the arguments.||
ArrowFormalParameterList : *CoverFormalsList*||
<#>Return the result of performing Indexed Binding Initialisation for *CoveredCFormalsList* or *CoverFormalsList* using *value*, *lenValue*, 0, and *environment* as the arguments.||

Deleted: *ConciseBody*

Comment [AWB7132]: Confirm: concise methods are always strict code.

Deleted: *current*

Deleted: *List*

Deleted: *ConciseBody*

Deleted: *Arrow*

Deleted: *Arrow*

Comment [AWB7133]: TODO, need to resolve whether or not ArrowBodies are always strict.

Comment [AWB9134]: TODO If *exprRef* is a Reference that invokes a getter we probably

Deleted: If *exprValue* is an abrupt completion, return *exprValue*

Deleted: {[type]}: return, {[value]};

Deleted: , {[target]}: empty;

Formatted: Note

13.3 Method Definitions

Syntax

MethodDefinition :

```
PropertyName ( FormalParameterList ) { FunctionBody }
* PropertyName ( FormalParameterList ) { FunctionBody }
get PropertyName ( ) { FunctionBody }
set PropertyName ( PropertySetParameterList ) { FunctionBody }
```

PropertySetParameterList :

```
BindingIdentifier
BindingPattern
```

NOTE The single element of a PropertySetParameterList may not have a default value Initialiser because set accessor are always called with an implicitly provided argument.

Static Semantics

Static Semantics: Early Errors

MethodDefinition : PropertyName (FormalParameterList) { FunctionBody }

and

MethodDefinition : * PropertyName (FormalParameterList) { FunctionBody }

- It is a Syntax Error if IsSimpleParameterList of FormalParameterList is true and any element of the BoundNames of FormalParameterList also occurs in the VarDeclaredNames of FunctionBody.
- It is a Syntax Error if IsSimpleParameterList of FormalParameterList is false and BoundNames of FormalParameterList contains any duplicate elements.
- It is a Syntax Error if IsSimpleParameterList of FormalParameterList is false and BoundNames of FormalParameterList contains either "eval" or "arguments".
- It is a Syntax Error if the source code matching this production is strict code and BoundNames of FormalParameterList contains any duplicate elements.
- It is a Syntax Error if any element of the BoundNames of FormalParameterList also occurs in the LexicallyDeclaredNames of FunctionBody.

MethodDefinition : PropertyName (FormalParameterList) { FunctionBody }

- It is a Syntax Error if FunctionBody Contains YieldExpression.

MethodDefinition : * PropertyName (FormalParameterList) { FunctionBody }

- It is a Syntax Error if FunctionBody Contains YieldExpression is false.

MethodDefinition : get PropertyName () { FunctionBody }

- It is a Syntax Error if FunctionBody Contains YieldExpression.

MethodDefinition : set PropertyName (PropertySetParameterList) { FunctionBody }

- It is a Syntax Error if IsSimpleParameterList of PropertySetParameterList is true and any element of the BoundNames of PropertySetParameterList also occurs in the VarDeclaredNames of FunctionBody.
- It is a Syntax Error if IsSimpleParameterList of PropertySetParameterList is false and BoundNames of PropertySetParameterList contains any duplicate elements.
- It is a Syntax Error if IsSimpleParameterList of PropertySetParameterList is false and BoundNames of PropertySetParameterList contains either "eval" or "arguments".
- It is a Syntax Error if BoundNames of PropertySetParameterList contains any duplicate elements.

Deleted: ConciseBody : { FunctionBody }
Return the result of evaluating FunctionBody.
¶

Deleted: ConciseBody

Deleted: ConciseBody

Deleted: {

Deleted: ConciseBody

Deleted: FunctionBody }
Deleted:

Deleted: {

Deleted: ConciseBody

Deleted: FunctionBody }
Deleted: ed

Deleted: ConciseBody

Deleted: ConciseBody

Deleted:

Deleted: <#>It is a Syntax Error if any element of the LexicallyDeclaredNames of FormalParameterList also occurs in the VarDeclaredNames of ConciseFunctionBody.

Deleted: s

Deleted: s

Deleted: <#>It is a Syntax Error if any element of the BoundNames of FormalParameterList also occurs in the LexicallyDeclaredNames of ConciseFunctionBody.¶

Deleted: ConciseBody

Deleted:

Deleted: ConciseBody

Deleted:

Deleted: ConciseBody

Deleted:

Deleted: ConciseBody

Deleted:

Deleted: ConciseBody

Deleted: FormalParameterList

Deleted: FormalParameterList

Deleted: FormalParameterList

Deleted: FormalsParameterList

Deleted: FormalParameterList

Deleted: FormalParameterList

- It is a Syntax Error if any element of the BoundNames of PropertySetParameterList also occurs in the LexicallyDeclaredNames of FunctionBody.
- It is a Syntax Error if PropertySetParameterList Contains YieldExpression.
- It is a Syntax Error if FunctionBody Contains YieldExpression.

Deleted: ConciseBody

Deleted: ConciseBody

Deleted:

Deleted: Static Semantics: BoundNames
PropertySetParameterList : BindingIdentifier ¶
 <#>It is a Syntax Error if BoundNames of BindingPattern contains any duplicate elements.
Deleted: Static Semantics: BoundNames
PropertySetParameterList : BindingIdentifier ¶
 <#>Return BoundNames of BindingIdentifier.¶
PropertySetParameterList : BindingPattern ¶
 <#>Return BoundNames of BindingPattern.¶

Static Semantics: ExpectedArgumentCount

PropertySetParameterList : BindingIdentifier

1. Return 1.

PropertySetParameterList : BindingPattern

1. Return 1.

Static Semantics: IsSimpleParameterList

PropertySetParameterList : BindingIdentifier

1. Return true.

PropertySetParameterList : BindingPattern

1. Return false.

Static Semantics: PropName

MethodDefinition :

```

PropertyName (FormalParameterList) { FunctionBody }
* PropertyName (FormalParameterList) { FunctionBody }
get PropertyName () { FunctionBody }
set PropertyName (PropertySetParameterList) { FunctionBody }
```

1. Return PropName of PropertyName.

Deleted: MethodDefinition : PropertyName (FormalParameterList) ConciseBody ¶

Deleted: MethodDefinition : * PropertyName (FormalParameterList) ConciseBody ¶
 <#>Return PropName of PropertyName.¶
MethodDefinition : get PropertyName () ConciseBody ¶
 <#>Return PropName of PropertyName.¶

Deleted: MethodDefinition : set PropertyName (PropertySetParameterList) ConciseBody ¶
 <#>Return PropName of PropertyName.¶

Deleted:
get PropertyName () { FunctionBody }
set PropertyName (PropertySetParameterList) { FunctionBody }

Static Semantics: ReferencesSuper

MethodDefinition :

```

PropertyName (FormalParameterList) { FunctionBody }
* PropertyName (FormalParameterList) { FunctionBody }
```

1. If FormalParameterList Contains super is true, then return true.
2. Return FunctionBody Contains super.

MethodDefinition : get PropertyName () { FunctionBody }

1. Return FunctionBody Contains super.

MethodDefinition : set PropertyName (PropertySetParameterList) { FunctionBody }

1. If PropertySetParameterList Contains super is true, then return true.
2. Return FunctionBody Contains super.

Static Semantics: SpecialMethod

MethodDefinition : PropertyName (FormalParameterList) { FunctionBody }

1. Return false.

MethodDefinition :

```
* PropertyName ( FormalParameterList ) { FunctionBody }
get PropertyName ( ) { FunctionBody }
set PropertyName ( PropertySetParameterList ) { FunctionBody }
```

1. Return **true**.

Runtime Semantics

Runtime Semantics: Property Definition Evaluation

With parameter object.

MethodDefinition : PropertyName (FormalParameterList) { FunctionBody }

1. Let propName be PropName of PropertyName.
2. Let strict be IsStrict of FunctionBody.
3. Let scope be the running execution context's LexicalEnvironment.
4. If ReferencesSuper of MethodDefinition is **true**, then
 - a. Let closure be the result of performing the FunctionCreate abstract operation with arguments Method, FormalParameterList, FunctionBody, scope, and strict and with object as the homeObject optional argument and propName as the methodName optional argument.
5. Else
 - a. Let closure be the result of performing the FunctionCreate abstract operation with arguments Method, FormalParameterList, FunctionBody, scope, and strict.
6. Let desc be the Property Descriptor{[[Value]]: closure, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}.
7. Let status be the result of DefinePropertyOrThrow(object, propName, desc).
8. ReturnIfAbrupt(status).
9. NormalCompletion(closure).

MethodDefinition : * PropertyName (FormalParameterList) { FunctionBody }

1. Let propName be PropName of PropertyName.
2. Let strict be IsStrict of FunctionBody.
3. Let scope be the running execution context's LexicalEnvironment.
4. If ReferencesSuper of MethodDefinition is **true**, then
 - a. Let closure be the result of performing the FunctionCreate abstract operation with arguments Method, FormalParameterList, FunctionBody, scope, and strict and with object as the homeObject optional argument and propName as the methodName optional argument.
5. Else
 - a. Let closure be the result of performing the FunctionCreate abstract operation with arguments Method, FormalParameterList, FunctionBody, scope, and strict.
6. Let desc be the Property Descriptor{[[Value]]: closure, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}.
7. Let status be the result of DefinePropertyOrThrow(object, propName, desc).
8. ReturnIfAbrupt(status).
9. Return NormalCompletion(closure).

MethodDefinition : get PropertyName () { FunctionBody }

1. Let propName be PropName of PropertyName.
2. Let strict be IsStrict of FunctionBody.
3. Let scope be the running execution context's LexicalEnvironment.
4. Let formalParameterList be the production FormalParameterList : [empty].
5. If ReferencesSuper of MethodDefinition is **true**, then
 - a. Let closure be the result of performing the FunctionCreate abstract operation with arguments Method, formalParameterList, FunctionBody, scope, and strict and with object as the homeObject optional argument and propName as the methodName optional argument.

Deleted: ConciseBody... FunctionBody }

Deleted: **true**

Deleted: **current**

Deleted: <#>Let needsSuperBinding be the result of FunctionBody Contains super.<!

<#>If needsSuperBinding is **false**, then let needsSuperBinding be the result of FormalParameterList Contains super.<!

Deleted: ConciseBody

Comment [AWB10135]: At its sept 2012 meeting TC39 decided that it wants methods to be enumerable.

Deleted: **true**,

Deleted: false...rue, [[Enumerable]]: false

Deleted: Return

Deleted: calling the [[...efineOwn...roperty]] internal

Deleted: ,

Deleted: and

Deleted: , and **false**

Deleted: ConciseBody... FunctionBody }

Deleted: **true**

Deleted: **current**

Comment [AWB8136]: A default value expression could reference super

Deleted: <#>Let needsSuperBinding be the result of FunctionBody Contains super.<!

<#>If needsSuperBinding is **false**, then let needsSuperBinding be the result of FormalParameterList Contains super.<!

Deleted: needsSuperBinding

Comment [AWB8137]: TODO: need to replace with creation of a generator object

Deleted: <#>Let closure be the result of performing the FunctionCreate abstract operation with arguments Method, FormalParameterList, ConciseBody, scope, and strict and with object as the homeObject optional argument and propName as the methodName optional argument.<!

Deleted: false...rue, [[Enumerable]]: false

Deleted: Return

Deleted: calling the [[...efineOwn...roperty OrThrow()]]

Deleted: ,

Deleted: and

Deleted: , and **false**

Deleted: ConciseBody... FunctionBody } { FunctionBody

Deleted: If this MethodDefinition is contained in strict code or if FunctionBody ConciseBody is strict code, then let strict be **true**. Otherwise, let strict be **false**.

Deleted: **current**

Deleted: <#>Let needsSuperBinding be the result of FunctionBody Contains super.<!

6. Else
 - a. Let *closure* be the result of performing the *FunctionCreate* abstract operation with arguments *Method*, *formalParameterList*, *FunctionBody*, *scope*, and *strict*.
7. Let *desc* be the Property Descriptor *{[[Get]]: closure, [[Enumerable]]: true, [[Configurable]]: true}*
8. Let *status* be the result of calling the *[[DefineOwnProperty]]* internal method of *object* with arguments *propName* and *desc*.
9. ReturnIfAbrupt(*status*).
10. Return *NormalCompletion(closure)*.

MethodDefinition : set *PropertyName* (*PropertySetParameterList*) { *FunctionBody* }

1. Let *propName* be *PropName* of *PropertyName*.
2. Let *strict* be *IsStrict* of *FunctionBody*.
3. Let *scope* be the running execution context's *LexicalEnvironment*.
4. If *ReferencesSuper* of *MethodDefinition* is **true**, then
 - a. Let *closure* be the result of performing the *FunctionCreate* abstract operation with arguments *Method*, *PropertySetParameterList*, *FunctionBody*, *scope*, and *strict* and with *object* as the *homeObject* optional argument and *propName* as the *methodName* optional argument.
5. Else
 - a. Let *closure* be the result of performing the *FunctionCreate* abstract operation with arguments *Method*, *PropertySetParameterList*, *FunctionBody*, *scope*, and *strict*.
6. Let *desc* be the Property Descriptor *{[[Set]]: closure, [[Enumerable]]: true, [[Configurable]]: true}*
7. Let *status* be the result of *DefinePropertyOrThrow*(*object*, *propName*, *desc*).
8. ReturnIfAbrupt(*status*).
9. Return *NormalCompletion(closure)*.

13.4 Generator Definitions

Syntax

GeneratorDeclaration :
function * BindingIdentifier (FormalParameterList) { FunctionBody }

GeneratorExpression :
function * BindingIdentifier_{opt} (FormalParameterList) { FunctionBody }

YieldExpression :
yield YieldDelegator_{opt} [Lexical goal InputElementRegExp] AssignmentExpression

YieldDelegator :
*
—

Static Semantics

Static Semantics: Early Errors

GeneratorDeclaration : function * BindingIdentifier (FormalParameterList) { FunctionBody }

and

GeneratorExpression : function * BindingIdentifier_{opt} (FormalParameterList) { FunctionBody }

- It is a Syntax Error if any element of the *BoundNames* of *FormalParameterList* also occurs in the *LexicallyDeclaredNames* of *FunctionBody*.
- It is a Syntax Error if *FunctionBody* Contains *YieldExpression* is **false**.

YieldExpression : yield YieldDelegator_{opt} AssignmentExpression

- It is a Syntax Error if *AssignmentExpression* Contains *YieldExpression*.

Static Semantics: BoundNames

Deleted: <#>Let *closure* be the result of performing the *FunctionCreate* abstract operation with arguments *Method*, *formalParameterList*, *ConciseBody*, *scope*, and *strict* and with *object* as *homeObject* optional argument and *propName* as *methodName* optional argument.
Deleted: <#>TODO: Make closure a construct for E5S compat¶

Deleted: Return

Deleted:,

Deleted:, and *false*

Deleted: *o*

Deleted: *ConciseBody*

Deleted: { *FunctionBody* }

Deleted: If this *MethodDefinition* is contained in strict code or if *FunctionBody ConciseBody* is strict code, then let *strict* be **true**. Otherwise, let *strict* be **false**.

Deleted: current

Deleted: <#>Let *needsSuperBinding* be the result of *FunctionBody Contains super*.¶

<#>If *needsSuperBinding* is **false**, then let *needsSuperBinding* be the result of *PropertySetParameterList cContains super*.¶

Deleted: *needsSuperBinding*

Deleted: *o*

Deleted: *o*

Deleted: <#>Let *closure* be the result of performing the *FunctionCreate* abstract operation with arguments *Method*, *PropertySetParameterList*, *ConciseBody*, *scope*, and *strict* and with *object* as the *homeObject* optional argument and *propName* as the *methodName* optional argument.
Deleted: <#>TODO: Make closure a construct for E5S compat¶

Deleted: Return

Deleted: calling the [[

Deleted: Own

Deleted:]] internal method of

Deleted: with arguments

Deleted: ,

Deleted: and

Deleted:, and *false*

Deleted: NOTE The strictness and proper attributes for *set* and *get MethodDefinition* productions differ from the other *MethodDefinition* productions in order to

Deleted: *f*

Comment [AWB10138]: This actually does

Deleted: *Function*

Deleted: *Function*

Deleted:)

Deleted: any

GeneratorDeclaration : **function** * BindingIdentifier (FormalParameterList) { FunctionBody }

1. Return the BoundNames of *BindingIdentifier*.

Static Semantics: Contains

With parameter *symbol*.

GeneratorDeclaration : **function** * BindingIdentifier (FormalParameterList) { FunctionBody }

1. Return **false**.

Deleted: *FunctionDeclaration*

GeneratorExpression : **function** * BindingIdentifier_{opt} (FormalParameterList) { FunctionBody }

1. Return **false**.

Deleted: *Function*

NOTE Static semantic rules that depend upon substructure generally do not look into function definitions.

Static Semantics: IsConstantDeclaration

GeneratorDeclaration : **function** * BindingIdentifier (FormalParameterList) { FunctionBody }

1. Return **false**.

Static Semantics: LexicallyDeclaredNames

GeneratorDeclaration : **function** * BindingIdentifier (FormalParameterList) { FunctionBody }

1. Return the BoundNames of *BindingIdentifier*.

Static Semantics: VarDeclaredNames

GeneratorDeclaration : **function** * BindingIdentifier (FormalParameterList) { FunctionBody }

1. Return an empty List.

Runtime Semantics

13.5 Class Definitions

Syntax

ClassDeclaration :
 class *BindingIdentifier* *ClassTail*

ClassExpression :
 class *BindingIdentifier_{opt}* *ClassTail*

ClassTail :
 ClassHeritage_{opt} { *ClassBody_{opt}* }

ClassHeritage :
 extends *AssignmentExpression*

ClassBody :
 ClassElementList

ClassElementList :

ClassElement
ClassElementList ClassElement

ClassElement :

MethodDefinition
static MethodDefinition
:

NOTE A ClassBody is always strict code.

Static Semantics

Static Semantics: Early Errors

ClassDeclaration : class BindingIdentifier ClassTail
and
ClassExpression : class BindingIdentifier ClassTail

- It is a Syntax Error if BindNames of BindingIdentifier contains either "eval" or "arguments"

ClassBody : ClassElementList

- It is a Syntax Error if PrototypePropertyNameList 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.
- 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.

Deleted: {
Deleted: }
Deleted: Method

ClassElement : MethodDefinition

- It is a Syntax Error if PropName of MethodDefinition is "constructor" and SpecialMethod of MethodDefinition is true.

Deleted: ClassHeritage : extends
AssignmentExpression ¶
<#>It is a Syntax Error if AssignmentExpression Contains YieldExpression.¶

ClassElement : static MethodDefinition

- It is a Syntax Error if PropName of MethodDefinition is "prototype".

Static Semantics: BoundNames

ClassDeclaration: class BindingIdentifier ClassTail

1. Return the BoundNames of BindingIdentifier.

Static Semantics: ConstructorMethod

ClassBody : ClassElementList

1. Let list be PrototypeMethodDefinitions of ClassElementList.
2. For each MethodDefinition m in list, do
 - a. If PropName of m is "constructor", return m.
3. Return empty.

NOTE Early Error rules ensure that there is only one method definition named "constructor" and that it isn't an accessor property or generator definition.

Static Semantics: Contains

With parameter *symbol*.

ClassTail : *ClassHeritage*_{opt} { *ClassBody* }

1. If *symbol* is *ClassBody*, return **true**.
2. If *ClassHeritage* is not present, return **false**.
3. If *symbol* is *ClassHeritage*, return **true**.
4. Return the result of Contains for *ClassHeritage* with argument *symbol*.

NOTE Static semantic rules that depend upon substructure generally do not look into class bodies.

Static Semantics: IsConstantDeclaration

ClassDeclaration: **class** *BindingIdentifier* *ClassTail*

1. Return **false**.

Deleted: true

Static Semantics: IsStatic

ClassElement : *MethodDefinition*

1. Return **false**.

ClassElement : **static** *MethodDefinition*

1. Return **true**.

ClassElement : :

1. Return **false**.

Static Semantics: LexicallyDeclaredNames

ClassDeclaration: **class** *BindingIdentifier* *ClassTail*

1. Return the BoundNames of *BindingIdentifier*.

Static Semantics: PrototypeMethodDefinitions

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 *ClassElement*.

ClassElementList : *ClassElementList* *ClassElement*

1. Let *list* be PrototypeMethodDefinitions of *ClassElementList*.
2. If PropName of *ClassElement* is **empty**, return *list*.
3. If IsStatic of *ClassElement* is **true**, return *list*.
4. Append *ClassElement* to the end of *list*.
5. Return *list*.

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*.

Static Semantics: PropName

ClassElement : ;

1. Return empty.

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*.

Static Semantics: StaticMethodDefinitions

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 *ClassElement*.

ClassElementList : *ClassElementList ClassElement*

1. Let *list* be *StaticMethodDefinitions* of *ClassElementList*.
2. If *PropName* of *ClassElement* is empty, return *list*.
3. If *IsStatic* of *ClassElement* is false, return *list*.
4. Append *ClassElement* to the end of *list*.
5. Return *list*.

Static Semantics: VarDeclaredNames

ClassDeclaration: **class** *BindingIdentifier ClassTail*

1. Return an empty List.

Runtime Semantics

Runtime Semantics: ClassDefinitionEvaluation

With parameter *className*.

ClassTail : *ClassHeritage_{opt}* { *ClassBody* }

1. If *ClassHeritage_{opt}* is not present, then
 - a. Let *protoParent* be the intrinsic object %ObjectPrototype%.
 - b. Let *constructorParent* be the intrinsic object %FunctionPrototype%.
2. Else
 - a. Let *superclass* be the result of evaluating *ClassHeritage*.
 - b. ReturnIfAbrupt(*superclass*).
 - c. If *superclass* is **null**, then
 - i. Let *protoParent* be **null**.
 - ii. Let *constructorParent* be the intrinsic object %FunctionPrototype%.
 - d. Else if Type(*superclass*) is not Object, throw a **TypeError** exception.
 - e. Else if IsConstructor(*superclass*) is **false**, then throw a **TypeError** exception.
 - f. Else
 - i. Let *protoParent* be the result of Get(*superclass*, "prototype").
 - ii. ReturnIfAbrupt(*protoParent*).
 - iii. If Type(*protoParent*) is neither Object or Null, throw a **TypeError** exception.
 - iv. Let *constructorParent* be *superclass*.
3. Let *proto* be the result of the abstract operation ObjectCreate with argument *protoParent*.
4. Let *lex* be the LexicalEnvironment of the running execution context.
5. If *className* is not **undefined**, then
 - a. Let *scope* be the result of calling NewDeclarativeEnvironment passing *lex* as the argument.
 - b. Let *envRec* be *scope*'s environment record.
 - c. Call the CreateImmutableBinding concrete method of *envRec* passing *className* as the argument.
 - d. Set the running execution context's LexicalEnvironment to *scope*.
6. Let *constructor* be ConstructorMethod of *ClassBody*.
7. If *ClassHeritage_{opt}* is present and *constructor* is empty, then
 - a. Let *constructor* be the result of parsing the String "**constructor**(... *args*) {super (... *args*) ; }" using the syntactic grammar with the goal symbol *MethodDefinition*.
8. Let *strict* be **true**.
9. Let *F* be the result of performing Property Definition Evaluation for *constructor* with argument *proto*.
10. Perform the abstract operation MakeConstructor with argument *F* and **false** as the optional *writablePrototype* argument and *proto* as the optional *prototype* argument.
11. Let *desc* be the Property Descriptor {[[Enumerable]]: **false**, [[Writable]]: **true**, [[Configurable]]: **true**}.
12. Call the [[DefineOwnProperty]] internal method of *proto* with arguments "**constructor**" and *desc*.
13. Let *protoMethods* be PrototypeMethodDefinitions of *ClassBody*.
14. For each *MethodDefinition m* in order from *protoMethods*
 - a. Perform Property Definition Evaluation for *m* with argument *proto*.
15. Let *staticMethods* be StaticMethodDefinitions of *ClassBody*.
16. For each *MethodDefinition s* in order from *staticMethods*
 - a. Perform Property Definition Evaluation for *s* with argument *F*.
17. Set the running execution context's LexicalEnvironment to *lex*.
18. Return *F*.

Runtime Semantics: Evaluation

ClassDeclaration: **class** *BindingIdentifier* *ClassTail*

1. Let *value* be the result of ClassDefinitionEvaluation of *ClassTail* with argument **undefined**.
2. ReturnIfAbrupt(*value*).
3. Let *env* be the running execution context's LexicalEnvironment.
4. Let *status* be the result of performing Binding Initialisation for *BindingIdentifier* passing *value* and *env* as the arguments.

Deleted:

Deleted: does not have a [[Construct]] internal propertymethod

Deleted: ¶

Deleted: Let *protoParent* be *superclass*.

Deleted: <#>Let *constructorParent* be the intrinsic object %FunctionPrototype%.¶

Deleted: calling the [[

Deleted:]] internal method of

Deleted:

Deleted: passing

Deleted: as the argument

Deleted: *proto*

Deleted: <#>If the *ClassTail* is contained in strict code or its FunctionBody is strict code, then let *strict* be **true**. Otherwise let *strict* be **false**.¶

Deleted: .*constructor*

Comment [AWB9139]: Note that this variable currently isn't used in this algorithm

Deleted: If the *ClassTail* is contained in strict code or if *constructor* is strict code, then ¶

Deleted: Otherwise let *strict* be **false**.

Comment [AWB8140]: As it now stands, this will never be an abrupt completion

Deleted: *ing*

Deleted: *false*

Deleted: *false*

Deleted: *object*

Deleted: ,

Deleted: , and *false*.

Deleted: *m*

Deleted: *m*

Deleted: <#>Let *className* be String Value of *BindingIdentifier*.¶

Deleted: *className*

Deleted: If *value* is an abrupt completion, return *value*

5. ReturnIfAbrupt(status).
6. Return NormalCompletion(empty).

NOTE The argument to `ClassDefinitionEvaluation` controls whether or not the class that is defined with a `BindingIdentifier` has a local binding to the identifier. Only a `ClassExpression` gets a local name binding of its name. A `ClassDeclaration` never has such a binding. This maintains the parallel with `FunctionExpression` and `FunctionDeclaration`.

ClassExpression: class BindingIdentifier_{opt} ClassTail

1. If `BindingIdentifieropt` is not present, then let `className` be `undefined`.
2. Else, let `className` be `StringValue` of `BindingIdentifier`.
3. Let `value` be the result of `ClassDefinitionEvaluation` of `ClassTail` with argument `className`.
4. ReturnIfAbrupt(value).
5. Return NormalCompletion(value).

13.6 Creating Function Objects and Constructors

Runtime Semantics: FunctionCreate Abstract Operation

The abstract operation `FunctionCreate` requires the arguments: `kind` which is one of (Normal, Method, Arrow), a parameter list specified by `ParameterList`, a body specified by `Body`, a Lexical Environment specified by `Scope`, a Boolean flag `Strict`, and optionally, an object `functionPrototype`, an object `homeObject` and a string `methodName`. `FunctionCreate` performs the following steps:

1. Create a new ECMAScript object and let `F` be that object.
2. Set `F`'s essential internal methods except for `[[Get]]` and `[[GetOwnProperty]]` to the default ordinary object definitions specified in 8.3.
3. Set `F`'s essential internal methods for `[[Call]]`, `[[Get]]` and `[[GetOwnProperty]]` to the default ordinary object definitions specified in 8.3.19.
4. Add the `[[BuiltinBrand]]` internal `data` property with value `BuiltinFunction` to `F`.
5. If the `functionPrototype` argument was not provided, then
 - a. Let `functionPrototype` be the intrinsic object `%FunctionPrototype%`.
6. Set the `[[Prototype]]` internal `data` property of `F` to `functionPrototype`.
7. Set the `[[Scope]]` internal `data` property of `F` to the value of `Scope`.
8. Set the `[[FormalParameters]]` internal property of `F` to `ParameterList`.
9. Set the `[[Code]]` internal `data` property of `F` to `Body`.
10. Set the `[[Extensible]]` internal `data` property of `F` to `true`.
11. Set the `[[Realm]]` internal `data` property of `F` to the running execution context's `Realm`.
12. If the `homeObject` argument was provided, set the `[[HomeObject]]` internal `data` property of `F` to `homeObject`.
13. If the `methodName` argument was provided, set the `[[MethodName]]` internal `data` property of `F` to `methodName`.
14. Set the `[[Strict]]` internal `data` property of `F` to `Strict`.
15. If `kind` is Arrow, then set the `[[ThisMode]]` internal `data` property of `F` to lexical.
16. Else if `Strict` is true, then set the `[[ThisMode]]` internal `data` property of `F` to strict.
17. Else set the `[[ThisMode]]` internal `data` property of `F` to global.
18. Let `len` be the `ExpectedArgumentCount` of `ParameterList`.
19. Call the `[[DefineOwnProperty]]` internal method of `F` with arguments `"length"` and Property Descriptor `{[[Value]]: len, [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false}`.
20. If `Strict` is true, then
 - a. Perform the `AddRestrictedFunctionProperties` abstract operation with argument `F`.
21. Return `F`.

Runtime Semantics: MakeConstructor 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 a "constructor" whose value is `F`. This operation converts `F` into a constructor by performing the following steps:

1. Let `installNeeded` be `false`.

Deleted:
Deleted: Value
Deleted: 13.1 Strict Mode Restrictions
It is a <code>SyntaxError</code> if any <code>Identifier</code> value occurs more than once within a <code>FormalParameterList</code> of a strict mode <code>FunctionDeclaration</code> or <code>FunctionExpression</code> . It is a <code>SyntaxError</code> if the <code>Identifier</code> "eval" or the <code>Identifier</code> "arguments" occurs within a
Deleted: 2
Deleted: 1.1
Deleted: 5
Comment [AWB12141]: This probably
Deleted: A <code>Function</code> object is constructed as
Deleted: optional
Deleted: <code>Formal...parameterList</code> , a body
Deleted: and ... Boolean flag <code>Strict</code> , and
Deleted: native
Deleted: P
Deleted: P
Deleted: <#>Set all the internal methods, exce
Deleted: Set ...dd the <code>[[Class</code>
Deleted: IsFunction
Deleted: NativeBrand...uiltinBrand]] internal d
Deleted: of ...o F to "Function"
Deleted: the
Deleted: .standard built-in Function prototype
Deleted: <#>Set the <code>[[GetProperty]]</code> internal
Deleted: <#>Set the <code>[[Construct]]</code> internal
Deleted: <#>Let <code>names</code> be a List containing, in
Deleted: Formal
Deleted: names
Deleted: Function
Deleted: internaldata
Deleted: current
Deleted: number of formal parameters specified
Deleted: Formal
Deleted: .
Deleted: If no parameters are specified, let <code>len</code>
Deleted: ", ... and Property Descriptor <code>{[[Value]</code>
Deleted: kind is Normal and
Deleted: o
Deleted: r
Deleted: <#>Let <code>thrower</code> be the
Deleted: <#>Set the <code>[[Strict]]</code> internal property
Deleted:
Deleted: It

2. If the prototype argument was not provided, then
 - a. Let installNeeded be **true**.
 - b. Let prototype be the result of the abstract operation ObjectCreate with the intrinsic object %ObjectPrototype% as its argument.
3. If the writablePrototype argument was not provided, then
 - a. Let writablePrototype be **true**.
4. Set F's essential internal method [[Construct]] to the definition specified in 8.3.19.2.
5. If installNeeded, then
 - a. Call the [[DefineOwnProperty]] internal method of prototype with arguments "constructor" and Property Descriptor {[[Value]]: F, [[Writable]]: writablePrototype, [[Enumerable]]: false, [[Configurable]]: writablePrototype}.
7. Call the [[DefineOwnProperty]] internal method of F with arguments "prototype" and Property Descriptor {[[Value]]: prototype, [[Writable]]: writablePrototype, [[Enumerable]]: false, [[Configurable]]: false}.
8. Return F.

13.6.3 The [[ThrowTypeError]] Function Object

The [[ThrowTypeError]] object is a unique function object that is defined once as follows:

1. Create a new ECMAScript object and let F be that object.
2. Set all the internal methods of F as described in 8.12.
3. Add the [[BuiltinBrand]] internal data property with value BuiltinFunction to F.
4. Set the [[Prototype]] internal data property of F to the standard built-in Function prototype object as specified in 15.3.3.1.
5. Set the [[Call]] internal method of F as described in 13.6.1.
6. Set the [[Scope]] internal data property of F to the Global Environment.
7. Set the [[FormalParameters]] internal data property of F to the FormalParameterList : [empty] production.
8. Set the [[Code]] internal data property of F to a FunctionBody that unconditionally throws a TypeError exception and performs no other action.
9. Call the [[DefineOwnProperty]] internal method of F with arguments "length" and Property Descriptor {[[Value]]: 0, [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false}.
10. Call the [[SetIntegrity]] internal method of F with argument "nonextensible".
11. Let [[ThrowTypeError]] be F.

Runtime Semantics: AddRestrictedFunctionProperties Abstract Operation

The abstract operation is called with a function object F as its argument. It performs the following steps:

1. Let thrower be the [[ThrowTypeError]] function Object defined above.
2. Call the [[DefineOwnProperty]] internal method of F with arguments "caller" and PropertyDescriptor {[[Get]]: thrower, [[Set]]: thrower, [[Enumerable]]: false, [[Configurable]]: false}.
3. Call the [[DefineOwnProperty]] internal method of F with arguments "arguments" and PropertyDescriptor {[[Get]]: thrower, [[Set]]: thrower, [[Enumerable]]: false, [[Configurable]]: false}.

13.7 Tail Position Calls

The wiki proposal has a preliminary attempt at defining tail position. See http://wiki.ecmascript.org/doku.php?id=harmony:proper_tail_calls.

This material still needs to be reviewed and updated for incorporation here.

- Deleted:** ion
Deleted: (15.2)
Deleted: [...] to the definitions
Deleted: Set the [[Construct]] internal property of F as described in 13.5.2.
Deleted: <#>Set the [[HasInstance]] internal property of F as described in 15.3.5.3.
Deleted: ¶
Deleted: <#>Set the [[Home]] internal property of F to
Deleted: <#>Let proto be the result of creating a new object
Deleted: ",
Deleted: {
Deleted: true... [[Enumerable]]: false, [[Configurable]]:
Deleted: , and false.
Deleted: ",
Deleted: proto
Deleted: {
Deleted: true
Deleted: , and false
Deleted: <#>If Strict is true, then¶
Comment [AWB 3142]: May need to update section
Comment [AWB143]: Exceptions could occur during
Deleted: NOTE A prototype property is
Deleted: 13.2156.1.1 [[Call]] Internal Method¶
Deleted: 2
Deleted: 1
Deleted: 5
Deleted: .1
Deleted: native
Deleted: Set ...dd the [[Class]]
Deleted: IsFunction
Deleted: NativeBrand..uiltinBrand]] internal data property
Deleted: of ...o F to "Function"
Deleted: property
Deleted: 2
Deleted: an empty List
Deleted: ", ... and Property Descriptor {[[Value]]: 0,
Deleted: Set
Deleted: PreventExtensions
Deleted: Extensible... internal property ...ethod of F with
Deleted: ion
Deleted: <#>Let [[ThrowTypeError]] be F.¶
Deleted: ... and PropertyDescriptor {[[Get]]: thrower,
Deleted: ... and PropertyDescriptor {[[Get]]: thrower,
Comment [AWB9144]: TODO: Need to define tail

14 Scripts and Modules

14.1 Script

Syntax

Script :

ScriptBody_{opt}

ScriptBody :

OuterStatementList

OuterStatementList :

OuterItem

OuterStatementList OuterItem

OuterItem :

ModuleDeclaration

ImportDeclaration

StatementListItem

Static Semantics

Static Semantics: Early Errors

ScriptBody : OuterStatementList

- It is a Syntax Error if the LexicallyDeclaredNames of OuterStatementList contains any duplicate entries.
- It is a Syntax Error if any element of the LexicallyDeclaredNames of OuterStatementList also occurs in the VarDeclaredNames of OuterStatementList.
- It is a Syntax Error if OuterStatementList Contains ReturnStatement.
- It is a Syntax Error if OuterStatementList Contains super.
- It is a Syntax Error if OuterStatementList Contains YieldExpression.

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.

Static Semantics: IsStrict

ScriptBody : OuterStatementList

1. If this ScriptBody is contained in strict code or if OuterStatementList is strict code, then return true. Otherwise, return false.

Deleted: Program

Static Semantics: LexicallyDeclaredNames

OuterStatementList : OuterStatementList OuterItem

1. Let names be LexicallyDeclaredNames of OuterStatementList.
2. Append to names the elements of the LexicallyDeclaredNames of OuterItem.
3. Return names.

Comment [AWB10145]: Need a better definition

OuterItem : ModuleDeclaration

1. Return the BoundNames of ModuleDeclaration.

Deleted: Import

OuterItem : ImportDeclaration

1. Return the BoundNames of ImportDeclaration.

OuterItem : StatementListItem

1. Return TopLevelLexicallyDeclaredNames of *StatementListItem*.

NOTE At the top level of a *Script*, function declarations are treated like *var* declarations rather than like lexical declarations.

Static Semantics: LexicallyScopedDeclarations

OuterStatementList : OuterStatementList OuterItem

1. Let *declarations* be LexicallyScopedDeclarations of *OuterStatementList*.
2. Append to *declarations* the elements of the LexicallyScopedDeclarations of *OuterItem*.
3. Return *declarations*.

OuterItem : ModuleDeclaration

1. Return a new List containing *ModuleDeclaration*.

OuterItem : ImportDeclaration

1. Return a new List containing *ImportDeclaration*.

OuterItem : StatementListItem

1. Return TopLevelLexicallyScopedDeclarations of *StatementListItem*.

Static Semantics: VarDeclaredNames

OuterStatementList : OuterStatementList OuterItem

1. Let *names* be VarDeclaredNames of *OuterStatementList*.
2. Append to *names* the elements of the VarDeclaredNames of *OuterItem*.
3. Return *names*.

OuterItem : ModuleDeclaration

2. Return an empty List.

OuterItem : ImportDeclaration

2. Return an empty List.

OuterItem : StatementListItem

2. Return TopLevelVarDeclaredNames of *StatementListItem*.

Static Semantics: VarScopedDeclarations

OuterStatementList : OuterStatementList OuterItem

1. Let *declarations* be VarScopedDeclarations of *OuterStatementList*.
2. Append to *declarations* the elements of the VarScopedDeclarations of *OuterItem*.
3. Return *declarations*.

OuterItem : ModuleDeclaration

1. Return a new empty List.

OuterItem : ImportDeclaration

1. Return a new empty List.

OuterItem : StatementListItem

1. Return the TopLevelVarScopedDeclarations of *StatementListItem*.

Runtime Semantics

Runtime Semantics: Script Evaluation

With argument *realm* and *deletableBindings*.

Script : ScriptBody_{opt}

1. The code of this *Script* is strict mode code if the Directive Prologue (14.1) of its *ScriptBody* contains a Use Strict Directive or if any of the conditions of 10.1.1 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 *status* be the result of performing Global Declaration Instantiation as described in 10.5.1 using *ScriptBody*, *globalEnv*, and *deletableBindings* as arguments.
5. ReturnIfAbrupt(*status*).
6. Let *progCxt* be a new ECMAScript code execution context.
7. Set the *progCxt*'s Realm to *realm*.
8. Set the *progCxt*'s VariableEnvironment to *globalEnv*.
9. Set the *progCxt*'s LexicalEnvironment to *globalEnv*.
10. If there is a currently running execution context, suspend it.
11. Push *progCxt* on to the execution context stack; *progCxt* is now the running execution context.
12. Let *result* be the result of evaluating *ScriptBody*.
13. Suspend *progCxt* and remove it from the execution context stack.
14. If the execution context stack is not empty, resume the context that is now on the top of the execution context stack as the running execution context. Otherwise, the execution context stack is now empty and there is no running execution context.
15. Return *result*.

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.

Runtime Semantics: Evaluation

OuterStatementList : OuterStatementList OuterItem

1. Let *sl* be the result of evaluating *OuterStatementList*.
2. ReturnIfAbrupt(*sl*).
3. Let *s* be the result of evaluating *OuterItem*.
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 See the 12.1 NOTE regarding evaluation of *StatementList : StatementListItem*.

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 *ScriptBody* or *FunctionBody* 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.

Deleted: SourceElement : Statement FunctionDeclaration

Deleted: Program

Deleted: Semantics
The production

Deleted: Program

Deleted: SourceElements_{opt}

Deleted: Program

Deleted: is evaluated as follows:

Deleted: Program

Deleted: SourceElements

Deleted: Program

Deleted: SourceElements

Deleted: ProgramBody

Deleted: SourceElements

Deleted: Program

Deleted: SourceElements

Deleted: ProgramBody

Deleted: SourceElements

Deleted: Program

Deleted: SourceElements

Deleted: Program

Deleted: SourceElements

Deleted: for global code as described in 10.4.1

Deleted: <#>Set the *progCxt*'s PreviousContext to empty.

Deleted: *realm*'s .[[Global Environment]]

Deleted: *realm*.[[globalEnv]]

Deleted: 's Global Environment

Deleted: <#>If ProgramBody is present, then<#>Perform Global Binding Instantiation as described in 10.5.x using the global code.

Deleted: SourceElements

Deleted: ProgramBody

Deleted:

Comment [AWB6146]: This is a place where we could put something about what to do with

Deleted: Exit the execution context *progCxt*.

Deleted: T

Deleted: running current execution context

Deleted: Program

Comment [AWB11147]: Not strictly true as

Deleted: The production SourceElements

Deleted: The production SourceElement :

Deleted: 1

Deleted: as the initial SourceElement

Deleted: Program

A Use Strict Directive is an *ExpressionStatement* in a Directive Prologue whose *StringLiteral* is either the exact character 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 or which does not have a meaning defined by the implementation.

Deleted: *SourceElements*

14.2 Modules

15 Standard Built-in ECMAScript Objects

There are certain built-in objects available whenever an ECMAScript program 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.

Unless specified otherwise, a built-in object has the `[[BuiltInBrand]]` internal *data* property with value `BuiltinFunction` if that built-in object has a `[[Call]]` internal *method*. Unless specified otherwise, the `[[Extensible]]` internal *data* property of a built-in object initially has the value `true`.

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 function or constructor described in this clause 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.

Unless otherwise specified in the description of a particular function, if a function or constructor described in this clause 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.

Every built-in function and every built-in constructor has the Function prototype object, which is the initial value of the expression `Function.prototype` (15.3.4), as the value of its `[[Prototype]]` internal *data* property.

Unless otherwise specified every built-in prototype object has the Object prototype object, which is the initial value of the expression `Object.prototype` (15.2.4), as the value of its `[[Prototype]]` internal *data* property, except the Object prototype object itself.

None of the built-in functions described in this clause that are not constructors shall implement the `[[Construct]]` internal method unless otherwise specified in the description of a particular function. The behavior specified in this clause for each built-in function is the specification of the `[[Call]]` internal method behavior for that function. None of the built-in functions described in this clause shall have a `prototype` property unless otherwise specified in the description of a particular function.

Deleted: the

Deleted: `[[Class]]` internal property of

Deleted: is "Function"

Deleted: `IsFunction`

Deleted: `NativeBrand`

Deleted: `NativeFunction`

Deleted: `property`

Deleted: , or "Object" if that built-in object does not have a `[[Call]]` internal property

This clause generally describes distinct behaviours for when a constructor is “called as a function” and for when it is “called as part of a **new** expression”. The “called as a function” behaviour corresponds to the invocation of the constructor’s [[Call]] internal method and the “called as part of a new expression” behaviour corresponds to the invocation of the constructor’s [[Construct]] internal method.

Deleted: ¶

Every built-in Function object, *F*, described in this clause—whether as a constructor, an ordinary function, or both—has the properties that are defined by performing the following step when the function object is created:

1. Perform the AddRestrictedFunctionProperties (13.6.3) abstract operation with argument *F*.

Deleted: operator

Every built-in Function object described in this clause—whether as a constructor, an ordinary function, or both—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.

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.

In every case, the **length** property of a built-in Function object described in this clause has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

Deleted:).

Every other **data** property described in this clause has the attributes { [[Writable]]: **true**, [[Enumerable]]: **false**, [[Configurable]]: **true** } unless otherwise specified.

Every accessor property described in this clause 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 function is described the get accessor is the default value, **undefined**.

Deleted:).

15.1 The Global Object

The unique **global object** is created before control enters any execution context.

Deleted: property

Unless otherwise specified, the standard built-in properties of the global object have attributes { [[Writable]]: **true**, [[Enumerable]]: **false**, [[Configurable]]: **true** }.

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.

Deleted: property

The global object does not have a [[Call]] internal method; it is not possible to invoke the global object as a function.

Deleted: property

The value of the [[Prototype]] internal data property of the global object is implementation-dependent.

Deleted: s

Deleted: and [[Class]]

Deleted: ies

Deleted: are

15.1.1 Value Properties of the Global Object

15.1.1.1 NaN

The value of **NaN** is **NaN** (see 8.5). This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

15.1.1.2 Infinity

The value of `Infinity` is $+\infty$ (see 8.5). This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

15.1.1.3 undefined

The value of `undefined` is `undefined` (see 8.1). This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

15.1.2 Function Properties of the Global Object

15.1.2.1 eval (x)

When the `eval` function is called with one argument `x`, the following steps are taken:

4. If `Type(x)` is not `String`, return `x`.
5. Let `script` be the ECMAScript code that is the result of parsing `x`, interpreted as UTF-16 encoded Unicode text as described in 8.4, for the goal symbol `Script`. If the parse fails or any early errors are detected, throw a `SyntaxError` exception (but see also clause 16).
6. If `script` Contains `ScriptBody` is `false`, return `undefined`.
7. Let `strictScript` be `IsStrict` of `script`.
8. If this is a direct call to `eval` (15.1.2.1.1), let `direct` be `true`, otherwise let `direct` be `false`.
9. 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`.
10. 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.
11. Let `evalRealm` be `ctx`'s Realm.
12. If `direct` is `false` and `strictScript` is `false`, then
 - a. Return the result of Script Evaluation for `script` with arguments `evalRealm` and `true`.
13. If `direct` is `true`, `strictScript` is `false`, `strictCaller` is `false`, and `ctx`'s LexicalEnvironment is the same as `evalRealm.[[globalEnv]]`, then
 - a. Return the result of Script Evaluation for `script` with arguments `evalRealm` and `true`.
14. If `direct` is `true`, then
 - a. If the code that made the direct call to `eval` is `function code` and `ValidInFunction` of `script` is `false`, then throw a `SyntaxError` exception.
 - b. If the code that made the direct call to `eval` is `module code` and `ValidInModule` of `script` is `false`, then throw a `SyntaxError` exception.
15. If `direct` is `true`, then
 - a. Let `lexEnv` be `ctx`'s LexicalEnvironment.
 - b. Let `varEnv` be `ctx`'s VariableEnvironment.
16. Else,
 - a. Let `lexEnv` be `evalRealm.[[globalEnv]]`.
 - b. Let `varEnv` be `evalRealm.[[globalEnv]]`.
17. If `strictScript` is `true` or if `direct` is `true` and `strictCaller` is `true`, then
 - a. Let `strictVarEnv` be the result of calling `NewDeclarativeEnvironment` passing the `lexEnv` as the argument.
 - b. Let `lexEnv` be `strictVarEnv`.
 - c. Let `varEnv` be `strictVarEnv`.
18. Let `status` be the result of performing Eval Declaration Instantiation as described in 10.5.5 with `script`, `varEnv`, and `lexEnv`.
19. `ReturnIfAbrupt(status)`.
20. Let `evalCxt` be a new ECMAScript code execution context.
21. Set the `evalCxt`'s Realm to `evalRealm`.
22. Set the `evalCxt`'s VariableEnvironment to `varEnv`.
23. Set the `evalCxt`'s LexicalEnvironment to `lexEnv`.
24. If there is a currently running execution context, suspend it.
25. Push `evalCxt` on to the execution context stack; `evalCxt` is now the running execution context.
26. Let `result` be the result of evaluating `script`.

Deleted: `prog`

Deleted: as a

Deleted: `Program`

Deleted: `k`

Deleted: `staticScript`

Deleted: `staticScript`

Comment [AWB11149]: or eval code that was direc
eval'ed by function code???

Comment [AWB11150]: TODO

Deleted: `k`

Comment [AWB11151]: or module code that was

Comment [AWB11152]: TODO

Deleted: `k`

Deleted: <#>Let `evalCxt` be the result of establishing a no

Deleted: ,

Deleted: <#>Set the `ThisBinding` to the same value as the

Deleted: `Lexical`

Deleted: `ironment`

Deleted: `to`

Deleted: the same value as the

Deleted: of the calling execution context

Deleted: Set the

Deleted: `Variable`

Deleted: toironment

Deleted: to the same value as the

Deleted: of the calling execution context

Deleted: `to`

Deleted: `to`

Deleted: `staticScript`

Deleted: the eval code is strict code

Deleted: `LexicalEnvironment`

Deleted: Set

Deleted: the

Deleted: `LexicalEnvironment`

Deleted: `to`

Deleted: Set

Deleted: the

Deleted: `VariableEnvironment`

Deleted: `to`

Deleted: `1`

Deleted: Perform

Deleted: Binding

Deleted: using the eval code

Deleted: `realm`

Deleted: the program

Deleted: `prog`

27. Suspend *evalCxt* and remove it from the execution context stack.
28. Resume the context that is now on the top of the execution context stack as the running execution context.
29. 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.

Deleted: <#>Exit the running execution context *evalCxt*, restoring the previous execution context.
 <#>If *result.type* is normal and its completion value is a value *V*, then return the value *V*.
 <#>If *result.type* is normal and its completion value is empty, then return the value **undefined**.
 Otherwise, *result.type* must be throw. Throw
Deleted: value as an exception.

15.1.2.1.1 Direct Call to Eval

A direct call to the eval function is one that is expressed as a *CallExpression* that meets the following two conditions:

The Reference that is the result of evaluating the *MemberExpression* in the *CallExpression* has an environment record as its base value and its reference name is "eval".

The result of calling the abstract operation GetValue with that Reference as the argument is the standard built-in function defined in 15.1.2.1.

15.1.2.2 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 character pairs **0x** or **0X**, in which case a radix of 16 is assumed. If *radix* is 16, the number may also optionally begin with the character pairs **0x** or **0X**.

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 character that is not a *StrWhiteSpaceChar* and all characters following that character. (In other words, remove leading white space.) If *inputString* does not contain any such characters, let *S* be the empty string.
4. Let *sign* be 1.
5. If *S* is not empty and the first character of *S* is a minus sign **-**, let *sign* be **-1**.
6. If *S* is not empty and the first character of *S* is a plus sign **+** or a minus sign **-**, then remove the first character from *S*.
7. Let *R* = *ToInt32(radix)*.
8. ReturnIfAbrupt(*R*).
9. Let *stripPrefix* be **true**.
10. If *R* \neq 0, then
 - a. If *R* $<$ 2 or *R* $>$ 36, then return **NaN**.
 - b. If *R* \neq 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 characters of *S* are either "**0x**" or "**0X**", then remove the first two characters from *S* and let *R* = 16.
13. If *S* contains any character that is not a radix-*R* digit, then let *Z* be the substring of *S* consisting of all characters before the first such character; 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 20th 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. Let *number* be the Number value for *mathInt*.
17. Return *sign* \times *number*.

Deleted:,

NOTE `parseInt` may interpret only a leading portion of *string* as an integer value; it ignores any characters that cannot be interpreted as part of the notation of an integer, and no indication is given that any such characters were ignored.

15.1.2.3 `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:

1. Let *inputString* be `ToString(string)`.
2. ReturnIfAbrupt(*string*).
3. Let *trimmedString* be a substring of *inputString* consisting of the leftmost character that is not a *StrWhiteSpaceChar* and all characters to the right of that character. (In other words, remove leading white space.) If *inputString* does not contain any such characters, let *trimmedString* be the empty string.
4. If neither *trimmedString* nor any prefix of *trimmedString* satisfies the syntax of a *StrDecimalLiteral* (see 9.3.1), return **NaN**.
5. Let *numberString* be the longest prefix of *trimmedString*, which might be *trimmedString* itself, that satisfies the syntax of a *StrDecimalLiteral*.
6. Return the Number value for the MV of *numberString*.

NOTE `parseFloat` may interpret only a leading portion of *string* as a Number value; it ignores any characters that cannot be interpreted as part of the notation of an decimal literal, and no indication is given that any such characters were ignored.

15.1.2.4 `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**.

Deleted: `ToNumber(number)`

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**.

15.1.2.5 `isFinite` (*number*)

Returns **false** if the argument coerces to **NaN**, $+\infty$, or $-\infty$, and otherwise returns **true**.

1. Let *num* be `ToNumber(number)`.
2. ReturnIfAbrupt(*num*).
3. If `ToNumber(num)` is **NaN**, $+\infty$, or $-\infty$, return **false**.
4. Otherwise, return **true**.

Deleted: *ber*

15.1.3 URI Handling Function Properties

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 15.1.3.1, 15.1.3.2, 15.1.3.3 and 15.1.3.4.

NOTE Many implementations of ECMAScript provide additional functions and methods that manipulate web pages; these functions are beyond the scope of this standard.

A URI is composed of a sequence of components separated by component separators. The general form is:

Scheme : *First* / *Second* ; *Third* ? *Fourth*

where the italicised names represent components and “:”, “/”, “;” and “?” are reserved characters used as separators. The `encodeURI` and `decodeURI` functions are intended to work with complete URIs; they assume that any reserved characters 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 characters represent text and so must be encoded so that they are not interpreted as reserved characters 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.

Runtime Semantics

When a character to be included in a URI is not listed above or is not intended to have the special meaning sometimes given to the reserved characters, that character must be encoded. The character 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".

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 characters in *string*.
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 character at position k within $string$.
 - c. If C is in $unescapedSet$, then
 - i. Let S be a String containing only the character 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 $unescapedSet$,
 - 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 character at position k within $string$.
 4. If $kChar$ is less than 0xDC00 or greater than 0xDFFF, throw a **URIError** exception.
 5. Let V be $((\text{the code unit value of } C) - 0xD800) \times 0x400 + (kChar - 0xDC00) + 0x10000$.
 - 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 position j within $Octets$.
 2. Let S be a String containing three characters "%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.

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 characters in $string$.
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 character at position k within $string$.
 - c. If C is not '%', then
 - i. Let S be the String containing only the character C .
 - d. Else C is '%',
 - i. Let $start$ be k .
 - ii. If $k + 2$ is greater than or equal to $strLen$, throw a **URIError** exception.
 - iii. If the characters at position $(k+1)$ 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 position $(k + 1)$ and $(k + 2)$.
 - v. Increment k by 2.
 - vi. If the most significant bit in B is 0, then
 1. Let C be the character with code unit value B .
 2. If C is not in $reservedSet$, then
 - a. Let S be the String containing only the character C .
 3. Else C is in $reservedSet$,
 - a. Let S be the substring of $string$ from position $start$ to position k included.
 - vii. Else the most significant bit in B is 1,

1. Let n be the smallest non-negative number 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 position 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 character at position k within *string* is not "%", throw a **URIError** exception.
 - c. If the characters at position $(k + 1)$ 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 position $(k + 1)$ 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 position 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 an **URIError** exception.
9. If $V \leq 0x10000$, then
 - a. Let C be the character with code unit value V .
 - b. If C is not in *reservedSet*, then
 - i. Let S be the String containing only the character C .
 - c. Else C is in *reservedSet*
 - i. Let S be the substring of *string* from position *start* to position k included.
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 characters with code unit values 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 31](#).

Table 31—UTF-8 Encodings

Code Unit Value	Representation	1st Octet	2nd Octet	3rd Octet	4th Octet
0x0000 – 0x007F	00000000 0zzzzzzz	0zzzzzzz			
0x0080 – 0x07FF	00000yyy yyzzzzzz	110yyyyy	10zzzzzz		
0x0800 – 0xD7FF	xxxxyyyy yyzzzzzz	1110xxxx	10yyyyyy	10zzzzzz	
0xD800 – 0xDBFF followed by 0xDC00 – 0xFFFF	110110vv vvvwwwxx followed by 110111yy yyzzzzzz	11110uuu	10uuwwww	10xxyyyy	10zzzzzz
0xDB800 – 0xDBFF not followed by 0xDC00 – 0xFFFF	causes URIerror				
0xDC00 – 0xFFFF	causes URIerror				
0xE000 – 0xFFFF	xxxxyyyy yyzzzzzz	1110xxxx	10yyyyyy	10zzzzzz	

Where

$$uuuuu = vvvv + 1$$

to account for the addition of 0x10000 as in Surrogates, section 3.7, of the Unicode Standard.

The range of code unit values 0xD800-0xDFFF 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 character U+0000. Implementations of the Decode algorithm are required to throw a **URIError** when encountering such invalid sequences.

15.1.3.1 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 character 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 character valid in *uriReserved* plus “#”.
4. Return the result of calling `Decode(uriString, reservedURISet)`

NOTE The character “#” is not decoded from escape sequences even though it is not a reserved URI character.

15.1.3.2 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 character that it represents.

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 the result of calling `Decode(componentString, reservedURIComponentSet)`

15.1.3.3 encodeURI (*uri*)

The **encodeURI** function computes a new version of a URI in which each instance of certain characters is replaced by one, two, three, or four escape sequences representing the UTF-8 encoding of the character.

When the **encodeURI** 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 character valid in *uriReserved* and *uriUnescaped* plus “#”.
4. Return the result of calling `Encode(uriString, unescapeURISet)`

NOTE The character “#” is not encoded to an escape sequence even though it is not a reserved or unescaped URI character.

15.1.3.4 encodeURIComponent (*uriComponent*)

The `encodeURIComponent` function computes a new version of a URI in which each instance of certain characters is replaced by one, two, three, or four escape sequences representing the UTF-8 encoding of the character.

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 character valid in *uriUnescaped*.
4. Return the result of calling `Encode(componentString, unescapeURIComponentSet)`

15.1.4 Constructor Properties of the Global Object

15.1.4.1 Object (...)

See 15.2.1 and 15.2.2.

15.1.4.2 Function (...)

See 15.3.1 and 15.3.2.

15.1.4.3 Array (...)

See 15.4.1 and 15.4.2.

15.1.4.4 String (...)

See 15.5.1 and 15.5.2.

15.1.4.5 Boolean (...)

See 15.6.1 and 15.6.2.

15.1.4.6 Number (...)

See 15.7.1 and 15.7.2.

15.1.4.7 Date (...)

See 15.9.2.

15.1.4.8 RegExp (...)

See 15.10.3 and 15.10.4.

15.1.4.9 Error (...)

See 15.11.1 and 15.11.2.

15.1.4.10 EvalError (...)

See 15.11.6.1.

15.1.4.11 RangeError (. . .)

See 15.11.6.2.

15.1.4.12 ReferenceError (. . .)

See 15.11.6.3.

15.1.4.13 SyntaxError (. . .)

See 15.11.6.4.

15.1.4.14 TypeError (. . .)

See 15.11.6.5.

15.1.4.15 URIError (. . .)

See 15.11.6.6.

15.1.4.16 Map (. . .)

See 15.14.3.

15.1.4.17 WeakMap (. . .)

See 15.15.3.

15.1.4.18 Set (. . .)

See 15.16.3.

15.1.5 Other Properties of the Global Object

15.1.5.1 Math

See 15.8.

15.1.5.2 JSON

See 15.12.

15.2 Object Objects

15.2.1 The Object Constructor Called as a Function

When `Object` is called as a function rather than as a constructor, it performs a type conversion.

15.2.1.1 Object ([value])

When the `Object` function is called with no arguments or with one argument `value`, the following steps are taken:

1. If `value` is `null`, `undefined` or not supplied, return the result of the abstract operation `ObjectCreate ObjectCreate with the intrinsic object %ObjectPrototype% as its argument`.
2. Return `ToObject(value)`.

Deleted: Runtime Semantics: ObjectCreate Abstract Operation¶

The abstract operation `ObjectCreate` with optional argument `proto` (an object or `null`) is used to specify the creation of new `Object` objects. It performs the following steps:¶

```
<#>If proto was not provided, let proto be the intrinsic %ObjectPrototype%.
<#>Let obj be a newly created ECMAScript object.¶
<#>Set the [[Prototype]] internal property of obj to proto.¶
<#>Set obj's common internal methods to the default definitions specified in 8.12.¶
<#>Set the [[Extensible]] internal property of obj to true.¶
<#>Return obj.¶
<#>¶
```

Deleted: create and

Deleted: ion

Deleted: a new `Object` object exactly as if the standard built-in `Object` constructor had been called with the same arguments (15.2.2.1)

15.2.2 The Object Constructor

When `Object` is called as part of a `new` expression, it is a constructor that may create an object.

15.2.2.1 `new Object ([value])`

When the `Object` constructor is called with no arguments or with one argument `value`, the following steps are taken:

1. If `value` is supplied, then
 - a. If `Type(value)` is `Object`, then return `value`.
 - b. If `Type(value)` is `String`, return `ToObject(value)`.
 - c. If `Type(value)` is `Boolean`, return `ToObject(value)`.
 - d. If `Type(value)` is `Number`, return `ToObject(value)`.
2. Assert: The argument `value` was not supplied or its type was `Null` or `Undefined`.
3. Return the result of the abstract operation `ObjectCreate` with the intrinsic object `%ObjectPrototype%` as its argument.

Deleted: ¶
If the `value` is a native ECMAScript object, do not create a new object but simply
Deleted: <#>If the `value` is a host object, then actions are taken and a result is returned in an implementation-dependent manner that may depend on the host object.¶

Deleted: <#>Let `obj` be a newly created native ECMAScript object.¶
<#>Set the `[[Prototype]]` internal property of `obj` to the standard built-in `Object` prototype object (15.2.4).¶
<#>Set the `[[Class]]` internal property of `obj` to "Object".¶
<#>Set the `[[Extensible]]` internal property of `obj` to `true`.¶
<#>Set all the internal methods of `obj` as specified in 8.12.¶

Deleted: `obj`

Deleted: `ion`

Deleted: the internal properties and

15.2.3 Properties of the Object Constructor

The value of the `[[Prototype]]` internal `data` property of the `Object` constructor is the standard built-in `Function` prototype object.

Besides the `length` property (whose value is `1`), the `Object` constructor has the following properties:

15.2.3.1 `Object.prototype`

The initial value of `Object.prototype` is the standard built-in `Object` prototype object (15.2.4).

This property has the attributes `{[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false}`.

15.2.3.2 `Object.getPrototypeOf (O)`

When the `getPrototypeOf` function is called with argument `O`, the following steps are taken:

1. If `Type(O)` is not `Object` throw a `TypeError` exception.
2. Return the result of calling the `[[GetInheritance]]` internal method of `O`.

Deleted: `value`

Deleted: the

Deleted: Prototype

Deleted: e

Deleted: property

Deleted: name

Deleted: ToString

Deleted: name

Deleted: name

Deleted: 10

15.2.3.3 `Object.getOwnPropertyDescriptor (O, P)`

When the `getOwnPropertyDescriptor` 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 the result of calling the `[[GetOwnProperty]]` internal method of `O` with argument `key`.
5. Return the result of calling `FromPropertyDescriptor(desc)` (8.2.5.4).

Deleted: `property`

Deleted: name

Deleted: `ToString`

Deleted: name

Deleted: name

Deleted: 10

15.2.3.4 `Object.getOwnPropertyNames (O)`

When the `getOwnPropertyNames` function is called, the following steps are taken:

1. If `Type(O)` is not `Object`, throw a `TypeError` exception.
2. Let `keys` be the result of calling the `[[OwnPropertyKeys]]` internal method of `O`.
3. ReturnIfAbrupt(`keys`).
4. Let `nameList` be a new empty List.
5. Let `gotAllNames` be `false`.
6. Repeat while `gotAllNames` is `false`.
 - a. Let `next` be the result of `Invoke(keys, "next")`.
 - b. If `IteratorComplete(next)` is `true`, then let `gotAllNames` be `true`.

Comment [AWB7153]: TODO: need to define

- c. Else.
 - i. If *next* is an abrupt completion, then return *next*.
 - ii. Assert *next.[[type]]* is normal.
 - iii. Let *nextKey* be *next.[[value]]*.
 - iv. If *Type(nextKey)* is String, then
 - 1. Append *nextKey* as the last element of *nameList*.
- 7. Return *CreateArrayFromList(keys)*.

15.2.3.5 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 the result of the abstract operation **ObjectCreate** with argument *O*.
3. If the argument **Properties** is present and not **undefined**, then
 - a. Return the result of the abstract operation **ObjectDefineProperties** with arguments *obj* and *Properties*.
4. Return *obj*.

15.2.3.6 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 *name* be *ToPropertyKey(P)*.
3. ReturnIfAbrupt(*name*).
4. Let *desc* be the result of calling **ToPropertyDescriptor** with *Attributes* as the argument.
5. ReturnIfAbrupt(*desc*).
6. Let *success* be the result of **DefinePropertyOrThrow(O, name, desc)**.
7. ReturnIfAbrupt(*success*).
8. Return *O*.

15.2.3.7 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*.

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 *names* be an internal list containing the *keys* of each enumerable own property of *props*.
4. Let *descriptors* be an empty internal List.
5. For each element *P* of *names* in list order,
 - a. Let *descObj* be the result of **Get(props, P)**.
 - b. ReturnIfAbrupt(*descObj*).
 - c. Let *desc* be the result of calling **ToPropertyDescriptor** with *descObj* as the argument.
 - d. ReturnIfAbrupt(*desc*).
 - e. Append the pair (a two element List) consisting of *P* and *desc* to the end of *descriptors*.
6. Let *pendingException* be **undefined**.
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. If *status* is an Abrupt Completion then

Deleted: <#> If *Type(O)* is not Object throw a **TypeError** exception.
Deleted: <#> Let *keys* be the result of calling the **[[OwnPropertyKeys]]** internal method of *O*.
Deleted: <#> ReturnIfAbrupt(*keys*).
Deleted: <#> Let *array* be the result of the abstraction operation **abstraction** operation **ArrayCreate** (15.4) with argument 0 the result of creating a new object as if by the expression **new Array** where **Array** is the standard built-in constructor with that name.
Deleted: <#> Let *n* be 0.
Deleted: <#> For each named own property *P* of *O*.
Deleted: <#> Let *name* be the String value that is the name of *P*.
Deleted: <#> Call the **[[DefineOwnProperty]]** internal method of *array* with arguments **Tostring(n)**, **PropertyDescriptor** {**[[Name]]: name, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true**}, and **false**.
Deleted: <#> Increment *n* by 1.
Deleted: <#> Return *arrayCreateArrayFromList(keys)*.
Deleted: NOTE If *O* is a String instance, the set of own properties processed in step 4 includes the implicit properties defined in 15.5.5.2 that correspond to character positions within the object's **[[PrimitiveValue]]** String.
Deleted: abstraction operation
Deleted: the result of creating a new object as if by the expression **new Object()** where **Object** is the standard built-in constructor.
Deleted: <#> Set the **[[Prototype]]** internal property of *obj* to *O*.
Deleted: add own properties to *obj* as if by calling the **Object.defineProperties** abstract operation.
Deleted: **Object.defineProperties**
Deleted: **Tostring**
Deleted: **Call**
Deleted: the **[[**
Deleted: **Own**
Deleted: **]**
Deleted: internal method of
Deleted: with arguments
Deleted: , and **true**
Deleted: **em**
Deleted: **s**
Deleted: **names**
Deleted: calling the **[[**
Deleted: **]]** internal method of
Deleted: with
Deleted: as the argument
Deleted: **Call**
Deleted: calling the **[[**
Deleted: **Own**
Deleted: **]**
Deleted: internal method of
Deleted: with arguments
Deleted: , and **true**
Deleted: **undefined**

- i. If `pendingException` is `undefined`, then set `pendingException` to `status`.
8. `ReturnIfAbrupt(pendingException)`.
9. Return `O`.

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.

NOTE An exception in defining an individual property in step 7 does not terminate the process of defining other properties. All valid property definitions are processed.

15.2.3.8 Object.seal (O)

When the `seal` function is called, the following steps are taken:

1. If `Type(O)` is not `Object` throw a `TypeError` exception.
2. Let `status` be the result of calling the `[[SetIntegrity]` internal methods of `O` with argument `"sealed"`.
3. `ReturnIfAbrupt(status)`.
4. If `status` is `false`, throw a `TypeError` exception.
5. Return `O`.

15.2.3.9 Object.freeze (O)

When the `freeze` function is called, the following steps are taken:

1. If `Type(O)` is not `Object` throw a `TypeError` exception.
2. Let `status` be the result of calling the `[[SetIntegrity]` internal methods of `O` with argument `"frozen"`.
3. `ReturnIfAbrupt(status)`.
4. If `status` is `false`, throw a `TypeError` exception.
5. Return `O`.

15.2.3.10 Object.preventExtensions (O)

When the `preventExtensions` function is called, the following steps are taken:

1. If `Type(O)` is not `Object` throw a `TypeError` exception.
2. Let `status` be the result of calling the `[[SetIntegrity]` internal method of `O` with argument `"nonextensible"`.
3. `ReturnIfAbrupt(status)`.
4. If `status` is `false`, throw a `TypeError` exception.
5. Return `O`.

15.2.3.11 Object.isSealed (O)

When the `isSealed` function is called with argument `O`, the following steps are taken:

1. If `Type(O)` is not `Object` throw a `TypeError` exception.
2. Return the result of calling the `[[HasIntegrity]` internal methods of `O` with argument `"sealed"`.

15.2.3.12 Object.isFrozen (O)

When the `isFrozen` function is called with argument `O`, the following steps are taken:

1. If `Type(O)` is not `Object` throw a `TypeError` exception.
2. Return the result of calling the `[[HasIntegrity]` internal methods of `O` with argument `"frozen"`.

15.2.3.13 Object.isExtensible (O)

When the `isExtensible` function is called with argument `O`, the following steps are taken:

1. If `Type(O)` is not `Object` throw a `TypeError` exception.
2. Return the result of `IsExtensible(O)`.

Deleted: `status`

Formatted: Note

Deleted: <#>For each named own property name `P` of `O`,
 <#>Let `desc` be the result of calling the `[[GetOwnProperty]]` internal method of `O` with `P`.
 <#>If `desc` [[Configurable]] is `true`, set `desc` [[Configurable]] to `false`.
 Call

Deleted: `of`

Deleted: `MakeObjectSecure`

Deleted: `(`

Deleted: `,`

Deleted: `P, desc`

Deleted: `false`)

Deleted: calling the `[[DefineOwnProperty]]` internal method of `O` with `P, desc`, and `true` as arguments

Deleted: <#>Set the `[[Extensible]]` internal property of `O` to `false`.
 Deleted:

<#>For each named own property name `P` of `O`,
 <#>Let `desc` be the result of calling the `[[GetOwnProperty]]` internal method of `O` with `P`.
 <#>If `IsDataDescriptor(desc)` is `true`, then
 <#>If `desc` [[Writable]] is `true`, set `desc` [[Writable]] to `false`.
 <#>If `desc` [[Configurable]] is `true`, set `desc` [[Configurable]] to `false`.
 Deleted:

Deleted:

Deleted: calling `Call` the `[[DefineOwnProperty]]` internal method of

Deleted: `MakeObjectSecure(O with , trueP, desc, and true as arguments)`

Deleted: <#>Set the `[[Extensible]]` internal property of `O` to `false`.
Deleted: Set

Deleted: PreventExtensions

Deleted: Extensible

Deleted: property

Deleted: to `false`

Deleted: <#>For each named own property name `P` of `O`,
 <#>Let `desc` be the result of calling the `[[GetOwnProperty]]` internal method of `O` with `P`.
Deleted: `TestIfSecureObject(O, false)`

Deleted: `false`

Deleted: <#>For each named own property name `P` of `O`,
Deleted: `TestIfSecureObject(O, falsetrue)`

Deleted: calling the Boolean value of the `[[`

Deleted: Get

Deleted: `]`

Deleted: internal property method of

15.2.3.14 Object.keys (O)

When the `keys` function is called with argument O , the following steps are taken:

8. If `Type(O)` is not `Object`, throw a `TypeError` exception.
9. Let `keys` be the result of calling the `[[OwnPropertyKeys]]` internal method of O .
10. ReturnIfAbrupt(`keys`).
11. Let `nameList` be a new empty List.
12. Let `gotAllNames` be `false`.
13. Repeat while `gotAllNames` is `false`.
 - a. Let `next` be the result of `Invoke(keys, "next")`.
 - b. If `IteratorComplete(next)` is `true`, then let `gotAllNames` be `true`.
 - c. Else,
 - i. If `next` is an abrupt completion, then return `next`.
 - ii. Assert `next.[[type]]` is normal.
 - iii. Let `nextKey` be `next.[[value]]`.
 - iv. If `Type(nextKey)` is `String`, then
 1. Let `desc` be the result of calling the `[[GetOwnProperty]]` internal method of O with argument `nextKey`.
 2. ReturnIfAbrupt(`desc`).
 3. If `desc` is not `undefined` and `desc.[[Enumerable]]` is `true`, then
 - a. Append `nextKey` as the last element of `nameList`.
14. Return `CreateArrayFromList(keys)`.

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 7.

15.2.3.15 Object.getOwnPropertyKeys (O)

When the `getOwnPropertyKeys` function is called, the following steps are taken:

1. If `Type(O)` is not `Object`, throw a `TypeError` exception.
2. Let `keys` be the result of calling the `[[OwnPropertyKeys]]` internal method of O .
3. Return `keys`.

TODO :

- May need to say something about order of enumeration and post call property additions and deletions

15.2.3.16 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)`.

15.2.3.17 Object.assign (target, source)

TODO :

- Only enumerable own properties of source
- Invoke `[[Get]]` on property list derived from source, for each property in list `[[Put]]` on target
- private names are not copied
- unique names are copied
- super mechanism (rebind super)

Deleted: the
Deleted: Keys

Comment [AWB7154]: TODO: need to define

Deleted: <#>Let n be the number of own enumerable properties of O

<#>Let `array` be the result of the abstraction operation `ArrayCreate` (15.4) with argument n the result of creating a new `Object` as if by the expression `new Array()` where `Array` is the standard built-in constructor with that name.

<#>Let `index` be 0 .

<#>For each own enumerable property of O whose name String is P

<#>Let P be the key of the property.

<#>Call the `[[DefineOwnProperty]]` internal method of $array$ with arguments `ToString(index)`, the `PropertyDescriptor` `{[[Value]]: P, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`, and `false`.

<#>Increment `index` by 1 .

<#>Return `array`.

If an implementation defines a specific order of enumeration for the `for-in` statement, that same enumeration order must be used in step 5 of this algorithm.

Deleted: 15

Comment [AWB11155]: TODO need an algorithm

Because `[[Get]]/[[Put]]` are invoked we need to figure out something to say about the order in which properties are accessed.

- Returns modified "target"

Deleted: ¶

15.2.3.18 Object.mixin (target, source)

Don't have TC39 concensus on including this or its name. Hower, there appears to be strong interest both within TC39 and on es-disuss and reasonable use cases. "mixin" seems to be the favorite name from es-discuss, although concerns have been raised that it might clash with some existing libraries.

TODO :

- All non-private properties of source
- Uses [[GetOwnProperty]]/[[DefineOwnProperty]]
- private symbols are not copied
- non-symbols are copied
- super mechanism (rebind super)
- Returns modified "target"

15.2.4 Properties of the Object Prototype Object

The value of the [[Prototype]] internal data property of the Object prototype object is null, and the initial value of the [[Extensible]] internal data property is true.

15.2.4.1 Object.prototype.constructor

The initial value of Object.prototype.constructor is the standard built-in Object constructor.

15.2.4.2 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 O is an exotic Symbol object, then return "[object Symbol]".
5. If O is an exotic Array object, then let builtinTag be "Array".
6. Else, if O is an exotic String object, then let builtinTag be "String".
7. Else, if O is an exotic arguments object, then let builtinTag be "Arguments".
8. Else, if O is an ordinary function object, a built-in function object, or a bound function exotic object, then let builtinTag be "Function".
9. Else, if O has a [[Error]] internal data property, then let builtinTag be "Error".
10. Else, if O has a [[BooleanData]] internal data property, then let builtinTag be "Boolean".
11. Else, if O has a [[NumberData]] internal data property, then let builtinTag be "Number".
12. Else, if O has a [[DateValue]] internal data property, then let builtinTag be "Date".
13. Else, if O has a [[RegExpMatcher]] internal data property, then let builtinTag be "RegExp".
14. Else, if O has a [[MathTag]] internal data property, then let builtinTag be "Math".
15. Else, if O has a [[JSONTag]] internal data property, then let builtinTag be "JSON".
16. Else, let builtinTag be "Object".
17. Let hasTag be the result of HasProperty(O, @@toStringTag).

Deleted: 15.2.3.15 Object.isObject (O)¶
When the isObject function is called with argument O, the following steps are taken:
If Type(O) is Object return true.¶
Return false.¶

Deleted: , the value of the [[Class]] internal property is "Object".

Deleted: let tag be "

Comment [AWB14156]: Need to decide how to tag Error objects

Comment [AWB14157]: Need to decide how to tag the Math object

Comment [AWB14158]: Need to decide how to tag the JSON object

Deleted: <#>Else if O has a [[NativeBrandBuiltInBrand]] internal data property
let tag be the corresponding value from Table 32Table 30Table 28.¶
<#>Else ¶

Deleted: calling the [[HasProperty]] internal method of

Deleted: with argument

18. ReturnIfAbrupt(hasTag).
19. If hasTag is **false**, then let tag be builtinTag.
20. Else,
 - a. Let tag be the result of Get(O, @@toStringTag).
 - b. If tag is an abrupt completion, let tag be NormalCompletion("???").
 - c. Let tag be tag.[[value]].
 - d. If Type(tag) is not **String**, let tag be **"???"**.
 - e. If tag is any of **"Arguments"**, **"Array"**, **"Boolean"**, **"Date"**, **"Error"**, **"Function"**, **"JSON"**, **"Math"**, **"Number"**, **"RegExp"**, or **"String"** and SameAs(tag, builtinTag) is **false**, then let tag be the string value **"~"** concatenated with the current value of tag.
21. Return the **String** value that is the result of concatenating the three **Strings** **"[object ", tag, and "]"**.

NOTE Historically, this function was occasionally used to access the **string** value of the **[[Class]]** internal data property 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 the ability to use it as a reliable test for those specific kinds of built-in objects but it does not provide a reliable type testing mechanism for other kinds of built-in or program defined objects.

15.2.4.3 Object.prototype.toLocaleString ()

When the **toLocaleString** method is called, the following steps are taken:

1. Let O be the **this** value.
2. ReturnIfAbrupt(O).
3. Return the result of Invoke(O, "toString").

NOTE 1 This function is provided to give all Objects a generic **toLocaleString** interface, even though not all may use it. Currently, **Array**, **Number**, and **Date** provide their own locale-sensitive **toLocaleString** methods.

NOTE 2 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.

15.2.4.4 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.

15.2.4.5 Object.prototype.hasOwnProperty (V)

When the **hasOwnProperty** method is called with argument V, the following steps are taken:

1. Let P be 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 calling the **[[HasOwnProperty]]** internal method of O passing P as the argument.

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**.

15.2.4.6 Object.prototype.isPrototypeOf (V)

When the **isPrototypeOf** method is called with argument V, the following steps are taken:

1. If V is not an object, return **false**.
2. Let O be the result of calling **ToObject** passing the **this** value as the argument.
3. ReturnIfAbrupt(O).

Deleted: "Object"
Deleted: calling the [[]] internal method of
Deleted:
Deleted: with argument
Deleted: i
Deleted: O
Deleted: a host object, let <u>tag</u> be an implementation defined string value. This value may not be
Deleted: "Object" ,
Deleted:
Deleted: <#>Else , Let let class tag be the string value "Object" of the [[Class]] internal property of <u>O</u> .
Deleted: class
Deleted: 1
Deleted: Table 323028 — [[BuiltInBrand]] Tag Value [[NativeBrandBuiltInBrand]] Value
Deleted: This
Deleted: result of calling ToObject passing the
Deleted: as the argument
Deleted: <#>Let toString be the result of calling the [[Get]] internal method of O passing "toString" as the argument.
Deleted: <#>If IsCallable(toString) is false, throw a TypeError exception.
Deleted: calling
Deleted: the abstract operation
Deleted: the
Deleted: with arguments
Deleted: [[Call]] internal method of
Deleted: ,toString passing <u>O</u> ,
Deleted: as the this value
Deleted: and
Deleted: no
Deleted: an empty arguments List
Deleted: <#>If O is the result of calling the Object constructor with a host object (15.2.2.1), then
Deleted: <#>Return either O or another value such as the host object originally passed to the constructor. The specific result that is returned is implementation-defined.
Deleted: ToString
Deleted: Let desc be
Deleted: GetProperty
Deleted: <#>If desc is undefined, return false.
Deleted: <#>Return true.
NOTE 1 Unlike [[HasProperty]] (8.12.6), this method does not consider objects in the prototype chain.
Deleted: 2
Deleted: 2

4. Repeat

- a. Let V be the result of calling the [[GetInheritance]] internal method of V with no arguments.
- b. if V is **null**, return **false**
- c. If O and V refer to the same object, return **true**.

NOTE The ordering of steps 1 and 2 is chosen to preserve 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**.

Deleted: value
Deleted: of
Deleted: Prototype
Deleted: e
Deleted: property

15.2.4.7 Object.prototype.propertyIsEnumerable (V)

When the **propertyIsEnumerable** method is called with argument V , the following steps are taken:

1. Let P be $\text{ToString}(V)$.
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. If $desc$ is **undefined**, return **false**.
7. Return the value of $desc.[[Enumerable]]$.

NOTE 1 This method does not consider objects in the prototype chain.

NOTE 2 The ordering of steps 1 and 2 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**.

15.2.5 Properties of Object Instances

Object instances have no special properties beyond those inherited from the Object prototype object.

15.3 Function Objects

15.3.1 The Function Constructor Called as a Function

When **Function** is called as a function rather than as a constructor, it creates and initialises a new Function object. Thus the function call **Function(...)** is equivalent to the object creation expression **new Function(...)** with the same arguments.

15.3.1.1 Function (p1, p2, ..., pn, body)

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. Create and return a new Function object as if the standard built-in constructor **Function** was used in a **new** expression with the same arguments (15.3.2.1).

15.3.2 The Function Constructor

When **Function** is called as part of a **new** expression, it is a constructor: it initialises the newly created object.

15.3.2.1 new 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** constructor 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 $argCount$ be the total number of arguments passed to this function invocation.
2. Let P be the empty String.

3. If `argCount` = 0, let `bodyText` be the empty String.
4. Else if `argCount` = 1, let `bodyText` be that argument.
5. Else ~~`argCount > 1`~~
 - a. Let `firstArg` be the first argument.
 - b. Let `P` be `ToString(firstArg)`.
 - c. ~~`ReturnIfAbrupt(P)`~~
 - d. Let `k` be 2.
 - e. Repeat, while $k < argCount$
 - i. Let `nextArg` be the k 'th argument.
 - ii. Let `nextArgString` be `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 the k 'th argument.
6. Let `bodyText` be `ToString(bodyText)`.
7. ~~`ReturnIfAbrupt(bodyText)`~~
8. Let `parameters` be the result of parsing `P`, interpreted as UTF-16 encoded Unicode text as described in 8.4, using `FormalParameterList` as the goal symbol. Throw a `SyntaxError` exception if the parse fails.
9. Let `body` be the result of parsing `bodyText`, interpreted as UTF-16 encoded Unicode text as described in 8.4, using `FunctionBody` as the goal symbol. Throw a `SyntaxError` exception if the parse fails or if any static semantics errors are detected.
10. If `bodyText` is strict mode code (see 10.1.1) then let `strict` be `true`, else let `strict` be `false`.
11. Return a new Function object created as specified in 13.6 passing `parameters` as the `FormalParameterList` and `body` as the `FunctionBody`. Pass in the Global Environment as the `Scope` parameter and `strict` as the `Strict` flag.

A `prototype` property is automatically created for every function created using the `Function` constructor, to provide for the possibility that the function will be used as a constructor.

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")
```

15.3.3 Properties of the Function Constructor

The `Function` constructor is itself a `Function` object and has a `[[BuiltinBrand]]` internal data property whose value is `BuiltinFunction`. The value of the `[[Prototype]]` internal data property of the `Function` constructor is the standard built-in `Function` prototype object (15.3.4).

The value of the `[[Extensible]]` internal data property of the `Function` constructor is `true`.

The `Function` constructor has the following properties:

15.3.3.1 `Function.prototype`

The initial value of `Function.prototype` is the standard built-in `Function` prototype object (15.3.4).

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

15.3.3.2 `Function.length`

This is a data property with a value of 1. This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

Deleted:,

Deleted: `ToString()`

Deleted:)

Deleted: If

Deleted: is not parsable as a

Deleted: `opt`

Deleted: then t

Deleted: <#>If `body` is not parsable as `FunctionBody` then throw a `SyntaxError` exception.¶

Deleted: <#>If `strict` is `true`, throw any exceptions specified in 13.1 that apply. ¶

Deleted: 2

Deleted: `P`

Deleted: `opt`

Deleted: its

Deleted: Class

Deleted: IsFunction

Deleted: NativeBrand

Deleted: is "Function"

Deleted: NativeFunction

15.3.4 Properties of the Function Prototype Object

The Function prototype object is itself a Function object and has a `[[BuiltinBrand]]` internal data property whose value is `BuiltinFunction`. When invoked, it accepts any arguments and returns `undefined`.

The value of the `[[Prototype]]` internal `data` property of the Function prototype object is the standard built-in Object prototype object (15.2.4). The initial value of the `[[Extensible]]` internal `data` property of the Function prototype object is `true`.

The function prototype object does not have a `prototype` property.

The Function prototype object does not have a `valueOf` property of its own; however, it inherits the `valueOf` property from the Object prototype Object.

The `length` property of the Function prototype object is `0`.

15.3.4.1 Function.prototype.constructor

The initial value of `Function.prototype.constructor` is the built-in `Function` constructor.

15.3.4.2 Function.prototype.toString()

An implementation-dependent representation of the function is returned. This representation has the syntax of a `FunctionDeclaration`. Note in particular that the use and placement of white space, line terminators, and semicolons within the representation String is implementation-dependent.

The `toString` function is not generic; it throws a `TypeError` exception if its `this` value is not a Function object. Therefore, it cannot be transferred to other kinds of objects for use as a method.

15.3.4.3 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`, then throw a `TypeError` exception.
2. If `argArray` is `null` or `undefined`, then
 - a. Return the result of calling the `[[Call]]` internal method of `func`, providing `thisArg` as `thisArgument` and an empty `List` of arguments as `argumentsList`.
3. If `Type(argArray)` is not `Object`, then throw a `TypeError` exception.
4. Let `len` be the result of `Get(argArray, "length")`.
5. Let `n` be `ToUint32(len)`.
6. ReturnIfAbrupt(n).
7. Let `argList` be an empty `List`.
8. Let `index` be `0`.
9. Repeat while `index < n`
 - a. Let `indexName` be `ToString(index)`.
 - b. Let `nextArg` be the result of `Get(argArray, indexName)`.
 - c. ReturnIfAbrupt(nextArg).
 - d. Append `nextArg` as the last element of `argList`.
 - e. Set `index` to `index + 1`.
10. Return the result of calling the `[[Call]]` internal method of `func`, providing `thisArg` as `thisArgument` and `argList` as `argumentsList`.

The `length` property of the `apply` method is `2`.

NOTE The `thisArg` value is passed without modification as the `this` value. This is a change from Edition 3, where a `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.

Deleted: `IsFunction`
Deleted: `NativeBrand`
Deleted: `NativeFunction`
Deleted: (its `[[Class]]` is "Function") that,
Deleted: `when`

Deleted: the `this` value
Deleted: `list`
Deleted: calling the `[[`
Deleted: `]]` internal method of
Deleted:
Deleted: with argument
Deleted: calling the `[[`
Deleted: `]]` internal method of
Deleted:
Deleted: with
Deleted: as the argument
Deleted: the
Deleted: this value
Deleted: the `list` of arguments

15.3.4.4 Function.prototype.call (thisArg [, arg1 [, arg2, ...]])

When the `call` method is called on an object `func` with argument `thisArg` and optional arguments `arg1`, `arg2` etc, the following steps are taken:

1. If `IsCallable(func)` is `false`, then 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 `arg1` append each argument as the last element of `argList`
4. Return the result of calling the `[[Call]]` internal method of `func`, providing `thisArg` as `thisArgument` and `argList` as `argumentsList`.

The `length` property of the `call` method is 1.

NOTE The `thisArg` value is passed without modification as the `this` value. This is a change from Edition 3, where a `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.

15.3.4.5 Function.prototype.bind (thisArg [, arg1 [, arg2, ...]])

The `bind` method takes one or more arguments, `thisArg` and (optionally) `arg1`, `arg2`, etc, and returns a new function object by performing the following steps:

1. Let `Target` be the `this` value.
2. If `IsCallable(Target)` is `false`, throw a `TypeError` exception.
3. Let `A` be a new (possibly empty) internal list consisting of all of the argument values provided after `thisArg` (`arg1`, `arg2` etc), in order.
4. Let `F` be the result of the abstract operation `BoundFunctionCreate` with arguments `Target`, `thisArg`, and `A`.
5. If `Target` has the `[[BuiltInBrand]]` internal property with value `BuiltinFunction`, then
 - a. Let `targetLen` be the result of `Get(Target, "length")`.
 - b. `ReturnIfAbrupt(targetLen)`.
 - c. Let `L` be the larger of 0 and the result of `targetLen` minus the number of elements of `A`.
6. Else let `L` be 0.
7. Call the `[[DefineOwnProperty]]` internal method of `F` with arguments `"length"` and `PropertyDescriptor` `{[[value]]: L, [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false}`.
8. Perform the `AddRestrictedFunctionProperties` abstract operation with argument `F`.
9. Return `F`.

The `length` property of the `bind` method is 1.

NOTE Function objects created using `Function.prototype.bind` are exotic objects. They also do not have a `prototype` property.

15.3.4.6 Function.prototype[@@create]()

The `@@create` method of an object `F` performs the following steps:

1. Return the result of calling `OrdinaryCreateFromConstructor(F, "%ObjectPrototype%")`.

15.3.4.7 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)`.

NOTE This is the default implementation of `@@hasInstance` that most functions inherit. `@@hasInstance` is call 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

Deleted: the `this` value

Deleted: the list of arguments

Deleted: a new native ECMAScript object

Deleted: <#>Set all the internal methods, except for `[[Get]]` of `F` as specified in 8.12.¶

<#>Set the `[[Get]]` internal property of `F` as specified in 15.3.5.4.¶

<#>Set `F` to `true`.¶

<#>Set the `[[TargetFunction]]` internal property of `F` to `Target`.

<#>Set the `[[BoundThis]]` internal property of `F` to the value of `thisArg`.¶

<#>Set the `[[BoundArgs]]` internal property of `F` to `A`.¶

<#>Set Add the `[[ClassIsFunctionNativeBrand]]` internal property with value `NativeFunction` of `F` to `"Function"`.¶

<#>Set the `[[Prototype]]` internal property of `F` to the intrinsic `%FunctionPrototype%` standard built-in Function prototype object as specified in 15.3.3.1.¶

<#>Set the `[[Call]]` internal property of `F` as described in 15.3.4.5.1.¶

<#>Set the `[[Construct]]` internal property of `F` as described in 15.3.4.5.2.¶

<#>Set the `[[HasInstance]]` internal property of `F` as described in 15.3.4.5.3.¶

Deleted: the `[[Class]]` internal property of

Deleted: is `"Function"`

Deleted: `IsFunction`

Deleted: `NativeBrand`

Deleted: `NativeFunction`

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with argument

Deleted: the `length` property of `Target`

Deleted: `length`

Deleted: <#>Set the `length` own property of `F` to either 0 or `L`, whichever is larger.¶

Deleted: set

Deleted: the `length` own property of `F` to

Deleted: ,

Deleted: , and `false`

Deleted: or

Deleted: <#>Set the attributes of the `length` own property of `F` to the values specified in 15.3.5.1.¶

Deleted: <#>Set the `[[Extensible]]` internal property of `F` to `true`.¶

Deleted: <#>Let `thrower` be the `[[ThrowTypeError]]` function Object (13.25.3).¶

Deleted: or the `[[Code]]`, `[[FormalParameters]]`, and

Deleted: When the `@@create` method of an object `F`,

Deleted: 15.3.4.5.1 `[[Call]]`¶

Deleted: 6

Deleted: ;

F[@@hasInstance] (v)

A constructor function can control which objects are recognized as its instances by `instanceof` by exposing a `@@hasInstance` method on the function.

15.3.5 Properties of Function Instances

In addition to the required internal properties, every function instance has a `[[Call]]` internal method and in most cases uses a different version of the `[[Get]]` internal method. Depending on how they are created (see 8.6.2, 13.6, 15, and 15.3.4.5), function instances may have a `[[Scope]]` internal data property, a `[[Construct]]` internal method, a `[[FormalParameters]]` internal data property, a `[[Code]]` internal data property, a `[[BoundTargetFunction]]` internal data property, a `[[BoundThis]]` internal data property, and a `[[BoundArguments]]` internal data property.

Every function instance has a `[[BuiltinBrand]]` internal data property whose value is `BuiltinFunction`.

Function instances that correspond to strict mode functions (13.6) and function instances created using the `Function.prototype.bind` method (15.3.4.5) 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.

15.3.5.1 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]]: false` }.

15.3.5.2 prototype

The value of the `prototype` property is used to initialise the `[[Prototype]]` internal data property of a newly created `ordinary` object before the `Function` object is invoked as a constructor for that newly created object. This property has the attribute { `[[Writable]]: true`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

NOTE Function objects created using `Function.prototype.bind` do not have a `prototype` property.

15.4 Array Objects

Array objects are exotic objects that give special treatment to a certain class of property names. See 8.4.2 for a definition of this special treatment.

An `Array` object, `O`, is said to be `sparse` if the following algorithm returns `true`:

1. Let `len` be the result of `Get(O, "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 `O` with argument `Tostring(i)`.
 - b. If `elem` is `undefined`, return `true`.
3. Return `false`.

15.4.1 The Array Constructor Called as a Function

When `Array` is called as a function rather than as a constructor, it creates and initialises a new `Array` object. Thus the function call `Array(...)` is equivalent to the object creation expression `new Array(...)` with the same arguments. However, if the `this` value passed in the call is an `Object` with an `[[InitializationState]]` internal data property whose value is `undefined`, it initializes the `this` value using the argument values. This permits `Array` to be used both as factory method and to perform constructor instance initialization.

Deleted: 15.3.4.5.3 `[[HasInstance]] (V)`

When the `[[HasInstance]]` internal method of a function object `F`, that was created using the `bind` function is called with argument `V`, the following steps are taken:[¶]

<#> Let `target` be the value of `F`'s `[[TargetFunction]]` internal property.[¶]
<#> If `target` has no `[[HasInstance]]` internal method, a `TypeError` exception is thrown.[¶]
<#> Return the result of calling the `[[HasInstance]]` internal method of `target` providing `V` as the argument.[¶]

Deleted: property

Deleted: property

Deleted: 2

Deleted: a `[[HasInstance]]` internal property,

Deleted: property

Comment [AWB12159]: TODO, need to update to reflect new internal method factorin

Deleted: `BoundArgs`

Deleted: The value of the `[[Class]]` internal property is "Function".

Deleted: `IsFunction`

Deleted: `NativeBrand`

Deleted: `NativeFunction`

Deleted: 2

Deleted: "

Deleted: "

Deleted: "

Deleted: "

Deleted: "

Deleted: 15.3.5.3 `[[HasInstance]] (V)`

Assume `F` is a `Function` object.[¶] When the `[[HasInstance]]` internal method of `F` is called with value `V`, the following steps are taken:[¶]

<#> If `V` is not an object, return `false`.[¶]
<#> Let `O` be the result of calling the `[[Get]]` internal method of `F` with property name "`prototype`".[¶]
<#> Return `IfAbrupt(O)`.[¶]
<#> If `Type(O)` is not `Object`, throw a `TypeError` exception.[¶]
<#> Repeat[¶]

Deleted: A property name `P` (in the form of a string value) is an `array index` if and only if

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with argument

Comment [AWB11160]: TODO: see if this algorithm is really needed

Deleted: Runtime Semantics: `ArrayCreateAbstractOperation`[¶]

Deleted: ¶

Array may be subclassed and subclass constructors may perform a super invocation of the **Array** constructor to initialize subclass instances.

15.4.1.1 Array ([item1 [, item2 [, ...]]])

This description applies if and only if the **Array** constructor is given no arguments or 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 constructor call.
2. Assert: numberOfArgs ≠ 1.
3. Let O be the this value.
4. If Type(O) is Object and O has a [[ArrayInitializationState]] internal data property and the value of [[InitializationState]] is false, then
 - a. Set the value of O's [[ArrayInitializationState]] internal data property to true.
 - b. Let array be O.
5. Else,
 - a. Let F be this function.
 - b. Let proto be the result of GetPrototypeOfFromConstructor(F, "%ArrayPrototype%").
 - c. ReturnIfAbrupt(proto).
 - d. Let array be the result of the abstract operation ArrayCreate with arguments numberOfArgs and proto.
6. ReturnIfAbrupt(array).
7. Let k be 0.
8. Let items be a zero-origin List contain the argument items in order.
9. Repeat, while k < numberOfArgs
 - a. Let Pk be ToString(k).
 - b. Let itemK be kth element of items.
 - c. Let defineStatus be the result of DefinePropertyOrThrow(array, Pk, Property Descriptor {[[Value]]: itemK, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}).
 - d. ReturnIfAbrupt(defineStatus).
 - e. Increase k by 1.
10. Let putStatus be the result of Put(array, "length", numberOfArgs, true).
11. ReturnIfAbrupt(putStatus).
12. Return array.

15.4.1.2 Array (len)

This description applies if and only if the **Array** constructor is given exactly one argument.

1. Let numberOfArgs be the number of arguments passed to this constructor call.
2. Assert: numberOfArgs = 1.
3. Let O be the this value.
4. If Type(O) is Object and O has an [[ArrayInitializationState]] internal data property and the value of [[InitializationState]] is false, then
 - a. Set the value of O's [[ArrayInitializationState]] internal data property to true.
 - b. Let array be O.
5. Else,
 - a. Let F be this function.
 - b. Let proto be the result of GetPrototypeOfFromConstructor(F, "%ArrayPrototype%").
 - c. ReturnIfAbrupt(proto).
 - d. Let array be the result of the abstract operation ArrayCreate with argument 0 and proto.
6. ReturnIfAbrupt(array).
7. If Type(len) is not Number, then
 - a. Let defineStatus be the result of DefinePropertyOrThrow(array, "0", Property Descriptor {[[Value]]: len, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}).
 - b. ReturnIfAbrupt(defineStatus).
 - c. Let intLen be 1.
8. Else,

Deleted: <#> Create and return a new Array object exactly if the standard built-in constructor Array was used in a new expression with the same arguments (15.4.2). Return the result that would be obtained if this functions had been called with the same arguments as constructor. This result is defined by 15.4.2.1 or 15.4.2.2 depending upon the actual number of arguments.

15.4.2 The **Array** Constructor

When **Array** is called as part of a new expression, it is a constructor: it initialises the newly created object.

15.4.2.1 new Array ([item0 [, item1 [, ...]]])
This description applies if and only if the **Array** constructor is given no arguments or at least two arguments.

Deleted: len

Deleted: of

Deleted: abstraction operation

Deleted: (15.4)

Deleted: len

Deleted: len

Deleted: Let defineStatus be the result of calling

Deleted: Call the [[

Deleted: Own

Deleted:]]

Deleted: internal method of

Deleted:

Deleted: with arguments

Deleted: and

Deleted: , and true

Deleted: <#> ReturnIfAbrupt(defineStatus).

Deleted: calling the [[

Deleted:]] internal method of

Deleted:

Deleted: with arguments

Deleted: len

Deleted: and

Deleted: The [[Prototype]] internal property of the newly constructed object is set to the original Array prototype object, the one that is the initial value of Array.prototype (15.4.3.1).

Deleted: 2

Deleted: new

Deleted: The [[Prototype]] internal property of the new

Deleted: <#> Let array be the result of the abstraction

Deleted: calling the [[

Deleted: Own

Deleted:]]

Deleted: internal method of

Deleted: with

Deleted: arguments

Deleted: , and true

Deleted: Return array.

- a. Let `intLen` be `ToInt32(len)`.
- b. If `intLen` ≠ `len`, then throw a **RangeError** exception.
9. Let `putStatus` be the result of `Put(array, "length", intLen, true)`.
10. ReturnIfAbrupt(`putStatus`).
11. Return `array`.

15.4.2 The Array Constructor

When **Array** is called as part of a **new** expression, it is a constructor: it initialises the newly created object.

1. Let `F` be the **Array** function object on which the **new** operator was applied.
2. Let `argumentsList` be the `argumentsList` argument of the `[[Construct]]` internal method that was invoked by the **new** operator.
3. Return the result of `OrdinaryConstruct(F, argumentsList)`.

If **Array** is implemented as an ordinary function object, its `[[Construct]]` internal method will perform the above steps.

15.4.3 Properties of the Array Constructor

The value of the `[[Prototype]]` internal `data` property of the **Array** constructor is the Function prototype object (15.3.4).

Besides and the `length` property (whose value is `1`), the **Array** constructor has the following properties:

15.4.3.1 Array.prototype

The initial value of **Array.prototype** is the **Array** prototype object (15.4.4).

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

15.4.3.2 Array.isArray (arg)

The `isArray` function takes one argument `arg`, and performs the following steps are taken:

1. If `Type(arg)` is not `Object`, return `false`.
2. If `arg` is an exotic **Array** object, then return `true`.
3. Return `false`.

15.4.3.3 Array.of (...items)

When the `of` method is called with any number of arguments, the following steps are taken:

1. Let `lenValue` be the result of `Get(items, "length")`.
2. Let `len` be `ToInteger(lenValue)`.
3. Let `C` be the `this` value.
4. If `IsConstructor(C)` is `true`, then
 - a. Let `newObj` be the result of calling the `[[Construct]]` internal method of `C` with an argument list containing the single item `len`.
 - b. Let `A` be `ToObject(newObj)`.
5. Else,
 - a. Let `A` be the result of the abstract operation `ArrayCreate` with argument `len`.
6. ReturnIfAbrupt(`A`).
7. Let `k` be `0`.
8. Repeat, while `k < len`
 - a. Let `Pk` be `ToString(k)`.
 - b. Let `kValue` be the result of `Get(items, Pk)`.
 - c. Let `defineStatus` be the result of `DefinePropertyOrThrow(A, Pk, Property Descriptor {[[Value]]: kValue, [[value]], [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true})`.

Deleted: <#>Let `array` be the result of the abstraction operation abstract operation `ArrayCreate(15.4)` with argument `intLen`.||

Deleted: the internal properties

Deleted: returns the Boolean value `true` if the argument is an object whose class `[[BuiltInBrand]]` internal property is `"Array"BuildinArray`; otherwise it returns `false`. The

Deleted: the value of the `[[Class]]` internal property of

Deleted: is `"Array"`

Deleted: has the `[[IsArrayNativeBrandBuiltinBrand]]` internal property with value `NativeArrayBuiltinArry`

Deleted: ...

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with the argument

Deleted: i

Comment [AWB7161]: It would be nice to have a more explicit way to create a collection with a pre-specified number of elements.

Deleted: abstraction operation

Deleted: (15.4)

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with argument

Deleted: of calling the `[[`

Deleted: Own

Deleted: `]]` internal method of

Deleted: with arguments

Deleted: , and `true`

- d. ReturnIfAbrupt(defineStatus).
- e. Increase k by 1.
- 9. Let putStatus be the result of 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.

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.

15.4.3.4 Array.from (arrayLike , mapfn=undefined, thisArg=undefined)

When the from method is called with argument arrayLike, the following steps are taken:

- 1. Let items be ToObject(arrayLike).
- 2. ReturnIfAbrupt(items).
- 3. Let lenValue be the result of Get(items, "length").
- 4. Let len be ToInteger(lenValue).
- 5. ReturnIfAbrupt(len).
- 6. Let C be the this value.
- 7. If IsConstructor(C) is **true**, then
 - a. Let newObj be the result of calling the [[Construct]] internal method of C with an argument list containing the single item len.
 - b. Let A be ToObject(newObj).
- 8. Else,
 - a. Let A be the result of the abstract operation ArrayCreate with argument len.
- 9. ReturnIfAbrupt(A).
- 10. Let k be **0**.
- 11. Repeat, while k < len
 - a. Let Pk be ToString(k).
 - b. Let kPresent be the result of HasProperty(items, Pk).
 - c. ReturnIfAbrupt(kPresent).
 - d. If kPresent is **true**, then
 - i. Let kValue be the result of Get(items, Pk).
 - ii. ReturnIfAbrupt(kValue).
 - iii. Let defineStatus be the result of DefinePropertyOrThrow(A, Pk, Property Descriptor {[[Value]]: kValue, [[value]], [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}).
 - iv. ReturnIfAbrupt(defineStatus).
 - e. Increase k by **1**.
- 12. Let putStatus be the result of Put(A, "length", len, true).
- 13. ReturnIfAbrupt(putStatus).
- 14. Return A.

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.

15.4.3.5 Array[@@create]()

The @@create method of an object F performs the following steps:

- 1. Let F be the this value.
- 2. Let proto be the result of GetPrototypeOfFromConstructor(F, "%ArrayPrototype%").
- 3. ReturnIfAbrupt(proto).
- 4. Let obj be the result of calling ArrayCreate with arguments undefined and proto.

Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: with arguments
Deleted: and

Deleted: 3
Deleted: any number of
Deleted: s

Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: with the argument
Deleted: i
Comment [AWB7162]: It would be nice to have a more explicit way to create a collection with a pre-specified number of elements.
Deleted: abstraction operation
Deleted: (15.4)

Deleted: calling the [[HasProperty]] internal method of
Deleted: with argument
Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: with argument
Deleted: calling the [[
Deleted: Own
Deleted:]] internal method of
Deleted: with arguments
Deleted:,
Deleted: and
Deleted:, and **true**
Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: with arguments
Deleted: and

5. Return *obj*.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

This method may be assigned to

NOTE 1 Passing **undefined** as the first argument to `ArrayCreate` causes the [[`ArrayInitializationState`]] internal data property 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 implementation may choose to encode the flag in any unobservable manner.

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.

15.4.4 Properties of the Array Prototype Object

The value of the [[`Prototype`]] internal `data` property of the `Array` prototype object is the standard built-in `Object` prototype object (15.2.4).

The `Array` prototype object is itself an ordinary object. It is not an `Array` instance and does not have a `length` property.

In following descriptions of functions that are properties of the `Array` prototype object, the phrase “this object” refers to the object that is the `this` value for the invocation of the function. It is permitted for the `this object` to be an object which is not an exotic `Array` object.

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.

15.4.4.1 `Array.prototype.constructor`

The initial value of `Array.prototype.constructor` is the standard built-in `Array` constructor.

15.4.4.2 `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 the result of `Get(array, "join")`.
4. **ReturnIfAbrupt(*func*)**
5. If `IsCallable(func)` is **false**, then let *func* be the standard built-in method `Object.prototype.toString` (15.2.4.2).
6. Return the result of calling the [[`Call`]] internal method of *func* providing *array* as `thisArgument` and an empty `List` as `argumentsList`.

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. Whether the `toString` function can be applied successfully to an exotic object that is not an `Array` is implementation-dependent.

15.4.4.3 `Array.prototype.toLocaleString()`

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.

The result is calculated as follows:

- Deleted:** array
- Deleted:** ; its [[Class]] is “`Array`” it has an [[`NativeBrandBuiltinBrandIsArray`]] internal data property with value `NativeArrayBuiltinArray`
- Deleted:** and it has
- Deleted:** (whose initial value is **+0**) and the special [[`DefineOwnProperty`]] internal method described in 15.4.5.1
- Deleted:** for
- Deleted:** the value of the [[Class]] internal property is not “`Array`”
- Deleted:** does not have an [[`IsArrayNativeBrandBuiltinBrand`]] internal data property with value `NativeArrayBuiltinArray`
- Deleted:** If *array* is an abrupt completion, return *array*.
- Deleted:** calling the [[
- Deleted:**]] internal method of
- Deleted:**
- Deleted:** with argument
- Deleted:** If *func* is an abrupt completion, return *func*.
- Deleted:** the `this` value
- Deleted:** /
- Deleted:** host

1. Let *array* be the result of calling `ToObject` passing the `this` value as the argument.
2. `ReturnIfAbrupt(array)`.
3. Let *arrayLen* be the result of `Get(array, "length")`.
4. Let *len* be `ToInt32(arrayLen)`.
5. `ReturnIfAbrupt(len)`.
6. 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).
7. If *len* is zero, return the empty String.
8. Let *firstElement* be the result of `Get(array, "0")`.
9. Let *noArgs* be an empty List.
10. `ReturnIfAbrupt(firstElement)`.
11. If *firstElement* is `undefined` or `null`, then
 - a. Let *R* be the empty String.
12. Else
 - a. Let *R* be the result of `Invoke(firstElement, "toLocaleString")`.
 - b. `Let R be ToString(R)`.
 - c. `ReturnIfAbrupt(R)`.
13. Let *k* be 1.
14. Repeat, while *k* < *len*
 - a. Let *S* be a String value produced by concatenating *R* and *separator*.
 - b. Let *nextElement* be the result of `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 the result of `Invoke(nextElement, "toLocaleString")`.
 - ii. `Let R be ToString(R)`.
 - iii. `ReturnIfAbrupt(R)`.
 - f. Let *R* be a String value produced by concatenating *S* and *R*.
 - g. Increase *k* by 1.
15. Return *R*.

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.

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. Whether the `toLocaleString` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.4 `Array.prototype.concat ([item1 [, item2 [, ...]]])`

When the `concat` method is called with zero or more arguments *item1*, *item2*, etc., 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 the result of the abstract operation `ArrayCreate` with argument 0.
4. Let *n* be 0.
5. Let *items* be an internal 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.
6. Repeat, while *items* is not empty
 - a. Remove the first element from *items* and let *E* be the value of the element.
 - b. If *E* has the `[[BuiltInBrand]]` internal data property with value `BuiltinArray`, then
 - i. Let *k* be 0.
 - ii. Let *len* be the result of `Get(E, "length")`.
 - iii. `ReturnIfAbrupt(len)`.
 - iv. Repeat, while *k* < *len*

Deleted: calling the <code>[[</code>
Deleted: <code>]]</code> internal method of
Deleted:
Deleted: with argument
Deleted: calling the <code>[[</code>
Deleted: <code>]]</code>
Deleted: internal method of
Deleted: with argument
Deleted: <code><#>Let elementObj be ToObject(firstElement)</code>
<code><#>Let func be the result of calling the <code>[[Get]]</code> internal method of <i>elementObj</i> with argument <code>"toLocaleString"</code></code>
<code><#>If IsCallable(func) is false, throw a <code>TypeError</code> exception</code>
Deleted: calling
Deleted: with arguments
Deleted: <code>, firstElement</code>
Deleted: and an empty arguments List
Comment [AWB7163]: This step was missing in ES<=5.1
Deleted: If <i>R</i> is an abrupt completion, return <i>R</i> .
Deleted: Let <i>R</i> be the result of calling the <code>[[Call]]</code> internal method of <i>func</i> providing <i>elementObj</i> as the <code>this</code> value and an empty arguments list.
Deleted: calling the <code>[[</code>
Deleted: <code>]]</code> internal method of
Deleted:
Deleted: with argument
Deleted: <code><#>Let elementObj be ToObject(nextElement)</code>
Deleted: calling
Deleted: with arguments
Deleted: <code>, nextElement</code>
Deleted: and an empty arguments List
Comment [AWB7164]: This step was missing in ES<=5.1
Deleted: If <i>R</i> is an abrupt completion, return <i>R</i> .
Deleted: <code><#>Let func be the result of calling the <code>[[Get]]</code> internal method of <i>elementObj</i> with argument <code>"toLocaleString"</code></code>
<code><#>If IsCallable(func) is false, throw a <code>TypeError</code> exception</code>
Deleted: host
Deleted: abstraction operation
Deleted: (15.4)
Deleted: a new array created as if by the expression <code>new</code>
Deleted: the value of the <code>[[Class]]</code> internal property of
Deleted: is <code>"Array"</code>
Deleted: IsArray
Deleted: NativeBrand
Deleted: NativeArray
Deleted: calling the <code>[[Get]]</code> internal method of <i>E</i> with

1. Let P be $\text{ToString}(k)$.
2. Let exists be the result of $\text{HasProperty}(E, P)$.
3. [ReturnIfAbrupt\(exists\)](#).
4. If exists is **true**, then
 - a. Let subElement be the result of $\text{Get}(E, P)$.
 - b. Call the $\text{[[DefineOwnProperty]]}$ internal method of A with arguments $\text{ToString}(n)$ and Property Descriptor $\{\text{[[Value]]: subElement, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}\}$.
5. Increase n by 1.
6. Increase k by 1.
- c. Else E is not an Array.
 - i. Call the $\text{[[DefineOwnProperty]]}$ internal method of A with arguments $\text{ToString}(n)$ and Property Descriptor $\{\text{[[Value]]: E, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}\}$.
 - ii. Increase n by 1.
7. Let putStatus be the result of $\text{Put}(A, "length", n, \text{true})$.
8. [ReturnIfAbrupt\(putStatus\)](#).
9. Return A .

The **length** property of the **concat** method is 1.

NOTE 1 The explicit setting of the **length** property in step 7 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. Whether the **concat** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.5 **Array.prototype.join (separator)**

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 lenVal be the result of $\text{Get}(O, "length")$.
4. Let len be $\text{ToUint32}(\text{lenVal})$.
5. [ReturnIfAbrupt\(len\)](#).
6. If *separator* is **undefined**, let *separator* be the single-character String `,`.
7. Let sep be $\text{ToString}(\text{separator})$.
8. If len is zero, return the empty String.
9. Let element0 be the result of $\text{Get}(O, "0")$.
10. If *element0* is **undefined** or **null**, let R be the empty String; otherwise, let R be $\text{ToString}(\text{element0})$.
11. [ReturnIfAbrupt\(R\)](#).
12. Let k be 1.
13. Repeat, while $k < \text{len}$
 - a. Let S be the String value produced by concatenating R and sep .
 - b. Let element be the result of $\text{Get}(O, \text{ToString}(k))$.
 - c. If *element* is **undefined** or **null**, then let next be the empty String; otherwise, let next be $\text{ToString}(\text{element})$.
 - 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.

Deleted: calling the [[HasProperty]] internal method of

Deleted: with

Deleted: calling the $\text{[[$

Deleted: $]$ internal method of

Deleted:

Deleted: with argument

Deleted: $)$,

Deleted: , and **false**

Deleted: ,

Deleted: $)$,

Deleted: , and **false**

Deleted: Call

Deleted: calling the [[Put]] internal method of A with arguments **"length"**, n , and **true**

Deleted: If *putStatus* is an abrupt completion, return *putStatus*.

Deleted: host

Deleted: calling the [[Get]] internal method of O with argument **"length"**

Deleted: calling the $\text{[[$

Deleted: $]$ internal method of

Deleted:

Deleted: with argument

Deleted: Let

Deleted: If R is an abrupt completion, return R

Deleted: calling the $\text{[[$

Deleted: $]$ internal method of

Deleted:

Deleted: with argument

Deleted: L

Deleted: If *next* is an abrupt completion, return *next*.

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. Whether the `join` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.6 Array.prototype.pop ()

The last element of the array is removed from the array and returned.

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(O).
3. Let $lenVal$ be the result of `Get(O, "length")`.
4. Let len be `ToInt32(lenVal)`.
5. ReturnIfAbrupt(len).
6. If len is zero,
 - a. Let `putStatus` be the result of `Put(O , "length", 0, true)`.
 - b. ReturnIfAbrupt(`putStatus`).
 - c. Return `undefined`.
7. Else $len > 0$,
 - a. Let $newLen$ be $len - 1$.
 - b. Let $indx$ be `ToString(newLen)`.
 - c. Let $element$ be the result of `Get(O , $indx$)`.
 - d. ReturnIfAbrupt($element$).
 - e. Let `deleteStatus` be the result of `DeletePropertyOrThrow(O , $indx$)`.
 - f. ReturnIfAbrupt(`deleteStatus`).
 - g. Let `putStatus` be the result of `Put(O , "length", $newLen$, true)`.
 - h. ReturnIfAbrupt(`putStatus`).
 - i. Return $element$.

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. Whether the `pop` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.7 Array.prototype.push ([item1 [, item2 [, ...]]])

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 $item1$, $item2$, 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 $lenVal$ be the result of `Get(O, "length")`.
4. Let n be `ToInt32(lenVal)`.
5. ReturnIfAbrupt(n).
6. Let $items$ be an internal List whose 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 `putStatus` be the result of `Put(O , ToString(n), E , true)`.
 - c. ReturnIfAbrupt(`putStatus`).
 - d. Increase n by 1.
8. Let `putStatus` be the result of `Put(O , "length", n , true)`.
9. ReturnIfAbrupt(`putStatus`).
10. Return n .

The `length` property of the `push` method is 1.

Deleted: host

Deleted: calling the [[Get]] internal method of O with argument "length"

Deleted: Call

Deleted: calling the [[Put]] internal method of O with arguments "length", 0, and true

Deleted: If `putStatus` is an abrupt completion, return `putStatus`.

Deleted:,

Deleted: $indx$

Deleted: `ToString`

Deleted:)

Deleted: calling the [[

Deleted:]] internal method of

Deleted::

Deleted: with argument

Deleted: If $element$ is an abrupt completion, return $element$

Deleted: of calling Call the [[

Deleted:]] internal method of

Deleted: with arguments

Deleted: and true

Deleted: If `deleteStatus` is an abrupt completion, return `deleteStatus`.

Deleted: calling Call the [[Put]] internal method of O with arguments "length", $indx$, $newLen$, and true

Deleted: If `putStatus` is an abrupt completion, return `putStatus`.

Deleted: host

Deleted: calling the [[Get]] internal method of O with argument "length"

Deleted: len

Deleted: calling Call the [[

Deleted:]] internal method of

Deleted::

Deleted: with arguments

Deleted: and

Deleted: If `putStatus` is an abrupt completion, return `putStatus`.

Deleted: calling Call the [[Put]] internal method of O with arguments "length", n , and true

Deleted: If `putStatus` is an abrupt completion, return `putStatus`

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. Whether the `push` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

Deleted: host

15.4.4.8 Array.prototype.reverse ()

The elements of the array are rearranged so as to reverse their order. The object is returned as the result of the call.

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(O).
3. Let $lenVal$ be the result of `Get(O , "length")`.
4. Let len be `ToInt32(lenVal)`.
5. ReturnIfAbrupt(len).
6. Let $middle$ be `floor(len/2)`.
7. Let $lower$ be 0 .
8. Repeat, while $lower \neq middle$
 - a. Let $upper$ be $len - lower - 1$.
 - b. Let $upperP$ be `ToString(upper)`.
 - c. Let $lowerP$ be `ToString(lower)`.
 - d. Let $lowerValue$ be the result of `Get(O , lowerP)`.
 - e. ReturnIfAbrupt(lowerValue).
 - f. Let $upperValue$ be the result of `Get(O , upperP)`.
 - g. ReturnIfAbrupt(upperValue).
 - h. Let $lowerExists$ be the result of `HasProperty(O , lowerP)`.
 - i. ReturnIfAbrupt(lowerExists).
 - j. Let $upperExists$ be the result of `HasProperty(O , upperP)`.
 - k. ReturnIfAbrupt(upperExists).
 - l. If $lowerExists$ is `true` and $upperExists$ is `true`, then
 - i. Let $putStatus$ be the result of `Put(O , lowerP, upperValue, true)`.
 - ii. ReturnIfAbrupt(putStatus).
 - iii. Let $putStatus$ be the result of `Put(O , upperP, lowerValue, true)`.
 - iv. ReturnIfAbrupt(putStatus).
 - m. Else if $lowerExists$ is `false` and $upperExists$ is `true`, then
 - i. Let $putStatus$ be the result of `Put(O , lowerP, upperValue, true)`.
 - ii. ReturnIfAbrupt(putStatus).
 - iii. Let $deleteStatus$ be the result of `DeletePropertyOrThrow (O , upperP)`.
 - iv. ReturnIfAbrupt(deleteStatus).
 - n. Else if $lowerExists$ is `true` and $upperExists$ is `false`, then
 - i. Let $deleteStatus$ be the result of `DeletePropertyOrThrow (O , lowerP)`.
 - ii. ReturnIfAbrupt(deleteStatus).
 - iii. Let $putStatus$ be the result of `Put(O , upperP, lowerValue, true)`.
 - iv. ReturnIfAbrupt(putStatus).
 - o. Else both $lowerExists$ and $upperExists$ are `false`.
 - i. No action is required.
 - p. Increase $lower$ by 1.
9. 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. Whether the `reverse` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

Deleted: calling the [[Get]] internal method of O with argument "length"

Deleted: calling the [[...et]] internal method of O

Deleted: If $lowerValue$ is an abrupt completion, return $lowerValue$

Deleted: calling the [[...et]] internal method of O

Deleted: If $upperValue$ is an abrupt completion, return $upperValue$

Deleted: calling the [[HasProperty]] internal method of O with argument $upperP$

Deleted: calling the [[HasProperty]] internal method of O with argument $lowerP$

Deleted: calling Call the [[...ut]] internal method of O

Deleted: If $putStatus$ is an abrupt completion, return $putStatus$

Deleted: calling Call the [[...ut]] internal method of O

Deleted: If $putStatus$ is an abrupt completion, return $putStatus$

Deleted: calling Call the [[...ut]] internal method of O

Deleted: If $putStatus$ is an abrupt completion, return $putStatus$

Deleted: calling

Deleted: Call

Deleted: the [[...eletePropertyOrThrow ()]] internal

Deleted: If $deleteStatus$ is an abrupt completion, return $deleteStatus$

Deleted: calling Call the [[...elete]] internal

Deleted: If $deleteStatus$ is an abrupt completion, return $deleteStatus$

Deleted: calling Call the [[...ut]] internal method of O

Deleted: If $putStatus$ is an abrupt completion, return $putStatus$

Deleted: ,

Deleted: host

Deleted: calling the [[Get]] internal method of O with argument "length"

15.4.4.9 Array.prototype.shift ()

The first element of the array is removed from the array and returned.

1. Let O be the result of calling `ToObject` passing the `this` value as the argument.
2. ReturnIfAbrupt(O).
3. Let $lenVal$ be the result of `Get(O , "length")`.
4. Let len be `ToInt32(lenVal)`.

5. ReturnIfAbrupt(len).
6. If *len* is zero, then
 - a. Let putStatus be the result of Put(*O*, "length", 0, true).
 - b. ReturnIfAbrupt(putStatus).
 - c. Return **undefined**.
7. Let *first* be the result of Get(*O*, "0").
8. ReturnIfAbrupt(first).
9. Let *k* be 1.
10. Repeat, while *k* < *len*
 - a. Let *from* be ToString(k).
 - b. Let *to* be ToString(k-1).
 - c. Let *fromPresent* be the result of HasProperty(*O*, *from*).
 - d. ReturnIfAbrupt(fromPresent).
 - e. If *fromPresent* is **true**, then
 - i. Let *fromVal* be the result of Get(*O*, *from*).
 - ii. ReturnIfAbrupt(fromVal).
 - iii. Let putStatus be the result of Put(*O*, *to*, *fromVal*, true).
 - iv. ReturnIfAbrupt(putStatus).
 - f. Else *fromPresent* is **false**,
 - i. Let deleteStatus be the result of DeletePropertyOrThrow(*O*, *to*).
 - ii. ReturnIfAbrupt(deleteStatus).
 - g. Increase *k* by 1.
11. Let deleteStatus be the result of DeletePropertyOrThrow(*O*, ToString(len-1)).
12. ReturnIfAbrupt(deleteStatus).
13. Let putStatus be the result of Put(*O*, "length", *len*-1, true).
14. ReturnIfAbrupt(putStatus).
15. Return *first*.

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. Whether the **shift** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.10 Array.prototype.slice (start, end)

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 *A* be the result of the abstract operation **ArrayCreate** with argument *O*.
4. Let *lenVal* be the result of Get(*O*, "length").
5. Let *len* be Uint32(lenVal).
6. ReturnIfAbrupt(len).
7. Let *relativeStart* be ToInteger(start).
8. ReturnIfAbrupt(relativeStart).
9. If *relativeStart* is negative, let *k* be $\max((len + relativeStart), 0)$; else let *k* be $\min(relativeStart, len)$.
10. If *end* is **undefined**, let *relativeEnd* be *len*; else let *relativeEnd* be ToInteger(end).
11. ReturnIfAbrupt(relativeEnd).
12. If *relativeEnd* is negative, let *final* be $\max((len + relativeEnd), 0)$; else let *final* be $\min(relativeEnd, len)$.
13. Let *n* be 0.
14. Repeat, while *k* < *final*
 - a. Let *Pk* be ToString(k).
 - b. Let *kPresent* be the result of HasProperty(*O*, *Pk*).
 - c. ReturnIfAbrupt(kPresent).
 - d. If *kPresent* is **true**, then
 - i. Let *kValue* be the result of Get(*O*, *Pk*).
 - ii. ReturnIfAbrupt(kValue).
 - iii. Let *status* be the result of CreateOwnProperty(*A*, ToString(n), *kValue*).

- Deleted:** calling Call the [[Put]] internal method of *O* with arguments "length", 0, and true
- Deleted:** If *putStatus* is an abrupt completion, return *putStatus*
- Deleted:** calling the [[...et]] internal method of... ... with
- Deleted:** If *first* is an abrupt completion, return *first*
- Deleted:** calling the [[HasProperty]] internal method of...
- Deleted:** calling the [[...et]] internal method of... ... with
- Deleted:** If *fromVal* is an abrupt completion, return *fromVal*
- Deleted:** calling Call the [[...ut]] internal method of... ... with
- Deleted:** If *putStatus* is an abrupt completion, return *putStatus*
- Deleted:** ,
- Deleted:** calling Call the [[...elete]] internal method
- Deleted:** If *deleteStatus* is an abrupt completion, return *deleteStatus*
- Deleted:** calling Call the [[...eletePropertyOrThrow()]]
- Deleted:** If *deleteStatus* is an abrupt completion, return *deleteStatus*
- Deleted:** calling Call the [[...ut]] internal method of... ... with
- Deleted:** If *putStatus* is an abrupt completion, return *putStatus*
- Deleted:** host

- Deleted:** abstraction operation
- Deleted:** (15.4)
- Deleted:** a new array created as if by the expression **new Array()** where **Array** is the standard built-in constructor with that name
- Deleted:** calling the [[Get]] internal method of *O* with argument "length"
- Deleted:** If *relativeStart* is an abrupt completion, return *relativeStart*
- Deleted:** If *relativeEnd* is an abrupt completion, return *relativeEnd*
- Deleted:** calling the [[HasProperty]] internal method of...
- Deleted:** calling the [[...et]] internal method of... ... with
- Deleted:** If *kValue* is an abrupt completion, return *kValue*
- Deleted:** Call the [[DefineOwnProperty]] internal method

- iv. ReturnIfAbrupt(status).
- v. If status is false, throw a **TypeError** exception.
- e. Increase k by 1.
- f. Increase n by 1.

15. Let `putStatus` be the result of `Put(A, "length", final, true)`.

16. ReturnIfAbrupt(`putStatus`).

17. 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 15 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. Whether the `slice` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.11 `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 $x > y$.

Let obj be the result of calling `ToObject` passing the `this` value as the argument.

Let len be the result of applying `Uint32` to the result of `Get(obj, "length")`.

If `comparefn` is not **undefined** and is not a consistent comparison function for the elements of this array (see below), the behaviour of `sort` is implementation-defined.

Let $proto$ be the result of calling the `[[GetInheritance]]` 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 behaviour of `sort` is implementation-defined:

- obj is sparse (15.4)
- $0 \leq j < len$
- The result of `HasProperty(proto, ToString(j))` is **true**.

The behaviour of `sort` is also implementation defined if obj is sparse and any of the following conditions are true:

- 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 behaviour of `sort` is also implementation defined 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**.

Otherwise, the following steps are taken.

1. Perform an implementation-dependent sequence of calls to the `[[Get]]` and `[[Set]]` internal methods of obj , to the `DeletePropertyOrThrow` abstract operation with obj as the first argument, and to `SortCompare` (described below), where the `property key` argument for each call to `[[Get]]`, `[[Set]]`, or `DeletePropertyOrThrow` is the string representation of a nonnegative integer less than len and where the arguments for calls to `SortCompare` are results of previous calls to the `[[Get]]` internal method. 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.

Comment [AWB9165]: Fix for ES5 bug
https://bugs.ecmascript.org/show_bug.cgi?id=17

Deleted: calling the `[[Put]]` internal method of A with arguments "`length`", `final`, and `true`

Deleted: host

Comment [AWB7166]: TODO: take completion values into account

Deleted: `O`

Deleted: calling the `[[Get]]` internal method of obj with argument "`length`"

Deleted: `value`

Deleted: `Prototype`

Deleted: `e`

Deleted: `property`

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with argument

Deleted: calling

Deleted: `[[`

Deleted: `]]` internal property method of

Deleted:

Deleted: `P`

Deleted: ,

Deleted: `Put`

Deleted: `P`

Deleted: and

Deleted: `[[`

Deleted: `]]`

Deleted: internal methods

Deleted: `of`

Deleted: `first`

Deleted: `P`

Deleted: `P`

Deleted: `Put`

Deleted: `[[Delete]`

Deleted: `]`

Deleted: `P`

Deleted: The throw argument to the `[[Put]]` and `[[Delete]]` internal methods will be the value `true`

Deleted: `[[`

Deleted: `]]`

Deleted: `P`

2. Return *obj*.

The returned object must have the following two properties.

- 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 $\text{SortCompare}(j, k) < 0$ (see *SortCompare* below), then $\pi(j) < \pi(k)$.

Here the notation *old[j]* is used to refer to the hypothetical result of calling the **[[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 **[[Get]]** internal method of *obj* with argument *j* after this function has been executed.

Deleted: P

Deleted: P

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 $a <_{\text{CF}} b$ means *comparefn(a,b) < 0*; $a =_{\text{CF}} b$ means *comparefn(a,b) = 0* (of either sign); and $a >_{\text{CF}} b$ means *comparefn(a,b) > 0*.

- Calling *comparefn(a,b)* always returns the same value *v* when given a specific pair of values *a* and *b* as its two arguments. Furthermore, *Type(v)* is *Number*, and *v* is not *NaN*. Note that this implies that exactly one of $a <_{\text{CF}} b$, $a =_{\text{CF}} b$, and $a >_{\text{CF}} b$ will be true for a given pair of *a* and *b*.
- Calling *comparefn(a,b)* does not modify the **this** object.
- $a =_{\text{CF}} a$ (reflexivity)
- If $a =_{\text{CF}} b$, then $b =_{\text{CF}} a$ (symmetry)
- If $a =_{\text{CF}} b$ and $b =_{\text{CF}} c$, then $a =_{\text{CF}} c$ (transitivity of $=_{\text{CF}}$)
- If $a <_{\text{CF}} b$ and $b <_{\text{CF}} c$, then $a <_{\text{CF}} c$ (transitivity of $<_{\text{CF}}$)
- If $a >_{\text{CF}} b$ and $b >_{\text{CF}} c$, then $a >_{\text{CF}} c$ (transitivity of $>_{\text{CF}}$)

NOTE 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.

Runtime Semantics: SortCompare Abstract Operation

When the *SortCompare* abstract operation is called with two arguments *j* and *k*, the following steps are taken:

1. Let *jString* be *ToString(j)*.
2. Let *kString* be *ToString(k)*.
3. Let *hasj* be the result of *HasProperty(obj, jString)*.
4. ReturnIfAbrupt(hasj).
5. Let *hask* be the result of *HasProperty(obj, kString)*.
6. ReturnIfAbrupt(hask).
7. If *hasj* and *hask* are both **false**, then return **+0**.
8. If *hasj* is **false**, then return **1**.
9. If *hask* is **false**, then return **-1**.
10. Let *x* be the result of *Get(obj, jString)*.
11. ReturnIfAbrupt(x).
12. Let *y* be the result of *Get(obj, kString)*.
13. ReturnIfAbrupt(y).
14. If *x* and *y* are both **undefined**, return **+0**.
15. If *x* is **undefined**, return **1**.
16. If *y* is **undefined**, return **-1**.
17. If the argument *comparefn* is not **undefined**, then
 - a. If *IsCallable(comparefn)* is **false**, throw a **TypeError** exception.
 - b. Return the result of calling the **[[Call]]** internal method of *comparefn* passing **undefined** as *thisArgument* and with a *List* contain the values of *x* and *y* as the *argumentsList*.
18. Let *xString* be *ToString(x)*.
19. ReturnIfAbrupt(xString).
20. Let *yString* be *ToString(y)*.
21. ReturnIfAbrupt(yString).

Deleted: calling the **[[GetProperty]]** internal method of

Deleted: with argument

Deleted: calling the **[[GetProperty]]** internal method of

Deleted: with argument

Deleted: calling the **[[**

Deleted: **]]** internal method of

Deleted:

Deleted: with argument

Deleted: calling the **[[**

Deleted: **]]** internal method of

Deleted:

Deleted: with argument

Deleted: the **this** value

Deleted: arguments

22. If $xString < yString$, return -1 .
23. If $xString > yString$, return 1 .
24. 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 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. Whether the ***sort*** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.12 Array.prototype.splice (start, deleteCount [, item1 [, item2 [, ...]]])

When the ***splice*** method is called with two or more arguments *start*, *deleteCount* and (optionally) *item1*, *item2*, etc., the *deleteCount* elements of the array starting at array index *start* are replaced by the arguments *item1*, *item2*, etc. 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 A be the result of the abstract operation **ArrayCreate** with argument 0 .
4. Let $lenVal$ be the result of **Get**(O , "length").
5. Let len be **ToUint32**($lenVal$).
6. ReturnIfAbrupt(len).
7. Let $relativeStart$ be **ToInteger**($start$).
8. ReturnIfAbrupt($relativeStart$).
9. If $relativeStart$ is negative, let $actualStart$ be $\max((len + relativeStart), 0)$; else let $actualStart$ be $\min(relativeStart, len)$.
10. Let $actualDeleteCount$ be $\min(\max(\text{ToInteger}(deleteCount), 0), len - actualStart)$.
11. Let k be 0 .
12. Repeat, while $k < actualDeleteCount$
 - a. Let $from$ be **ToString**($actualStart + k$).
 - b. Let $fromPresent$ be the result of **HasProperty**(O , $from$).
 - c. ReturnIfAbrupt($fromPresent$).
 - d. If $fromPresent$ is **true**, then
 - i. Let $fromValue$ be the result of **Get**(O , $from$).
 - ii. ReturnIfAbrupt($fromValue$).
 - iii. Call the **[[DefineOwnProperty]]** internal method of A with arguments **ToString**(k) and Property Descriptor **{[[Value]]: $fromValue$, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}**.
 - e. Increment k by 1 .
13. Let $putStatus$ be the result of **Put**(A , "length", $actualDeleteCount$, **true**).
14. ReturnIfAbrupt($putStatus$).
15. Let $items$ be an internal List whose elements are, in left to right order, the portion of the actual argument list starting with *item1*. The list will be empty if no such items are present.
16. Let $itemCount$ be the number of elements in $items$.
17. If $itemCount < actualDeleteCount$, then
 - a. Let k be $actualStart$.
 - b. Repeat, while $k < (len - actualDeleteCount)$
 - i. Let $from$ be **ToString**($k + actualDeleteCount$).
 - ii. Let to be **ToString**($k + itemCount$).
 - iii. Let $fromPresent$ be the result of **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 the result of **Put**(O , to , $fromValue$, **true**).
 4. ReturnIfAbrupt($putStatus$).
 - vi. Else $fromPresent$ is false
 1. Let $deleteStatus$ be the result of **DeletePropertyOrThrow**(O , to).

Deleted: host
Deleted: abstraction operation
Deleted: (15.4)
Deleted: a new array created as if by the expression new Array() where Array is the standard built-in constructor with that name
Deleted: calling the [[Get]] internal method of O with argument "length" .
Deleted: calling the [[HasProperty]] internal method of O
Deleted: with argument
Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: with argument
Deleted:) ,
Deleted: , and false
Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: with arguments
Deleted: and
Deleted: calling the [[HasProperty]] internal method of O
Deleted: with argument
Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: with argument
Deleted: Call
Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: with arguments
Deleted: and
Deleted: ,
Deleted: Call
Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: with arguments
Deleted: and true

2. `ReturnIfAbrupt(deleteStatus)`.
- vii. Increase k by 1.
 - c. Let k be len .
 - d. Repeat, while $k > (len - actualDeleteCount + itemCount)$
 - i. Let $deleteStatus$ be the result of `DeletePropertyOrThrow(O, ToString(k-1))`.
 - ii. `ReturnIfAbrupt(deleteStatus)`.
 - iii. Decrease k by 1.
18. Else if $itemCount > actualDeleteCount$, then
- a. Let k be $(len - actualDeleteCount)$.
 - b. Repeat, while $k > actualStart$
 - i. Let $from$ be $ToString(k + actualDeleteCount - 1)$.
 - ii. Let to be $ToString(k + itemCount - 1)$
 - iii. Let $fromPresent$ be the result of `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 the result of `Put(O, to, fromValue, true)`.
 - 4. `ReturnIfAbrupt(putStatus)`.
 - vi. Else $fromPresent$ is **false**,
 - 1. Let $deleteStatus$ be the result of `DeletePropertyOrThrow(O, to)`.
 - 2. `ReturnIfAbrupt(deleteStatus)`.
 - vii. Decrease k by 1.
19. Let k be $actualStart$.
20. Repeat, while $items$ is not empty
- a. Remove the first element from $items$ and let E be the value of that element.
 - b. Let $putStatus$ be the result of `Put(O, ToString(k), E, true)`.
 - c. `ReturnIfAbrupt(putStatus)`.
 - d. Increase k by 1.
21. Let $putStatus$ be the result of `Put(O, "length", len - actualDeleteCount + itemCount, true)`.
22. `ReturnIfAbrupt(putStatus)`.
23. Return A .

The `length` property of the `splice` method is 2.

NOTE 1 The explicit setting of the `length` property of the result Array in step 13 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. Whether the `splice` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.13 `Array.prototype.unshift([item1 [, item2 [, ...]]])`

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 $lenVal$ be the result of `Get(O, "length")`.
4. Let len be `ToUint32(lenVal).`
5. `ReturnIfAbrupt(len)`.
6. Let $argCount$ be the number of actual arguments.
7. Let k be len .
8. Repeat, while $k > 0$,
 - a. Let $from$ be $ToString(k-1)$.
 - b. Let to be $ToString(k+argCount-1)$.

Deleted: calling Call the [[Delete]] internal method of O with arguments len and $"length"$.
Deleted: with arguments
Deleted: and true

Deleted: calling the [[HasProperty]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling Call the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling Call the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling Call the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling Call the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling Call the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling Call the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling Call the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling Call the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling Call the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

Deleted: calling the [[Delete]] internal method of O with argument $"length"$.
Deleted: with argument

- c. Let *fromPresent* be the result of HasProperty(*O*, *from*).
 - d. ReturnIfAbrupt(*fromPresent*).
 - e. If *fromPresent* is **true**, then
 - i. Let *fromValue* be the result of Get(*O*, *from*).
 - ii. ReturnIfAbrupt(*fromValue*).
 - iii. Let *putStatus* be the result of Put(*O*, *to*, *fromValue*, **true**).
 - iv. ReturnIfAbrupt(*putStatus*).
 - f. Else *fromPresent* is **false**,
 - i. Let *deleteStatus* be the result of DeletePropertyOrThrow(*O*, *to*).
 - ii. ReturnIfAbrupt(*deleteStatus*).
 - g. Decrease *k* by 1.
9. Let *j* be 0.
10. Let *items* be an internal List whose elements are, in left to right order, the arguments that were passed to this function invocation.
11. Repeat, while *items* is not empty
 - a. Remove the first element from *items* and let *E* be the value of that element.
 - b. Let *putStatus* be the result of Put(*O*, ToString(*j*), *E*, **true**).
 - c. ReturnIfAbrupt(*putStatus*).
 - d. Increase *j* by 1.
12. Let *putStatus* be the result of Put(*O*, "length", *len+argCount*, **true**).
13. ReturnIfAbrupt(*putStatus*).
14. 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. Whether the **unshift** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.14 Array.prototype.indexOf (*searchElement* [, *fromIndex*])

indexOf compares *searchElement* to the elements of the array, in ascending order, using the internal Strict Equality Comparison Algorithm (11.9.1), and if found at one or more positions, returns the index of the first such position; 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.

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 *lenValue* be the result of Get(*O*, "length").
4. Let *len* be **ToInt32**(*lenValue*).
5. ReturnIfAbrupt(*len*).
6. If *len* is 0, return -1.
7. If argument *fromIndex* was passed let *n* be **ToInteger**(*fromIndex*); else let *n* be 0.
8. ReturnIfAbrupt(*n*).
9. If *n* \geq *len*, return -1.
10. If *n* \geq 0, then
 - a. Let *k* be *n*.
11. Else *n* < 0,
 - a. Let *k* be *len* - **abs**(*n*).
 - b. If *k* \leq 0, then let *k* be 0.
12. Repeat, while *k* < *len*
 - a. Let *kPresent* be the result of HasProperty(*O*, ToString(*k*)).
 - b. ReturnIfAbrupt(*kPresent*).

- Deleted:** calling the [[HasProperty]] internal method of
- Deleted:** with argument
- Deleted:** calling the [[
- Deleted:**]] internal method of
- Deleted:**
- Deleted:** with argument
- Deleted:** calling Call the [[
- Deleted:**]] internal method of
- Deleted:**
- Deleted:** with arguments
- Deleted:** and
- Deleted:**,
- Deleted:** calling Call the [[
- Deleted:**]] internal method of
- Deleted:** with arguments
- Deleted:**, and **true**
- Deleted:** calling Call the [[
- Deleted:**]] internal method of
- Deleted:**
- Deleted:** with arguments
- Deleted:** and
- Deleted:** calling Call the [[
- Deleted:**]] internal method of
- Deleted:**
- Deleted:** with arguments
- Deleted:** and
- Deleted:** calling Call the [[
- Deleted:**]] internal method of
- Deleted:**
- Deleted:** with arguments
- Deleted:** host
- Deleted:** 6

- 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 the Strict Equality Comparison Algorithm
searchElement === elementK.
 - iv. If *same* is **true**, return *k*.
 - d. Increase *k* by 1.
13. 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. Whether the **indexOf** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.15 Array.prototype.lastIndexOf (*searchElement* [, *fromIndex*])

lastIndexOf compares *searchElement* to the elements of the array in descending order using the internal Strict Equality Comparison Algorithm (11.9.1), and if found at one or more positions, returns the index of the last such position; 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 *lenValue* be the result of Get(*O*, "length").
 4. Let *len* be **ToUint32**(*lenValue*).
 5. ReturnIfAbrupt(*len*).
 6. If *len* is 0, return -1.
 7. If argument *fromIndex* was passed let *n* be **ToInteger**(*fromIndex*); else let *n* be *len*-1.
 8. ReturnIfAbrupt(*n*).
 9. If *n* ≥ 0, then let *k* be **min**(*n*, *len* - 1).
 10. Else, *n* < 0.
 - a. Let *k* be *len* - **abs**(*n*).
 11. Repeat, while *k* ≥ 0
 - a. Let *kPresent* be the result of 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 Algorithm
searchElement === elementK.
 - iv. If *same* is **true**, return *k*.
 - d. Decrease *k* by 1.
12. Return -1.

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. Whether the **lastIndexOf** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.16 Array.prototype.every (*callbackfn* [, *thisArg*])

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

Deleted: calling the [[Delete]] internal method of
Deleted:]]) internal method of
Deleted:
Deleted: with the argument
Deleted: If *elementK* is an abrupt completion, return *elementK*.
Deleted: applying
Deleted: to
Deleted: and
Deleted: host

Deleted: 6

Deleted: calling the [[Get]] internal method of *O* with the argument "length".

Deleted: If *n* is an abrupt completion, return *n*.

Deleted:,

Deleted: calling the [[HasProperty]] internal method of
Deleted: with argument

Deleted: calling the [[Delete]] internal method of
Deleted:]]) internal method of
Deleted:
Deleted: with the argument
Deleted: If *elementK* is an abrupt completion, return *elementK*.
Deleted: applying
Deleted: the
Deleted: Algorithm
Deleted: to
Deleted: and
Deleted: host

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*.

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 *lenValue* be the result of *Get(O, "length")*.
4. Let *len* be *ToInt32(lenValue)*.
5. **ReturnIfAbrupt(*len*)**.
6. If *IsCallable(callbackfn)* is **false**, throw a **TypeError** exception.
7. If *thisArg* was supplied, let *T* be *thisArg*; else let *T* be **undefined**.
8. Let *k* be 0.
9. Repeat, while *k* < *len*
 - a. Let *Pk* be *ToString(k)*.
 - b. Let *kPresent* be the result of *GetProperty(*O*, *Pk*)*.
 - c. If *kPresent* is **true**, then
 - i. Let *kValue* be the result of *Get(*O*, *Pk*)*.
 - ii. **ReturnIfAbrupt(*kValue*)**.
 - iii. Let *testResult* be the result of calling the **[[Call]]** internal method of *callbackfn* with *T* as **thisArgument** and a List containing *kValue*, *k*, and *O* as **argumentsList**.
 - iv. **ReturnIfAbrupt(*testResult*)**.
 - v. If *ToBoolean(testResult)* is **false**, return **false**.
 - d. Increase *k* by 1.
10. Return **true**.

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. Whether the **every** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.17 Array.prototype.some (*callbackfn* [, *thisArg*])

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.

Deleted: calling the **[[Get]]** internal method of *O* with the argument "**length**".

Deleted: calling the **[[HasProperty]]** internal method of *O* with argument *Pk*.

Deleted: with argument *k*.

Deleted: calling the **[[Call]]** internal method of *callbackfn* with *T* as **thisArgument** and a List containing *kValue*, *k*, and *O* as **argumentsList**.

Deleted: **]]** internal method of *callbackfn*.

Deleted:

Deleted: with argument *kValue*.

Deleted: If *kValue* is an abrupt completion, return *kValue*.

Deleted: the **this** value.

Deleted: argument.

Deleted: list.

Deleted: If *testResult* is an abrupt completion, return *testResult*.

Deleted: host.

`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 $lenValue$ be the result of `Get(O , "length")`
4. Let len be `ToInt32(lenValue)`.
5. `ReturnIfAbrupt(len)`
6. If `IsCallable(callbackfn)` is `false`, throw a `TypeError` exception.
7. If `thisArg` was supplied, let T be `thisArg`; else let T be `undefined`.
8. Let k be 0 .
9. Repeat, while $k < len$
 - a. Let P_k be `ToString(k)`.
 - b. Let $kPresent$ be the result of `HasProperty(O , P_k)`.
 - c. `ReturnIfAbrupt(kPresent)`
 - d. If $kPresent$ is `true`, then
 - i. Let $kValue$ be the result of `Get(O , P_k)`.
 - ii. `ReturnIfAbrupt(kValue)`
 - iii. Let $testResult$ be the result of calling the `[[Call]]` internal method of `callbackfn` with T as `thisArgument` and a List containing $kValue$, k , and O as `argumentsList`.
 - iv. `ReturnIfAbrupt(testResult)`
 - v. If `ToBoolean(testResult)` is `true`, return `true`.
 - e. Increase k by 1 .
10. 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. Whether the `some` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.18 `Array.prototype.forEach (callbackfn [, thisArg])`

`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.

`forEach` 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 `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

Deleted: calling the `[[Get]]` internal method of O with the argument "length"

Deleted: calling the `[[HasProperty]]` internal method of

Deleted: with argument

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with argument

Deleted: If $kValue$ is an abrupt completion, return $kValue$.

Deleted: the `this` value

Deleted: argument

Deleted: list

Deleted: If $testResult$ is an abrupt completion, return $testResult$.

Deleted: host

the array are changed, their value as passed to callback 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 $lenValue$ be the result of `Get(O , "length")`.
4. Let len be `ToInt32(lenValue)`.
5. `ReturnIfAbrupt(len)`.
6. If `IsCallable(callbackfn)` is `false`, throw a `TypeError` exception.
7. If `thisArg` was supplied, let T be `thisArg`; else let T be `undefined`.
8. Let k be 0.
9. Repeat, while $k < len$
 - a. Let Pk be `ToString(k).`
 - b. Let $kPresent$ be the result of `HasProperty(O , Pk)`.
 - c. `ReturnIfAbrupt($kPresent$)`.
 - d. If $kPresent$ is `true`, then
 - i. Let $kValue$ be the result of `Get(O , Pk)`.
 - ii. `ReturnIfAbrupt($kValue$)`.
 - iii. Let $funcResult$ be the result of calling the `[[Call]]` internal method of `callbackfn` with T as `thisArgument` and a List containing $kValue$, k , and O as `argumentsList`.
 - iv. `ReturnIfAbrupt(funcResult)`.
 - e. Increase k by 1.
10. Return `undefined`.

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. Whether the `forEach` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.19 `Array.prototype.map (callbackfn [, thisArg])`

`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 $lenValue$ be the result of `Get(O , "length")`.
4. Let len be `ToInt32(lenValue)`.
5. `ReturnIfAbrupt(len)`.

Deleted: calling the `[[Get]]` internal method of O with the argument "length".

Deleted: calling the `[[HasProperty]]` internal method of O with argument

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with argument

Deleted: If $kValue$ is an abrupt completion, return $kValue$.

Deleted: Call

Deleted: the `this` value

Deleted: argument

Deleted: list

Deleted: If $funcResult$ is an abrupt completion, return $funcResult$.

Deleted: host

6. If `IsCallable(callbackfn)` is `false`, throw a `TypeError` exception.
7. If `thisArg` was supplied, let `T` be `thisArg`; else let `T` be `undefined`.
8. Let `A` be the result of the abstract operation `ArrayCreate` with argument `len`.
9. Let `k` be `0`.
10. Repeat, while `k < len`
 - a. Let `Pk` be `ToString(k)`.
 - b. Let `kPresent` be the result of `HasProperty(O, Pk)`.
 - c. `ReturnIfAbrupt(kPresent)`.
 - d. If `kPresent` is `true`, then
 - i. Let `kValue` be the result of `Get(O, Pk)`.
 - ii. `ReturnIfAbrupt(kValue)`.
 - iii. Let `mappedValue` be the result of calling the `[[Call]]` internal method of `callbackfn` with `T` as `thisArgument` and a `List` containing `kValue`, `k`, and `O` as `argumentsList`.
 - iv. `ReturnIfAbrupt(mappedValue)`.
 - v. Call the `[[DefineOwnProperty]]` internal method of `A` with arguments `Pk` and `Property Descriptor` `{[[Value]]: mappedValue, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
 - 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. Whether the `map` function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.20 `Array.prototype.filter (callbackfn [, thisArg])`

`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.

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 `lenValue` be the result of `Get(O, "length")`.
4. Let `len` be `ToUint32(lenValue)`.
5. `ReturnIfAbrupt(len)`.
6. If `IsCallable(callbackfn)` is `false`, throw a `TypeError` exception.
7. If `thisArg` was supplied, let `T` be `thisArg`; else let `T` be `undefined`.
8. Let `A` be the result of the abstract operation `ArrayCreate` with argument `0`.
9. Let `k` be `0`.
10. Let `toBe` to `0`.
11. Repeat, while `k < len`

- Deleted:** abstraction operation
- Deleted:** (15.4)
- Deleted:** a new array created as if by the expression `new Array(len)` where `Array` is the standard built-in constructor with that name and `len` is the value of `len`
- Deleted:** calling the `[[HasProperty]]` internal method of `O` with argument
- Deleted:** calling the `[[`
- Deleted:** `]]` internal method of
- Deleted:**
- Deleted:** with argument
- Deleted:** the `this` value
- Deleted:** argument
- Deleted:** list
- Deleted:**,
- Deleted:**, and `false`
- Deleted:** host

- a. Let Pk be $\text{ToString}(k)$.
 - b. Let $kPresent$ be the result of `HasProperty(O, Pk)`.
 - c. `ReturnIfAbrupt(kPresent)`.
 - d. If $kPresent$ is **true**, then
 - i. Let $kValue$ be the result of `Get(O, Pk)`.
 - ii. `ReturnIfAbrupt(kValue)`.
 - iii. Let $selected$ be the result of calling the `[[Call]]` internal method of $callbackfn$ with T as `thisArgument` and a List containing $kValue$, k , and O as `argumentsList`.
 - iv. `ReturnIfAbrupt(selected)`.
 - v. If $\text{.ToBoolean}(selected)$ is **true**, then
 1. Call the `[[DefineOwnProperty]]` internal method of A with arguments $\text{ToString}(to)$ and `Property Descriptor {[[Value]]: kValue, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
 2. 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. Whether the **filter** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.21 `Array.prototype.reduce (callbackfn [, initialValue])`

`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 $lenValue$ be the result of `Get(O, "length")`.
4. Let len be `ToInt32(lenValue)`.
5. `ReturnIfAbrupt(len)`.
6. If `IsCallable(callbackfn)` is **false**, throw a **TypeError** exception.
7. If len is 0 and `initialValue` is not present, throw a **TypeError** exception.
8. Let k be 0.
9. If `initialValue` is present, then
 - a. Set `accumulator` to `initialValue`.
10. Else, `initialValue` is not present.
 - a. Let $kPresent$ be **false**.
 - b. Repeat, while $kPresent$ is **false** and $k < len$
 - i. Let Pk be $\text{ToString}(k)$.

- Deleted:** calling the `[[HasProperty]]` internal method of O with argument
- Deleted:** calling the `[[`
- Deleted:** `]]` internal method of
- Deleted:**
- Deleted:** with argument
- Deleted:** If $kValue$ is an abrupt completion, return $kValue$
- Deleted:** the **this** value
- Deleted:** argument
- Deleted:** list
- Deleted:** If $selected$ is an abrupt completion, return $selected$.
- Deleted:** `),`
- Deleted:** `, and false`
- Deleted:** host

- ii. Let *kPresent* be the result of `HasProperty(O, Pk)`.
 - iii. `ReturnIfAbrupt(kPresent)`.
 - iv. If *kPresent* is **true**, then
 - 1. Let *accumulator* be the result of `Get(O, Pk)`.
 - 2. `ReturnIfAbrupt(accumulator)`.
 - v. Increase *k* by 1.
 - c. If *kPresent* is **false**, throw a **TypeError** exception.
11. Repeat, while *k* < *len*
- a. Let *Pk* be `ToString(k)`.
 - b. Let *kPresent* be the result of `HasProperty(O, Pk)`.
 - c. `ReturnIfAbrupt(kPresent)`.
 - d. If *kPresent* is **true**, then
 - i. Let *kValue* be the result of `Get(O, Pk)`.
 - ii. `ReturnIfAbrupt(kValue)`.
 - iii. Let *accumulator* be the result of calling the `[[Call]]` internal method of *callbackfn* with **undefined** as *thisArgument* and a *List* containing *accumulator*, *kValue*, *k*, and *O* as *argumentsList*.
 - iv. `ReturnIfAbrupt(accumulator)`.
 - e. Increase *k* by 1.
12. 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. Whether the **reduce** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.4.22 `Array.prototype.reduceRight (callbackfn [, initialValue])`

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:

1. Let *O* be the result of calling `ToObject` passing the **this** value as the argument.
2. `ReturnIfAbrupt(O)`.
3. Let *lenValue* be the result of `Get(O, "length")`.
4. Let *len* be `ToInt32(lenValue)`.
5. `ReturnIfAbrupt(len)`.
6. If `IsCallable(callbackfn)` is **false**, throw a **TypeError** exception.
7. If *len* is 0 and *initialValue* is not present, throw a **TypeError** exception.
8. Let *k* be *len*-1.
9. If *initialValue* is present, then

- Deleted:** calling the `[[HasProperty]]` internal method of *O* with argument
- Deleted:** calling the `[[`
- Deleted:** `]]` internal method of
- Deleted:**
- Deleted:** with argument
- Deleted:** If *accumulator* is an abrupt completion, return *accumulator*.
- Deleted:** calling the `[[HasProperty]]` internal method of *O* with argument
- Deleted:** calling the `[[`
- Deleted:** `]]` internal method of
- Deleted:**
- Deleted:** with argument
- Deleted:** If *kValue* is an abrupt completion, return *kValue*
- Deleted:** the **this** value
- Deleted:** argument
- Deleted:** list
- Deleted:** If *accumulator* is an abrupt completion, return *accumulator*
- Deleted:** host

- a. Set *accumulator* to *initialValue*.
10. Else, *initialValue* is not present,
 - a. Let *kPresent* be **false**.
 - b. Repeat, while *kPresent* is **false** and *k* ≥ 0
 - i. Let *Pk* be *ToString(k)*.
 - ii. Let *kPresent* be the result of *HasProperty(O, Pk)*.
 - iii. *ReturnIfAbrupt(kPresent)*.
 - iv. If *kPresent* is **true**, then
 1. Let *accumulator* be the result of *Get(O, Pk)*.
 2. *ReturnIfAbrupt(accumulator)*.
 - v. Decrease *k* by 1.
 - c. If *kPresent* is **false**, throw a **TypeError** exception.
11. Repeat, while *k* ≥ 0
 - a. Let *Pk* be *ToString(k)*.
 - b. Let *kPresent* be the result of *HasProperty(O, Pk)*.
 - c. *ReturnIfAbrupt(kPresent)*.
 - d. If *kPresent* is **true**, then
 - i. Let *kValue* be the result of *Get(O, Pk)*.
 - ii. *ReturnIfAbrupt(kValue)*.
 - iii. Let *accumulator* be the result of calling the **[[Call]]** internal method of *callbackfn* with **undefined** as *thisArgument* and a **List** containing *accumulator*, *kValue*, *k*, and *O* as *argumentsList*.
 - iv. *ReturnIfAbrupt(accumulator)*.
 - e. Decrease *k* by 1.
12. 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. Whether the **reduceRight** function can be applied successfully to an exotic object that is not an Array is implementation-dependent.

15.4.23 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 the result of calling the **CreateArrayIterator** abstract operation with arguments *O* and "**key+value**".

15.4.24 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 the result of calling the **CreateArrayIterator** abstract operation with arguments *O* and "**key**".

15.4.25 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 the result of calling the **CreateArrayIterator** abstract operation with arguments *O* and "**value**".

Deleted:,

Deleted: calling the **[[HasProperty]]** internal method of *O* with argument

Deleted: of calling the **[[**

Deleted: **]]** internal method of

Deleted:

Deleted: with argument

Deleted: If *accumulator* is an abrupt completion return *accumulator*

Deleted: calling the **[[HasProperty]]** internal method of *O* with argument

Deleted: calling the **[[**

Deleted: **]]** internal method of

Deleted:

Deleted: with argument

Deleted: If *kValue* is an abrupt completion, return *kValue*

Deleted: the **this** value

Deleted: argument

Deleted: list

Deleted: If *accumulator* is an abrupt completion return *accumulator*

Deleted: host

Comment [AWB11167]: Need to decide whether to allow an argument that requests sparse iteration

Deleted: items

Comment [AWB11168]: Need to decide whether to allow an argument that requests sparse iteration

Comment [AWB11169]: Need to decide whether to allow an argument that requests sparse iteration

15.4.4.26 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.

15.4.5 Properties of Array Instances

Array instances are exotic Array objects and have the internal methods specified for such objects. Array instances inherit properties from the Array prototype object. Array instances also have a `[[InitializationState]]` internal data property.

Array instances have a `length` property, and a set of enumerable properties with array index names.

15.4.5.1 length

The `length` property of this Array object is a data property whose value is always numerically greater than the name of every deletable 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 property name of an existing array indexed non-deletable property of the array will result in the `length` being set to a numeric value that is one greater than that largest numeric property name. See [8.4.2.1](#).

15.4.6 Array Iterator Object Structure

An Array Iterator is an object, with the structure defined below, that represent 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.

15.4.6.1 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. Let `O` be the result of calling `ToObject(array)`.
2. ReturnIfAbrupt(`O`).
3. Let `itr` be the result of the abstract operation `ObjectCreate` with the intrinsic object `%ArrayIteratorPrototype%` as its argument.
4. Add a `[[IteratedObject]]` internal data property to `itr` with value `O`.
5. Add a `[[ArrayIteratorNextIndex]]` internal data property to `itr` with value `0`.
6. Add a `[[ArrayIterationKind]]` internal data property of `itr` with value `kind`.
7. Return `itr`.

15.4.6.2 The Array Iterator Prototype

All Array Iterator Objects inherit properties from a common Array Iterator Prototype object. The `[[Prototype]]` internal data property of the Array Iterator Prototype is the `%ObjectPrototype%` intrinsic object. In addition, the Array Iterator Prototype has the following properties:

15.4.6.2.1 ArrayIterator.prototype.constructor

15.4.6.2.2 ArrayIterator.prototype.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 properties of a Array Iterator Instance (15.4.6.1.2), throw a `TypeError` exception.
4. Let `a` be the value of the `[[IteratedObject]]` internal data property of `O`.

Comment [AWB10170]: This is how we identify a property whose key is a built-in Symbol

Comment [AWB10171]: Do we really want to do this sort of method sharing. It has a bad smell.

Deleted: items

Deleted: that

Deleted: and

Deleted: their `[[Class]]`

Deleted: the

Deleted: IsArray

Deleted: NativeBrand

Deleted: BuiltinBrand

Deleted: with value NativeArrayBuiltinArray

Deleted: value is "Array"

Deleted: Array instances also have the following properties.

Deleted: 15.4.5.1 `[[DefineOwnProperty]]` (`P, Desc, Throw`)

Array objects use a variation of the `[[DefineOwnProperty]]` internal method used for other native ECMAScript objects (8.12.9). ¶ Assume `A` is an Array object, `Desc` is a Property Descriptor, and `Throw` is a Boolean flag. ¶

In the following algorithm, the term "Reject" means "If `Throw` is true, then throw a `TypeError` exception, otherwise return `false`. ¶ When the `[[DefineOwnProperty]]` internal method of `A` is called with property `P`, Property Descriptor `Desc`, and Boolean flag `Throw`, the following steps are taken: ¶

```
<#>ReturnIfAbrupt(A).¶
<#>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. ¶
<#>Let oldLen be oldLenDesc.[[Value]].¶
<#>If P is "length", then¶
<#>If the [[Value]] field of Desc is absent, then¶
<#>Return the result of calling the default [[DefineOwnProperty]] internal method (8.12.9) on A passing "length", Desc, and Throw as arguments. ¶
<#>Let newLenDesc be a copy of Desc.¶
<#>Let newLen be ToUint32(Desc.[[Value]]).¶
<#>If newLen is not equal to ToNumber(Desc.[[Value]]), throw a RangeError exception. ¶
<#>Set newLenDesc.[[Value]] to newLen. ¶
<#>If newLen  $\geq$  oldLen, then¶
<#>Return the result of calling the default [[DefineOwnProperty]] internal method (8.12.9) on A passing "length", newLenDesc, and Throw as arguments. ¶
<#>Reject if oldLenDesc.[[Writable]] is false. ¶
<#>If newLenDesc.[[Writable]] is absent or has the value true, let newWritable be true. ¶
<#>Else, ¶
```

Deleted: 2

Deleted: 15

Deleted: 5

Comment [AWB10172]: TODO: need to decide what to use for a constructor for these sort of objects.

5. Let *index* be the value of the `[[ArrayIteratorNextIndex]]` internal data property of *O*.
6. Let *itemKind* be the value of the `[[ArrayIterationKind]]` internal data property of *O*.
7. Let *lenValue* be the result of `Get(a, "length")`.
8. Let *len* be `ToUint32(lenValue)`.
9. `ReturnIfAbrupt(len)`.
10. If *itemKind* contains the substring `"sparse"`, then
 - a. Let *found* be `false`.
 - b. Repeat, while *found* is `false` and *index* < *len*
 - i. Let *elementKey* be `ToString(index)`.
 - ii. Let *found* be the result of `HasProperty(a, elementKey)`.
 - iii. `ReturnIfAbrupt(found)`.
 - iv. If *found* is `false`, then
 1. Increase *index* by 1.
11. If *index* > *len*, then
 - a. Set the value of the `[[ArrayIteratorNextIndex]]` internal data property of *O* to $+\infty$.
 - b. Return `Completion({[type]: "throw", [value]: "%StopIteration%", [target]: empty})`.
12. Let *elementKey* be `ToString(index)`.
13. Set the value of the `[[ArrayIteratorNextIndex]]` internal data property of *O* to *index*+1.
14. If *itemKind* contains the substring `"value"`, then
 - a. Let *elementValue* be the result of `Get(a, elementKey)`.
 - b. `ReturnIfAbrupt(elementValue)`.
15. If *itemKind* contains the substring `"key+value"`, then
 - a. Let *result* be the result of the abstract operation `ArrayCreate` with argument 2.
 - b. Assert: *result* is a new, well-formed Array object so the following operations will never fail.
 - c. Call the `[[DefineOwnProperty]]` internal method of *result* with arguments `"0"` and `Property Descriptor {[[Value]: elementKey, [[Writable]: true, [[Enumerable]: true, [[Configurable]: true]]] }.`
 - d. Call the `[[DefineOwnProperty]]` internal method of *result* with arguments `"1"` and `Property Descriptor {[[Value]: elementValue, [[Writable]: true, [[Enumerable]: true, [[Configurable]: true]]] }.`
 - e. Return *result*.
16. Else If *itemKind* contains the substring `"key"` then, return *elementKey*.
17. Else *itemKind* is `"value"`,
 - a. Return *elementValue*.

15.4.6.2.3 `ArrayIterator.prototype.[@@iterator]`

The following steps are taken:

1. Return the `this` value.

15.4.6.2.4 `ArrayIterator.prototype.[@@toStringTag]`

The initial value of the `[@@toStringTag]` property is the string value `"Array Iterator"`.

15.4.6.3 Properties of Array Iterator Instances

Array Iterator instances inherit properties from the Array Iterator prototype (the intrinsic, `%ArrayIteratorPrototype%`.) Array Iterator instances are initially created with the internal properties listed in Table 32.

Table 32—Internal Data Properties of Array Iterator Instances

Internal Data Property Name	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.

Deleted: calling the `[[Get]]` internal method of *a* with the argument `"length"`

Deleted: calling the `[[HasProperty]]` internal method of *a* with argument

Deleted: Infinity

Comment [AWB10173]: We may need to elaborate on this??

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted: with argument

Deleted:,

Comment [AWB11174]: This is a string. Should be return the numeric value of *index* instead?

Deleted:, and `false`

Deleted:,

Deleted:, and `false`

Comment [AWB11175]: This is a string. Should be return the numeric value of *index* instead?

Comment [AWB10176]: This is how we identify a property whose key is a built-in Symbol

Deleted: Table 33Table 31Table 29

Deleted: 333129

[[ArrayIterationKind]]	A string value that identifies what is to be returned for each element of the iteration. The possible values are: "key", "value", "key+value", "sparse:key", "sparse:value", "sparse:key+value".
------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

15.5 String Objects

15.5.1 The String Constructor Called as a Function

When `String` is called as a function rather than as a constructor, it performs a type conversion. However, if the `this` value passed in the call is an Object with an uninitialized `[[StringData]]` internal data property, 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 initialization.

`String` may be subclassed and subclass constructors may perform a super invocation of the `String` constructor to initialize the `[[StringData]]` state of subclass instances.

15.5.1.1 `String (value)`

Returns a String value (not a String object) computed by `ToString(value)`. If `value` is not supplied, the empty String "" is returned.

When `String` is called with argument `value`, the following steps are taken:

1. Let `O` be the `this` value.
2. If `value` is `undefined`, then let `s` be "".
3. Else, let `s` be `ToString(value)`.
4. ReturnIfAbrupt(`s`).
5. If Type(`O`) is Object and `O` has a `[[StringData]]` internal data property and the value of `[[StringData]]` is `undefined`, then
 - a. Let `length` be the number of code unit elements in `s`.
 - b. Let `status` be the result of `DefinePropertyOrThrow(O, "length", Property Descriptor{[[Value]]: length, [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false })`.
 - c. ReturnIfAbrupt(`status`).
 - d. Set the value of `O`'s `[[StringData]]` internal data property to `s`.
 - e. Return `O`.
6. Return `s`.

Deleted: [

Deleted:]

15.5.2 The String Constructor

When `String` is called as part of a `new` expression, it is a constructor: it initialises the newly created exotic `String` object.

15.5.2.1 `new String (value)`

`String` called as part of a `new` expression with optional argument `value` performs the following steps:

1. Let `F` be the `String` function object on which the `new` operator was applied.
2. Let `argumentsList` be the `argumentsList` argument of the `[[Construct]]` internal method that was invoked by the `new` operator.
3. Return the result of `OrdinaryConstruct(F, argumentsList)`.

Deleted:

Deleted: [

Deleted:

Deleted:]

If `String` is implemented as an ordinary function object, its `[[Construct]]` internal method will perform the above steps.

15.5.3 Properties of the String Constructor

The value of the `[[Prototype]]` internal `data` property of the String constructor is the standard built-in Function prototype object (15.3.4).

Besides the `length` property (whose value is 1), the String constructor has the following properties:

15.5.3.1 String.prototype

The initial value of `String.prototype` is the standard built-in String prototype object (15.5.4).

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

15.5.3.2 String.fromCharCode(...codeUnits)

The `String.fromCharCode` function may be called with a variable number of arguments which form the rest parameter `codeUnits`. The following steps are taken:

1. Assert: `codeUnits` is a well-formed rest parameter object.
2. Let `length` be the result of `Get(codeUnits, "length")`.
3. Let `elements` be a new List.
4. Let `nextIndex` be 0.
5. Repeat while `nextIndex < length`
 - a. Let `next` be the result of `Get(codeUnits, ToString(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.

15.5.3.3 String.fromCodePoint(...codePoints)

The `String.fromCodePoint` function may be called with a variable number of arguments which form the rest parameter `codePoints`. The following steps are taken:

1. Assert: `codePoints` is a well-formed rest parameter object.
2. Let `length` be the result of `Get(codePoints, "length")`.
3. Let `elements` be a new List.
4. Let `nextIndex` be 0.
5. Repeat while `nextIndex < length`
 - a. Let `next` be the result of `Get(codePoints, ToString(nextIndex))`.
 - b. Let `nextCP` be `ToNumber(next)`.
 - c. ReturnIfAbrupt(`nextCP`).
 - d. If `SameValue(nextCP, ToInteger(nextCP))` is `false` then throw a `RangeError` exception.
 - e. If `nextCP < 0` or `nextCP > 0x10FFFF`, then throw a `RangeError` exception.
 - f. Append the elements of the UTF-16 Encoding (clause 6) 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.

The `length` property of the `fromCodePoint` function is 0.

Deleted: The `[[Prototype]]` internal data property of the newly constructed object is set to the standard built-in String prototype object that is the initial value of `String.prototype` (15.5.3.1).
The `[[Class]]` internal property of the newly constructed object is set to "String" has the `[[IsStringNativeBrand]]` internal property with value `StringWrapper`.
The `[[Extensible]]` internal data property of the newly constructed object is set to `true`.
The `[[PrimitiveValueStringData]]` internal data property of the newly constructed object is set to `ToString(value)`, or to the empty String if `value` is not supplied.

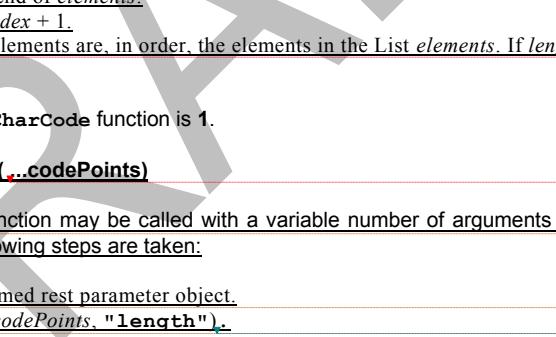
Deleted: the internal properties and

Comment [AWB9177]: Should we provide fromCodeUnit as an alias for this property and remove fromCharCode as obsolete.

Deleted: [

Deleted: ...

Deleted: char0 [, char1 [, ...]]]

Deleted: Returns a String value containing as many characters as the number of arguments. Each argument specifies one character of the resulting String, with the first argument specifying the first character, and so on, from left to right. An argument is converted to a character by applying the operation `ToUint16` (9.7) and regarding the resulting 16-bit integer as the code unit value of a character. If no arguments are supplied, the result is the empty String.


Deleted: ing

Deleted: calling the `[[Get]]` internal method of `codeUnits` with argument "length"

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with argument

Deleted: s

Deleted: ...

Deleted: charCode

Deleted: Units

Deleted: ing

Deleted: calling the `[[Get]]` internal method of `codeUnitsPoints` with argument "length"

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted: with argument

Deleted: v

Deleted: v

Deleted: s

Comment [AWB9178]: Note this follows the ES6 convention for rest parameters rather than the precedent established by fromCharCode

15.5.3.4 String.raw (callSite, ...substitutions)

The `String.raw` function may be called with a variable number of arguments. The first argument is `callSite` and the remainder of the arguments form the rest parameter `substitutions`. The following steps are taken:

1. Assert: `substitutions` is a well-formed rest parameter object.
2. Let `cooked` be `ToObject(callSite)`.
3. ReturnIfAbrupt(`cooked`).
4. Let `rawValue` be the result of `Get(cooked, "raw")`.
5. Let `raw` be `ToObject(rawValue)`.
6. ReturnIfAbrupt(`raw`).
7. Let `len` be the result of `Get(raw, "length")`.
8. Let `literalSegments` be `ToUint(len)`.
9. ReturnIfAbrupt(`literalSegments`).
10. If `literalSegments = 0`, then 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 elements are, in order, the elements in the List `stringElements`. If `length` is 0, the empty string is returned.
 - g. Let `next` be the result of `Get(substitutions, nextKey)`.
 - h. Let `nextSub` be `ToString(next)`.
 - i. ReturnIfAbrupt(`nextSub`).
 - j. Append in order the code unit elements of `nextSub` to the end of `stringElements`.
 - k. Let `nextIndex` be `nextIndex + 1`.

The `length` property of the `raw` function is 1.

NOTE `String.raw` is intended for use as a tag function of a Tagged Template String (11.2.6). When called as such the first argument will be a well formed template call site object and the rest parameter will contain the substitution values.

15.5.4.5 String[@@create]()

The `@@@create` method of an object `F` performs the following steps:

1. Let `F` be the `this` value.
2. Let `proto` be the result of `GetPrototypeOfConstructor(F, "%StringPrototype%")`.
3. ReturnIfAbrupt(`proto`).
4. Let `obj` be the result of calling `StringCreate(proto)`.
5. Return `obj`.

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

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 implementation may choose to encode the flag in some other manner.

15.5.4 Properties of the String Prototype Object

The `String` prototype object is itself an ordinary `String` object. It is not a `String` instance and does not have a `[[StringData]]` internal data property.

Deleted: ...

Deleted: ing

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with argument

Deleted: ing

Deleted: calling the `[[Get]]` internal method of `raw` with argument `"length"`

Comment [AWB10179]: TODO: this is something we probably need if we are going to eliminate array usage ToUint32

Deleted: while `nextIndex < literalSegments`

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with argument

Deleted: elements

Deleted: elements

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with argument

Deleted: elements

Deleted: Quasi

Deleted: quasi

Deleted: (its `[[Class]]` is "String")

Deleted: whose value is an empty String

Deleted: The `String` prototype object has the `[[IsStringNativeBrandBuiltinBrand]]` internal data property with value `StringWrapperBuiltinStringWrapper`.

The value of the `[[Prototype]]` internal `data` property of the String prototype object is the standard built-in Object prototype object (15.2.4).

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 data property 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 data property, then
 - a. Let `s` be the value of `value`'s `[[StringData]]` internal data property.
 - b. If `s` is not `undefined`, then return `s`.
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.

15.5.4.1 `String.prototype.constructor`

The initial value of `String.prototype.constructor` is the built-in `String` constructor.

15.5.4.2 `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.)

15.5.4.3 `String.prototype.valueOf()`

When the `valueOf` method is called, the following steps are taken:

1. Let `s` be `thisStringValue(this value)`.
2. Return `s`.

15.5.4.4 `String.prototype.charAt(pos)`

NOTE Returns a single element String containing the code unit at element position `pos` in the String value resulting from converting this object to a String. If there is no element at that position, 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 `CheckObjectCoercible(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 position `position`, where the first (leftmost) code unit in `S` is considered to be at position 0, the next one at position 1, and so on.

Deleted: Returns this String value. (

Deleted: that, f

Formatted: Note

Deleted: ote

Deleted: The `toString` function is not generic; it throws a `TypeError` exception if its `this` value is not a String or a String object. Therefore, it cannot be transferred to other kinds of objects for use as a method.¶

Comment [AWB9180]: Perhaps BMPChar should be provided as an alias for this method and charAt should be marked as obsolete.

Deleted: Returns this String value.¶ The `valueOf` function is not generic; it throws a `TypeError` exception if its `this` value is not a String or String object. Therefore, it cannot be transferred to other kinds of objects for use as a method.¶

Formatted: Note

Deleted: character

Deleted: String

Deleted: character

Deleted: ReturnIfAbrupt(

Deleted: Call

Deleted: passing the

Deleted: as its argument

Deleted:)

Deleted: the result of calling

Deleted: , giving it the `this` value as its argument

Deleted: s

Deleted: characters

Deleted: character

Deleted: character

Deleted: character

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.

15.5.4.5 `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 position pos` in the String resulting from converting this object to a String. If there is no `element at that position`, the result is `NaN`.

When the `charCodeAt` method is called with one argument `pos`, the following steps are taken:

1. Let `O` be `CheckObjectCoercible(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 position position` in the String `S`, where the first (leftmost) `element` in `S` is considered to be at position 0, the next one at position 1, and so on.

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.

15.5.4.6 `String.prototype.concat(...args)`

NOTE When the `concat` method is called with zero or more arguments, it returns a String consisting of the `string elements of this object (converted to a String) followed by the string elements of each of the arguments converted to a String`. The result is a String value, not a String object.

The following steps are taken:

1. Assert: `args` is a well-formed rest parameter object.
2. Let `O` be `CheckObjectCoercible(this value)`.
3. Let `S` be `ToString(O)`.
4. ReturnIfAbrupt(`S`).
5. Let `args` be an internal list that is a copy of the argument list passed to this function.
6. Let `R` be `S`.
7. 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 `ToString(next)`.
 - c. ReturnIfAbrupt(`nextString`).
 - d. Let `R` be the String value consisting of the `string elements in the previous value of R followed by the string elements of nextString`.
8. Return `R`.

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.

15.5.4.7 `String.prototype.indexOf(searchString, position)`

If `searchString` appears as a substring of the result of converting this object to a String, at one or more positions that are greater than or equal to `position`, then the index of the smallest such position 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:

- Deleted:** representing
- Deleted:** character
- Formatted:** Note
- Deleted:** character
- Deleted:** ReturnIfAbrupt()
- Deleted:**)
- Deleted:** Call `CheckObjectCoercible` passing the `this` value of its argument.
- Deleted:** the result of calling
- Deleted:** , giving it the `this` value as its argument
- Deleted:** characters
- Deleted:** character
- Deleted:** character
- Deleted:** [`string1` [, `string2` [, ...]]]
- Deleted:** ...
- Deleted:** `string1`, `string2`, etc.
- Deleted:** characters
- Formatted:** Note
- Deleted:** characters
- Deleted:** `string1`, `string2`, etc. (where each argument is)
- Deleted:**)
- Deleted:** .
- Deleted:** strings
- Deleted:** ReturnIfAbrupt()
- Deleted:**)
- Deleted:** Call `CheckObjectCoercible` passing the `this` value of its argument.
- Deleted:** the result of calling
- Deleted:** , giving it the `this` value as its argument
- Deleted:** characters
- Deleted:** characters
- Deleted:** `ToString`
- Deleted:**)

1. Let O be `CheckObjectCoercible(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 position $k+j$ of S is the same as the code unit at position j of $searchStr$; but if there is no such integer k , then return the value `-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 a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

15.5.4.8 `String.prototype.lastIndexOf (searchString, position)`

If $searchString$ appears as a substring of the result of converting this object to a String at one or more positions that are smaller than or equal to $position$, then the index of the greatest such position 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.

The `lastIndexOf` method takes two arguments, `searchString` and `position`, and performs the following steps:

1. Let O be `CheckObjectCoercible(this value)`.
2. Let S be `ToString(O)`.
3. `ReturnIfAbrupt(S)`.
4. Let $searchStr$ be `ToString(searchString)`.
5. `ReturnIfAbrupt($searchStr$)`.
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 position $k+j$ of S is the same as the code unit at position j of $searchStr$; but if there is no such integer k , then return the value `-1`.

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.

15.5.4.9 `String.prototype.localeCompare (that)`

When the `localeCompare` method is called with one 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 the system 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.

Before perform the comparisons the following steps are performed to prepare the Strings:

- Deleted:** `ReturnIfAbrupt(`
- Deleted:** `)`
- Deleted:** Call `CheckObjectCoercible` passing the `this` value as its argument.
- Deleted:** the result of calling `CheckObjectCoercible`
- Deleted:** , giving it the `this` value as its argument
- Deleted:** characters
- Deleted:** characters
- Deleted:** character
- Deleted:** character

1. Let O be `CheckObjectCoercible(this value)`.
2. Let S be `Tostring(O)`.
3. ReturnIfAbrupt(S).
4. Let $That$ be `Tostring(that)`.
5. ReturnIfAbrupt($That$).

The `localeCompare` method, if considered as a function of two arguments `this` and `that`, is a consistent comparison function (as defined in 15.4.4.11) 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 and to return `0` when comparing Strings that are considered canonically equivalent by the Unicode standard.

If no language-sensitive comparison at all is available from the host environment, this function may perform a bitwise comparison.

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. It is strongly recommended that this function treat Strings that are canonically equivalent according to the Unicode standard as identical (in other words, compare the Strings as if they had both been converted to Normalised Form C or D first). It is also recommended that this function not honour Unicode compatibility equivalences or decompositions.

NOTE 3 The second 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.

NOTE 4 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.

15.5.4.10 String.prototype.match (regexp)

When the `match` method is called with argument `regexp`, the following steps are taken:

1. Let O be `CheckObjectCoercible(this value)`.
2. Let S be `Tostring(O)`.
3. ReturnIfAbrupt(S).
4. If `Type(regexp)` is Object and `HasProperty(regexp, @@isRegExp)` is `true`, then let rx be `regexp`;
5. Else, let rx be the result of the `abstract operation RegExpCreate` (15.10.4.1) with arguments `regexp` and `undefined`.
6. ReturnIfAbrupt(rx).
7. Let $args$ be a new List with S as its sole element.
8. Return the result of `Invoke(regexp, "match", args)`.

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.

15.5.4.11 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 `CheckObjectCoercible(this value)`.
2. Let $string$ be `Tostring(O)`.
3. ReturnIfAbrupt($string$).
4. If `Type(searchValue)` is Object and `HasProperty(searchValue, @@isRegExp)` is `true`, then
 - a. Let $args$ be a new List with elements `string` and `replaceValue`.
 - b. Return the result of `Invoke(regexp, "replace", args)`.

- Deleted:** `ReturnIfAbrupt()`
- Deleted:** `)`
- Deleted:** Call `CheckObjectCoercible` passing the `this` value as its argument.
- Deleted:** the result of calling
- Deleted:** , giving it the `this` value as its argument
- Deleted:** `ReturnIfAbrupt()`
- Deleted:** `)`
- Deleted:** Call `CheckObjectCoercible` passing the `this` value as its argument.
- Deleted:** the result of calling
- Deleted:** , giving it the `this` value as its argument
- Deleted:** the value of the `[[Class]]` internal property of
- Deleted:** is `"RegExp"` has the internal property `[[IsRegExpNativeBrandBuiltinBrand]]` internal data property whose value is `NativeRegExpBuiltinRegExp`
- Deleted:** abstraction operation
- Deleted:** a new `RegExp` object created as if by the expression `new RegExp(regexp)` where `RegExp` is the standard built-in constructor with that name.
- Deleted:** `<#>Let global be the result of calling the [[Get]] internal method of rx with argument, "global".`
- Deleted:** `<#>ReturnIfAbrupt(global).`
- Deleted:** `<#>Let exec be the standard built-in function RegExp.prototype.exec (see 15.10.6.2).`
- Deleted:** `<#>If global is not true, then`
- Deleted:** `<#>Return the result of calling the [[Call]] internal method exec abstract operation RegExpExec (see 15.10.6.2) with arguments rx as and the this value and argument list containing S .`
- Deleted:** `<#>Else, global is true.`
- Deleted:** `<#>Let putStatus be the result of calling Call the [[Put]] internal method of rx with arguments, "lastIndex", and true.`
- Deleted:** `<#>ReturnIfAbrupt(putStatus).`
- Deleted:** `<#>Let A be a new array created as if by the expression new Array() where Array is the standard built-in constructor with that name the result of the abstraction operation AbstractOperationArrayCreate (15.4) with argument 0.`
- Deleted:** `<#>Let previousLastIndex be 0 .`
- Deleted:** `<#>Let n be 0 .`
- Deleted:** `<#>Let lastMatch be true.`
- Deleted:** `<#>Repeat, while lastMatch is true`
- Deleted:** `<#>Let result be the result of calling the abstract operation RegExpExec (see 15.10.6.2)[[Call]] internal method of $exec$ with arguments rx as the this value and argument list containing and S .`
- Deleted:** `<#>ReturnIfAbrupt(result).`
- Deleted:** `A`
- Deleted:** First set `string` according to the following steps
- Deleted:** `ReturnIfAbrupt()`
- Deleted:** `)`
- Deleted:** Call `CheckObjectCoercible` passing the `this` value as its argument.
- Deleted:** the result of calling
- Deleted:** , giving it the `this` value as its argument

5. Assert: *searchValue* is not a regular expression.
6. Let *searchString* be *ToString(searchValue)* and ReturnIfAbrupt(*searchString*).
7. Search *string* for the first occurrence of *searchString* and let *pos* be the index position within *string* of the first code unit of the matched substring and let *matched* be *searchString*. If no occurrences of *searchString* were found, let *pos* be 0 and let *matched* be the empty String.
8. If *IsCallable(replaceValue)* is true, then
 - a. Let *rep1Value* be the result of calling the [[Call]] internal methods of *replaceValue* passing *undefined* as the *this* Value and a List containing *matched*, *pos*, and *string* as the argument list.
 - b. Let *rep1Str* be *ToString(rep1Value)*.
 - c. ReturnIfAbrupt(*rep1Str*).
9. Else,
 - a. Let *captures* be an empty List.
 - b. Let *rep1Str* be the result of the abstract operation *GetReplaceSubstitution(matched, string, pos, capture)*.
10. Let *tailPos* be *pos* + the number of code units in *matched*.
11. Let *newString* be the String formed by concatenating the first *pos* code units of *string*, *rep1Str*, 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.
12. 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.

Runtime Semantics: GetReplaceSubstitution Abstract Operation

The abstract operation *GetReplaceSubstitution(matched, string, position, capture)* 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 non-negative integer.
6. Assert: *position* < *stringLength*.
7. Assert: *capture* is a possibly empty List of Strings.
8. Let *tailPos* be *position* + *matchLength*.
9. Let *m* be the number of elements in *capture*.
- Let *result* be a String value derived from *matched* by replacing code unit elements in *matched* by replacement text as specified in
10. Table 33. These \$ replacements are done left-to-right, and, once such a replacement is performed, the new replacement text is not subject to further replacements.
11. Return *result*.

Table 33— Replacement Text Symbol Substitutions

Code unit	Unicode Characters	Replacement text
0x0024, 0x0024	\$\$	\$
0x0024, 0x0026	\$&	<i>matched</i>
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> ≥ <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 < N ≤ 0x0039	\$n where n is one of 1 2 3 4 5 6 7 8 9 and \$n is not followed by	The <i>n</i> th element of <i>capture</i> , where <i>n</i> is a single digit in the range 1 to 9. If <i>n</i> ≤ <i>m</i> and the <i>n</i> th element of <i>capture</i> is <i>undefined</i> , use the empty String instead. If <i>n</i> > <i>m</i> , the result is implementation-defined.

Deleted: <#> If *searchValue* is a regular expression (an object whose [[Class]] that has the [[IsRegExpNativeBrandBuiltinBrand]] internal data property whose value is NativeRegExpBuiltinRegExp is "RegExp"), do the following: If *searchValue.global* is false, then search *string* for the first match of the regular expression *searchValue*. If *searchValue.global* is true, then search *string* for all matches of the regular expression *searchValue*. Do the search in the same manner as in `String.prototype.match`, including the update of *searchValue.lastIndex*. Let *m* be the number of left capturing parentheses of *searchValue* (using *NcapturingParens* as specified in 15.10.2.1).¶

Deleted: If

Deleted: ,

Deleted: 1

Deleted: search *string* for the first occurrence of *searchString*. Let *m* be 0.

Deleted: Let *m* be 0.

Deleted:

Deleted: is a function

Deleted: then

Deleted: for

Deleted: each matched substring, call the function with the following *m* + 3 arguments. Argument 1 is the substring that matched. If *searchValue* is a regular expression, the next *m* arguments are all of the captures in the MatchResult (see 15.10.2.1). Argument *m* + 2 is the offset within *string* where match occurred, and argument *m* + 3 is *string*. The result is a String value derived from the original input by replacing each matched substring with the corresponding return value of the function call, converted to a String if need be.

Deleted: If *Type(value)* is Object and *value* has [[StringData]] internal data property, then¶

Otherwise, let *newstring* denote the result of converting *replaceValue* to a String. The result is a String value derived from the original input String by replacing each matched substring with a String derived from *newstring* by replacing characters

Deleted: 343230

Deleted: The

Deleted: substring.

Deleted: \$`

Deleted: The

Deleted: portion of

Deleted: that precedes the matched substring

Deleted: '

Deleted: The portion of *string* that follows the matched substring.

Deleted: and \$n is not followed by a decimal digit.

Deleted: 0

Deleted: 0

Comment [AWB14181]: Why is this implementation defined? Can we specify this??

	a decimal digit	
0x0024, N, N where 0x0030 < N < 0x0039	\$nn where n is one of 0 1 2 3 4 5 6 7 8 9	The nn th elemet of capture, where nn is a two-digit decimal number in the range 01 to 99. If nn≤m and the nn th element of capture is undefined, use the empty String instead. If nn is 00 or nn>m, the result is implementation-defined.
0x0024	\$ in any context that does not match on of the above.	\$

15.5.4.12 String.prototype.search (regexp)

When the search method is called with argument *regexp*, the following steps are taken:

1. Let *O* be CheckObjectCoercible(this value).
2. Let *string* be ToString(*O*).
3. ReturnIfAbrupt(*string*).
4. If Type(*regexp*) is Object and HasProperty(*regexp*, @@isRegExp) is true, then
 - a. Let *rx* be *regexp*;
5. Else,
 - a. Let *rx* be the result of the abstract operation RegExpCreate (15.10.3.1) with arguments *regexp* and undefined.
6. ReturnIfAbrupt(*rx*).
7. Let *args* be a new List with the single element *string*.
8. Return the result of Invoke(*rx*, "search", *args*).

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.

15.5.4.13 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 element position *start* and running to, but not including, element position *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 CheckObjectCoercible(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. If *end* is undefined, let *intEnd* be *len*; else let *intEnd* be ToInteger(*end*).
7. If *intStart* is negative, let *from* be max(*len*+*intStart*, 0); else let *from* be min(*intStart*, *len*).
8. If *intEnd* is negative, let *to* be max(*len*+*intEnd*, 0); else let *to* be min(*intEnd*, *len*).
9. Let *span* be max(*to*-*from*, 0).
10. Return a String value containing *span* consecutive elements from *S* beginning with the element at position *from*.

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.

15.5.4.14 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.

Comment [AWB14182]: "12345".replace("1",function(m,p,r){x=[this,m,p,r];return null})

Deleted: 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.¶

Deleted: ReturnIfAbrupt()

Deleted:)

Deleted: Call CheckObjectCoercible passing the *this* value as its argument.

Deleted: the result of calling

Deleted: , giving it the *this* value as its argument

Deleted: *S*

Deleted: the value of the [[Class]] internal property of

Deleted: *regexp* has the [[IsRegExpNativeBrandBuiltInBrand]] internal data property whose value is NativeRegExpBuiltInRegExp

Deleted: is "RegExp"

Deleted:

Deleted: I

Deleted: ,

Deleted: let

Deleted: abstraction operation

Deleted: 4

Deleted: a new RegExp object created as if by the expression new RegExp (*regexp*) where **RegExp** is the standard built-in constructor with that name

Deleted: <#>Search the value *string* from its beginning for an occurrence of the regular expression pattern *rx*. Let *result* be a Number indicating the offset within *string* where the pattern matched, or -1 if there was no match. If an abrupt completion occurs during the search, *result* is that Completion Record. The **lastIndex** and **global** properties of *regexp* are ignored when performing the search. The **lastIndex** property of *regexp* is left unchanged.¶

Deleted: *result*

Deleted: character

Deleted: character

Deleted: ReturnIfAbrupt()

Deleted:)

Deleted: Call CheckObjectCoercible passing the *this* value as its argument.

Deleted: the result of calling

Deleted: , giving it the *this* value as its argument

Deleted: characters

Deleted: characters

Deleted: character

Deleted: (i.e., an object with the [[IsRegExpNativeBrandBuiltInBrand]] internal data property whose value is NativeRegExpBuiltInRegExp whose [[Class]] internal property is "RegExp"; see 15.10)

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 position of the **this** String is considered, even if backtracking could yield a non-empty-substring match at that position. (For example, "ab".split(/a*?/) evaluates to the array ["a", "b"], while "ab".split(/a*/) evaluates to the array ["", "b"].)

Deleted: characters
Deleted: character

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.

When the **split** method is called, the following steps are taken:

1. Let *O* be CheckObjectCoercible(this value).
2. ReturnIfAbrupt(O).
3. If Type(separator) is Object and HasProperty(separator, @@isRegExp) is true, then,
 - a. Let *args* be a new List with elements *S* and *limit*.
 - b. Return the result of Invoke(separator, "split", args).
4. Let *S* be ToString(O).
5. ReturnIfAbrupt(S).
6. Let *A* be the result of the abstract operation ArrayCreate with argument 0.
7. Let *lengthA* be 0.
8. If *limit* is **undefined**, let *lim* = $2^{32}-1$; else let *lim* = ToInt32(limit).
9. Let *s* be the number of elements in *S*.
10. Let *p* = 0.
11. Let *R* be ToString(separator).
12. ReturnIfAbrupt(R).
13. If *lim* = 0, return *A*.
14. If *separator* is **undefined**, then
 - a. Call the [[DefineOwnProperty]] internal method of *A* with arguments "0" and Property Descriptor {[[Value]]: *S*, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}.
 - b. Assert: the previous step will never result in an abrupt completion.
 - c. Return *A*.
15. If *s* = 0, then
 - a. Let *z* be the result of SplitMatch(S, 0, R).
 - b. If *z* is not **false**, return *A*.
 - c. Call the [[DefineOwnProperty]] internal method of *A* with arguments "0" and Property Descriptor {[[Value]]: *S*, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}.
 - d. Assert: the previous step will never result in an abrupt completion.
 - e. Return *A*.
16. Let *q* = *p*.
17. Repeat, while *q* ≠ *s*
 - a. Let *e* be the result of SplitMatch(S, *q*, *R*).
 - b. If *e* is **false**, then let *q* = *q*+1.

Deleted: ReturnIfAbrupt
Deleted:)
Deleted: Call CheckObjectCoercible passing the this value as its argument.
Deleted: <#>Let *S* be the result of calling ToString, giving it the **this** value as its argument.
Deleted: *S*
Deleted: a new array created as if by the expression **new Array()** where **Array** is the standard built-in constructor with that name
Deleted: characters
Deleted: If *separator* has the [[IsRegExpNativeBrandBuiltInBrand]] internal data property whose value is **NativeRegExpBuiltInRegExp** is a RegExp object (its [[Class]] is "**RegExp**"), let *R* be *separator* let *R* = *separator*; otherwise *R* = *separator*
Deleted: =
Deleted: separator
Deleted: "
Deleted: , and false
Deleted: Call
Deleted: and let *z* be its MatchResult result
Deleted: failure
Deleted: "
Deleted: , and false
Deleted: Call
Deleted: and let *z* be its MatchResult result
Deleted: *z*
Deleted: failure

- c. Else, e is an integer index into S .
 - i. If $e = p$, then let $q = q+1$.
 - ii. Else, $e \neq p$.
 1. Let T be a String value equal to the substring of S consisting of the code units at positions p (inclusive) through q (exclusive).
 2. Call the [[DefineOwnProperty]] internal method of A with arguments `ToString(lengthA)` and Property Descriptor {[[Value]]: T , [[Writable]]: **true**, [[Enumerable]]: **true**, [[Configurable]]: **true**}.
 3. Assert: the previous step will never result in an abrupt completion.
 4. Increment $lengthA$ by 1.
 5. If $lengthA = lim$, return A .
 6. Let $p = e$.
 7. Let $q = p$.
- 18. Let T be a String value equal to the substring of S consisting of the code units at positions p (inclusive) through s (exclusive).
- 19. Call the [[DefineOwnProperty]] internal method of A with arguments `ToString(lengthA)` and Property Descriptor {[[Value]]: T , [[Writable]]: **true**, [[Enumerable]]: **true**, [[Configurable]]: **true**}.
- 20. Assert: the previous step will never result in an abrupt completion.
- 21. Return A .

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. Type(R) must be String. Let r be the number of code units in R .
2. Let s be the number of code units in S .
3. If $q+r > s$ then return **false**.
4. If there exists an integer i between 0 (inclusive) and r (exclusive) such that the code unit at position $q+i$ of S is different from the code unit at position i of R , then return **false**.
5. Return $q+r$.

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.

15.5.4.15 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 element position `start` and running to, but not including, element position `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 `CheckObjectCoercible(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. If `end` is `undefined`, let $intEnd$ be len ; else let $intEnd$ be `ToInteger(end)`.
7. Let $finalStart$ be $\min(\max(intStart, 0), len)$.
8. Let $finalEnd$ be $\min(\max(intEnd, 0), len)$.

- Deleted:** ,
Deleted: z
Deleted: not failure
Deleted: $<\#>z$ must be a State. Let e be z 's `endIndex` and cap be z 's `captures` array.
Deleted: ,
Deleted: characters
Deleted: elements
Deleted:),
Deleted: , and false
Deleted: $<\#>\text{Let } i = 0.$
 $<\#>\text{Repeat, while } i \text{ is not equal to the number of elements in }$
 $cap.$
 $<\#>\text{Let } i = i + 1.$
 $<\#>\text{Call the [[DefineOwnProperty]] internal method of } A \text{ with arguments }$
 $\text{arguments } \text{ToString}(lengthA),) \text{ and Property Descriptor }$
 $\{[[Value]]: cap[i], [[Writable]]: \text{true}, [[Enumerable]]: \text{true}, [[Configurable]]: \text{true}, \text{and false}.\}$
Deleted: characters
Deleted: elements
Deleted:),
Deleted: , and false
Deleted: or RegExp
Deleted: a MatchResult (see 15.10.2.1)
Deleted: $<\#>\text{If } R \text{ has thea}$
Deleted: characters
Deleted: elements
Deleted: characters
Deleted: elements
Deleted: the MatchResult failure
Deleted: character
Deleted: character
Deleted: failure
Deleted: $<\#>\text{Let } cap \text{ be an empty array of captures (see }$
Deleted: the State (,
Deleted: , cap)
Deleted: (see 15.10.2.1)
Deleted: NOTE 1 The `split` method ignores the va
Deleted: 2
Deleted: character
Deleted: character
Deleted: ReturnIfAbrupt()
Deleted:)
Deleted: Call CheckObjectCoercible passing the `this` value
Deleted: the result of calling
Deleted: , giving it the `this` value as its argument
Deleted: characters

9. Let *from* be $\min(\text{finalStart}, \text{finalEnd})$.
10. Let *to* be $\max(\text{finalStart}, \text{finalEnd})$.
11. 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.

Deleted: characters

Deleted: characters

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.

15.5.4.16 String.prototype.toLowerCase ()

This function interprets a string value as a sequence of code points, as described in 8.4. The following steps are taken:

1. Let *O* be CheckObjectCoercible(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 8.4 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 (clause 6) of *c*.
8. Let *L* be a String whose elements are, in order, the elements of *cuList*.
9. Return *L*.

Deleted: ReturnIfAbrupt()

Deleted:)

Deleted: Call CheckObjectCoercible passing *this* value as its argument.

Deleted: the result of calling

Deleted: , giving it the **this** value as its argument

Deleted: replace

Deleted: where each character of *L* is either the Unicode lowercase equivalent of the corresponding character of *S* or the actual corresponding character of *S* if no Unicode lowercase equivalent exists

Deleted: For the purposes of this operation, the 16-bit code units of the Strings are treated as code points in the Unicode Basic Multilingual Plane. Surrogate code points are directly transferred from *S* to *L* without any mapping.

Deleted: in Unicode 2.1.8 and later

Deleted: characters

Deleted: characters

The result must be derived according to the case mappings in the Unicode character database (this explicitly includes not only the `UnicodeData.txt` file, but also 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()`.

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.

15.5.4.17 String.prototype.toLocaleLowerCase ()

This function interprets a string value as a sequence of code points, as described in 8.4.

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.

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.

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.

15.5.4.18 String.prototype.toUpperCase ()

This function interprets a string value as a sequence of code points, as described in 8.4.

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.

Deleted: characters

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.

15.5.4.19 `String.prototype.toLocaleUpperCase ()`

This function interprets a string value as a sequence of code points, as described in 8.4.

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.

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.

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.

15.5.4.20 `String.prototype.trim ()`

This function interprets a string value as a sequence of code points, as described in 8.4.

The following steps are taken:

1. Let O be `CheckObjectCoercible(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 character is in Unicode general category “Zs”, code unit sequences are interpreted as UTF-16 encoded code point sequences as specified in 8.4.
5. Return T .

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.

15.5.4.21 `String.prototype.repeat (count)`

The following steps are taken:

1. Let O be `CheckObjectCoercible(this value)`.
2. Let S be `ToString(O)`.
3. **ReturnIfAbrupt(S)**.
4. Let n be the result of calling `ToInteger(count)`.
5. **ReturnIfAbrupt(n)**.
6. If $n < 0$, then throw a `RangeError` exception.
7. If n is $+\infty$, then throw a `RangeError` exception.
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.
9. **Return T** .

NOTE 1 This method creates a String consisting of the string elements of this object (converted to String) repeated `count` time.

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.

15.5.4.22 `String.prototype.startsWith (searchString [, position])`

The following steps are taken:

- Deleted:** `ReturnIfAbrupt()`
- Deleted:** `)`
- Deleted:** Call `CheckObjectCoercible` passing the `this` value as its argument.
- Deleted:** the result of calling
- Deleted:** , giving it the `this` value as its argument

- Deleted:** `ReturnIfAbrupt()`
- Deleted:** `)`
- Deleted:** the result of calling
- Deleted:** , giving it the `this` value as its argument
- Deleted:** \leq
- Deleted:** `rh`
- Deleted:** `E`

- Deleted:** characters

1. Let O be `CheckObjectCoercible(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 $searchLength$ be the number of elements in `searchString`.
11. If $searchLength + start$ is greater than len , return `false`.
12. If the $searchLength$ sequence of elements of S starting at $start$ is the same as the full element sequence of `searchString`, return `true`.
13. 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 `position`. Otherwise returns `false`.

NOTE 2 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.

15.5.4.23 String.prototype.endsWith (searchString [, endPosition])

The following steps are taken:

1. Let O be `CheckObjectCoercible(this value)`.
2. Let S be `ToString(O)`.
3. ReturnIfAbrupt(S).
4. Let $searchStr$ be `ToString(searchString)`.
5. ReturnIfAbrupt($searchStr$).
6. Let len be the number of elements in S .
7. If `endPosition` is `undefined`, let pos be len , else let pos be `ToInteger(endPosition)`.
8. ReturnIfAbrupt(pos).
9. Let end be `min(max(pos, 0), len)`.
10. Let $searchLength$ be the number of elements in `searchString`.
11. Let $start$ be $end - searchLength$.
12. If $start$ is less than `0`, return `false`.
13. If the $searchLength$ sequence of elements of S starting at $start$ is the same as the full element sequence of `searchString`, return `true`.
14. Otherwise, return `false`.

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 - length(this)`. Otherwise returns `false`.

NOTE 2 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.

15.5.4.24 String.prototype.contains (searchString, position = 0)

The `contains` method takes two arguments, `searchString` and `position`, and performs the following steps:

1. Let O be `CheckObjectCoercible(this value)`.
2. Let S be `ToString(O)`.
3. ReturnIfAbrupt(S).
4. Let $searchStr$ be `ToString(searchString)`.

Deleted: `ReturnIfAbrupt()`
Deleted: `)`
Deleted: the result of calling
Deleted: , giving it the `this` value as its argument

Deleted: characters

Deleted: characters

Deleted: characters

Deleted: character

Deleted: characters
Deleted: characters

Deleted: `ReturnIfAbrupt()`
Deleted: `)`
Deleted: the result of calling
Deleted: , giving it the `this` value as its argument
Deleted: characters

Deleted: characters

Deleted: characters
Deleted: character

Deleted: characters
Deleted: characters

Deleted: [
Deleted:]

Deleted: `ReturnIfAbrupt()`
Deleted: `)`
Deleted: the result of calling
Deleted: , giving it the `this` value as its argument

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 characters in *searchStr*.
11. 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 character at position *k+j* of *S* is the same as the character at position *j* of *searchStr*, return **true**; but if there is no such integer *k*, return **false**.

The **length** property of the **contains** 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 positions that are greater than or equal to *position*, then return **true**; otherwise, returns **false**. If *position* is **undefined**, **0** is assumed, so as to search all of the String.

NOTE 2 The **contains** 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.

15.5.4.25 String.prototype.codePointAt(*pos*)

NOTE Returns a Number (a nonnegative integer less than 1114112) that is the UTF-16 encoded code point value starting at the string element at position *pos* in the String resulting from converting this object to a String. If there is no element at that position, the result is **Nan**. 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 CheckObjectCoercible(**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*, then 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, then return *first*.
12. Return ((*first* - 0xD800) × 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.

15.5.4.26 String.prototype.normalize (*form* = "NFC")

When the **normalize** method is called with one argument *form*, the following steps are taken:

1. Let *O* be CheckObjectCoercible(**this** value).
2. Let *S* be ToString(*O*).
3. ReturnIfAbrupt(*S*).
4. If *form* is not provided or **undefined**.
5. Let *f* be ToString(*form*).
6. ReturnIfAbrupt(*f*).
7. If *f* is not one of "NFC", "NFD", "NFKC", or "NFC", then let *form* be "NFKD", then throw a **RangeError** Exception.
8. Let *ns* be the String value is the result of normalizing *S* into the normalization form named by *f* as specified by in UTR 15, Unicode Normalization Forms.
9. Return *ns*.

Deleted: characters

Comment [AWB9183]: Do we also need UnicodeCharAt that returns a string of length 1 or 2?

Deleted: dsa

Deleted: ReturnIfAbrupt(

Deleted:)

Deleted: the result of calling

Deleted: , giving it the **this** value as its argument

Comment [AWB9184]: Note that this is inconsistent with the pre-existing behaviour of charCodeAt which returns NaN for out of bounds positions

Deleted: NaN

Deleted: position

Deleted: , where the first (leftmost) element in *S* is considered to be at position 0, the next one at position 1, and on.

Deleted: position

Deleted: *first*

Deleted: charCode

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.

15.5.5 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 data property.

String instances have a `length` property, and a set of enumerable properties with array index names.

15.5.5.1 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` }.

15.6 Boolean Objects

15.6.1 The Boolean Constructor Called as a Function

When `Boolean` is called as a function rather than as a constructor, it performs a type conversion. However, if the `this` value passed in the call is an Object with an uninitialized `[[BooleanData]]` internal data property, it initializes the `this` value using the argument value. This permits `Boolean` to be used both to perform type conversion and to perform constructor instance initialization.

`Boolean` may be subclassed and subclass constructors may perform a super invocation of the `Boolean` constructor to initialize the `[[BooleanData]]` state of subclass instances.

15.6.1.1 Boolean (value)

When `Boolean` is called with argument `value`, the following steps are taken:

1. Let `O` be the `this` value.
2. Let `b` be `ToBoolean(value)`.
3. If `Type(O)` is `Object` and `O` has a `[[BooleanData]]` internal data property and the value of `[[BooleanData]]` is `undefined`, then
 - a. Set the value of `O`'s `[[BooleanData]]` internal data property to `b`.
 - b. Return `O`.
4. Return `b`.

15.6.2 The Boolean Constructor

When `Boolean` is called as part of a `new` expression it is a constructor: it initialises the newly created ordinary object.

15.6.2.1 new Boolean (value)

`Boolean` called as part of a `new` expression with optional argument `value` performs the following steps:

4. Let `F` be the `Boolean` function object on which the `new` operator was applied.
5. Let `argumentsList` be the `argumentsList` argument of the `[[Construct]]` internal method that was invoked by the `new` operator.
6. Return the result of `OrdinaryConstruct(F, argumentsList)`.

If `Boolean` is implemented as an ordinary function object, its `[[Construct]]` internal method will perform the above steps.

Deleted: 15.5.4.25 `String.prototype.toArray()`
 The following steps are taken:
 ReturnIfAbrupt(`CheckObjectCoercible(thisValue)`).
 Let `S` be the result of calling `ToString`, giving it the `this` value as its argument.
 ReturnIfAbrupt(`S`).
 Let `len` be the number of characters in `S`.
 Let `array` be the result of the abstraction operation `ArrayCreate` (15.4) with argument `len`.
 Let `n` be `0`.
 Repeat, while `n < len`:
 Let `c` be the character at position `n` in `S`.
 Call the `[[DefineOwnProperty]]` internal method of `array` with arguments `ToString` of the `PropertyDescriptor` { `[[Value]]: c`, `[[Writable]]: true`, `[[Enumerable]]: true`, `[[Configurable]]: true`, and `false` }.
 Increment `n` by 1.
 Return `array`.
 The length property of the `toArray` method is `0`.
NOTE 1 Returns an `Array` object with elements corresponding to the characters in this object (converted to a `String`).
NOTE 2 The `toArray` 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: and internal data properties

Deleted:

Deleted: and their `[[Class]]` have a `[[IsStringNativeBrand]]` internal property with value `StringWrapper`

Deleted: value is "String"

Deleted:

Deleted: also

Deleted: a `[[PrimitiveValue]]` internal property

Deleted: The `[[PrimitiveValue]]` internal property is the `String` value represented by the `String` object. The array index named properties correspond to the individual characters elements of the `String` value. A special `[[GetOwnProperty]]` internal method is used to specify the number, values, and attributes of array index named properties.

Deleted: characters

Deleted: created

Deleted: 15.5.5.2 `[[GetOwnProperty]]` (`P`)
 String objects use a variation of the `[[GetOwnProperty]]` internal method used for other native ECMAScript objects (8.12.1). This special internal method provides access to named properties corresponding to the individual characters elements of `String` object. Assume `S` is a `String` object and `P` is a `String`. When the `[[GetOwnProperty]]` internal method of `S` is called with property name `P`, the following steps are taken:
 Let `desc` be the result of calling the default `[[GetOwnProperty]]` internal method (8.12.1) on `S` with argument `P`.

Deleted: Returns a `Boolean` value (not a `Boolean` object) computed by `ToBoolean(value)`

15.6.3 Properties of the Boolean Constructor

The value of the [[Prototype]] internal data property of the Boolean constructor is the Function prototype object (15.3.4).

Besides the length property (whose value is **1**), the Boolean constructor has the following property:

15.6.3.1 Boolean.prototype

The initial value of **Boolean.prototype** is the Boolean prototype object (15.6.4).

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

15.6.3.2 Boolean[@@create]()

The @@create method of an object *F* performs the following steps:

1. Let *F* be the **this** value.
2. Let *obj* be the result of calling *OrdinaryCreateFromConstructor(F, "%BooleanPrototype%", ([[BooleanData]]))*.
3. Return *obj*.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

NOTE [[BooleanData]] is initially assigned the value **undefined** as a flag to indicate that the instance has not yet been initialized by the Boolean constructor. This flag value is never directly exposed to ECMAScript code; hence implementation may choose to encode the flag in some other manner.

15.6.4 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 data property.

The value of the [[Prototype]] internal data property of the Boolean prototype object is the standard built-in Object prototype object (15.2.4).

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 data property, then
 - a. Let *b* be the value of *value*'s [[BooleanData]] internal data property.
 - b. If *b* is not **undefined**, then return *n*.
3. Throw a **TypeError** exception.

15.6.4.1 Boolean.prototype.constructor

The initial value of **Boolean.prototype.constructor** is the built-in **Boolean** constructor.

15.6.4.2 Boolean.prototype.toString()

The following steps are taken:

1. Let *b* be **thisBooleanValue(this value)**.
2. ReturnIfAbrupt(*b*).
3. If *b* is **true**, then return "**true**"; else return "**false**".

15.6.4.3 Boolean.prototype.valueOf()

The following steps are taken:

Deleted: The [[Prototype]] internal data property of the newly constructed object is set to the original Boolean prototype object, the one that is the initial value of **Boolean.prototype** (15.6.3.1).
 The [[Class]] internal property of the newly constructed Boolean object is set to "**Boolean**" has a [[IsBooleanNativeBrandBuiltInBrand]] internal data property with value **BooleanWrapperBuiltInBooleanWrapper**.
 The [[PrimitiveValueBooleanValueData]] internal data property of the newly constructed Boolean object is set to **Boolean(value)**.
 The [[Extensible]] internal data property of the newly constructed object is set to **true**.

Deleted: the internal properties and

Comment [AWB14185]: Because the @@create method is essential to the integrity of this "class" definition just like the prototype property, it seems appropriate to freeze it in the same manner.

Deleted: itself

Deleted: Boolean

Deleted:

Deleted: (its [[Class]] is "**Boolean**")

Deleted: whose

Deleted: value

Deleted: Value

Deleted: has the value is **false**

Deleted: The Boolean prototype object has a [[IsBooleanNativeBrandBuiltInBrand]] internal data property whose value is **BooleanWrapperBuiltInBooleanWrapper**.

Deleted: *B*

Deleted: the **this** value

Deleted: <#>If **Type(B)** is Boolean, then let *b* be *B*.
 <#>Else if **Type(B)** is Object and the value of the [[Class]] internal property of *B* has "**Boolean**" as a [[IsBooleanNativeWrapperBooleanData]] internal data property whose value is BooleanWrapper, then let *b* be the value of the [[BooleanDataPrimitiveValue]] internal data property of *B*.
 <#>Else throw a **TypeError** exception.

1. Return thisBooleanValue(this value)

15.6.5 Properties of Boolean Instances

Boolean instances are ordinary objects that inherit properties from the Boolean prototype object. Boolean instances have a [[BooleanData]] internal data property. The [[BooleanData]] internal data property is the Boolean value represented by this Boolean object.

15.7 Number Objects

15.7.1 The Number Constructor Called as a Function

When Number is called as a function rather than as a constructor, it performs a type conversion. However, if the this value value passed in the call is an Object with an uninitialized [[NumberData]] internal data property, 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 initialization.

Number may be subclassed and subclass constructors may perform a super invocation of the Number constructor to initialize the [[NumberData]] state of subclass instances.

15.7.1.1 Number (value)

When Number is called with argument number, the following steps are taken:

7. Let O be the this value.
8. If value is undefined, then let n be +0.
9. Else, let n be ToNumber(value).
10. ReturnIfAbrupt(n).
11. If Type(O) is Object and O has a [[NumberData]] internal data property and the value of [[NumberData]] is undefined, then
 - a. Set the value of O's [[NumberData]] internal data property to n.
 - b. Return O.
12. Return n.

15.7.2 The Number Constructor

When Number is called as part of a new expression it is a constructor: it initialises the newly created ordinary object.

15.7.2.1 new Number (...args)

Number called as part of a new expression with argument list args it performs the following steps:

1. Let F be the Number function object on which the new operator was applied.
2. Let argumentsList be the argumentsList argument of the [[Construct]] internal method that was invoked by the new operator.
3. Return the result of OrdinaryConstruct (F, argumentsList).

If Number is implemented as an ordinary function object, its [[Construct]] internal method will perform the above steps.

15.7.3 Properties of the Number Constructor

The value of the [[Prototype]] internal data property of the Number constructor is the Function prototype object (15.3.4).

Besides the length property (whose value is 1), the Number constructor has the following properties:

Deleted: <#>Let B be the this value.
 <#>If Type(B) is Boolean, then let b be B.
 <#>Else if Type(B) is Object and the value of the [[Class]] internal property of B is "Boolean" has a [[IsBooleanNativeWrapperBooleanData]] internal data property whose value is BooleanWrapper, then let b be the value of the [[BooleanDataPrimitiveValue]] internal data property of B.
 <#>Else throw a TypeError exception.
Deleted: b
Deleted: and
Deleted: Boolean instance objects their have [[ClassIsBooleanNativeBrandBuiltInBrand]] internal data property whose value is BooleanWrapperBuiltInBooleanWrapper
Deleted: value is "Boolean"
Deleted: .
Deleted: also
Deleted: PrimitiveValue
Deleted: ¶
Deleted: PrimitiveValue
Deleted:
Deleted: [
Deleted:]
Deleted: Returns a Number value (not a Number object) computed by ToNumber(value) if value was supplied, else returns +0.

Deleted: [value]
Deleted: []
Deleted: The [[Prototype]] internal data property of the newly constructed object is set to the original Number prototype object, the one that is the initial value of Number.prototype (15.7.3.1).
 The [[Class]] internal property of the newly constructed object is set to "Number" has a [[IsNumberNativeBrandBuiltInBrand]] internal data property whose value is NumberWrapperBuiltInNumberWrapper.
 The [[PrimitiveValueNumberData]] internal data property of the newly constructed object is set to ToNumber(value) if value was supplied, else +0.
 The [[Extensible]] internal data property of the newly constructed object is set to true.

Deleted: the internal properties and

15.7.3.1 Number.prototype

The initial value of `Number.prototype` is the Number prototype object (15.7.4).

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

15.7.3.2 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` }.

15.7.3.3 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.

Deleted: precision

Deleted: ed

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

15.7.3.4 Number.NaN

The value of `Number.NaN` is `NaN`.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

15.7.3.5 Number.NEGATIVE_INFINITY

The value of `Number.NEGATIVE_INFINITY` is $-\infty$.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

15.7.3.6 Number.POSITIVE_INFINITY

The value of `Number.POSITIVE_INFINITY` is $+\infty$.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

15.7.3.7 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` }.

Deleted: 7

15.7.3.8 Number.MAX_INTEGER

The value of `Number.MAX_INTEGER` is the largest integer value that can be represented as a Number value without losing precision, which is 9007199254740991.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

15.7.3.9 Number.parseInt (string, radix)

Same as 15.1.2.2.

Deleted: 8

Comment [AWB7186]: Same specification same value?

Deleted: 9

15.7.3.10 Number.parseFloat (string)

Same as 15.1.2.3.

Deleted: 0

Comment [AWB7187]: Same specification same value?

15.7.3.11 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 (15.1.2.4) in that it does not convert its argument to a `Number` before determining whether it is `NaN`.

15.7.3.12 Number.isFinite (number)

Deleted: 1

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`, $+\infty$, or $-\infty$, return `false`.
3. Otherwise, return `true`.

15.7.3.13 Number.isInteger (number)

Deleted: 2

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. Let `integer` be `ToInteger(number)`.
3. If `integer` is not equal to `number`, return `false`.
4. Otherwise, return `true`.

15.7.3.14 Number.toInteger (number)

Comment [AWB7188]: Name changed from `toInteger` to `toInt` at Marodh 29 TC39 meeting. And changed back to `toInteger` at the Jan 29, 2013 meeting.

Deleted: 3

Deleted: eger

Deleted: ¶

When the `Number.toInt` is called with one argument `number`, the following steps are taken:

1. Return `ToInteger(number)`.

15.7.3.15 Number[@@create]()

The `@@create` method of an object `F` performs the following steps:

1. Let `F` be the `this` value.
2. Let `obj` be the result of calling `OrdinaryCreateFromConstructor(F, "%NumberPrototype%", ([[NumberData]]))`.
3. Return `obj`.

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

Deleted: itself a Number

Deleted: (its `[[Class]]` is "Number")

Deleted: with

Deleted: IsNumber

Deleted: NativeBrand

Deleted: BuiltinBrand

Deleted: whose value is `NumberWrapper`/`BuiltinNumberWrapper`. whose Its value is `+0`

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 implementation may choose to encode the flag in some other manner.

15.7.4 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 data property.

The value of the `[[Prototype]]` internal `data` property of the `Number` prototype object is the standard built-in `Object` prototype object (15.2.4).

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 `data` property 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 `data` property, then
 - a. Let `n` be the value of `value`'s `[[NumberData]]` internal `data` property.
 - b. If `n` is not `undefined`, then return `n`.
3. Throw a `TypeError` exception.

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.

15.7.4.1 `Number.prototype.constructor`

The initial value of `Number.prototype.constructor` is the built-in `Number` constructor.

15.7.4.2 `Number.prototype.toString ([radix])`

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`. If `ToInteger(radix)` is the `Number` 10 then this `Number` value is given as an argument to the `ToString` abstract operation; the resulting String value is returned.

If `ToInteger(radix)` is not an integer between 2 and 36 inclusive throw a `RangeError` exception. If `ToInteger(radix)` 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 `a-z` 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 9.1.8.1.

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.

15.7.4.3 `Number.prototype.toLocaleString()`

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`.

NOTE 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.

15.7.4.4 `Number.prototype.valueOf ()`

3. Let `x` be `thisNumberValue(this value)`.
4. Return `x`.

15.7.4.5 `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)`.

- Deleted:** Object
- Deleted:** for which the value of
- Deleted:** the
- Deleted:** Class
- Deleted:** IsNumber
- Deleted:** NativeBrand
- Deleted:** whose value is NumberWrapper
- Deleted:** is "Number"

Deleted: In the following descriptions of functions that are properties of the `Number` prototype object, the phrase "this Number object" refers to either the object that is the `this` value for the invocation of the function or, if `Type(this value)` is `Number`, an object that is created as if by the expression `new Number (this value)` where `Number` is the standard built-in constructor with that name. Also, t

Deleted: refers to either the

- Deleted:** Number value represented by this `Number` object, that is, the value of the `[[PrimitiveValueNumberData]]` internal `data` property of this `Number` object or the `this` value if its type is `Number`. A `TypeError` exception is thrown if the `this` value is neither an object for which the value of the `has` `[[ClassIsNumberNativeBrandNumberData]]` internal `data` property is "Number" or a value whose type is `Number`.

Comment [AWB7189]: TODO: need to provide algorithm that orders abnormal completion detection

- Deleted:**
- Deleted:** v
- Deleted:** Returns this `Number` value.||
- Deleted:** The `valueOf` 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.||
- Deleted:** Return
- Deleted:** .
- Deleted:** Specifically, perform the following steps

2. ReturnIfAbrupt(x).
3. Let f be $\text{ToInteger}(fractionDigits)$. (If $fractionDigits$ is **undefined**, this step produces the value **0**).
4. ReturnIfAbrupt(f).
5. If $f < 0$ or $f > 20$, throw a **RangeError** exception.
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 $n \div 10^f - x$ 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 .

Deleted: <#>Let x be this Number value.
<#>ReturnIfAbrupt(x).

Deleted: ,

Deleted: characters

Deleted: character

Deleted: '**0**'

Deleted: characters

Deleted: characters

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 15).

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.

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, $(100000000000000128).toString()$ returns "**100000000000000100**", while $(100000000000000128).toFixed(0)$ returns "**1000000000000000128**".

15.7.4.6 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 $\text{ToInteger}(fractionDigits)$.
4. ReturnIfAbrupt(f).
5. If x is **NaN**, return the String "**NaN**".
6. Let s be the empty String.
7. If $x < 0$, then
 - a. Let s be **"-"**.
 - b. Let $x = -x$.
8. If $x = +\infty$, then
 - a. Return the concatenation of the Strings s and "**Infinity**".
9. If $fractionDigits$ is not **undefined** and $(f < 0 \text{ or } f > 20)$, throw a **RangeError** exception.

Deleted:
Deleted: value

10. If $x = 0$, then
 - a. If *fractionDigits* is **undefined**, then let $f = 0$.
 - b. Let m be the String consisting of $f+1$ occurrences of the code unit `0x0030`.
 - c. Let $e = 0$.
11. Else $x \neq 0$.
 - 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).
12. If $f \neq 0$, 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 .
13. If $e = 0$, then
 - a. Let $c = "+"$.
 - b. Let $d = "0"$.
14. Else
 - a. If $e > 0$, then let $c = "+"$.
 - b. Else $e \leq 0$
 - i. Let $c = "-"$.
 - 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).
15. Let m be the concatenation of the four Strings m , `"e"`, c , and d .
16. 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 15).

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.

NOTE For implementations that provide more accurate conversions than required by the rules above, it is recommended that the following alternative version of step 9.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.

15.7.4.7 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` (9.8.1) instead. Specifically, perform the following steps:

1. Let x be `thisNumberValue(this value)`.
2. ReturnIfAbrupt(x).
3. If *precision* is **undefined**, return `ToString(x)`.
4. Let p be `ToInteger(precision)`.

Deleted: *al*
Deleted: Let
Deleted: character
Deleted: `'0'`
Deleted: ,

Deleted:,

Deleted: character
Deleted: characters

Deleted:,

Deleted:
Deleted: v

5. ReturnIfAbrupt(p).
6. If x is ***NaN***, return the String "***NaN***".
7. Let s be the empty String.
8. If $x < 0$, then
- Let s be `"-"`.
 - Let $x = -x$.
9. If $x = +\infty$, then
- Return the concatenation of the Strings s and "***Infinity***".
10. If $p < 1$ or $p > 21$, throw a **RangeError** exception.
11. If $x = 0$, then
- Let m be the String consisting of p occurrences of the code unit `0x0030` (the Unicode character '`0`').
 - Let $e = 0$.
12. Else $x \neq 0$,
- 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.
 - Let m be the String consisting of the digits of the decimal representation of n (in order, with no leading zeroes).
 - If $e < -6$ or $e \geq p$, then
 - Let a be the first element of m , and let b be the remaining $p-1$ elements of m .
 - Let m be the concatenation of the three Strings a , `"."`, and b .
 - If $e = 0$, then
 - Let $c = "+"$ and $d = "0"$.
 - Else $e \neq 0$,
 - If $e > 0$, then
 - Let $c = "+"$.
 - Else $e < 0$,
 - Let $c = "-"$.
 - Let $e = -e$.
 - Let d be the String consisting of the digits of the decimal representation of e (in order, with no leading zeroes).
 - Let m be the concatenation of the five Strings s , m , `"e"`, c , and d .
- If $e = p-1$, then return the concatenation of the Strings s and m .
- If $e \geq 0$, then
 - Let m be the concatenation of the first $e+1$ elements of m , the code unit `0x002E` (Unicode character `"."`), and the remaining $p-(e+1)$ elements of m .
- Else $e < 0$,
 - Let m be the concatenation of the String `"0."`, $-(e+1)$ occurrences of code unit `0x0030` (the Unicode character '`0`'), and the String m .
- Return the concatenation of the Strings 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 15).

An implementation is permitted to extend the behaviour of `toPrecision` for values of $precision$ less than 1 or greater than 21. In this case `toPrecision` would not necessarily throw **RangeError** for such values.

15.7.4.8 Number.prototype.clz()

When the `Number.prototype.clz` is called with one argument `number`, the following steps are taken:

- Let x be `thisNumberValue(this value)`.
- Let n be `ToUint32(x)`.
- ReturnIfAbrupt(n).
- Let p be the number of leading zero bits in the 32-bit binary representation of n .
- Return p .

Deleted: character

Deleted: character

Deleted: characters

Deleted: characters

Deleted: s

Deleted: characters

Deleted: c

Comment [AWB7190]: Added at March 2013 TC39 meeting

Deleted: 3

Deleted: 14

Deleted:

Deleted: v

Comment [AWB7191]: Unsigned seems most general, signed values could be converted in a previous step.

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.

Deleted: f

15.7.5 Properties of Number Instances

Number instances are ordinary objects that inherit properties from the Number prototype object. Number instances also have a `[[NumberData]]` internal data property. The `[[NumberData]]` internal data property is the Number value represented by this Number object.

Deleted: and their have an `[[ClassIsNumberNativeBrandBuiltinBrand]]` internal data property whose value is `NumberWrapperBuiltinNumberWrapper`

15.8 The Math Object

The Math object is a single ordinary object.

The value of the `[[Prototype]]` internal data property of the Math object is the standard built-in Object prototype object (15.2.4). The Math object has a `[[MathTag]]` internal data property whose value is `true`.

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 8.5.

15.8.1 Value Properties of the Math Object

15.8.1.1 `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` }.

Deleted: that has some named properties, some of which are functions
Deleted: value of the `[[Class]]` internal property of the object
Deleted: is `"Math"`
Deleted: the
Deleted: IsMath
Deleted: NativeBrand
Deleted: BuiltinBrand
Deleted: NativeMath
Deleted: BuiltinMath
Deleted: object
Deleted: property
Deleted: `¶`
Deleted: property

15.8.1.2 `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` }.

15.8.1.3 `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` }.

15.8.1.4 `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`.

15.8.1.5 `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`.

15.8.1.6 **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** }.

15.8.1.7 **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**.

15.8.1.8 **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** }.

15.8.2 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, function performs a computation on the resulting Number value(s).

Deleted: operator

Deleted: and then

In the function descriptions below, the symbols NaN , -0 , $+0$, $-\infty$ and $+\infty$ refer to the Number values described in 8.5.

NOTE The behaviour of the functions **acos**, **asin**, **atan**, **atan2**, **cos**, **exp**, **log**, **pow**, **sin**, **sqrt**, and **tan** 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>) .

15.8.2.1 **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 $+\infty$.

15.8.2.2 **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 $+0$.

15.8.2.3 **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.

15.8.2.4 **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 $-\pi/2$.

15.8.2.5 **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 $x = +0$, the result is an implementation-dependent approximation to $+\pi/2$.
- If $y > 0$ and $x = -0$, the result is an implementation-dependent approximation to $+\pi/2$.
- If $y = +0$ and $x > 0$, the result is +0.
- If $y = +0$ and $x = +0$, the result is +0.
- If $y = +0$ and $x = -0$, the result is an implementation-dependent approximation to $+\pi$.
- If $y = +0$ and $x < 0$, the result is an implementation-dependent approximation to $+\pi$.
- If $y = -0$ and $x > 0$, the result is -0.
- If $y = -0$ and $x = +0$, the result is -0.
- If $y = -0$ and $x = -0$, the result is an implementation-dependent approximation to $-\pi$.
- If $y = -0$ and $x < 0$, the result is an implementation-dependent approximation to $-\pi$.
- If $y < 0$ and $x = +0$, the result is an implementation-dependent approximation to $-\pi/2$.
- If $y < 0$ and $x = -0$, the result is an implementation-dependent approximation to $-\pi/2$.
- If $y > 0$ and y is finite and $x = +\infty$, the result is +0.
- If $y > 0$ and y is finite and $x = -\infty$, the result is an implementation-dependent approximation to $+\pi$.
- If $y < 0$ and y is finite and $x = +\infty$, the result is -0.
- If $y < 0$ and y is finite and $x = -\infty$, the result is an implementation-dependent approximation to $-\pi$.
- If $y = +\infty$ and x is finite, the result is an implementation-dependent approximation to $+\pi/2$.
- If $y = -\infty$ and x is finite, the result is an implementation-dependent approximation to $-\pi/2$.
- If $y = +\infty$ and $x = +\infty$, the result is an implementation-dependent approximation to $+\pi/4$.
- If $y = +\infty$ and $x = -\infty$, the result is an implementation-dependent approximation to $+3\pi/4$.
- If $y = -\infty$ and $x = +\infty$, the result is an implementation-dependent approximation to $-\pi/4$.
- If $y = -\infty$ and $x = -\infty$, the result is an implementation-dependent approximation to $-3\pi/4$.

15.8.2.6 **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)`.

15.8.2.7 `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.

15.8.2.8 `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.

15.8.2.9 `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)`.

15.8.2.10 `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 $+\infty$.

15.8.2.11 `Math.max([value1[, value2[, ...]]])`

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 (11.8.1) except that +0 is considered to be larger than -0.

The `length` property of the `max` method is 2.

15.8.2.12 `Math.min ([value1 [, value2 [, ...]]])`

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 (11.8.1) except that +0 is considered to be larger than -0.

The `length` property of the `min` method is 2.

15.8.2.13 `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 $\text{abs}(x)$ is 1 and y is $+\infty$, the result is NaN.
- If $\text{abs}(x)$ is 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 +0.
- 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 +0.
- 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.

Deleted: Comparision
Deleted: og
Deleted: as in
Deleted: 5

Deleted: Comparision
Deleted: og
Deleted: as in
Deleted: 5

Deleted:)==
Deleted:)==

15.8.2.14 `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.

15.8.2.15 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 .

NOTE 2 The value of `Math.round(x)` is the same as the value of `Math.floor(x+0.5)`, except when x is -0 or is less than 0 but greater than or equal to -0.5 ; for these cases `Math.round(x)` returns -0 , but `Math.floor(x+0.5)` returns $+0$.

15.8.2.16 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.

15.8.2.17 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 $+\infty$.

15.8.2.18 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.

15.8.2.19 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 $+\infty$.

15.8.2.20 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 $+\infty$.

15.8.2.21 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.

- 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 $+\infty$.

15.8.2.22 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.

- 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.

15.8.2.23 Math.cosh(x)

Returns an implementation-dependent approximation to the hyperbolic cosine of x .

- 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 $(\exp(x) + \exp(-x))/2$.

15.8.2.24 Math.sinh(x)

Returns an implementation-dependent approximation to the hyperbolic sine 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 $-\infty$.

NOTE The value of $\cosh(x)$ is the same as $(\exp(x) - \exp(-x))/2$.

15.8.2.25 Math.tanh(x)

Returns an implementation-dependent approximation to the hyperbolic tangent 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 $+1$.
- If x is $-\infty$, the result is -1 .

NOTE The value of $\tanh(x)$ is the same as $(\exp(x) - \exp(-x))/(\exp(x) + \exp(-x))$.

15.8.2.26 Math.acosh(x)

Returns an implementation-dependent approximation to the inverse hyperbolic cosine of x .

- 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 $+\infty$.

15.8.2.27 Math.asinh(x)

Returns an implementation-dependent approximation to the inverse hyperbolic sine 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 $-\infty$.

15.8.2.28 Math.atanh(x)

Returns an implementation-dependent approximation to the inverse hyperbolic tangent of x .

- 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 .

15.8.2.29 Math.hypot(value1 , value2 , value3 = 0)

Given two or three arguments, `hypot` returns an implementation-dependent approximation of the square root of the sum of squares of up to three arguments.

- 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 .

Deleted: [

Deleted:]

Deleted: its

- If all arguments are either +0 or -0, the result is +0.

The length property of the `hypot` function is 2.

15.8.2.30 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 $-\infty$.

15.8.2.31 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.

15.8.2.32 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 $-\infty$.

15.9 Date Objects

15.9.1 Overview of Date Objects and Definitions of Abstract Operations

The following functions are abstract operations that operate on time values (defined in 15.9.1.1). Note that, in every case, if any argument to one of these functions is NaN, the result will be NaN.

15.9.1.1 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 8,640,000,000,000,000 milliseconds to either side of 01 January, 1970 UTC.

Comment [AWB7192]: Concensus at March29 TC3 meeting was to drop this function. See March29 meeting notes

Deleted: 15.8.2.30 hypot2(value1 , value2 [, value3])
 Given two or three arguments, hypot2 returns an implementation-dependent approximation of the sum squares of its arguments. ¶
 <#> If no arguments are given, 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.

Deleted: Operators

The exact moment of midnight at the beginning of 01 January, 1970 UTC is represented by the value **+0**.

15.9.1.2 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:

$$\text{TimeWithinDay}(t) = t \bmod \text{msPerDay}$$

15.9.1.3 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:

$$\begin{aligned}\text{InLeapYear}(t) &= 0 \text{ if } \text{DaysInYear}(\text{YearFromTime}(t)) = 365 \\ &= 1 \text{ if } \text{DaysInYear}(\text{YearFromTime}(t)) = 366\end{aligned}$$

15.9.1.4 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:

$$\begin{aligned}\text{MonthFromTime}(t) &= 0 \quad \text{if} \quad 0 & \leq \text{DayWithinYear}(t) < 31 \\ &= 1 \quad \text{if} \quad 31 & \leq \text{DayWithinYear}(t) < 59+\text{InLeapYear}(t) \\ &= 2 \quad \text{if} \quad 59+\text{InLeapYear}(t) & \leq \text{DayWithinYear}(t) < 90+\text{InLeapYear}(t) \\ &= 3 \quad \text{if} \quad 90+\text{InLeapYear}(t) & \leq \text{DayWithinYear}(t) < 120+\text{InLeapYear}(t) \\ &= 4 \quad \text{if} \quad 120+\text{InLeapYear}(t) & \leq \text{DayWithinYear}(t) < 151+\text{InLeapYear}(t) \\ &= 5 \quad \text{if} \quad 151+\text{InLeapYear}(t) & \leq \text{DayWithinYear}(t) < 181+\text{InLeapYear}(t) \\ &= 6 \quad \text{if} \quad 181+\text{InLeapYear}(t) & \leq \text{DayWithinYear}(t) < 212+\text{InLeapYear}(t) \\ &= 7 \quad \text{if} \quad 212+\text{InLeapYear}(t) & \leq \text{DayWithinYear}(t) < 243+\text{InLeapYear}(t) \\ &= 8 \quad \text{if} \quad 243+\text{InLeapYear}(t) & \leq \text{DayWithinYear}(t) < 273+\text{InLeapYear}(t) \\ &= 9 \quad \text{if} \quad 273+\text{InLeapYear}(t) & \leq \text{DayWithinYear}(t) < 304+\text{InLeapYear}(t) \\ &= 10 \quad \text{if} \quad 304+\text{InLeapYear}(t) & \leq \text{DayWithinYear}(t) < 334+\text{InLeapYear}(t) \\ &= 11 \quad \text{if} \quad 334+\text{InLeapYear}(t) & \leq \text{DayWithinYear}(t) < 365+\text{InLeapYear}(t)\end{aligned}$$

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 MonthFromTime(0) = 0, corresponding to Thursday, 01 January, 1970.

15.9.1.5 Date Number

A date number is identified by an integer in the range 1 through 31, inclusive. The mapping DateFromTime(t) from a time value t to a month number is defined by:

$$\begin{aligned}
 \text{DateFromTime}(t) &= \text{DayWithinYear}(t)+1 \\
 &= \text{DayWithinYear}(t)-30 \\
 &= \text{DayWithinYear}(t)-58-\text{InLeapYear}(t) \\
 &= \text{DayWithinYear}(t)-89-\text{InLeapYear}(t) \\
 &= \text{DayWithinYear}(t)-119-\text{InLeapYear}(t) \\
 &= \text{DayWithinYear}(t)-150-\text{InLeapYear}(t) \\
 &= \text{DayWithinYear}(t)-180-\text{InLeapYear}(t) \\
 &= \text{DayWithinYear}(t)-211-\text{InLeapYear}(t) \\
 &= \text{DayWithinYear}(t)-242-\text{InLeapYear}(t) \\
 &= \text{DayWithinYear}(t)-272-\text{InLeapYear}(t) \\
 &= \text{DayWithinYear}(t)-303-\text{InLeapYear}(t) \\
 &= \text{DayWithinYear}(t)-333-\text{InLeapYear}(t)
 \end{aligned}$$

if MonthFromTime(t)=0
 if MonthFromTime(t)=1
 if MonthFromTime(t)=2
 if MonthFromTime(t)=3
 if MonthFromTime(t)=4
 if MonthFromTime(t)=5
 if MonthFromTime(t)=6
 if MonthFromTime(t)=7
 if MonthFromTime(t)=8
 if MonthFromTime(t)=9
 if MonthFromTime(t)=10
 if MonthFromTime(t)=11

15.9.1.6 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 WeekDay(0) = 4, corresponding to Thursday, 01 January, 1970.

15.9.1.7 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.

NOTE It is recommended that implementations use the time zone information of the IANA Time Zone Database.

15.9.1.8 Daylight Saving Time Adjustment

An implementation of ECMAScript is expected to make its best effort to determine the local daylight saving time adjustment. An implementation dependent algorithm using best available information on time zones to determine the local daylight saving time adjustment DaylightSavingTA(t), measured in milliseconds.

15.9.1.9 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 that $\text{UTC}(\text{LocalTime}(t))$ is not necessarily always equal to t .

15.9.1.10 Hours, Minutes, Second, and Milliseconds

The following functions are useful in decomposing time values:

Deleted: The value LocalTZA does not vary with time but depends only on the geographic location.

Comment [AWB8193]: Need a reference

Deleted: algorithm

Deleted: The

Deleted: ,

Deleted: must depend only on four things:

(1) the time since the beginning of the year
 $t - \text{TimeFromYear}(\text{YearFromTime}(t))$
 (2) whether t is in a leap year
 $\text{InLeapYear}(t)$
 (3) the week day of the beginning of the year
 $\text{WeekDay}(\text{TimeFromYear}(\text{YearFromTime}(t)))$
 and (4) the geographic location.

The implementation of ECMAScript should not try to determine whether the exact time was subject to daylight saving time, but just whether daylight saving time would have been in effect if the current daylight saving time algorithm had been used at the time. This avoids complications such as taking into account the years the locale observed daylight saving time year round.

If the host environment provides functionality for determining daylight saving time, the implementation of ECMAScript is free to map the year in question to an equivalent year (same leap-year-ness and same starting week day for the year) for which the host environment provides daylight saving time information. The only restriction is that all equivalent years should produce the same result.

$\text{HourFromTime}(t) = \text{floor}(t / \text{msPerHour}) \bmod \text{HoursPerDay}$
 $\text{MinFromTime}(t) = \text{floor}(t / \text{msPerMinute}) \bmod \text{MinutesPerHour}$
 $\text{SecFromTime}(t) = \text{floor}(t / \text{msPerSecond}) \bmod \text{SecondsPerMinute}$
 $\text{msFromTime}(t) = t \bmod \text{msPerSecond}$

where

$\text{HoursPerDay} = 24$
 $\text{MinutesPerHour} = 60$
 $\text{SecondsPerMinute} = 60$
 $\text{msPerSecond} = 1000$
 $\text{msPerMinute} = 60000 = \text{msPerSecond} \times \text{SecondsPerMinute}$
 $\text{msPerHour} = 3600000 = \text{msPerMinute} \times \text{MinutesPerHour}$

15.9.1.11 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 $\text{ToInteger}(hour)$.
3. Let *m* be $\text{ToInteger}(min)$.
4. Let *s* be $\text{ToInteger}(sec)$.
5. Let *milli* be $\text{ToInteger}(ms)$.
6. Let *t* be $h * \text{msPerHour} + m * \text{msPerMinute} + s * \text{msPerSecond} + milli$, performing the arithmetic according to IEEE 754 rules (that is, as if using the ECMAScript operators ***** and **+**).
7. Return *t*.

15.9.1.12 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 $\text{ToInteger}(year)$.
3. Let *m* be $\text{ToInteger}(month)$.
4. Let *dt* be $\text{ToInteger}(date)$.
5. Let *ym* be $y + \text{floor}(m / 12)$.
6. Let *mn* be *m* modulo 12.
7. Find a value *t* such that $\text{YearFromTime}(t) \text{ is } ym$ and $\text{MonthFromTime}(t) \text{ is } mn$ and $\text{DateFromTime}(t) \text{ is } 1$; but if this is not possible (because some argument is out of range), return **NaN**.
8. Return $\text{Day}(t) + dt - 1$.

Deleted: ==
Deleted: ==
Deleted: ==

15.9.1.13 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 $day \times \text{msPerDay} + time$.

15.9.1.14 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 an implementation-dependent choice of either $\text{ToInteger}(\text{time})$ or $\text{ToInteger}(\text{time}) + (+0)$. (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**.

15.9.1.15 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**

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.
- :
- 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.
- .
- 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:

THH:mm
THH:mm:ss
THH: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**

- Deleted:** The value of an
- Deleted:** absent
- Deleted:** in
- Deleted:** is “z”

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.

15.9.1.15.1 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.
+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.

15.9.2 The Date Constructor Called as a Function

When `Date` is called as a function rather than as a constructor, it returns a String representing the current time (UTC). However, if the `this` value passed in the call is an Object with an uninitialized `[[DateValue]]` internal data property, `Date` initializes the `this` object using the argument value. This permits `Date` to be used both as a function for creating date strings and to perform constructor instance initialization.

`Date` may be subclassed and subclass constructors may perform a super invocation of the `Date` constructor to initialize the `[[DateValue]]` state of subclass instances.

15.9.2.1 `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 constructor call.
2. Assert: `numberOfArgs > 2`.
3. Let `O` be the `this` value.
4. If `Type(O)` is Object and `O` has a `[[DateValue]]` internal data property and the value of `[[DateValue]]` is `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 then let `dt` be `ToNumber(date)`; else let `dt` be `1`.
 - f. `ReturnIfAbrupt(dt)`.
 - g. If `hours` is supplied then let `h` be `ToNumber(hours)`; else let `h` be `0`.
 - h. `ReturnIfAbrupt(h)`.
 - i. If `minutes` is supplied then let `min` be `ToNumber(minutes)`; else let `min` be `0`.
 - j. `ReturnIfAbrupt(min)`.
 - k. If `seconds` is supplied then let `s` be `ToNumber(seconds)`; else let `s` be `0`.
 - l. `ReturnIfAbrupt(s)`.
 - m. If `ms` is supplied then let `milli` be `ToNumber(ms)`; else let `milli` be `0`.
 - n. `ReturnIfAbrupt(milli)`.
 - o. If `y` is not `NaN` and $0 \leq \text{ToInteger}(y) \leq 99$, then let `yr` be $1900 + \text{ToInteger}(y)$; otherwise, let `yr` be `y`.

Deleted: ¶

NOTE The function call `Date(...)` is not equivalent to the object creation expression `new Date(...)` with the same arguments.¶ 15.9.2.1 `Date ([year [,month [,date [,hours [,minutes [,seconds [,ms]]]]]])` All of the arguments are optional; any arguments supplied are accepted but are completely ignored. A String is created and returned as if by the expression `(new Date()).toString()` where `Date` is the standard built-in constructor with that name and `toString` is the standard built-in method `Date.prototype.toString`.¶ 15.9.3 The Date Constructor¶ When `Date` is called as part of a `new` expression, it is a constructor: it initialises the newly created ordinary object.¶

Deleted: 3

Deleted: new

Deleted: When `Date` is called with two to seven arguments, it computes the date from `year`, `month`, and (optionally) `date`, `hours`, `minutes`, `seconds` and `ms`.¶

Deleted: The `[[Prototype]]` internal data property of the newly constructed object is set to the original Date prototype object, the one that is the initial value of `Date.prototype` (15.9.4.1).¶

The `[[Class]]` internal property of the newly constructed object is set to "Date" has a `[[IsDateNativeBrandBuiltInBrand]]` internal data property whose value is NativeDateBuiltInDate. The `[[Extensible]]` internal data property of the newly constructed object is set to `true`.¶

The `[[PrimitiveValueDateValue]]` internal data property of the newly constructed object is set as follows:¶

- p. Let *finalDate* be *MakeDate*(*MakeDay*(*yr*, *m*, *dt*), *MakeTime*(*h*, *min*, *s*, *milli*)).
 q. Set the ***[[DateValue]]*** internal data property of *O* to *TimeClip*(*UTC*(*finalDate*)).
 r. **Return *O*.**

5. **Else.**

- a. Return the result computed as if by the expression ***(new Date()).toString()*** where ***Date*** is this function and ***toString*** is the standard built-in method ***Date.prototype.toString***.

15.9.2.2 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 constructor call.
2. Assert: *numberOfArgs* = 1.
3. Let *O* be the ***this*** value.
4. If *Type(O)* is Object and *O* has a ***[[DateValue]]*** internal data property and the value of ***[[DateValue]]*** is ***undefined***, then
 - a. Let *v* be *ToPrimitive*(*value*).
 - b. If *Type(v)* is String, then
 - i. Let *V* be the result of parsing *v* as a date, in exactly the same manner as for the ***parse*** method (15.9.4.2). If the parse resulted in an abrupt completion, *V* is the Completion Record.
 - c. Else,
 - i. Let *V* be *ToNumber*(*v*).
 - d. **ReturnIfAbrupt(V).**
 - e. Set the ***[[DateValue]]*** internal data property of *O* to *TimeClip(V)*.
 - f. **Return *O*.**
5. **Else,**
 - a. Return the result computed as if by the expression ***(new Date()).toString()*** where ***Date*** is this function and ***toString*** is the standard built-in method ***Date.prototype.toString***.

15.9.2.3 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 constructor call.
2. Assert: *numberOfArgs* = 0.
3. Let *O* be the ***this*** value.
4. If *Type(O)* is Object and *O* has a ***[[DateValue]]*** internal data property and the value of ***[[DateValue]]*** is ***undefined***, then
 - a. Set the ***[[DateValue]]*** internal data property of *O* to the time value (UTC) identifying the current time.
 - b. **Return *O*.**
5. **Else,**
 - a. Return the result computed as if by the expression ***(new Date()).toString()*** where ***Date*** is this function and ***toString*** is the standard built-in method ***Date.prototype.toString***.

15.9.3 The Date Constructor

When ***Date*** is called as part of a ***new*** expression, it is a constructor: it initialises the newly created ordinary object.

Deleted: PrimitiveValue

Deleted: the newly constructed object

Comment [AWB14194]: Need to express as an intrinsic from same realm as this function.

Deleted: 3

Deleted: new

Deleted: <#>The ***[[Prototype]]*** internal data property of the newly constructed object is set to the original Date prototype object, the one that is the initial value of ***Date.prototype*** (15.9.4.1).||

<#>The newly constructed object has a ***[[IsDateNativeBrandBuiltInBrand]]*** internal data property whose value is NativeDateBuiltInDate. The ***[[Class]]*** internal property of the newly constructed object is set to "Date".||

<#>The ***[[Extensible]]*** internal data property of the newly constructed object is set to ***true***.||

<#>The ***[[PrimitiveValueDateValue]]*** internal data property of the newly constructed object is set as follows:

Deleted: Parse

Deleted:; let *V* be the time value for this date

Deleted: return

Deleted:,

Deleted: let

Deleted: Primitive

Deleted: the newly constructed object

Deleted: <#>Return the newly constructed object.||

Comment [AWB14195]: Need to express as an intrinsic from same realm as this function.

Deleted: Set the ***[[PrimitiveValue]]*** internal property of the newly constructed object to *TimeClip(V)* and return.||

Deleted: 3

Deleted: new

Comment [AWB14196]: Need to express as an intrinsic from same realm as this function.

Deleted: The ***[[Prototype]]*** internal data property of the newly constructed object is set to the original Date prototype object, the one that is the initial value of ***Date.prototype*** (15.9.4.1).||

The newly constructed object has a ***[[IsDateNativeBrandBuiltInBrand]]*** internal data property whose value is NativeDateBuiltInDate. The ***[[Class]]*** internal property of the newly constructed object is set to "Date".||

The ***[[Extensible]]*** internal data property of the newly constructed object is set to ***true***.||

The ***[[PrimitiveValueDateValue]]*** internal data property of the newly constructed object is set to the time value (UTC) identifying the current time.||

15.9.3.1 new Date (...args)

Date called as part of a new expression with argument list *args* performs the following steps:

1. Let *F* be the **Date** function object on which the **new** operator was applied.
2. Let *argumentsList* be the *argumentsList* argument of the **[[Construct]]** internal method that was invoked by the **new** operator.
3. Return the result of **OrdinaryConstruct** (*F*, *argumentsList*).

If **Date** is implemented as an ordinary function object, its **[[Construct]]** internal method will perform the above steps.

15.9.4 Properties of the Date Constructor

The value of the **[[Prototype]]** internal **data** property of the Date constructor is the Function prototype object (15.3.4).

Besides the **length** property (whose value is 7), the Date constructor has the following properties:

Deleted: the internal properties and

15.9.4.1 Date.prototype

The initial value of **Date.prototype** is the built-in Date prototype object (15.9.5).

This property has the attributes { **[[Writable]]**: **false**, **[[Enumerable]]**: **false**, **[[Configurable]]**: **false** }.

Deleted:
Deleted: and

15.9.4.2 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 called out in Date Time String Format (15.9.1.15). If the String does not conform to that format the function may fall back to any implementation-specific heuristics or implementation-specific date formats. Unrecognisable Strings or dates containing illegal element values in the format String shall cause **Date.parse** to return **Nan**.

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 (15.9.1.15) and that could not be produced in that implementation by the **toString** or **toUTCString** method.

15.9.4.3 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 then let *dt* be `ToNumber(date)`; else let *dt* be **1**.
6. ReturnIfAbrupt(*dt*).
7. If *hours* is supplied then let *h* be `ToNumber(hours)`; else let *h* be **0**.
8. ReturnIfAbrupt(*h*).
9. If *minutes* is supplied then let *min* be `ToNumber(minutes)`; else let *min* be **0**.
10. ReturnIfAbrupt(*min*).
11. If *seconds* is supplied then let *s* be `ToNumber(seconds)`; else let *s* be **0**.
12. ReturnIfAbrupt(*s*).
13. If *ms* is supplied then let *milli* be `ToNumber(ms)`; else let *milli* be **0**.
14. ReturnIfAbrupt(*milli*).
15. If *y* is not `NaN` and $0 \leq \text{ToInteger}(y) \leq 99$, then let *yr* be $1900 + \text{ToInteger}(y)$; otherwise, let *yr* be *y*.
16. Return `TimeClip(MakeDate(MakeDay(yr, m, dt), MakeTime(h, min, s, milli)))`.

Deleted: *s*

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.

15.9.4.4 `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`.

15.9.4.5 `Date[@@create]()`

The `@@create` method of an object *F* performs the following steps:

1. Let *obj* be the result of calling `OrdinaryCreateFromConstructor(F, "%DatePrototype%", ([[DateValue]])`.
2. ReturnIfAbrupt(*obj*).
3. Return *obj*.

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

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 implementation may choose to encode the flag in some other manner.

15.9.5 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 data property.

The value of the `[[Prototype]]` internal data property of the Date prototype object is the standard built-in Object prototype object (15.2.4).

Unless explicitly stated 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 data property 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 data property, then
 - a. Let *n* be the Number that is the value of *value*'s `[[NumberData]]` internal data property.
 - b. If *n* is not `undefined`, then return *n*.
2. Throw a `TypeError` exception.

Deleted: *s*

Deleted: When *t*

Deleted: `Date`

Deleted: .

Deleted: are taken

Deleted: <#>Add a `[[DateValue]]` internal data property to *obj*.
 <#>Add a `[[NativeBrand]]` internal data property to *obj*.
 <#>Set the `[[NativeBrand]]` internal data property of *obj* to `BuiltinDate`.

Comment [AWB14197]: Because the `@@create` method is essential to the integrity of this "class" definition just like the `prototype` property, it seems appropriate to freeze it in the same manner.

Deleted: `Date`

Deleted: (its `[[Class]]` is "`Date`")

Deleted: and has a `[[IsDateNativeBrandBuiltinBrand]]` internal data property whose value is `NativeDateBuiltinDate`.

Deleted: whose

Deleted:

Deleted: Its `[[PrimitiveValueDateValue]]` is `NaN`

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. 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.

15.9.5.1 `Date.prototype.constructor`

The initial value of `Date.prototype.constructor` is the built-in `Date` constructor.

15.9.5.2 `Date.prototype.toString()`

This function returns a String value. If this time value is `Nan`, the String value is "Invalid Date", otherwise 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.

NOTE For any Date value `d` whose milliseconds amount is zero, the result of `Date.parse(d.toString())` is equal to `d.valueOf()`. See 15.9.4.2.

Deleted: Unless explicitly noted otherwise, none of these functions are generic; a `TypeError` exception is thrown if the **this** value is not an object for which the value of the `[[Class]]` with a `[[IsDateNativeBrandDateValue]]` internal data property is "`Date`". Also, the phrase "this time value" refers to the Number value for the time represented by this Date object, that is, the value of the `[[PrimitiveValueDateValue]]` internal data property of this Date object.||

Deleted: The

15.9.5.3 `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.

15.9.5.4 `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.

15.9.5.5 `Date.prototype.toLocaleString()`

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.

NOTE 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.

15.9.5.6 `Date.prototype.toLocaleDateString()`

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.

NOTE 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.

15.9.5.7 `Date.prototype.toLocaleTimeString()`

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.

NOTE 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.

15.9.5.8 Date.prototype.valueOf ()

The `valueOf` function returns a Number, which is this time value.

15.9.5.9 Date.prototype.getTime ()

1. Return this time value.

15.9.5.10 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)).

15.9.5.11 Date.prototype.getUTCFullYear ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is NaN, return NaN.
4. Return YearFromTime(t).

15.9.5.12 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)).

15.9.5.13 Date.prototype.getUTCMonth ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is NaN, return NaN.
4. Return MonthFromTime(t).

15.9.5.14 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)).

15.9.5.15 Date.prototype.getUTCDate ()

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. If t is NaN, return NaN.
4. Return DateFromTime(t).

15.9.5.16 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)).

15.9.5.17 Date.prototype.getUTCDay ()

1. Let t be this time value.

2. ReturnIfAbrupt(*t*).
3. If *t* is NaN, return NaN.
4. Return WeekDay(*t*).

15.9.5.18 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*)).

15.9.5.19 Date.prototype.getUTCHours ()

1. Let *t* be this time value.
2. ReturnIfAbrupt(*t*).
3. If *t* is NaN, return NaN.
4. Return HourFromTime(*t*).

15.9.5.20 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*)).

15.9.5.21 Date.prototype.getUTCMilliseconds ()

1. Let *t* be this time value.
2. ReturnIfAbrupt(*t*).
3. If *t* is NaN, return NaN.
4. Return MinFromTime(*t*).

15.9.5.22 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*)).

15.9.5.23 Date.prototype.getUTCSeconds ()

1. Let *t* be this time value.
2. ReturnIfAbrupt(*t*).
3. If *t* is NaN, return NaN.
4. Return SecFromTime(*t*).

15.9.5.24 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*)).

15.9.5.25 Date.prototype.getUTCMilliseconds ()

1. Let *t* be this time value.
2. ReturnIfAbrupt(*t*).
3. If *t* is NaN, return NaN.
4. Return msFromTime(*t*).

15.9.5.26 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 $(t - \text{LocalTime}(t)) / \text{msPerMinute}$.

15.9.5.27 Date.prototype.setTime (time)

1. Let v be **TimeClip(ToNumber($time$))**.
2. ReturnIfAbrupt(v).
3. Set the **$[[\text{DateValue}]]$** internal **data** property of this Date object to v .
4. Return v .

Deleted: PrimitiveValue

15.9.5.28 Date.prototype.setMilliseconds (ms)

1. Let t be the result of **LocalTime(this time value)**.
2. Let $time$ be **MakeTime(HourFromTime(t), MinFromTime(t), SecFromTime(t), ToNumber(ms))**.
3. Let u be **TimeClip(UTC(MakeDate(Day(t), $time$)))**.
4. Set the **$[[\text{DateValue}]]$** internal **data** property of this Date object to u .
5. Return u .

Deleted: PrimitiveValue

15.9.5.29 Date.prototype.setUTCMilliseconds (ms)

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. Let $time$ be **MakeTime(HourFromTime(t), MinFromTime(t), SecFromTime(t), ToNumber(ms))**.
4. Let v be **TimeClip(MakeDate(Day(t), $time$))**.
5. Set the **$[[\text{DateValue}]]$** internal **data** property of this Date object to v .
6. Return v .

Deleted: PrimitiveValue

15.9.5.30 Date.prototype.setSeconds (sec [, ms])

If ms is not specified, this behaves as if ms were specified with the value **getMilliseconds ()**.

1. Let t be the result of **LocalTime(this time value)**.
2. Let s be **ToNumber(sec)**.
3. If ms is not specified, then let $milli$ be **msFromTime(t)**; otherwise, let $milli$ be **ToNumber(ms)**.
4. Let $date$ be **MakeDate(Day(t), MakeTime(HourFromTime(t), MinFromTime(t), s , $milli$))**.
5. Let u be **TimeClip(UTC(date))**.
6. Set the **$[[\text{DateValue}]]$** internal **data** property of this Date object to u .
7. Return u .

Deleted: PrimitiveValue

The **length** property of the **setSeconds** method is **2**.

15.9.5.31 Date.prototype.setUTCMilliseconds (sec [, ms])

If ms is not specified, this behaves as if ms were specified with the value **getUTCMilliseconds ()**.

1. Let t be this time value.
2. ReturnIfAbrupt(t).
3. Let s be **ToNumber(sec)**.
4. If ms is not specified, then 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 **$[[\text{DateValue}]]$** internal **data** property of this Date object to v .
8. Return v .

Deleted: PrimitiveValue

The `length` property of the `setUTCSeconds` method is 2.

15.9.5.32 Date.prototype.setMinutes (min [, sec [, ms]])

If `sec` is not specified, this 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()`.

1. Let `t` be the result of `LocalTime(this time value)`.
2. Let `m` be `ToNumber(min)`.
3. If `sec` is not specified, then let `s` be `SecFromTime(t)`; otherwise, let `s` be `ToNumber(sec)`.
4. If `ms` is not specified, then let `milli` be `msFromTime(t)`; otherwise, let `milli` be `ToNumber(ms)`.
5. Let `date` be `MakeDate(Day(t), MakeTime(HourFromTime(t), m, s, milli))`.
6. Let `u` be `TimeClip(UTC(date))`.
7. Set the `[[DateValue]]` internal `data` property of this `Date` object to `u`.
8. Return `u`.

Deleted: PrimitiveValue

The `length` property of the `setMinutes` method is 3.

15.9.5.33 Date.prototype.setUTCMMinutes (min [, sec [, ms]])

If `sec` is not specified, this behaves as if `sec` were specified with the value `getUTCSeconds()`.

If `ms` is not specified, this function behaves as if `ms` were specified with the value return by `getUTCMilliseconds()`.

1. Let `t` be this time value.
2. ReturnIfAbrupt(t).
3. Let `m` be `ToNumber(min)`.
4. If `sec` is not specified, then let `s` be `SecFromTime(t)`; otherwise, let `s` be `ToNumber(sec)`.
5. If `ms` is not specified, then let `milli` be `msFromTime(t)`; otherwise, let `milli` be `ToNumber(ms)`.
6. Let `date` be `MakeDate(Day(t), MakeTime(HourFromTime(t), m, s, milli))`.
7. Let `v` be `TimeClip(date)`.
8. Set the `[[DateValue]]` internal `data` property of this `Date` object to `v`.
9. Return `v`.

Deleted: PrimitiveValue

The `length` property of the `setUTCMMinutes` method is 3.

15.9.5.34 Date.prototype.setHours (hour [, min [, sec [, ms]]])

If `min` is not specified, this behaves as if `min` were specified with the value `getMinutes()`.

If `sec` is not specified, this 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()`.

1. Let `t` be the result of `LocalTime(this time value)`.
2. Let `h` be `ToNumber(hour)`.
3. If `min` is not specified, then let `m` be `MinFromTime(t)`; otherwise, let `m` be `ToNumber(min)`.
4. If `sec` is not specified, then let `s` be `SecFromTime(t)`; otherwise, let `s` be `ToNumber(sec)`.
5. If `ms` is not specified, then let `milli` be `msFromTime(t)`; otherwise, let `milli` be `ToNumber(ms)`.
6. Let `date` be `MakeDate(Day(t), MakeTime(h, m, s, milli))`.
7. Let `u` be `TimeClip(UTC(date))`.
8. Set the `[[DateValue]]` internal `data` property of this `Date` object to `u`.
9. Return `u`.

Deleted: PrimitiveValue

The `length` property of the `setHours` method is 4.

15.9.5.35 Date.prototype.setUTCHours (hour [, min [, sec [, ms]]])

If *min* is not specified, this behaves as if *min* were specified with the value `getUTCMinutes()`.

If *sec* is not specified, this behaves as if *sec* were specified with the value `getUTCSeconds()`.

If *ms* is not specified, this behaves as if *ms* were specified with the value `getUTCMilliseconds()`.

1. Let *t* be this time value.
2. [ReturnIfAbrupt\(*t*\)](#).
3. Let *h* be `ToNumber(hour)`.
4. If *min* is not specified, then let *m* be `MinFromTime(t)`; otherwise, let *m* be `ToNumber(min)`.
5. If *sec* is not specified, then let *s* be `SecFromTime(t)`; otherwise, let *s* be `ToNumber(sec)`.
6. If *ms* is not specified, then let *milli* be `msFromTime(t)`; otherwise, let *milli* be `ToNumber(ms)`.
7. Let *newDate* be `MakeDate(Day(t), MakeTime(h, m, s, milli))`.
8. Let *v* be `TimeClip(newDate)`.
9. Set the `[[DateValue]]` internal `data` property of this Date object to *v*.
10. Return *v*.

Deleted: PrimitiveValue

The `length` property of the `setUTCHours` method is **4**.

15.9.5.36 Date.prototype.setDate (date)

1. Let *t* be the result of `LocalTime(this time value)`.
2. Let *dt* be `ToNumber(date)`.
3. Let *newDate* be `MakeDate(MakeDay(YearFromTime(t), MonthFromTime(t), dt), TimeWithinDay(t))`.
4. Let *u* be `TimeClip(UTC(newDate))`.
5. Set the `[[DateValue]]` internal `data` property of this Date object to *u*.
6. Return *u*.

Deleted: PrimitiveValue

15.9.5.37 Date.prototype.setUTCDate (date)

1. Let *t* be this time value.
2. [ReturnIfAbrupt\(*t*\)](#).
3. Let *dt* be `ToNumber(date)`.
4. Let *newDate* be `MakeDate(MakeDay(YearFromTime(t), MonthFromTime(t), dt), TimeWithinDay(t))`.
5. Let *v* be `TimeClip(newDate)`.
6. Set the `[[DateValue]]` internal `data` property of this Date object to *v*.
7. Return *v*.

Deleted: PrimitiveValue

15.9.5.38 Date.prototype.setMonth (month [, date])

If *date* is not specified, this behaves as if *date* were specified with the value `getDate()`.

1. Let *t* be the result of `LocalTime(this time value)`.
2. Let *m* be `ToNumber(month)`.
3. If *date* is not specified, then let *dt* be `DateFromTime(t)`; otherwise, let *dt* be `ToNumber(date)`.
4. Let *newDate* be `MakeDate(MakeDay(YearFromTime(t), m, dt), TimeWithinDay(t))`.
5. Let *u* be `TimeClip(UTC(newDate))`.
6. Set the `[[DateValue]]` internal `data` property of this Date object to *u*.
7. Return *u*.

Deleted: PrimitiveValue

The `length` property of the `setMonth` method is **2**.

15.9.5.39 Date.prototype.setUTCMonth (month [, date])

If *date* is not specified, this behaves as if *date* were specified with the value `getUTCDate()`.

1. Let *t* be this time value.

2. ReturnIfAbrupt(*t*).

3. Let *m* be ToNumber(*month*).
4. If *date* is not specified, then 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 **data** property of this Date object to *v*.
8. Return *v*.

Deleted: PrimitiveValue

The **length** property of the **setUTCMonth** method is **2**.

15.9.5.40 Date.prototype.setFullYear (year [, month [, date]])

If *month* is not specified, this behaves as if *month* were specified with the value **getMonth ()**.

If *date* is not specified, this behaves as if *date* were specified with the value **getDate ()**.

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. If *month* is not specified, then let *m* be MonthFromTime(*t*); otherwise, let *m* be ToNumber(*month*).
4. If *date* is not specified, then let *dt* be DateFromTime(*t*); otherwise, let *dt* be ToNumber(*date*).
5. Let *newDate* be MakeDate(MakeDay(*y*, *m*, *dt*), TimeWithinDay(*t*)).
6. Let *u* be TimeClip(UTC(*newDate*)).
7. Set the **[[DateValue]]** internal **data** property of this Date object to *u*.
8. Return *u*.

Deleted: PrimitiveValue

The **length** property of the **setFullYear** method is **3**.

15.9.5.41 Date.prototype.setUTCFullYear (year [, month [, date]])

If *month* is not specified, this behaves as if *month* were specified with the value **getUTCMonth ()**.

If *date* is not specified, this behaves as if *date* were specified with the value **getUTCDate ()**.

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. If *month* is not specified, then let *m* be MonthFromTime(*t*); otherwise, let *m* be ToNumber(*month*).
5. If *date* is not specified, then let *dt* be DateFromTime(*t*); otherwise, let *dt* be ToNumber(*date*).
6. Let *newDate* be MakeDate(MakeDay(*y*, *m*, *dt*), TimeWithinDay(*t*)).
7. Let *v* be TimeClip(*newDate*).
8. Set the **[[DateValue]]** internal **data** property of this Date object to *v*.
9. Return *v*.

Deleted: PrimitiveValue

The **length** property of the **setUTCFullYear** method is **3**.

15.9.5.42 Date.prototype.toUTCString ()

This function returns a String value. The contents of the String are implementation-dependent, but are intended to represent the Date 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 15.9.1.15. It is not essential that the chosen format be unambiguous or easily machine parsable. If an implementation does not have a preferred human-readable format it is recommended to use the format defined in 15.9.1.15 but with a space rather than a "T" used to separate the date and time elements.

15.9.5.43 Date.prototype.toISOString ()

This function returns a String value represent the instance in time represented by this Date object. The format of the String is the Date Time string format defined in 15.9.1.15. All fields are present in the String. The time

zone is always UTC, denoted by the suffix Z. If the time value of this object is not a finite Number a **RangeError** exception is thrown.

15.9.5.44 Date.prototype.toJSON (key)

This function provides a String representation of a Date object for use by **JSON.stringify** (15.12.3).

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. If *tv* is a Number and is not finite, return **null**.
4. Let *toISO* be the result of **Get**(*O*, "toISOString").
5. **ReturnIfAbrupt**(*toISO*).
6. If **IsCallable**(*toISO*) is **false**, throw a **TypeError** exception.
7. Return the result of calling the [[Call]] internal method of *toISO* with *O* as *thisArgument* and an empty List as *argumentsList*.

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. An object is free to use the argument *key* to filter its stringification.

Deleted: calling the [[]]
Deleted: internal method of
Deleted:
Deleted: with argument
Deleted: the **this** value
Deleted: argument l

15.9.5.45 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 object in that they treat "default" as being equivalent to "string". All other built-in ECMAScript objects treat "default" as being equivalent to "number".

Deleted: d

When the **@@ToPrimitive** method is called with argument *hint*, the following steps are taken:

1. Let *O* be **this Date object**.
2. If **Type**(*O*) is not Object, then throw a **TypeError** exception.
3. If *hint* is "string" or "default", then
 - a. Let *tryFirst* be "string".
4. Else if *hint* is "number", then
 - a. Let *tryFirst* be "number".
5. Else, throw a **TypeError** exception.
6. Return the result of **OrdinaryToPrimitive**(*O*, *tryFirst*).

Deleted: the
Deleted:
Deleted:
Deleted:
Deleted:

15.9.6 Properties of Date Instances

Date instances are ordinary objects that inherit properties from the Date prototype object. Date instances also have a [[DateValue]] internal data property. The [[DateValue]] internal data property is the time value represented by this Date object.

Deleted: and their have a [[ClassIsDateNativeBrandBuiltinBrand]] internal whose value is NativeDateBuiltinDate
Deleted: property value is "Date"
Deleted: PrimitiveValue
Deleted: ¶
Deleted: PrimitiveValue

15.10 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.

15.10.1 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 ::
 Disjunction

Disjunction ::
 Alternative
 Alternative | *Disjunction*

Alternative ::
 [empty]
 Alternative Term

Term ::
 Assertion
 Atom
 Atom Quantifier

Assertion ::
 ^
 \$
 \ b
 \ B
 (? = *Disjunction*)
 (? ! *Disjunction*)

Quantifier ::
 QuantifierPrefix
 QuantifierPrefix ?

QuantifierPrefix ::
 *
 +
 ?
 { *DecimalDigits* }
 { *DecimalDigits* , }
 { *DecimalDigits* , *DecimalDigits* }

Atom ::
 PatternCharacter
 .
 \ *AtomEscape*
 CharacterClass
 (*Disjunction*)
 (? : *Disjunction*)

PatternCharacter ::
 SourceCharacter but not one of
 ^ \$ \ . * + ? () [] { } |

AtomEscape ::
 DecimalEscape
 CharacterEscape
 CharacterClassEscape

CharacterEscape ::

ControlEscape
c *ControlLetter*
HexEscapeSequence
UnicodeEscapeSequence
IdentityEscape

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

IdentityEscape ::

SourceCharacter but not IdentifierPart
<ZWJ>
<ZWNJ>

DecimalEscape ::

DecimalIntegerLiteral [lookahead \notin DecimalDigit]

CharacterClassEscape :: one of

d **D** **s** **S** **w** **W**

CharacterClass ::

[lookahead $\notin \{\wedge\}$] *ClassRanges* [
[\wedge *ClassRanges*]

ClassRanges ::

[empty]
NonemptyClassRanges

NonemptyClassRanges ::

ClassAtom
ClassAtom NonemptyClassRangesNoDash
ClassAtom - ClassAtom ClassRanges

NonemptyClassRangesNoDash ::

ClassAtom
ClassAtomNoDash NonemptyClassRangesNoDash
ClassAtomNoDash - ClassAtom ClassRanges

ClassAtom ::

-
ClassAtomNoDash

ClassAtomNoDash ::

SourceCharacter but not one of \ or] or -
\ *ClassEscape*

ClassEscape ::

DecimalEscape
b
CharacterEscape
CharacterClassEscape

15.10.2 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 data property.

Deleted: [[Match]]

15.10.2.1 Notation

The descriptions below use the following variables:

- *Input* is the String being matched by the regular expression pattern. 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 the *Input* String.
- *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 the setting of the RegExp object's *ignoreCase* property.
- *Multiline* is the setting of the RegExp object's property.

Furthermore, the descriptions below use the following internal data structures:

- A *CharSet* is a mathematical set of characters.
- A *State* is an ordered pair (*endIndex*, *captures*) where *endIndex* is an integer and *captures* is an internal array 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 String 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 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 the input String, 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 the input String, 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 the input String and returns **true** if the condition matched or **false** if not.
- 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 *n*th set of capturing parentheses.

15.10.2.2 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. Let *Input* be the given String *str*. This variable will be used throughout the algorithms in 15.10.2.
 2. Let *InputLength* be the length of *Input*. This variable will be used throughout the algorithms in 15.10.2.
 3. Let *c* be a Continuation that always returns its State argument as a successful MatchResult.
 4. Let *cap* be an internal array of *NcapturingParens* **undefined** values, indexed 1 through *NcapturingParens*.
 5. Let *x* be the State (*index*, *cap*).
 6. Call *m(x, c)* and return its result.

NOTE A Pattern evaluates ("compiles") to an internal procedure value. `RegExp.prototype.exec` 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 15.10.2 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).

15.10.2.3 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:
 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]
```

15.10.2.4 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:
 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 the input String. 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*.

15.10.2.5 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:

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 by evaluating *Atom* to obtain a Matcher and returning that Matcher.

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*, then 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 :: (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:
 1. Call *RepeatMatcher(m, min, max, greedy, x, c, parenIndex, parenCount)* and return its result.

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:

1. If *max* is zero, then call *c(x)* and return its result.
2. Create an internal Continuation closure *d* that takes one State argument *y* and performs the following:
 1. If *min* is zero and *y*'s *endIndex* is equal to *x*'s *endIndex*, then return **failure**.
 2. If *min* is zero then let *min2* be zero; otherwise let *min2* be *min*-1.
 3. If *max* is ∞ , then 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* internal array.
4. For every integer *k* that satisfies *parenIndex* < *k* and *k* \leq *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, then call *m(xr, d)* and return its result.
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.

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 String 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("abcdefghijklm")
```

which returns "abcde" with

```
/a[a-z]{2,4}?/.exec("abcdefghijklm")
```

which returns "abc".

Consider also

```
/(aa|aabaac|ba|b|c)*/.exec("aabaac")
```

which, by the choice point ordering above, returns the array

```
["aaba", "ba"]
```

and not any of:

```
["aabaaac", "aabaac"]
["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(/^(\a+)\1*/,\1+$1,"$1")
```

which returns the gcd in unary notation "aaaaa".

NOTE 3 Step 4 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("zaacbbbcac")
```

which returns the array

```
["zaacbbbcac", "z", "ac", "a", undefined, "c"]
```

and not

```
["zaacbbbcac", "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 String 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", ""]
```

15.10.2.6 Assertion

The production *Assertion* :: `^` evaluates by returning an internal AssertionTester closure that takes a State argument *x* and performs the following:

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**.

The production *Assertion* :: `$` evaluates by returning an internal AssertionTester closure that takes a State argument *x* and performs the following:

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**.

Deleted: *multiline*

The production *Assertion* :: `\ b` evaluates by returning an internal AssertionTester closure that takes a State argument *x* and performs the following:

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:

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 **false**.
 4. Let *y* be *r*'s State.
 5. Let *cap* be *y*'s *captures* internal array.
 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.

Runtime Semantics: IsWordChar Abstract Operation

The abstract operation *IsWordChar* takes an integer parameter e and performs the following:

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**.

15.10.2.7 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 by returning the two results 0 and ∞ .

The production *QuantifierPrefix* :: + evaluates by returning the two results 1 and ∞ .

The production *QuantifierPrefix* :: ? evaluates by returning the two results 0 and 1.

The production *QuantifierPrefix* :: { *DecimalDigits* } evaluates as follows:

1. Let i be the MV of *DecimalDigits* (see 7.8.3).
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 .

15.10.2.8 Atom

The production *Atom* :: *PatternCharacter* evaluates as follows:

1. Let ch be the character represented by *PatternCharacter*.
2. Let A be a one-element CharSet containing the character ch .
3. Call *CharacterSetMatcher*(A , **false**) and return its Matcher result.

Deleted: ==
Deleted: =
Deleted: =

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 by evaluating *AtomEscape* to obtain a Matcher and returning that Matcher.

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* internal array.
 2. Let *xe* be *x*'s *endIndex*.
 3. Let *ye* be *y*'s *endIndex*.
 4. Let *s* be a fresh String whose characters are the characters of *Input* at positions *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.

The production *Atom :: (? : Disjunction)* evaluates by evaluating *Disjunction* to obtain a Matcher and returning that Matcher.

Runtime Semantics: CharacterSetMatcher Abstract Operation

The abstract operation *CharacterSetMatcher* takes two arguments, a CharSet *A* and a Boolean flag *invert*, and performs the following:

1. Return an internal Matcher closure that takes two arguments, a State *x* and a Continuation *c*, and performs the following steps:
 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 *Canonicalize(a)* is *cc*, return **failure**.
 6. Else *invert* is **true**,
 - a. If there exists a member *a* of set *A* such that *Canonicalize(a)* is *cc*, return **failure**.
 7. Let *cap* be *x*'s *captures* internal array.
 8. Let *y* be the State (*e+1, cap*).
 9. Call *c(y)* and return its result.

Deleted: ==

Deleted: ==

Deleted: ==

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. Let *u* be *ch* converted to upper case as if by calling the standard built-in method `String.prototype.toUpperCase` on the one-character String *ch*.
3. If *u* does not consist of a single character, return *ch*.
4. Let *cu* be *u*'s character.
5. If *ch*'s code unit value is greater than or equal to decimal 128 and *cu*'s code unit value is less than decimal 128, then return *ch*.
6. Return *cu*.

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 `(\n` 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\2c)\2(.*)/.exec("baaabaac")
```

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:

```
[ "baaabaac", "ba", undefined, "abaac" ]
```

In case-insensitive matches all characters are implicitly converted to upper case immediately before they are compared. However, if converting a character to upper case would expand that character into more than one character (such as converting "**B**" (`\u000DF`) into "ss"), then the character is left as-is instead. The character is also left as-is if it is not an ASCII character but converting it to upper case would make it into an ASCII character. This prevents Unicode characters such as `\u0131` and `\u017F` from matching regular expressions such as `/[a-z]/i`, which are only intended to match ASCII letters. Furthermore, if these conversions were allowed, then `/[^w]/i` would match each of **a**, **b**, ..., **h**, but not **i** or **s**.

15.10.2.9 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. *E* must be an integer. Let *n* be that integer.
4. If *n*=0 or *n*>*NcapturingParens* then throw a **SyntaxError** exception.
5. Return an internal Matcher closure that takes two arguments, a State *x* and a Continuation *c*, and performs the following:
1. Let *cap* be *x*'s *captures* internal array.
 2. Let *s* be *cap[n]*.
 3. If *s* is **undefined**, then call *c(x)* and return its result.
 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 as *Canonicalize(Input[e+i])*, then return **failure**.
 9. Let *y* be the State (*f, cap*).
 10. Call *c(y)* and return its result.

Deleted: *NcapturingParens*

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 15.10.2.11). 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.

15.10.2.10 CharacterEscape

The production *CharacterEscape :: ControlEscape* evaluates by returning the character according to [Table 34](#).

Table 34 — ControlEscape Character Values

Deleted: Table 35Table 33Table 31

Deleted: 353331

ControlEscape	Code Unit	Name	Symbol
t	\u0009	horizontal tab	<HT>
n	\u000A	line feed (new line)	<LF>
v	\u000B	vertical tab	<VT>
f	\u000C	form feed	<FF>
r	\u000D	carriage return	<CR>

The production *CharacterEscape :: c ControlLetter* evaluates as follows:

1. Let *ch* be the character represented by *ControlLetter*.
2. Let *i* be *ch*'s code unit value.
3. Let *j* be the remainder of dividing *i* by 32.
4. Return the character whose code unit value is *j*.

The production *CharacterEscape :: HexEscapeSequence* evaluates by evaluating the CV of the *HexEscapeSequence* (see 7.8.4) and returning its character result.

The production *CharacterEscape* :: *UnicodeEscapeSequence* evaluates by evaluating the CV of the *UnicodeEscapeSequence* (see 7.8.4) and returning its character result.

The production *CharacterEscape* :: *IdentityEscape* evaluates by returning the character represented by *IdentityEscape*.

15.10.2.11 DecimalEscape

The production *DecimalEscape* :: *DecimalIntegerLiteral* [lookahead ≠ *DecimalDigit*] evaluates as follows:

1. Let *i* be the MV of *DecimalIntegerLiteral*.
2. If *i* is zero, return the EscapeValue consisting of a <NUL> character (Unicode value 0000).
3. Return the EscapeValue consisting of the integer *i*.

The definition of “the MV of *DecimalIntegerLiteral*” is in 7.8.3.

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.

15.10.2.12 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* (7.2) or *LineTerminator* (7.3) 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*.

15.10.2.13 CharacterClass

The production *CharacterClass* :: [[lookahead ≠ ^] *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**.

15.10.2.14 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.

15.10.2.15 NonemptyClassRanges

The production *NonemptyClassRanges* :: *ClassAtom* evaluates by evaluating *ClassAtom* to obtain a CharSet and returning that CharSet.

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*.

Runtime Semantics: CharacterRange Abstract Operation

The abstract operation *CharacterRange* takes two CharSet parameters *A* and *B* and performs the following:

1. If *A* does not contain exactly one character or *B* does not contain exactly one character then throw a **SyntaxError** exception.
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 code unit value of character *a*.
5. Let *j* be the code unit value of character *b*.
6. If *i > j* then throw a **SyntaxError** exception.
7. Return the set containing all characters numbered *i* through *j*, inclusive.

15.10.2.16 NonemptyClassRangesNoDash

The production *NonemptyClassRangesNoDash* :: *ClassAtom* evaluates by evaluating *ClassAtom* to obtain a CharSet and returning that CharSet.

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 code unit value is greater than the second *ClassAtom*'s code unit 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 ASCII letters 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.

15.10.2.17 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.

15.10.2.18 ClassAtomNoDash

The production *ClassAtomNoDash* :: *SourceCharacter* **but not one of \ or] or -** evaluates by returning a one-element CharSet containing the character represented by *SourceCharacter*.

The production *ClassAtomNoDash* :: \ *ClassEscape* evaluates by evaluating *ClassEscape* to obtain a CharSet and returning that CharSet.

15.10.2.19 ClassEscape

The production *ClassEscape* :: *DecimalEscape* evaluates as follows:

1. Evaluate *DecimalEscape* to obtain an EscapeValue *E*.
2. If *E* is not a character then throw a **SyntaxError** exception.
3. Let *ch* be *E*'s character.
4. Return the one-element CharSet containing the character *ch*.

The production *ClassEscape* :: \b evaluates by returning the CharSet containing the one character <BS> (Unicode value 0008).

The production *ClassEscape* :: *CharacterEscape* evaluates by evaluating *CharacterEscape* to obtain a character and returning a one-element CharSet containing that character.

The production *ClassEscape* :: *CharacterClassEscape* evaluates by evaluating *CharacterClassEscape* to obtain a CharSet and returning that CharSet.

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.

15.10.3 The RegExp Constructor Called as a Function

When **RegExp** is called as a function rather than as a constructor, it creates and initialises a new **RegExp** object. Thus the function call **RegExp**(...) is equivalent to the object creation expression **new RegExp**(...) with the same arguments. However, if the **this** value value passed in the call is an Object with an **[!RegExpMatcher]** internal data property 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.

RegExp may be subclassed and subclass constructors may perform a super invocation of the **RegExp** constructor to initialize subclass instances.

15.10.3.1 RegExp(pattern, flags)

The following steps are taken:

1. Let *func* be this **ReqExp** function object.
2. Let *O* be the **this** value.
3. If **Type(O)** is not Object or **Type(O)** is Object and *O* does not have a **[[RegExpMatcher]]** internal data property or **Type(O)** is Object and *O* has a **[[RegExpMatcher]]** internal data property and the value of **[[RegExpMatcher]]** is not **undefined**, then
 - a. If **Type(pattern)** is Object and *O* has a **[[RegExpMatcher]]** internal data property and *flags* is **undefined**, then
 - i. Return *pattern*;
 - b. Let *O* be the result of calling the abstract operation **RegExpAlloc** with argument *func*.
 - c. ReturnIfAbrupt(*O*).
4. If **Type(pattern)** is Object and *pattern* has a **[[RegExpMatcher]]** internal data property, then
 - a. If the value of *pattern*'s **[[RegExpMatcher]]** internal data property is **undefined**, then throw a **TypeError** exception.
 - b. If *flags* is not **undefined**, then throw a **TypeError** exception.
 - c. Let *P* be the value of *pattern*'s **[[OriginalSource]]** internal data property.
 - d. Let *F* be the value of *pattern*'s **[[OriginalFlags]]** internal data property.
5. Else
 - a. If *pattern* is **undefined**, then let *P* be the empty String.
 - b. Else, let *P* be **ToString(pattern)**.
 - c. ReturnIfAbrupt(*P*).
 - d. If *flags* is **undefined**, then let *F* be the empty String.
 - e. Else, let *F* be **ToString(flags)**.
 - f. ReturnIfAbrupt(*F*).
6. Return the result of the abstract operation **RegExpInitialize** with arguments *obj*, *P*, and *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 recognised by **RegExp**, any backslash \ characters must be escaped within the *StringLiteral* to prevent them being removed when the contents of the *StringLiteral* are formed.

Runtime Semantics: **ReqExpAlloc** Abstract Operation

When the abstract operation **RegExpAlloc** with argument *constructor* is called, the following steps are taken:

1. Assert: *constructor* is a constructable function.
2. Let *obj* be the result of calling **OrdinaryCreateFromConstructor**(*constructor*, "%**ReqExpPrototype**%", **[[RegExpMatcher]]**, **[[OriginalSource]]**, **[[OriginalFlags]]**).
3. Let *status* be the result of **DefinePropertyOrThrow**(*obj*, "lastIndex", **PropertyDescriptor** {**[[Writable]]**: **true**, **[[Enumerable]]**: **false**, **[[Configurable]]**: **false**}).
4. ReturnIfAbrupt(*status*).
5. Return *obj*.

NOTE **[[ReqExpMatcher]]** is initially assigned the value **undefined** as a flag to indicate that the instance has not yet been initialized by the **RegExp** constructor. This flag value is never directly exposed to ECMAScript code; hence implementation may choose to encode the flag in some other manner.

Runtime Semantics: **ReqExpInitialize** Abstract Operation

When the abstract operation **RegExpInitialize** with arguments *obj*, *P*, and *F* is called, the following steps are taken:

1. Assert: *P* and *F* are both Strings.
2. If *F* contains any character other than "g", "i", "m", "u", or "y" or if it contains the same character more than once, then throw a **SyntaxError** exception.
3. Parse *P* interpreted as UTF-16 encoded Unicode characters using the grammars in 15.10.1 for the goal symbol *Pattern*. Throw a **SyntaxError** exception if *P* did not conform to the grammar or if all characters of *P* were not matched by the parse.
4. Set *obj*'s **[[RegExpMatcher]]** internal data property to the internal procedure obtained by evaluating ("compiling") the step 3's parse of *P* and applying the semantics provided in 15.10.2.
5. Set the value of *obj*'s **[[OriginalSource]]** internal data property to *P*.

Comment [AWB14198]: This then clause corresponds to the "called as a function" case in the ES5 spec.

Deleted: <#>If **Type(pattern)** is oObject and *pattern* has a **[[NativeBrandBuiltInBrand]]** internal data property whose value is NativeRegExpBuiltInRegExp and *flags* is **undefined**, then return *pattern*.¶

Deleted: the result of the abstraction operation abstract operation **RegExpCreate** with arguments *pattern* and *flags*

Deleted: Create

Deleted: The

Deleted: Create

Deleted: pattern

Deleted:

Deleted: flags

Deleted: does the following:

6. Set the value of *obj*'s `[[OriginalFlags]]` internal data property to *F*.
7. Let *escapedSource* be the result of calling the abstract operation `EscapeRegExpPattern` with arguments *P* and *F*.
8. Let *putStatus* be the result of `Put(obj, "lastIndex", 0, true)`.
9. `ReturnIfAbrupt(putStatus)`.
10. `Return obj`.

Runtime Semantics: RegExpCreate Abstract Operation

When the abstract operation `RegExpInitialize` with arguments *P* and *F* is called, the following steps are taken:

1. `Assert: P and F are both Strings.`
2. Let *obj* be the result of calling the abstract operation `RegExpAlloc` with argument `%RegExp%`.
3. `ReturnIfAbrupt(obj)`.
4. `Return the result of the abstract operation RegExpInitialize with arguments obj, P, and F.`

Runtime Semantics: EscapeRegExpPattern Abstract Operation

When the abstract operation `EscapeRegExpPattern` with arguments *P* and *F* is called, the following occurs:

Let *S* be a String in the form of a *Pattern* equivalent to *P* interpreted as UTF-16 encoded Unicode characters, in which certain characters are escaped as described below. *S* may or may not be identical to *P* or *pattern*; however, the internal procedure that would result from evaluating *S* as a *Pattern* must behave identically to the internal procedure given by the constructed object's `[[ReqExpMatcher]]` internal data property. Separate calls to this abstract operation using the same values for *P* and *F* most produce identical results.

The characters `/` 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 `"(?:)"`.

Return *S*.

15.10.4 The RegExp Constructor

When `RegExp` is called as part of a `new` expression, it is a constructor: it initialises the newly created object.

15.10.4.1 new RegExp(... args)

RegExp called as part of a new expression with argument list args it performs the following steps:

1. Let *F* be the `RegExp` function object on which the `new` operator was applied.
2. Let *argumentsList* be the `argumentsList` argument of the `[[Construct]]` internal method that was invoked by the `new` operator.
3. `Return the result of OrdinaryConstruct (F, argumentsList)`.

If `RegExp` is implemented as an ordinary function object, its `[[Construct]]` internal method will perform the above steps.

15.10.5 Properties of the RegExp Constructor

The value of the `[[Prototype]]` internal data property of the `RegExp` constructor is the standard built-in Function prototype object (15.3.4).

Besides the `length` property (whose value is **2**), the `RegExp` constructor has the following properties:

Deleted: If *pattern* is an object *R* that has an `[[IsRegExpNativeBrandBuiltinBrand]]` internal data property whose value is `NativeRegExpBuiltinRegExp` whose `[[Class]]` internal property is `"RegExp"` and flag `undefined`, then let *P* be the pattern used to construct *R*. If *pattern* is an object *R* that has an `[[IsRegExpNativeBrandBuiltinBrand]]` internal data property whose value is `NativeRegExpBuiltinRegExp` whose `[[Class]]` internal property is `"RegExp"` and flag is `undefined`, then let *P* be the empty String if *pattern* is an object *R* that has an `[[IsRegExpNativeBrandBuiltinBrand]]` internal data property whose value is `NativeRegExpBuiltinRegExp` whose `[[Class]]` internal property is `"RegExp"` and flags is `undefined`, then throw a `TypeError` exception. Otherwise, let *P* be the empty String if *pattern* is `undefined` and `ToString(pattern)` otherwise, and let *F* be the empty String if *flags* is `undefined` and `ToString(flags)` otherwise. ¶ If the characters of *P* do not have the syntactic form *Pattern*, then throw a `SyntaxError` exception. Otherwise, let the newly constructed object have a `[[Match]]` internal data property obtained by evaluating `("compiling")` the characters of *P* as a *Pattern* as described in 15.10.2. ¶ If *F* contains any character other than `"g"`, `"i"`, or `"m"` or if it contains the same character more than once, then throw a `SyntaxError` exception. ¶ If a `SyntaxError` exception is not thrown, then: ¶

Deleted: `[[Match]]`

Comment [AWB14199]: Why is this underspecified? Why not specify an required escaping? Do different implementation differ in their results?

Deleted: The following properties of the newly constructed object are data properties with the attributes that are specified in 15.10.7. The `[[Value]]` of each property is set as follows: ¶

The `source` property of the newly constructed object is set to *S*. ¶

The `global` property of the newly constructed object is set to a Boolean value that is `true` if *F* contains the character `"g"` and `false` otherwise. ¶

The `ignoreCase` property of the newly constructed object is set to a Boolean value that is `true` if *F* contains the character `"i"` and `false` otherwise. ¶

The multiline property of the newly constructed object is set to a Boolean value that is `true` if *F* contains the character `"m"` and `false` otherwise. ¶

The `lastIndex` property of the newly constructed object is set to `0`. ¶

The `[[Prototype]]` internal data property of the newly constructed object is set to the standard built-in `RegExp` prototype object as specified in 15.10.6. ¶

The `[[Class]]` internal property of the newly constructed object has an `[[IsRegExpNativeBrandBuiltinBrand]]` internal data property whose value is `NativeRegExpBuiltinRegExp` is set to `"RegExp"`. ¶

NOTE: If *pattern* is 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 recognised by `RegExp`, any backslash \ characters must be escaped within the *StringLiteral* to prevent them being removed when the contents of the *StringLiteral* are formed. ¶

Deleted: the internal properties and

15.10.5.1 RegExp.prototype

The initial value of `RegExp.prototype` is the RegExp prototype object (15.10.6).

This property shall have the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

15.9.4.5 RegExp[@@create]()

The `@@create` method of an object *F* performs the following:

1. Return the result of calling the abstract operation `RegExpAlloc` with argument *F*.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

15.10.6 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 data property or any of the other internal data properties of `RegExp` instance objects.

The value of the `[[Prototype]]` internal `data` property of the `RegExp` prototype object is the standard built-in Object prototype object (15.2.4).

The `RegExp` prototype object does not have a `valueOf` property of its own; however, it inherits the `valueOf` property from the Object prototype object.

15.10.6.1 RegExp.prototype.constructor

The initial value of `RegExp.prototype.constructor` is the standard built-in `RegExp` constructor.

15.10.6.2 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`, then throw a `TypeError` exception.
3. If *R* does not have a `[[RegExpMatcher]]` internal data property, then throw a `TypeError` exception.
4. If the value of *R*'s `[[RegExpMatch]]` internal data property is `undefined`, then throw a `TypeError` exception.
5. Let *S* be the value of `ToString(string)`.
6. `ReturnIfAbrupt(S)`.
7. Return the result of the `RegExpExec` abstract operation with arguments *R* and *S*.

Runtime Semantics: `RegExpExec` Abstract Operation

The abstract operation `RegExpExec` with arguments *R* (an object) and *S* (a string) performs the following steps:

1. Assert: *R* is an initialized `RegExp` instance.
2. Let *matcher* be the value of *R*'s `[[RegExpMatcher]]` internal data property.
3. Let *length* be the length of *S*.
4. Let *lastIndex* be the result of `Get(R, "lastIndex")`.
5. Let *i* be the value of `ToInteger(lastIndex)`.
6. `ReturnIfAbrupt(i)`.
7. Let *global* be the result of `Get(R, "global")`.
8. `ReturnIfAbrupt(global)`.
9. If *global* is `false`, then let *i* = 0.

Comment [AWB14200]: Because the `@@create` method is essential to the integrity of this “class” definition, just like the prototype property, it seems appropriate to freeze it in the same manner.

Deleted: The `RegExp` prototype object is its a regular expression object; it has an `[[IsRegExpNativeBrandBuiltInBrand]]` internal data property whose value is `NativeRegExpBuiltInRegExp`. The initial values of the `RegExp` prototype object's data properties (15.10.7) are set as if the object was created by the expression `new RegExp()` where `RegExp` is that standard built-in constructor with that name.

Deleted: In the following descriptions of functions that are properties of the `RegExp` prototype object, the phrase “this `RegExp` object” refers to the object that is the `this` value for the invocation of the function; a `TypeError` exception is thrown if the `this` value is not an object or an object for which the value of the `[[Class]]` internal data property whose value is `NativeRegExpBuiltInRegExp` is not “`RegExp`”.

Deleted: <#>Let *R* be this `RegExp` object.
<#>ReturnIfAbrupt(*R*).¶

Deleted: abstraction operation

Deleted: calling the `[[`
Deleted: `]]` internal method of
Deleted:
Deleted: with argument
Deleted: calling the `[[`
Deleted: `]]` internal method of
Deleted:
Deleted: with argument

10. Let `matchSucceeded` be `false`.
11. Repeat, while `matchSucceeded` is `false`
 - a. If $i < 0$ or $i > length$, then
 - i. Let `putStatus` be the result of `Put(R, "lastIndex", 0, true)`.
 - ii. ReturnIfAbrupt(`putStatus`).
 - iii. Return `null`.
 - b. Let `r` be the result of calling the `matcher` with arguments `S` and `i`.
 - c. If `r` is `failure`, then
 - i. Let $i = i + 1$.
 - d. else
 - i. Assert: `r` is a State.
 - ii. Set `matchSucceeded` to `true`.
12. Let `e` be `r's` `endIndex` value.
13. If `global` is `true`,
 - a. Let `putStatus` be the result of `Put(R, "lastIndex", e, true)`.
 - b. ReturnIfAbrupt(`putStatus`).
14. Let `n` be the length of `r's` `captures` array. (This is the same value as 15.10.2.1's `NCapturingParens`.)
15. Let `A` be the result of the abstract operation `ArrayCreate` with argument 0.
16. Let `matchIndex` be `i`.
17. Assert: The following `[DefineOwnProperty]` calls will not result in an abrupt completion.
18. Call the `[[DefineOwnProperty]]` internal method of `A` with arguments `"index"` and Property Descriptor `{[[Value]]: matchIndex, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
19. Call the `[[DefineOwnProperty]]` internal method of `A` with arguments `"input"` and Property Descriptor `{[[Value]]: S, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
20. Call the `[[DefineOwnProperty]]` internal method of `A` with arguments `"length"` and Property Descriptor `{[[Value]]: $n + 1$ }`.
21. Let `matchedSubstr` be the matched substring (i.e. the portion of `S` between offset `i` inclusive and offset `e` exclusive).
22. Call the `[[DefineOwnProperty]]` internal method of `A` with arguments `"0"` and Property Descriptor `{[[Value]]: matchedSubstr, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
23. For each integer `i` such that $i > 0$ and $i \leq n$
 - a. Let `captureI` be i^{th} element of `r's` `captures` array.
 - b. Call the `[[DefineOwnProperty]]` internal method of `A` with arguments `Tostring(i)` and Property Descriptor `{[[Value]]: captureI, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
24. Return `A`.

15.10.6.3 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`, then throw a `TypeError` exception.
3. If `R` does not have a `[OriginalFlags]` internal data property throw a `TypeError` exception.
4. Let `flags` be the value of `R`'s `[OriginalFlags]` internal data property.
5. If `flags` is `undefined`, then throw a `TypeError` exception.
6. If `flags` contains the character `"g"`, then return `true`.
7. Return `false`.

15.10.6.4 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`, then throw a `TypeError` exception.
3. If `R` does not have a `[OriginalFlags]` internal data property throw a `TypeError` exception.
4. Let `flags` be the value of `R`'s `[OriginalFlags]` internal data property.
5. If `flags` is `undefined`, then throw a `TypeError` exception.

Deleted: calling Call the <code>[</code>
Deleted: <code>]]</code> internal method of
Deleted:
Deleted: with arguments
Deleted: and
Deleted: Call
Deleted: <code>[[Match]]</code>
Deleted: internal method of
Deleted: <code>R</code>
Deleted: <code>[[Match]]</code> returned
Deleted: Let
Deleted: be the
Deleted: result of the call to <code>[[Match]]</code>
Deleted: calling Call the <code>[</code>
Deleted: <code>]]</code> internal method of
Deleted:
Deleted: with arguments
Deleted: and
Deleted: <code>NCapturingParens</code>
Deleted: a new array created as if by the expression <code>new Array()</code> where <code>Array</code> is the standard built-in constructor with that name.
Deleted: ,
Deleted: , and <code>true</code>
Deleted: ",
Deleted: , and <code>true</code>
Deleted: ",
Deleted: , and <code>true</code>
Deleted: ,
Deleted: , and <code>true</code>
Deleted: ,
Deleted: , and <code>true</code>

6. If `flags` contains the character "`i`", then return `true`.
7. Return `false`.

15.10.6.5 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`, then throw a `TypeError` exception.
3. If `R` does not have a `[[OriginalFlags]]` internal data property throw a `TypeError` exception.
4. Let `flags` be the value of `R`'s `[[OriginalFlags]]` internal data property.
5. If `flags` is `undefined`, then throw a `TypeError` exception.
6. If `flags` contains the character "`m`", then return `true`.
7. Return `false`.

15.10.6.6 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`, then throw a `TypeError` exception.
3. If `R` does not have a `[[OriginalSource]]` internal data property throw a `TypeError` exception.
4. If `R` does not have a `[[OriginalFlags]]` internal data property throw a `TypeError` exception.
5. Let `src` be the value of `R`'s `[[OriginalSource]]` internal data property.
6. Let `flags` be the value of `R`'s `[[OriginalFlags]]` internal data property.
7. If either `src` or `flags` is `undefined`, then throw a `TypeError` exception.
8. Return the result of the abstract operation `EscapeRegExpPattern` with arguments `src` and `flags`.

15.10.6.7 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:

1. Let `R` be the `this` value.
2. If `Type(R)` is not `Object`, then throw a `TypeError` exception.
3. If `R` does not have a `[[OriginalFlags]]` internal data property throw a `TypeError` exception.
4. Let `flags` be the value of `R`'s `[[OriginalFlags]]` internal data property.
5. If `flags` is `undefined`, then throw a `TypeError` exception.
6. If `flags` contains the character "`y`", then return `true`.
7. Return `false`.

15.10.6.8 RegExp.prototype.test(string)

Deleted: 3

The following steps are taken:

1. Let `R` be the `this` value.
2. If `Type(R)` is not `Object`, then throw a `TypeError` exception.
3. If `R` does not have a `[[RegExpMatcher]]` internal data property, then throw a `TypeError` exception.
4. If the value of `R`'s `[[RegExpMatcher]]` internal data property is `undefined`, then throw a `TypeError` exception.
5. Let `S` be the value of `ToString(string)`
6. `ReturnIfAbrupt(S)`.
7. Let `match` be the result of the `RegExpExec` abstract operation with arguments `R` and `S`.
8. `ReturnIfAbrupt(match)`.
9. If `match` is not null, then return `true`; else return `false`.

Deleted: <#>Let `R` be this `RegExp` object.
<#>ReturnIfAbrupt(`R`).¶

Deleted: abstraction operation

Deleted: evaluating the
`RegExp.prototype.exec` (15.10.6.2)
algorithm upon this `RegExp` object using `string` as
the argument

15.10.6.9 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`, then throw a `TypeError` exception.
3. If `R` does not have a `[[OriginalFlags]]` internal data property throw a `TypeError` exception.
4. Let `flags` be the value of `R`'s `[[OriginalFlags]]` internal data property.
5. If `flags` is `undefined`, then throw a `TypeError` exception.
6. If `flags` contains the character "`u`", then return `true`.
7. Return `false`.

15.10.6.10 RegExp.prototype.toString()

Deleted: 4

1. Let `R` be the `this` value.
2. If `Type(R)` is not `Object`, then throw a `TypeError` exception.
3. If `R` does not have a `[[RegExpMatcher]]` internal data property, then throw a `TypeError` exception.
4. If the value of `R`'s `[[RegExpMatcher]]` internal data property is `undefined`, then throw a `TypeError` exception.
5. Let `pattern` be the result of `Get(R, "source")`.
6. `ReturnIfAbrupt(pattern)`.
7. Let `result` be the the String value formed by concatenating `/`, `pattern`, and `/`.
8. Let `unicode` be the result of `Get(R, "unicode")`.
9. `ReturnIfAbrupt(unicode)`.
10. If `SameValue(unicode, "u")` is `true`, then append `"u"` as the last character of `result`.
11. Let `ignoreCase` be the result of `Get(R, "ignoreCase")`.
12. `ReturnIfAbrupt(ignoreCase)`.
13. If `SameValue(ignoreCase, "i")` is `true`, then append `"i"` as the last character of `result`.
14. Let `multiline` be the result of `Get(R, "multiline")`.
15. `ReturnIfAbrupt(multiline)`.
16. If `SameValue(multiline, "m")` is `true`, then append `"m"` as the last character of `result`.
17. Let `sticky` be the result of `Get(R, "sticky")`.
18. `ReturnIfAbrupt(sticky)`.
19. If `SameValue(global, "y")` is `true`, then append `"y"` as the last character of `result`.
20. Return `result`.

NOTE The returned String has the form of a `RegularExpressionLiteral` that evaluates to another `RegExp` object with the same behaviour as this object.

15.10.6.11 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`, then throw a `TypeError` exception.
3. If `rx` does not have a `[[RegExpMatcher]]` internal data property, then throw a `TypeError` exception.
4. If the value of `rx`'s `[[RegExpMatcher]]` internal data property is `undefined`, then throw a `TypeError` exception.
5. Let `S` be the value of `ToString(string)`.
6. `ReturnIfAbrupt(S)`.
7. Let `global` be the result of `Get(rx, "global")`.
8. `ReturnIfAbrupt(global)`.
9. If `global` is not `true`, then
 - a. Return the result of calling the abstract operation `RegExpExec` (see 15.10.6.2) with arguments `rx` and `S`.
10. Else `global` is `true`,
 - a. Let `putStatus` be the result of `Put(rx, "lastIndex", 0, true)`.
 - b. `ReturnIfAbrupt(putStatus)`.

Deleted: Return the String value formed by concatenating the Strings `/`, the String value of the `source` property of this `RegExp` object, and `/`; plus `"g"` if the `global` property is `true`, `"i"` if the `ignoreCase` property is `true`, and `"m"` if the `multiline` property is `true`. ¶

c. Let A be the result of the abstract operation `ArrayCreate` with argument 0 .
d. Let $previousLastIndex$ be 0 .
e. Let n be 0 .
f. Let $lastMatch$ be `true`.
g. Repeat, while $lastMatch$ is `true`

- i. Let $result$ be the result of the abstract operation `RegExpExec` with arguments rx and S .
- ii. ReturnIfAbrupt($result$).
iii. If $result$ is `null`, then set $lastMatch$ to `false`.
iv. Else $result$ is not `null`,
 - 1. Let $thisIndex$ be the result of `Get(rx, "lastIndex")`.
 - 2. ReturnIfAbrupt($thisIndex$).
 - 3. If $thisIndex = previousLastIndex$ then
 - a. Let $putStatus$ be the result of `Put(rx, "lastIndex", thisIndex+1, true)`.
 - b. ReturnIfAbrupt($putStatus$).
 - c. Set $previousLastIndex$ to $thisIndex+1$.
 - 4. Else,
 - a. Set $previousLastIndex$ to $thisIndex$.
 - 5. Let $matchStr$ be the result of `Get(result, "0")`.
 - 6. Let $defineStatus$ be the result of `DefinePropertyOrThrow(A, ToString(n), PropertyDescriptor {[[Value]]: matchStr, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true})`.
 - 7. ReturnIfAbrupt($defineStatus$).
 - 8. Increment n .
- h. If $n = 0$, then return `null`.

15.10.6.12 `RegExp.prototype.replace (S, replaceValue)`

When the `replace` method is called with arguments S and $replaceValue$ the following steps are taken:

TODO: need to finish this and have it make use of `GetReplaceSubstitution` operation in 15.5.4.11

1. Let rx be the `this` value.
2. If `Type(rx)` is not `Object`, then throw a `TypeError` exception.
3. If rx does not have a `[[RegExpMatcher]]` internal data property, then throw a `TypeError` exception.
4. If the value of rx 's `[[RegExpMatcher]]` internal data property is `undefined`, then throw a `TypeError` exception.
5. Let $string$ be `ToString(S).`
6. ReturnIfAbrupt($string$).
7. If $searchValue.global$ is `false`, then search $string$ for the first match of the regular expression $searchValue$. If $searchValue.global$ is `true`, then search $string$ for all matches of the regular expression $searchValue$. Do the search in the same manner as in `RegExp.prototype.match`, including the update of $searchValue.lastIndex$. Let m be the number of left capturing parentheses in $searchValue$ (using `NcapturingParens` as specified in 15.10.2.1).
8. If $replaceValue$ is a function, then
 - a. For each matched substring, call the function with the following $m + 3$ arguments. Argument 1 is the substring that matched. If $searchValue$ is a regular expression, the next m arguments are all of the captures in the `MatchResult` (see 15.10.2.1). Argument $m + 2$ is the offset within $string$ where the match occurred, and argument $m + 3$ is $string$. The result is a String value derived from the original input by replacing each matched substring with the corresponding return value of the function call, converted to a String if need be.
9. Else,

Let *newstring* denote the result of converting *replaceValue* to a String. The result is a String value derived from the original input String by replacing each matched substring with a String derived from *newstring* by replacing elements in *newstring* by replacement text as specified in

- a. Table 33. These \$ replacements are done left-to-right, and, once such a replacement is performed, the new replacement text is not subject to further replacements. For example, `"$1,$2".replace(/(\$(\d))/g, "$$1-$1$2")` returns `"$1-$11,$1-$22"`. A \$ in *newstring* that does not match any of the forms below is left as is.

Comment [AWB7201]: Needs a real algorithm and also completion record checks.

15.10.4.13 RegExp.prototype.search (S)

When the search method is called with argument *S*, the following steps are taken:

1. Let *rx* be the **this** value.
2. If *Type(rx)* is not Object, then throw a **TypeError** exception.
3. If *rx* does not have a **[[RegExpMatcher]]** internal data property, then throw a **TypeError** exception.
4. If the value of *rx*'s **[[RegExpMatcher]]** internal data property is **undefined**, then throw a **TypeError** exception.
5. Let *string* be *ToString(S)*.
6. ReturnIfAbrupt(*string*).
7. Search the value *string* from its beginning for an occurrence of the regular expression pattern *rx*. Let *result* be a Number indicating the offset within *string* where the pattern matched, or -1 if there was no match. If an abrupt completion occurs during the search, *result* is that Completion Record. The **lastIndex** and **global** properties of *regexp* are ignored when performing the search. The **lastIndex** property of *regexp* is left unchanged.
8. Return *result*.

Comment [AWB7202]: Needs better spec language

15.10.4.14 RegExp.prototype.split (string, limit)

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 position of the **this** String is considered, even if backtracking could yield a non-empty-substring match at that position. (For example, `/a*?/.split("ab")` evaluates to the array `["a", "b"]`, while `/a*/.split("ab")` evaluates to the array `["", "b"]`.)

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,

`/<(\w+)?([^\>]+)>/.split("Aboldand<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, then throw a **TypeError** exception.
3. If *rx* does not have a **[[RegExpMatcher]]** internal data property, then throw a **TypeError** exception.

4. If the value of *rx*'s `[[RegExpMatcher]]` internal data property is `undefined`, then throw a **TypeError** exception.
5. Let *matcher* be the value of *rx*'s `[[RegExpMatcher]]` internal data property.
6. Let *S* be `ToString(string)`.
7. ReturnIfAbrupt(*S*).
8. Let *A* be the result of the abstract operation `ArrayCreate` with argument 0.
9. ReturnIfAbrupt(*A*).
10. Let *lengthA* be 0.
11. If *limit* is `undefined`, let *lim* = $2^{32}-1$; else let *lim* = `ToUint32(limit)`.
12. Let *s* be the number of elements in *S*.
13. Let *p* = 0.
14. If *lim* = 0, return *A*.
15. If *s* = 0, then
 - a. Let *z* be the result of calling the *matcher* with arguments *S* and *q*.
 - b. ReturnIfAbrupt(*z*).
 - c. If *z* is not `failure`, return *A*.
 - d. Call the `[[DefineOwnProperty]]` internal method of *A* with arguments `"0"` and Property Descriptor `{[[Value]]: S, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
 - e. Assert: the previous step will never result in an abrupt completion.
 - f. Return *A*.
16. Let *g* = *p*.
17. Repeat, while *q* ≠ *s*
 - a. Let *z* be the result of calling the *matcher* with arguments *S* and *q*.
 - b. ReturnIfAbrupt(*z*).
 - c. If *z* is `failure`, then let *g* = *q*+1.
 - d. Else *z* is not `failure`.
 - i. *z* must be a State. Let *e* be *z*'s `endIndex` and let *cap* be *z*'s `captures` array.
 - ii. If *e* = *p*, then let *g* = *q*+1.
 - iii. Else *e* ≠ *p*.
 1. Let *T* be a String value equal to the substring of *S* consisting of the elements at positions *p* (inclusive) through *q* (exclusive).
 2. Call the `[[DefineOwnProperty]]` internal method of *A* with arguments `ToString(lengthA)` and Property Descriptor `{[[Value]]: T, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
 3. Assert: the previous step will never result in an abrupt completion.
 4. Increment *lengthA* by 1.
 5. If *lengthA* = *lim*, return *A*.
 6. Let *p* = *e*.
 7. Let *i* = 0.
 8. Repeat, while *i* is not equal to the number of elements in *cap*.
 - a. Let *i* = *i*+1.
 - b. Call the `[[DefineOwnProperty]]` internal method of *A* with arguments `ToString(lengthA)` and Property Descriptor `{[[Value]]: cap[i], [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
 - c. Assert: the previous step will never result in an abrupt completion.
 - d. Increment *lengthA* by 1.
 - e. If *lengthA* = *lim*, return *A*.
 9. Let *g* = *p*.
 18. Let *T* be a String value equal to the substring of *S* consisting of the elements at positions *p* (inclusive) through *s* (exclusive).
 19. Call the `[[DefineOwnProperty]]` internal method of *A* with arguments `ToString(lengthA)` and Property Descriptor `{[[Value]]: T, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
 20. Assert: the previous step will never result in an abrupt completion.
 21. Return *A*.

The `length` property of the `split` method is 2.

NOTE 1 The `split` method ignores the value of the `global` property of this RegExp object.

15.10.4.14 RegExp.prototype.@@isRegExp

The initial value of the @@iterator property is **true**.

15.10.7 Properties of RegExp Instances

RegExp instances are ordinary objects that inherit properties from the RegExp prototype object. **RegExp instances have internal data properties [[RegExpMatcher]], [[OriginalSource]], and [[OriginalFlags]]**. The value of the [[RegExpMatcher]] internal data property is an implementation dependent representation of the *Pattern* of the RegExp object.

RegExp instances also have the following properties.

15.10.7.1 lastIndex

The value of the **lastIndex** property specifies the String position at which to start the next match. It is coerced to an integer when used (see 15.10.6.2). This property shall have the attributes { [[Writable]]: **true**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

NOTE Unlike the other standard built-in properties of RegExp instances, **lastIndex** is writable.

15.11 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.

15.11.1 The Error Constructor Called as a Function

When **Error** is called as a function rather than as a constructor, it creates and initialises a new Error object. Thus the function call **Error(...)** is generally equivalent to the object creation expression **new Error(...)** with the same arguments. However, if the **this** value passed in the call is an Object with an uninitialized [[ErrorData]] internal data property, 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 initialization.

Error may be subclassed and subclass constructors may perform a super invocation of the **Error** constructor to initialize subclass instances.

15.11.1.1 Error (message)

The following steps are taken:

1. Let **func** be this **Error** function object.
2. Let **O** be the **this** value.
3. If **Type(O)** is not **Object** or **Type(O)** is **Object** and **O** does not have an [[ErrorData]] internal data property or **Type(O)** is **Object** and **O** has an [[ErrorData]] internal data property and the value of [[ErrorData]] is not **undefined**, then
 - a. Let **O** be the result of calling **OrdinaryCreateFromConstructor(F, "%ErrorPrototype%", [[ErrorData]])**.
 - b. **ReturnIfAbrupt(O)**.
4. Assert: **Type(O)** is **Object**.
5. Set the value of **O**'s [[ErrorData]] internal data property to any value other than **undefined**.
6. Else,
7. If **message** is not **undefined**, then
 - a. Let **msg** be **ToString(message)**.
 - b. **ReturnIfAbrupt(msg)**.
 - c. Let **status** be the result of **CreateOwnProperty(O, "message", msg)**.
 - d. **ReturnIfAbrupt(status)**.

Deleted: and

Deleted: their

Deleted: a [[ClassIsRegExpNativeBrandBuiltinBrand]]

Deleted: property

Deleted: whose value is NativeRegExpBuiltinRegExp value is "RegExp". RegExp instances also have a [[Match]]

Deleted: internal data property and a **length** property

Deleted: ¶

Deleted: [[Match]]

Deleted: 15.10.7.1 source¶

The value of the **source** property is a String in the form of a *Pattern* representing the current regular expression. This property shall have the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.¶

15.10.7.2 global¶

The value of the **global** property is a Boolean value indicating whether the flags contained the character "g". This property shall have the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.¶

15.10.7.3 ignoreCase¶

The value of the **ignoreCase** property is a Boolean value indicating whether the flags contained the character "i". This property shall have the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.¶

15.10.7.4 multiline¶

The value of the **multiline** property is a Boolean value indicating whether the flags contained the character "m". This property shall have the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.¶

Deleted: 5

Comment [AWB14203]: This then clause corresponds to the "called as a function" case in the ES5 spec.

8. Return *O*.

15.11.2 The Error Constructor

Error called as part of a **new** expression, it is a constructor; it initialises the newly created object.

15.10.4.1 **new Error(... args)**

Error called as part of a new expression with argument list *args* it performs the following steps:

1. Let *F* be the **Error** function object on which the **new** operator was applied.
2. Let *argumentsList* be the the *argumentsList* argument of the **[[Construct]]** internal method that was invoked by the **new** operator.
3. Return the result of OrdinaryConstruct (*F*, *argumentsList*).

If **Error** is implemented as an ordinary function object, its **[[Construct]]** internal method will perform the above steps.

15.11.3 Properties of the Error Constructor

The value of the **[[Prototype]]** internal **data** property of the Error constructor is the Function prototype object (15.3.4).

Besides the internal properties and the **length** property (whose value is **1**), the Error constructor has the following property:

15.11.3.1 **Error.prototype**

The initial value of **Error.prototype** is the Error prototype object (15.11.4).

This property has the attributes { **[[Writable]]: false**, **[[Enumerable]]: false**, **[[Configurable]]: false** }.

15.11.3.2 **Error[@@create]()**

The **@@create** method of an object *F* performs the following steps:

1. Let *F* be the **this** value.
2. Let *obj* be the result of calling OrdinaryCreateFromConstructor(*F*, "%ErrorPrototype%", (**[[ErrorData]]**)).
3. Return *obj*.

This property has the attributes { **[[Writable]]: false**, **[[Enumerable]]: false**, **[[Configurable]]: false** }.

NOTE **[[ErrorData]]** is initially assigned the value **undefined** as a flag to indicate that the instance has not yet been initialized by the Boolean constructor. This flag value is never directly exposed to ECMAScript code; hence implementation may choose to encode the flag in some other manner.

15.11.4 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 **data** property.

The value of the **[[Prototype]]** internal **data** property of the Error prototype object is the standard built-in Object prototype object (15.2.4).

15.11.4.1 **Error.prototype.constructor**

The initial value of **Error.prototype.constructor** is the built-in **Error** constructor.

Deleted: The **[[Prototype]]** internal data property of the newly constructed object is set to the original Error prototype object, the one that is the initial value of **Error.prototype** (15.11.3.1).¶

The **[[Class]]** internal property of the newly constructed object is set to "**Error**" has an **[[IsErrorNativeBrandBuiltinBrand]]** internal data property whose value is **NativeErrorBuiltinError**. The **[[Extensible]]** internal data property of the newly constructed object is set to **true**.¶ If the argument **message** is not **undefined**, the **message** own property of the newly constructed object is set to **ToString(message)**.¶

Deleted: When **Error** is called as part of a new expression, it is a constructor: it initialises the newly created object.¶

15.11.2.1 **new Error (message)**

The **[[Prototype]]** internal data property of the newly constructed object is set to the original Error prototype object, the one that is the initial value of **Error.prototype** (15.11.3.1).¶ The **[[Class]]** internal property of the newly constructed Error object has an **[[IsErrorNativeBrandBuiltinBrand]]** internal data property whose value is **NativeErrorBuiltinError** is set to "**error**".¶

The **[[Extensible]]** internal data property of the newly constructed object is set to **true**.¶ If the argument **message** is not **undefined**, the **message** own property of the newly constructed object is set to **ToString(message)**.¶

Comment [AWB14204]: Because the **@@create** method is essential to the integrity of this "class" definition, just like the prototype property, it seems appropriate to freeze it in the same manner.

Deleted: itself an Error object and has an **[[IsErrorNativeBrandBuiltinBrand]]** internal data property whose value is **NativeErrorBuiltinError**

Deleted: (its **[[Class]]** is "**Error**")

15.11.4.2 Error.prototype.name

The initial value of `Error.prototype.name` is "Error".

15.11.4.3 Error.prototype.message

The initial value of `Error.prototype.message` is the empty String.

15.11.4.4 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`, then let `name` be "Error"; else let `name` be `ToString(name)`.
6. Let `msg` be the result of `Get(O , "message")`.
7. ReturnIfAbrupt(msg).
8. If `msg` is `undefined`, then let `msg` be the empty String; else let `msg` be `ToString(msg)`.
9. If `name` is the empty String, return `msg`.
10. If `msg` is the empty String, return `name`.
11. Return the result of concatenating `name`, ":" , a single space character, and `msg`.

15.11.5 Properties of Error Instances

Error instances are ordinary objects that inherit properties from the `Error` prototype object and have a `[[ErrorData]]` internal data property whose initial value is `undefined`. The only specified use of `[[ErrorData]]` is to flag whether or not an `Error` instance has been initialized by the `Error` constructor.

15.11.6 Native Error Types Used in This Standard

One of the `BuiltinError` objects below is thrown when a runtime error is detected. All of these objects share the same structure, as described in 15.11.7.

15.11.6.1 EvalError

This exception is not currently used within this specification. This object remains for compatibility with previous editions of this specification.

15.11.6.2 RangeError

Indicates a numeric value has exceeded the allowable range. 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.

15.11.6.3 ReferenceError

Indicate that an invalid reference value has been detected. See 8.9.1, 8.9.2, 10.2.1, 10.2.1.1.4, 10.2.1.2.4, and 11.13.1.

15.11.6.4 SyntaxError

Indicates that a parsing error has occurred. 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.

Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: with argument
Deleted: calling the [[
Deleted:]] internal method of
Deleted:
Deleted: with argument
Deleted: <#>If <code>msg</code> is undefined, then let <code>msg</code> be the empty String; else let <code>msg</code> be <code>ToString(msg)</code> .
Deleted: <code>n</code>
Deleted: <code>IsError</code>
Deleted: <code>NativeBrand</code>
Deleted: <code>BuiltinBrand</code>
Deleted: value is <code>NativeErrorBuiltinError</code>
Deleted: their <code>[[Class]]</code> internal property value is "Error"
Deleted: . <code>Error</code> instances have no special properties
Deleted: <code>NativeError</code>

15.11.6.5 TypeError

Indicates the actual type of an operand is different than the expected type. 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, 11.8.6, 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, 15.3.4.2, 15.3.4.3, 15.3.4.4, 15.3.4.5, 15.3.4.5.2, 15.3.4.5.3, 15.3.5, 15.3.5.3, 15.3.5.4, 15.4.4.3, 15.4.4.11, 15.4.4.16, 15.4.4.17, 15.4.4.18, 15.4.4.19, 15.4.4.20, 15.4.4.21, 15.4.4.22, 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: 7

15.11.6.6 URIError

Indicates that one of the global URI handling functions was used in a way that is incompatible with its definition. See 15.1.3.

Comment [AWB10205]: Sectin references have not yet been updated to reflect ES6

15.11.7 NativeError Object Structure

When an ECMAScript implementation detects a runtime error, it throws an instance of one of the *NativeError* objects defined in 15.11.6. Each of these objects has the structure described below, differing only in the name used as the constructor name instead of *NativeError*, in the **name** property of the prototype object, and in the implementation-defined **message** property of the prototype object.

For each error object, references to *NativeError* in the definition should be replaced with the appropriate error object name from 15.11.6.

15.11.7.1 NativeError Constructors Called as Functions

When a *NativeError* constructor is called as a function rather than as a constructor, it creates and initialises a new object. A call of the object as a function is equivalent to calling it as a constructor with the same arguments. However, if the **this** value value passed in the call is an Object with an uninitialized **[[ErrorData]]** internal data property, it initializes the **this** value using the argument value. This permits **Error** to be used both as factory method and to perform constructor instance initialization.

A *NativeError* constructor may be subclassed and subclass constructors may perform a super invocation of the *NativeError* constructor to initialize subclass instances.

15.11.7.1.1 NativeError (message)

Deleted: 2

1. Let **func** be this *NativeError* function object.
2. Let **O** be the **this** value.
3. If Type(**O**) is not Object or Type(**O**) is Object and **O** does not have an **[[ErrorData]]** internal data property or Type(**O**) is Object and **O** has an **[[ErrorData]]** internal data property and the value of **[[ErrorData]]** is not **undefined**, then
 - a. Let **O** be the result of calling **OrdinaryCreateFromConstructor(F, "%NativeErrorPrototype%", **[[ErrorData]]**)**.
 - b. **ReturnIfAbrupt(O)**.
4. Assert: Type(**O**) is Object.
5. Set the value of **O**'s **[[ErrorData]]** internal data property to any value other than **undefined**.
6. Else,
7. If **message** is not **undefined**, then
 - a. Let **msg** be **ToString(message)**.
 - b. **ReturnIfAbrupt(msg)**.
 - c. Let **status** be the result of **CreateOwnDataProperty(O, "message", msg)**.
 - d. **ReturnIfAbrupt(status)**.
8. **Return O**.

Comment [AWB14206]: This then clause corresponds to the "called as a function" case the ES5 spec.

The actual value of the string passed in step 3.a is either "%EvalErrorPrototype%", "%RangeErrorPrototype%", "%ReferenceErrorPrototype%", "%SyntaxErrorPrototype%".

"`%TypeErrorPrototype%`", or "`%URIErrorPrototype%`" corresponding to which `NativeError` constructor is being defined.

15.11.7.2 The `NativeError` Constructors

When a `NativeError` constructor is called as part of a `new` expression, it is a constructor: it initialises the newly created object.

15.11.7.2.1 `new NativeError (... args)`

When a `NativeError` constructor is called as part of a new expression with argument list `args` it performs the following steps:

1. Let `F` be this `NativeError` function object on which the `new` operator was applied.
2. Let `argumentsList` be the `argumentsList` argument of the `[[Construct]]` internal method that was invoked by the `new` operator.
3. Return the result of `OrdinaryConstruct (F, argumentsList)`.

If a `NativeError` constructor is implemented as an ordinary function object, its `[[Construct]]` internal method will perform the above steps.

15.11.7.3 Properties of the `NativeError` Constructors

The value of the `[[Prototype]]` internal data property of a `NativeError` constructor is the `Error` constructor object (15.11.1).

Besides the `length` property (whose value is 1), each `NativeError` constructor has the following property:

15.11.7.3.1 `NativeError.prototype`

The initial value of `NativeError.prototype` is a `NativeError` prototype object (15.11.7.4). Each `NativeError` constructor has a separate prototype object.

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

15.11.7.3.2 `NativeError [@@create] ()`

The `@@create` method of an object `F` performs the following steps:

1. Let `F` be the `this` value.
2. Let `obj` be the result of calling `OrdinaryCreateFromConstructor(F, "%ErrorPrototype%", ([[ErrorData]]))`.
3. Return `obj`.

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.

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

NOTE `[[ErrorData]]` is initially assigned the value `undefined` as a flag to indicate that the instance has not yet been initialized by the Boolean constructor. This flag value is never directly exposed to ECMAScript code; hence implementation may choose to encode the flag in some other manner.

15.11.7.4 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 data property.

Deleted: The `[[Prototype]]` internal data property of the newly constructed object is set to the prototype object of this error constructor. The `[[Class]]` internal property of the newly constructed object has an `[[IsErrorNativeBrandBuiltinBrand]]` internal data property whose value is `NativeErrorBuiltinError` is set to "`Error`". The `[[Extensible]]` internal data property of the newly constructed object is set to `true`.
If the argument `message` is not `undefined`, the `message` own property of the newly constructed object is set to `ToString(message)`.

Deleted: 3

Deleted: 4

Deleted: message

Deleted: The `[[Prototype]]` internal data property of the newly constructed object is set to the prototype object of this `NativeError` constructor. The `[[Class]]` internal property of the newly constructed object has an `[[IsErrorNativeBrandBuiltinBrand]]` internal data property whose value is `NativeErrorBuiltinError` is set to "`Error`". The `[[Extensible]]` internal data property of the newly constructed object is set to `true`.
If the argument `message` is not `undefined`, the `message` own property of the newly constructed object is set to `ToString(message)`.

Deleted: 5

Deleted: Function

Deleted: prototype

Deleted: 3

Deleted: 4

Deleted: the internal properties and

Deleted: 6

Deleted: 5

Deleted: 7

Comment [AWB14207]: Because the `@@create` method is essential to the integrity of this "class" definition just like the prototype property, it seems appropriate to freeze it in the same manner.

Deleted: 7

Deleted: 6

Deleted: `Error` object and has an `[[IsErrorNativeBrandBuiltinBrand]]` internal data property whose value is `NativeErrorBuiltinError` (its `[[Class]]` is "`Error`").

The value of the `[[Prototype]]` internal `data` property of each `NativeError` prototype object is the standard built-in `Error` prototype object (15.11.4).

15.11.7.4.1 `NativeError.prototype.constructor`

The initial value of the `constructor` property of the prototype for a given `NativeError` constructor is the `NativeError` constructor function itself (15.11.7).

Deleted: 8
Deleted: 6

15.11.7.4.2 `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`).

Deleted: 9
Deleted: 6

15.11.7.4.3 `NativeError.prototype.message`

The initial value of the `message` property of the prototype for a given `NativeError` constructor is the empty String.

Deleted: 10
Deleted: 6

15.11.7.5 Properties of `NativeError` Instances

`NativeError` instances are ordinary objects that inherit properties from their `NativeError` prototype object and have a `[[ErrorData]]` internal `data` property 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.

Deleted: NOTE: The prototypes for the `NativeError` constructors do not themselves provide a `toString` function, but instances errors will inherit it from the `Error` prototype object.
Deleted: 11
Deleted: 8
Deleted: n
Deleted: IsError
Deleted: NativeBrand
Deleted: BuiltinBrand
Deleted: value is
Deleted: NativeError
Deleted: BuiltinError their `[[Class]]` internal property value is "Error". `NativeError` instances have no special properties

15.12 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 described in RFC 4627 <<http://www.ietf.org/rfc/rfc4627.txt>>. The JSON interchange format used in this specification is exactly that described by RFC 4627 with two exceptions:

- The top level `JSONText` production of the ECMAScript JSON grammar may consist of any `JSONValue` rather than being restricted to being a `JSONObject` or a `JSONArray` as specified by RFC 4627.
- 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. This differs from RFC 4627 which permits a JSON parser to accept non-JSON forms and extensions.

Deleted: value of the `[[Class]]` internal property of the
Deleted: n
Deleted: IsJSON
Deleted: NativeBrand
Deleted: BuiltinBrand
Deleted: NativeJSON
Deleted: BuiltinJSON
Deleted: is "JSON"
Deleted: property
Deleted: property

The value of the `[[Prototype]]` internal `data` property of the `JSON` object is the standard built-in `Object` prototype object (15.2.4). The `JSON` object has a `[[JSONTag]]` internal `data` property whose value is `true`. The value of the `[[Extensible]]` internal `data` property of the `JSON` object is set to `true`.

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.

15.12.1 The JSON Grammar

`JSON.stringify` produces a String that conforms to the following JSON grammar. `JSON.parse` accepts a String that conforms to the JSON grammar.

15.12.1.1 The JSON Lexical Grammar

JSON is similar to ECMAScript source text in that it consists of a sequence of `Unicode` characters conforming to the rules of `SourceCharacter`. The JSON Lexical Grammar defines the tokens that make up a JSON text similar to the manner that the ECMAScript lexical grammar defines the tokens of an ECMAScript source text.

The JSON Lexical grammar only recognises the white space character specified by the production *JSONWhiteSpace*. The JSON lexical grammar shares some productions with the ECMAScript lexical grammar. All nonterminal symbols of the grammar that do not begin with the characters "JSON" are defined by productions of the ECMAScript lexical grammar.

Syntax

```

JSONWhiteSpace ::=
    <TAB>
    <CR>
    <LF>
    <SP>

JSONString ::=
    " JSONStringCharactersopt "

JSONStringCharacters ::=
    JSONStringCharacter JSONStringCharactersopt

JSONStringCharacter ::=
    SourceCharacter but not one of " or \ or U+0000 through U+001F
    \ JSONEscapeSequence

JSONEscapeSequence ::=
    JSONEscapeCharacter
    u HexDigit HexDigit HexDigit HexDigit

JSONEscapeCharacter :: one of
    " / \ b f n r t

JSONNumber ::=
    -opt DecimalIntegerLiteral JSONFractionopt ExponentPartopt

JSONFraction ::=
    . DecimalDigits

JSONNullLiteral ::=
    NullLiteral

JSONBooleanLiteral ::=
    BooleanLiteral

```

15.12.1.2 The JSON Syntactic Grammar

The JSON Syntactic Grammar defines a valid JSON text in terms of tokens defined by the JSON lexical grammar. The goal symbol of the grammar is *JSONText*.

Syntax

```

JSONText :
    JSONValue

JSONValue :
    JSONNullLiteral
    JSONBooleanLiteral
    JSONObject
    JSONArray
    JSONString
    JSONNumber

```

```
JSONObject :
  { }
  { JSONMemberList }
```

```
JSONMember :
  JSONString : JSONValue
```

```
JSONMemberList :
  JSONMember
  JSONMemberList , JSONMember
```

```
JSONArray :
  [ ]
  [ JSONElementList ]
```

```
JSONElementList :
  JSONValue
  JSONElementList , JSONValue
```

15.12.2 `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 restricted form of ECMAScript literal. JSON objects are realized as ECMAScript objects. JSON arrays are realized as ECMAScript arrays. JSON strings, numbers, booleans, and null are realized as ECMAScript Strings, Numbers, Booleans, and `null`. JSON uses a more limited set of white space characters than `WhiteSpace` and allows Unicode code points U+2028 and U+2029 to directly appear in `JSONString` literals without using an escape sequence. The process of parsing is similar to 11.1.4 and 11.1.5 as constrained by the JSON grammar.

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.

1. Let `JText` be `ToString(text)`.
2. ~~ReturnIfAbrupt(`text`)~~
3. Parse `JText` interpreted as UTF-16 encoded Unicode characters using the grammars in 15.12.1. Throw a `SyntaxError` exception if `JText` did not conform to the JSON grammar for the goal symbol `JSONText`.
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 `JSONString` in place of `StringLiteral`. Note that since `JText` conforms to the JSON grammar this result will be either a primitive value or an object that is defined by either an `ArrayLiteral` or an `ObjectLiteral`.
6. Let `unfiltered` be `completion.[[value]]`.
7. If `IsCallable(reviver)` is `true`, then
 - a. Let `root` be the result of the abstract operation `ObjectCreate` with the intrinsic object `%ObjectPrototype%` as its argument.
 - b. Call `CreateOwnProperty(root, the empty String, unfiltered)`.
 - c. Return the result of calling the abstract operation `Walk`, passing `root` and the empty String. The abstract operation `Walk` is described below.
8. Else
 - a. Return `unfiltered`.

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 the result of `Get(holder, name)`.

Deleted: er

Deleted: unfiltered

Deleted: `JText`

Deleted: Program

Deleted: abstraction operation

Deleted: (15.2)

Deleted: a new object created as if by the expression `new Object()`, where `Object` is standard built-in constructor with that name

Deleted: the `[[DefineOwnProperty]]` internal method of

Deleted: with

Deleted: the `PropertyDescriptor` `{[[Value]]}`:

Deleted: `, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true`, and `false` as arguments

Deleted: calling the `[[`

Deleted: `]]` internal method of

Deleted:

Deleted: with argument

2. `ReturnIfAbrupt(val)`.
3. If `val` is an object, then
 - a. If `val` has a `[[BuiltInBrand]]` internal data property with value `BuiltinArray`, then
 - i. Set `I` to 0.
 - ii. Let `len` be the result of `Get(val, "length")`.
 - iii. Assert: `len` is not an abrupt completion and its value is a positive integer.
 - iv. Repeat while `I < len`,
 1. Let `newElement` be the result of calling the abstract operation `Walk`, passing `val` and `Tostring(I)`.
 2. 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.
 3. Else
 - a. Let `status` be the result of calling the `[[DefineOwnProperty]]` internal method of `val` with arguments `Tostring(I)` and Property Descriptor `{[[Value]]: newElement, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
 - b. NOTE The above is intentionally not a strict define and does not throw if status is `false`.
 4. `ReturnIfAbrupt(status)`.
 5. Add 1 to `I`.
 - b. Else
 - i. Let `keys` be an internal 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.
 - ii. For each String `P` in `keys` do,
 1. Let `newElement` be the result of calling the abstract operation `Walk`, passing `val` and `P`.
 2. If `newElement` is `undefined`, then
 - a. Let `status` be the result of calling the `[[Delete]]` internal method of `val` with `P` as the argument.
 3. Else
 - a. Let `status` be the result of calling the `[[DefineOwnProperty]]` internal method of `val` with arguments `P` and Property Descriptor `{[[Value]]: newElement, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true}`.
 - b. NOTE The above is intentionally not a strict define and does not throw if status is `false`.
 4. `ReturnIfAbrupt(status)`.
4. Return the result of calling the `[[Call]]` internal method of `reviver` passing `holder` as `thisArgument` and with a List containing `name` and `val` as `argumentsList`.

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.

15.12.3 `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.

Comment [AWB12208]: TODO make this a more extensible condition to check

Deleted: the `[[Class]]` internal property of

Deleted: is `"Array"`

Deleted: `isArray`

Deleted: `NativeBrand`

Deleted: `NativeArray`

Deleted: calling the `[[Get]]` internal method of `val` with argument `"length"`

Deleted: `Call`

Deleted: `and false`

Deleted: `s`

Deleted: `Call`

Deleted: `, the`

Deleted: `, and false`

Deleted: `should`

Deleted: `be`

Deleted: `Call`

Deleted: `and false`

Deleted: `arguments`

Deleted: `Call`

Deleted: `, the`

Deleted: `, and false`

Deleted: `the this value`

Deleted: `n`

Deleted: `argument l`

Deleted: `consisting`

Deleted: `of`

Deleted: The first parameter is required.

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 *replacer* has a *[[BuiltInBrand]]* internal data property with value *BuiltinArray*, then
 - i. Let *PropertyList* be an empty internal List
 - ii. 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.
 1. Let *item* be **undefined**.
 2. If *Type(v)* is String then let *item* be *v*.
 3. Else if *Type(v)* is Number then let *item* be *ToString(v)*.
 4. Else if *Type(v)* is Object then,
 - a. If *v* has a *[[StringData]]* or *[[NumberData]]* internal data property, then let *item* be *ToString(v)*.
 5. If *item* is not **undefined** and *item* is not currently an element of *PropertyList* then,
 - a. Append *item* to the end of *PropertyList*.
5. If *Type(space)* is Object then,
 - a. If *space* has a *[[NumberData]]* internal data property, then,
 - i. Let *space* be *ToNumber(space)*.
 - b. Else if *space* has a *[[StringData]]* internal data property, then,
 - i. Let *space* be *ToString(space)*.
6. If *Type(space)* is Number
 - a. Let *space* be *min(10, ToInteger(space))*.
 - b. Set *gap* to a String containing *space* occurrences of code unit 0x0020 (the Unicode space character). This will be the empty String if *space* is less than 1.
7. Else if *Type(space)* is String
 - a. 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
 - a. Set *gap* to the empty String.
9. Let *wrapper* be the result of the abstract operation *ObjectCreate* with the intrinsic object *%ObjectPrototype%* as its argument.
10. *Call CreateOwnProperty(wrapper, the empty String, value)*
11. Return the result of calling the abstract operation *Str* with the empty String and *wrapper*.



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 the result of *Get(holder, key)*.
2. *ReturnIfAbrupt(value)*.
3. If *Type(value)* is Object, then
 - a. Let *toJSON* be the result of *Get(value, " toJSON")*.
 - b. If *IsCallable(toJSON)* is **true**
 - i. Let *value* be the result of calling the *[[Call]]* internal method of *toJSON* passing *value* as *thisArgument* and a List containing *key* as *argumentsList*.
 - ii. *ReturnIfAbrupt(value)*.
4. If *ReplacerFunction* is not **undefined**, then
 - a. Let *value* be the result of calling the *[[Call]]* internal method of *ReplacerFunction* passing *holder* as the *this* value and with an argument list consisting of *key* and *value*.
 - b. *ReturnIfAbrupt(value)*.
5. If *Type(value)* is Object then,
 - a. If *value* has an *[[NumberData]]* internal data property, then,
 - i. Let *value* be *ToNumber(value)*.
 - b. Else if *value* has an *[[StringData]]* internal data property, then,

- i. Let *value* be `ToString(value)`.
- c. Else if *value* has an `[[BooleanData]]` internal data property, then
 - i. Let *value* be the value of the `[[BooleanData]]` internal data property of *value*.
6. If *value* is `null` then return `"null"`.
7. If *value* is `true` then return `"true"`.
8. If *value* is `false` then return `"false"`.
9. If `Type(value)` is String, then return the result of calling the abstract operation `Quote` with argument *value*.
10. If `Type(value)` is Number
 - a. If *value* is finite then return `ToString(value)`.
 - b. Else, return `"null"`.
11. If `Type(value)` is Object, and `IsCallable(value)` is false
 - a. If *value* has an `[[BuiltInBrand]]` internal data property with value `BuiltinArray`, then
 - i. Return the result of calling the abstract operation `J4` with argument *value*.
 - b. Else, return the result of calling the abstract operation `JO` with argument *value*.
12. Return `undefined`.

Runtime Semantics: Quote Abstract Operation

The abstract operation `Quote(value)` wraps a String value in double quotes and escapes characters within it.

1. Let *product* be code unit 0x0022 (the Unicode double quote character).
2. For each code unit *C* in *value*
 - a. If *C* is 0x0022 or 0x005C (the Unicode reverse solidus character)
 - i. Let *product* be the concatenation of *product* and code unit 0x005C.
 - ii. Let *product* be the concatenation of *product* and *C*.
 - b. Else if *C* is backspace, formfeed, newline, carriage return, or tab
 - i. Let *product* be the concatenation of *product* and code unit 0x005C (the Unicode backslash character).
 - ii. Let *abbrev* be the string value corresponding to the value of *C* as follows:

backspace	"\b"
formfeed	"\f"
newline	"\n"
carriage return	"\r"
tab	"\t"
 - iii. Let *product* be the concatenation of *product* and *abbrev*.
 - c. Else if *C* has a code unit value less than 0x0020 (the Unicode space character)
 - i. Let *product* be the concatenation of *product* and code unit 0x005C (the Unicode backslash character).
 - ii. Let *product* be the concatenation of *product* and "\u".
 - iii. 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 characters.
 - iv. Let *product* be the concatenation of *product* and *hex*.
 - d. Else
 - i. Let *product* be the concatenation of *product* and *C*.
3. Let *product* be the concatenation of *product* and code unit 0x0022 (the Unicode double quote character).
4. Return *product*.

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.

1. If *stack* contains *value* then 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. If `PropertyList` is not `undefined`, then
 - a. Let *K* be `PropertyList`.
6. Else

Deleted: the `[[Class]]` internal property of
Deleted: NativeBrand
Deleted: IsBoolean
Deleted: is "Boolean"
Deleted: PrimitiveValue

Deleted: the `[[Class]]` internal property of
Deleted: IsArray
Deleted: NativeBrand
Deleted: NativeArray
Deleted: is "Array"

Deleted: character
Deleted: the double quote character
Deleted: or
Deleted: backslash
Deleted: (the Unicode backslash character)
Deleted: product and the backslash character.
Deleted: and
Deleted: character
Deleted: value

Deleted: is
Deleted: control character having a
Deleted: and

Deleted: and the double quote character

Deleted: ,
Deleted: ReplacerFunction, and space

- a. Let K be an internal List of Strings consisting of the keys of all the own properties of $value$ whose [[Enumerable]] attribute is **true** and whose property key is a **String value**. The ordering of the Strings is the same as that used by the **Object.keys** standard built-in function.
7. Let $partial$ be an empty List.
8. For each element P of K .
 - a. Let $strP$ be the result of calling the abstract operation **Str** with arguments P and $value$.
 - b. **ReturnIfAbrupt(strP)**.
 - c. If $strP$ is not **undefined**
 - i. Let $member$ be the result of calling the abstract operation **Quote** with argument P .
 - ii. Let $member$ be the concatenation of $member$ and the string ":.
 - iii. If gap is not the empty String
 1. Let $member$ be the concatenation of $member$ and code unit 0x0020 (the Unicode space character).
 - iv. Let $member$ be the concatenation of $member$ and $strP$.
 - v. Append $member$ to $partial$.
9. If $partial$ is empty, then
 - a. Let $final$ be "{ }".
10. Else
 - a. If gap is the empty String
 - 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 0x002C (the Unicode comma character). 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 gap is not the empty String
 - i. Let $separator$ be the result of concatenating code unit 0x002C (the comma character), code unit 0x000A (the line feed character), 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 0x000A (the line feed character), $indent$, $properties$, code unit 0x000A, $stepback$, and "}".
11. Remove the last element of $stack$.
12. Let $indent$ be $stepback$.
13. Return $final$.

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 open left bracket, elements separated by comma, and a closing right bracket.

1. If $stack$ contains $value$ then 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. Assert: $value$ is a standard array object and hence its "length" property is a non-negative integer.
7. Let len be the result of Get(value, "length").
8. Let $index$ be 0.
9. Repeat while $index < len$
 - a. Let $strP$ be the result of calling the abstract operation **Str** with arguments **Tostring(index)** and $value$.
 - b. **ReturnIfAbrupt(strP)**.
 - c. If $strP$ is **undefined**
 - i. Append "**null**" to $partial$.
 - d. Else
 - i. Append $strP$ to $partial$.
 - e. Increment $index$ by 1.

Deleted: names

Deleted: should be

Deleted: colon character

Deleted: the line feed character

Deleted: , and space

Deleted: Named p

Deleted: are

Deleted: nativ

Deleted: e

Deleted: of calling the [[Get]] internal method on $value$ with argument "length".

10. If *partial* is empty ,then
 - a. Let *final* be " [] ".
11. Else
 - a. If *gap* is the empty String
 - 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 0x002C (the comma character). A comma is not inserted either before the first String or after the last String.
Let *final* be the result of concatenating " [", *properties*, and "] ".
 - b. Else
 - i. Let *separator* be the result of concatenating code unit 0x002C (the comma character), code unit 0x000A (the line feed character), 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 0x000A (the line feed character), *indent*, *properties*, code unit 0x000A, *stepback*, and "] ".
12. Remove the last element of *stack*.
13. Let *indent* be *stepback*.
14. Return *final*.

Deleted: the line feed character

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 an 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 double quotes. The characters " and \ are escaped with \ prefixes. Control characters are replaced with escape sequences \uHHHH, or with the shorter forms, \b (backspace), \f (formfeed), \n (newline), \r (carriage return), \t (tab).

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 opening left brace followed by zero or more properties, separated with commas, closed with a right brace. 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 bracket followed by zero or more values, separated with commas, closed with a right bracket.

15.13 Binary Data Objects

15.13.1 The BinaryData Module

15.13.2 The BinaryData.Type Object

15.13.2.5 BinaryData.ScalarType Type Instance Objects

15.13.3 The BinaryData.ArrayType Object

15.13.4 The BinaryData.StructType Object

Deleted: ,

Comment [AWB10209]: This is a place holder for material in the Binary Data proposal http://wiki.ecmascript.org/doku.php?id=harmony:binary_data

15.13.5 ArrayBuffer Objects

15.13.5.1 Abstract Operations For ArrayBuffer Objects

15.13.5.1.1 AllocateArrayBuffer(constructor)

The abstract operation `AllocateArrayBuffer` with argument `constructor` is used to create an uninitialized `ArrayBuffer` object. It performs the following steps:

1. Let `obj` be the result of calling `OrdinaryCreateFromConstructor(constructor, "%ArrayBufferPrototype%", {[[ArrayBufferData]], [[ArrayBufferByteLength]]})`.
2. ReturnIfAbrupt(`obj`).
3. Set the `[[ArrayBufferByteLength]` internal data property of `obj` to 0.
4. Return `obj`.

Deleted: <#>Assert: IsConstructor(`constructor` true.)

Deleted: <#>Add a `[[ArrayBufferData]]` internal data property to `obj`.
Add

Deleted: a

Deleted: to

Deleted: <#>Set `obj`'s `[[ArrayBufferData]]` internal data property to `undefined`.
<#>Set `obj`'s `[[ArrayBufferByteLength]]` internal data property to 0.

Deleted: an Number value in the Uint32 range

Comment [AWB13210]: TODO: need to define abstract operations for allocating data blocks. Should throw a `RangeError` if alloc fa

15.13.5.1.2 SetArrayBufferData(arrayBuffer, bytes)

The abstract operation `SetArrayBufferData` with arguments `arrayBuffer` and `bytes` is used to initialize the storage block encapsulated by an `ArrayBuffer` object. It performs the following steps:

1. Assert: `arrayBuffer` has an `[[ArrayBufferData]]` internal data property.
2. Assert: `bytes` is positive integer.
3. Let `block` be the result of `CreateByteArrayBlock(bytes)`.
4. ReturnIfAbrupt(`block`).
5. Set `arrayBuffer`'s `[[ArrayBufferData]]` to `block`.
6. Set `arrayBuffer`'s `[[ArrayBufferByteLength]]` internal data property to `byteLength`.
7. Return `arrayBuffer`.

15.13.5.1.3 GetValueFromBuffer (arrayBuffer, byteIndex, type, isBigEndian)

The internal operation `GetValueFromBuffer` takes four parameters, an `ArrayBuffer` `arrayBuffer`, an integer `byteIndex`, a String `valueType`, and optionally a Boolean `isBigEndian`. If `isBigEndian` is not present, its default value is `false`. This operation performs the follow steps:

1. Assert: There are sufficient bytes in `arrayBuffer` starting at `byteIndex` to represent a value of `valueType`.
2. Assert: `byteIndex` is a positive integer.
3. Let `block` be `arrayBuffer`'s `[[ArrayBufferData]]` internal data property.
4. Let `elementSize` be the Number value of the Element Size value specified in Table 36 for `valueType`.
5. Let `rawValue` be the `elementSize` bytes starting at `byteIndex` of `block`.
6. If `isBigEndian` is `true`, reverse the order of the bytes of `rawValue`.
7. If `type` is "Float32", then
 - a. `rawValue` is interpreted, taking into account the value of `isBigEndian`, as a bit string encoding of an IEEE 754-208 binary32 value.

- b. If *rawValue* is any an IEEE 754-208 binary32 NaN value, return the NaN Number value.
 - c. Return the Number value that is encoded by *rawValue* as
8. If *type* is "Float64", then
- a. *rawValue* is interpreted, taking into account the value of *isBigEndian*, as a bit string encoding of an IEEE 754-208 binary64 value.
 - b. If *rawValue* is any an IEEE 754-208 binary64 NaN value, return the NaN Number value.
 - c. Return the Number value that is encoded by *rawValue* as
9. If the first character of *type* is "U", then
- a. Let *intValue* be the positive integer that is the result of interpreting, taking into account the value of *isBigEndian*, *rawValue* as an unsigned binary number.
10. Else
- a. Let *intValue* be the signed integer that is the result of interpreting, taking into account the value of *isBigEndian*, *rawValue* as a binary 2's complement number of bit length *elementSize* × 4.
11. Return *intValue*.

NOTE The default number storage formal for all implementation is little endian, regardless of the native endianness of the underlying hardware.

Formatted: Note

15.13.5.1.4 SetValueInBuffer (*arrayBuffer*, *byteIndex*, *type*, *value*, *isBigEndian*)

The internal operation *SetValueFromBuffer* takes five parameters, an ArrayBuffer *arrayBuffer*, an integer *byteIndex*, a String *valueType*, a Number *value*, and optionally a Boolean *isBigEndian*. If *isBigEndian* is not present, its default value is false. This operation performs the follow steps:

1. Assert: There are sufficient bytes in *arrayBuffer* starting at *byteIndex* to represent a value of *valueType*.
2. Assert: *byteIndex* is a positive integer.
3. Let *block* be *arrayBuffer*'s [[ArrayBufferData]] internal data property.
4. Let *elementSize* be the Number value of the Element Size value specified in Table 35 on the row with Element Type is *type*.
5. Let *rawValue* be the *elementSize* bytes starting at *byteIndex* of *arrayBuffer*.
6. If *isBigEndian* is true, reverse the order of the bytes of *rawValue*.
7. If *type* is "Float32", then
 - a. Set *rawValue* to the 4 bytes that are the result of converting *value* to IEEE-868-2005 binary32 format using "Round to nearest, ties to even" rounding mode. If *isBigEndian* is true, the bytes are arranged in big endian order. Otherwise, the bytes are arranged in little endian order. If *value* is NaN, *rawValue* is may be set of any implementation chooses non-signaling NaN encoding.
8. Else, if *type* is "Float64", then
 - a. Set *rawValue* to the 8 bytes that are IEEE-868-2005 binary64 format encoding of *value*. If *isBigEndian* is true, the bytes are arranged in big endian order. Otherwise, the bytes are arranged in little endian order. If *value* is NaN, *rawValue* is may be set of any implementation chooses non-signaling NaN encoding.
9. Else
 - a. Let *n* be the Size Element value in Table 35 for the row containing the value of *type* as its Element Type entry.
 - b. Let *convOp* be the abstract operation named in the Conversion Opoeration column in Table 35 for the row containing the value of *type* as its Element Type entry.
 - c. Let *intValue* be the result of calling *convOp* with *value* as its argument.
 - d. If *intValue* > 0, then
 - i. Let *rawBytes* be the *n*-byte binary encoding of *intValue*. If *isBigEndian* is true, the bytes are arranged in big endian order. Otherwise, the bytes are arranged in little endian order.
 - e. Else
 - i. Let *rawBytes* be the *n*-byte binary 2's complement encoding of *intValue*. If *isBigEndian* is true, the bytes are arranged in big endian order. Otherwise, the bytes are arranged in little endian order.
10. Store the individual bytes of *rawBytes* in order starting at position *byteIndex* of *block*.
11. Return CompletionNormal(**undefined**).

Deleted: Table 36

Deleted: Table 36

Deleted: ion

Deleted: Table 36

15.13.5.2 The ArrayBuffer Object Called as a Function

Deleted: 1

When `ArrayBuffer` is called as a function rather than as a constructor, it initializes its `this` value with the internal state that supports the `ArrayBuffer.prototype` internal methods. This permits super invocation of the `ArrayBuffer` constructor by `ArrayBuffer` subclasses. If its `this` value is `undefined`, it creates and initialises a new `ArrayBuffer` object. Thus the function call `ArrayBuffer(...)` is equivalent to the object creation expression `new ArrayBuffer(...)` with the same arguments.

15.13.5.2.1 ArrayBuffer(length)

Deleted: 1

`ArrayBuffer` called as function with argument `length` performs the following steps:

1. Let `O` be the `this` value.
2. If `Type(O)` is neither `Object` or `Undefined`, then throw a `TypeError` exception
3. If `O` is `undefined` or does not have an `[[ArrayBufferData]]` internal data property, then
 - a. Let `F` be this function object.
 - b. Let `argumentsList` be the `argumentsList` argument of the `[[Call]]` internal method that invoked `F`.
 - c. Return the result of calling `OrdinaryCreate(F, argumentsList)`.
4. If the value of `O`'s `[[ArrayBufferData]]` internal data property is not `undefined`, then throw a `TypeError` exception.
5. Let `byteLength` be `ToPositiveInteger(length)`.
6. ReturnIfAbrupt(`byteLength`).
7. Return the result of `SetArrayBufferData(O, byteLength)`.

Deleted: `ToUint32`

15.13.5.3 The ArrayBuffer Constructor

Deleted: 2

When `ArrayBuffer` is called as part of a new expression, it is a constructor: it initialises the newly created object.

Deleted: 2
Deleted: `len`
Deleted: with arguments
Deleted:
Deleted: and
Deleted: `Map`

The `ArrayBuffer` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class declaration. Subclass constructors that intended to inherit the specified `ArrayBuffer` behaviour must include a `super` call to `ArrayBuffer`.

15.13.5.3.1 new ArrayBuffer(...args)

Deleted: The `[[Prototype]]` internal data property of the newly constructed object is set to the original `ArrayBuffer` prototype object, the one that is the initial value of `ArrayBuffer.prototype` (16.1.3.1). The `[[Class]]` internal data property of the newly constructed object is set to "ArrayBuffer". The `[[Extensible]]` internal data property of the newly constructed object is set to `true`.
 The length property of the newly constructed object is set to `ToUint32(len)`.
 A fresh native buffer `nativeBuffer` of length `byteLength` is allocated. The contents of this native buffer are zero initialized. If the requested number of bytes could not be allocated, a `RangeError` is raised. The `[[NativeBuffer]]` internal data property of the newly constructed object is set to `nativeBuffer`.

Deleted: 3
Deleted: the internal properties are the
Deleted: 3
Deleted: 16
Deleted: 1

`ArrayBuffer` called as part of a new expression with argument `length` performs the following steps:

1. Let `F` be the `ArrayBuffer` function object on which the `new` operator was applied.
2. Let `argumentsList` be the `argumentsList` argument of the `[[Construct]]` internal method that was invoked by the `new` operator.
3. Return the result of `OrdinaryConstruct(F, argumentsList)`.

If `ArrayBuffer` is implemented as an ordinary function object, its `[[Construct]]` internal method will perform the above steps.

15.13.5.4 Properties of the ArrayBuffer Constructor

The value of the `[[Prototype]]` internal data property of the `ArrayBuffer` constructor is the `Function` prototype object (15.3.4).

Besides its `length` property (whose value is 1), the `ArrayBuffer` constructor has the following properties:

15.13.5.4.1 ArrayBuffer.prototype

The initial value of `ArrayBuffer.prototype` is the `ArrayBuffer` prototype object (15.13.5.4).

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

15.13.5.4.2 ArrayBuffer@@create 1()

The @@create method of a ArrayBuffer function object F performs the following steps:

1. Let F be the **this** value.
2. Return the result of calling `AllocateArrayBuffer(F)`.

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

15.13.5.5 Properties of the ArrayBuffer Prototype Object

The value of the [[Prototype]] internal data property of the ArrayBuffer prototype object is the standard built-in Object prototype object (15.2.4). The ArrayBuffer prototype object is an ordinary object. It does not have a [[ArrayBufferData]] or [[ArrayBufferByteLength]] internal data property.

15.13.5.5.1 ArrayBuffer.prototype.constructor

The initial value of `ArrayBuffer.prototype.constructor` is the standard built-in `ArrayBuffer` constructor.

15.13.5.5.2 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 result of calling `ToObject` with the **this** value as its argument.
2. ReturnIfAbrupt(O).
3. If O does not have a [[ArrayBufferByteLength]] internal data property throw a `TypeError` exception.
4. Let $length$ be the value of O 's [[ArrayBufferByteLength]] internal data property.
5. Return $length$.

15.13.5.5.3 ArrayBuffer.prototype.slice (start , end)

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. If O does not have a [[ArrayBufferData]] internal data property throw a `TypeError` exception.
4. Let len be the value of O 's [[ArrayBufferByteLength]] internal data property.
5. Let $relativeStart$ be `ToInteger(start)`.
6. ReturnIfAbrupt($relativeStart$).
7. If $relativeStart$ is negative, let $first$ be $\max((len + relativeStart), 0)$; else let $first$ be $\min(relativeStart, len)$.
8. If end is `undefined`, let $relativeEnd$ be len ; else let $relativeEnd$ be `ToInteger(end)`.
9. ReturnIfAbrupt($relativeEnd$).
10. If $relativeEnd$ is negative, let $final$ be $\max((len + relativeEnd), 0)$; else let $final$ be $\min(relativeEnd, len)$.
11. Let $newLen$ be $final - first$.
12. Let $ctor$ be the result of `GetMethod(O, "constructor")`.
13. ReturnIfAbrupt($ctor$).
14. If `IsConstructor(ctor)` is `false`, then throw a `TypeError` exception.
15. Let new be the result of calling the [[Construct]] internal method of $ctor$ with a new List containing the single element $newLen$.
16. ReturnIfAbrupt(new).
17. If new does not have a [[ArrayBufferData]] internal data property throw a `TypeError` exception.
18. Let $fromBuf$ be the value of O 's [[ArrayBufferData]] internal data property.
19. Let $toBuf$ be the value of new 's [[ArrayBufferData]] internal data property.
20. Let $status$ be the result of `CopyBlockElements(fromBuf, first, toBuf, 0, newLen)`.
21. ReturnIfAbrupt($status$).
22. Return new .

Deleted: 3

Deleted: ,

Deleted: <#> If `IsConstructor(F)` is `false`, then throw a `TypeError` exception.

Comment [AWB14211]: Because the @@create method is essential to the integrity of this "class" definition just like the prototype property, it seems appropriate to freeze it in the same manner.

Deleted: 4

Deleted: The [[Class]] internal data property of the newly constructed object is set to "Object".

Deleted: The [[Extensible]] internal data property of the newly constructed object is set to `true`.

Deleted: 4

Comment [AWB13212]: `byteLength` needs to be an accessor both to comply with WebIDL requirements and to support the Kronos neutering strawman requirement.

Deleted: 4

Deleted: `size`

Deleted: 4

Comment [AWB13213]: TODO: need to define abstract operations for allocating and manipulating data blocks.

15.13.5.4 ArrayBuffer.prototype.@@toStringTag

The initial value of the @@toStringTag property is the string value "ArrayBuffer".

15.13.5.6 Properties of the ArrayBuffer Instances

ArrayBuffer instances inherit properties from the ArrayBuffer prototype object. After initialisation by the ArrayBuffer constructor, ArrayBuffer instances also have a [[ArrayBufferData]] internal data property and a [[ArrayBufferByteLength]] internal data property.

15.13.6 TypedArray Object Structures

For each constructor in the Table 35 is a separate TypedArray constructor object, with corresponding prototype and instances. Each of these TypedArray constructor objects has the structure described below, differing only in the name used as the constructor name instead of TypedArray, in Table 35.

Table 35 – The TypedArray Constructors

Constructor Name	Element Type	Element Size	Conversion Operation	Description	Equivalent C Type
Int8Array	Int8	1	ToInt8	8-bit 2's complement signed integer	signed char
Uint8Array	Uint8	1	ToUint8	8-bit unsigned integer	unsigned char
Uint8ClampedArray	Uint8C	1	ToUint8Clamp	8-bit unsigned integer (clamped)	unsigned char
Int16Array	Int16	2	ToInt16	16-bit 2's complement signed integer	Short
Uint16Array	Uint16	2	ToUint16	16-bit unsigned integer	unsigned short
Int32Array	Int32	4	ToInt32	32-bit 2's complement signed integer	Int
Uint32Array	Uint32	4	ToUint32	32-bit unsigned integer	unsigned int
Float32Array	Float32	4		32-bit IEEE floating point	Float
Float64Array	Float64	8		64-bit IEEE floating point	Double

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.

15.13.6.1 TypedArray Constructors Called as a Function

When a TypedArray constructor is called as a function rather than as a constructor, it creates and initialises a new object. A call of the constructor as a function is equivalent to calling it as a constructor with the same arguments.

When a TypedArray constructor is called as a function rather than as a constructor, it initializes its this value with the internal state that supports the TypedArray.prototype internal methods. This permits super invocation of the TypedArray constructor by TypedArray subclasses. If the this value is undefined, it creates and initialises a new TypedArray object. Thus the function call TypedArray (...) is equivalent to the object creation expression new TypedArray (...) with the same arguments.

15.13.6.1.1 TypedArray (length)

TypedArray called as function with argument length performs the following steps:

1. Assert: Type(length) is not Object.

Deleted: 4

Deleted: 5

Deleted: and their [[Class]] internal data property value is "ArrayBuffer"

Deleted: ArrayBuffer instances also have the following properties.

Deleted: 15.13.5.5.1 byteLength

The byteLength property of this ArrayBuffer object is a data property whose value is the length of the ArrayBuffer in bytes, as fixed at construction time.

The length property has the attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }.

Deleted:

Deleted: Table 36

Deleted: following table

Deleted: TypeArray

Deleted: TypeArray

Deleted:

Deleted: Table 36

Deleted: XXXXXXXX

Deleted: 36

Deleted: Element

Deleted: Size

Comment [AWB13214]: TODO

Comment [AWB13215]: TODO

Comment [AWB13216]: Issue: this is a made up name. What should it be?

Comment [AWB13217]: TODO

Deleted: TypeArray

Deleted: TypeArray

Comment [AWB13218]: The BinaryData proposal, would like "called as a function" invocation of a TypedArray constructor to return a new BinaryData type rather than a array type instance. This could be accomplished by changing steps 5.a-5.c in the 15.13.6.1.1.

However, this seems like to be a breaking change for some current web apps.

Comment [AWB13219]: Issue: we need to decide whether we are going to fully apply WebIDL's complex set of overload resolution rules.

Deleted: ;

2. Let `elementType` be the string value of the Element Type value in Table 35 for this `TypedArray` constructor.
3. Let `O` be the `this` value.
4. If `Type(O)` is neither Object or Undefined, then throw a `TypeError` exception
5. If `O` is `undefined` or does not have an `[[TypedArrayData]]` internal data property, then
 - a. Let `F` be this function object.
 - b. Let `argumentsList` be the `argumentsList` argument of the `[[Call]]` internal method that invoked `F`.
 - c. Return the result of calling `OrdinaryConstruct(F, argumentsList)`.
6. If the value of `O`'s `[[TypedArrayData]]` internal data property is not `undefined`, then throw a `TypeError` exception.
7. Let `elementLength` be `ToPositiveInteger(length)`.
8. ~~ReturnIfAbrupt(elementLength)~~
9. Let `data` be the result of calling `AllocateArrayBuffer(%ArrayBuffer%)`.
10. ~~ReturnIfAbrupt(data)~~
11. Let `elementSize` be the Size Element value in Table 35 for this `TypedArray` constructor.
12. Let `byteLength` be `elementSize × elementLength`.
13. Let `status` be the result of `SetArrayBufferData(data, byteLength)`
14. ~~ReturnIfAbrupt(status)~~
15. Set `O`'s `[[TypedArrayData]]` to `data`.
16. Set `O`'s `[[TypedArrayElementKind]]` internal data property to `elementType`.
17. Set `O`'s `[[ByteLength]]` internal data property to `byteLength`.
18. Set `O`'s `[[ByteOffset]]` internal data property to 0.
19. Set `O`'s `[[ArrayLength]]` internal data property to `elementLength`.
20. Return `O`.

Deleted: Table 36

15.13.6.1.2 `TypedArray (typedArray)`

`TypedArray` called as function with argument `typedArray` performs the following steps:

1. ~~Assert: `Type(typedArray)` is Object and `typedArray` has a `[[TypedArrayData]]` internal data property.~~
2. Let `srcArray` be `typedArray`.
3. Let `elementType` be the string value of the Element Type value in Table 35 for this `TypedArray` constructor.
4. Let `O` be the `this` value.
5. If `Type(O)` is neither Object or Undefined, then throw a `TypeError` exception
6. If `O` is `undefined` or does not have an `[[TypedArrayData]]` internal data property, then
 - a. Let `F` be this function object.
 - b. Let `argumentsList` be the `argumentsList` argument of the `[[Call]]` internal method that invoked `F`.
 - c. Return the result of calling `OrdinaryConstruct(F, argumentsList)`.
7. If the value of `O`'s `[[TypedArrayData]]` internal data property is not `undefined`, then throw a `TypeError` exception.
8. Let `elementLength` be the value of `srcArray`'s `[[ArrayLength]]` internal data property.
9. Let `srcType` be the value of `srcArray`'s `[[TypedArrayElementKind]]` internal data property.
10. Let `srcData` be the value of `srcArray`'s `[[TypedArrayData]]` internal data property.
11. Let `data` be the result of calling `CloneArrayBuffer(srcData, srcType, elementType, elementLength)`.
12. ~~ReturnIfAbrupt(data)~~
13. Let `elementSize` be the Size Element value in Table 35 for this `TypedArray` constructor.
14. Let `byteLength` be `elementSize × elementLength`.
15. Let `data` be the result of `SetArrayBufferData(data, byteLength)`.
16. ~~ReturnIfAbrupt(data)~~
17. Set `O`'s `[[TypedArrayData]]` to `data`.
18. Set `O`'s `[[TypedArrayElementKind]]` internal data property to `elementType`.
19. Set `O`'s `[[ByteLength]]` internal data property to `byteLength`.
20. Set `O`'s `[[ByteOffset]]` internal data property to 0.
21. Set `O`'s `[[ArrayLength]]` internal data property to `elementLength`.
22. Return `O`.

Comment [AWB13220]: Issue: we need to decide whether we are going to fully apply WebIDL's complex of overload resolution rules.

Deleted: ;

Deleted: Table 36

Comment [AWB13221]: TODO

Deleted: Table 36

15.13.6.1.3 `TypedArray (array)`

`TypedArray` called as function with argument `array` performs the following steps:

Comment [AWB13222]: Issue: The khronos spec allows array-likes here. Should we also recognize iterables and use @@iterator for them? This algorithm current doesn't deal with iterables.

1. Assert: `Type(array)` is Object and `array` does not have either a `[[TypedArrayData]]` or a `[[ArrayBufferData]]` internal data property.
2. Let `O` be the `this` value.
3. If `Type(O)` is neither Object or Undefined, then throw a **TypeError** exception
4. Let `srcArray` be `array`.
5. Let `elementType` be the string value of the Element Type value in Table 35 for this `TypedArray` constructor.
6. If `O` is **undefined** or does not have an `[[TypedArrayData]]` internal data property, then
 - a. Let `F` be this function object.
 - b. Let `argumentsList` be the `argumentsList` argument of the `[[Call]]` internal method that invoked `F`.
 - c. Return the result of calling `OrdinaryConstruct(F, argumentsList)`.
7. If the value of `O`'s `[[TypedArrayData]]` internal data property is not **undefined**, then throw a **TypeError** exception.
8. Let `arrayLength` be the result of `Get(array, "length")`.
9. Let `elementLength` be `ToPositiveInteger(arrayLength)`.
10. ReturnIfAbrupt(`elementLength`).
11. Let `data` be the result of calling `AllocateArrayBuffer(%ArrayBuffer%)`.
12. ReturnIfAbrupt(`data`).
13. Let `elementSize` be the Size Element value in Table 35 for this `TypedArray` constructor.
14. Let `byteLength` be `elementSize × elementLength`.
15. Let `status` be the result of `SetArrayBufferData(data, byteLength)`
16. Let `k` be 0.
17. Repeat, while `k < elementLength`
 - a. Let `Pk` be `ToString(k)`.
 - b. Let `kValue` be the result of `Get(O, Pk)`.
 - c. Let `kNumber` be `ToNumber(kValue)`.
 - d. ReturnIfAbrupt(`kNumber`).
 - e. Perform `SetValueInBuffer(data, k × elementSize, elementType, kNumber)`.
 - f. Increase `k` by 1.
18. Set `O`'s `[[TypedArrayData]]` to `data`.
19. Set `O`'s `[[TypedArrayElementKind]]` internal data property to `elementType`.
20. Set `O`'s `[[ByteLength]]` internal data property to `byteLength`.
21. Set `O`'s `[[ByteOffset]]` internal data property to 0.
22. Set `O`'s `[[ArrayLength]]` internal data property to `elementLength`.
23. Return `O`.

15.13.6.1.4 `TypedArray (buffer, byteOffset=0, length=undefined)`

`TypedArray` called as function with arguments `length`, `byteOffset`, and `length` performs the following steps:

1. Assert: `Type(buffer)` is Object and `typedArray` has a `[[ArrayBufferData]]` internal data property.
2. Let `O` be the `this` value.
3. If `Type(O)` is neither Object or Undefined, then throw a **TypeError** exception
4. Let `elementType` be the String value of the Element Type value in Table 35 for this `TypedArray` constructor.
5. Let `elementSize` be the Number value of the Element Size value in Table 35 for this `TypedArray` constructor.
6. Let `offset` be `ToPositiveInteger(byteOffset)`.
7. ReturnIfAbrupt(`offset`).
8. If `offset` modulo `elementSize` ≠ 0, then throw a **RangeError** exception.
9. Let `bufferByteLength` be the value of `buffer`'s `[[ArrayBufferByteLength]]` internal data property.
10. If `length` is **undefined**, then
 - a. If `bufferByteLength` modulo `elementSize` ≠ 0, then throw a **RangeError** exception.
 - b. Let `newByteLength` be `bufferByteLength - offset`.
11. Else,
 - a. Let `newLength` be `ToPositiveInteger(length)`.
 - b. ReturnIfAbrupt(`newLength`).
 - c. Let `newByteLength` be `newLength × elementSize`.
 - d. If `newByteLength > bufferByteLength`, then throw a **RangeError** exception.
12. If the value of `O`'s `[[TypedArrayData]]` internal data property is not **undefined**, then throw a **TypeError** exception.
13. Set `O`'s `[[TypedArrayData]]` to `buffer`.

Deleted: ;

Comment [AWB13223]: Issue: we need to decide whether we are going to fully apply WebIDL's complex set of overload resolution rules.

Deleted: Table 36

Deleted: `Uint32`

Deleted: Table 36

Comment [AWB13224]: Issue: we need to decide whether we are going to fully apply WebIDL's complex set of overload resolution rules.

Deleted: ;

Deleted: Table 36

Deleted: Table 36

Deleted: `Uint32`

Comment [AWB13225]: Issue, the order of exceptions that may be thrown during argument validation is probably not currently the same as would be produced by WebIDL overloading per Khronos validation rules (if that order is even well defined??). It isn't clear that this difference is very important.

Deleted: `Uint32`

14. Set O 's `[[TypedArrayElementKind]]` internal data property to `elementType`.
15. Set O 's `[[ByteLength]]` internal data property to `newByteLength`.
16. Set O 's `[[ByteOffset]]` internal data property to `offset`.
17. Set O 's `[[ArrayLength]]` internal data property to `newByteLength / elementSize`.
18. Return O .

15.13.6.1.5 TypedArray (binary data stuff)

15.13.6.2 The TypedArray Constructors

When a `TypedArray` function is called as part of a new expression, it is a constructor: it initialises the newly created object.

The `TypedArray` constructors is designed to be subclassable. They may be used as the value of an `extends` clause of a class declaration. Subclass constructors that intended to inherit the specified `TypedArray` behaviour must include a `super` call to the `TypedArray`.

15.13.6.2.1 new TypedArray (...args)

When a `TypedArray` function called as part of a new expression with argument lists `args` performs the following steps:

1. Let F be the `TypedArray` function object on which the `new` operator was applied.
2. Let `argumentsList` be the `argumentsList` argument of the `[[Construct]]` internal method that was invoked by the `new` operator.
3. Return the result of `OrdinaryConstruct(F , argumentsList)`.

If `TypedArray` is implemented as an ordinary function object, its `[[Construct]]` internal method will perform the above steps.

15.13.6.3 Properties of the TypedArray Constructors

The value of the `[[Prototype]]` internal data property of each `TypedArray` constructor is the Function prototype object (15.3.4).

Besides a `length` property (whose value is 3), each `TypedArray` constructor has the following properties:

15.13.6.3.1 TypedArray.prototype

The initial value of `TypedArray.prototype` is the corresponding `TypedArray` prototype object (15.13.5.4).

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

15.13.6.3.2 TypedArray[@@create 1 ()]

The `@@create` method of a `TypedArray` function object F performs the following steps:

1. Let F be the `this` value.
2. Let `proto` be the result of `GetPrototypeOfFromConstructor(F , "%TypedArrayPrototype%")`.
3. ReturnIfAbrupt(`proto`).
4. Let `obj` be the result of calling `IndexedDelegatorCreate(proto)`.
5. Add a `[[TypedArrayData]]` internal data property to `obj` and set its initial value to `undefined`.
6. Add a `[[TypedArrayElementKind]]` internal data property to `obj` and set its initial value to `undefined`.
7. Add a `[[ByteLength]]` internal data property to `obj` and set its initial value to 0.
8. Add a `[[ByteOffset]]` internal data property to `obj` and set its initial value to 0.
9. Add a `[[ArrayLength]]` internal data property to `obj` and set its initial value to 0.
10. Return `obj`.

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

Comment [AWB13226]: TODO: this is a place holding assuming that we may need to construct `TypedArrays` from binary data objects.

Deleted: `TypeArray`

Deleted: 5

Deleted: with arguments

Deleted: and

Deleted: When a `TypeArray` constructor is called as part of a new expression, it is a constructor: it initialises the newly created object.

15.13.6.2.1 new TypeArray(arg0 [, arg1 [, arg2]])

The `[[Prototype]]` internal data property of the newly constructed object is set to the original `TypeArray` prototype object, the one that is the initial value of `TypeArray.prototype` (16.2.3.1). The `[[Class]]` internal data property of the newly constructed object is set to "TypeArray". The `[[Extensible]]` internal data property of the newly constructed object is set to `true`. The remaining properties of the newly constructed object are set as follows:

```
<#> If Type(arg0) is Number, then
<#> Let length be ToUInt32(arg0).
<#> ReturnIfAbrupt(length).
<#> The length property of the newly constructed object is set to length.
<#> The byteLength property of the newly constructed object is set to length multiplied by the element size in bytes.
<#> Let arrayBuffer be an object constructed as if by a call to the built-in ArrayBuffer constructor, as "new ArrayBuffer(byteLength)".
<#> The buffer property of the newly constructed object is set to arrayBuffer.
<#> The byteOffset property of the newly constructed object is set to 0.
<#> Else
<#> Let  $O$  be the result of calling ToObject(arg0).
<#> ReturnIfAbrupt( $O$ ).
<#> Let class be the value of the [[Class]] internal data property of  $O$ .
<#> If class is "ArrayBuffer", then
<#> Let byteOffset be the result of calling ToUInt32 on arg1 provided, or else 0.
<#> If byteOffset is not an integer multiple of the element size in bytes, throw a RangeError exception. data
```

Deleted: `TypeArray`

Deleted: `TypeArray`

Deleted: the internal properties and the

Deleted: `TypeArray`

Deleted: `TypeArray`

Deleted: `TypeArray`

Deleted: 2

Deleted: ,

Deleted: <#> If `IsConstructor(F)` is `false`, then throw a `TypeError` exception.

Deleted: <#> If `Type(proto)` is not Object, then

Deleted: <#> Set `obj`'s `[[TypedArrayData]]` internal data property to `undefined`.

Comment [AWB14227]: Because the `@@create` method is essential to the integrity of this "class" definition.

15.13.6.4 Properties of the *TypedArray* Prototype Object

The value of the `[[Prototype]]` internal data property of each `TypedArray` prototype object is the standard built-in `Object` prototype object (15.2.4). The `TypedArray` prototype objects are ordinary objects. They do not have a `[[TypedArrayData]]` or any other of the internal data properties that are specific to `TypedArray` instance objects.

15.13.6.4.1 `TypedArray.prototype.constructor`

The initial value of `TypedArray.prototype.constructor` is the standard built-in `TypedArray` constructor.

15.13.6.4.2 `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 35 for `TypedArray`.

This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

15.13.6.4.3 `|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 result of calling `ToObject` with the `this` value as its argument.
2. ReturnIfAbrupt(O).
3. If O does not have a `[[TypedArrayData]]` internal data property throw a `TypeError` exception.
4. Let $buffer$ be the value of O 's `[[TypedArrayData]]` internal data property.
5. If $buffer$ is `undefined`, then throw a `TypeError` exception.
6. Return $buffer$.

15.13.6.4.4 `|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 result of calling `ToObject` with the `this` value as its argument.
2. ReturnIfAbrupt(O).
3. If O does not have a `[[TypedArrayData]]` internal data property throw a `TypeError` exception.
4. Let $buffer$ be the value of O 's `[[TypedArrayData]]` internal data property.
5. If $buffer$ is `undefined`, then throw a `TypeError` exception.
6. Let $size$ be the value of O 's `[[ByteLength]]` internal data property.
7. Return $size$.

15.13.6.4.5 `|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:

1. Let O be the result of calling `ToObject` with the `this` value as its argument.
2. ReturnIfAbrupt(O).
3. If O does not have a `[[TypedArrayData]]` internal data property throw a `TypeError` exception.
4. Let $buffer$ be the value of O 's `[[TypedArrayData]]` internal data property.
5. If $buffer$ is `undefined`, then throw a `TypeError` exception.
6. Let $offset$ be the value of O 's `[[ByteOffset]]` internal data property.
7. Return $offset$.

Deleted: 15.13.6.3.2
Deleted: `TypedArray.BYTES_PER_ELEMENT`
The initial value of `TypedArray.BYTES_PER_ELEMENT` is the element size in bytes.
This property has the attributes { `[[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false` }.

Deleted: `TypedArray`
Deleted: `TypedArray`
Deleted: If its `[[Class]]` is "TypedArray".
Deleted: `TypedArray`
Deleted: `TypedArray`
Deleted: `TypedArray`
Deleted: `Table 36`

Comment [AWB13228]: buffer needs to be an accessor both to comply with WebIDL requirements and to support the Kronos neutering strawman requirements.

Deleted: :

Comment [AWB13229]: buffer needs to be an accessor both to comply with WebIDL requirements and to support the Kronos neutering strawman requirements.

Comment [AWB13230]: buffer needs to be an accessor both to comply with WebIDL requirements and to support the Kronos neutering strawman requirements.

15.13.6.6.6 |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 result of calling `ToObject` with the `this` value as its argument.
2. `ReturnIfAbrupt(O)`.
3. If O does not have a `[[TypedArrayData]]` internal data property throw a `TypeError` exception.
4. Let $buffer$ be the value of O 's `[[TypedArrayData]]` internal data property.
5. If $buffer$ is undefined, then throw a `TypeError` exception.
6. Let $length$ be the value of O 's `[[ArrayLength]]` internal data property.
7. `Return length`.

15.13.6.6.7 TypedArray.prototype.set(array, offset = 0)

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: `typedArray` does not have a `[[TypedArrayData]]` internal data property. If it does, the definition in 15.13.6.6.8 applies.
2. Let $target$ be the result of calling `ToObject` with the `this` value as its argument.
3. `ReturnIfAbrupt(target)`.
4. If $target$ does not have a `[[TypedArrayData]]` internal data property throw a `TypeError` exception.
5. Let $targetBuffer$ be the value of $target$'s `[[TypedArrayData]]` internal data property.
6. If $targetBuffer$ is undefined, then throw a `TypeError` exception.
7. Let $targetLength$ be the value of $target$'s `[[ArrayLength]]` internal data property.
8. Let $targetOffset$ be `ToPositiveInteger(offset)`.
9. `ReturnIfAbrupt(targetOffset)`.
10. Let $targetType$ be the value of $target$'s `[[TypedArrayElementKind]]` internal data property.
11. Let $targetElementSize$ be the Number value of the Element Size value specified in Table 35 for $targetType$.
12. Let $targetByteOffset$ be the value of $target$'s `[[ByteOffset]]` internal data property.
13. Let src be the result of `ToObject(array)`.
14. `ReturnIfAbrupt(src)`.
15. Let $srcLen$ be the result of `Get(src, "length")`.
16. Let $srcLength$ be `ToPositiveInteger(srcLen)`.
17. `ReturnIfAbrupt(srcLength)`.
18. If $srcLength + targetOffset > targetLength$, then throw a `RangeError` exception.
19. Let $targetByteIndex$ be $targetOffset \times targetElementSize + targetByteOffset$.
20. Let k be 0.
21. Let $limit$ be $targetByteIndex + targetElementSize \times \min(srcLength, targetLength - targetOffset)$.
22. Repeat while $targetByteIndex < limit$
 - a. Let P_k be `ToString(k)`.
 - b. Let $kValue$ be the result of `Get(src, P_k)`.
 - c. Let $kNumber$ be `ToNumber(kValue)`.
 - d. `ReturnIfAbrupt(kNumber)`.
 - e. Perform `SetValueInBuffer(data, k \times elementSize, elementType, kNumber)`.
 - f. Set k to $k + 1$.
 - g. Set $targetByteIndex$ to $targetByteIndex + targetElementSize$.
23. `Return undefined`.

15.13.6.6.8 TypedArray.prototype.set(typedArray, offset = 0)

Set multiple values in this `TypedArray`, reading the values from the `typedArray` parameter 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.

1. Assert: `typedArray` has a `[[TypedArrayData]]` internal data property. If it does not, the definition in 15.13.6.6.7 applies.
2. Let $target$ be the result of calling `ToObject` with the `this` value as its argument.

Comment [AWB13231]: buffer needs to be an accessor both to comply with WebIDL requirements and to support the Kronos neutering strawman requirement

Deleted: Uint32

Deleted: Table 36

Deleted: Uint32

Deleted: 4
Deleted: 2
Deleted: `TypedArray`
Deleted: `array [`
Deleted: `]`
Deleted: the
Deleted: `a`
Deleted: `input`
Deleted: `.., reading input values from the array`
Deleted: the
Deleted: current array

3. ReturnIfAbrupt(target).
4. If target does not have a [[TypedArrayData]] internal data property throw a **TypeError** exception.
5. Let targetBuffer be the value of target's [[TypedArrayData]] internal data property.
6. If targetBuffer is **undefined**, then throw a **TypeError** exception.
7. Let targetLength be the value of target's [[ArrayLength]] internal data property.
8. Let targetOffset be ToPositiveInteger(offset)
9. ReturnIfAbrupt(targetOffset).
10. Let targetType be the value of target's [[TypedArrayElementKind]] internal data property.
11. Let targetElementSize be the Number value of the Element Size value specified in Table 36 for targetType.
12. Let targetByteOffset be the value of target's [[ByteOffset]] internal data property.
13. Let srcBuffer be the value of typedArray's [[TypedArrayData]] internal data property.
14. If srcBuffer is **undefined**, then throw a **TypeError** exception.
15. Let srcType be the value of typedArray's [[TypedArrayElementKind]] internal data property.
16. Let srcElementSize be the Number value of the Element Size value specified in Table 36 for srcType.
17. Let srcLength be the value of typedArray's [[ArrayLength]] internal data property.
18. Let srcByteOffset be the value of typedArray's [[ByteOffset]] internal data property.
19. If srcLength + targetOffset > targetLength, then throw a **RangeError** exception.
20. If SameValue(srcBuffer, targetBuffer) is **true**, then
 - a. Let srcBuffer be the result of calling `CloneArrayBuffer(srcData, srcType, srcType, srcLength)`.
21. Let targetByteIndex be $\text{targetOffset} \times \text{targetElementSize} + \text{targetByteOffset}$.
22. Let srcByteIndex be srcByteOffset.
23. Let limit be $\text{targetByteIndex} + \text{targetElementSize} \times \min(\text{srcLength}, \text{targetLength} - \text{targetOffset})$.
24. Repeat, while $\text{targetByteIndex} \leq \text{limit}$
 - a. Let value the result of `GetValueFromBuffer(srcBuffer, srcByteIndex, srcType)`.
 - b. Let status be the result of `SetValueInBuffer(targetBuffer, targetByteIndex, targetType, value)`.
 - c. Set srcByteIndex to $\text{srcByteIndex} + \text{srcElementSize}$. Return.
 - d. Set targetByteIndex to $\text{targetByteIndex} + \text{targetElementSize}$.
25. Return **undefined**.

15.13.6.6.9 TypedArray.prototype.subarray(begin = 0, end = this.length)

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 result of calling `ToObject` with the `this` value as its argument.
2. ReturnIfAbrupt(O).
3. If O does not have a [[TypedArrayData]] internal data property throw a **TypeError** exception.
4. Let buffer be the value of O's [[TypedArrayData]] internal data property.
5. If buffer is **undefined**, then throw a **TypeError** exception.
6. Let srcLength be the value of O's [[ArrayLength]] internal data property.
7. Let beginInt be `ToInt32(begin)`.
8. ReturnIfAbrupt(beginInt).
9. If *beginInt* < 0, then let *beginInt* be *srcLength* + *beginInt*.
10. Let beginIndex be $\min(\text{srcLength}, \max(0, \text{beginInt}))$.
11. If *end* is **undefined**, then let *end* be *srcLength*.
12. Let endInt be `ToInt32(end)`.
13. ReturnIfAbrupt(endInt).
14. If *endInt* < 0, then let *endInt* be *srcLength* + *endInt*.
15. Let endIndex be $\max(0, \min(\text{srcLength}, \text{endInt}))$.
16. If *endIndex* < *beginIndex*, then let *endIndex* be *beginIndex*.
17. Let *newLength* be *endIndex* - *beginIndex*.
18. Let elementType be the value of O's [[TypedArrayElementKind]] internal data property.
19. Let elementSize be the Number value of the Element Size value specified in Table 35 for elementType.
20. Let srcByteOffset be the value of O's [[ByteOffset]] internal data property.
21. Let beginByteOffset be *srcByteOffset* + *beginIndex* × *elementSize*.
22. Let constructor be the result of `Get(O, "constructor")`.
23. ReturnIfAbrupt(constructor).
24. If `IsConstructor(constructor)` is **false**, then return a **TypeError** exception.

Deleted: <#>If this does not have class "TypeArray", throw a **TypeError** exception.¶

Deleted: offsetIndex

Deleted: UInt32

Deleted: <#>Let O be the result of calling `ToObject(array)`.¶

<#>Let *srcLength* be the result `Get(O, "length")` of calling [[Get]] on O with property name "length".¶

<#>Let *targetLength* be the result of calling [[Get]] on (this with property name, "length")."length" on (this with property name, "length")."length"

Deleted: offset

Deleted: ¶

Comment [AWB13232]: TODO

Comment [AWB13233]: TODO: not yet updated from wik

Deleted: <#>Let temp be a new TypeArray created as if by a call to "new TypeArray(srcLength)"¶

<#>Let k be 0¶

<#>While *k* < *srcLength*¶

<#>Let v be the result of calling [[Get]] on (src property name, `toString(k)`).¶

<#>Call [[Put]] on (temp, with arguments `ToString(k), v, and false`).¶

<#>Let k be offset.¶

<#>While k < targetLength¶

<#>Let v be the result of calling [[Get]] on (temp with property name, `ToString(k-offset)`).¶

<#>Call [[Put]] on (temp with arguments, `ToString(k), v, and false`).¶

Deleted: 4

Deleted: 3

Deleted: TypeArray

Deleted: [

Deleted:]

Deleted: view

Deleted: of the

Deleted: store for

Deleted: <#>If this does not have class "TypeArray", throw a **TypeError** exception.¶

Deleted: Let *srcLength* be the result `Get(this, "length")`.

Deleted: of calling [[Get]] on this with property name "length"

Deleted: if end was provided, else srcLength

Deleted: Table 36

29. Let `argumentsList` be a List consisting of `buffer`, `beginByteOffset`, and `newLength`.
 30. Return the result of calling the `[[Construct]]` internal method of `constructor` with `argumentList` as the argument.

15.13.6.6.10 `TypedArray.prototype.@@elementGet (index)`

1. Assert: `index` is an array index value.
2. Let `O` be the result of calling `ToObject` with the `this` value as its argument.
3. ReturnIfAbrupt(`O`).
4. If `O` does not have a `[[TypedArrayData]]` internal data property throw a `TypeError` exception.
5. Let `buffer` be the value of `O`'s `[[TypedArrayData]]` internal data property.
6. If `buffer` is `undefined`, then throw a `TypeError` exception.
7. Let `length` be the value of `O`'s `[[ArrayLength]]` internal data property.
8. Let `intIndex` be `ToPositiveInteger(index)`.
9. ReturnIfAbrupt(`index`).
10. If `intIndex > length`, then return `undefined`.
11. Let `offset` be the value of `O`'s `[[ByteOffset]]` internal data property.
12. Let `elementSize` be the Number value of the Element Size value specified in Table 36 for `TypedArray`.
13. Let `indexedPosition = (intIndex × elementSize) + offset`.
14. Let `elementType` be the value of `O`'s `[[TypedArrayElementKind]]` internal data property.
15. Return the result of `GetArrayBuffer(buffer, indexedPosition, elementType)`.

15.13.6.6.11 `TypedArray.prototype.@@elementSet (index, value)`

1. Assert: `index` is an array index value.
2. Let `O` be the result of calling `ToObject` with the `this` value as its argument.
3. ReturnIfAbrupt(`O`).
4. If `O` does not have a `[[TypedArrayData]]` internal data property throw a `TypeError` exception.
5. Let `buffer` be the value of `O`'s `[[TypedArrayData]]` internal data property.
6. If `buffer` is `undefined`, then throw a `TypeError` exception.
7. Let `length` be the value of `O`'s `[[ArrayLength]]` internal data property.
8. Let `intIndex` be `ToPositiveInteger(index)`.
9. ReturnIfAbrupt(`index`).
10. Let `numValue` be `ToNumber(value)`.
11. ReturnIfAbrupt(`numValue`).
12. If `intIndex > length`, then return `numValue`.
13. Let `offset` be the value of `O`'s `[[ByteOffset]]` internal data property.
14. Let `elementSize` be the Number value of the Element Size value specified in Table 36 for `TypedArray`.
15. Let `indexedPosition = (intIndex × elementSize) + offset`.
16. Let `elementType` be the value of `O`'s `[[TypedArrayElementKind]]` internal data property.
17. Let `status` be the result of `SetArrayBuffer(buffer, indexedPosition, elementType, numValue)`.
18. ReturnIfAbrupt(`status`).
19. Return `numValue`.

15.13.6.6.12 `TypedArray.prototype.@@toStringTag`

The initial value of the `@@toStringTag` property is the string value of the name `TypedArray`.

15.13.6.5 Properties of `TypedArray` instances

`TypedArray` instances are exotic Index Delegation objects. Each `TypedArray` instances inherits properties from the corresponding `TypedArray` prototype object. After initialisation by a `TypedArray` constructor, `TypedArray` instances have the following internal data properties: `[[TypedArrayData]]`, `[[TypedArrayElementKind]]`, `[[ByteLength]]`, `[[ByteOffset]]`, and `[[ArrayLength]]`.

15.13.7 DataView Objects

The following sections define `DataViews` is derived from the Kronos specification. This material is a very early draft based upon the strawman at

Comment [AWB13234]: If we make this a private symbol that is not exposed, then it is just a specification device. If we make it an exposed symbol (whether private or not) it becomes a ES programmer extension point.

Deleted: <#>Return a new `TypedArray` with the following values for it's propertiesproperties:
 <#> The length property of the newly constructed object is set to `endIndex - beginIndex`
 <#> The byteLength property of the newly constructed object is set to `length multiplied by the size in bytes of Type`
 <#> The buffer property of the newly constructed object is set to `this.buffer`.
 <#> The byteOffset property of the newly constructed object is set to `this.offset + beginIndex`.
Deleted: `Uint32`

Comment [AWB13235]: If we make this a private symbol that is not exposed, then it is just a specification device. If we make it an exposed symbol (whether private or not) it becomes a ES programmer extension point.

Deleted: `Uint32`

Deleted: `4`

Deleted: `1`

Deleted: `TypeArray`

Comment [AWB10236]: This entire section has been copied from the strawman with only minor formatting fix. It has not yet had any technical review or integration

Deleted: `TypeArray` instances inherit properties from the `TypeArray` prototype object and their `[[Class]]` internal data property value is "TypeArray". `TypeArray` instances also have the following properties.
 15.13.6.5.1 `[[DefineOwnProperty]] (p, desc, throw)`

TypeArray objects use a variation of the `[[DefineOwnProperty]]` internal method used for other native ECMAScript objects (8.12.9).
 When the `[[DefineOwnProperty]]` internal method of `A` is called with property `P`, Property Descriptor `Desc` and Boolean flag `Throw`, the following steps are taken:
 <#> Let `succeeded` be the result of calling the default `[[DefineOwnProperty]]` internal method (8.12.9) on a passing `P`, `Desc`, and `Throw` as arguments.
 <#> If `succeeded` is `false`, return `false`.
 <#> If `Desc` contains a `Value` field, let `newValue` be `Desc.Value`.
 <#> Let `convertedValue` to `ToType(newValue)`.
 <#> Let `index` be `ToUInt32(P)`.
 <#> Call the `SetValueInBuffer` internal operation with arguments `A.buffer.[[NativeBuffer]]`, `A.byteOffset`, `index`, `convertedValue`, and `Type`.
 <#> Return `true`.

The internal operation `SetValueInBuffer` takes five parameters, a native buffer `nativeBuffer`, an integer `byteOffset`, an integer `index`, a value of type `Type` `newValue`, and a `Type` `valueType`. It operates as follows:
 <#> Let `size` be the size in bytes of the type `valueType`.
 <#> Let `bytes` be the array of bytes from `nativeBuffer` between offset `byteOffset+(index*size)` and offset `byteOffset+(index+1)*size-1` inclusive.
 <#> Let `newValueBytes` be the result of converting `newValue` to an array of bytes, using the platform endianness

Deleted: `v`

Deleted: `e`

http://wiki.ecmascript.org/doku.php?id=strawman:typed_arrays. This material still needs significant work to fully integrate it into the ES6 spec. and also to integrate typed arrays with ES6 binary data.

Don't waste a lot of time reviewing this material until it is closer to a finished state.

15.13.7.1 The DataView Constructor Called as a Function

When DataView is called as a function rather than as a constructor, it creates and initialises a new DataView object. Thus the function call `DataView(...)` is equivalent to the object creation expression `new DataView(...)` with the same arguments.

15.13.7.2 The DataView Constructor

When DataView is called as part of a new expression, it is a constructor: it initialises the newly created object.

15.13.7.2.1 `new DataView(buffer [, byteOffset [, byteLength]])`

The `[[Prototype]]` internal data property of the newly constructed object is set to the original `DataView` prototype object, the one that is the initial value of `DataView.prototype` (15.13.3.3.1). The `[[Class]]` internal data property of the newly constructed object is set to "DataView". The `[[Extensible]]` internal data property of the newly constructed object is set to `true`.

The remaining properties are set as follows:

1. Let O be `ToObject(buffer)`
2. If the `[[Class]]` internal data property of O is not "ArrayBuffer", throw a `TypeError` exception.
3. Let byteOffset be the result of calling `ToUInt32` on `byteOffset`, if provided, or else 0.
4. Let bufferLength be the result of `Get(O, "byteLength")`.
5. Let byteLength be the result of calling `ToUInt32` on `byteLength`, if provided, or else `bufferLength - byteOffset`.
6. If `byteOffset + byteLength` is greater than `bufferLength`, throw a `RangeError` exception.
7. The `byteLength` property of the newly constructed object is set to `byteLength`.
8. The `buffer` property of the newly constructed object is set to O.
9. The `byteOffset` property of the newly constructed object is set to `byteOffset`.

Deleted: proeprties

Comment [AWB10237]: Not yet audited

Deleted: raise

Deleted: calling [[

Deleted:]] on

Deleted:

Deleted: with property name

Deleted: "

Deleted: "

Deleted: raise

Deleted: Proeprties

15.13.7.3 Properties of the DataView Constructor

The value of the `[[Prototype]]` internal data property of the `DataView` constructor is the `Function` prototype object (15.3.4).

Besides the internal properties and the `length` property (whose value is 3), the `DataView` constructor has the following properties:

15.13.7.3.1 `DataView.prototype`

The initial value of `DataView.prototype` is the `DataView` prototype object (15.13.3.4).

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: false` }.

15.13.7.4 Properties of the DataView Prototype Object

The value of the `[[Prototype]]` internal data property of the `DataView` prototype object is the standard built-in `Object` prototype object (15.2.4). The `[[Class]]` internal data property of the newly constructed object is set to “`Object`”. The `[[Extensible]]` internal data property of the newly constructed object is set to `true`.

The abstract operation `GetValue(byteOffset, isLittleEndian, type)` used by functions on `DataView` instances is defined as follows:

1. Let `byteOffsetInt` be `ToUInt32(byteOffset)`
2. Let `totalOffset` be `byteOffsetInt` plus the result of `Get(this, "byteOffset")`
3. Let `byteLength` be the result of `Get(this, "byteLength")`
4. If `totalOffset > byteLength`, throw a `RangeError` exception.
5. Let `value` be the result of calling the `GetValueInBuffer` internal operation (2.5.2) with arguments `this.buffer.[[NativeBuffer]], totalOffset, 0` and `type`.
6. Return `value`

The internal operation `SetValue(byteOffset, isLittleEndian, type, value)` used by functions on `DataView` instances is defined as follows:

1. Let `byteOffsetInt` be `ToUInt32(byteOffset)`
2. Let `totalOffset` be `byteOffsetInt` plus the result of `Get(this, "byteOffset")`
3. Let `byteLength` be the result of `Get(this, "byteLength")`
4. If `totalOffset > byteLength`, throw a `RangeError` exception.
5. Let `value` be the result of calling the `SetValueInBuffer` internal operation (2.5.2) with arguments `this.buffer.[[NativeBuffer]], totalOffset, 0, value` and `type`.
6. Return `value`

15.13.7.4.1 DataView.prototype.constructor

The initial value of `DataView.prototype.constructor` is the standard built-in `DataView` constructor.

15.13.7.4.2 DataView.prototype.getInt8(byteOffset)

Gets the `Int8` value at offset `byteOffset` in the `DataView`.

1. Let `O` be `ToObject(this)`
2. If the `[[Class]]` internal data property of `O` is not “`DataView`”, throw a `TypeError` exception.
3. Return `GetValue(byteOffset, true, Int8)`

15.13.7.4.3 DataView.prototype.getUint8(byteOffset)

Gets the `Uint8` value at offset `byteOffset` in the `DataView`.

1. Let `O` be `ToObject(this)`
2. If the `[[Class]]` internal data property of `O` is not “`DataView`”, throw a `TypeError` exception.
3. Return `GetValue(byteOffset, true, Uint8)`

Deleted: internal

Deleted: calling `[[`

Deleted: `]]` on

Deleted:

Deleted: with parameter

Deleted: “

Deleted: ”

Deleted: calling `[[`

Deleted: `]]` on

Deleted:

Deleted: with parameter

Deleted: “

Deleted: ”

Comment [AWB14238]: +ElementSize ???

Deleted: `>=`

Deleted: raise

Deleted: calling `[[`

Deleted: `Get]]` on this with parameter “`byteOffset`”

Deleted: calling `[[Get]]` on this with parameter “`byteLength`”

Comment [AWB14239]: +elementSize

Deleted: `>=`

Deleted: raise

Deleted: raise

Deleted: raise

15.13.7.4.4 DataView.prototype.getInt16(byteOffset, littleEndian)

Gets the `Int16` value at offset `byteOffset` in the `DataView`, using the provided endianness.

1. Let `O` be `ToObject(this)`
2. Let `isLittleEndian` be `ToBoolean(littleEndian)` if provided, else `false`
3. If the `[[Class]]` internal data property of `O` is not “`DataView`”, throw a `TypeError` exception.
4. Return `GetValue(byteOffset, isLittleEndian, Int16)`

Deleted: raise

15.13.7.4.5 DataView.prototype.getUint16(byteOffset, littleEndian)

Gets the Uint16 value at offset byteOffset in the DataView, using the provided endianness.

1. Let O be ToObject(this)
2. Let isLittleEndian be ToBoolean(littleEndian) if provided, else **false**
3. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
4. Return GetValue(byteOffset, isLittleEndian, Uint16)

Deleted: raise

15.13.7.4.6 DataView.prototype.getInt32(byteOffset, littleEndian)

Gets the Int32 value at offset byteOffset in the DataView, using the provided endianness.

1. Let O be ToObject(this)
2. Let isLittleEndian be ToBoolean(littleEndian) if provided, else **false**
3. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
4. Return GetValue(byteOffset, isLittleEndian, Int32)

Deleted: raise

15.13.7.4.7 DataView.prototype.getUint32(byteOffset, littleEndian)

Gets the Uint32 value at offset byteOffset in the DataView, using the provided endianness.

1. Let O be ToObject(this)
2. Let isLittleEndian be ToBoolean(littleEndian) if provided, else **false**
3. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
4. Return GetValue(byteOffset, isLittleEndian, Uint32)

Deleted: raise

15.13.7.4.8 DataView.prototype.getFloat32(byteOffset, littleEndian)

Gets the Float32 value at offset byteOffset in the DataView, using the provided endianness.

1. Let O be ToObject(this)
2. Let isLittleEndian be ToBoolean(littleEndian) if provided, else **false**
3. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
4. Return GetValue(byteOffset, isLittleEndian, Float32)

Deleted: raise

15.13.7.4.9 DataView.prototype.getFloat64(byteOffset, littleEndian)

Gets the Float64 value at offset byteOffset in the DataView, using the provided endianness.

1. Let O be ToObject(this)
2. Let isLittleEndian be ToBoolean(littleEndian) if provided, else **false**
3. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
4. Return GetValue(byteOffset, isLittleEndian, Float64)

Deleted: raise

15.13.7.4.10 DataView.prototype.setInt8(byteOffset, value)

Sets the Int8 value at offset byteOffset in the DataView.

1. Let O be ToObject(this)
2. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
3. Return SetValue(byteOffset, **true**, Int8,ToInt8(value))

Deleted: raise

Deleted: G

15.13.7.4.11 DataView.prototype.setUint8(byteOffset, value)

Sets the Uint8 value at offset byteOffset in the DataView.

4. Let O be ToObject(this)
5. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.

Deleted: raise

6. Return SetValue(byteOffset, **true**, Uint8, ToUint8(value))

Deleted: G

15.13.7.4.12 DataView.prototype.setInt16(byteOffset, value, littleEndian)

Sets the Int16 value at offset byteOffset in the DataView.

1. Let O be ToObject(this)
2. Let isLittleEndian be ToBoolean(littleEndian) if provided, else **false**
3. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
4. Return SetValue(byteOffset, isLittleEndian, Int16,ToInt16(value))

Deleted: raise

Deleted: G

15.13.7.4.13 DataView.prototype.setUint16(byteOffset, value, littleEndian)

Sets the Uint16 value at offset byteOffset in the DataView.

1. Let O be ToObject(this)
2. Let isLittleEndian be ToBoolean(littleEndian) if provided, else **false**
3. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
4. Return SetValue(byteOffset, isLittleEndian, Uint16,ToUint16(value))

Deleted: raise

Deleted: G

15.13.7.4.14 DataView.prototype.setInt32(byteOffset, value, littleEndian)

Sets the Int32 value at offset byteOffset in the DataView.

1. Let O be ToObject(this)
2. Let isLittleEndian be ToBoolean(littleEndian) if provided, else **false**
3. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
4. Return SetValue(byteOffset, isLittleEndian, Int32,ToInt32(value))

Deleted: raise

Deleted: G

15.13.7.4.15 DataView.prototype.setUint32(byteOffset, value, littleEndian)

Sets the Uint32 value at offset byteOffset in the DataView.

1. Let O be ToObject(this)
2. Let isLittleEndian be ToBoolean(littleEndian) if provided, else **false**
3. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
4. Return GetValue(byteOffset, isLittleEndian, Uint32,ToUint32(value))

Deleted: raise

15.13.7.4.16 DataView.prototype.setFloat32(byteOffset, value, littleEndian)

Sets the Float32 value at offset byteOffset in the DataView.

1. Let O be ToObject(this)
2. Let isLittleEndian be ToBoolean(littleEndian) if provided, else **false**
3. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
4. Return SetValue(byteOffset, isLittleEndian, Float32,ToFloat32(value))

Deleted: raise

Deleted: G

15.13.7.4.17 DataView.prototype.setUint16(byteOffset, value, littleEndian)

Sets the Float64 value at offset byteOffset in the DataView.

1. Let O be ToObject(this)
2. Let isLittleEndian be ToBoolean(littleEndian) if provided, else **false**
3. If the [[Class]] internal data property of O is not “DataView”, throw a **TypeError** exception.
4. Return SetValue(byteOffset, isLittleEndian, Float64,ToFloat64(value))

Deleted: raise

Deleted: G

15.13.7.5 Properties of DataView Instances

DataView instances inherit properties from the DataView prototype object and their [[Class]] internal data property value is "DataView". DataView instances also have the following properties.

15.13.7.5.1 byteLength

The value of the byteLength property is the length of the DataView object, which was fixed at creation. This property has attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }.

15.13.7.5.2 buffer

The value of the buffer property is the length of the DataView object, which was fixed at creation. This property has attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }.

15.13.7.5.3 byteOffset

The value of the byteOffset property is the length of the DataView object, which was fixed at creation. This property has attributes { [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }.

15.14 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 a comparison algorithm that is selected when the Map is created.

A Map object can iterate its elements in insertion order. Map object 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 Map objects specification is only intended to describe the required observable semantics of Map objects. It is not intended to be a viable implementation model.

15.14.1 The Map Constructor Called as a Function

When Map is called as a function rather than as a constructor, it initializes its this value with the internal state necessary to support the Map.prototype internal methods. 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 Map.

15.14.1.1 Map (iterable = undefined , comparator = undefined)

When the Map function is called with optional arguments iterable and comparator the following steps are taken:

1. Let map be the this value.
2. If Type(map) is not Object then, throw a TypeError exception.
3. If map does not have a [[MapData]] internal data property, then throw a TypeError exception.
4. If map's [[MapData]] internal data property is not undefined, then throw a TypeError exception.
5. If iterable is not present, let iterable be undefined.
6. If iterable is neither undefined or null, then let itr be undefined.
7. Else,
 - a. Let hasValues be the result of HasProperty(iterable, "entries").
 - b. ReturnIfAbrupt(hasValues).
 - c. If hasValues is true, then
 - i. Let itr be the result of Invoke(obj, "entries").
 - d. Else,
 - i. Let iterator be the @@iterator symbol.
 - ii. Let itr be the result of Invoke(iterator, iterator).
 - e. ReturnIfAbrupt(itr).
 - f. ReturnIfAbrupt(itr).

Deleted: e

Deleted: also

Deleted: 15.14.1 Abstract Operations For Map Objects

15.14.1.1 MapInitialization

The abstract operation MapInitialization with arguments object and iterable is used to initialize an object as a map. It performs the following steps:

<#> If Type(obj) is not Object, throw a TypeError exception.
 <#> If obj already does not have a [[MapData]] internal data property, throw a TypeError exception.
 <#> If the result of calling the [[GetIsExtensible]] internal property method of obj is false, throw a TypeError exception.
 <#> If iterable is not undefined, then
 <#> Let iterable be ToObject(iterable).
 <#> ReturnIfAbrupt(iterable)
 <#> Let iterator be the intrinsic symbol @@iterator.
 <#> Let itr be the result of calling the Invoke(iterator, obj), abstraction operation with iterator, obj, and an empty List as arguments.
 <#> ReturnIfAbrupt(itr).
 <#> Let adder be the result of calling the [[Get]] internal method of obj with argument, "set".
 <#> ReturnIfAbrupt(adderaddr).
 <#> If IsCallable(adderaddr) is false, throw a TypeError Exception.
 <#> Add a [[MapData]] internal data property to obj.
 <#> Set obj's [[MapData]] internal data method property to a new empty List.
 <#> If iterable is undefined, return obj.
 <#> Repeat
 <#> Let next be the result of performing Invoke(
 <#> with arguments "next"), itr, and an empty arguments List.
 <#> If IteratorComplete(next) is true, then return NormalCompletion(obj).
 <#> Let next be ToObject(next).
 <#> ReturnIfAbrupt(next).
 <#> Let k be the result of calling the [[Get]] internal method of next with argument, "0".
 <#> ReturnIfAbrupt(k).

Deleted: 2

Deleted: This permits super invocation of the Map constructor by Map subclasses.

Deleted: 2

Deleted: []

Deleted: m

Deleted: <#> If m is undefined or the intrinsic %MapPrototype%
 <#> Let map be the result of the abstract operation ObjectCreate (15.2) with the intrinsic %MapPrototype% as the argument.
 <#> Else

Deleted: <#> Let map be the result of ToObject(m).
 <#> ReturnIfAbrupt(map).

- g. Let `adder` be the result of `Get(map, "set")`.
- h. `ReturnIfAbrupt(adder)`.
- i. If `IsCallable(adder)` is `false`, throw a `TypeError` Exception.
- 8. If `comparator` is not `undefined`, then
 - a. If `comparator` is not `"is"`, then throw a `RangeError` Exception.
- 9. Set `map`'s `[[MapData]]` internal data property to a new empty List.
- 10. Set `map`'s `[[MapComparator]]` internal data property to `comparator`.
- 11. If `itr` is `undefined`, then return `map`.
- 12. Repeat
 - a. Let `next` be the result of `Invoke(itr, "next")`.
 - b. If `IteratorComplete(next)` is `true`, then return `NormalCompletion(map)`.
 - c. Let `next` be `ToObject(next)`.
 - d. `ReturnIfAbrupt(next)`.
 - e. Let `k` be the result of `Get(next, "0")`.
 - f. `ReturnIfAbrupt(k)`.
 - g. Let `v` be the result of `Get(next, "1")`.
 - h. `ReturnIfAbrupt(v)`.
 - i. Let `status` be the result of calling the `[[Call]]` internal method of `adder` with `map` as `thisArgument` and a List whose elements are `k` and `v` as `argumentsList`.
 - j. `ReturnIfAbrupt(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 two element array-like objects whose first element is a value that will be used as an Map key and whose second element is the value to associate with that key.

15.14.2 The Map Constructor

When `Map` is called as part of a `new` expression it is a constructor: it initialises a newly created object.

The `Map` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class declaration. Subclass constructors that intended to inherit the specified `Map` behaviour must include a `super` call to `Map`.

15.14.2.1 new Map (... args)

`Map` called as part of a new expression with argument list `args` performs the following steps:

1. Let `F` be the `Map` function object on which the `new` operator was applied.
2. Let `argumentsList` be the `argumentsList` argument of the `[[Construct]]` internal method that was invoked by the `new` operator.
3. Return the result of `OrdinaryConstruct(F, argumentsList)`.

If `Map` is implemented as an ordinary function object, its `[[Construct]]` internal method will perform the above steps.

15.14.3 Properties of the Map Constructor

The value of the `[[Prototype]]` internal data property of the `Map` constructor is the `Function prototype` object (15.3.4).

Besides the `length` property (whose value is `0`), the `Map` constructor has the following property:

15.14.3.1 Map.prototype

The initial value of `Map.prototype` is the `Map` prototype object (15.14.4).

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

Comment [AWB7240]: TODO: need to define

Comment [AWB12241]: Note that using a method for inserting pairs during initialization provides allows subclasses to be more expressive.

Deleted: <#>Let `status` be the result of `MapInitialization` with `map` and `iterable` as arguments.
¶

Deleted: <#>Return `map`.¶

Deleted: 3

Deleted: the

Deleted: ¶

Deleted: 3

Deleted: `iterable = []`undefined

Deleted: with arguments

Deleted: and

Deleted: <#>Let `map` be the result of the abstract operation `ObjectCreate` (15.2) with the intrinsic `%MapPrototype%` as the `prototype` argument.
¶
<#>If `iterable` is not present, let `iterable` be `undefined`.¶
<#>Let `status` be the result of `MapInitialization` with `map` and `iterable` as arguments.¶
<#>`ReturnIfAbrupt(status)`.¶
<#>Return `map`.¶

Deleted: 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 two element array-like objects whose first element is a value that will be used as an Map key and whose second element is the value to associate with that key.¶

Deleted: 4

Deleted: internal properties and the

Deleted: 4

15.14.3.2 Map[@@create]()

The @@create method of a Map function object F performs the following steps:

1. Let F be the **this** value.
2. Let obj be the result of calling `OrdinaryCreateFromConstructor(F , "%MapPrototype%", ([[MapData]], [[MapComparator]])).`
3. Return obj .

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

15.14.4 Properties of the Map Prototype Object

The value of the [[Prototype]] internal data property of the Map prototype object is the standard built-in Object prototype object (15.2.4). The Map prototype object is an ordinary object. It does not have a [[MapData]] or a [[MapComparator]] internal data property.

15.14.4.1 Map.prototype.constructor

The initial value of `Map.prototype.constructor` is the built-in `Map` constructor.

15.14.4.2 Map.prototype.clear()

The following steps are taken:

1. Let M be the **this** value.
2. If `Type(M)` is not `Object`, then throw a `TypeError` exception.
3. If M does not have a [[MapData]] internal data property throw a `TypeError` exception.
4. If M 's [[MapData]] internal data property is `undefined`, then throw a `TypeError` exception.
5. Let $entries$ be the List that is the value of M 's [[MapData]] internal data property.
6. 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`.
7. Return `undefined`.

15.14.4.3 Map.prototype.delete (key)

The following steps are taken:

1. Let M be the **this** value.
2. If `Type(M)` is not `Object`, then throw a `TypeError` exception.
3. If M does not have a [[MapData]] internal data property throw a `TypeError` exception.
4. If M 's [[MapData]] internal data property is `undefined`, then throw a `TypeError` exception.
5. If M 's [[MapComparator]] internal data property is `undefined`, then let $same$ be the abstract operation `SameValueZero`.
6. Else, let $same$ be the abstract operation `SameValue`.
7. Let $entries$ be the List that is the value of M 's [[MapData]] internal data property.
8. Repeat for each Record `{[[key]], [[value]]}` p that is an element of $entries$.
 - a. If $same(p.[[key]], key)$, then
 - i. Set $p.[[key]]$ to `empty`.
 - ii. Set $p.[[value]]$ to `empty`.
 - iii. Return `true`.
9. Return `false`.

15.14.4.4 Map.prototype.forEach (callbackfn ,thisArg = undefined)

`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.

Deleted: 4

Deleted: ,

Deleted: <#>Add a [[MapData]] internal data property to obj .
<#>Set obj 's [[MapData]] internal data property a new empty List.
Comment [AWB14242]: Because the @@create method is essential to the integrity this "class" definition, just like the prototype property, it seems appropriate to freeze it in the same manner.

Deleted: 5

Deleted: 5

Deleted: 5

Deleted: result of calling `ToObject` with the
Deleted: as its argument
Deleted: `ReturnIfAbrupt(M)`

Deleted: <#>Set the value of M 's [[MapData]] internal data property to a new empty List.
Deleted: 5

Deleted: 2

Deleted: result of calling `ToObject` with the
Deleted: as its argument
Deleted: `ReturnIfAbrupt(M)`

Deleted: s
Deleted: Value

Deleted: 5
Deleted: 3

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.

NOTE If `callbackfn` is an Arrow Function, `this` was lexically bound when the function was created so `thisArg` will have no effect.

`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`.

NOTE Each key is visited only once with the value that is current at the time of the visit. If the value associated with a key is modified after it has been visited, it is not re-visited. Keys that are deleted after the call to `forEach` begins and before being visited are not visited. New keys 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 M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, then throw a `TypeError` exception.
3. If M does not have a `[[MapData]]` internal data property throw a `TypeError` exception.
4. If M 's `[[MapData]]` internal data property is `undefined`, then throw a `TypeError` exception.
5. If $\text{IsCallable}(callbackfn)$ is `false`, throw a `TypeError` exception.
6. If `thisArg` was supplied, let T be `thisArg`; else let T be `undefined`.
7. Let $entries$ be the List that is the value of M 's `[[MapData]]` internal data property.
8. Repeat for each Record $\{[[key]], [[value]]\}$ e that is an element of $entries$, in original key insertion order
 - a. If $e.[[key]]$ is not empty, then
 - i. Let $funcResult$ be the result of calling the `[[Call]]` internal method of `callbackfn` with T as `thisArgument` and a `List` containing $e.[[value]]$, $e.[[key]]$, and M as `argumentsList`.
 - ii. $\text{ReturnIfAbrupt}(funcResult)$.
9. Return `undefined`.

Deleted: result of calling `ToObject` with the
Deleted: as its argument
Deleted: `ReturnIfAbrupt(M)`

The `length` property of the `forEach` method is `1`.

15.14.4.5 Map.prototype.get (key)

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, then throw a `TypeError` exception.
3. If M does not have a `[[MapData]]` internal data property throw a `TypeError` exception.
4. If M 's `[[MapData]]` internal data property is `undefined`, then throw a `TypeError` exception.
5. Let $entries$ be the List that is the value of M 's `[[MapData]]` internal data property.
6. If M 's `[[MapComparator]]` internal data property is `undefined`, then let $same$ be the abstract operation `SameValueZero`.
7. Else, let $same$ be the abstract operation `SameValue`.
8. Repeat for each Record $\{[[key]], [[value]]\}$ p that is an element of $entries$.
 - a. If $same(p.[[key]], key)$, then return $p.[[value]]$.
9. Return `undefined`.

Deleted: the `this` value
Deleted: argument
Deleted: l

15.14.4.6 Map.prototype.has (key)

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, then throw a `TypeError` exception.
3. If M does not have a `[[MapData]]` internal data property throw a `TypeError` exception.
4. If M 's `[[MapData]]` internal data property is `undefined`, then throw a `TypeError` exception.
5. Let $entries$ be the List that is the value of M 's `[[MapData]]` internal data property.

Deleted: S
Deleted: Value
Deleted: 5
Deleted: 5

6. If M 's $\text{[[MapComparator]]$ internal data property is **undefined**, then let $same$ be the abstract operation **SameValueZero**.
7. Else, let $same$ be the abstract operation **SameValue**.
8. Repeat for each Record $\{\text{[[key]], \text{[[value]]}\}$ p that is an element of $entries$.
 - a. If $same(p.\text{[[key]]}, \text{key})$, then return **true**.
9. Return **false**.

15.14.4.7 Map.prototype.entries ()

The following steps are taken:

1. Let M be the **this** value.
2. If $\text{Type}(M)$ is not **Object**, then throw a **TypeError** exception.
3. Return the result of calling the **CreateMapIterator** abstract operation with arguments M and **"key+value"**.

15.14.4.8 Map.prototype.keys ()

The following steps are taken:

1. Let M be the **this** value.
2. If $\text{Type}(M)$ is not **Object**, then throw a **TypeError** exception.
3. Return the result of calling the **CreateMapIterator** abstract operation with arguments M and **"key"**.

15.14.4.9 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**, then throw a **TypeError** exception.
3. If M does not have a [[MapData]] internal data property throw a **TypeError** exception.
4. If M 's [[MapData]] internal data property is **undefined**, then throw a **TypeError** exception.
5. Let $entries$ be the List that is the value of M 's [[MapData]] internal data property.
6. If M 's [[MapComparator]] internal data property is **undefined**, then let $same$ be the abstract operation **SameValueZero**.
7. Else, let $same$ be the abstract operation **SameValue**.
8. Repeat for each Record $\{\text{[[key]], \text{[[value]]}\}$ p that is an element of $entries$.
 - a. If $same(p.\text{[[key]]}, \text{key})$, then
 - i. Set $p.\text{[[value]]}$ to $value$.
 - ii. Return M .
9. Let p be the Record $\{\text{[[key]]: key, \text{[[value]]: value}\}$.
10. Append p as the last element of $entries$.
11. Return M .

15.14.4.10 get Map.prototype.size

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**, then throw a **TypeError** exception.
3. If M does not have a [[MapData]] internal data property throw a **TypeError** exception.
4. If M 's [[MapData]] internal data property is **undefined**, then throw a **TypeError** exception.
5. Let $entries$ be the List that is the value of M 's [[MapData]] internal data property.
6. Let $count$ be 0.
7. For each Record $\{\text{[[key]], \text{[[value]]}\}$ p that is an element of $entries$
 - a. If $p.\text{[[key]]}$ is not empty then
 - i. Set $count$ to $count+1$.
8. Return $count$.

Deleted: <i>S</i>
Deleted: <i>Value</i>
Comment [AWB14243]: Need to move after delete
Deleted: <i>5</i>
Deleted: <i>6</i>
Deleted: <i>items</i>
Deleted: result of calling ToObject with the
Deleted: as its argument
Deleted: ReturnIfAbrupt(<i>M</i>)
Deleted: <i>O</i>
Deleted: <i>5</i>
Deleted: <i>7</i>
Deleted: result of calling ToObject with the
Deleted: as its argument
Deleted: ReturnIfAbrupt(<i>M</i>)
Deleted: <i>O</i>
Deleted: <i>5</i>
Deleted: <i>8</i>
Deleted: result of calling ToObject with the
Deleted: as its argument
Deleted: ReturnIfAbrupt(<i>M</i>)
Deleted: <i>undefined</i>
Deleted: <i>undefined</i>
Deleted: <i>undefined</i>
Deleted: <i>5</i>
Deleted: <i>9</i>
Deleted: <i>(key)</i>
Deleted: The
Deleted: are taken
Deleted: result of calling ToObject with the
Deleted: as its argument
Deleted: ReturnIfAbrupt(<i>M</i>)
Deleted: <i>I</i> s

15.14.4.11 Map.prototype.values ()

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, then throw a `TypeError` exception.
3. Return the result of calling the `CreateMapIterator` abstract operation with arguments M and `"value"`.

Deleted: 5

Deleted: 10

Deleted: result of calling `ToObject` with the

Deleted: as its argument

Deleted: `ReturnIfAbrupt(M)`

Deleted: O

Comment [AWB10244]: This is how we identify a property whose key is a built-in `Symbol`

Deleted: 5

Deleted: 1

Deleted: `items`

Comment [AWB10245]: Do we really want to do this sort of method sharing. It has a bad smell.

Deleted: 5

Deleted: 2

Deleted: $()$

Deleted: 6

Deleted: `z`

Deleted: 7

Deleted:

Deleted: `s`

Deleted: 7

15.14.4.12 Map.prototype.[@@iterator|()])

The initial value of the `[@@iterator` property is the same function object as the initial value of the `entries` property.

15.14.4.13 Map.prototype.[@@toStringTag]

The initial value of the `[@@toStringTag` property is the string value `"Map"`.

15.14.5 Properties of Map Instances

Map instances inherit properties from the `Map` prototype. After initialisation by the `Map` constructor, `Map` instances also have a `[[MapData]]` internal data property and a `[[MapComparator]]` internal data property.

15.14.6 Map Iterator Object Structure

A `Map Iterator` is an object, with the structure defined below, that represent 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.

15.14.6.1 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. Let M be the result of calling `ToObject(map)`.
2. `ReturnIfAbrupt(M)`.
3. If M does not have a `[[MapData]]` internal data property throw a `TypeError` exception.
4. Let `entries` be the List that is the value of M 's `[[MapData]]` internal data property.
5. Let itr be the result of `ObjectCreate(%MapIteratorPrototype%, [[Map]], [[MapNextIndex]], [[MapIterationKind]]).`
6. Set itr 's `[[Map]]` internal data property to M .
7. Set itr 's `[[MapNextIndex]]` internal data property to `0`.
8. Set itr 's `[[MapIterationKind]]` internal data property to `kind`.
9. Return itr .

Deleted: the abstract operation

Deleted: with the intrinsic object

Deleted: as its argument

Deleted: Add a

Deleted: itr with value

Deleted: Add a

Deleted: itr with value

Deleted: Add a

Deleted: itr with value

Deleted: of itr with

Deleted: value

Deleted: 7

Deleted: s

Comment [AWB10246]: TODO: need to decide what to use for a constructor for these sort of objects. Probably we should try to consistently follow the "class model" wherever we can.

Deleted: 7

Deleted: 7

15.14.6.2 The Map Iterator Prototype

All `Map Iterator` Objects inherit properties from a common `Map Iterator` Prototype object. The `[[Prototype]]` internal data property of the `Map Iterator` Prototype is the `%ObjectPrototype%` intrinsic object. In addition, the `Map Iterator` Prototype has the following properties:

15.14.6.2.1 MapIterator.prototype.constructor

15.14.6.2.2 MapIterator.prototype.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 properties of a `Map Iterator` Instance (15.14.7.1.2), throw a `TypeError` exception.
4. Let m be the value of the `[[Map]]` internal data property of O .

5. Let *index* be the value of the `[[MapNextIndex]]` internal data property of *O*.
6. Let *itemKind* be the value of the `[[MapIterationKind]]` internal data property of *O*.
7. Assert: *m* has a `[[MapData]]` internal data property and *m* has been initialized so the value of `[[MapData]]` is not `undefined`.
8. Let *entries* be the List that is the value of the `[[MapData]]` internal data property of *m*.
9. Repeat while *index* is less than the total number of element of *entries*. The number of elements must be redetermined each time this method is evaluated.
 - a. Let *e* be the Record `{[[key]], [[value]]}` at 0-origin insertion position *index* of *entries*.
 - b. Set *index* to *index+1*.
 - c. Set the `[[MapNextIndex]]` internal data property of *O* to *index*.
 - d. If *e.[[key]]* is not empty, then
 - i. If *itemKind* is `"key"` then, let *result* be *e.[[key]]*.
 - ii. Else if *itemKind* is `"value"` then, let *result* be *e.[[value]]*.
 - iii. Else
 1. Assert: *itemKind* is `"key+value"`.
 2. Let *result* be the result of the abstract operation `ArrayCreate` with argument 2.
 3. Assert: *result* is a new, well-formed Array object so the following operations will never fail.
 4. Call `CreateOwnProperty(result, "0", e.[[key]])`.
 5. Call `CreateOwnProperty(result, "1", e.[[value]])`.
 - iv. Return *result*.
10. Return Completion `{[[type]]: throw, [[value]]: "%StopIteration%", [[target]]: empty}`.

15.14.6.2.3 MapIterator.prototype.[@@iterator]()

The following steps are taken:

1. Return the `this` value.

15.14.6.2.4 MapIterator.prototype.[@@toStringTag]

The initial value of the `[@@toStringTag]` property is the string value `"Map Iterator"`.

15.14.6.3 Properties of Map Iterator Instances

Map Iterator instances inherit properties from the Map Iterator prototype (the intrinsic, `%MapIteratorPrototype%`.) Map Iterator instances are initially created with the internal properties described in Table 36.

Table 36—Internal Data Properties of Map Iterator Instances

Internal Data Property Name	Description
<code>[[Map]]</code>	The Map object that is being iterated.
<code>[[MapNextIndex]]</code>	The integer index of the next Map data element to be examined by this iteration.
<code>[[MapIterationKind]]</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> .

Deleted: Object

Deleted: the `[[DefineOwnProperty]]` internal method of *Object*

Deleted: with arguments

Deleted: Property Descriptor `{[[Value]]: ...}`

Deleted: `, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true, ...`

Deleted: and false

Deleted: the `[[DefineOwnProperty]]` internal method of *Object*

Deleted:

Deleted: with arguments

Deleted: Property Descriptor `{[[Value]]: ...}`

Deleted: `, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true, ...`

Deleted: , and false

Comment [AWB10247]: We may need to elaborate on this??

Comment [AWB10248]: This is how we identify a property whose key is a built-in Symbol

Deleted: 5

Deleted: 7

Deleted: 11

Deleted: 7

Deleted: 3

Deleted:

Deleted: 7

Deleted: following

Deleted: Table 37Table 34Table 32Table 33

Deleted: 37343233

Deleted: queried

15.15 WeakMap Objects

WeakMap objects are collections of key/value pairs where the keys are ECMAScript 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 structures 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 are intended to provide a mechanism for dynamically associating state with an object in a manner that does not "leak" memory resources if, in the absence of the WeakMap, the object otherwise became inaccessible and subject to resource reclamation by the implementation's garbage collection mechanisms. Achieving this characteristic requires coordination between the WeakMap implementation and the garbage collector. The following references describe mechanism that may be useful to implementations of WeakMap:

Barry Hayes. 1997. Ephemeros: 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

15.15.1 The WeakMap Constructor Called as a Function

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** methods. 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 **WeakMap**.

15.15.1.1 WeakMap (iterable = undefined)

When the **WeakMap** function is called with optional argument **iterable** the following steps are taken:

1. Let **map** be the **this** value.
2. If **Type(map)** is not **Object** then, throw a **TypeError** exception.
3. If **map** does not have a **[[WeakMapData]]** internal data property, then throw a **TypeError** exception.
4. If **map**'s **[[WeakMapData]]** internal data property is not **undefined**, then throw a **TypeError** exception.
5. If **iterable** is not present, let **iterable** be **undefined**.
6. If **iterable** is neither **undefined** or **null**, then let **itr** be **undefined**.
7. Else,
 - a. Let **iterator** be the intrinsic symbol **@@iterator**.
 - b. Let **itr** be the result of **Invoke(iterator, iterable)**.
 - c. **ReturnIfAbrupt(itr)**.
 - d. Let **adder** be the result of **Get(map, "set")**.
 - e. **ReturnIfAbrupt(adder)**.
 - f. If **IsCallable(adder)** is **false**, throw a **TypeError** Exception.
8. Set **map**'s **[[WeakMapData]]** internal data property to a new empty List.
9. If **itr** is **undefined**, then return **map**.
10. Repeat
 - a. Let **next** be the result of **Invoke(itr, "next")**.
 - b. If **IteratorComplete(next)** is **true**, then return **NormalCompletion(map)**.
 - c. Let **next** be **ToObject(next)**.

Deleted: specific
Deleted: mechanisms
Deleted:
Deleted: s
Deleted: should
Deleted: make
Deleted: m
Deleted: m
Deleted: directly test for the presence of any specific
Deleted: value
Deleted: the object would
Deleted:
Deleted: become
Deleted: reclamation
Deleted: ion
Deleted: s
Deleted: 15.15.1 Abstract Operations For WeakMap Objects
Deleted: 15.15.1.1 WeakMapInitialisation

The abstract operation WeakMapInitialisation with arguments **obj** and **iterable** is used to initialize an object as a map. It performs the following steps:
 <#> If **Type(obj)** is not **Object**, throw a **TypeError** exception.
 <#> If **obj** does not have already has a **[[WeakMapData]]** internal data property, throw a **TypeError** exception.
 <#> If the result of calling the **[[GetIsExtensible]]** internal property method of **obj** is **false**, throw a **TypeError** exception.
 <#> If **iterable** is not **undefined**, then
 <#> Let **iterable** be **ToObject(iterable)**.
 <#> **ReturnIfAbrupt(iterable)**.
 <#> Let **iterator** be the intrinsic symbol **@@iterator**.
 <#> Let **itr** be the result of calling the **Invoke(iterator, obj)** abstraction operation with **iterator**, **obj**, and an empty List as arguments).
 <#> **ReturnIfAbrupt(itr)**.
 <#> Let **adder** be the result of calling the **[[Get]]** internal method of **obj** with argument, "**set**".
 <#> **ReturnIfAbrupt(adder)**.
 <#> If **IsCallable(adder)** is **false**, throw a **TypeError** Exception.
 <#> Add a **[[WeakMapData]]** internal data property to **obj**.
 <#> Set **obj**'s **[[WeakMapData]]** internal data property to a new empty List.
Deleted: 2
Deleted: internal
Deleted: This permits super invocation of the **WeakMap** constructor by **WeakMap** subclasses.
Deleted: 2
Deleted: m
Deleted: <#> If **m** is **undefined** or the intrinsic %WeakMapPrototype%
Deleted: Let **map** be the result of **ToObject(m)**
Deleted: **ReturnIfAbrupt(map)**
Comment [AWB7249]: TODO: need to define

- d. `ReturnIfAbrupt(next)`.
- e. Let `k` be the result of `Get(next, "0")`.
- f. `ReturnIfAbrupt(k)`.
- g. Let `v` be the result of `Get(next, "1")`.
- h. `ReturnIfAbrupt(v)`.
- i. Let `status` be the result of calling the `[[Call]]` internal method of `adder` with `map` as `thisArgument` and a List whose elements are `k` and `v` as `argumentsList`.
- j. `ReturnIfAbrupt(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 two element array-like objects 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.

15.15.2 The WeakMap Constructor

When `WeakMap` is called as part of a `new` expression it is a constructor: it initialises a newly created object.

15.15.2.1 new WeakMap (... args)

`WeakMap` called as part of a `new` expression with argument list `args` performs the following steps:

1. Let `F` be the `WeakMap` function object on which the `new` operator was applied.
2. Let `argumentsList` be the `argumentsList` argument of the `[[Construct]]` internal method that was invoked by the `new` operator.
3. Return the result of `OrdinaryConstruct(F, argumentsList)`.

If `WeakMap` is implemented as an ordinary function object, its `[[Construct]]` internal method will perform the above steps.

15.15.3 Properties of the WeakMap Constructor

The value of the `[[Prototype]]` internal data property of the `WeakMap` constructor is the `Function` prototype object (15.3.4).

Besides the `length` property (whose value is `0`), the `WeakMap` constructor has the following property:

15.15.3.1 WeakMap.prototype

The initial value of `WeakMap.prototype` is the `WeakMap` prototype object (15.15.4).

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

15.15.3.2 WeakMap[@@create] ()

The `@@create` method of a `WeakMap` object `F` performs the following steps:

1. Let `F` be the `this` value.
2. Let `obj` be the result of calling `OrdinaryCreateFromConstructor(F, "%WeakMapPrototype%", { [[WeakMapData]] })`.
3. Return `obj`.

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

15.15.4 Properties of the WeakMap Prototype Object

The value of the `[[Prototype]]` internal data property of the `WeakMap` prototype object is the standard built-in `Object` prototype object (15.2.4). The `WeakMap` prototype object is an ordinary object. It does not have a `[[WeakMapData]]` internal data property.

Comment [AWB12250]: Note that using a method call for inserting pairs during initialization provides allows subclasses to be more expressive.

Deleted: <#>Let `status` be the result of `MapInitialisation with map and iterable as arguments.`

Deleted: <#>Return `map`.

Deleted: `3`

Deleted: the

Deleted: The `WeakMap` constructor is designed to be subclassable. It may be used as the value of an `extends` clause of a class declaration. Subclass constructors that intended to inherit the specified `WeakMap` behaviour must include a `super` call to `WeakMap`.

Deleted: `3`

Deleted: `iterable = undefined`

Deleted: with arguments

Deleted: and

Deleted: <#>Let `map` be the result of the abstract operation `ObjectCreate (15.2) with the intrinsic %WeakMapPrototype% as the argument.`

<#>If `iterable` is not present, let `iterable` be `undefined`.

<#>Let `status` be the result of `WeakMapInitialisation with map and iterable as arguments.`

<#>Return `fAbrupt(status)`.

<#>Return `map`.

Deleted: 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 two element array-like objects 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.

Deleted: `4`

Deleted: the internal properties and

Deleted: `4`

Deleted: `4`

Deleted: ,

Deleted: <#>Add a `[[WeakMapData]]` internal data property to `obj`.

<#>Set `obj`'s `[[WeakMapData]]` internal data property to a new empty List.

Comment [AWB14251]: Because the `@@create` method is essential to the integrity of this "class" definition, just like the `prototype` property, it seems appropriate to freeze it in the same manner.

Deleted: `5`

15.15.4.1 WeakMap.prototype.constructor

The initial value of `WeakMap.prototype.constructor` is the built-in `WeakMap` constructor.

15.15.4.2 WeakMap.prototype.clear ()

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, then throw a `TypeError` exception.
3. If M does not have a `[[WeakMapData]]` internal data property throw a `TypeError` exception.
4. If M 's `[[WeakMapData]]` internal data property is `undefined`, then throw a `TypeError` exception.
5. Set the value of M 's `[[WeakMapData]]` internal data property to a new empty List.
6. Return `undefined`.

Deleted: 5

15.15.4.3 WeakMap.prototype.delete (key)

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, then throw a `TypeError` exception.
3. If M does not have a `[[WeakMapData]]` internal data property throw a `TypeError` exception.
4. Let entries be the List that is the value of M 's `[[WeakMapData]]` internal data property.
5. If entries is `undefined`, then throw a `TypeError` exception.
6. If $\text{Type}(key)$ is not `Object`, then throw a `TypeError` exception.
7. Repeat for each Record $\{[[\text{key}]], [[\text{value}]]\}$ p that is an element of entries .
 - a. If $p.[[\text{key}]]$ and key are the same object, then
 - i. Set $p.[[\text{key}]]$ to `empty`.
 - ii. Set $p.[[\text{value}]]$ to `empty`.
 - iii. Return `true`.
8. Return `false`.

Deleted: 5

15.15.4.4 WeakMap.prototype.get (key)

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, then throw a `TypeError` exception.
3. If M does not have a `[[WeakMapData]]` internal data property throw a `TypeError` exception.
4. Let entries be the List that is the value of M 's `[[WeakMapData]]` internal data property.
5. If entries is `undefined`, then throw a `TypeError` exception.
6. If $\text{Type}(key)$ is not `Object`, then throw a `TypeError` exception.
7. Repeat for each Record $\{[[\text{key}]], [[\text{value}]]\}$ p that is an element of entries .
 - a. If $p.[[\text{key}]]$ and key are the same object, then return $p.[[\text{value}]]$
8. Return `undefined`.

Deleted: result of calling `ToObject` with the
Deleted: as its argument
Deleted: `ReturnIfAbrupt(M)`

Deleted: <#>Let k be `ToObject(key).
<#>ReturnIfAbrupt(k).
Deleted: SameValue(
Deleted: ,
Deleted: k
Deleted:)
Deleted: 5`

15.15.4.5 WeakMap.prototype.has (key)

The following steps are taken:

1. Let M be the `this` value.
2. If $\text{Type}(M)$ is not `Object`, then throw a `TypeError` exception.
3. If M does not have a `[[WeakMapData]]` internal data property throw a `TypeError` exception.
4. Let entries be the List that is the value of M 's `[[WeakMapData]]` internal data property.
5. If entries is `undefined`, then throw a `TypeError` exception.
6. If $\text{Type}(key)$ is not `Object`, then throw a `TypeError` exception.
7. Repeat for each Record $\{[[\text{key}]], [[\text{value}]]\}$ p that is an element of entries .
 - a. If $p.[[\text{key}]]$ and key are the same object, then return `true`.
8. Return `false`.

Deleted: result of calling `ToObject` with the
Deleted: as its argument
Deleted: `ReturnIfAbrupt(M)`

Deleted: <#>Let k be `ToObject(key).
<#>ReturnIfAbrupt(k).
Deleted: SameValue(
Deleted: ,
Deleted: k
Deleted:)
Deleted: 4
Deleted: 5`

Deleted: result of calling `ToObject` with the
Deleted: as its argument
Deleted: `ReturnIfAbrupt(M)`

Deleted: <#>Let k be `ToObject(key).
<#>ReturnIfAbrupt(k).
Deleted: SameValue(
Deleted: ,
Deleted:)`

15.15.4.6 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`, then throw a `TypeError` exception.
3. If M does not have a `[[WeakMapData]]` internal data property throw a `TypeError` exception.
4. Let entries be the List that is the value of M 's `[[WeakMapData]]` internal data property.
5. If entries is `undefined`, then throw a `TypeError` exception.
6. If $\text{Type}(\text{key})$ is not `Object`, then throw a `TypeError` exception.
7. Repeat for each Record $\{\text{key}, \text{value}\}$ p that is an element of entries .
 - a. If $p.[[key]]$ and key are the same object, then
 - i. Set $p.[[value]]$ to value .
 - ii. Return M .
8. Let p be the Record $\{\text{key}, \text{value}\}$.
9. Append p as the last element of entries .
10. Return M .

15.15.4.7 WeakMap.prototype.@@toStringTag

The initial value of the `@@toStringTag` property is the string value "`WeakMap`".

15.15.5 Properties of WeakMap Instances

WeakMap instances are ordinary objects that inherit properties from the WeakMap prototype. WeakMap instances also have a `[[WeakMapData]]` internal data property.

15.16 Set Objects

Set objects are collections of ECMAScript language values. A distinct value may only occur once as elements of a Set's collection. Distinct values are discriminated using the a comparision algorithm that is selected when the Set is created.

A Set object can iterate its elements in insertion order. 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.

15.16.1 The Set Constructor Called as a Function

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` internal methods. 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 `Set`.

15.16.1.1 Set (iterable = undefined, comparator = undefined)

When the `set` function is called with optional arguments `iterable` and `comparator` the following steps are taken:

1. Let set be the `this` value.
2. If $\text{Type}(set)$ is not `Object` then, throw a `TypeError` exception.
3. If set does not have a `[[SetData]]` internal data property, then throw a `TypeError` exception.
4. If set 's `SetData` internal data property is not `undefined`, then throw a `TypeError` exception.
5. If iterable is not present, let iterable be `undefined`.
6. If iterable is neither `undefined` or `null`, then let itr be `undefined`.
7. Else,
 - a. Let iterator be the intrinsic symbol `@@iterator`.
 - b. Let itr be the result of `Invoke(iterator, iterator)`.

Deleted: 4
Deleted: 5
Deleted: result of calling <code>ToObject</code> with the
Deleted: as its argument
Deleted: <code>ReturnIfAbrupt(M)</code>
Deleted: <#>Let k be <code>ToObject(key)</code> . <#> <code>ReturnIfAbrupt(k)</code> .
Deleted: <code>SameValue</code> (
Deleted: ,
Deleted:)
Deleted: <code>undefined</code>
Deleted: k
Deleted: <code>undefined</code>
Deleted: 5
Deleted: 6
Deleted: After initialisation by the <code>WeakWeakMap</code> constructor,
Deleted: of arbitrary
Deleted: arbitrary
Deleted: Each d
Deleted: , as determined using the <code>SavmeValue</code> algorithm,
Deleted: within
Deleted:
Deleted: also
Comment [AWB7252]: TODO: need to define
Deleted: 15.16.1 Abstract Operations For Set Objects
Deleted: 15.16.1.1 SetInitialisation
The abstract operation <code>SetInitialisation</code> with arguments <code>obj</code> and <code>iterable</code> is used to initialize an object as a set instance. It performs the following steps: <#>If $\text{Type}(obj)$ is not <code>Object</code> , throw a <code>TypeError</code> exception. <#>If obj already hasdoes not have a <code>[[SetData]]</code> internal data property, throw a <code>TypeError</code> exception. <#>If the result of calling the <code>[[GetIsExtensible]</code> internal propertymethod of obj is <code>false</code> , throw a <code>TypeError</code> exception. <#>If iterable is not <code>undefined</code> , then <#>Let iterable be <code>ToObject(iterable)</code> . <#> <code>ReturnIfAbrupt(iterable)</code> <#>Let hasValues be the result of <code>HasProperty</code> (calling the <code>[[HasProperty]]</code> internal method of iterable with argument, <code>"values"</code>). Deleted: 2
Deleted: This premitspermits super invocation
Deleted: 2
Deleted: O
Deleted: <#>If O is <code>undefined</code> or the intrinsic
Deleted: <#>Let set be the result of

- c. ReturnIfAbrupt(itr).
- d. Let adder be the result of Get(set, "add").
- e. ReturnIfAbrupt(add).
f. If IsCallable(add) is false, throw a **TypeError** Exception.
- 8. If comparator is not **undefined**, then
 - a. If comparator is not "is", then throw a **RangeError** Exception.
- 9. Set set's [[SetData]] internal data property to a new empty List.
- 10. Set set's [[SetComparator]] internal data property to comparator.
- 11. If itr is **undefined**, then return set.
- 12. Repeat
 - a. Let next be the result of Invoke(itr, "next").
 - b. If IteratorComplete(next) is true, then return NormalCompletion(set).
 - c. ReturnIfAbrupt(next).
 - d. Let status be the result of calling the [[Call]] internal method of adder with set as thisArgument and a List whose sole element is next as argumentsList.
 - e. ReturnIfAbrupt(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 two element array-like objects whose first element is a value that will be used as an Map key and whose second element is the value to associate with that key.

15.16.2 The Set Constructor

When **Set** is called as part of a **new** expression it is a constructor: it initialises a newly created object.

The **Set** constructor is designed to be subclassable. It may be used as the value of an **extends** clause of a class declaration. Subclass constructors that intended to inherit the specified **Set** behaviour must include a **super** call to **Set**.

15.16.2.1 new Set (... args)

Set called as part of a new expression with argument list **args** performs the following steps:

1. Let F be the Set function object on which the **new** operator was applied.
2. Let argumentsList be the argumentsList argument of the [[Construct]] internal method that was invoked by the **new** operator.
3. Return the result of OrdinaryConstruct(F, argumentsList).

If **Set** is implemented as an ordinary function object, its [[Construct]] internal method will perform the above steps.

NOTE If the parameter iterable is present, it is expected to be an object that implements either a **values** method or an @@iterator method. Either method is expected to return an iterator object that returns the values that will be the initial elements of the set.

15.16.3 Properties of the Set Constructor

The value of the [[Prototype]] internal data property of the **Set** constructor is the Function prototype object (15.3.4).

Besides the **length** property (whose value is **0**), the **Set** constructor has the following property:

15.16.3.1 Set.prototype

The initial value of **Set.prototype** is the intrinsic %SetPrototype% object (15.16.4).

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

Comment [AWB7253]: TODO: need to define

Comment [AWB12254]: Note that using a method for inserting pairs during initialization provides allows subclasses to be more expressive.

Deleted: <#>Let status be the result of SetInitialisation with set and iterable as arguments.¶

Deleted: <#>Return set.¶

Deleted: 3

Deleted: the

Deleted: 3

Deleted: iterable = undefined

Deleted: <#>Let set be the result of the abstract operation ObjectCreate (15.2) with the intrinsic %SetPrototype% as the argument.¶

<#>If iterable is not present, let iterable be **undefined**.¶

<#>Let status be the result of SetInitialisation with set and iterable as arguments.¶

<#>ReturnIfAbrupt(status).¶

<#>Return set.¶

Deleted: with arguments

Deleted: and

Deleted: 4

Deleted: the internal properties and

Deleted: 4

15.16.3.2 Set @@create ()

The @@create method of a Set function object F performs the following steps:

1. Let F be the **this** value.
2. Let obj be the result of calling `OrdinaryCreateFromConstructor(F , "%SetPrototype%", ([[SetData]], [[SetComparator]]))`.
3. Return obj .

This property has the attributes `{ [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }`.

15.16.4 Properties of the Set Prototype Object

The value of the [[Prototype]] internal data property of the Set prototype object is the standard built-in Object prototype object (15.2.4). The set prototype object is an ordinary object. It does not have a [[SetData]] or a [[SetComparator]] internal data property.

15.16.4.1 Set.prototype.constructor

The initial value of `Set.prototype.constructor` is the built-in `Set` constructor.

15.16.4.2 Set.prototype.add (value)

The following steps are taken:

1. Let S be the **this**.
2. If `Type(S)` is not `Object`, then throw a `TypeError` exception.
3. If S does not have a [[SetData]] internal data property throw a `TypeError` exception.
4. If S 's [[SetData]] internal data property is `undefined`, then throw a `TypeError` exception.
5. Let $entries$ be the List that is the value of S 's [[SetData]] internal data property.
6. If S 's [[SetComparator]] internal data property is `undefined`, then let $same$ be the abstract operation `SameValueZero`.
7. Else, let $same$ be the abstract operation `SameValue`.
8. Repeat for each e that is an element of $entries$, in original insertion order
 - a. If p is not empty and $same(p, value)$ is `true`, then
 - i. Return S .
9. Append $value$ as the last element of $entries$.
10. Return S .

15.16.4.3 Set.prototype.clear ()

The following steps are taken:

1. Let S be the **this** value.
2. If `Type(S)` is not `Object`, then throw a `TypeError` exception.
3. If S does not have a [[SetData]] internal data property throw a `TypeError` exception.
4. If S 's [[SetData]] internal data property is `undefined`, then throw a `TypeError` exception.
5. Repeat for each Record `{[[key]], [[value]]}`; p 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`.

15.16.4.4 Set.prototype.delete (value)

The following steps are taken:

1. Let S be the **this** value.
2. If `Type(S)` is not `Object`, then throw a `TypeError` exception.
3. If S does not have a [[SetData]] internal data property throw a `TypeError` exception.
4. If S 's [[SetData]] internal data property is `undefined`, then throw a `TypeError` exception.

Deleted: 4

Deleted: ,

Deleted: <#>Add a [[SetData]] internal data property to obj .
<#>Set obj 's [[SetData]] internal data property to a new empty List.
Comment [AWB14255]: Because the @@create method is essential to the integrity of this "class" definition, just like the prototype property, it seems appropriate to freeze it in the same manner.

Deleted: 5

Deleted: 5

Deleted: 5

Deleted: result of calling `ToObject` with the
Deleted: value as its argument
Deleted: `ReturnIfAbrupt(S)`

Deleted: <#>Repeat for each p that is an element of $entries$.

Deleted: S

Deleted: Value

Deleted: undefined

Deleted: p

Deleted: undefined

Deleted: 4

Deleted: 5

Deleted: the result of calling `ToObject` with the

Deleted: as its argument

Deleted: `ReturnIfAbrupt(S)`

Deleted: <#>Set the value of S 's [[SetData]] internal data property to a new empty List.
Deleted:

Deleted: 5

Deleted: Map

Deleted: result of calling `ToObject` with the

Deleted: as its argument

Deleted: `ReturnIfAbrupt(S)`

5. Let *entries* be the List that is the value of *S*'s [[SetData]] internal data property.
6. If *S*'s [[SetComparator]] internal data property is **undefined**, then let *same* be the abstract operation *SameValueZero*.
7. Else, let *same* be the abstract operation *SameValue*.
8. Repeat for each *e* that is an element of *entries*, in original insertion order
 - a. If *e* is not empty and *same(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**.
9. Return **false**.

Deleted: *s*
Deleted: Value

15.16.4.5 Set.prototype.entries ()

The following steps are taken:

1. Let *S* be the **this** value.
2. If Type(*S*) is not Object, then throw a **TypeError** exception.
3. Return the result of calling the *CreateSetIterator* abstract operation with arguments *S* and "**key+value**".

NOTE For iteration purposes, a Set appears similar to a Map where each entry has the same value for its key and value.

15.16.4.6 Set.prototype.forEach (callbackfn , thisArg = undefined)

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.

Deleted: 5
Deleted: 5
Deleted: two
Deleted: 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.

NOTE If *callbackfn* is an Arrow Function, **this** was lexically bound when the function was created so *thisArg* will have no effect.

callbackfn is called with three arguments: the first two arguments are a value contained in the Set. The same value of passed for both arguments. The Set object being traversed is passed as the third argument.

Deleted: two
Deleted: value of the item
Deleted: and t

NOTE 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*.

NOTE 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.

Deleted: if

When the *forEach* method is called with one or two arguments, the following steps are taken:

1. Let *S* be the **this**.
2. If Type(*S*) is not Object, then throw a **TypeError** exception.
3. If *S* does not have a [[SetData]] internal data property throw a **TypeError** exception.
4. If *S*'s [[SetData]] internal data property is **undefined**, then throw a **TypeError** exception.
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 *entries* be the List that is the value of *S*'s [[SetData]] internal data property.
8. Repeat for each *e* that is an element of *entries*, in original insertion order
 - a. If *e* is not empty, then

Deleted: result of calling *ToObject* with the
Deleted: value as its argument
Deleted: *ReturnIfAbrupt(S)*

- i. Let *funcResult* be the result of calling the **[[Call]]** internal method of *callbackfn* with *T* as *thisArgument* and a List containing *e* and *S* as *argumentsList*.
- ii. ReturnIfAbrupt(*funcResult*).

9. Return **undefined**.

The **length** property of the **forEach** method is **1**.

15.16.4.7 Set.prototype.has (value)

The following steps are taken:

1. Let *S* be the **this** value.
2. If *Type(S)* is not **Object**, then throw a **TypeError** exception.
3. If *S* does not have a **[[SetData]]** internal data property throw a **TypeError** exception.
4. If *S*'s **[[SetData]]** internal data property is **undefined**, then throw a **TypeError** exception.
5. Let *entries* be the List that is the value of *S*'s **[[SetData]]** internal data property.
6. If *S*'s **[[SetComparator]]** internal data property is **undefined**, then let *same* be the abstract operation **SameValueZero**.
7. Else, let *same* be the abstract operation **SameValue**.
8. Repeat for each *e* that is an element of *entries*.
 - a. If *e* is not empty and *same(e, value)*, then return **true**.
9. Return **false**.

15.16.4.8 Set.prototype.keys ()

The initial value of the **keys** property is the same function object as the initial value of the **values** property.

NOTE For iteration purposes, a Set appears similar to a Map where each entry has the same value for its key and value.

15.16.4.9 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:

9. Let *S* be the **this** value.
10. If *Type(S)* is not **Object**, then throw a **TypeError** exception.
11. If *S* does not have a **[[SetData]]** internal data property throw a **TypeError** exception.
12. If *S*'s **[[SetData]]** internal data property is **undefined**, then throw a **TypeError** exception.
13. Let *entries* be the List that is the value of *S*'s **[[SetData]]** internal data property.
14. Let *count* be **0**.
15. For each *e* that is an element of *entries*
 - a. If *e* is not empty then
 - i. Set *count* to *count+1*.
16. Return *count*.

15.16.4.10 Set.prototype.values ()

The following steps are taken:

1. Let *S* be the **this** value.
2. If *Type(S)* is not **Object**, then throw a **TypeError** exception.
3. Return the result of calling the **CreateSetIterator** abstract operation with argument *S* and **"value"**.

15.16.4.11 Set.prototype.[@@iterator ()]

The initial value of the **[@@iterator]** property is the same function object as the initial value of the **values** property.

Deleted: 5

Deleted: 6

Deleted: result of calling **ToObject** with the

Deleted: as its argument

Deleted: **ReturnIfAbrupt(S)**

Deleted: *S*

Deleted: Value

Comment [AWB10256]: Do we really want to do this sort of method sharing.

Formatted: Note

Deleted: 5

Deleted: 7

Deleted: are taken

Deleted: result of calling **ToObject** with the

Deleted: as its argument

Deleted: **ReturnIfAbrupt(S)**

Deleted: 5

Deleted: 8

Deleted: Map

Deleted: result of calling **ToObject** with the

Deleted: as its argument

Deleted: **ReturnIfAbrupt(S)**

Comment [AWB10257]: This is how we identify a property whose key is a built-in Symbol

Deleted: 5

Deleted: 9

Deleted: Map

Comment [AWB10258]: Do we really want to do this sort of method sharing.

15.16.4.12 Set.prototype.@@toStringTag

The initial value of the @@toStringTag property is the string value "Set".

Deleted: 5

Deleted: 0

15.16.6 Properties of Set Instances

Set instances inherit properties from the Set prototype. After initialisation by the Set constructor, Set instances also have a [[SetData]] internal data property and a [[SetComparator]] internal data property.

15.16.7 Set Iterator Object Structure

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.

Deleted: Map

15.16.7.1 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. Let *S* be the result of calling `ToObject(set)`.
2. ReturnIfAbrupt(*S*).
3. If *S* does not have a [[SetData]] internal data property throw a **TypeError** exception.
4. If *S*'s [[SetData]] internal data property is **undefined**, then throw a **TypeError** exception.
5. Let *entries* be the List that is the value of *S*'s [[SetData]] internal data property.
6. Let *itr* be the result of `ObjectCreate(%SetIteratorPrototype%, {[[IteratedSet]]: S, [[SetNextIndex]]: 0, [[SetIterationKind]]: kind})`.
7. Set *itr*'s [[IteratedSet]] internal data property to *S*.
8. Set *itr*'s [[SetNextIndex]] internal data property to 0.
9. Set *itr*'s [[SetIterationKind]] internal data property to *kind*.
10. Return *itr*.

Deleted: The value and @@iterator

15.16.7.2 The Set Iterator Prototype

All Set Iterator Objects inherit properties from a common Set Iterator Prototype object. The [[Prototype]] internal data property of the Set Iterator Prototype is the %ObjectPrototype% intrinsic object. In addition, the Set Iterator Prototype has the following properties:

Deleted: the abstract operation

Deleted: with the intrinsic object

Deleted: as its argument

Deleted: Add a

Deleted: *itr* with value

Deleted: Add a

Deleted: to *itr* with value

15.16.7.2.1 SetIterator.prototype.constructor

15.16.7.2.2 SetIterator.prototype.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 properties of a Set Iterator Instance (15.16.7.1.2), throw a **TypeError** exception.
4. Let *s* be the value of the [[IteratedSet]] internal data property of *O*.
5. Let *index* be the value of the [[SetNextIndex]] internal data property of *O*.
6. Let *itemKind* be the value of the [[SetIterationKind]] internal data property of *O*.
7. Assert: *s* has a [[SetData]] internal data property and *s* has been initialized so the value of [[MapData]] is not **undefined**.
8. Let *entries* be the List that is the value of the [[SetData]] internal data property of *s*.
9. 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 element at 0-originated insertion position *index* of *entries*.
 - b. Set *index* to *index*+1;
 - c. Set the [[SetNextIndex]] internal data property of *O* to *index*.
 - d. If *e* is not **empty**, then
 - i. If *itemKind* is "**key+value**" then,

Comment [AWB10259]: TODO: need to decide what to use for a constructor for these sort of objects.

Deleted:

1. Let *result* be the result of the abstract operation `ArrayCreate` with argument *2*.
2. Assert: *result* is a new, well-formed `Array` object so the following operations will never fail.
3. Call `CreateOwnProperty(result, "0", e)`.
4. Call `CreateOwnProperty(result, "1", e)`.
5. Return *result*.

ii. Return *e*.

10. Return Completion {[[type]]: throw, [[value]]: %StopIteration%, [[target]]: empty}.

15.16.7.2.3 `SetIterator.prototype[@@iterator]()`

The following steps are taken:

1. Return the `this` value.

15.16.7.2.4 `SetIterator.prototype[@@toStringTag]`

The initial value of the `@@toStringTag` property is the string value "`Set Iterator`".

15.16.7.3 Properties of Set Iterator Instances

Set Iterator instances inherit properties from the Set Iterator prototype (the intrinsic, `%SetIteratorPrototype%`.) Set Iterator instances are initially created with the internal properties specified in [Table 37](#).

Table 37.— Internal Data Properties of Set Iterator Instances

Internal Data Property Name	Description
<code>[[IteratedSet]]</code>	The <code>Set</code> object that is being iterated.
<code>[[SetNextIndex]]</code>	The integer index of the next <code>Set</code> data element to be examined by this iteration.
<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> , <code>"key+value"</code> . <code>"key"</code> and <code>"value"</code> have the same meaning.

the material in http://wiki.ecmascript.org/doku.php?id=harmony:reflect_api

Deleted: If *itemKind* is `"key"` then, r

Comment [AWB10260]: We may need to elaborate on this??

Comment [AWB10261]: This is how we identify a property whose key is a built-in Symbol

Deleted: Table 38Table 35Table 33

Deleted: 383533

15.17 The Reflect Module

This is a place holder for

Comment [AWB10262]: TODO

15.17.1 Exported Function Properties Reflecting the Essential Internal Methods

15.17.1.1 `Reflect.getPrototypeOf(target)`

When the `getPrototypeOf` function is called with argument *target* the following steps are taken:

1. Let *obj* be `ToObject(target)`.
2. ReturnIfAbrupt(*obj*).
3. Return the result of calling the `[[GetInheritance]]` internal method of *obj*.

Deleted: e

15.17.1.2 `Reflect.setPrototypeOf(target, proto)`

When the `setPrototypeOf` function is called with arguments *target* and *propertyKey*, the following steps are taken:

1. Let *obj* be `ToObject(target)`.
2. ReturnIfAbrupt(*obj*).
3. If `Type(proto)` is not `Object` and *proto* is not `null`, then throw a `TypeError` exception.
4. Return the result of calling the `[[SetInheritance]]` internal method of *obj* with argument *proto*.

15.17.1.3 Reflect.isExtensible (target)

When the `isExtensible` function is called with argument `target` the following steps are taken:

1. Let `obj` be `ToObject(target)`.
2. ReturnIfAbrupt(`obj`).
3. Return the result of calling `IsExtensible(obj)`.

15.17.1.4 Reflect.preventExtensions (target)

When the `preventExtensions` function is called with argument `target`, the following steps are taken:

5. Let `obj` be `ToObject(target)`.
6. ReturnIfAbrupt(`obj`).
7. Return the result of calling the `[[SetIntegrity]]` internal method of `obj` with argument `"nonextensible"`.

Deleted: the `[[SetIntegrity]]` internal method of `obj`
Deleted: `[[SetIntegrity]]` internal method of `obj`
Deleted:

Deleted: PreventExtensions

15.17.1.5 Reflect.has (target, propertyKey)

When the `has` function is called with arguments `target` and `propertyKey`, the following steps are taken:

1. Let `obj` be `ToObject(target)`.
2. ReturnIfAbrupt(`obj`).
3. Let `key` be `ToPropertyKey(propertyKey)`.
4. ReturnIfAbrupt(`key`).
5. Return the result of calling the `[[HasProperty]]` internal method of `obj` with argument `key`.

Deleted: 5

When the `has` function is called with arguments `target` and `propertyKey`, the following steps are taken:

6. Let `obj` be `ToObject(target)`.
7. ReturnIfAbrupt(`obj`).
8. Let `key` be `ToPropertyKey(propertyKey)`.
9. ReturnIfAbrupt(`key`).
10. Return the result of calling the `[[HasOwnProperty]]` internal method of `obj` with argument `key`.

15.17.1.6 Reflect.hasOwn (target, propertyKey)

When the `getOwnPropertyDescriptor` function is called with arguments `target` and `propertyKey`, the following steps are taken:

1. Let `obj` be `ToObject(target)`.
2. ReturnIfAbrupt(`obj`).
3. Let `key` be `ToPropertyKey(propertyKey)`.
4. ReturnIfAbrupt(`key`).
5. Return the result of calling the `[[GetOwnProperty]]` internal method of `obj` with argument `key`.

Deleted: 6

15.17.1.7 Reflect.getOwnPropertyDescriptor(target, propertyKey)

When the `get` function is called with arguments `target`, `propertyKey`, and `receiver` the following steps are taken:

1. Let `obj` be `ToObject(target)`.
2. ReturnIfAbrupt(`obj`).
3. Let `key` be `ToPropertyKey(propertyKey)`.
4. ReturnIfAbrupt(`key`).
5. If `receiver` is not present, then
 - a. Let `receiver` be `target`.
6. Return the result of calling the `[[Get]]` internal method of `obj` with arguments `key`, and `receiver`.

Deleted: 7

Deleted: P

15.17.1.9 Reflect.set (target, propertyKey, V, receiver=target)

Deleted: 8

When the `set` function is called with arguments `target`, `V`, `propertyKey`, and `receiver` the following steps are taken:

1. Let `obj` be `ToObject(target)`.
2. ReturnIfAbrupt(`obj`).
3. Let `key` be `ToPropertyKey(propertyKey)`.
4. ReturnIfAbrupt(`key`).
5. If `receiver` is not present, then
 - a. Let `receiver` be `target`.
6. Return the result of calling the `[[Set]]` internal method of `obj` with arguments `key`, `V`, and `receiver`.

15.17.1.10 Reflect.deleteProperty (target, propertyKey)

Deleted: P

Deleted: 9

When the `deleteProperty` function is called with arguments `target` and `propertyKey`, the following steps are taken:

1. Let `obj` be `ToObject(target)`.
2. ReturnIfAbrupt(`obj`).
3. Let `key` be `ToPropertyKey(propertyKey)`.
4. ReturnIfAbrupt(`key`).
5. Return the result of calling the `[[Delete]]` internal method of `obj` with argument `key`.

15.17.1.11 Reflect.defineProperty(target, propertyKey, attributes)

Deleted: 0

Deleted: A

Deleted: A

When the `defineProperty` function is called with arguments `target`, `propertyKey`, and `attributes` the following steps are taken:

7. Let `obj` be `ToObject(target)`.
8. ReturnIfAbrupt(`obj`).
9. Let `key` be `ToPropertyKey(propertyKey)`.
10. ReturnIfAbrupt(`key`).
11. Let `desc` be the result of calling `ToPropertyDescriptor` with `attributes` as the argument.
12. ReturnIfAbrupt(`desc`).
13. Return the result of calling the `[[DefineOwnProperty]]` internal method of `obj` with arguments `key`, and `desc`.

Deleted: A

15.17.1.12 Reflect.enumerate (target)

Deleted: 1

When the `enumerate` function is called with argument `target` the following steps are taken:

1. Let `obj` be `ToObject(target)`.
2. ReturnIfAbrupt(`obj`).
3. Let `itr` be the result of calling the `[[Enumerate]]` internal method of `obj`.
4. Return `itr`.

15.17.1.13 Reflect.ownKeys (target)

Deleted: 15.17.1.12 Reflect.keys (target)

When the `ownKeys` function is called with argument `target` the following steps are taken:

<#> Let `obj` be `ToObject(target)`.

<#> ReturnIfAbrupt(`obj`).

<#> Let `keys` be the result of calling the `[[Keys]]` internal method of `obj`.

<#> ReturnIfAbrupt(`keys`).

<#> Return `CreateArrayFromList(keys)`.

Deleted: getOwnPropertyNames

Deleted: getO

Deleted: PropertyNames

Deleted: <#>Let `keys` be the result of calling the `[[OwnPropertyKeys]]` internal method of `obj`.

<#>ReturnIfAbrupt(`keys`).

Deleted: Return `CreateArrayFromList(keys)`.

When the `ownKeys` function is called with argument `target` the following steps are taken:

1. Let `obj` be `ToObject(target)`.
2. ReturnIfAbrupt(`obj`).
3. Let `keys` be the result of calling the `[[OwnPropertyKeys]]` internal method of `obj`.

15.17.1.14 Reflect.freeze (target)

When the `freeze` function is called with argument `target` the following steps are taken:

1. Let `obj` be `ToObject(target)`.
2. ReturnIfAbrupt(`obj`).

3. Return the result of calling the `[[Freeze]]` internal method of *obj*.

15.17.1.15 Reflect.seal (target)

When the `seal` function is called with argument *target* the following steps are taken:

1. Let *obj* be `ToObject(target)`.
2. ReturnIfAbrupt(*obj*).
3. Return the result of calling the `[[Seal]]` internal method of *obj*.

Deleted: Freeze

15.17.1.16 Reflect.isFrozen (target)

When the `isFrozen` function is called with argument *target* the following steps are taken:

1. Let *obj* be `ToObject(target)`.
2. ReturnIfAbrupt(*obj*).
3. Return the result of calling the `[[IsFrozen]]` internal method of *obj*.

15.17.1.17 Reflect.isSealed (target)

When the `isSealed` function is called with argument *target* the following steps are taken:

1. Let *obj* be `ToObject(target)`.
2. ReturnIfAbrupt(*obj*).
3. Return the result of calling the `[[IsSealed]]` internal method of *obj*.

15.18 Proxy Objects

16 Errors

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. An implementation must report early errors in a *Script* prior to the first evaluation of that *Script*. Early errors in `eval` code are reported at the time `eval` is called but prior to evaluation of any construct within the `eval` code. All errors that are not early errors are runtime errors.

An implementation must treat any instance of the following kinds of errors as an early error:

- Any syntax error.
- Attempts to define an *ObjectLiteral* that has multiple `get` property assignments with the same name or multiple `set` property assignments with the same name.
- Attempts to define an *ObjectLiteral* that has both a data property assignment and a `get` or `set` property assignment with the same name.
- Errors in regular expression literals that are not implementation-defined syntax extensions.
- Attempts in strict mode code to define an *ObjectLiteral* that has multiple data property assignments with the same name.
- The occurrence of a *WithStatement* in strict mode code.
- The occurrence of an *Identifier* value appearing more than once within a *FormalParameterList* of an individual strict mode *FunctionDeclaration* or *FunctionExpression*.
- Improper uses of `return`, `break`, and `continue`.
- Attempts to call `PutValue` on any value for which an early determination can be made that the value is not a Reference (for example, executing the assignment statement `3=4`).

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.

An implementation shall report all errors as specified, except for the following:

Deleted: 15.17.2 Exported Function Properties
Derived from the Essential Internal Methods

15.17.2.1 Reflect.has (target, propertyKey)
When the `has` 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 HasProperty(obj, key).
```

15.17.2.1 Reflect.instanceOf (target, O)
When the `instanceof` function is called with arguments *target* and *O*, the following steps are taken:

```
<#>Return the result of OrdinaryInstanceOf(target, O).
```

Deleted: ¶

Deleted: Program

Deleted: Program

Deleted: Program

- An implementation may extend script 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.
- 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`).
- 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.

Deleted: program

Deleted: program

DRAFT

DRAFT

Annex A (informative)

Grammar Summary

Field Code Changed
Field Code Changed
Field Code Changed

A.1 Lexical Grammar

SourceCharacter ::
any Unicode code unit

InputElementDiv ::
WhiteSpace
LineTerminator
Comment
Token
DivPunctuator

InputElementRegExp ::
WhiteSpace
LineTerminator
Comment
Token
RegularExpressionLiteral

WhiteSpace ::
<TAB>
<VT>
<FF>
<SP>
<NBSP>
<BOM>
<USP>

LineTerminator ::
<LF>
<CR>
<LS>
<PS>

LineTerminatorSequence ::
<LF>
<CR> [lookahead \notin <LF>]
<LS>
<PS>
<CR> <LF>

Comment ::
MultiLineComment
SingleLineComment

See clause 6

See clause 7

See clause 7

See 7.2

See 7.3

See 7.3

See 7.4

<i>MultiLineComment ::</i>	See 7.4
<i>/* MultiLineCommentChars_{opt} */</i>	
<i>MultiLineCommentChars ::</i>	See 7.4
<i>MultiLineNotAsteriskChar MultiLineCommentChars_{opt}</i>	
<i>* PostAsteriskCommentChars_{opt}</i>	
<i>PostAsteriskCommentChars ::</i>	See 7.4
<i>MultiLineNotForwardSlashOrAsteriskChar MultiLineCommentChars_{opt}</i>	
<i>* PostAsteriskCommentChars_{opt}</i>	
<i>MultiLineNotAsteriskChar ::</i>	See 7.4
<i>SourceCharacter but not *</i>	
<i>MultiLineNotForwardSlashOrAsteriskChar ::</i>	See 7.4
<i>SourceCharacter but not one of / or *</i>	
<i>SingleLineComment ::</i>	See 7.4
<i>// SingleLineCommentChars_{opt}</i>	
<i>SingleLineCommentChars ::</i>	See 7.4
<i>SingleLineCommentChar SingleLineCommentChars_{opt}</i>	
<i>SingleLineCommentChar ::</i>	See 7.4
<i>SourceCharacter but not LineTerminator</i>	
<i>Token ::</i>	See 7.5
<i>IdentifierName</i>	
<i>Punctuator</i>	
<i>NumericLiteral</i>	
<i>StringLiteral</i>	
<i>Identifier ::</i>	See 7.6
<i>IdentifierName but not ReservedWord</i>	
<i>IdentifierName ::</i>	See 7.6
<i>IdentifierStart</i>	
<i>IdentifierName IdentifierPart</i>	
<i>IdentifierStart ::</i>	See 7.6
<i>UnicodeLetter</i>	
<i>\$</i>	
<i>\ UnicodeEscapeSequence</i>	

IdentifierPart ::

IdentifierStart
UnicodeCombiningMark
UnicodeDigit
UnicodeConnectorPunctuation
<ZWNJ>
<ZWJ>

See 7.6

UnicodeLetter ::

any character in the Unicode categories “Uppercase letter (Lu)”, “Lowercase letter (Ll)”, “Titlecase letter (Lt)”, “Modifier letter (Lm)”, “Other letter (Lo)”, or “Letter number (Ni)”. See 7.6

UnicodeCombiningMark ::

any character in the Unicode categories “Non-spacing mark (Mn)” or “Combining spacing mark (Mc)” See 7.6

UnicodeDigit ::

any character in the Unicode category “Decimal number (Nd)” See 7.6

UnicodeConnectorPunctuation ::

any character in the Unicode category “Connector punctuation (Pc)” See 7.6

ReservedWord ::

Keyword
FutureReservedWord
NullLiteral
BooleanLiteral

See 7.6.1

Keyword :: one of

break
case
catch
continue
debugger
default
delete
do
else
finally
for
function
if
in

instanceof
new
return
switch
this
throw
try

typeof
var
void
while
with

See 7.6.1.1

FutureReservedWord :: one of

class
const
enum
export

extends
import

super

See 7.6.1.2

The following tokens are also considered to be *FutureReservedWords* when parsing strict mode code (see 10.1.1).

implements
interface
yield

let
package

private
protected

public
static

<i>Punctuator :: one of</i>						<i>See 7.7</i>
{	}	()	[]	
.	;	,	<	>	<=	
>=	==	!=	====	!==		
+	-	*	%	++	--	
<<	>>	>>>	&		^	
!	~	&&	 	?	:	
=	+=	-=	*=	%=	<<=	
>>=	>>>=	&=	 =	^=		
<i>DivPunctuator :: one of</i>						<i>See 7.7</i>
/	/=					
<i>Literal ::</i>						<i>See 7.8</i>
<i>NullLiteral</i>						
<i>BooleanLiteral</i>						
<i>NumericLiteral</i>						
<i>StringLiteral</i>						
<i>RegularExpressionLiteral</i>						
<i>NullLiteral ::</i>						<i>See 7.8.1</i>
null						
<i>BooleanLiteral ::</i>						<i>See 7.8.2</i>
true						
false						
<i>NumericLiteral ::</i>						<i>See 7.8.3</i>
<i>DecimalLiteral</i>						
<i>DecimalIntegerLiteral</i>	.	<i>DecimalDigits_{opt}</i>	<i>ExponentPart_{opt}</i>			<i>See 7.8.3</i>
.	<i>DecimalDigits</i>	<i>ExponentPart_{opt}</i>				
<i>DecimalIntegerLiteral</i>			<i>ExponentPart_{opt}</i>			
<i>DecimalIntegerLiteral ::</i>						<i>See 7.8.3</i>
0						
<i>NonZeroDigit DecimalDigits_{opt}</i>						
<i>DecimalDigits ::</i>						<i>See 7.8.3</i>
<i>DecimalDigit</i>						
<i>DecimalDigits DecimalDigit</i>						
<i>DecimalDigit :: one of</i>						<i>See 7.8.3</i>
0	1	2	3	4	5	
6	7	8	9			

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

See 7.8.3

ExponentPart ::
ExponentIndicator *SignedInteger*

See 7.8.3

ExponentIndicator :: **one of**
 e E

See 7.8.3

SignedInteger ::
DecimalDigits
 + *DecimalDigits*
 - *DecimalDigits*

See 7.8.3

HexIntegerLiteral ::
 0x *HexDigit*
 0X *HexDigit*
HexIntegerLiteral *HexDigit*

See 7.8.3

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 7.8.3

StringLiteral ::
 " *DoubleStringCharacters*_{opt} "
 ' *SingleStringCharacters*_{opt} '

See 7.8.4

DoubleStringCharacters ::
DoubleStringCharacter *DoubleStringCharacters*_{opt}

See 7.8.4

SingleStringCharacters ::
SingleStringCharacter *SingleStringCharacters*_{opt}

See 7.8.4

DoubleStringCharacter ::
SourceCharacter **but not one of** " or \ or *LineTerminator*
 \ *EscapeSequence*
LineContinuation

See 7.8.4

SingleStringCharacter ::
SourceCharacter **but not one of** ' or \ or *LineTerminator*
 \ *EscapeSequence*
LineContinuation

See 7.8.4

LineContinuation ::
 \ *LineTerminatorSequence*

See 7.8.4

EscapeSequence ::
CharacterEscapeSequence
 0 [lookahead \notin *DecimalDigit*]
HexEscapeSequence
UnicodeEscapeSequence

See 7.8.4

CharacterEscapeSequence ::
SingleEscapeCharacter
NonEscapeCharacter

See 7.8.4

SingleEscapeCharacter :: **one of**
 ' " \ b f n r t v

See 7.8.4

<i>NonEscapeCharacter</i> ::		See 7.8.4
<i>SourceCharacter</i> but not one of <i>EscapeCharacter</i> or <i>LineTerminator</i>		
<i>EscapeCharacter</i> ::		See 7.8.4
<i>SingleEscapeCharacter</i>		
<i>DecimalDigit</i>		
x		
u		
<i>HexEscapeSequence</i> ::		See 7.8.4
x <i>HexDigit HexDigit</i>		
<i>UnicodeEscapeSequence</i> ::		See 7.8.4
u <i>HexDigit HexDigit HexDigit HexDigit</i>		
<i>RegularExpressionLiteral</i> ::		See 7.8.5
/ <i>RegularExpressionBody</i> / <i>RegularExpressionFlags</i>		
<i>RegularExpressionBody</i> ::		See 7.8.5
<i>RegularExpressionFirstChar</i> <i>RegularExpressionChars</i>		
<i>RegularExpressionChars</i> ::		See 7.8.5
[empty]		
<i>RegularExpressionChars</i> <i>RegularExpressionChar</i>		
<i>RegularExpressionFirstChar</i> ::		See 7.8.5
<i>RegularExpressionNonTerminator</i> but not one of * or \ or / or [
<i>RegularExpressionBackslashSequence</i>		
<i>RegularExpressionClass</i>		
<i>RegularExpressionChar</i> ::		See 7.8.5
<i>RegularExpressionNonTerminator</i> but not \ or / or [
<i>RegularExpressionBackslashSequence</i>		
<i>RegularExpressionClass</i>		
<i>RegularExpressionBackslashSequence</i> ::		See 7.8.5
\ <i>RegularExpressionNonTerminator</i>		
<i>RegularExpressionNonTerminator</i> ::		See 7.8.5
<i>SourceCharacter</i> but not <i>LineTerminator</i>		
<i>RegularExpressionClass</i> ::		See 7.8.5
[<i>RegularExpressionClassChars</i>]		
<i>RegularExpressionClassChars</i> ::		See 7.8.5
[empty]		
<i>RegularExpressionClassChars</i> <i>RegularExpressionClassChar</i>		
<i>RegularExpressionClassChar</i> ::		See 7.8.5
<i>RegularExpressionNonTerminator</i> but not] or \		
<i>RegularExpressionBackslashSequence</i>		

RegularExpressionFlags ::=
[empty]
RegularExpressionFlags IdentifierPart

See 7.8.5

A.2 Number Conversions

StringNumericLiteral ::=
StrWhiteSpace_{opt}
StrWhiteSpace_{opt} *StrNumericLiteral* *StrWhiteSpace_{opt}*

See 9.1.3.1

StrWhiteSpace ::=
StrWhiteSpaceChar *StrWhiteSpace_{opt}*

See 9.1.3.1

StrWhiteSpaceChar ::=
WhiteSpace
LineTerminator

See 9.1.3.1

StrNumericLiteral ::=
StrDecimalLiteral
HexIntegerLiteral

See 9.1.3.1

StrDecimalLiteral ::=
StrUnsignedDecimalLiteral
+ *StrUnsignedDecimalLiteral*
- *StrUnsignedDecimalLiteral*

See 9.1.3.1

StrUnsignedDecimalLiteral ::=
infinity
DecimalDigits . *DecimalDigits_{opt}* *ExponentPart_{opt}*
. *DecimalDigits* *ExponentPart_{opt}*
DecimalDigits *ExponentPart_{opt}*

See 9.1.3.1

DecimalDigits ::=
DecimalDigit
DecimalDigits *DecimalDigit*

See 9.1.3.1

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

See 9.1.3.1

ExponentPart ::=
ExponentIndicator *SignedInteger*

See 9.1.3.1

ExponentIndicator :: **one of**
e **E**

See 9.1.3.1

SignedInteger ::=
DecimalDigits
+ *DecimalDigits*
- *DecimalDigits*

See 9.1.3.1

| *HexIntegerLiteral* ::=
 0x *HexDigit*
 0X *HexDigit*
HexIntegerLiteral *HexDigit*

See 9.1.3.1

| *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 9.1.3.1

A.3 Expressions

PrimaryExpression :
 this
 Identifier
 Literal
 ArrayLiteral
 ObjectLiteral
 (Expression)

See 11.1

ArrayLiteral :
 [Elision_{opt}]
 [ElementList]
 [ElementList , Elision_{opt}]

See 11.1.4

ElementList :
 Elision_{opt} AssignmentExpression
ElementList , Elision_{opt} AssignmentExpression

See 11.1.4

Elision :
 ,
Elision ,

See 11.1.4

ObjectLiteral :
 { }
 { PropertyDefinitionList }
 { PropertyDefinitionList , }

See 11.1.5

PropertyDefinitionList :
 PropertyDefinition
PropertyDefinitionList , PropertyDefinition

See 11.1.5

PropertyDefinition :
 PropertyName : AssignmentExpression
 get PropertyName () { FunctionBody }
 set PropertyName (PropertySetParameterList) { FunctionBody }

See 11.1.5

PropertyName :
 IdentifierName
 StringLiteral
 NumericLiteral

See 11.1.5

PropertySetParameterList :
 Identifier

See 11.1.5

Deleted: PropertyNameAndValueList

Deleted: PropertyNameAndValueList

Deleted: PropertyNameAndValueList

Deleted: PropertyAssignment

Deleted: PropertyNameAndValueList

Deleted: PropertyAssignment

Deleted: PropertyAssignment

MemberExpression :

- PrimaryExpression*
- FunctionExpression*
- MemberExpression [Expression]*
- MemberExpression . IdentifierName*
- new MemberExpression Arguments**

See 11.2

NewExpression :

- MemberExpression*
- new NewExpression**

See 11.2

CallExpression :

- MemberExpression Arguments*
- CallExpression Arguments*
- CallExpression [Expression]*
- CallExpression . IdentifierName*

See 11.2

Arguments :

- ()*
- (ArgumentList)*

See 11.2

ArgumentList :

- AssignmentExpression*
- ArgumentList , AssignmentExpression*

See 11.2

LeftHandSideExpression :

- NewExpression*
- CallExpression*

See 11.2

PostfixExpression :

- LeftHandSideExpression*
- LeftHandSideExpression [no LineTerminator here] ++*
- LeftHandSideExpression [no LineTerminator here] --*

See 11.3

UnaryExpression :

- PostfixExpression*
- delete UnaryExpression**
- void UnaryExpression**
- typeof UnaryExpression**
- ++ UnaryExpression**
- UnaryExpression**
- + UnaryExpression**
- UnaryExpression**
- ~ UnaryExpression**
- ! UnaryExpression**

See 11.4

MultiplicativeExpression :

- UnaryExpression*
- MultiplicativeExpression * UnaryExpression*
- MultiplicativeExpression / UnaryExpression*
- MultiplicativeExpression % UnaryExpression*

See 11.5

AdditiveExpression :
MultiplicativeExpression
AdditiveExpression + MultiplicativeExpression
AdditiveExpression - MultiplicativeExpression

See 11.6

ShiftExpression :
AdditiveExpression
ShiftExpression << AdditiveExpression
ShiftExpression >> AdditiveExpression
ShiftExpression >>> AdditiveExpression

See 11.7

RelationalExpression :
ShiftExpression
RelationalExpression < ShiftExpression
RelationalExpression > ShiftExpression
RelationalExpression <= ShiftExpression
RelationalExpression >= ShiftExpression
RelationalExpression instanceof ShiftExpression
RelationalExpression in ShiftExpression

See 11.8

RelationalExpressionNoIn :
ShiftExpression
RelationalExpressionNoIn < ShiftExpression
RelationalExpressionNoIn > ShiftExpression
RelationalExpressionNoIn <= ShiftExpression
RelationalExpressionNoIn >= ShiftExpression
RelationalExpressionNoIn instanceof ShiftExpression

See 11.8

EqualityExpression :
RelationalExpression
EqualityExpression == RelationalExpression
EqualityExpression != RelationalExpression
EqualityExpression === RelationalExpression
EqualityExpression !== RelationalExpression

See 11.9

EqualityExpressionNoIn :
RelationalExpressionNoIn
EqualityExpressionNoIn == RelationalExpressionNoIn
EqualityExpressionNoIn != RelationalExpressionNoIn
EqualityExpressionNoIn === RelationalExpressionNoIn
EqualityExpressionNoIn !== RelationalExpressionNoIn

See 11.9

BitwiseANDExpression :
EqualityExpression
BitwiseANDExpression & EqualityExpression

See 11.10

BitwiseANDExpressionNoIn :
EqualityExpressionNoIn
BitwiseANDExpressionNoIn & EqualityExpressionNoIn

See 11.10

BitwiseXORExpression :

BitwiseANDExpression

BitwiseXORExpression ^ BitwiseANDExpression

See 11.10

BitwiseXORExpressionNoIn :

BitwiseANDExpressionNoIn

BitwiseXORExpressionNoIn ^ BitwiseANDExpressionNoIn

See 11.10

BitwiseORExpression :

BitwiseXORExpression

BitwiseORExpression | BitwiseXORExpression

See 11.10

BitwiseORExpressionNoIn :

BitwiseXORExpressionNoIn

BitwiseORExpressionNoIn | BitwiseXORExpressionNoIn

See 11.10

LogicalANDExpression :

BitwiseORExpression

LogicalANDExpression && BitwiseORExpression

See 11.11

LogicalANDExpressionNoIn :

BitwiseORExpressionNoIn

LogicalANDExpressionNoIn && BitwiseORExpressionNoIn

See 11.11

LogicalORExpression :

LogicalANDExpression

LogicalORExpression || LogicalANDExpression

See 11.11

LogicalORExpressionNoIn :

LogicalANDExpressionNoIn

LogicalORExpressionNoIn || LogicalANDExpressionNoIn

See 11.11

ConditionalExpression :

LogicalORExpression

LogicalORExpression ? AssignmentExpression : AssignmentExpression

See 11.12

ConditionalExpressionNoIn :

LogicalORExpressionNoIn

LogicalORExpressionNoIn ? AssignmentExpression : AssignmentExpressionNoIn

See 11.12

AssignmentExpression :

ConditionalExpression

LeftHandSideExpression = AssignmentExpression

LeftHandSideExpression AssignmentOperator AssignmentExpression

See 11.13

AssignmentExpressionNoIn :

ConditionalExpressionNoIn

LeftHandSideExpression = AssignmentExpressionNoIn

LeftHandSideExpression AssignmentOperator AssignmentExpressionNoIn

See 11.13

AssignmentOperator : **one of**
 $\ast=$ $/=$ $\%=$ $+=$ $-=$ $<=$ $>=$ $>>=$ $\&=$ $\wedge=$ $|=$

See 11.13

Expression :
AssignmentExpression
Expression , AssignmentExpression

See 11.14

ExpressionNoIn :
AssignmentExpressionNoIn
ExpressionNoIn , AssignmentExpressionNoIn

See 11.14

A.4 Statements

Statement :
Block
VariableStatement
EmptyStatement
ExpressionStatement
IfStatement
IterationStatement
ContinueStatement
BreakStatement
ReturnStatement
WithStatement
LabelledStatement
SwitchStatement
ThrowStatement
TryStatement
DebuggerStatement

See clause 12

Block :
 $\{ \text{StatementList}_{\text{opt}} \}$

See 12.1

StatementList :
Statement
StatementList Statement

See 12.1

VariableStatement :
var *VariableDeclarationList* ;

See 12.2

VariableDeclarationList :
VariableDeclaration
VariableDeclarationList , VariableDeclaration

See 12.2

VariableDeclarationListNoIn :
VariableDeclarationNoIn
VariableDeclarationListNoIn , VariableDeclarationNoIn

See 12.2

VariableDeclaration :
*Identifier Initialiser*_{opt}

See 12.2

VariableDeclarationNoIn :
*Identifier InitialiserNoIn*_{opt}

See 12.2

Initialiser :
 $= \text{AssignmentExpression}$ See 12.2

InitialiserNoIn :
 $= \text{AssignmentExpressionNoIn}$ See 12.2

EmptyStatement :
 $;$ See 12.3

ExpressionStatement :
 $[\text{lookahead } \notin \{\{, \text{function}\}] \text{Expression} ;$ See 12.4

IfStatement :
 $\text{if} (\text{Expression}) \text{ Statement} \text{ else Statement}$
 $\text{if} (\text{Expression}) \text{ Statement}$ See 12.5

IterationStatement :
 $\text{do Statement while} (\text{Expression}) ;$
 $\text{while} (\text{Expression}) \text{ Statement}$
 $\text{for} (\text{ExpressionNoIn}_{\text{opt}}; \text{Expression}_{\text{opt}}; \text{Expression}_{\text{opt}}) \text{ Statement}$
 $\text{for} (\text{var VariableDeclarationListNoIn}; \text{Expression}_{\text{opt}}; \text{Expression}_{\text{opt}}) \text{ Statement}$
 $\text{for} (\text{LeftHandSideExpression} \text{ in Expression}) \text{ Statement}$
 $\text{for} (\text{var VariableDeclarationNoIn} \text{ in Expression}) \text{ Statement}$ See 12.6

ContinueStatement :
 $\text{continue} ;$
 $\text{continue} [\text{no LineTerminator here}] \text{Identifier} ;$ See 12.7

BreakStatement :
 $\text{break} ;$
 $\text{break} [\text{no LineTerminator here}] \text{Identifier} ;$ See 12.8

ReturnStatement :
 $\text{return} ;$
 $\text{return} [\text{no LineTerminator here}] \text{Expression} ;$ See 12.9

WithStatement :
 $\text{with} (\text{Expression}) \text{ Statement}$ See 12.10

SwitchStatement :
 $\text{switch} (\text{Expression}) \text{ CaseBlock}$ See 12.11

CaseBlock :
 $\{ \text{CaseClauses}_{\text{opt}} \}$
 $\{ \text{CaseClauses}_{\text{opt}} \text{ DefaultClause} \text{ CaseClauses}_{\text{opt}} \}$ See 12.11

CaseClauses :
 CaseClause
 $\text{CaseClauses CaseClause}$ See 12.11

CaseClause : **case** Expression : StatementList_{opt} See 12.11

DefaultClause : **default** : StatementList_{opt} See 12.11

LabelledStatement : Identifier : Statement See 12.12

ThrowStatement : **throw** [no LineTerminator here] Expression ; See 12.13

TryStatement :
try Block *Catch*
try Block *Finally*
try Block *Catch Finally* See 12.14

Catch : **catch** (Identifier) Block See 12.14

Finally : **finally** Block See 12.14

DebuggerStatement : **debugger** ; See 12.15

A.5 Functions and Scripts

FunctionDeclaration : **function** Identifier (FormalParameterList_{opt}) { FunctionBody } See clause 13

FunctionExpression : **function** Identifier_{opt} (FormalParameterList_{opt}) { FunctionBody } See clause 13

FormalParameterList : Identifier
FormalParameterList , Identifier See clause 13

FunctionBody : SourceElements_{opt} See clause 13

Program : SourceElements_{opt} See clause 14

SourceElements : SourceElement
SourceElements SourceElement See clause 14

Deleted: Programs

SourceElement :
Statement
FunctionDeclaration

See clause 14

A.6 Universal Resource Identifier Character Classes

uri ::=
uriCharacters_{opt}

See 15.1.3

uriCharacters ::=
uriCharacter uriCharacters_{opt}

See 15.1.3

uriCharacter ::=
uriReserved
uriUnescaped
uriEscaped

See 15.1.3

uriReserved ::= one of
; */* *?* *:* *@* *&* *=* *+* *\$* *,*

See 15.1.3

uriUnescaped ::=
uriAlpha
DecimalDigit
uriMark

See 15.1.3

uriEscaped ::=
% HexDigit HexDigit

See 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 15.1.3

uriMark ::= one of
*- _ . ! ~ * ' ()*

See 15.1.3

A.7 Regular Expressions

Pattern ::=
Disjunction

See 15.10.1

Disjunction ::=
Alternative
Alternative | Disjunction

See 15.10.1

Alternative ::=
[empty]
Alternative Term

See 15.10.1

Term ::=
Assertion
Atom
Atom Quantifier

See 15.10.1

Assertion ::

\wedge
 $\$$
 $\backslash b$
 $\backslash B$
 $(? = Disjunction)$
 $(? ! Disjunction)$

See 15.10.1

Quantifier ::

QuantifierPrefix
 $QuantifierPrefix \ ?$

See 15.10.1

QuantifierPrefix ::

$*$
 $+$
 $?$
 $\{ DecimalDigits \}$
 $\{ DecimalDigits , \}$
 $\{ DecimalDigits , DecimalDigits \}$

See 15.10.1

Atom ::

PatternCharacter
 $.$
 $\backslash AtomEscape$
CharacterClass
 $(Disjunction)$
 $(?: Disjunction)$

See 15.10.1

PatternCharacter ::

SourceCharacter but not one of
 $\wedge \ \$ \ \backslash \ . \ * \ + \ ? \ (\) \ [\] \ { \ } \ |$

See 15.10.1

AtomEscape ::

DecimalEscape
CharacterEscape
CharacterClassEscape

See 15.10.1

CharacterEscape ::

ControlEscape
 $\text{\c} ControlLetter$
HexEscapeSequence
UnicodeEscapeSequence
IdentityEscape

See 15.10.1

ControlEscape :: one of

$f \ n \ r \ t \ v$

See 15.10.1

ControlLetter :: one of

$a \ b \ c \ d \ e \ f \ g \ h \ i \ j \ k \ l \ m \ n \ o \ p \ q \ r \ s \ t \ u \ v \ w \ x \ y \ z$	See 15.10.1
$A \ B \ C \ D \ E \ F \ G \ H \ I \ J \ K \ L \ M \ N \ O \ P \ Q \ R \ S \ T \ U \ V \ W \ X \ Y \ Z$	

IdentityEscape :: See 15.10.1

SourceCharacter **but not** IdentifierPart
 <ZWJ>
 <ZWNJ>

DecimalEscape :: See 15.10.1

DecimalIntegerLiteral [lookahead \notin DecimalDigit]

CharacterClassEscape :: one of See 15.10.1

d D s S w W

CharacterClass :: See 15.10.1

[[lookahead \notin {}] ClassRanges]
 [^ ClassRanges]

ClassRanges :: See 15.10.1

[empty]
 NonemptyClassRanges

NonemptyClassRanges :: See 15.10.1

ClassAtom
 ClassAtom NonemptyClassRangesNoDash
 ClassAtom - ClassAtom ClassRanges

NonemptyClassRangesNoDash :: See 15.10.1

ClassAtom
 ClassAtomNoDash NonemptyClassRangesNoDash
 ClassAtomNoDash - ClassAtom ClassRanges

ClassAtom :: See 15.10.1

-
 ClassAtomNoDash

ClassAtomNoDash :: See 15.10.1

SourceCharacter **but not one of \ or] or -**
 \ ClassEscape

ClassEscape :: See 15.10.1

DecimalEscape
b
 CharacterEscape
 CharacterClassEscape

A.8 JSON

A.8.1 JSON Lexical Grammar

JSONWhiteSpace :: See 15.12.1.1

<TAB>

<CR>

<LF>
<SP>

JSONString ::
 " *JSONStringCharacters_{opt}* "

See 15.12.1.1

JSONStringCharacters ::
 JSONStringCharacter *JSONStringCharacters_{opt}*

See 15.12.1.1

JSONStringCharacter ::
 SourceCharacter **but not one of " or \ or U+0000 through U+001F**
 \ *JSONEscapeSequence*

See 15.12.1.1

JSONEscapeSequence ::
 JSONEscapeCharacter
 UnicodeEscapeSequence

See 15.12.1.1

JSONEscapeCharacter :: **one of**
 " / \ b f n r t

See 15.12.1.1

JSONNumber ::
 -_{opt} *DecimalIntegerLiteral* *JSONFraction_{opt}* *ExponentPart_{opt}*

See 15.12.1.1

JSONFraction ::
 . *DecimalDigits*

See 15.12.1.1

JSONNullLiteral ::
 NullLiteral

See 15.12.1.1

JSONBooleanLiteral ::
 BooleanLiteral

See 15.12.1.1

A.8.2 JSON Syntactic Grammar

JSONText ::
 JSONValue

See 15.12.1.2

JSONValue ::
 JSONNullLiteral
 JSONBooleanLiteral
 JSONObject
 JSONArray
 JSONString
 JSONNumber

See 15.12.1.2

JSONObject ::
 { }
 { *JSONMemberList* }

See 15.12.1.2

JSONMember ::
 JSONString : *JSONValue*

See 15.12.1.2

JSONMemberList ::
 JSONMember
 JSONMemberList , *JSONMember*

See 15.12.1.2

JSONArray ::
 []
 [*JSONElementList*]

See 15.12.1.2

JSONElementList :
JSONValue
JSONElementList , JSONValue

See 15.12.1.2

DRAFT

DRAFT

Annex B (normative)

Additional ECMAScript Features for Web Browsers

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 7.8.3 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
```

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*.

B.1.2 String Literals

The syntax and semantics of 7.8.4 is extended as follows except that this extension is not allowed for strict mode code:

Syntax

```
EscapeSequence ::  
  CharacterEscapeSequence  
  OctalEscapeSequence  
  HexEscapeSequence  
  UnicodeEscapeSequence
```

```
OctalEscapeSequence ::  
  OctalDigit [lookahead  $\notin$  DecimalDigit]  
  ZeroToThree OctalDigit [lookahead  $\notin$  DecimalDigit]  
  FourToSeven OctalDigit  
  ZeroToThree OctalDigit OctalDigit
```

```
ZeroToThree :: one of  
  0 1 2 3
```

Comment [AW263]: Need to add new material that is not in previous versions of annex B

Deleted: informative

Deleted: Compatibility

Deleted: is

Deleted: s

Deleted: It

Deleted: <#> Past editions of ECMAScript have included additional syntax and semantics for specifying octal literals and octal escape sequences. These have been removed from this edition of ECMAScript. This non-normative annex presents uniform syntax and semantics for octal literals and octal escape sequences for compatibility with some older ECMAScript programs. ¶

Deleted: can be

Deleted: OctalDigit :: one of¶ 0 1 2 3 4 5 6 7¶

Deleted: <#> The MV of NumericLiteral :: OctalIntegerLiteral is the MV of OctalIntegerLiteral. ¶

<#> The MV of OctalDigit :: 0 is 0. ¶

<#> The MV of OctalDigit :: 1 is 1. ¶

<#> The MV of OctalDigit :: 2 is 2. ¶

<#> The MV of OctalDigit :: 3 is 3. ¶

<#> The MV of OctalDigit :: 4 is 4. ¶

<#> The MV of OctalDigit :: 5 is 5. ¶

<#> The MV of OctalDigit :: 6 is 6. ¶

<#> The MV of OctalDigit :: 7 is 7. ¶

Deleted: can be

FourToSeven :: one of
 4 5 6 7

Static Semantics

- The CV of *EscapeSequence :: OctalEscapeSequence* is the CV of the *OctalEscapeSequence*.
- The CV of *OctalEscapeSequence :: OctalDigit* [*lookahead* \notin *DecimalDigit*] is the character whose code unit value is the MV of the *OctalDigit*.
- The CV of *OctalEscapeSequence :: ZeroToThree OctalDigit* [*lookahead* \notin *DecimalDigit*] is the character whose code unit value is (8 times the MV of the *ZeroToThree*) plus the MV of the *OctalDigit*.
- The CV of *OctalEscapeSequence :: FourToSeven OctalDigit* is the character whose code unit value is (8 times the MV of the *FourToSeven*) plus the MV of the *OctalDigit*.
- The CV of *OctalEscapeSequence :: ZeroToThree OctalDigit OctalDigit* is the character whose code unit 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.

B.2 Additional Properties

When the `ECMAScript` host is a web browser the following additional properties of the standard built-in objects are defined.

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 characters have been replaced by a hexadecimal escape sequence.

For those characters being replaced whose code unit value is `0xFF` 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 `0xFF`, a four-digit escape sequence of the form `%uxxxx` is used.

When the `escape` function is called with one argument `string`, the following steps are taken:

1. Call `ToString(string)`.
2. Compute the number of characters in `Result(1)`.
3. Let `R` be the empty string.
4. Let `k` be 0.
5. If `k` equals `Result(2)`, return `R`.
6. Get the character (represented as a 16-bit unsigned integer) at position `k` within `Result(1)`.
7. If `Result(6)` is one of the 69 nonblank characters
`"ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123456789@*_+-./"`
then go to step 13.
8. If `Result(6)` is less than 256, go to step 11.
9. Let `S` be a String containing six characters "`%uvwxyz`" where `wxyz` are four hexadecimal digits encoding the value of `Result(6)`.
10. Go to step 14.
11. Let `S` be a String containing three characters "`%xy`" where `xy` are two hexadecimal digits encoding the value of `Result(6)`.

Deleted: Some implementations of

Deleted: have included

Deleted: these

Deleted: for some

Deleted: native

Deleted: This non-normative annex suggests uniform semantics for such properties without making the properties or their semantics part of this standard.

12. Go to step 14.
13. Let *S* be a String containing the single character Result(6).
14. Let *R* be a new String value computed by concatenating the previous value of *R* and *S*.
15. Increase *k* by 1.
16. Go to step 5.

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 character that it represents.

When the `unescape` function is called with one argument *string*, the following steps are taken:

1. Call `ToString(string)`.
2. Compute the number of characters in Result(1).
3. Let *R* be the empty String.
4. Let *k* be 0.
5. If *k* equals Result(2), return *R*.
6. Let *c* be the character at position *k* within Result(1).
7. If *c* is not %, go to step 18.
8. If *k* is greater than Result(2)–6, go to step 14.
9. If the character at position *k*+1 within Result(1) is not u, go to step 14.
10. If the four characters at positions *k*+2, *k*+3, *k*+4, and *k*+5 within Result(1) are not all hexadecimal digits, go to step 14.
11. Let *c* be the character whose code unit value is the integer represented by the four hexadecimal digits at positions *k*+2, *k*+3, *k*+4, and *k*+5 within Result(1).
12. Increase *k* by 5.
13. Go to step 18.
14. If *k* is greater than Result(2)–3, go to step 18.
15. If the two characters at positions *k*+1 and *k*+2 within Result(1) are not both hexadecimal digits, go to step 18.
16. Let *c* be the character whose code unit value is the integer represented by two zeroes plus the two hexadecimal digits at positions *k*+1 and *k*+2 within Result(1).
17. Increase *k* by 2.
18. Let *R* be a new String value computed by concatenating the previous value of *R* and *c*.
19. Increase *k* by 1.
20. Go to step 5.

B.2.2 Additional Properties of the `String.prototype` Object

B.2.2.1 `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 character position *start* and running for *length* characters (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 `CheckObjectCoercible(this value)`.
2. Let *S* be `ToString(O)`.
3. Let *intStart* be `ToInteger(start)`.
4. ReturnIfAbrupt(*intStart*).
5. If *length* is `undefined`, let *end* be $+\infty$; otherwise let *end* be `ToInteger(length)`.
6. ReturnIfAbrupt(*end*).

Deleted: <code>ReturnIfAbrupt()</code>
Deleted: <code>)</code>
Deleted: <code>Call</code>
Deleted: the result of performing
Deleted: , giving it the <code>this</code> value as its argument
Deleted: <code>Call</code>
Deleted: use
Deleted: call

7. Let *size* be the number of characters in *S*.
8. If *intStart* is negative, then let *intStart* be *max(size + intStart, 0)*.
9. Let *resultLength* be *min(max(end, 0), size - intStart)*.
10. If *resultLength* ≤ 0, return the empty String " ".
11. Return a String containing *resultLength* consecutive characters from *S* beginning with the character at position *intStart*.

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.2.2.2 **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 the result of performing the abstract operation **CreateHTML** with arguments *S*, "a", "name" and *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 *CheckObjectCoercible(string)*.
2. Let *S* be *ToString(str)*.
3. ReturnIfAbrupt(*S*).
4. Let *p1* be the string value that is the concatenation of "<" and *tag*.
5. If *attribute* is not the empty String, then
 - a. Let *V* be the result of performing **ToString(value)**.
 - b. ReturnIfAbrupt(*V*).
 - c. Let *escapedV* be the string value that is the same as *V* except that each occurrence of the character " " (code unit value 0x0020) in *V* has been replaced with the six character sequence """.
 - d. Let *p1* be the string value that is the concatenation of the following string values:
 - *p1*
 - a single space code unit 0x0020
 - *attribute*
 - "="
 - " "
 - *escapedV*
 - " "
6. Let *p2* be the string value that is the concatenation of *p1* and ">".
7. Let *p3* be the string value that is the concatenation of *p2*, "</", *tag*, and ">".
8. Return *p3*.

B.2.2.3 **String.prototype.big ()**

When the **big** method is called with no arguments, the following steps are taken:

1. Let *S* be the **this** value.
2. Return the result of performing the abstract operation **CreateHTML** with arguments *S*, "big", " " and " ".

B.2.2.4 **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 the result of performing the abstract operation **CreateHTML** with arguments *S*, "blink", " " and " ".

- Deleted:** Compute
- Deleted:** Result(1)
- Deleted:** Result(2)
- Deleted:** positive or zero
- Deleted:** use Result(2); else
- Deleted:** use
- Deleted:** Result(4)
- Deleted:** Result(2)
- Deleted:** Compute
- Deleted:** Result(3)
- Deleted:** Result(4)
- Deleted:** Result(5)
- Deleted:** Result(6)
- Deleted:** " "
- Deleted:** Result(6)
- Deleted:** Result(1)
- Deleted:** Result(5)

- Deleted:** ReturnIfAbrupt()
- Deleted:**)
- Deleted:** the result of performing
- Deleted:** *string*
- Deleted:** <#>If *attribute* is not the empty String, then
<#>Let *V* be the result of performing **ToString(value)**.
<#>ReturnIfAbrupt(*V*).|

Deleted: character

Deleted: *V*

Deleted: *c*

B.2.2.5 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 the result of performing the abstract operation CreateHTML with arguments S , "b", "" and "".

Deleted: S

B.2.2.6 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 the result of performing the abstract operation CreateHTML with arguments S , "tt", "" and "".

Deleted: A

B.2.2.7 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 the result of performing the abstract operation CreateHTML with arguments S , "font", "color" and *color*.

Deleted: S

B.2.2.8 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 the result of performing the abstract operation CreateHTML with arguments S , "font", "size" and *size*.

Deleted: A

B.2.2.9 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 the result of performing the abstract operation CreateHTML with arguments S , "i", "" and "".

Deleted: S

B.2.2.10 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 the result of performing the abstract operation CreateHTML with arguments S , "a", "href" and *url*.

Deleted: A

B.2.2.11 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 the result of performing the abstract operation CreateHTML with arguments S , "small", "" and "".

Deleted: S

Deleted: s

B.2.2.12 String.prototype.strike ()

When the **strike** method is called with no arguments, the following steps are taken:

1. Let S be the **this** value.

Deleted: A

Deleted: S

2. Return the result of performing the abstract operation `CreateHTML` with arguments *S*, `"strike"`, `" "` and `" "`.

Deleted: return

Deleted: *s*

Deleted: *A*

B.2.2.13 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 the result of performing the abstract operation `CreateHTML` with arguments *S*, `"sub"`, `" "` and `" "`.

Deleted: *S*

Deleted: return

Deleted: *s*

Deleted: *A*

B.2.2.14 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 the result of performing the abstract operation `CreateHTML` with arguments *S*, `"sup"`, `" "` and `" "`.

Deleted: *S*

Deleted: return

Deleted: *s*

B.2.3 Additional Properties of the Date.prototype Object

B.2.3.1 Date.prototype.getYear ()

NOTE The `getFullYear` method is preferred for nearly all purposes, because it avoids the “year 2000 problem.”

When the `getYear` 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.2.3.2 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 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. If *y* is `NaN`, set the `[[DateValue]] internal data property of this Date object` to `NaN` and return `NaN`.
4. If *y* is not `NaN` and $0 \leq \text{ToInteger}(y) \leq 99$ then let *yyyy* be `ToInteger(y) + 1900`. Otherwise, let *yyyy* be *y*.
5. Let *d* be `MakeDay(yyyy, MonthFromTime(t), DateFromTime(t))`.
6. Let *date* be `UTC(MakeDate(d, TimeWithinDay(t)))`.
7. Set the `[[DateValue]] internal data property of this Date object` to `TimeClip(date)`.
8. Return the value of the `[[DateValue]] internal data property of this Date object`.

B.2.3.3 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`.

Deleted: Call

Deleted: Result(2)

Deleted: PrimitiveValue

Deleted: the `this` value

Deleted: Result(2)

Deleted: Result(2)

Deleted: Result(4)

Deleted: is

Deleted: Result(2)

Deleted: Result(4)

Deleted: is

Deleted: Result(2)

Deleted: Compute

Deleted: Result(4)

Deleted: Compute

Deleted: Result(5)

Deleted: PrimitiveValue

Deleted: the `this` value

Deleted: Result(6)

Deleted: PrimitiveValue

Deleted: the `this` value

B.3 Other Additional Features

B.3.1 The `proto` pseudo property.

B.3.1.1 `Object.prototype.proto`

The initial value of the `proto` property of the Object prototype object is a data property whose initial value is `null`. This property initially has the attributes { `[[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true` }.

Manipulations of this property as tracked by the Boolean valued primordial internal variable UnderscoreProtoEnabled. The default initial value of UnderscoreProtoEnabled is `true` only if this property is initially present on the primordial Object prototype object.

NOTE Any modification of this property or its attributes causes UnderscoreProtoEnabled to be set to `false`.

B.3.1.2 Changes To Internal Methods

The definition of the `[[Get]]` internal method given in 8.12.3 is replaced with the following:

1. If P is the string value "`proto`" and UnderscoreProtoEnabled is `true`, then
 - a. Let $desc$ be the result of calling the `[[GetProperty]]` internal method of O with property name P .
 - b. If $desc$ is not `undefined` and was created by step 1.a to describe the property defined in B.3.1.1 then,
 - i. Return the value of the `[[Prototype]]` internal data property of O .
2. Continue by executing the steps of 8.12.3 starting with step 1.

The definition of the `[[Put]]` internal method given in 8.12.5 is replaced with the following:

1. If P is the string value "`proto`" and UnderscoreProtoEnabled is `true` and O is not the standard built-in Object prototype object, then
 - a. Let $desc$ be the result of calling the `[[GetProperty]]` internal method of O with property name P .
 - b. If $desc$ is not `undefined` and was created by step 1.a to describe the property defined in B.3.1.1 then,
 - i. If the type of V is neither Object or Null, return
 - ii. Set the value of the `[[Prototype]]` internal data property of O to V .
 - iii. Return.
2. Continue by executing the steps of 8.12.5 starting with step 1.

The definition of the `[[Delete]]` internal method given in 8.12.7 is replaced with the following:

1. If UnderscoreProtoEnabled is `true` and P is the string value "`proto`" and O is the standard built-in Object prototype object, then
 - a. Set UnderscoreProtoEnabled to `false`.
2. Continue by executing the steps of 8.12.7 starting with step 1.

The definition of the `[[DefineOwnProperty]]` internal method given in 8.12.9 is replaced with the following:

1. If UnderscoreProtoEnabled is `true` and P is the string value "`proto`" and O is the standard built-in Object prototype object, then
 - a. If any attribute contained in $Desc$ is not present or has a different value from the corresponding attribute in { `[[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true` } then,
 - i. Set UnderscoreProtoEnabled to `false`.
2. Continue by executing the steps of 8.12.9 starting with step 1.

Comment [AWB264]: The section and algorithm reference in this draft are based up the ES5.1 spec. When the corresponding sections of this document are stable, this section will need to be updated.

Comment [AWB8265]: This material is going to be made mandatory and integrated into the main body of the spec.

Comment [AWB266]: This is anticipating specification material related to Module loader and establishing a primordial environment. The basic assumption is that a module loader must be able to disable this feature. This seems to suggest that the ability to do so must exist in module loader APIs even if this feature is not present in an implementation.

Deleted: P

Comment [AWB12267]: This how thing needs be be rewritten, and in the process we will eliminate using `[[GetProperty]]`

Deleted:

Comment [AWB12268]: Need to be updated to use `[[SetP]]`

Comment [AWB12269]: This how thing needs be be rewritten, and in the process we will eliminate using `[[GetProperty]]`

Comment [AWB270]: Note that `Object.defineProperty(obj, 'proto', desc)` nor any other call of `[[DefineOwnProperty]]` does not modify `[[Prototype]]`.

B.3.1.3 proto Object Initialisers

Definitions of two algorithms in 11.1.5 are replaced with the following:

The production *PropertyDefinitionList* : *PropertyDefinition* is evaluated as follows:

1. Let *obj* be the result of the abstract operation *ObjectCreate* with the intrinsic object %ObjectPrototype% as its argument.
2. Let *propId* be the result of evaluating *PropertyDefinition*.
3. If *propId.name* is the string value "proto" and *UnderscoreProtoEnabled* is true and *IsDataDescriptor(propId.descriptor)* is true, then
 - a. Let *v* be *propId.descriptor.value*.
 - b. If *desc* be *propId.descriptor*
 - c. If the type of *v* is either Object or Null,
 - i. Set the value of the [[Prototype]] internal data property of *obj* to *v*.
 - d. Return *obj*.
4. Call the [[DefineOwnProperty]] internal method of *obj* with arguments *propId.name*, *propId.descriptor*, and false.
5. Return *obj*.

The production

PropertyDefinitionList : *PropertyDefinitionList* , *PropertyDefinition* is evaluated as follows:

1. Let *obj* be the result of evaluating *PropertyDefinitionList*.
2. Let *propId* be the result of evaluating *PropertyDefinition*.
3. Let *previous* be the result of calling the [[GetOwnProperty]] internal method of *obj* with argument *propId.name*.
4. If *previous* is not undefined then throw a **SyntaxError** exception if any of the following conditions are true
 - a. This production is contained in strict code and *IsDataDescriptor(previous)* is true and *IsDataDescriptor(propId.descriptor)* is true.
 - b. *IsDataDescriptor(previous)* is true and *IsAccessorDescriptor(propId.descriptor)* is true.
 - c. *IsAccessorDescriptor(previous)* is true and *IsDataDescriptor(propId.descriptor)* is true.
 - d. *IsAccessorDescriptor(previous)* is true and *IsAccessorDescriptor(propId.descriptor)* is true and either both *previous* and *propId.descriptor* have [[Get]] fields or both *previous* and *propId.descriptor* have [[Set]] fields
5. If *propId.name* is the string value "proto" and *UnderscoreProtoEnabled* is true and *IsDataDescriptor(propId.descriptor)* is true, then
 - a. Let *v* be *propId.descriptor.value*.
 - b. If *desc* be *propId.descriptor*
 - c. If the type of *v* is either Object or Null,
 - i. Set the value of the [[Prototype]] internal data property of *obj* to *v*.
 - d. Return *obj*.
5. Call the [[DefineOwnProperty]] internal method of *obj* with arguments *propId.name*, *propId.descriptor*, and false.
6. Return *obj*.

Deleted: *PropertyNameAndValueList*

Deleted: *PropertyAssignment*

Deleted: creating a new object as if by the expression *new Object()* where *Object* is the standard built-in constructor with that name

Deleted: *PropertyAssignment*

Deleted: *O*

Deleted: *V*

Deleted: *PropertyNameAndValueList*

Deleted: *PropertyNameAndValueList*

Deleted: *PropertyAssignment*

Deleted: *PropertyNameAndValueList*

Deleted: *PropertyAssignment*

Deleted: *O*

Deleted: *V*

Annex C (informative)

The Strict Mode of ECMAScript

Field Code Changed
Field Code Changed
Field Code Changed

The strict mode restriction and exceptions

- The identifiers "implements", "interface", "let", "package", "private", "protected", "public", "static", and "yield" are classified as *FutureReservedWord* tokens within strict mode code. (7.6.12).
- A conforming implementation, when processing strict mode code, may not extend the syntax of *NumericLiteral* (7.8.3) to include *OctalIntegerLiteral* as described in B.1.1.
- A conforming implementation, when processing strict mode code (see 10.1.1), may not extend the syntax of *EscapeSequence* to include *OctalEscapeSequence* 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 (8.9.2). 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 `data` property has the value `false`. In these cases a **TypeError** exception is thrown (11.13.1). Deleted: 7
- The identifier `eval` or `arguments` may not appear as the *LeftHandSideExpression* of an Assignment operator (11.13) or of a *PostfixExpression* (11.3) or as the *UnaryExpression* operated upon by a Prefix Increment (11.4.4) or a Prefix Decrement (11.4.5) operator.
- Arguments objects for strict mode functions define non-configurable accessor properties named "`caller`" and "`callee`" which throw a **TypeError** exception on access (10.6).
- Arguments objects for strict mode functions do not dynamically share their array indexed property values with the corresponding formal parameter bindings of their functions. (10.6).
- 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. (10.5).
- It is a **SyntaxError** if strict mode code contains an *ObjectLiteral* with more than one definition of any data property (11.1.5).
- 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 (11.1.5). Deleted: PropertyAssignment
- 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 (10.4.2).
- 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 (10.4.3, 11.1.1, 15.3.4.3, 15.3.4.4).
- 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(11.4.1).

- When a `delete` operator occurs within strict mode code, a **TypeError** is thrown if the property to be deleted has the attribute `{ [[Configurable]]:false }` (11.4.1).
- It is a **SyntaxError** if a *VariableDeclaration* or *VariableDeclarationNoIn* occurs within strict code and its *Identifier* is `eval` or `arguments` (12.2.1).
- Strict mode code may not include a *WithStatement*. The occurrence of a *WithStatement* in such a context is an **SyntaxError** (12.10).
- 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` (12.14.1)
- It is a **SyntaxError** if the identifier `eval` or `arguments` appears within a *FormalParameterList* of a strict mode *FunctionDeclaration* or *FunctionExpression* (13.1)
- A strict mode function may not have two or more formal parameters that have the same name. An attempt to create such a function using a *FunctionDeclaration*, *FunctionExpression*, or *Function* constructor is a **SyntaxError** (13.1, 15.3.2).
- 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 (10.6, 13.6, 15.3.4.5.3).
- It is a **SyntaxError** to use within strict mode code the identifiers `eval` or `arguments` as the *Identifier* of a *FunctionDeclaration* or *FunctionExpression* or as a formal parameter name (13.1). Attempting to dynamically define such a strict mode function using the *Function* constructor (15.3.2) will throw a **SyntaxError** exception.

Deleted: 2

Annex D (informative)

Corrections and Clarifications with Possible Compatibility Impact

Deleted: in the 5th Edition
Deleted: 3rd Edition

Deleted: the 6th

Deleted: 5.1

In Edition 6

15.9.1.15: 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".

15.9.5.2: 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**".

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.

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.

15.3.4.3: 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.

15.4.4.12: In step 9.a, incorrect reference to `relativeStart` was replaced with a reference to `actualStart`.

15.4.4.15: Clarified that the default value for `fromIndex` is the length minus 1 of the array.

15.4.4.18: In step 9 of the algorithm, `undefined` is now the specified return value.

15.4.4.22: In step 9.c.ii 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.I.ii and 3.I.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`.

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 `J/A` internal 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.

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

Deleted: the
Deleted: 5th

that the actual built-in object is to be used rather than the current dynamically resolved value of the correspondingly identifier binding.

Deleted: named property

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.

Deleted: 2

Deleted: , 11.8.3, 11.8.5

11.1.4: Edition 5 clarifies the fact that a trailing comma at the end of an `ArrayInitialiser` 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.

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`.

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.

13: In Edition 3, the algorithm for the production `FunctionExpression` with an `Identifier` adds an object created as if by `new Object()` to the scope chain to serve as a scope for looking up the name of the function. The identifier resolution rules (10.1.4 in Edition 3) when applied to such an object will, if necessary, follow the object's prototype chain when attempting to resolve an identifier. This means all the properties of `Object.prototype` are visible as identifiers within that scope. In practice most implementations of Edition 3 have not implemented this semantics. Edition 5 changes the specified semantics by using a Declarative Environment Record to bind the name of the function.

14: In Edition 3, the algorithm for the production `SourceElements : SourceElements SourceElement` did not correctly propagate statement result values in the same manner as `Block`. This could result in the `eval` function producing an incorrect result when evaluating a `Program` text. In practice most implementations of Edition 3 have implemented the correct propagation rather than what was specified in Edition 5.

15.10.6: `RegExp.prototype` is now a `RegExp` object rather than an instance of `Object`. The value of its `[[Class]]` internal `data` property which is observable using `Object.prototype.toString` is now "RegEx" rather than "Object".

DRAFT

Annex E (informative)

Additions and Changes that Introduce Incompatibilities with Prior Editions

Field Code Changed
Field Code Changed
Field Code Changed
Deleted: in the 5th Edition
Deleted: the 3rd

In the 6th Edition

12.6: In Edition 6, a terminating semi-colon is no longer required at the end of a do-while statement.

12.14: 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.

Deleted:

13.3 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. In Edition 5, they were constructors.

Deleted: t

Deleted: I

15.2.3.5 and 15.2.3.7: In Edition 6, all property additions and changes are processed, even if one of them throws an exception. If an exception occurs during such processing, the first such exception is thrown after all properties are processed. In Edition 5, processing of property additions and changes immediately terminated when the first exception occurred.

15.5.4 In Edition 6, the *Array* prototype object is not a *Array* instance. In previous editions it was an *Array* instance with a `length` property whose value was `+0`.

15.5.4 In Edition 6, the *String* prototype object is not a *String* instance. In previous editions it was a *String* instance whose number value was the empty string.

15.6.4 In Edition 6, the *Boolean* prototype object is not a *Boolean* instance. In previous editions it was a *Boolean* instance whose number value was `false`.

15.7.4 In Edition 6, the *Number* prototype object is not a *Number* instance. In previous editions it was a *Date* instance whose number value was `+0`.

15.9.5 In Edition 6, the *Date* prototype object is not a *Date* instance. In previous editions it was a *Date* instance whose `TimeValue` was `Nan`.

15.10.6 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.

15.10.7 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.

In the 5th Edition

7.1: Unicode format control characters 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.

7.2: Unicode character <BOM> 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

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.

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.

15.4.4: 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.

10.6: In Edition 5 the value of the `[[Class]]` internal `data` property 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.

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`.

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.

15.1.2.2: The specification of the function `parseInt` no longer allows implementations to treat Strings beginning with a `0` character as octal values.

15.3.4.3: 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.

15.3.4.3, 15.3.4.4: 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.

15.3.5.2: 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.

Deleted: PrimitiveValue

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 <BOM>.

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.

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.

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.

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.

DRAFT

Annex F (informative)

Static Semantic Rule Cross Reference

Field Code Changed
Field Code Changed
Field Code Changed
Deleted: Technically Significant Corrections and Clarifications in the 5.1 Edition

<u>BoundNames</u>	Produces a list of the Identifiers bound by a production. Does not include Identifiers that are bound within inner environments associated with the production.	<u>12.2.1,</u> <u>12.2.2,</u> <u>12.2.4,</u> <u>12.6.4, 13.1,</u> <u>13.2, 13.5</u>		
<u>ConstructorMethod</u>	From a <i>ClassBody</i> return the first <i>ClassElement</i> whose PropName is "constructor". Returns empty if the <i>ClassBody</i> does not contain one.	<u>13.5</u>		
<u>Contains</u>	Determine if a grammar production either directly or indirectly includes a grammar symbol.	<u>5.3, 13.1,</u> <u>13.2, 13.5</u>		
<u>CoveredFormalsList</u>	Reparse a covered <i>Expression</i> using <i>FormalsList</i> as the goal symbol.	<u>13.2</u>		
<u>CV</u>	Determines the "character value" of a component of a <i>StringLiteral</i> .	<u>7.8.4</u>		
<u>Elision Width</u>	Determine the number of commas in an <i>Elision</i> .	<u>11.1.4.1</u>		
<u>ExpectedArgumentCount</u>	Determine the "length" of an argument list for the purpose of initializing the "length" property of a function object.	<u>13.1, 13.2,</u> <u>13.3</u>		
<u>HasInitialiser</u>	Determines whether the production contains an <i>Initialiser</i> production.	<u>12.2.4, 13.1</u>		
<u>IsConstantDeclaration</u>	Determines whether the production introduces a immutable environment record binding	<u>12.2, 13.1,</u> <u>13.5</u>		
<u>IsValidAssignmentPattern</u>	Determines if a <i>LeftHandSideExpression</i> is a valid assignment target. Primarily for dealing with destructuring assignment targets.	<u>11.2</u>		
<u>LexicalDeclarations</u>	Return a List containing the components of a production that are processed as lexical declarations	<u>12.1, 12.11,</u> <u>12.5</u>		
<u>LexicallyDeclaredNames</u>	Returns a list of the lexically scoped identifiers declared by a production.	<u>12.1, 13.1,</u> <u>13.2, 13.5</u>		
<u>PrototypeMethodDefinitions</u>	Return a list of the non-static <i>MethodDefinition</i> productions that are part of a <i>ClassElementList</i> .	<u>13.5</u>		
<u>MV</u>	Determines the "mathematical value" of a numeric	<u>7.8.3</u>		

Deleted: s

	<u>literal or component of a numeric literal.</u>		
<u>PropName</u>	Determines the string value of the property name referenced by a production.	<u>11.1.5.1,</u> <u>13.3, 13.5</u>	
<u>PropNameList</u>	Returns a List of the string values of the property names referenced by a production. The list reflects the order of the references in the source text. The list may contain duplicate elements.	<u>11.5.1, 13.5</u>	
<u>PrototypeMethodDefinitions</u>	Return a list of the non-static <i>MethodDefinition</i> productions that are part of a <i>ClassElementList</i> .	<u>13.5</u>	
<u>ReferencesSuper</u>	Determine if a <i>MethodDefinition</i> contains any references to the ReservedWord super .	<u>13.3</u>	
<u>SpecialMethod</u>	Determine if a <i>MethodDefinition</i> defines a generator method or an accessor property.	<u>13.3</u>	
<u>StaticMethodDefinitions</u>	Return a list of the static <i>MethodDefinition</i> productions that are part of a <i>ClassElementList</i> .	<u>13.5</u>	
<u>SV</u>	Determines the "string value" of a <i>StringLiteral</i> or component of a <i>StringLiteral</i> .	<u>7.8.4</u>	
<u>VarDeclaredNames</u>	Returns a list of the local top-level scoped identifiers declared by a production. These are identifier that are scoped as if by a var statement.	<u>12.1, 12.5,</u> <u>12.6.1,</u> <u>12.6.2,</u> <u>12.6.3,</u> <u>12.6.4,</u> <u>12.12, 13.1,</u> <u>13.5</u>	

► Formatted: Heading 1

Scrap Heap

A place to temporarily hand on to stuff that's been deleted

MemberExpression :

MemberExpression <| TriangleLiteral

TriangleLiteral :

SealedArrayLiteral
SealedObjectLiteral
FunctionExpression
ArrowFunction
ValueLiteral

CallExpression :

CallExpression <| TriangleLiteral

15.2.3.15 Object.isObject (O)

When the **isObject** function is called with argument *O*, the following steps are taken:

1. If Type(*O*) is Object return **true**.
2. Return **false**.

15.5.4.25 String.prototype.toArray()

The following steps are taken:

1. Let *O* be CheckObjectCoercible(this value).
2. Let *S* be ToString(*O*).
3. ReturnIfAbrupt(*S*).
4. Let *len* be the number of characters in *S*.
5. Let *array* be the result of the abstract operation ArrayCreate with argument *len*.
6. Let *n* be **0**.
7. Repeat, while *n* < *len*:
 - a. Let *c* be the character at position *n* in *S*.
 - b. Call the [[DefineOwnProperty]] internal method of *array* with arguments ToString(*n*), the PropertyDescriptor {[[Value]]: *c*, [[Writable]]: **true**, [[Enumerable]]: **true**, [[Configurable]]: **true**}, and **false**.
 - c. Increment *n* by 1.
8. Return *array*.

Deleted: ReturnIfAbrupt()

Deleted:)

Deleted: the result of calling

Deleted: , giving it the **this** value as its argument

Deleted: (15.4)

The **length** property of the **toArray** method is **0**.

NOTE 1 Returns an Array object with elements corresponding to the characters of this object (converted to a String).

NOTE 2 The **toArray** 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.

Static Semantics: TopLevelLexicallyDeclaredNames

OuterStatementList : OuterStatementList OuterItem

1. Let *names* be `TopLevelLexicallyDeclaredNames` of *OuterStatementList*.
2. Append to *names* the elements of the `TopLevelLexicallyDeclaredNames` of *OuterItem*.
3. Return *names*.

OuterItem : StatementListItem

1. Return a new empty List.

StatementListItem : Declaration

1. If *Declaration* is `Declaration : FunctionDeclaration`, then return a new empty List.
2. Return the `BoundNames` of *Declaration*.

8.3.10 [[Enumerate]] (includePrototype, onlyEnumerable)

When the `[[Enumerate]]` internal method of *O* is called with Boolean arguments `includePrototype` and `onlyEnumerable`, the following steps are taken:

1. Return an Iterator object (reference *xxxx*) whose next method iterates over all the keys of enumerable property keys of *O*. If `includePrototype` is `false`, then only own properties of *O* are included. If `onlyEnumerable` is `false`, then all properties that do not have private name keys are included. The mechanics and order of enumerating the properties is not specified but must conform to the rules specified below.

Comment [AWB6271]: This is an experiment to see we can use this internal method to define Object.keys, Object.getOwnPropertyNames, and perhaps some other things

Comment [AWB6272]: TODO

Enumerated properties do not include properties whose property key is a private name. Properties of the object being enumerated may be deleted during enumeration. If a property that has not yet been visited during enumeration is deleted, then it will not be visited. If new properties are added to the object being enumerated during enumeration, the newly added properties are not guaranteed to be visited in the active enumeration. A property name must not be visited more than once in any enumeration.

Enumerating the properties of an object includes enumerating properties of its prototype, and the prototype of the prototype, and so on, recursively; but a property of a prototype is not enumerated if it is "shadowed" because some previous object in the prototype chain has a property with the same name. The values of `[[Enumerable]]` attributes are not considered when determining if a property of a prototype object is shadowed by a previous object on the prototype chain.

The following is an informative algorithm that conforms to these rules

Comment [AWB6273]: TODO: Finish this up, and turn it into iterator definition include a next method

1. Let *obj* be *O*.
2. Let *proto* be the value of the `[[Prototype]]` internal data property of *O*.
3. If `includePrototype` is `false` or *proto* is the value `null`, then
 - a. Let *propList* be a new empty List.
4. Else
 - a. Let *propList* be the result of calling the `[[Enumerate]]` internal method of *proto* with arguments `true` and `onlyEnumerable`.
5. For each string *name* that is the property key of an own property of *O*
 - a. Let *desc* be the result of calling the `[[GetOwnProperty]]` internal method of *O* with argument *name*.
 - b. If *name* is an element of *propList*, then remove *name* as an element of *propList*.
 - c. If `onlyEnumerable` is `false` or *desc.[[Enumerable]]* is `true`, then add *name* as an element of *propList*.
6. Order the elements of *propList* in an implementation defined order.
7. Return *propList*.

This follow version places function body declarations in scope of parameter initializers

10.5.3 Function Declaration Instantiation

NOTE When an execution context is established for evaluating function code a new Declarative Environment Record is created and bindings for each formal parameter, and each function level variable, constant, or function declared in the function are instantiated in the environment record. Formal parameters and functions are initialized as part of this process. All other bindings are initialized during execution of the function code.

Function Declaration Instantiation 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 declarative environment record in which bindings are to be created.

1. Let *code* be the value of the **[[Code]]** internal property of *func*.
2. Let *strict* be the value of the **[[Strict]]** internal property of *func*.
3. Let *formals* be the value of the **[[FormalParameterList]]** internal property of *func*.
4. Let *parameterNames* be the *BoundNames* of *formals*.
5. Let *varDeclarations* be the *VarScopedDeclarations* of *code*.
6. Let *functionsToInitialize* be an emptyList.
7. Let *argumentsObjectNotNeeded* be **false**.
8. For each *d* in *varDeclarations*, in reverse list order do
 - a. If *d* is a *FunctionDeclaration* then
 - i. **NOTE** If there are multiple *FunctionDeclarations* for the same name, the last declaration is used.
 - ii. Let *fn* be the sole element of the *BoundNames* of *d*.
 - iii. If *fn* is "**arguments**", then let *argumentsObjectNotNeeded* be **true**.
 - iv. Let *alreadyDeclared* be the result of calling *env*'s *HasBinding* concrete method passing *fn* as the argument.
 - v. If *alreadyDeclared* is **false**, then
 1. Let *status* be the result of calling *env*'s *CreateMutableBinding* concrete method passing *fn* as the argument.
 2. Assert: *status* is never an Abrupt Completion.
 3. Append *d* to *functionsToInitialize*.
9. For each String *paramName* in *parameterNames*, do
 - a. Let *alreadyDeclared* be the result of calling *env*'s *HasBinding* concrete method passing *paramName* as the argument.
 - b. **NOTE** Duplicate parameter names can only occur in non-strict functions. Parameter names that are the same as function declaration names do not get initialized to **undefined**.
 - c. If *alreadyDeclared* is **false**, then
 - i. If *paramName* is "**arguments**", then let *argumentsObjectNotNeeded* be **true**.
 - ii. Let *status* be the result of calling *env*'s *CreateMutableBinding* concrete method passing *paramName* as the argument.
 - iii. Assert: *status* is never an Abrupt Completion.
 - iv. Call *env*'s *InitializeBinding* concrete method passing *paramName*, and **undefined** as the arguments.
10. **NOTE** If there is a function declaration or formal parameter with the name "**arguments**" then an argument object is not created.
11. If *argumentsObjectNotNeeded* is **false**, then
 - a. If *strict* is **true**, then
 - i. Call *env*'s *CreateImmutableBinding* concrete method passing the String "**arguments**" as the argument.
 - b. Else,
 - i. Call *env*'s *CreateMutableBinding* concrete method passing the String "**arguments**" as the argument.
12. Let *varNames* be the *VarDeclaredNames* of *code*.
13. For each String *varName* in *varNames*, in list order do
 - a. Let *alreadyDeclared* be the result of calling *env*'s *HasBinding* concrete method passing *varName* as the argument.
 - b. **NOTE** A *VarDeclaredNames* is only instantiated and initialized here if it is not also the name of a formal parameter or a *FunctionDeclarations*.

Comment [AWB7274]: TODO: don't create an arguments binding for arrow functions (and perhaps for concise methods)

- c. If `alreadyDeclared` is `false`, then
- Call `env`'s `CreateMutableBinding` concrete method passing `varName` as the argument.
14. Let `lexDeclarations` be the `LexicalDeclarations` of `code`.
15. For each element `d` in `lexDeclarations` do
- NOTE** A lexically declared name can not be the same as a function 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
 - Call `env`'s `CreateImmutableBinding` concrete method passing `dn` as the argument.
 - Else,
 - Call `env`'s `CreateMutableBinding` concrete method passing `dn` and `false` as the arguments.
16. For each `FunctionDeclaration` `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 `env`.
 - Call `env`'s `SetMutableBinding` concrete method passing `fn`, `fo`, and `false` as the arguments.
17. **NOTE** Function declarations are initialised prior to parameter initialisation so that default value expressions may reference them. It is not extended code. "`arguments`" is not initialised until after parameter initialisation.
18. Let `ao` be the result of `InstantiateArgumentsObject` with argument `argumentsList`.
19. **NOTE** If `argumentsObjectNotNeeded` is `true` then the value of `ao` is not directly observable to ECMAScript code and need not actually exist. In that case, its use in the above steps is strictly as a device for specifying formal parameter initialisation semantics.
20. If `argumentsObjectNotNeeded` is `false`, then
- If `strict` is `true`, then
 - Perform the abstract operation `CompleteStrictArgumentsObject` with argument `ao`.
 - Else,
 - Perform the abstract operation `CompleteMappedArgumentsObject` with arguments `ao`, `func`, `formals`, and `env`.
 - Call `env`'s `InitializeBinding` concrete method passing "`arguments`" and `ao` as arguments.
21. Let `formalStatus` be the result of performing Binding Initialisation for `formals` with `ao` and `undefined` as arguments.
22. `ReturnIfAbrupt(formalStatus)`.
23. `ReturnNormalCompletion(empty)`.

Comment [AWB7275]: TODO: don't create an arguments binding for arrow functions (and perhaps for concise methods)

Deleted: ..

DRAFT

Table 1— Internal Properties Only Defined for Some Objects

<i>Internal Property</i>	<i>Value Type Domain</i>	<i>Description</i>
<code>[[BuiltinBrand]]</code>	<code>The BuiltinBrand enumeration.</code>	A tag value used by this specification to categorize various kinds of ECMAScript objects defined in this specification.
<code>[[PrimitiveValue]]</code>	<code>primitive</code>	Internal state information associated with this object. Of the standard built-in ECMAScript objects, only Boolean, Date, Number, and String objects implement <code>[[PrimitiveValue]]</code> .
<code>[[Scope]]</code>	<code>Lexical Environment</code>	A lexical environment that is the environment in which a Function object is executed. Of the standard built-in ECMAScript objects, only Function objects implement <code>[[Scope]]</code> .
<code>[[FormalParameters]]</code>	<code>Parse Tree</code>	A parse tree for ECMAScript code parsed with <i>FormalParameterList</i> as the goal symbol. Of the standard built-in ECMAScript objects, only Function objects implement <code>[[FormalParameters]]</code> .
<code>[[Code]]</code>	<code>Parse Tree</code>	A parse tree for ECMAScript code parsed with <i>FunctionBody</i> as the goal symbol. Of the standard built-in ECMAScript objects, only Function objects implement <code>[[Code]]</code> .
<code>[[Strict]]</code>	<code>Boolean</code>	<code>true</code> if a Function object is a strict mode function. Of the standard built-in ECMAScript objects, only Function objects implement <code>[[Strict]]</code> .
<code>[[BoundTargetFunction]]</code>	<code>Object</code>	The target function of a function object created using the standard built-in <code>Function.prototype.bind</code> method. Only ECMAScript objects created using <code>Function.prototype.bind</code> have a <code>[[BoundTargetFunction]]</code> internal property.
<code>[[BoundThis]]</code>	<code>any</code>	The pre-bound <code>this</code> value of a function Object created using the standard built-in <code>Function.prototype.bind</code> method. Only ECMAScript objects created using <code>Function.prototype.bind</code> have a <code>[[BoundThis]]</code> internal property.
<code>[[BoundArguments]]</code>	<code>List of any</code>	The pre-bound argument values of a function Object created by the standard built-in <code>Function.prototype.bind</code> method. Only objects created by <code>Function.prototype.bind</code> have a <code>[[BoundArguments]]</code> internal property.
<code>[[RegExpMatcher]]</code>	<code>SpecOp(String, index) → MatchResult</code>	Tests for a regular expression match and returns a <code>MatchResult</code> value (see 15.10.2.1). Of the standard built-in ECMAScript objects, only RegExp objects implement <code>[[RegExpMatch]]</code> .
<code>[[ParameterMap]]</code>	<code>Object</code>	Provides a mapping between the properties of an arguments object (see 10.6) and the formal parameters of the associated function. Only objects that are arguments objects have a <code>[[ParameterMap]]</code> internal property.

Deleted: 119

Deleted: NativeBrand

Deleted: Members of t

Deleted: NativeBrand

Deleted: native

Deleted: True if

Deleted: [[Match]]

Deleted: [[Match]]

DRAFT

Bibliography

- [1] IEEE Std 754-2008: IEEE Standard for Floating-Point Arithmetic. Institute of Electrical and Electronic Engineers, New York (2008)
- [2] The Unicode Consortium. The Unicode Standard, Version 3.0, defined by: The Unicode Standard, Version 3.0 (Reading, MA, Addison-Wesley, 2000. ISBN 0-201-61633-5)
- [3] ISO 8601:2004(E) *Data elements and interchange formats – Information interchange -- Representation of dates and times*
- [4] RFC 1738 “Uniform Resource Locators (URL)”, available at <<http://tools.ietf.org/html/rfc1738>>
- [5] RFC 2396 “Uniform Resource Identifiers (URI): Generic Syntax”, available at <<http://tools.ietf.org/html/rfc2396>>
- [6] RFC 3629 “UTF-8, a transformation format of ISO 10646”, available at <<http://tools.ietf.org/html/rfc3629>>
- [7] RFC 4627 “The application/json Media Type for JavaScript Object Notation (JSON)”, available at <<http://tools.ietf.org/html/rfc4627>>
- [8] Unicode Inc. (2010). Unicode Technical Report #15: “Unicode Normalization Forms”, available at <<http://www.unicode.org/reports/tr15/tr15-29.html>>

Deleted: ¶
Unicode Inc. (2010), Unicode Technical Report #15:
Unicode Normalization Forms

Deleted: "
Deleted:)"
Deleted: "
Deleted: "
Deleted: "
Deleted: "
Deleted: "
Deleted: ")"

DRAFT