

# Theory: Math functions

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We already learned how to perform basic arithmetics in Python. We covered addition, subtraction, multiplication, division and several other built-in operations. But if we want to do more complex operations on numbers we can use built-in mathematical functions or functions from the `math` module.

`math` module provides useful mathematical functions and constants. This module is available on every platform in the standard library.

## §1. Advanced arithmetics

There are built-in functions `abs`, `round`, `pow`, `max` and `min`:

- `abs(x)` returns the absolute value of `x` (i.e. value without a regard to its sign);
- `round(x, ndigits)` returns `x` rounded to `ndigits` number of decimal part digits;
- `pow(x, y)` returns `x` raised to the power of `y`;
- `max(a, b, c, ...)` returns the largest argument;
- `min(a, b, c, ...)` returns the smallest argument.

```
1 abs_integer = abs(-10) # 10
2 abs_float = abs(-10.0) # 10.0
3
4
5 round_integer = round(10.0) # 10, returns integer when ndigits is omitted
6 round_float = round(10.2573, 2) # 10.26
7
8 pow_integer = pow(2, 10) # 1024
9 pow_float = pow(2.0, 10) # 1024.0
10
11
12 largest = max(1, 2, 3, 4, 5) # 5
13
14 smallest = min(1, 2, 3, 4, 5) # 1
```

`abs()` and `pow()` functions have equivalents in the `math` module. The key difference of `math.fabs()` and `math.pow()` is that they always return floats:

```
1 import math
2
3 fabs_integer = math.fabs(-10) # 10.0
4 fabs_float = math.fabs(-10.0) # 10.0
5
6 pow_integer = math.pow(2, 10) # 1024.0
7 pow_float = math.pow(2.0, 10) # 1024.0
```

Remember that in order to use definitions from `math`, you should import the module first.

Suppose you raised `x` to the power `y`, and then forgot `y`. You can recover it using the `math.log()` function:

```
1 import math
2
3 x = 2
4 y = 10
5 pow = math.pow(x, y) # 1024.0
6 log = math.log(pow, x) # 10.0
```

`math.log(pow, x)` returns `z` such that `x` raised to the power `z` equals `pow`. If the second argument `x` (called the base of the logarithm) is omitted, it is considered equal to a special number `e` (approximately 2.718):

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Table of contents:

- [1 Math functions](#)
- [§1. Advanced arithmetics](#)
- [§2. Geometry](#)
- [§3. The volume of a cylinder](#)
- [Feedback & Comments](#)

```
1 import math
2
3 natural_log = math.log(1024) # 6.931471805599453
```

Besides the `round()` function, we can use `floor()` and `ceil()` from the `math` module to obtain integer values from floats:

- `math.floor(a)` returns the nearest integer less than or equal to `a`;
- `math.ceil(a)` returns the nearest integer greater than or equal to `a`.

The `math` module also provides the `sqrt` function to calculate the square root of a number.

```
1 import math
2
3 result = math.sqrt(100) # 10.0
```

## §2. Geometry

The number  $\pi$  is often used in geometry and other mathematical fields. It is the ratio of the circumference of a circle to its diameter. It can be found in the `math` module as `pi`.

The next example shows how to calculate the circumference of a circle:

```
1 import math
2
3 r = 3.5
4 circumference = 2 * math.pi * r # 21.991...
```

There are also common trigonometric functions available in the `math` module:

- `math.cos(a)` returns the cosine of `a` radians;
- `math.sin(a)` returns the sine of `a` radians;
- `math.degrees(a)` returns angle `a` converted from radians to degrees;
- `math.radians(a)` returns angle `a` converted from degrees to radians.

```
1 import math
2
3 deg = 60.0
4 x = math.radians(deg) # 1.047...
5
6 cos = math.cos(x) # 0.500...
7 sin = math.sin(x) # 0.866...
8
9 degrees = math.degrees(x) # 59.999...
```

As you can see, due to a limited precision of floats the value of `degrees` is actually `59.99999999999999` instead of expected `60.0`.

It is impossible to cover all the `math` module in this topic so you can learn more from its [documentation](#).

## §3. The volume of a cylinder

Let's assume we have a cylinder with the height `h = 5` and the radius of the base `r = 3`. The formula for the volume of a cylinder is  $V = \pi r^2 h$ . This is how we can calculate the volume using Python:

```
1 import math
2
3 h = 5
4 r = 3
5
6 volume = math.pi * math.pow(r, 2) * h # 141.3716...
7
8 print(round(volume, 1)) # 141.4
```

In the code above, we used the `round` function to get a prettier value for printing.

As you can see, it is possible to round a number or find a maximum value in Python using just built-in functions. However, now you can use functions from the `math` module for more advanced tasks.

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