# Formulae and expressions

- Changing the subject of a formula
- Using more complex formulae
- Writing a formula from a sentence
- Deriving a new formula from a known formula
- Recognising units of length, area and volume in an expression

Keywords

You should know

explanation 1

**1** Substitute the given value into the expression and write the answer.

a  $3s + 2$ when $s = 1.5$      b  $x^2 - 3x$ when $x = 4$

c  $5(y^2 - y)$ when $y = 3$      d  $2z(z^2 - 4z)$ when $z = 4$

e  $\dfrac{g^2}{4}$ when $g = 6$      f  $2m + 12$ when $m = -3$

g  $20 - k$ when $k = -5$      h  $\dfrac{2y + 6}{y}$ when $y = -6$

i  $\sqrt{9s^2}$ when $s = 3$      j  $\dfrac{3p^2(p - 3)}{2}$ when $p = 10$

**2** Substitute the values $x = 7.4$ and $y = 2.1$ into these expressions.
Use a calculator to help you. Give each answer to 1 d.p.

a  $3x - 4y$      b  $2y^2 + 3x$      c  $3(x^2 - y^2)$

d  $4xy(y - x)^2$      e  $\dfrac{(y - 4)^2}{3y}$      f  $\sqrt{(x^2 - y^2)}$
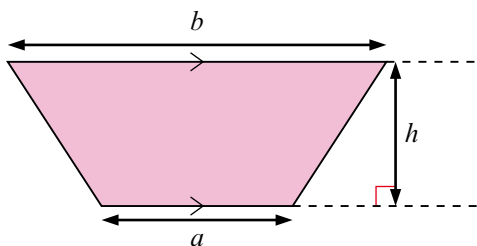
**3** Copy this table. Work out the value of each expression.

| Expression | Value of $p$ | Value of $q$ | Value of expression |
|---|---|---|---|
| $3p^2 + q$ | 4 | 2 | |
| $2(p^2 - q^2)$ | −5 | 3 | |
| $5p(p^2 + q)$ | 3.4 | 1.7 | |
| $\dfrac{p^2 + 2pq}{5}$ | 0.25 | −0.25 | |

**4** Work out the area of the trapezium.

$a = 4.4\,\text{cm}$, $b = 8.2\,\text{cm}$ and $h = 1.7\,\text{cm}$

Use a calculator to help you.



Area of a trapezium:

Area $= \dfrac{h}{2}(a + b)$

**5** The formula for the $n$th triangular number is $\dfrac{n(n + 1)}{2}$.

For example, the first triangular number has $n = 1$.

Substitute this into the formula to give $\dfrac{1 \times 2}{2} = 1$, so the first triangular number is 1.

Find these triangular numbers using the formula.

**a**  3rd          **b**  5th          **c**  10th          **d**  25th          **e**  100th

**6** The volume of a sphere is $\frac{4}{3}\pi r^3$, where $r$ is the radius of the sphere.
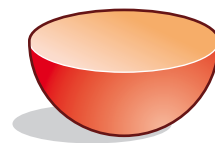
**a**  Find the volume of the sphere with each radius.
Give each answer correct to 2 d.p. with the correct units.

   **i**  5 cm          **ii**  7.5 cm          **iii**  1 m          **iv**  25 mm

**b**  If the radius of the Earth is 6 378 km, find the volume of the Earth.
(Assume that the Earth is spherical.)

**c**  What is the volume of a hemisphere of radius 20 m?
(A hemisphere is a sphere cut in half through the centre.)

**7** To convert temperatures in degrees Fahrenheit (°F) into degrees Celsius (°C), this formula is useful.

$C = \frac{5}{9}(F - 32)$

where $F$ is the temperature in °F and $C$ is the temperature in °C.
Convert these tempertures into °C. Give your answers to 2 d.p.

**a**  60°F       **b**  32°F       **c**  75°F       **d**  212°F       **e**  0°F       **f**  −10°F

**8** The formula $F = ma$ relates force, $F$, to the mass of an object, $m$, and acceleration, $a$.

   **a** Calculate $F$ when $m = 20$ and $a = 3.5$.

   **b** Make $m$ the subject of the formula.

   **c** Calculate $m$ if $F = 20$ and $a = 2.5$.

   **d** Make $a$ the subject of the formula and then calculate $a$ if $F = 10$ and $m = 8$.

**9** The volume of a cuboid is $V = lbh$, where $l$ is the length, $b$ is the breadth and $h$ is the height of the cuboid.

By changing the subject of the formula and then substituting, find these.

   **a** The length of a cuboid with $V = 60\,\text{cm}^3$, $b = 2.5\,\text{cm}$ and $h = 3\,\text{cm}$.

   **b** The height of a cuboid with $V = 88.2\,\text{m}^3$, $b = 4.5\,\text{m}$ and $l = 7\,\text{m}$.

**10** The cost of hiring a taxi from the airport is given by $C = 5 + 0.75m$, where $C$ is the cost in pounds and $m$ is the number of miles driven.

   **a** Make $m$ the subject of the formula.

   **b** Tom hired a taxi from the airport to his house. The cost was £33.
How far does Tom live from the airport? Give your answer to 1 d.p.

**11** The formula for the volume of a cylinder is $V = \pi r^2 h$, where $r$ is the radius and $h$ is the height. (Use the approximation $\pi = 3.14$ for this question.)
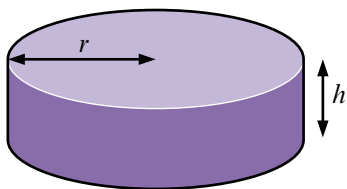


   **a** Find the volume of a cylinder which has radius $3\,\text{cm}$ and height $2.5\,\text{cm}$.

   **b** A cylindrical swimming pool has a volume of $150\,\text{m}^3$ and a radius of $5\,\text{m}$.
Rearrange the formula to make $h$ the subject then calculate the height (depth) of the swimming pool in metres.

explanation 3

**12** The number of children at a party is three times the number of adults.

    **a**  Write a formula for the total number of people at the party.

    **b**  Two teenagers are helping with the party.
       How could you change your formula to include this fact?

**13** On each long side of a table at a restaurant, the number of seats is equal to
the length of the table (in metres) multiplied by 2.
Three more people can sit at each end of the table.

    **a**  Write a formula that relates the number of people at a table to the length
       of the table.

    **b**  Find the number of people who can sit at a table 12 m long.

    **c**  What length of table would have 30 seats?

    **d**  Make a chart showing the length of table (in metres) and the number of
       seats for table lengths 1, 2, 3, 4, 5, 6. What do you notice?

**14** Calculate the pink area in the diagrams below to 2 d.p.

[Hint: the area of a circle, $A = \pi r^2$]

    **a**            **b**          **c**

                                                    4.8 mm