0.1 Linear equations

$$x + 2 = y \tag{1}$$

This is an example of a **linear equation**, one that has two variables, x and y, and it describes how the value of one of the variables depends on the value of the other variable.

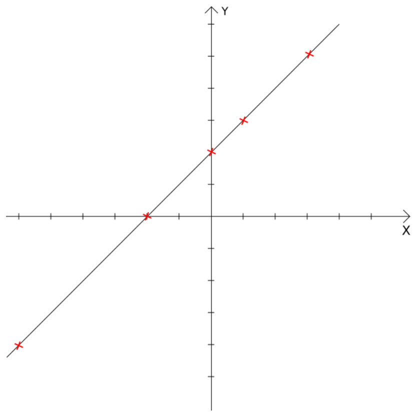
What makes it **linear** is that every variable is only raised to the first power, so *this*

$$x^2 + 2 = y$$

is **not** a linear equation.

Lets plot (draw) equation (1), for a few diferent values of x, say, -6, -2, 1 and 5.

As you can see, the graph of this equation is a **straight line**, which is true for all linear equations



0.2 Linear equation with multiple variables

$$x + 9y + z = 3 \tag{2}$$

Lets now extend our definition of a linear equation to include more variables. (1) had only x and y, but (2) has 3 variables, x, y and z.

The 9 in front of the y? That is called a *coefficient*, and the 3 on the right-hand-side is called a *constant*

Because we will (eventually) run out of letters in the alphabet, we write our equations like this:

$$c_1x_1 + c_2x_2 + c_3x_3 + \ldots + c_nx_n = b$$

Here the c's are the *coefficients*, the x's are the *variables* and the b is (spoiler) the *constant* .
It may look complex the first time, but you'll get used to reading equations like this.

Lets look at an example: Jimmy goes to the store to buy cokes, snickers and apples. Jimmy knows that a can of coke is 2.2\$, snickers is 1.6\$ and an apple is 3.0\$
If c_1 is price of coke, c_2 is price of snickers and c_3 is price of apples, our equation would look like this

$$2.2x_1 + 1.6x_2 + 3.0x_3 = b$$

Jimmy needs a couple of cokes (x_1) and four apples (x_3). Jimmy has 20\$.

How many snickers bars can he buy with the leftover money?

$$2.2 \cdot 2 + 1.6x_2 + 3.0 \cdot 4 = 20$$

Do the math and help Jimmy get his snickers by solving for x_2.

0.3 System of equations

$$2x_1 + x_2 = 17$$
$$x_1 + 3x_2 = 26$$

The equations above are an example of a **system of equations**.

We want to solve these systems by finding the correct values for the *variables*, in this case, x_1 and x_2, so that both equations work out.

We could start by *guessing* that $x_1 = 3$ and $x_2 = 5$, which would give us

$$2 \cdot 3 + 2 = 8 \neq 17$$
$$3 + 3 \cdot 5 = 18 \neq 26$$

This is far from correct, we need the **the substitution method**.

The substitution method consists of **two** steps, that you use over and over again until the system has been solved. These steps are:

1. Isolating a variable
2. Substitution
3. Simplification

Lets take another look at our system

$$2x_1 + x_2 = 17 \tag{3}$$
$$x_1 + 3x_2 = 26 \tag{4}$$

and solve it using the substitution method.

1. isolate the x_1 from (4), $x_1 = 26 - 3x_2$
2. substitute x_1 into (3), $2(26 - 3x_2) + x_2 = 17$

3. now the system looks like

$$2(26 - 3x_2) + x_2 = 17 \tag{5}$$
$$x_1 + 3x_2 = 26 \tag{6}$$

4. which simplifies to

$$x_2 = 7 \tag{7}$$
$$x_1 + 3x_2 = 26 \tag{8}$$

5. now we just insert x_2 into (8) to get

$$x_2 = 7 \tag{9}$$
$$x_1 + 21 = 26 \tag{10}$$

6. so (8) simplifies to $\mathbf{x_1 = 5}$

Now its your turn to solve the following

$$6x_1 + 2x_2 = 70$$
$$3x_1 + 3x_2 = 45$$