

# Formulae

A **formula** is a mathematical rule.

You can write formulae using algebra.

This label shows a formula for working out the cooking time of a chicken.

You can write this formula using algebra as

$T = 25w + 30$ , where  $T$  is the cooking time in minutes and  $w$  is the weight in kg.

In the description of each variable, you must give the units.

If  $T$  was the cooking time in hours then this formula would give you a very crispy chicken!

## FREE-RANGE CHICKEN

| WEIGHT (KG) | PRICE PER KG | COOKING INSTRUCTIONS                                  |
|-------------|--------------|---|
| 1.8         | £3.95        | Cook at 170°C for 25 minutes per kg plus half an hour |

### Worked example

Target grade 4

This formula is used in physics to calculate distance:

$$D = ut - 5t^2$$

$$u = 14 \text{ and } t = -3$$

Work out the value of  $D$ .

(2 marks)

$$\begin{aligned} D &= (14)(-3) - 5(-3)^2 \\ &= (14)(-3) - 5(9) \\ &= -42 - 45 \\ &= -87 \end{aligned}$$

Substitute the values for  $u$  and  $t$  into the formula.

If you use brackets then you're less likely to make a mistake. This is really important when there are negative numbers involved.

Remember **BIDMAS** for the correct priority of operations. You need to do:

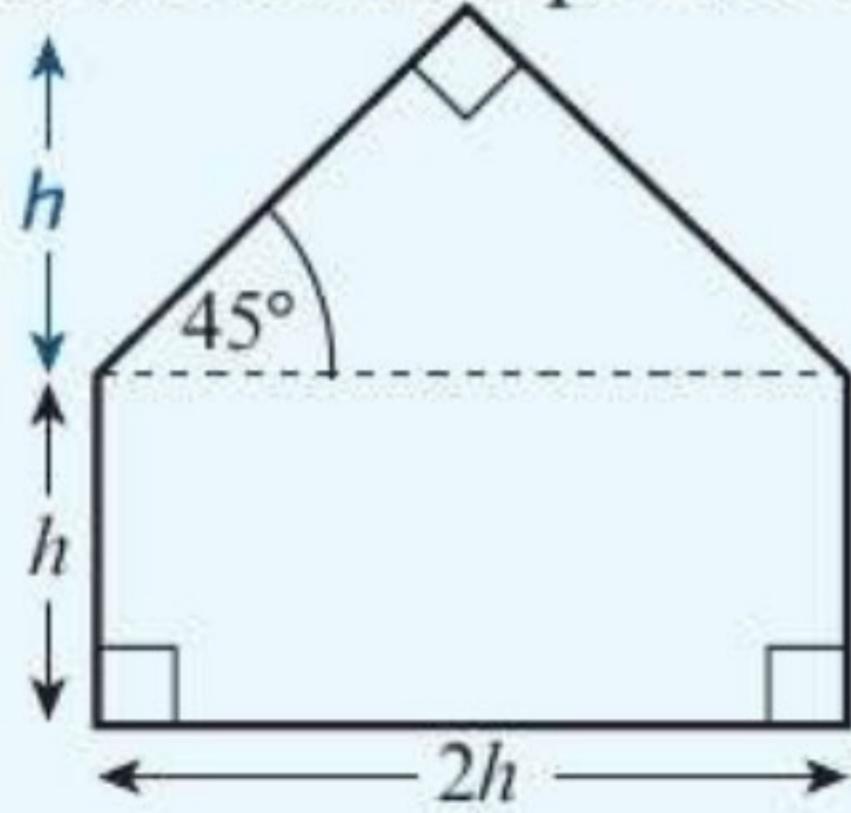
Indices → Multiplication → Subtraction

Don't try to do more than one operation on each line of working.

### Worked example

Target grade 4

The area of this shape is  $A \text{ cm}^2$ .



Everything in blue is part of the answer.

Write a formula for  $A$  in terms of  $h$ .

Give your answer in its simplest form. (3 marks)

$$\begin{aligned} A &= 2h \times h + \frac{1}{2} \times 2h \times h \\ &= 2h^2 + h^2 \\ A &= 3h^2 \end{aligned}$$



You are only given the dimensions of the rectangle. You need to **infer** the height of the triangle. The angle of the slope is 45° and the base of the triangle is  $2h$  so the height of the triangle must be  $h$ . Write this dimension on your diagram.

Use these dimensions to write an expression for the area of the triangle. Remember to write 'A ='. If you only write ' $3h^2$ ' it is an **expression**, not a **formula**.

### Now try this

Target grade 5

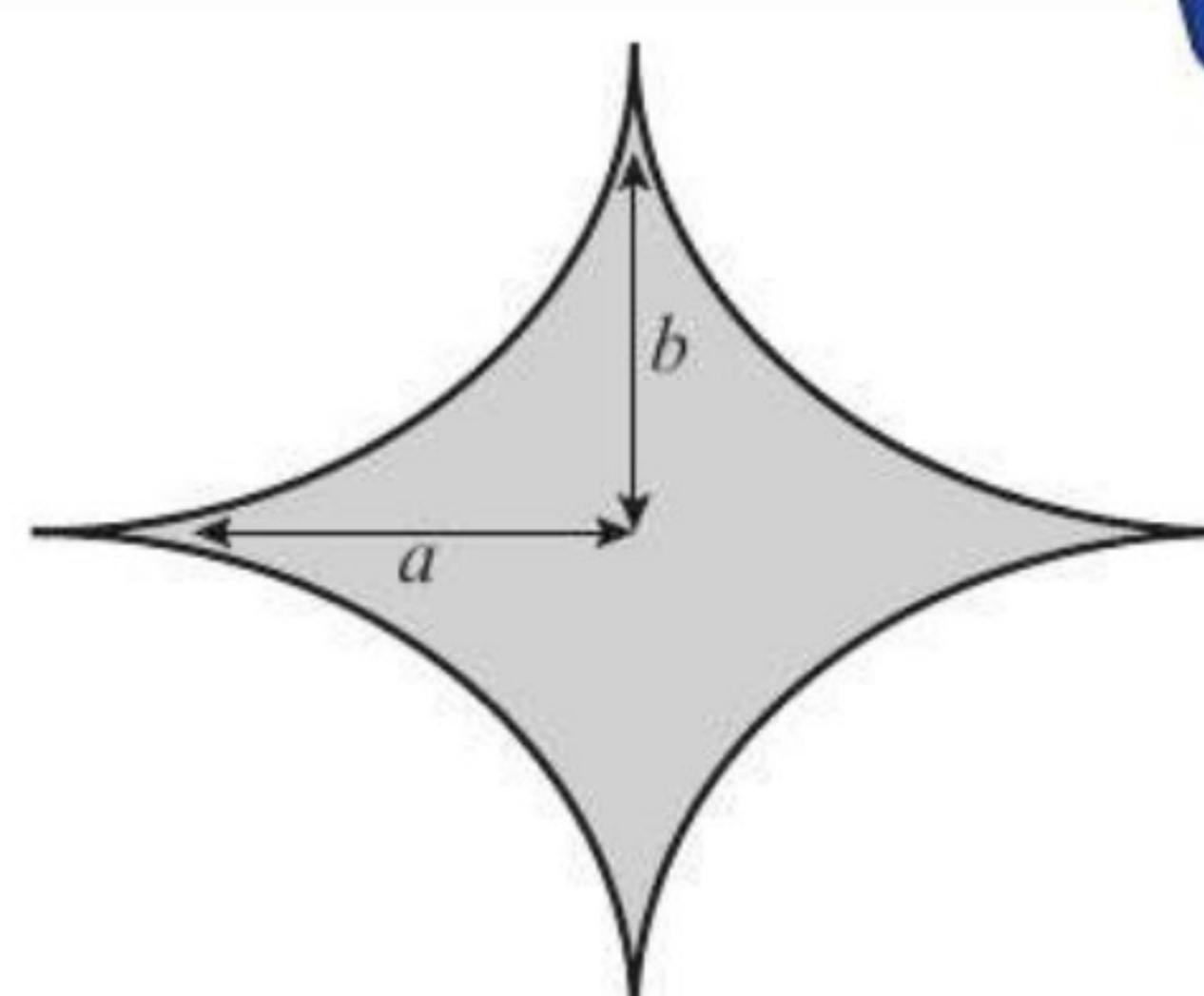
The perimeter of this shape can be calculated using the formula

$$P = \frac{4(a^2 + ab + b^2)}{a + b}$$

Find the value of  $P$  when  $a = 4.3 \text{ cm}$  and  $b = 2.9 \text{ cm}$ .

Give your answer correct to 3 significant figures.

(2 marks)



# Rearranging formulae

Most formulae have one letter on its own on one side of the formula. This letter is called the **subject** of the formula.

$$E = mc^2 \quad E \text{ is the subject of the formula.}$$

Changing the **subject** of a formula is like solving an equation. You have to do the same thing to both sides of the formula until you have the new letter on its own on one side.

$$\begin{aligned} E &= mc^2 & (\div m) & \text{The inverse operation to } x^2 \text{ is } \sqrt{x}. \\ \frac{E}{m} &= c^2 & (\sqrt{\phantom{x}}) & \text{You need to square root everything} \\ \sqrt{\frac{E}{m}} &= c & & \text{on both sides of the formula.} \end{aligned}$$

*c is now the subject of the formula.*

## Harder formulae

If the letter you need **appears twice** in the formula you need to **factorise**.

Group all the terms with that letter on one side of the formula and all the other terms on the other side.

Factorise so the letter only appears once.

Divide by everything in the bracket to get the letter on its own.

For a reminder about factorising have a look at page 18.

### Worked example

Target grade **5**

$$N = \frac{3h + 20}{100}$$

Rearrange the formula to make  $h$  the subject.  
(2 marks)

$$\begin{aligned} N &= \frac{3h + 20}{100} & (\times 100) \\ 100N &= 3h + 20 & (-20) \\ 100N - 20 &= 3h & (\div 3) \\ \frac{100N - 20}{3} &= h \\ h &= \frac{100N - 20}{3} \end{aligned}$$

Your final answer should look like  $h = \dots$

### Worked example

Target grade **7**

Make  $Q$  the subject of the formula  $P = \frac{Q}{Q - 100}$   
(3 marks)

$$\begin{aligned} P &= \frac{Q}{Q - 100} & [\times (Q - 100)] \\ P(Q - 100) &= Q & (\text{multiply out brackets}) \\ PQ - 100P &= Q & (+100P) \\ PQ &= Q + 100P & (-Q) \\ PQ - Q &= 100P & (\text{factorise}) \\ Q(P - 1) &= 100P & [\div (P - 1)] \\ Q &= \frac{100P}{P - 1} \end{aligned}$$

Your final answer should look like  $Q = \dots$   
You need to factorise to get  $Q$  on its own.

### Now try this

Target grade **5**

1 Rearrange this formula to make  $t$  the subject:  
 $4p = 3t - 1$  (2 marks)

2 Make  $w$  the subject of  $m = \sqrt{5w + 7}$  (2 marks)

Target grade **7**

3 Rearrange this formula to make  $P$  the subject:

$$Q = \sqrt{\frac{100 - 5P}{P}} \quad (4 \text{ marks})$$

Worked solution video

