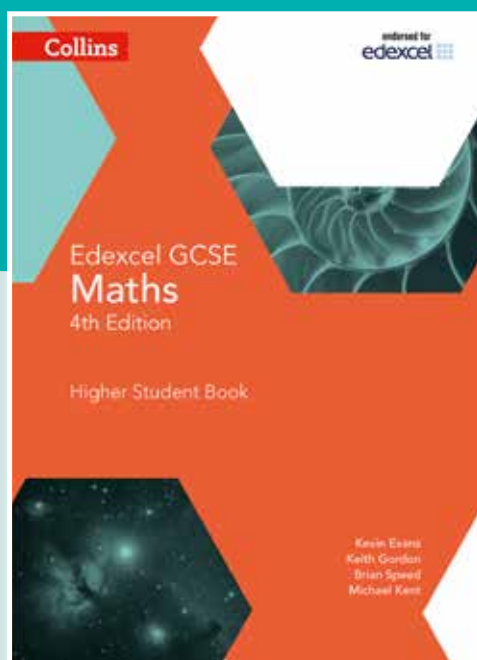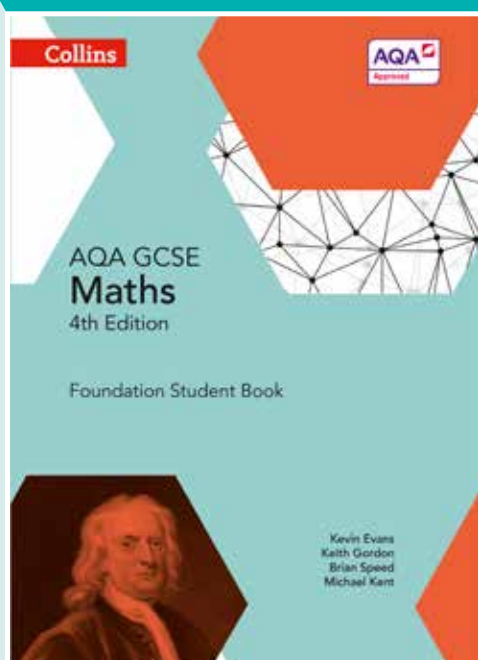**Collins**

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8.1 Basic algebra

This section will show you how to:

- recognise expressions, equations, formulae and identities
- substitute into, manipulate and simplify algebraic expressions.

Here are some algebraic words that you need to know.

Key terms	
equation	expand
expression	formula
identity	like terms
simplify	substitute
variable	

Variable   Letters that are used to represent numbers are called **variables**. These letters can take on any value, so they are said to *vary*.

Expression   An **expression** is any combination of letters and numbers.

For example, $2x + 4y$ and $\frac{p-6}{5}$ are expressions.

Equation   An **equation** contains an 'equals' sign and at least one variable. The important fact is that a value can be found for the variable. This is called *solving the equation*.

Formula   You may already have seen lots of formulae (the plural of **formula**). These are like equations in that they contain an 'equals' sign, but there is more than one variable and they are rules for working out things such as area or the cost of taxi fares.

For example, $V = x^3$, $A = \frac{1}{2}bh$ and $C = 3 + 4m$ are formulae.

Identity   These look like formulae, but the important fact about an **identity** is that it is true for all values, whether numerical or algebraic.

For example, $5n \equiv 2n + 3n$ and $(x + 1)^2 \equiv x^2 + 2x + 1$ are identities. Note that the special sign $\equiv$ is sometimes used to show an identity.

Term   Terms are the separate parts of expressions, equations, formulae and identities.

For example, in $3x + 2y - 7$, there are three terms: $3x$, $+2y$ and -7.

Example 1

State if each of the following is an expression, equation, formula or identity.

A: $x - 5 = 7$ B: $P = 4x$ C: $2x - 3y$ D: $3n - n = 2n$

A is an equation as it can be solved to give $x = 12$.

B is a formula. This is the formula for the perimeter of a square with a side of length x.

C is an expression with two terms.

D is an identity as it is true for all values of n.

Substitution

Substitution involves replacing one or more letters with numbers in an expression or formula.

Whenever you **substitute** a number for a variable in an expression, always put the value in brackets before working it out. This will help you to avoid calculation errors, especially with negative numbers.

To find the value of $3x^2 - 5$ when $x = 3$, write
$$3(3)^2 - 5 = 3 \times 9 - 5$$
$$= 27 - 5$$
$$= 22$$

To find the value when $x = -4$, write
$$3(-4)^2 - 5 = 3 \times 16 - 5$$
$$= 48 - 5$$
$$= 43$$

Example 2

Find the value of $L = a^2 - 8b^2$ when $a = -6$ and $b = \frac{1}{2}$.

Substitute the values -6 and $\frac{1}{2}$ for the letters a and b.

$L = a^2 - 8b^2$
$$= (-6)^2 - 8(\tfrac{1}{2})^2$$
$$= 36 - 8 \times \tfrac{1}{4}$$
$$= 36 - 2$$
$$= 34$$

Note: If you do not use brackets and write -6^2, you could wrongly evaluate L as -36.

Example 3

The formula for the electricity bill each quarter in a household is total bill = £7.50 + £0.07 × number of units. A family uses 6720 units in a quarter.

a   How much is their total bill?

b   The family pays a direct debit of £120 per month towards their electricity costs.
By how much will they be in credit or debit after the quarter?

a   Substituting 6720 into the formula   £7.50 + £0.07 × number of units = total bill
$$7.5 + 0.07 \times 6720 = 477.9$$
             Total bill = £477.90

b   A quarter is three months, so the family pays £360 through their direct debit.
£360 is less than £477.90, so they haven't paid enough, which means they are in debit.
$$477.90 - 360 = 117.90$$
The family are £117.90 in debit.

Exercise 8A

1   Find the value of $4b + 3$ when: **a** $b = 2.5$ **b** $b = -1.5$ **c** $b = \frac{1}{2}$.

2   Where $P = \frac{5w - 4y}{w + y}$, find the value of P when:

   a $w = 3$ and $y = 2$ **b** $w = 6$ and $y = 4$ **c** $w = 2$ and $y = 3$.

3   Where $A = b^2 + c^2$, find the value of A when:

   a $b = 2$ and $c = 3$ **b** $b = 5$ and $c = 7$ **c** $b = -1$ and $c = -4$.

4   Where $A = \frac{180(n - 2)}{n + 5}$, find the value of A when:

   a $n = 7$ **b** $n = 3$ **c** $n = -1$.

5   Where $Z = \frac{y^2 + 4}{4 + y}$, find the value of Z when:
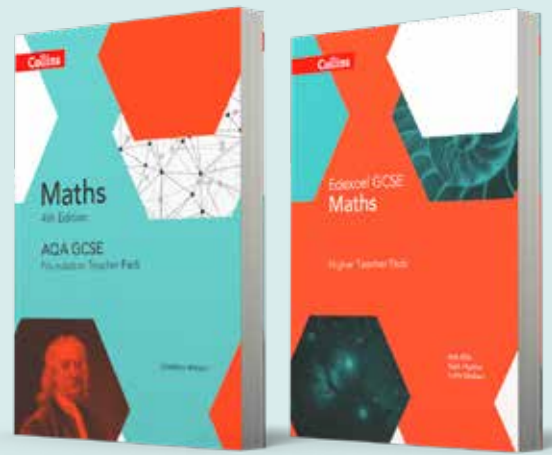
   a $y = 4$ **b** $y = -6$ **c** $y = -1.5$.

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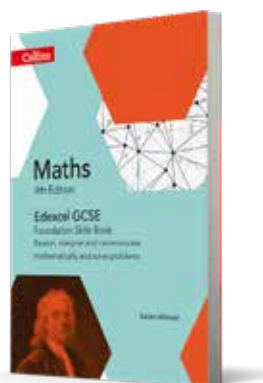
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