

# Expressions

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 8)**

Unknown directive type "index".

```
.. index:: expression, BNF
```

This chapter explains the meaning of the elements of expressions in Python.

**Syntax Notes:** In this and the following chapters, extended BNF notation will be used to describe syntax, not lexical analysis. When (one alternative of) a syntax rule has the form

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 16)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   name: `othername`
```

and no semantics are given, the semantics of this form of `name` are the same as for `othername`.

## Arithmetic conversions

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 28)**

Unknown directive type "index".

```
.. index:: pair: arithmetic; conversion
```

When a description of an arithmetic operator below uses the phrase "the numeric arguments are converted to a common type", this means that the operator implementation for built-in types works as follows:

- If either argument is a complex number, the other is converted to complex;
- otherwise, if either argument is a floating point number, the other is converted to floating point;
- otherwise, both must be integers and no conversion is necessary.

Some additional rules apply for certain operators (e.g., a string as a left argument to the `%` operator). Extensions must define their own conversion behavior.

## Atoms

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 51)**

Unknown directive type "index".

```
.. index:: atom
```

Atoms are the most basic elements of expressions. The simplest atoms are identifiers or literals. Forms enclosed in parentheses, brackets or braces are also categorized syntactically as atoms. The syntax for atoms is:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 57)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   atom: `identifier` | `literal` | `enclosure`
   enclosure: `parenth_form` | `list_display` | `dict_display` | `set_display`
             : | `generator_expression` | `yield_atom`
```

## Identifiers (Names)

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 68)

Unknown directive type "index".

```
.. index:: name, identifier
```

An identifier occurring as an atom is a name. See section [ref`identifiers`](#) for lexical definition and section [ref`naming`](#) for documentation of naming and binding.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 70); [backlink](#)

Unknown interpreted text role "ref".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 70); [backlink](#)

Unknown interpreted text role "ref".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 74)

Unknown directive type "index".

```
.. index:: exception: NameError
```

When the name is bound to an object, evaluation of the atom yields that object. When a name is not bound, an attempt to evaluate it raises a [exc:`NameError`](#) exception.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 76); [backlink](#)

Unknown interpreted text role "exc".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 82)

Unknown directive type "index".

```
.. index::
   pair: name; mangling
   pair: private; names
```

**Private name mangling:** When an identifier that textually occurs in a class definition begins with two or more underscore characters and does not end in two or more underscores, it is considered a [dfn:`private name`](#) of that class. Private names are transformed to a longer form before code is generated for them. The transformation inserts the class name, with leading underscores removed and a single underscore inserted, in front of the name. For example, the identifier `__spam` occurring in a class named `Ham` will be transformed to `_Ham__spam`. This transformation is independent of the syntactical context in which the identifier is used. If the transformed name is extremely long (longer than 255 characters), implementation defined truncation may happen. If the class name consists only of underscores, no transformation is done.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 86); [backlink](#)

Unknown interpreted text role "dfn".

## Literals

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 104)

Unknown directive type "index".

```
.. index:: single: literal
```

Python supports string and bytes literals and various numeric literals:

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Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
    literal: `stringliteral` | `bytesliteral`
           : | `integer` | `floatnumber` | `imagnumber`
```

Evaluation of a literal yields an object of the given type (string, bytes, integer, floating point number, complex number) with the given value. The value may be approximated in the case of floating point and imaginary (complex) literals. See section :ref:`literals` for details.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 112); [backlink](#)**

Unknown interpreted text role "ref".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 117)**

Unknown directive type "index".

```
.. index::
    triple: immutable; data; type
    pair: immutable; object
```

All literals correspond to immutable data types, and hence the object's identity is less important than its value. Multiple evaluations of literals with the same value (either the same occurrence in the program text or a different occurrence) may obtain the same object or a different object with the same value.

## Parenthesized forms

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 133)**

Unknown directive type "index".

```
.. index::
    single: parenthesized form
    single: () (parentheses); tuple display
```

A parenthesized form is an optional expression list enclosed in parentheses:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 139)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
    parenth_form: "(" [ `starred_expression` ] ")"
```

A parenthesized expression list yields whatever that expression list yields: if the list contains at least one comma, it yields a tuple; otherwise, it yields the single expression that makes up the expression list.

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Unknown directive type "index".

```
.. index:: pair: empty; tuple
```

An empty pair of parentheses yields an empty tuple object. Since tuples are immutable, the same rules as for literals apply (i.e., two occurrences of the empty tuple may or may not yield the same object).

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 152)

Unknown directive type "index".

```
.. index::
   single: comma
   single: , (comma)
```

Note that tuples are not formed by the parentheses, but rather by use of the comma operator. The exception is the empty tuple, for which parentheses *are* required --- allowing unparenthesized "nothing" in expressions would cause ambiguities and allow common typos to pass uncaught.

## Displays for lists, sets and dictionaries

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 167)

Unknown directive type "index".

```
.. index:: single: comprehensions
```

For constructing a list, a set or a dictionary Python provides special syntax called "displays", each of them in two flavors:

- either the container contents are listed explicitly, or
- they are computed via a set of looping and filtering instructions, called a `:dfn:comprehension``.

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Unknown interpreted text role "dfn".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 177)

Unknown directive type "index".

```
.. index::
   single: for; in comprehensions
   single: if; in comprehensions
   single: async for; in comprehensions
```

Common syntax elements for comprehensions are:

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Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   comprehension: `assignment_expression` `comp_for`
   comp_for: ["async"] "for" `target_list` "in" `or_test` [`comp_iter`]
   comp_iter: `comp_for` | `comp_if`
   comp_if: "if" `or_test` [`comp_iter`]
```

The comprehension consists of a single expression followed by at least one `:keyword:`!for`` clause and zero or more `:keyword:`!for`` or `:keyword:`!if`` clauses. In this case, the elements of the new container are those that would be produced by considering each of the `:keyword:`!for`` or `:keyword:`!if`` clauses a block, nesting from left to right, and evaluating the expression to produce an element each time the innermost block is reached.

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main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 190); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 190); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 190); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 190); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 190); [backlink](#)

Unknown interpreted text role "keyword".

However, aside from the iterable expression in the leftmost `keyword: !for` clause, the comprehension is executed in a separate implicitly nested scope. This ensures that names assigned to in the target list don't "leak" into the enclosing scope.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 197); [backlink](#)

Unknown interpreted text role "keyword".

The iterable expression in the leftmost `keyword: !for` clause is evaluated directly in the enclosing scope and then passed as an argument to the implicitly nested scope. Subsequent `keyword: !for` clauses and any filter condition in the leftmost `keyword: !for` clause cannot be evaluated in the enclosing scope as they may depend on the values obtained from the leftmost iterable. For example:

```
[x*y for x in range(10) for y in range(x, x+10)].
```

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 201); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 201); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 201); [backlink](#)

Unknown interpreted text role "keyword".

To ensure the comprehension always results in a container of the appropriate type, `yield` and `yield from` expressions are prohibited in the implicitly nested scope.

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Unknown directive type "index".

```
.. index::  
   single: await; in comprehensions
```

Since Python 3.6, in an `keyword: async def` function, an `keyword: !async for` clause may be used to iterate over a `term: asynchronous iterator`. A comprehension in an `keyword: !async def` function may consist of either a `keyword: !for` or

:keyword: 'async for' clause following the leading expression, may contain additional :keyword: 'for' or :keyword: 'async for' clauses, and may also use :keyword: 'await' expressions. If a comprehension contains either :keyword: 'async for' clauses or :keyword: 'await' expressions or other asynchronous comprehensions it is called an :dfn: 'asynchronous comprehension'. An asynchronous comprehension may suspend the execution of the coroutine function in which it appears. See also [PEP 530](#).

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Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 215); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 215); [backlink](#)

Unknown interpreted text role "term".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 215); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 215); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 215); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 215); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 215); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 215); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 215); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 215); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 215); [backlink](#)

Unknown interpreted text role "dfn".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 227)**

Unknown directive type "versionadded".

```
.. versionadded:: 3.6
   Asynchronous comprehensions were introduced.
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 230)**

Unknown directive type "versionchanged".

```
.. versionchanged:: 3.8
   ``yield`` and ``yield from`` prohibited in the implicitly nested scope.
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 233)**

Unknown directive type "versionchanged".

```
.. versionchanged:: 3.11
   Asynchronous comprehensions are now allowed inside comprehensions in
   asynchronous functions. Outer comprehensions implicitly become
   asynchronous.
```

## List displays

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 244)**

Unknown directive type "index".

```
.. index::
   pair: list; display
   pair: list; comprehensions
   pair: empty; list
   object: list
   single: [] (square brackets); list expression
   single: , (comma); expression list
```

A list display is a possibly empty series of expressions enclosed in square brackets:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 255)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   list_display: "[" [ `starred_list` | `comprehension` ] "]"
```

A list display yields a new list object, the contents being specified by either a list of expressions or a comprehension. When a comma-separated list of expressions is supplied, its elements are evaluated from left to right and placed into the list object in that order. When a comprehension is supplied, the list is constructed from the elements resulting from the comprehension.

## Set displays

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 270)**

Unknown directive type "index".

```
.. index::
   pair: set; display
   pair: set; comprehensions
   object: set
   single: {} (curly brackets); set expression
```



```
single: , (comma); expression list
```

A set display is denoted by curly braces and distinguishable from dictionary displays by the lack of colons separating keys and values:

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Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   set_display: "{" (`starred_list` | `comprehension`) "}"
```

A set display yields a new mutable set object, the contents being specified by either a sequence of expressions or a comprehension. When a comma-separated list of expressions is supplied, its elements are evaluated from left to right and added to the set object. When a comprehension is supplied, the set is constructed from the elements resulting from the comprehension.

An empty set cannot be constructed with {}; this literal constructs an empty dictionary.

## Dictionary displays

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 298)**

Unknown directive type "index".

```
.. index::
   pair: dictionary; display
   pair: dictionary; comprehensions
   key, datum, key/datum pair
   object: dictionary
   single: {} (curly brackets); dictionary expression
   single: : (colon); in dictionary expressions
   single: , (comma); in dictionary displays
```

A dictionary display is a possibly empty series of key/datum pairs enclosed in curly braces:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 310)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   dict_display: "{" [`key_datum_list` | `dict_comprehension`] "}"
   key_datum_list: `key_datum` ("," `key_datum`)* [","]
   key_datum: `expression` ":" `expression` | "***" `or_expr`
   dict_comprehension: `expression` ":" `expression` `comp_for`
```

A dictionary display yields a new dictionary object.

If a comma-separated sequence of key/datum pairs is given, they are evaluated from left to right to define the entries of the dictionary: each key object is used as a key into the dictionary to store the corresponding datum. This means that you can specify the same key multiple times in the key/datum list, and the final dictionary's value for that key will be the last one given.

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Unknown directive type "index".

```
.. index::
   unpacking; dictionary
   single: **; in dictionary displays
```

A double asterisk \*\* denotes `:dfn:'dictionary unpacking'`. Its operand must be a `:term'mapping'`. Each mapping item is added to the new dictionary. Later values replace values already set by earlier key/datum pairs and earlier dictionary unpackings.

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Unknown interpreted text role "dfn".



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Unknown interpreted text role "term".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 333)**

Unknown directive type "versionadded".

```
.. versionadded:: 3.5
   Unpacking into dictionary displays, originally proposed by :pep:`448`.
```

A dict comprehension, in contrast to list and set comprehensions, needs two expressions separated with a colon followed by the usual "for" and "if" clauses. When the comprehension is run, the resulting key and value elements are inserted in the new dictionary in the order they are produced.

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Unknown directive type "index".

```
.. index:: pair: immutable; object
          hashable
```

Restrictions on the types of the key values are listed earlier in section [ref`types`](#). (To summarize, the key type should be [term`hashable`](#), which excludes all mutable objects.) Clashes between duplicate keys are not detected; the last datum (textually rightmost in the display) stored for a given key value prevails.

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Unknown interpreted text role "ref".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 344); [backlink](#)**

Unknown interpreted text role "term".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 350)**

Unknown directive type "versionchanged".

```
.. versionchanged:: 3.8
   Prior to Python 3.8, in dict comprehensions, the evaluation order of key
   and value was not well-defined. In CPython, the value was evaluated before
   the key. Starting with 3.8, the key is evaluated before the value, as
   proposed by :pep:`572`.
```

## Generator expressions

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 362)**

Unknown directive type "index".

```
.. index::
   pair: generator; expression
   object: generator
   single: () (parentheses); generator expression
```

A generator expression is a compact generator notation in parentheses:

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 369)

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   generator_expression: "(" `expression` `comp_for` ")"
```

A generator expression yields a new generator object. Its syntax is the same as for comprehensions, except that it is enclosed in parentheses instead of brackets or curly braces.

Variables used in the generator expression are evaluated lazily when the `meth:~generator.__next__` method is called for the generator object (in the same fashion as normal generators). However, the iterable expression in the leftmost `keyword:!for` clause is immediately evaluated, so that an error produced by it will be emitted at the point where the generator expression is defined, rather than at the point where the first value is retrieved. Subsequent `keyword:!for` clauses and any filter condition in the leftmost `keyword:!for` clause cannot be evaluated in the enclosing scope as they may depend on the values obtained from the leftmost iterable. For example: `(x*y for x in range(10) for y in range(x, x+10))`.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 376); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 376); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 376); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 376); [backlink](#)

Unknown interpreted text role "keyword".

The parentheses can be omitted on calls with only one argument. See section `ref:calls` for details.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 387); [backlink](#)

Unknown interpreted text role "ref".

To avoid interfering with the expected operation of the generator expression itself, `yield` and `yield from` expressions are prohibited in the implicitly defined generator.

If a generator expression contains either `keyword:!async for` clauses or `keyword:await` expressions it is called an `dfn:asyncronous generator expression`. An asynchronous generator expression returns a new asynchronous generator object, which is an asynchronous iterator (see `ref:async-iterators`).

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 394); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 394); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 394); [backlink](#)

Unknown interpreted text role "dfn".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 394); [backlink](#)**

Unknown interpreted text role "ref".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 400)**

Unknown directive type "versionadded".

```
.. versionadded:: 3.6
   Asynchronous generator expressions were introduced.
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 403)**

Unknown directive type "versionchanged".

```
.. versionchanged:: 3.7
   Prior to Python 3.7, asynchronous generator expressions could
   only appear in :keyword:`async def` coroutines. Starting
   with 3.7, any function can use asynchronous generator expressions.
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 408)**

Unknown directive type "versionchanged".

```
.. versionchanged:: 3.8
   ``yield`` and ``yield from`` prohibited in the implicitly nested scope.
```

## Yield expressions

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 417)**

Unknown directive type "index".

```
.. index::
   keyword: yield
   keyword: from
   pair: yield; expression
   pair: generator; function
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 423)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   yield_atom: "(" `yield_expression` ")"
   yield_expression: "yield" [`expression_list` | "from" `expression`]
```

The yield expression is used when defining a `term`generator`` function or an `term`asynchronous generator`` function and thus can only be used in the body of a function definition. Using a yield expression in a function's body causes that function to be a generator function, and using it in an `keyword:`async def`` function's body causes that coroutine function to be an asynchronous generator function. For example:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 427); [backlink](#)**

Unknown interpreted text role "term".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 427); [backlink](#)**

Unknown interpreted text role "term".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 427); [backlink](#)**

Unknown interpreted text role "keyword".

```
def gen(): # defines a generator function
    yield 123

async def agen(): # defines an asynchronous generator function
    yield 123
```

Due to their side effects on the containing scope, `yield` expressions are not permitted as part of the implicitly defined scopes used to implement comprehensions and generator expressions.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 444)**

Unknown directive type "versionchanged".

```
.. versionchanged:: 3.8
   Yield expressions prohibited in the implicitly nested scopes used to
   implement comprehensions and generator expressions.
```

Generator functions are described below, while asynchronous generator functions are described separately in section [ref: asynchronous-generator-functions](#).

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 448); [backlink](#)**

Unknown interpreted text role "ref".

When a generator function is called, it returns an iterator known as a generator. That generator then controls the execution of the generator function. The execution starts when one of the generator's methods is called. At that time, the execution proceeds to the first `yield` expression, where it is suspended again, returning the value of `:token:~python-grammar:expression_list` to the generator's caller. By suspended, we mean that all local state is retained, including the current bindings of local variables, the instruction pointer, the internal evaluation stack, and the state of any exception handling. When the execution is resumed by calling one of the generator's methods, the function can proceed exactly as if the `yield` expression were just another external call. The value of the `yield` expression after resuming depends on the method which resumed the execution. If `:meth:~generator.__next__` is used (typically via either a `:keyword: for` or the `:func:next` builtin) then the result is `:const:None`. Otherwise, if `:meth:~generator.send` is used, then the result will be the value passed in to that method.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 452); [backlink](#)**

Unknown interpreted text role "token".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 452); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 452); [backlink](#)**

Unknown interpreted text role "keyword".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 452); [backlink](#)**

Unknown interpreted text role "func".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 452); [backlink](#)**

Unknown interpreted text role "const".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 452); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 468)

Unknown directive type "index".

```
.. index:: single: coroutine
```

All of this makes generator functions quite similar to coroutines; they yield multiple times, they have more than one entry point and their execution can be suspended. The only difference is that a generator function cannot control where the execution should continue after it yields; the control is always transferred to the generator's caller.

Yield expressions are allowed anywhere in a `keyword: try` construct. If the generator is not resumed before it is finalized (by reaching a zero reference count or by being garbage collected), the generator-iterator's `meth: ~generator.close` method will be called, allowing any pending `keyword: finally` clauses to execute.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 476); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 476); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 476); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 482)

Unknown directive type "index".

```
.. index::
   single: from; yield from expression
```

When `yield from <expr>` is used, the supplied expression must be an iterable. The values produced by iterating that iterable are passed directly to the caller of the current generator's methods. Any values passed in with `meth: ~generator.send` and any exceptions passed in with `meth: ~generator.throw` are passed to the underlying iterator if it has the appropriate methods. If this is not the case, then `meth: ~generator.send` will raise `exc: AttributeError` or `exc: TypeError`, while `meth: ~generator.throw` will just raise the passed in exception immediately.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 485); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 485); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 485); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 485); [backlink](#)

Unknown interpreted text role "exc".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 485); [backlink](#)

Unknown interpreted text role "exc".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 485); [backlink](#)

Unknown interpreted text role "meth".

When the underlying iterator is complete, the `attr`~StopIteration.value`` attribute of the raised `exc:`StopIteration`` instance becomes the value of the yield expression. It can be either set explicitly when raising `exc:`StopIteration``, or automatically when the subiterator is a generator (by returning a value from the subgenerator).

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 494); [backlink](#)

Unknown interpreted text role "attr".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 494); [backlink](#)

Unknown interpreted text role "exc".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 494); [backlink](#)

Unknown interpreted text role "exc".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 500)

Unknown directive type "versionchanged".

```
.. versionchanged:: 3.3
   Added ``yield from <expr>`` to delegate control flow to a subiterator.
```

The parentheses may be omitted when the yield expression is the sole expression on the right hand side of an assignment statement.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 506)

Unknown directive type "seealso".

```
.. seealso::

:pep:`255` - Simple Generators
  The proposal for adding generators and the :keyword:`yield` statement to Python.

:pep:`342` - Coroutines via Enhanced Generators
  The proposal to enhance the API and syntax of generators, making them
  usable as simple coroutines.

:pep:`380` - Syntax for Delegating to a Subgenerator
  The proposal to introduce the :token:`~python-grammar:yield_from` syntax,
  making delegation to subgenerators easy.

:pep:`525` - Asynchronous Generators
  The proposal that expanded on :pep:`492` by adding generator capabilities to
  coroutine functions.
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 523)**

Unknown directive type "index".

```
.. index:: object: generator
```

## Generator-iterator methods

This subsection describes the methods of a generator iterator. They can be used to control the execution of a generator function.

Note that calling any of the generator methods below when the generator is already executing raises a :exc:`ValueError` exception.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 532); [backlink](#)**

Unknown interpreted text role "exc".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 535)**

Unknown directive type "index".

```
.. index:: exception: StopIteration
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 538)**

Unknown directive type "method".

```
.. method:: generator.__next__()
```

Starts the execution of a generator function or resumes it at the last executed yield expression. When a generator function is resumed with a :meth:`~generator.\_\_next\_\_` method, the current yield expression always evaluates to :const:`None`. The execution then continues to the next yield expression, where the generator is suspended again, and the value of the :token:`~python-grammar:expression\_list` is returned to :meth:`~\_\_next\_\_`'s caller. If the generator exits without yielding another value, a :exc:`~StopIteration` exception is raised.

This method is normally called implicitly, e.g. by a :keyword:`for` loop, or by the built-in :func:`next` function.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 553)**

Unknown directive type "method".

```
.. method:: generator.send(value)
```

Resumes the execution and "sends" a value into the generator function. The \*value\* argument becomes the result of the current yield expression. The :meth:`~send` method returns the next value yielded by the generator, or raises :exc:`~StopIteration` if the generator exits without yielding another value. When :meth:`~send` is called to start the generator, it must be called with :const:`None` as the argument, because there is no yield expression that could receive the value.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 564)**

Unknown directive type "method".

```
.. method:: generator.throw(value)
               generator.throw(type[, value[, traceback]])
```

Raises an exception at the point where the generator was paused,



and returns the next value yielded by the generator function. If the generator exits without yielding another value, a `:exc: `StopIteration`` exception is raised. If the generator function does not catch the passed-in exception, or raises a different exception, then that exception propagates to the caller.

In typical use, this is called with a single exception instance similar to the way the `:keyword: `raise`` keyword is used.

For backwards compatibility, however, the second signature is supported, following a convention from older versions of Python. The `*type*` argument should be an exception class, and `*value*` should be an exception instance. If the `*value*` is not provided, the `*type*` constructor is called to get an instance. If `*traceback*` is provided, it is set on the exception, otherwise any existing `:attr: `~BaseException.__traceback__`` attribute stored in `*value*` may be cleared.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 585)**

Unknown directive type "index".

```
.. index:: exception: GeneratorExit
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 588)**

Unknown directive type "method".

```
.. method:: generator.close()
```

Raises a `:exc: `GeneratorExit`` at the point where the generator function was paused. If the generator function then exits gracefully, is already closed, or raises `:exc: `GeneratorExit`` (by not catching the exception), `close` returns to its caller. If the generator yields a value, a `:exc: `RuntimeError`` is raised. If the generator raises any other exception, it is propagated to the caller. `:meth: `close`` does nothing if the generator has already exited due to an exception or normal exit.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 598)**

Unknown directive type "index".

```
.. index:: single: yield; examples
```

## Examples

Here is a simple example that demonstrates the behavior of generators and generator functions:

```
>>> def echo(value=None):
...     print("Execution starts when 'next()' is called for the first time.")
...     try:
...         while True:
...             try:
...                 value = (yield value)
...             except Exception as e:
...                 value = e
...     finally:
...         print("Don't forget to clean up when 'close()' is called.")
...
>>> generator = echo(1)
>>> print(next(generator))
Execution starts when 'next()' is called for the first time.
1
>>> print(next(generator))
None
>>> print(generator.send(2))
2
>>> generator.throw(TypeError, "spam")
TypeError('spam',)
>>> generator.close()
Don't forget to clean up when 'close()' is called.
```

For examples using `yield from`, see [ref`pep-380`](#) in "What's New in Python."

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 630); [backlink](#)

Unknown interpreted text role "ref".

### Asynchronous generator functions

The presence of a `yield` expression in a function or method defined using `keyword`async def`` further defines the function as an `term`asynchronous generator`` function.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 638); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 638); [backlink](#)

Unknown interpreted text role "term".

When an asynchronous generator function is called, it returns an asynchronous iterator known as an asynchronous generator object. That object then controls the execution of the generator function. An asynchronous generator object is typically used in an `keyword`async for`` statement in a coroutine function analogously to how a generator object would be used in a `keyword`for`` statement.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 642); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 642); [backlink](#)

Unknown interpreted text role "keyword".

Calling one of the asynchronous generator's methods returns an `term`awaitable`` object, and the execution starts when this object is awaited on. At that time, the execution proceeds to the first `yield` expression, where it is suspended again, returning the value of `token`~python-grammar:expression_list`` to the awaiting coroutine. As with a generator, suspension means that all local state is retained, including the current bindings of local variables, the instruction pointer, the internal evaluation stack, and the state of any exception handling. When the execution is resumed by awaiting on the next object returned by the asynchronous generator's methods, the function can proceed exactly as if the `yield` expression were just another external call. The value of the `yield` expression after resuming depends on the method which resumed the execution. If `meth`~agen.__anext__`` is used then the result is `const`None``. Otherwise, if `meth`~agen.asend`` is used, then the result will be the value passed in to that method.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 649); [backlink](#)

Unknown interpreted text role "term".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 649); [backlink](#)

Unknown interpreted text role "token".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 649); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 649); [backlink](#)

Unknown interpreted text role "const".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 649); [backlink](#)

Unknown interpreted text role "meth".

If an asynchronous generator happens to exit early by `keyword:'break'`, the caller task being cancelled, or other exceptions, the generator's async cleanup code will run and possibly raise exceptions or access context variables in an unexpected context--perhaps after the lifetime of tasks it depends, or during the event loop shutdown when the async-generator garbage collection hook is called. To prevent this, the caller must explicitly close the async generator by calling `meth:'~agen.aclose'` method to finalize the generator and ultimately detach it from the event loop.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 664); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 664); [backlink](#)

Unknown interpreted text role "meth".

In an asynchronous generator function, yield expressions are allowed anywhere in a `keyword:'try'` construct. However, if an asynchronous generator is not resumed before it is finalized (by reaching a zero reference count or by being garbage collected), then a yield expression within a `keyword:'!try'` construct could result in a failure to execute pending `keyword:'finally'` clauses. In this case, it is the responsibility of the event loop or scheduler running the asynchronous generator to call the asynchronous generator-iterator's `meth:'~agen.aclose'` method and run the resulting coroutine object, thus allowing any pending `keyword:'!finally'` clauses to execute.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 674); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 674); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 674); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 674); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 674); [backlink](#)

Unknown interpreted text role "keyword".

To take care of finalization upon event loop termination, an event loop should define a *finalizer* function which takes an asynchronous generator-iterator and presumably calls `meth:'~agen.aclose'` and executes the coroutine. This *finalizer* may be registered by calling `:func:'sys.set_asyncgen_hooks'`. When first iterated over, an asynchronous generator-iterator will store the registered *finalizer* to be called upon finalization. For a reference example of a *finalizer* method see the implementation of `asyncio.Loop.shutdown_asyncgens` in `source:'Lib/asyncio/base_events.py'`.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 685); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-

main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 685); [backlink](#)

Unknown interpreted text role "func".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 685); [backlink](#)

Unknown interpreted text role "source".

The expression `yield from <expr>` is a syntax error when used in an asynchronous generator function.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 697)

Unknown directive type "index".

```
.. index:: object: asynchronous-generator
```

### Asynchronous generator-iterator methods

This subsection describes the methods of an asynchronous generator iterator, which are used to control the execution of a generator function.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 707)

Unknown directive type "index".

```
.. index:: exception: StopAsyncIteration
```

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 709)

Unknown directive type "coroutinemethod".

```
.. coroutinemethod:: agen.__anext__()
```

Returns an awaitable which when run starts to execute the asynchronous generator or resumes it at the last executed yield expression. When an asynchronous generator function is resumed with an `:meth:`~agen.__anext__`` method, the current yield expression always evaluates to `:const:`None`` in the returned awaitable, which when run will continue to the next yield expression. The value of the `:token:`~python-grammar:expression_list`` of the yield expression is the value of the `:exc:`StopIteration`` exception raised by the completing coroutine. If the asynchronous generator exits without yielding another value, the awaitable instead raises a `:exc:`StopAsyncIteration`` exception, signalling that the asynchronous iteration has completed.

This method is normally called implicitly by a `:keyword:`async for`` loop.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 726)

Unknown directive type "coroutinemethod".

```
.. coroutinemethod:: agen.asend(value)
```

Returns an awaitable which when run resumes the execution of the asynchronous generator. As with the `:meth:`~generator.send()`` method for a generator, this "sends" a value into the asynchronous generator function, and the `*value*` argument becomes the result of the current yield expression. The awaitable returned by the `:meth:`~asend`` method will return the next value yielded by the generator as the value of the raised `:exc:`StopIteration``, or raises `:exc:`StopAsyncIteration`` if the asynchronous generator exits without yielding another value. When `:meth:`~asend`` is called to start the asynchronous generator, it must be called with `:const:`None`` as the argument, because there is no yield expression that could receive the value.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 741)**

Unknown directive type "coroutinemethod".

```
.. coroutinemethod:: agen.athrow(type[, value[, traceback]])
```

Returns an awaitable that raises an exception of type ``type`` at the point where the asynchronous generator was paused, and returns the next value yielded by the generator function as the value of the raised :exc:`StopIteration` exception. If the asynchronous generator exits without yielding another value, a :exc:`StopAsyncIteration` exception is raised by the awaitable. If the generator function does not catch the passed-in exception, or raises a different exception, then when the awaitable is run that exception propagates to the caller of the awaitable.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 753)**

Unknown directive type "index".

```
.. index:: exception: GeneratorExit
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 756)**

Unknown directive type "coroutinemethod".

```
.. coroutinemethod:: agen.aclose()
```

Returns an awaitable that when run will throw a :exc:`GeneratorExit` into the asynchronous generator function at the point where it was paused. If the asynchronous generator function then exits gracefully, is already closed, or raises :exc:`GeneratorExit` (by not catching the exception), then the returned awaitable will raise a :exc:`StopIteration` exception. Any further awaitables returned by subsequent calls to the asynchronous generator will raise a :exc:`StopAsyncIteration` exception. If the asynchronous generator yields a value, a :exc:`RuntimeError` is raised by the awaitable. If the asynchronous generator raises any other exception, it is propagated to the caller of the awaitable. If the asynchronous generator has already exited due to an exception or normal exit, then further calls to :meth:`aclose` will return an awaitable that does nothing.

## Primaries

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 776)**

Unknown directive type "index".

```
.. index:: single: primary
```

Primaries represent the most tightly bound operations of the language. Their syntax is:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 781)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   primary: `atom` | `attributeref` | `subscription` | `slicing` | `call`
```

## Attribute references

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-**

**main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 790)**

Unknown directive type "index".

```
.. index::
   pair: attribute; reference
   single: . (dot); attribute reference
```

An attribute reference is a primary followed by a period and a name:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 796)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   attributeref: `primary` "." `identifier`
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 799)**

Unknown directive type "index".

```
.. index::
   exception: AttributeError
   object: module
   object: list
```

The primary must evaluate to an object of a type that supports attribute references, which most objects do. This object is then asked to produce the attribute whose name is the identifier. This production can be customized by overriding the `meth: `__getattr__`` method. If this attribute is not available, the exception `exc: `AttributeError`` is raised. Otherwise, the type and value of the object produced is determined by the object. Multiple evaluations of the same attribute reference may yield different objects.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 804); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 804); [backlink](#)**

Unknown interpreted text role "exc".

## Subscriptions

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 818)**

Unknown directive type "index".

```
.. index::
   single: subscription
   single: [] (square brackets); subscription
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 822)**

Unknown directive type "index".

```
.. index::
   object: sequence
   object: mapping
   object: string
   object: tuple
   object: list
   object: dictionary
   pair: sequence; item
```

The subscription of an instance of a `.ref: container class <sequence-types>` will generally select an element from the container. The subscription of a `.term: generic class <generic type>` will generally return a `.ref: GenericAlias <types-genericalias>` object.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 831); [backlink](#)

Unknown interpreted text role "ref".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 831); [backlink](#)

Unknown interpreted text role "term".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 831); [backlink](#)

Unknown interpreted text role "ref".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 836)

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   subscription: `primary` "[" `expression_list` "]"
```

When an object is subscripted, the interpreter will evaluate the primary and the expression list.

The primary must evaluate to an object that supports subscription. An object may support subscription through defining one or both of `.meth:~object.__getitem__` and `.meth:~object.__class_getitem__`. When the primary is subscripted, the evaluated result of the expression list will be passed to one of these methods. For more details on when `__class_getitem__` is called instead of `__getitem__`, see `.ref: class_getitem-versus-getitem`.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 842); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 842); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 842); [backlink](#)

Unknown interpreted text role "ref".

If the expression list contains at least one comma, it will evaluate to a `.class: tuple` containing the items of the expression list. Otherwise, the expression list will evaluate to the value of the list's sole member.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 849); [backlink](#)

Unknown interpreted text role "class".

For built-in objects, there are two types of objects that support subscription via `.meth:~object.__getitem__`:

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 853); [backlink](#)

Unknown interpreted text role "meth".

1. Mappings. If the primary is a `.term: mapping`, the expression list must evaluate to an object whose value is one of the keys of the mapping, and the subscription selects the value in the mapping that corresponds to that key. An example of a builtin mapping class is the `.class: dict` class.



**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 856); [backlink](#)

Unknown interpreted text role "term".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 856); [backlink](#)

Unknown interpreted text role "class".

- Sequences. If the primary is a `:term:`sequence``, the expression list must evaluate to an `:class:`int`` or a `:class:`slice`` (as discussed in the following section). Examples of builtin sequence classes include the `:class:`str``, `:class:`list`` and `:class:`tuple`` classes.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 860); [backlink](#)

Unknown interpreted text role "term".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 860); [backlink](#)

Unknown interpreted text role "class".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 860); [backlink](#)

Unknown interpreted text role "class".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 860); [backlink](#)

Unknown interpreted text role "class".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 860); [backlink](#)

Unknown interpreted text role "class".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 860); [backlink](#)

Unknown interpreted text role "class".

The formal syntax makes no special provision for negative indices in `:term:`sequences` <sequence>`. However, built-in sequences all provide a `:meth:`~object.__getitem__`` method that interprets negative indices by adding the length of the sequence to the index so that, for example, `x[-1]` selects the last item of `x`. The resulting value must be a nonnegative integer less than the number of items in the sequence, and the subscription selects the item whose index is that value (counting from zero). Since the support for negative indices and slicing occurs in the object's `:meth:`~__getitem__`` method, subclasses overriding this method will need to explicitly add that support.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 865); [backlink](#)

Unknown interpreted text role "term".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 865); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 865); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 875)

Unknown directive type "index".

```
.. index::
   single: character
   pair: string; item
```

A `:class:`string <str>`` is a special kind of sequence whose items are *characters*. A character is not a separate data type but a string of exactly one character.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 879); [backlink](#)

Unknown interpreted text role "class".

## Slicings

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 889)

Unknown directive type "index".

```
.. index::
   single: slicing
   single: slice
   single: : (colon); slicing
   single: , (comma); slicing
```

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 895)

Unknown directive type "index".

```
.. index::
   object: sequence
   object: string
   object: tuple
   object: list
```

A slicing selects a range of items in a sequence object (e.g., a string, tuple or list). Slicings may be used as expressions or as targets in assignment or `keyword:del` statements. The syntax for a slicing:

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 901); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 905)

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   slicing: `primary` "[" `slice_list` "]"
   slice_list: `slice_item` ("," `slice_item`)* [" ,"]
   slice_item: `expression` | `proper_slice`
```

```
proper_slice: ['lower_bound'] ":" ['upper_bound'] [ ":" ['stride'] ]
lower_bound: `expression`
upper_bound: `expression`
stride: `expression`
```

There is ambiguity in the formal syntax here: anything that looks like an expression list also looks like a slice list, so any subscription can be interpreted as a slicing. Rather than further complicating the syntax, this is disambiguated by defining that in this case the interpretation as a subscription takes priority over the interpretation as a slicing (this is the case if the slice list contains no proper slice).

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 921)**

Unknown directive type "index".

```
.. index::
   single: start (slice object attribute)
   single: stop (slice object attribute)
   single: step (slice object attribute)
```

The semantics for a slicing are as follows. The primary is indexed (using the same `.meth: '__getitem__'` method as normal subscription) with a key that is constructed from the slice list, as follows. If the slice list contains at least one comma, the key is a tuple containing the conversion of the slice items; otherwise, the conversion of the lone slice item is the key. The conversion of a slice item that is an expression is that expression. The conversion of a proper slice is a slice object (see section `ref:types`) whose `attr:~slice.start`, `attr:~slice.stop` and `attr:~slice.step` attributes are the values of the expressions given as lower bound, upper bound and stride, respectively, substituting `None` for missing expressions.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 926); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 926); [backlink](#)**

Unknown interpreted text role "ref".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 926); [backlink](#)**

Unknown interpreted text role "attr".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 926); [backlink](#)**

Unknown interpreted text role "attr".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 926); [backlink](#)**

Unknown interpreted text role "attr".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 939)**

Unknown directive type "index".

```
.. index::
   object: callable
   single: call
   single: argument; call semantics
   single: () (parentheses); call
   single: , (comma); argument list
   single: = (equals); in function calls
```

A call calls a callable object (e.g., a `term` `function`) with a possibly empty series of `term` arguments `<argument>`:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 952); [backlink](#)**

Unknown interpreted text role "term".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 952); [backlink](#)**

Unknown interpreted text role "term".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 955)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   call: `primary` "(" [ `argument_list` [ ",", "]" | `comprehension` ] ")"
   argument_list: `positional_arguments` [ ",", " `starred_and_keywords`"
       : [ ",", " `keywords_arguments`"
       : | `starred_and_keywords` [ ",", " `keywords_arguments`"
       : | `keywords_arguments`
   positional_arguments: positional_item ( ",", " positional_item)*
   positional_item: `assignment_expression` | " " " `expression`
   starred_and_keywords: ( " " " `expression` | " " " `keyword_item` )
       : ( ",", " " " `expression` | " " " `keyword_item` ) *
   keywords_arguments: ( `keyword_item` | " " " " `expression` )
       : ( ",", " `keyword_item` | " " " " `expression` ) *
   keyword_item: `identifier` "=" `expression`
```

An optional trailing comma may be present after the positional and keyword arguments but does not affect the semantics.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 972)**

Unknown directive type "index".

```
.. index::
   single: parameter; call semantics
```

The primary must evaluate to a callable object (user-defined functions, built-in functions, methods of built-in objects, class objects, methods of class instances, and all objects having a `meth: '__call__'` method are callable). All argument expressions are evaluated before the call is attempted. Please refer to section `ref: function` for the syntax of formal `term: parameter` lists.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 975); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 975); [backlink](#)**

Unknown interpreted text role "ref".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 975); [backlink](#)**

Unknown interpreted text role "term".

If keyword arguments are present, they are first converted to positional arguments, as follows. First, a list of unfilled slots is created for the formal parameters. If there are N positional arguments, they are placed in the first N slots. Next, for each keyword argument, the identifier is used to determine the corresponding slot (if the identifier is the same as the first formal parameter name, the first slot is used, and so on). If the slot is already filled, a `exc: 'TypeError'` exception is raised. Otherwise, the argument is placed in the slot, filling it (even if the expression is `None`, it fills the slot). When all arguments have been processed, the slots that are still unfilled are filled with the corresponding default value from the function definition. (Default values are calculated, once, when the function is defined; thus, a mutable object such as a list or dictionary used as default value will be shared by all calls that don't specify an

argument value for the corresponding slot; this should usually be avoided.) If there are any unfilled slots for which no default value is specified, a `:exc:'TypeError'` exception is raised. Otherwise, the list of filled slots is used as the argument list for the call.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 983); [backlink](#)**

Unknown interpreted text role "exc".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 983); [backlink](#)**

Unknown interpreted text role "exc".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1001)**

Unknown directive type "impl-detail".

```
.. impl-detail::
```

An implementation may provide built-in functions whose positional parameters do not have names, even if they are 'named' for the purpose of documentation, and which therefore cannot be supplied by keyword. In CPython, this is the case for functions implemented in C that use `:c:func:'PyArg_ParseTuple'` to parse their arguments.

If there are more positional arguments than there are formal parameter slots, a `:exc:'TypeError'` exception is raised, unless a formal parameter using the syntax `*identifier` is present; in this case, that formal parameter receives a tuple containing the excess positional arguments (or an empty tuple if there were no excess positional arguments).

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1009); [backlink](#)**

Unknown interpreted text role "exc".

If any keyword argument does not correspond to a formal parameter name, a `:exc:'TypeError'` exception is raised, unless a formal parameter using the syntax `**identifier` is present; in this case, that formal parameter receives a dictionary containing the excess keyword arguments (using the keywords as keys and the argument values as corresponding values), or a (new) empty dictionary if there were no excess keyword arguments.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1015); [backlink](#)**

Unknown interpreted text role "exc".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1022)**

Unknown directive type "index".

```
.. index::
   single: * (asterisk); in function calls
   single: unpacking; in function calls
```

If the syntax `*expression` appears in the function call, `expression` must evaluate to an `:term:'iterable'`. Elements from these iterables are treated as if they were additional positional arguments. For the call `f(x1, x2, *y, x3, x4)`, if `y` evaluates to a sequence `y1, ..., yM`, this is equivalent to a call with `M+4` positional arguments `x1, x2, y1, ..., yM, x3, x4`.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1026); [backlink](#)**

Unknown interpreted text role "term".

A consequence of this is that although the `*expression` syntax may appear *after* explicit keyword arguments, it is processed *before* the keyword arguments (and any `**expression` arguments -- see below). So:

```
>>> def f(a, b):
```

```
...     print(a, b)
...
>>> f(b=1, *(2,))
2 1
>>> f(a=1, *(2,))
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: f() got multiple values for keyword argument 'a'
>>> f(1, *(2,))
1 2
```

It is unusual for both keyword arguments and the `*expression` syntax to be used in the same call, so in practice this confusion does not often arise.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1052)**

Unknown directive type "index".

```
.. index::
   single: **; in function calls
```

If the syntax `**expression` appears in the function call, `expression` must evaluate to a `:term:`mapping``, the contents of which are treated as additional keyword arguments. If a keyword is already present (as an explicit keyword argument, or from another unpacking), a `:exc:`TypeError`` exception is raised.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1055); [backlink](#)**

Unknown interpreted text role "term".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1055); [backlink](#)**

Unknown interpreted text role "exc".

Formal parameters using the syntax `*identifier` or `**identifier` cannot be used as positional argument slots or as keyword argument names.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1064)**

Unknown directive type "versionchanged".

```
.. versionchanged:: 3.5
   Function calls accept any number of ``*`` and ``**`` unpackings,
   positional arguments may follow iterable unpackings (``*``),
   and keyword arguments may follow dictionary unpackings (``**``).
   Originally proposed by :pep:`448`.
```

A call always returns some value, possibly `None`, unless it raises an exception. How this value is computed depends on the type of the callable object.

If it is---

a user-defined function:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1077)**

Unknown directive type "index".

```
.. index::
   pair: function; call
   triple: user-defined; function; call
   object: user-defined function
   object: function
```

The code block for the function is executed, passing it the argument list. The first thing the code block will do is bind the

formal parameters to the arguments; this is described in section [:ref:`function`](#). When the code block executes a [:keyword:`return`](#) statement, this specifies the return value of the function call.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1083); [backlink](#)**

Unknown interpreted text role "ref".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1083); [backlink](#)**

Unknown interpreted text role "keyword".

a built-in function or method:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1090)**

Unknown directive type "index".

```
.. index::
    pair: function; call
    pair: built-in function; call
    pair: method; call
    pair: built-in method; call
    object: built-in method
    object: built-in function
    object: method
    object: function
```

The result is up to the interpreter; see [:ref:`built-in-funcs`](#) for the descriptions of built-in functions and methods.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1100); [backlink](#)**

Unknown interpreted text role "ref".

a class object:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1104)**

Unknown directive type "index".

```
.. index::
    object: class
    pair: class object; call
```

A new instance of that class is returned.

a class instance method:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1111)**

Unknown directive type "index".

```
.. index::
    object: class instance
    object: instance
    pair: class instance; call
```



The corresponding user-defined function is called, with an argument list that is one longer than the argument list of the call: the instance becomes the first argument.

a class instance:

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1121)

Unknown directive type "index".

```
.. index::
   pair: instance; call
   single: __call__() (object method)
```

The class must define a `meth: `__call__`` method; the effect is then the same as if that method was called.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1125); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1129)

Unknown directive type "index".

```
.. index:: keyword: await
```

## Await expression

Suspend the execution of `term: `coroutine`` on an `term: `awaitable`` object. Can only be used inside a `term: `coroutine function``.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1135); [backlink](#)

Unknown interpreted text role "term".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1135); [backlink](#)

Unknown interpreted text role "term".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1135); [backlink](#)

Unknown interpreted text role "term".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1138)

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   await_expr: "await" `primary`
```

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1141)

Unknown directive type "versionadded".

```
.. versionadded:: 3.5
```

## The power operator

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1149)

Unknown directive type "index".

```
.. index::
   pair: power; operation
   operator: **
```

The power operator binds more tightly than unary operators on its left; it binds less tightly than unary operators on its right. The syntax is:

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1156)

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   power: (await_expr | primary) ["**" u_expr]
```

Thus, in an unparenthesized sequence of power and unary operators, the operators are evaluated from right to left (this does not constrain the evaluation order for the operands):  $-1**2$  results in  $-1$ .

The power operator has the same semantics as the built-in `func:pow` function, when called with two arguments: it yields its left argument raised to the power of its right argument. The numeric arguments are first converted to a common type, and the result is of that type.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1163); [backlink](#)

Unknown interpreted text role "func".

For int operands, the result has the same type as the operands unless the second argument is negative; in that case, all arguments are converted to float and a float result is delivered. For example,  $10**2$  returns 100, but  $10**-2$  returns 0.01.

Raising 0.0 to a negative power results in a `exc:ZeroDivisionError`. Raising a negative number to a fractional power results in a `class:complex` number. (In earlier versions it raised a `exc:ValueError`.)

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1173); [backlink](#)

Unknown interpreted text role "exc".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1173); [backlink](#)

Unknown interpreted text role "class".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1173); [backlink](#)

Unknown interpreted text role "exc".

This operation can be customized using the special `meth: __pow__` method.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1177); [backlink](#)

Unknown interpreted text role "meth".

## Unary arithmetic and bitwise operations

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-

**main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1184)**

Unknown directive type "index".

```
.. index::
   triple: unary; arithmetic; operation
   triple: unary; bitwise; operation
```

All unary arithmetic and bitwise operations have the same priority:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1190)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   u_expr: `power` | "-" `u_expr` | "+" `u_expr` | "~" `u_expr`
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1193)**

Unknown directive type "index".

```
.. index::
   single: negation
   single: minus
   single: operator; - (minus)
   single: - (minus); unary operator
```

The unary `-` (minus) operator yields the negation of its numeric argument; the operation can be overridden with the `meth: `__neg__`` special method.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1199); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1202)**

Unknown directive type "index".

```
.. index::
   single: plus
   single: operator; + (plus)
   single: + (plus); unary operator
```

The unary `+` (plus) operator yields its numeric argument unchanged; the operation can be overridden with the `meth: `__pos__`` special method.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1207); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1210)**

Unknown directive type "index".

```
.. index::
   single: inversion
   operator: ~ (tilde)
```

The unary `~` (invert) operator yields the bitwise inversion of its integer argument. The bitwise inversion of `x` is defined as `-(x+1)`. It only applies to integral numbers or to custom objects that override the `meth: `__invert__`` special method.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1214); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1221)

Unknown directive type "index".

```
.. index:: exception: TypeError
```

In all three cases, if the argument does not have the proper type, a `:exc:`TypeError`` exception is raised.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1223); [backlink](#)

Unknown interpreted text role "exc".

## Binary arithmetic operations

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1232)

Unknown directive type "index".

```
.. index:: triple: binary; arithmetic; operation
```

The binary arithmetic operations have the conventional priority levels. Note that some of these operations also apply to certain non-numeric types. Apart from the power operator, there are only two levels, one for multiplicative operators and one for additive operators:

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1239)

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
    m_expr: `u_expr` | `m_expr` "*" `u_expr` | `m_expr` "@" `m_expr` |
           : `m_expr` "/" `u_expr` | `m_expr` "/" `u_expr` |
           : `m_expr` "%" `u_expr`
    a_expr: `m_expr` | `a_expr` "+" `m_expr` | `a_expr` "-" `m_expr`
```

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1245)

Unknown directive type "index".

```
.. index::
    single: multiplication
    operator: * (asterisk)
```

The `*` (multiplication) operator yields the product of its arguments. The arguments must either both be numbers, or one argument must be an integer and the other must be a sequence. In the former case, the numbers are converted to a common type and then multiplied together. In the latter case, sequence repetition is performed; a negative repetition factor yields an empty sequence.

This operation can be customized using the special `meth: `__mul__`` and `meth: `__rmul__`` methods.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1255); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1255); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1258)**

Unknown directive type "index".

```
.. index::
   single: matrix multiplication
   operator: @ (at)
```

The @ (at) operator is intended to be used for matrix multiplication. No builtin Python types implement this operator.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1265)**

Unknown directive type "versionadded".

```
.. versionadded:: 3.5
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1267)**

Unknown directive type "index".

```
.. index::
   exception: ZeroDivisionError
   single: division
   operator: / (slash)
   operator: //
```

The / (division) and // (floor division) operators yield the quotient of their arguments. The numeric arguments are first converted to a common type. Division of integers yields a float, while floor division of integers results in an integer; the result is that of mathematical division with the 'floor' function applied to the result. Division by zero raises the `exc:'ZeroDivisionError'` exception.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1273); [backlink](#)**

Unknown interpreted text role "exc".

This operation can be customized using the special `meth:'__truediv__'` and `meth:'__floordiv__'` methods.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1280); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1280); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1283)**

Unknown directive type "index".

```
.. index::
   single: modulo
   operator: % (percent)
```

The % (modulo) operator yields the remainder from the division of the first argument by the second. The numeric arguments are first converted to a common type. A zero right argument raises the `exc:'ZeroDivisionError'` exception. The arguments may be floating point numbers, e.g.,  $3.14 \% 0.7$  equals  $0.34$  (since  $3.14$  equals  $4 * 0.7 + 0.34$ ). The modulo operator always yields a result with the same sign as its second operand (or zero); the absolute value of the result is strictly smaller than the absolute value of the second operand [1].

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1287); [backlink](#)

Unknown interpreted text role "exc".

The floor division and modulo operators are connected by the following identity:  $x == (x//y)*y + (x\%y)$ . Floor division and modulo are also connected with the built-in function `:func:`divmod``: `divmod(x, y) == (x//y, x%y)`. [2].

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1296); [backlink](#)

Unknown interpreted text role "func".

In addition to performing the modulo operation on numbers, the `%` operator is also overloaded by string objects to perform old-style string formatting (also known as interpolation). The syntax for string formatting is described in the Python Library Reference, section [ref: old-string-formatting](#).

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1301); [backlink](#)

Unknown interpreted text role "ref".

The *modulo* operation can be customized using the special `:meth:`__mod__`` method.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1306); [backlink](#)

Unknown interpreted text role "meth".

The floor division operator, the modulo operator, and the `:func:`divmod`` function are not defined for complex numbers. Instead, convert to a floating point number using the `:func:`abs`` function if appropriate.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1308); [backlink](#)

Unknown interpreted text role "func".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1308); [backlink](#)

Unknown interpreted text role "func".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1312)

Unknown directive type "index".

```
.. index::
   single: addition
   single: operator; + (plus)
   single: + (plus); binary operator
```

The `+` (addition) operator yields the sum of its arguments. The arguments must either both be numbers or both be sequences of the same type. In the former case, the numbers are converted to a common type and then added together. In the latter case, the sequences are concatenated.

This operation can be customized using the special `:meth:`__add__`` and `:meth:`__radd__`` methods.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1322); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1322); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1325)

Unknown directive type "index".

```
.. index::
   single: subtraction
   single: operator; - (minus)
   single: - (minus); binary operator
```

The `-` (subtraction) operator yields the difference of its arguments. The numeric arguments are first converted to a common type. This operation can be customized using the special `meth: ``__sub__``` method.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1333); [backlink](#)

Unknown interpreted text role "meth".

## Shifting operations

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1341)

Unknown directive type "index".

```
.. index::
   pair: shifting; operation
   operator: <<
   operator: >>
```

The shifting operations have lower priority than the arithmetic operations:

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1348)

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   shift_expr: `a_expr` | `shift_expr` ("<<" | ">>") `a_expr`
```

These operators accept integers as arguments. They shift the first argument to the left or right by the number of bits given by the second argument.

This operation can be customized using the special `meth: ``__lshift__``` and `meth: ``__rshift__``` methods.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1354); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1354); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1357)

Unknown directive type "index".

```
.. index:: exception: ValueError
```

A right shift by  $n$  bits is defined as floor division by `pow(2, n)`. A left shift by  $n$  bits is defined as multiplication with `pow(2, n)`.



## Binary bitwise operations

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1368)**

Unknown directive type "index".

```
.. index:: triple: binary; bitwise; operation
```

Each of the three bitwise operations has a different priority level:

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1372)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   and_expr: `shift_expr` | `and_expr` "&" `shift_expr`
   xor_expr: `and_expr` | `xor_expr` "^" `and_expr`
   or_expr: `xor_expr` | `or_expr` "|" `xor_expr`
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1377)**

Unknown directive type "index".

```
.. index::
   pair: bitwise; and
   operator: & (ampersand)
```

The `&` operator yields the bitwise AND of its arguments, which must be integers or one of them must be a custom object overriding `meth: '__and__'` or `meth: '__rand__'` special methods.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1381); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1381); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1385)**

Unknown directive type "index".

```
.. index::
   pair: bitwise; xor
   pair: exclusive; or
   operator: ^ (caret)
```

The `^` operator yields the bitwise XOR (exclusive OR) of its arguments, which must be integers or one of them must be a custom object overriding `meth: '__xor__'` or `meth: '__rxor__'` special methods.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1390); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1390); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1394)

Unknown directive type "index".

```
.. index::
    pair: bitwise; or
    pair: inclusive; or
    operator: | (vertical bar)
```

The `|` operator yields the bitwise (inclusive) OR of its arguments, which must be integers or one of them must be a custom object overriding `.meth: '__or__'` or `.meth: '__ror__'` special methods.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1399); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1399); [backlink](#)

Unknown interpreted text role "meth".

## Comparisons

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1409)

Unknown directive type "index".

```
.. index::
    single: comparison
    pair: C; language
    operator: < (less)
    operator: > (greater)
    operator: <=
    operator: >=
    operator: ==
    operator: !=
```

Unlike C, all comparison operations in Python have the same priority, which is lower than that of any arithmetic, shifting or bitwise operation. Also unlike C, expressions like `a < b < c` have the interpretation that is conventional in mathematics:

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1424)

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
    comparison: `or_expr` (`comp_operator` `or_expr`)*
    comp_operator: "<" | ">" | "==" | ">=" | "<=" | "!="
                  : | "is" ["not"] | ["not"] "in"
```

Comparisons yield boolean values: `True` or `False`. Custom `.dfn: 'rich comparison methods'` may return non-boolean values. In this case Python will call `.func: 'bool'` on such value in boolean contexts.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1429); [backlink](#)

Unknown interpreted text role "dfn".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1429); [backlink](#)

Unknown interpreted text role "func".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1433)

Unknown directive type "index".

```
.. index:: pair: chaining; comparisons
```

Comparisons can be chained arbitrarily, e.g.,  $x < y \leq z$  is equivalent to  $x < y$  and  $y \leq z$ , except that  $y$  is evaluated only once (but in both cases  $z$  is not evaluated at all when  $x < y$  is found to be false).

Formally, if  $a, b, c, \dots, y, z$  are expressions and  $op1, op2, \dots, opN$  are comparison operators, then  $a \text{ op1 } b \text{ op2 } c \dots y \text{ opN } z$  is equivalent to  $a \text{ op1 } b$  and  $b \text{ op2 } c$  and  $\dots y \text{ opN } z$ , except that each expression is evaluated at most once.

Note that  $a \text{ op1 } b \text{ op2 } c$  doesn't imply any kind of comparison between  $a$  and  $c$ , so that, e.g.,  $x < y > z$  is perfectly legal (though perhaps not pretty).

## Value comparisons

The operators  $<$ ,  $>$ ,  $==$ ,  $>=$ ,  $<=$ , and  $!=$  compare the values of two objects. The objects do not need to have the same type.

Chapter [ref`objects`](#) states that objects have a value (in addition to type and identity). The value of an object is a rather abstract notion in Python: For example, there is no canonical access method for an object's value. Also, there is no requirement that the value of an object should be constructed in a particular way, e.g. comprised of all its data attributes. Comparison operators implement a particular notion of what the value of an object is. One can think of them as defining the value of an object indirectly, by means of their comparison implementation.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1456); [backlink](#)

Unknown interpreted text role "ref".

Because all types are (direct or indirect) subtypes of `:class:`object``, they inherit the default comparison behavior from `:class:`object``. Types can customize their comparison behavior by implementing `:dfn:`rich comparison methods`` like `:meth:`__lt__``, described in [ref`customization`](#).

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1465); [backlink](#)

Unknown interpreted text role "class".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1465); [backlink](#)

Unknown interpreted text role "class".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1465); [backlink](#)

Unknown interpreted text role "dfn".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1465); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1465); [backlink](#)

Unknown interpreted text role "ref".

The default behavior for equality comparison (`==` and `!=`) is based on the identity of the objects. Hence, equality comparison of instances with the same identity results in equality, and equality comparison of instances with different identities results in inequality. A motivation for this default behavior is the desire that all objects should be reflexive (i.e.  $x \text{ is } y$  implies  $x == y$ ).

A default order comparison ( $<$ ,  $>$ ,  $<=$ , and  $>=$ ) is not provided; an attempt raises `:exc:`TypeError``. A motivation for this default behavior is the lack of a similar invariant as for equality.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1478); [backlink](#)

Unknown interpreted text role "exc".

The behavior of the default equality comparison, that instances with different identities are always unequal, may be in contrast to what types will need that have a sensible definition of object value and value-based equality. Such types will need to customize their comparison behavior, and in fact, a number of built-in types have done that.

The following list describes the comparison behavior of the most important built-in types.

- Numbers of built-in numeric types (`:ref:`typesnumeric``) and of the standard library types `:class:`fractions.Fraction`` and `:class:`decimal.Decimal`` can be compared within and across their types, with the restriction that complex numbers do not support order comparison. Within the limits of the types involved, they compare mathematically (algorithmically) correct without loss of precision.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1491); [backlink](#)

Unknown interpreted text role "ref".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1491); [backlink](#)

Unknown interpreted text role "class".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1491); [backlink](#)

Unknown interpreted text role "class".

The not-a-number values `float('NaN')` and `decimal.Decimal('NaN')` are special. Any ordered comparison of a number to a not-a-number value is false. A counter-intuitive implication is that not-a-number values are not equal to themselves. For example, if `x = float('NaN')`, `3 < x`, `x < 3` and `x == x` are all false, while `x != x` is true. This behavior is compliant with IEEE 754.

- `None` and `NotImplemented` are singletons. [PEP 8](#) advises that comparisons for singletons should always be done with `is` or `is not`, never the equality operators.
- Binary sequences (instances of `:class:`bytes`` or `:class:`bytearray``) can be compared within and across their types. They compare lexicographically using the numeric values of their elements.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1509); [backlink](#)

Unknown interpreted text role "class".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1509); [backlink](#)

Unknown interpreted text role "class".

- Strings (instances of `:class:`str``) compare lexicographically using the numerical Unicode code points (the result of the built-in function `:func:`ord``) of their characters. [\[3\]](#)

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1513); [backlink](#)

Unknown interpreted text role "class".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-

resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst,  
line 1513); [backlink](#)

Unknown interpreted text role "func".

Strings and binary sequences cannot be directly compared.

- Sequences (instances of :class:`tuple`, :class:`list`, or :class:`range`) can be compared only within each of their types, with the restriction that ranges do not support order comparison. Equality comparison across these types results in inequality, and ordering comparison across these types raises :exc:`TypeError`.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst,  
line 1519); [backlink](#)

Unknown interpreted text role "class".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst,  
line 1519); [backlink](#)

Unknown interpreted text role "class".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst,  
line 1519); [backlink](#)

Unknown interpreted text role "class".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst,  
line 1519); [backlink](#)

Unknown interpreted text role "exc".

Sequences compare lexicographically using comparison of corresponding elements. The built-in containers typically assume identical objects are equal to themselves. That lets them bypass equality tests for identical objects to improve performance and to maintain their internal invariants.

Lexicographical comparison between built-in collections works as follows:

- For two collections to compare equal, they must be of the same type, have the same length, and each pair of corresponding elements must compare equal (for example, `[1, 2] == (1, 2)` is false because the type is not the same).
- Collections that support order comparison are ordered the same as their first unequal elements (for example, `[1, 2, x] <= [1, 2, y]` has the same value as `x <= y`). If a corresponding element does not exist, the shorter collection is ordered first (for example, `[1, 2] < [1, 2, 3]` is true).
- Mappings (instances of :class:`dict`) compare equal if and only if they have equal (*key*, *value*) pairs. Equality comparison of the keys and values enforces reflexivity.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst,  
line 1543); [backlink](#)

Unknown interpreted text role "class".

Order comparisons (`<`, `>`, `<=`, and `>=`) raise :exc:`TypeError`.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst,  
line 1547); [backlink](#)

Unknown interpreted text role "exc".

- Sets (instances of :class:`set` or :class:`frozenset`) can be compared within and across their types.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-

**resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1549); [backlink](#)**

Unknown interpreted text role "class".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1549); [backlink](#)**

Unknown interpreted text role "class".

They define order comparison operators to mean subset and superset tests. Those relations do not define total orderings (for example, the two sets  $\{1, 2\}$  and  $\{2, 3\}$  are not equal, nor subsets of one another, nor supersets of one another). Accordingly, sets are not appropriate arguments for functions which depend on total ordering (for example, `:func:`min``, `:func:`max``, and `:func:`sorted`` produce undefined results given a list of sets as inputs).

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1552); [backlink](#)**

Unknown interpreted text role "func".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1552); [backlink](#)**

Unknown interpreted text role "func".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1552); [backlink](#)**

Unknown interpreted text role "func".

Comparison of sets enforces reflexivity of its elements.

- Most other built-in types have no comparison methods implemented, so they inherit the default comparison behavior.

User-defined classes that customize their comparison behavior should follow some consistency rules, if possible:

- Equality comparison should be reflexive. In other words, identical objects should compare equal:

$x \text{ is } y \text{ implies } x == y$

- Comparison should be symmetric. In other words, the following expressions should have the same result:

$x == y \text{ and } y == x$

$x != y \text{ and } y != x$

$x < y \text{ and } y > x$

$x <= y \text{ and } y >= x$

- Comparison should be transitive. The following (non-exhaustive) examples illustrate that:

$x > y \text{ and } y > z \text{ implies } x > z$

$x < y \text{ and } y <= z \text{ implies } x < z$

- Inverse comparison should result in the boolean negation. In other words, the following expressions should have the same result:

$x == y \text{ and } \text{not } x != y$

$x < y \text{ and } \text{not } x >= y \text{ (for total ordering)}$

$x > y \text{ and } \text{not } x <= y \text{ (for total ordering)}$

The last two expressions apply to totally ordered collections (e.g. to sequences, but not to sets or mappings). See also the `:func:`~functools.total_ordering`` decorator.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1600); [backlink](#)

Unknown interpreted text role "func".

- The `:func:`hash`` result should be consistent with equality. Objects that are equal should either have the same hash value, or be marked as unhashable.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1604); [backlink](#)

Unknown interpreted text role "func".

Python does not enforce these consistency rules. In fact, the not-a-number values are an example for not following these rules.

## Membership test operations

The operators `:keyword:`in`` and `:keyword:`not in`` test for membership. `x in s` evaluates to `True` if `x` is a member of `s`, and `False` otherwise. `x not in s` returns the negation of `x in s`. All built-in sequences and set types support this as well as dictionary, for which `:keyword:`!in`` tests whether the dictionary has a given key. For container types such as list, tuple, set, frozenset, dict, or collections.deque, the expression `x in y` is equivalent to `any(x is e or x == e for e in y)`.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1619); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1619); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1619); [backlink](#)

Unknown interpreted text role "keyword".

For the string and bytes types, `x in y` is `True` if and only if `x` is a substring of `y`. An equivalent test is `y.find(x) != -1`. Empty strings are always considered to be a substring of any other string, so `"" in "abc"` will return `True`.

For user-defined classes which define the `:meth:`__contains__`` method, `x in y` returns `True` if `y.__contains__(x)` returns a true value, and `False` otherwise.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1632); [backlink](#)

Unknown interpreted text role "meth".

For user-defined classes which do not define `:meth:`__contains__`` but do define `:meth:`__iter__``, `x in y` is `True` if some value `z`, for which the expression `x is z or x == z` is true, is produced while iterating over `y`. If an exception is raised during the iteration, it is as if `:keyword:`in`` raised that exception.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1636); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1636); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1636); [backlink](#)



Unknown interpreted text role "keyword".

Lastly, the old-style iteration protocol is tried: if a class defines `meth: '__getitem__'`, `x in y` is True if and only if there is a non-negative integer index `i` such that `x is y[i]` or `x == y[i]`, and no lower integer index raises the `exc: 'IndexError'` exception. (If any other exception is raised, it is as if `keyword: 'in'` raised that exception).

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1642); [backlink](#)

Unknown interpreted text role "meth".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1642); [backlink](#)

Unknown interpreted text role "exc".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1642); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1648)

Unknown directive type "index".

```
.. index::
   operator: in
   operator: not in
   pair: membership; test
   object: sequence
```

The operator `keyword: 'not in'` is defined to have the inverse truth value of `keyword: 'in'`.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1654); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1654); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1657)

Unknown directive type "index".

```
.. index::
   operator: is
   operator: is not
   pair: identity; test
```

## Identity comparisons

The operators `keyword: 'is'` and `keyword: 'is not'` test for an object's identity: `x is y` is true if and only if `x` and `y` are the same object. An Object's identity is determined using the `meth: 'id'` function. `x is not y` yields the inverse truth value. [4]

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1669); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1669); [backlink](#)**

Unknown interpreted text role "keyword".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1669); [backlink](#)**

Unknown interpreted text role "meth".

## Boolean operations

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1683)**

Unknown directive type "index".

```
.. index::
   pair: Conditional; expression
   pair: Boolean; operation
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1687)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   or_test: `and_test` | `or_test` "or" `and_test`
   and_test: `not_test` | `and_test` "and" `not_test`
   not_test: `comparison` | "not" `not_test`
```

In the context of Boolean operations, and also when expressions are used by control flow statements, the following values are interpreted as false: False, None, numeric zero of all types, and empty strings and containers (including strings, tuples, lists, dictionaries, sets and frozensets). All other values are interpreted as true. User-defined objects can customize their truth value by providing a `meth:`__bool__`` method.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1692); [backlink](#)**

Unknown interpreted text role "meth".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1699)**

Unknown directive type "index".

```
.. index:: operator: not
```

The operator `keyword:`not`` yields `True` if its argument is false, `False` otherwise.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1701); [backlink](#)**

Unknown interpreted text role "keyword".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1704)**

Unknown directive type "index".

```
.. index:: operator: and
```

The expression `x and y` first evaluates `x`; if `x` is false, its value is returned; otherwise, `y` is evaluated and the resulting value is returned.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-**

main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1709)

Unknown directive type "index".

```
.. index:: operator: or
```

The expression `x or y` first evaluates `x`; if `x` is true, its value is returned; otherwise, `y` is evaluated and the resulting value is returned.

Note that neither `:keyword:'and'` nor `:keyword:'or'` restrict the value and type they return to `False` and `True`, but rather return the last evaluated argument. This is sometimes useful, e.g., if `s` is a string that should be replaced by a default value if it is empty, the expression `s or 'foo'` yields the desired value. Because `:keyword:'not'` has to create a new value, it returns a boolean value regardless of the type of its argument (for example, `not 'foo'` produces `False` rather than `' '`.)

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1714); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1714); [backlink](#)

Unknown interpreted text role "keyword".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1714); [backlink](#)

Unknown interpreted text role "keyword".

## Assignment expressions

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1726)

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   assignment_expression: [`identifier` "!="] `expression`
```

An assignment expression (sometimes also called a "named expression" or "walrus") assigns an `:token:'~python-grammar:expression'` to an `:token:'~python-grammar:identifier'`, while also returning the value of the `:token:'~python-grammar:expression'`.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1729); [backlink](#)

Unknown interpreted text role "token".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1729); [backlink](#)

Unknown interpreted text role "token".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1729); [backlink](#)

Unknown interpreted text role "token".

One common use case is when handling matched regular expressions:

```
if matching := pattern.search(data):
    do_something(matching)
```

Or, when processing a file stream in chunks:

```
while chunk := file.read(9000):
    process(chunk)
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1748)**

Unknown directive type "versionadded".

```
.. versionadded:: 3.8
   See :pep:`572` for more details about assignment expressions.
```

## Conditional expressions

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1757)**

Unknown directive type "index".

```
.. index::
   pair: conditional; expression
   pair: ternary; operator
   single: if; conditional expression
   single: else; conditional expression
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1763)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   conditional_expression: `or_test` ["if" `or_test` "else" `expression`]
   expression: `conditional_expression` | `lambda_expr`
```

Conditional expressions (sometimes called a "ternary operator") have the lowest priority of all Python operations.

The expression `x if C else y` first evaluates the condition, `C` rather than `x`. If `C` is true, `x` is evaluated and its value is returned; otherwise, `y` is evaluated and its value is returned.

See [PEP 308](#) for more details about conditional expressions.

## Lambdas

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1783)**

Unknown directive type "index".

```
.. index::
   pair: lambda; expression
   pair: lambda; form
   pair: anonymous; function
   single: : (colon); lambda expression
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1789)**

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
   lambda_expr: "lambda" [`parameter_list`] ":" `expression`
```

Lambda expressions (sometimes called lambda forms) are used to create anonymous functions. The expression `lambda parameters: expression` yields a function object. The unnamed object behaves like a function object defined with:

**System Message: WARNING/2 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1796)**

Cannot analyze code. No Pygments lexer found for "none".

```
.. code-block:: none

def <lambda>(parameters):
    return expression
```

See section [ref`function`](#) for the syntax of parameter lists. Note that functions created with lambda expressions cannot contain statements or annotations.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1801); [backlink](#)

Unknown interpreted text role "ref".

## Expression lists

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1811)

Unknown directive type "index".

```
.. index::
    pair: expression; list
    single: , (comma); expression list
```

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1815)

Unknown directive type "productionlist".

```
.. productionlist:: python-grammar
    expression_list: `expression` ("," `expression`)* [","]
    starred_list: `starred_item` ("," `starred_item`)* [","]
    starred_expression: `expression` | (`starred_item` ",")* [`starred_item`]
    starred_item: `assignment_expression` | "``" `or_expr`
```

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1821)

Unknown directive type "index".

```
.. index:: object: tuple
```

Except when part of a list or set display, an expression list containing at least one comma yields a tuple. The length of the tuple is the number of expressions in the list. The expressions are evaluated from left to right.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1828)

Unknown directive type "index".

```
.. index::
    pair: iterable; unpacking
    single: * (asterisk); in expression lists
```

An asterisk `*` denotes [:dfn:`iterable unpacking`](#). Its operand must be an [:term:`iterable`](#). The iterable is expanded into a sequence of items, which are included in the new tuple, list, or set, at the site of the unpacking.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1832); [backlink](#)

Unknown interpreted text role "dfn".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\ (cpython-main) (Doc) (reference) expressions.rst, line 1832); [backlink](#)

Unknown interpreted text role "term".

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1837)**

Unknown directive type "versionadded".

```
.. versionadded:: 3.5
   Iterable unpacking in expression lists, originally proposed by :pep:`448`.
```

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1840)**

Unknown directive type "index".

```
.. index:: pair: trailing; comma
```

The trailing comma is required only to create a single tuple (a.k.a. a *singleton*); it is optional in all other cases. A single expression without a trailing comma doesn't create a tuple, but rather yields the value of that expression. (To create an empty tuple, use an empty pair of parentheses: `()`.)

## Evaluation order

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1854)**

Unknown directive type "index".

```
.. index:: pair: evaluation; order
```

Python evaluates expressions from left to right. Notice that while evaluating an assignment, the right-hand side is evaluated before the left-hand side.

In the following lines, expressions will be evaluated in the arithmetic order of their suffixes:

```
expr1, expr2, expr3, expr4
(expr1, expr2, expr3, expr4)
{expr1: expr2, expr3: expr4}
expr1 + expr2 * (expr3 - expr4)
expr1(expr2, expr3, *expr4, **expr5)
expr3, expr4 = expr1, expr2
```

## Operator precedence

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1875)**

Unknown directive type "index".

```
.. index::
   pair: operator; precedence
```

The following table summarizes the operator precedence in Python, from highest precedence (most binding) to lowest precedence (least binding). Operators in the same box have the same precedence. Unless the syntax is explicitly given, operators are binary. Operators in the same box group left to right (except for exponentiation, which groups from right to left).

Note that comparisons, membership tests, and identity tests, all have the same precedence and have a left-to-right chaining feature as described in the [ref`comparisons`](#) section.

**System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference) expressions.rst, line 1884); [backlink](#)**

Unknown interpreted text role "ref".

Operator	Description
(expressions...), [expressions...], {key: value...}, {expressions...}	Binding or parenthesized expression, list display, dictionary display, set display

Operator	Description
<code>x[index], x[index:index], x(arguments...), x.attribute</code> <code>:keyword:'await' x</code>	Subscription, slicing, call, attribute reference
<div> <b>System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)</b>  <b>(reference)expressions.rst, line 1902);</b>  <a href="#">backlink</a>  Unknown interpreted text role "keyword". </div>	Await expression
<code>**</code>	Exponentiation <a href="#">[5]</a>
<code>+x, -x, ~x</code>	Positive, negative, bitwise NOT
<code>*, @, /, //, %</code>	Multiplication, matrix multiplication, division, floor division, remainder <a href="#">[6]</a>
<code>+, -</code>	Addition and subtraction
<code>&lt;&lt;, &gt;&gt;</code>	Shifts
<code>&amp;</code>	Bitwise AND
<code>^</code>	Bitwise XOR
<code> </code>	Bitwise OR
<code>:keyword:'in', :keyword:'not in', :keyword:'is', :keyword:'is not', &lt;, &lt;=, &gt;, &gt;=, !=, ==</code>	Comparisons, including membership tests and identity tests
<div> <b>System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)</b>  <b>(reference)expressions.rst, line 1922);</b>  <a href="#">backlink</a>  Unknown interpreted text role "keyword". </div>	
<div> <b>System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)</b>  <b>(reference)expressions.rst, line 1922);</b>  <a href="#">backlink</a>  Unknown interpreted text role "keyword". </div>	
<div> <b>System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)</b>  <b>(reference)expressions.rst, line 1922);</b>  <a href="#">backlink</a>  Unknown interpreted text role "keyword". </div>	
<div> <b>System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)</b>  <b>(reference)expressions.rst, line 1922);</b>  <a href="#">backlink</a>  Unknown interpreted text role "keyword". </div>	



Operator	Description
<p>:keyword: 'not' x</p> <div> <p><b>System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)</b>  <b>(reference)expressions.rst, line 1926);</b>  <a href="#">backlink</a></p> <p>Unknown interpreted text role "keyword".</p> </div>	Boolean NOT
<p>:keyword: 'and'</p> <div> <p><b>System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)</b>  <b>(reference)expressions.rst, line 1928);</b>  <a href="#">backlink</a></p> <p>Unknown interpreted text role "keyword".</p> </div>	Boolean AND
<p>:keyword: 'or'</p> <div> <p><b>System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)</b>  <b>(reference)expressions.rst, line 1930);</b>  <a href="#">backlink</a></p> <p>Unknown interpreted text role "keyword".</p> </div>	Boolean OR
<p>:keyword: 'if&lt;_expr&gt;' -- :keyword: 'else'</p> <div> <p><b>System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)</b>  <b>(reference)expressions.rst, line 1932);</b>  <a href="#">backlink</a></p> <p>Unknown interpreted text role "keyword".</p> </div> <div> <p><b>System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)</b>  <b>(reference)expressions.rst, line 1932);</b>  <a href="#">backlink</a></p> <p>Unknown interpreted text role "keyword".</p> </div>	Conditional expression
<p>:keyword: 'lambda'</p> <div> <p><b>System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)</b>  <b>(reference)expressions.rst, line 1934);</b>  <a href="#">backlink</a></p> <p>Unknown interpreted text role "keyword".</p> </div>	Lambda expression

Operator	Description
<code>:=</code>	Assignment expression

## Footnotes

- [1] While `abs(x*y) < abs(y)` is true mathematically, for floats it may not be true numerically due to roundoff. For example, and assuming a platform on which a Python float is an IEEE 754 double-precision number, in order that `-1e-100 % 1e100` have the same sign as `1e100`, the computed result is `-1e-100 + 1e100`, which is numerically exactly equal to `1e100`. The function `func:math.fmod` returns a result whose sign matches the sign of the first argument instead, and so returns `-1e-100` in this case. Which approach is more appropriate depends on the application.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference)expressions.rst, line 1941); [backlink](#)

Unknown interpreted text role "func".

- [2] If `x` is very close to an exact integer multiple of `y`, it's possible for `x//y` to be one larger than `(x-x*y)//y` due to rounding. In such cases, Python returns the latter result, in order to preserve that `divmod(x, y)[0] * y + x % y` be very close to `x`.

- [3] The Unicode standard distinguishes between `dfn:code points` (e.g. U+0041) and `dfn:abstract characters` (e.g. "LATIN CAPITAL LETTER A"). While most abstract characters in Unicode are only represented using one code point, there is a number of abstract characters that can in addition be represented using a sequence of more than one code point. For example, the abstract character "LATIN CAPITAL LETTER C WITH CEDILLA" can be represented as a single `dfn:precomposed character` at code position U+00C7, or as a sequence of a `dfn:base character` at code position U+0043 (LATIN CAPITAL LETTER C), followed by a `dfn:combining character` at code position U+0327 (COMBINING CEDILLA).

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference)expressions.rst, line 1955); [backlink](#)

Unknown interpreted text role "dfn".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference)expressions.rst, line 1955); [backlink](#)

Unknown interpreted text role "dfn".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference)expressions.rst, line 1955); [backlink](#)

Unknown interpreted text role "dfn".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference)expressions.rst, line 1955); [backlink](#)

Unknown interpreted text role "dfn".

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc) (reference)expressions.rst, line 1955); [backlink](#)

Unknown interpreted text role "dfn".

The comparison operators on strings compare at the level of Unicode code points. This may be counter-intuitive to humans. For example, `"\u00C7" == "\u0043\u0327"` is `False`, even though both strings represent the same abstract character "LATIN CAPITAL LETTER C WITH CEDILLA".

To compare strings at the level of abstract characters (that is, in a way intuitive to humans), use `func:unicodedata.normalize`.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)  
(reference)expressions.rst, line 1971); [backlink](#)

Unknown interpreted text role "func".

- [4] Due to automatic garbage-collection, free lists, and the dynamic nature of descriptors, you may notice seemingly unusual behaviour in certain uses of the `:keyword:'is'` operator, like those involving comparisons between instance methods, or constants. Check their documentation for more info.

**System Message: ERROR/3** (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\reference\cpython-main) (Doc)  
(reference)expressions.rst, line 1974); [backlink](#)

Unknown interpreted text role "keyword".

- [5] The power operator `**` binds less tightly than an arithmetic or bitwise unary operator on its right, that is, `2**-1` is `0.5`.
- [6] The `%` operator is also used for string formatting; the same precedence applies.