**Book conventions**

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**Order of operations**

**PEMDAS**: parentheses, exponents, multiplication, division, addition, and subtraction

**Expressing dependent and independent variables in a function**

You can use *y = 2x + 1* or *f(x) = 2x + 1* to express the dependent variable *y* as a function of *x*.

If you have *two independent variables* you write the function like *f(x, y) = 2x + 3y*. In this function two independent variables *x* and *y* and one dependent variable the output of *f(x, y)*. The graph of this function will be plotted on three dimensions to produce a plane of values rather than a line.

**Cartesian plane, x-y plane, coordinate plane**

When we plot on a two-dimensional plane with two number lines (one for each variable) it is known as a *Cartesian plane*, *x-y plane*, or *coordinate plane*. По-русски: *прямоугольная система координат* или *Декартова система*. We trace a given x-value and then look up the corresponding y-value, and plot the intersections

as a line.

Example of a Cartesian plane:

A graph of a line in a graph

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Notice that due to the nature of real numbers (or decimals, if you prefer), there are an infinite number of x values. This is why when we plot the function f(x) we get a continuous line with no breaks in it. There are an infinite number of points on that line, or any part of that line.

**Straight-line function / straight-line graph**

This is a straight-line *f(x) = 2x + 1*:

A graph of a function

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**Parabola function / parabola graph**

This is a parabola *f(x) = x2 + 1*:

A graph of a function

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It is continuous but not linear. It does not produce values in a straight line. When a function is continuous but curvy, rather than linear and straight, we call it a *curvilinear function*.

**Summation symbol sigma Σ**

If I want to iterate the numbers 1 through 5, multiply each by 2, and sum them, here is how I would express that using a summation

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**Exponents**

23 2 is the base and 3 is the exponent (number of times 2 should be multiplied by 2: 2 \* 2 \* 2)

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When we multiply exponents together with the same base, we simply add the exponents, which is known as the *product rule*:



Division:

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**Roots**

A  asks “What number multiplied by itself will give me 4?” which of course is 2. Note here that 41/2 is the same as 4:

41/2 =  = 2

Cubed roots are similar to square roots, but they seek a number multiplied by itself three times to give a result. A cubed root of 8 is expressed as  and asks “What number multiplied by itself three times gives me 8?” This number would be 2 because 2 \* 2 \* 2 = 8.

A math equation with numbers and equations

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A number and equal sign

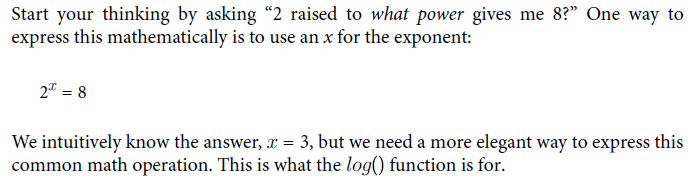
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**Logarithms *log()***

A logarithm is a math function that finds a power for a specific number and base.





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Algebraically speaking, this is a way of isolating the *x*, which is important to solve for *x*.

**Properties for exponents and logarithms**

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**Natural logarithms *log() ln()***

When we use *e* as our base for a logarithm, we call it a *natural logarithm*.



However, in Python, a natural logarithm is specified by the log() function. As discussed earlier, the default base for the log() function is *e*. Just leave the second argument for the base empty and it will default to using *e* as the base

**Function that approaches 0 but never reaches 0 *lim***

A graph of a function

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**Derivatives**



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**Partial derivatives**

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**The chain rule**

Finding the derivative of *z* with respect to *x*:

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This is the chain rule, which says that for a given function *y* (with input variable *x*) composed into another function *z* (with input variable *y*), we can find the derivative of *z* with respect to *x* by multiplying the two respective derivatives together:

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The chain rule is a key part of training a neural network with the proper weights and biases. Rather than untangle the derivative of each node in a nested onion fashion, we can multiply the derivatives across each node instead, which is mathematically a lot easier.

**Integrals**

The opposite of a derivative is an integral, which finds the area under the curve for a given range.

Packing rectangles under a curve to approximate area:

A graph on a grid

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**Reimann sums**

Khan Academy has a great [article](https://www.khanacademy.org/math/ap-calculus-ab/ab-integration-new/ab-6-3/a/definite-integral-as-the-limit-of-a-riemann-sum) explaining how to use limits for Reimann Sums.