## How algebra works

## What is algebra?

It might be easier to start by deciding what is not algebra. The processes of adding, subtracting, multiplying and dividing normal numbers come under the heading arithmetic. For example, $1+1=2,2 \times 3=6,10 \div 2=5$ and $9-2=7$ are all arithmetic.

When one or more numbers are unknown, it can be useful to represent them with a symbol. Using symbols to represent unknown numbers is algebra. We could use question marks:

$$
2+?=5
$$

In this particular example, it's quite easy to work out that $?=3$.
If you have a situation where there are two different unknown numbers, you can't use a question mark for both of them, because you wouldn't be able to tell the difference between the two:
$2+?+?=4$
One symbol always represents just one unknown number, so in this case, 1 is the only value of? that gives the correct result of 4 . If you want to describe two different numbers, you need two different symbols. For example, the equation
$2+a+b=4$
is true for
or

$$
a=2, b=0
$$

$a=1, b=1$
or $\quad a=0, b=2$.

## Algebra has its own language

The different things you see written down in algebra have names. It's well worth learning and understanding these - they come up in exams all the time and there are marks for using them in the right place. It's also satisfying to know and use the correct word because everyone will understand exactly what you mean straight away.

Individual letters such as $x, y, z, a, b$ and $c$ are called symbols.

Symbols usually represent an unknown number. If this unknown number could potentially have any value, it is called a variable.

A fixed number is called a constant. A constant can be known or unknown. If a constant and a variable are multiplied together, the constant is called a coefficient and is written before the variable's symbol.

For example, the expression $2 x$ consists of the coefficient 2 multiplied by the variable $x$.
Anything with more than just a symbol representing a known or unknown number is called an expression. Examples include $x+1,2 x-3, x^{2}+3 x+5,2 x+3 y+z$.

Certain expressions have an equals sign in them. These are called equations. Examples include $x=2, y=x+1, y=3 x+4, \frac{1}{x}=5, x^{2}+x+2=0$ and $x y=4$.

Equations that describe real-life situations are called formulae. The word 'formulae' is the plural of formula - you would say one formula, two formulae. They are very common in science, especially in physics. They are also widespread in maths - there are formulae for finding things like the volume of solids such as spheres $\left(V=\frac{4}{3} \pi r^{3}\right)$ and cubes $\left(V=a^{3}\right)$.

Equations that are true for all values of $x$ (or any other variables, like $y, z, a, b$, etc.) are called identities. They can be considered definitions, such as $x \times x=x^{2}$. This is an identity because no matter what number you decide to let $x$ be, this equation will always be true.

## Summary

- Single letters are called symbols.
- Symbols usually represent unknown numbers called variables.
- Combinations of variables and numbers are called expressions.
- Expressions with an equals sign (=) are called equations.
- Equations that describe something in real life are called formulae.
- Equations that are true for all values of their variables are called identities.


