EDEXCEL FUNCTIONAL SKILLS PILOT

Maths Level 2

Chapter 3

Working with ratio, proportion, formulae and equations

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Maths Level 2

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Draft for pilot centres

How to use the Functional mathematics materials

The skills pages enable learners to develop the skills that are outlined in the QCA Functional Skills Standards for mathematics. Within each section, the units provide both a summary of key learning points in the *Learn the skill* text, and the opportunity for learners to develop skills using the *Try the skill* activities. The *Remember what you have learned* units at the end of each section enable learners to consolidate their grasp of the skills covered within the section.

All Functional Skills standards are covered in a clear and direct way using engaging accompanying texts, while at the same time familiarising learners with the kinds of approaches and questions that reflect the Edexcel Functional Skills SAMs (see http://developments.edexcel.org.uk/fs/ under 'assessment').

The *Teacher's Notes* suggest one-to-one, small-group and whole-group activities to facilitate learning of the skills, with the aim of engaging all the learners in the learning process through discussion and social interaction. Common misconceptions for each unit are addressed, with suggestions for how these can be overcome.

One important aspect of Functional mathematics teaching is to ensure that learners develop the necessary process skills of *representing, analysing* and *interpreting.* At Level 1, learners should select the methods and procedures and adopt an organised approach to the task. The teacher may provide guidance, but learners should make their own decisions about finding the solutions to the task.

The inclusion of *Apply the skills* in the *Teacher's Notes* for each section, aims to provide real-life scenarios to encourage application of the skills that have been practised. To make the most of them, talk through how the tasks require the use of the skills developed within the section. The tasks can be undertaken as small-group activities so that the findings from each group can be compared and discussed in a whole-group activity. The scenarios can be extended and developed according to the abilities and needs of the learners. As part of the discussion, learners should identify other real-life situations where the skills may be useful.

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E Working with ratio and proportion

You should already know how to:

✓ work out simple ratio and direct proportion.

By the end of this section you will know how to:

- write a ratio in its simplest terms
- use direct proportion to scale quantities up or down
- use ratio in calculations
- work out dimensions from scale drawings.

1 Writing a ratio

Learn the skill

- A **ratio** is a way of comparing two or more quantities.

The numbers are written with a colon between them.

- You usually write ratios in their simplest form.

For example, 8 : 6 = 4 : 3, dividing both numbers by 2.

The order of the numbers in a ratio is important.

For example, 4 : 3 is not the same as 3 : 4.

Example 1: In a particular week, a total of 1 050 people visited a leisure centre. 675 were children and the rest were adults. What is the ratio of the number of children to the number of adults, in its simplest form?

If there are 675 children, then the number of adults is 1 050 – 675 = 375. The order of the ratio is important.

Number of children : number of adults = 675 : 375

Dividing both numbers by 25 and then by 3:

$$\frac{675}{375} \overset{\div 25}{=} \frac{27}{15} \overset{\div 3}{=} \frac{9}{5}$$

Answer: 9 : 5

Remember

Writing a ratio in its simplest form is like writing a fraction in its lowest terms: divide all the terms by any common factors.

Tip

Ratios do not have units. 2 : 5 could mean 2 cm to 5 cm or 2 m to 5 m.

Tip

There are four 25s in every hundred so, for example, in 600 there will be 4 × 6 = 24.

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Example 2: Write down the ratio of 45 minutes to 2 hours and simplify it.

Express the times in the same units by changing the hours to minutes. 2 hours = 2 × 60 = 120 minutes.

Now write the ratio without units:

45 : 120

Dividing both numbers by 5 and then by 3:

45 : 120
= 9 : 24
= 3 : 8

Answer: 3 : 8

Tip

To compare units of measure, make sure they are *in the same units.*

Tip

You can use a calculator to write a ratio in its simplest form by making use of the ab/c key

Try the skill

For each of these, find the ratio in its simplest form.

1. On a bus there are 24 seats upstairs and 27 seats downstairs. What is the ratio of the number of seats upstairs to the number of seats downstairs?

÷ 3

8:9

2. One morning a postman delivered 42 first-class letters and 48 second-class letters. What is the ratio of the number of first-class letters to the number of second-class letters?

7:8

3. The area of the Earth's surface is approximately equal to 510 000 000 km^2. Land covers approximately 150 000 000 km^2 and sea covers the rest of the surface. What is the approximate ratio of land to sea?

5:12

510 − 150, or
51 − 15 = 36 so 15: 36 or
5:12

Remember

You need to find a factor that is common to each of the numbers involved in the ratio.

4. On a camp site there are 12 caravans, 15 tents and 27 cabins. What is the ratio of the number of caravans to the number of tents to the number of cabins?

12: 15: 27 (÷3) 4:5:9

5. In a business, it takes 55 minutes to deal with an internet order and 1 hour and 5 minutes to deal with a telephone order. What is the ratio of the time an internet order takes to the time a telephone order takes?

55 : 65 (÷5) 11:13

£2·45 = 245p

Tip

Make sure the quantities are in the same units.

6. A small packet of crisps costs 35p. A family packet costs £2.45. What is the ratio of the cost of the smaller packet to the cost of the family packet?

35 : 245 (÷5) 7: 49 (÷7) 1:7

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2 Scaling quantities up or down

Learn the skill

When there is a ratio between quantities, they increase or decrease in the same **proportion**.

- If a ratio is 3:5 there are 8 parts altogether. So the proportions are $\frac{3}{8}$ and $\frac{5}{8}$.
- You can use a ratio to scale quantities up or down. You multiply or divide each amount by the same number.

150 : 100 : 50,
75 : 50 : 25 and
225 : 150 : 75
are all equivalent ratios.

Example 1: A recipe for eight portions of shortbread takes:
• 150 g plain flour • 100 g butter • 50 g caster sugar
What quantities are needed for 12 portions?

The quantities need to stay in the same proportion. 12 portions is the same as 3 lots of 4 portions.

8 portions require 150 : 100 : 50.

4 ($= 8 \times \frac{1}{2}$) portions will need half as much of each.

• 75 g plain flour • 50 g butter • 25 g caster sugar

12 ($= 4 \times 3$) portions will need three times as much:

• $75 \times 3 = 225$ g plain flour • $50 \times 3 = 150$ g butter
• $25 \times 3 = 75$ g caster sugar

Answer: 225 g plain flour, 150 g butter, 75 g caster sugar

An alternative method is to work out what 1 portion will need by dividing by 8, and then finding twelve portions by multiplying by 12. Check this will give you the same answer. Be careful not to round too soon when using this method.

Try the skill

1. It is estimated that swimming for 15 minutes will burn up 75 calories. Approximately how many calories would you burn up in a 45 minute swim?
   $45 \div 15 = 3 \rightarrow 3 \times 75 = 225$

75cl
0·75L

2. A 75 centilitre carton of orange juice contains enough orange juice to fill six small glasses. How many small glasses will three one-litre cartons fill? 1 litre = 100 cl.
   $3 \div 0{\cdot}75 = 4 \rightarrow 4 \times 6 = 24$ glasses

= 165 g
= 165 g
= 165 g

3. A recipe for a sponge cake providing eight portions takes:
   • 110 g butter • 110 g caster sugar
   • 110 g self-raising flour • 2 eggs
   a How much butter, caster sugar and self-raising flour are needed if 3 eggs are used in the recipe?
   ÷ by 2 and multiply (×) by 3
   b How many 250 g packs of butter are needed to make 140 portions of sponge cake? 8

Two quantities are *directly proportional* if they are connected in such a way that one of the quantities is a constant multiple of the other. If the two quantities are y and x, then they can be connected by an equation $y = mx$, where m is called the *constant of proportionality*. m can be positive or negative. Examples of using direct proportion are currency calculations and recipes.

$140 \div 8 = 17{\cdot}5$
$17{\cdot}5 \times 110 = 1{,}925$
$1{,}925\text{g} \div 250 = 7{\cdot}7$

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3 Calculations with ratio

Learn the skill

You can share a quantity in a given ratio.

Think of a ratio as being made up of a number of parts: 3 : 2 is three parts to two parts, a total of five parts.

Example 1: Pink paint is made by mixing white paint with red paint in the ratio 3 : 2. A girl needs 10 litres of pink paint for her room, how much white paint does she need?

There are three parts of white paint for every two parts of red paint. This makes a total of 3 + 2 = 5 parts. First find the value of 1 part.

If 10 litres is split into 5 parts, then
5 parts = 10 litres means 1 part = 2 litres
3 parts of white = 3 × 2 = 6 litres

Answer: 6 litres

Tip

Check:
2 parts of red = 2 × 2 = 4 litres
6 + 4 = 10 litres.

Example 2: Mortar for laying bricks is made up of sand and cement in the ratio 7 : 3. If 140 kg of sand is used, how much mortar can be made?

Here 7 parts = 140 kg, so 1 part = 140 ÷ 7 = 20 kg

There is a total of 10 parts (7 parts sand + 3 parts cement)

So the total amount of mortar is 10 × 20 = 200 kg

Answer: 200 kg

Tip

Read the question carefully. Sometimes you are told the total amount and sometimes the amount for one of the components.

Try the skill

1. A girl and a boy share the weekly rent on their flat in the ratio 5 : 4. The weekly rent is £90. How much does the girl pay per week?

   5 + 4 = 9 parts. £90 ÷ 9 = £10 each part. Girl pays 5 parts so 5 × £10 = £50

2. Two gardeners share 132 kg of compost in the ratio 2 : 9. How much does each one get?

   132 ÷ 11 = 12 so 24 and 108 (to double check; 108 + 24 = 132)

3. In puff pastry the ratio of fat to flour is 2 : 3. How much flour would be needed if 500 g of fat were used?

   2 : 3
   500g, 1 part = 250g, 3 parts = 750g

4. A fruit punch is made from orange juice, cranberry juice and mango juice in the ratio 5 : 4 : 1. How much cranberry juice will there be in a 250 ml glass of fruit punch?

   5 + 4 + 1 = 10
   250 ml ÷ 10 = 25
   Cranberry = 4 parts. 25 ml × 4 = 100 ml

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4 Scale diagrams

Learn the skill

The scale on a drawing or map is a ratio.

On a map with a scale of 1 : 100, every length of 1 unit on the map represents a length of 100 units on the ground.

Example 1: The scale on a road map is 2 cm to 5 km.
Two towns are 45 km apart.
What is their distance apart on the map?

Every 5 km on the ground is represented by 2 cm on the map. Find how many 'lots of' 5 km there are in 45 km and then multiply this by 2 cm.

$\frac{45}{5} \times 2 = 9 \times 2 = 18$

Answer: 18 cm

Tip

Check the units given in the answer.
Here, map distances are in cm and real distances in km.

Example 2: A scale model car has a bonnet of length 6 cm. The scale is 1 : 20. What is the length of the bonnet on the original car?

Every length on the real car is 20 times the equivalent length on the model.

Length of bonnet on real car = 20 × 6 cm = 120 cm

Answer: 120 cm

Tip

A scale on a map can be given in 3 ways:
Graphically as a line marked with distances such as miles or kilometres
Verbally as a statement such as 2 cm to 5 km
As a ratio such as 1:50 000

Example 3: A student draws a scale diagram of the drama studio, using a scale of 1 : 50. The width of the drama studio is 14 m. What is the width on the diagram?

Every length in the drama studio is 50 times the length in the diagram.

The ratio is 1 : 50.

50 parts represent 14 m = 14 × 100 cm = 1400 cm

1 part represents $\frac{1400}{50}$ = 28 cm

Answer: 28 cm

Tip

Changing to cm makes the calculation easier.

Try the skill

1. The scale on a map is 1 : 190 000. On the map, the distance between two towns is 20 cm.
   What is the real distance between the two towns?
   190,000 × 20 = 3,800,000 cm

*. Tip, check or remind yourself of metric conversions.

3,800,000 cm
= 38,000 m
= 38 km

2. A scale diagram of a nursery shows the width of the nursery as 6.5 cm. The scale is 1 : 200.
What is the real width of the nursery, in metres?

6·5 × 200 = 1,300 cm

1,300 ÷ 100 = (metres) 13 m

Check the question carefully. You may be asked to work out the length in real life or the length on a drawing or map. You may be asked to measure lengths and use the scale to work out the real-life measurement.

3. A map of a town is drawn, using a scale of 1 cm to 0.5 miles. On the map, the distance between the library and the museum is 8 cm.
What is the real distance between the library and the museum?

8 × 0·5 (this is the same as half of 8)

= 4 miles

4. A designer draws a scale diagram of a kitchen, using a scale of 1 : 50. The actual length of a wall unit is 3.5 m.
What is the length of the wall unit on the scale diagram?

Read this question very carefully!!!

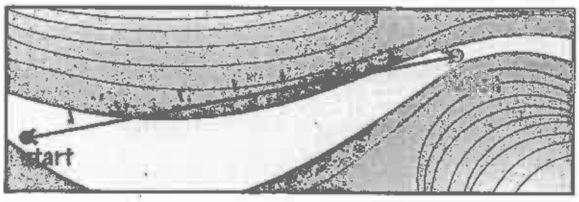
3·5 m = 350 cm

350 cm ÷ 50 = 7 cm on the scale diagram.

5. The heights of three girls on a photograph are 10 cm, 9 cm and 7 cm. The scale of the photograph is 1 : 16.
What are the girls' real heights?

10 × 16 = 160 cm, 9 × 16 = 144 cm, 7 × 16 = 112 cm

6. The map shows the start and finish points for a sponsored walk. The scale is 1 cm to 0.5 miles.



8cm distance on scale plan.

What is the distance, in miles, between the start and finish points?

8 × 0·5 = 4 miles

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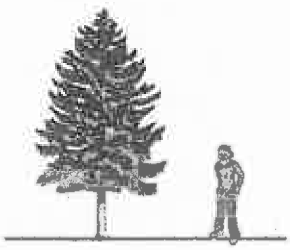
5 Estimating using proportion

Learn the skill

You can use proportion to estimate amounts or quantities.

Example 1:



The woman has a height of 1.5 metres. Use proportion to estimate the height of the tree.

Here proportion refers to the relative size of the woman and the tree.

The woman in the diagram is approximately 2 cm high. The tree is approximately 5 cm high. This means the tree is $\frac{5}{2}$ = 2.5 times as high as the woman, so you can estimate the height of the tree as

2.5 x 1.5 = 3.75 metres.

Answer: 3.75 metres

Example 2: A tin of paint is approximately $\frac{3}{4}$ full. The tin holds 10 litres of paint when full. Estimate how much paint is left in the tin.

Here proportion refers to the fraction of the tin that is full of paint.

You need to find $\frac{3}{4}$ of 10 litres. $\frac{10}{4} \times 3 = 7.5$ litres

Answer: 7.5 litres

Try the skill

1 The width of a room is 3 metres. Use the scale diagram and proportion to estimate the length of the room.

About 9 metres

2. A litre of water is poured into a jug.

a What proportion of the jug has been filled?

b Estimate how much water the jug will hold when filled right to the top.

First estimate what fraction of the jug has been filled. The fraction represents the proportion that has been filled.

About $\frac{3}{4}$

$\frac{3}{4}$ = 1 litre so full, about 1·3 Litres

6 Remember what you have learned

Learn the skill

- A ratio is a way of comparing two or more quantities.
- You usually write ratios in their Simplest form.
- You can use a ratio to scale quantities up or down. You multiply or divide each amount by the same number.
- To compare units of measure, make sure they are in the same units. Very important!
- Think of a ratio as being made up of a number of parts. 3 : 2 is a total of 5 parts.
- The scale on a drawing or map is a ratio.

Try the skill

1. On a map, the distance between two towns is 27 centimetres. The scale of the map is 2 centimetres to 5 kilometres.

   What is the actual distance between the two towns?

   $(27 \div 2) \times 5$

   A ☐ 2.7 km
   B ☐ 10.8 km
   C ☑ 67.5 km
   D ☐ 135 km

2. Approximately what proportion of the jar is filled with sweets?

   A ☐ $\frac{1}{4}$
   B ☐ $\frac{1}{3}$
   C ☐ $\frac{2}{3}$
   D ☑ $\frac{3}{4}$

3. A designer draws a plan of a coffee shop, using a scale of 1 : 50. The actual length of the counter in the coffee shop is 4 metres.

   What is the length of the counter on the scale drawing?

   A ☐ 2 cm
   B ☑ 8 cm
   C ☐ 12.5 cm
   D ☐ 20 cm

4. A barman makes a fruit cocktail by mixing apple juice, pineapple juice and orange juice in the ratio 1 : 2 : 2. He uses 5 litres of orange juice.

   How much fruit cocktail does he make?

   A ☐ 10 litres
   B ☑ 12.5 litres
   C ☐ 25 litres
   D ☐ 37.5 litres

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5. A nursery nurse makes 14 litres of orange drink for the children in a playgroup. She mixes orange concentrate and water in the ratio 2:5.

How many litres of orange concentrate does she use?

A ☐ 2
B ☐ 3
C ☑ 4
D ☐ 5

When a ratio is in its simplest form, the numbers are whole numbers. Sometimes it is useful to write a ratio in the form 1 : *n* or *n*: 1. For example, 2 : 5 is 1 : 2.5 [dividing both by 2]and 5 : 4 is 1.25 : 1 [dividing both by 4]

6. On a map with a scale of 1 : 500 000, the distance between a family's home and the airport is 30 cm.

What is the actual distance between their home and the airport?

A ☐ 15 km
B ☐ 750 km
C ☑ 150 km
D ☐ 75 km

7. A car has an average fuel consumption of 5.6 litres per 100 km.

Which of these calculations would you use to estimate how much fuel you would need for a journey of 88 km?

A ☐ 5.6 ÷ 88 × 100
B ☑ 5.6 ÷ 100 × 88
C ☐ 88 ÷ 5.6 × 100
D ☐ 88 × 100 ÷ 5.6

8. A recipe for 20 almond biscuits requires:
- 150 g margarine
- 150 g sugar
- 1 egg
- 300 g self-raising flour
- 50 g ground almonds

300 ÷ 2 × 6·5 = 975
or
300 ÷ 4 = 75g for 5.
75 × 13 = 975

How much flour will be needed to make 65 biscuits?

A ☐ 900 g
B ☑ 975 g
C ☐ 1000 g
D ☐ 1050 g

9. A model of a boat is made to a scale of 1 : 40. The length of the real boat is 25 metres.

What is the length of the model boat?

A ☐ 6.25 cm
B ☐ 10 cm
C ☑ 62.5 cm
D ☐ 100 cm

10. A man shares 480 g of dog food between a small dog and a larger dog in the ratio 3 : 5.

How much does the larger dog get?

480 ÷ (3+5=8) 8 = 60

(3×60) : (5×60)

A ☐ 180 g
B ☑ 300 g
C ☐ 288 g
D ☐ 280 g

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F

Working with formulae and equations

You should already know how to:

- use formulae expressed in words

By the end of this section you will know how to:

- apply the BIDMAS rule to evaluate an expression
- use formulae expressed in symbols
- use simple equations

1 Applying the BIDMAS rule to evaluate an expression

Learn the skill

An **expression** is a combination of numbers, operators, brackets and/or variables.
For example, 2 x [3 + 5] ÷ 4 or 3a + 5b.

Use the **BIDMAS rule** to help you remember which order to follow, to evaluate an expression.

- The BIDMAS rule is:
  - **B**rackets
  - **I**ndices
  - **D**ivision or **M**ultiplication
  - **A**ddition or **S**ubtraction.

Example 1: Evaluate these.
a 12 – 5 × 4 + 2 **b** (12 – 5) × 4 + 2 **c** (12 – 5) × (4 + 2)

a Multiplication before addition and subtraction.
12 – 5 × 4 + 2 = 12 – 20 + 2 = –6

Answer: –6

b Brackets must be worked out first.
(12 – 5) × 4 + 2 = 7 × 4 + 2 = 28 + 2 = 30

Answer: 30

Tip

The symbols +, –, ×, ÷ are called operators.

Tip

Always follow this order or you will get the wrong answer.

Tip

A **variable** is an unknown quantity, usually represented by a letter, that can change its numerical value.

Tip

Questions may ask you to evaluate, work out or calculate the value.

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c The two sets of brackets must be worked out first.

$(12 - 5) \times (4 + 2) = 7 \times 6 = 42$

Answer: 42

Remember

Indices are powers:
$3^2 = 3 \times 3$
It is a common mistake to say
$3^2 = 3 \times 2$

Example 2: Work out the value of $2 \times 3^2 \times 4$.

The indices must be worked out first.
$2 \times 3^2 \times 4 = 2 \times 9 \times 4 = 72$

Answer: 72

Tip

A number written outside a bracket with no sign between the number and the bracket must be multiplied by the bracket.

Example 3: Calculate the value of $2(5^2 - 4^2)$

Brackets must be worked out first.
$2(5^2 - 4^2) = 2(25 - 16) = 2 \times 9 = 18$

Answer: 72

Try the skill

1. Evaluate $6 + 4 \div 2 - 1$ $4 \div 2 = 2 + 6 = 8 - 1 = 7$
2. Evaluate $(6 + 4) \div 2 - 1$ $10 \div 2 = 5 - 1 = 4$
3. Evaluate $(6 + 4) \div (2 - 1)$ $10 \div 1 = 10$
4. Evaluate $6 + 4 \div (2 - 1)$ $4 \div 1 = 4 + 6 = 10$
5. Evaluate $\frac{(10 - 2)}{4}$ $8 \div 4 = 2$
6. Evaluate $3 \times 2^2 \times 5$ $3 \times 4 \times 5 = 60$
7. Evaluate $3(5 + 4)$ $3 \times 9 = 27$
8. Evaluate $\frac{1}{2}(4^2 - 6)$

$\frac{1}{2}(4^2 - 6)$ original

$\frac{1}{2} \times ((4 \times 4) - 6)$ indices expanded

$\frac{1}{2} \times (16 - 6)$ indices solved

$0.5 \times (10) = 5$ fraction to decimal form, brackets solved

Tip

Remember to apply **BIDMAS**.

Tip

When there is no operator between numbers and variables they should be multiplied. For example:
$5b = 5 \times b$
$3a^2 = 3 \times a^2 = 3 \times a \times a$
$4abc = 4 \times a \times b \times c$

Remember

$3(5 + 4)$ means $3 \times (5 + 4)$

Tip

The BIDMAS rule also applies to algebraic expressions.

2 Formulae and equations in symbols

Learn the skill

A formula (plural formulae), is a way of describing a rule or relationship.

The words or symbols in formulae represent variable quantities.

Level 2 questions involve making substitutions in given formulae in words and symbols.

Remember

$30n$ means $30 \times n$.

Example 1: A DIY-hire company uses the formula $C = 30n + 50$ to work out the cost, C pounds, of a customer using a machine for n days. Use the formula to work out the cost of using the machine for 10 days.

Tip

The formula expressed in words would be: The cost of using the machine is £30 per day plus a £50 fixed charge.

To find C, put the value of n in the formula.

$C = 30 \times 10 + 50$
$C = 300 + 50 = £350$

Answer: £350

Example 2: The formula to convert a temperature in Celsius, C, to a temperature in Fahrenheit, F, is $F = \frac{9}{5}C + 32$. Use the formula to convert 45°C to the Fahrenheit equivalent.

Tip

You can multiply or divide in any order. Here, dividing first cancels out factors and makes the calculation easier.

Substituting $C = 45$:

$F = \frac{9}{5} \times 45 + 32$

$F = 81 + 32 = 113$ °F

$\frac{9}{\cancel{5}_1} \times \frac{\cancel{45}^9}{1} = \frac{9}{1} \times \frac{9}{1} = 81$

Answer: 113 °F

Example 3: The formula to convert a temperature in Fahrenheit, F, to the equivalent temperature in Celsius, C, is $C = \frac{5}{9}(F - 32)$. Use the formula to convert 59 °F to the Celsius equivalent.

Tip

Work out the brackets first.

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

Substituting $F = 59$:

$C = \frac{5}{9}(59 - 32) = \frac{5}{9} \times 27 = \frac{5}{\cancel{9}_1} \times \frac{\cancel{27}^3}{1} = \frac{5}{1} \times \frac{3}{1} = 15$

Answer: 15 °C

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Try the skill

1. A mobile phone company uses the formula $C = 12 + 0.06t$ to work out the charge, C pounds, for a customer who makes t minutes of phone calls in a month. Work out the charge in a month where a customer makes 500 minutes of phone calls.

Challenge question!

What does the 0.06 represent in the formula $C = 12 + 0.06t$?

2. A bank uses the formula $I = 0.04P$ to work out the interest, I pounds, when an amount P pounds is invested for one year. Work out the interest in a year when £250 is invested.

Challenge question!

What rate of interest does the bank use?

3. An electricity company uses the formula $C = 8.5 + 0.064e$ to work out the charge, C pounds, to a customer in a month where e units of electricity were used. How much is a customer charged in a month where 600 units of electricity are used?

Challenge question!

What is the cost per unit of electricity?

4. The formula for calculating the area of a rectangle is $A = LW$, where L is the length of the rectangle and W is the width. Calculate the area of a rectangle with length 12 cm and width 4.5 cm.

5. A formula for converting centimetres, I = c is
$I = \frac{c}{2.5}$
Use the formula to convert 12.8 cm to inches.

$I = \frac{C}{2.5}$ So $I = \frac{12.8}{2.5}$

So $I = 5.12$(inch)

6. The formula to calculate simple interest, I, when an amount of money, P, is invested at a rate, R, for a period of time, T, is
$I = \frac{PRT}{100}$ $\quad I = \frac{3 \times 5 \times 500}{100}$
Calculate the simple interest when £500 is invested for 3 years at a rate of 5%.

£75

7. The formula that converts a temperature in Celsius, C, to the equivalent temperature in Fahrenheit, F, is $F = \frac{9}{5}C + 32$. Use the formula to convert 55 °C to Fahrenheit.

Tip

Always check that your answer makes sense, by substituting back into the formula.

$\boxed{F = \frac{9}{5} \times C + 32}$ $\quad \boxed{F = 1.8 \times 55 + 32}$

$F = 131\,°F$

To change fractions to decimal form, divide top by bottom number.

3 Using equations

Learn the skill

An **equation** is a mathematical statement, in symbols, that two things are the same, (or equivalent). Equations are written with an equal sign.

In Example 1 of Formula with Symbols the formula $C = 30n + 50$ was used to calculate the cost, C pounds, using the machine for any number of days n.

Suppose the company charged a customer £500 for using the machine. Substituting this into the formula gives:

$500 = 30n + 50$

This is an equation which you can use to work the number of days, n, that the customer hired the machine.

At Level 2 you will be asked to solve equations to find the value of a variable.

Example 1: Use the equation $500 = 30n + 50$, to work out the number of days, n, that the customer hired the machine.

You can use an inverse flowchart on the formula $C = 30n + 50$ to work out n:

Start with the variable you want to find as the input:

Input $n \longrightarrow \boxed{\times 30} \longrightarrow \boxed{+50} \longrightarrow$ Output C

now write it in reverse:

Output $n \longleftarrow \boxed{\div 30} \longleftarrow \boxed{-50} \longleftarrow$ Input C

Putting $C = 500$ and working through the flowchart backwards:

$15 \longleftarrow \frac{450}{30} \longleftarrow 450 \longleftarrow 500$

Answer: 15 days

Example 2: A simplified formula to convert from degrees Fahrenheit to degrees Celsius is $C = \frac{F}{5} - 16$. Use this formula to convert 20 °C to degrees Fahrenheit.

The equation to solve is $20 = \frac{F}{2} - 16$. The flowchart for the formula starts with F:

Input F $\longrightarrow \boxed{\div 2} \longrightarrow \boxed{-16} \longrightarrow$ Output C

Now write it in reverse:

Output F $\longleftarrow \boxed{\times 2} \longleftarrow \boxed{+16} \longleftarrow$ Input C

Putting $C = 20$ and working through the flowchart backwards:

$72 \longleftarrow 36 \times 2 \longleftarrow 36 \longleftarrow 20$

Answer: 72 °F

Tip

Equations and formulae are similar.
A **formula** is true for all values of the variables. For example, $C = 30n + 50$ will find the cost for all different values of n
An **equation** is only true for specific values of the variable(s). For example, $500 = 30n + 50$ is only true for $n = 15$

Remember

For the inverse flowchart
+ is inverse to −
× is inverse to ÷

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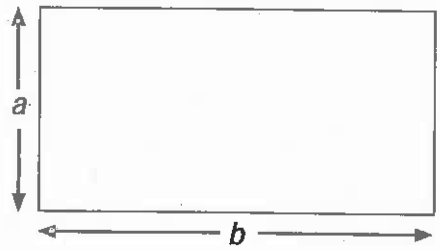
Example3: The formula to find the perimeter, P, of a rectangle with sides of length a and b is $P = 2(a + b)$. The perimeter of a rectangle is 34 cm, one of the sides is of length 7 cm. What is the length of the second side of the rectangle?

Here $P = 34$ and $a = 7$. Substitute into the formula to find the equation.



$34 = 2(7 + b)$. Use this to set up the flowchart:

Input $b \longrightarrow \boxed{+7} \longrightarrow \boxed{\times 2} \longrightarrow$ Output P

Now write it in reverse:

Output $b \longleftarrow \boxed{-7} \longleftarrow \boxed{\div 2} \longleftarrow$ Input P

Putting $P = 34$ and working through the flowchart backwards:

$10 \longleftarrow 17 - 7 \longleftarrow 17 \longleftarrow$ Input 34

Try the skill

In questions 1–4, solve the following equations for n:

1. $100 = 30n - 20$ 4 $(100+20) = 30n$
2. $450 = \frac{n}{3} + 10$ 1,320
3. $250 = 20n + 90$ 8
4. $18 = \frac{n}{4} - 12$ 120

The inverse of squaring is finding the square root. Use the √ symbol on your calculator.

5. The formula to work out the monthly cost, C for a mobile phone is $C = 12 + 0.09n$, where n is the number of minutes of phone calls made in the month. A customer receives a bill for £40.80 for the month. How many minutes of phone calls did the customer make in the month? 320 minutes

$40.80 - 12 = 0.09n$
£28.80 $= n \times 0.09$
$28.8 \div 0.09 = n$

The word 'solve' is often used when you need to find the value of a variable in an equation.

6. The formula a building society uses to work out the interest, I, payable for a year when P pounds is invested is $I = 0.062P$. A customer receives £34.10 in interest for one year. How much money did he invest? £ 550

7. The formula used to work out a person's Body Mass Index, BMI, is shown in the box, where w is the weight in kilograms and h is the height in metres. An athlete has a BMI of 24.8 and a height of 1.62 metres. What is the athlete's weight to the nearest kilogram? 65 Kg

$\text{BMI} = \frac{w}{h^2}$

8. The formula for the area, A cm², of a circle is $A = \pi r^2$, where π is a constant, approximately equal to 3.14 and r is the radius in centimetres. The area of a circle is 78.5 cm². What is its radius? 5cm

Challenge question!

→ Re-arrange so
$3.14 \times r \times r = 78.5$
$78.5 \div 3.14 = r^2$
$78.5 \div 3.14 = 25$ $\sqrt{\ } = 5.$

3 Remember what you have learned

Learn the skill

- A formula is a way of describing a statement or rule.
- The BIDMAS rule is:
  - Brackets
  - Indices or Order
  - Division or Multiplication
  - Addition or Subtraction.
- Indices are powers, for example, $3^2 = 3 \times 3$.
- $30n$ means $30 \times n$.
- A formula is true for all values of the variables
- An equation is only true for specific values of the variables

Use the skill

1. To calculate the cost of printing leaflets, a printer uses the formula $C = 25 + 0.08n$, where C is the cost, in pounds, and n is the number of leaflets.

   How much would he charge for printing 500 leaflets?

   A ☐ £29
   B ☑ £65
   C ☐ £87.50
   D ☐ £425

2. The cooking time, T minutes, for a joint of beef weighing w kilograms is given by:

   $T = \frac{105w}{2} + 25$

   How long would it take to cook a 4 kilogram joint of beef?

   A ☐ 2 hours 35 mins
   B ☑ 2 hours 55 mins
   C ☐ 3 hours 35 mins
   D ☐ 3 hours 55 mins

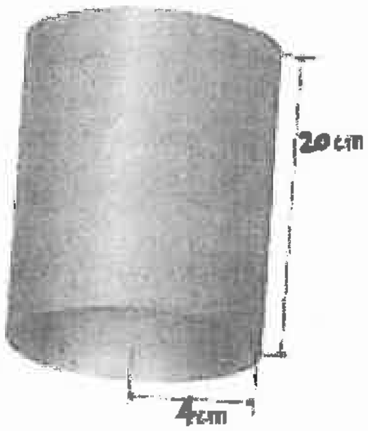
   Careful, answer is in minutes!

3. A water bottle is shaped like a cylinder.

   Volume of cylinder = $\pi r^2 h$

   where r is the base radius and h is the height.

   Taking the value of π as 3, work out approximately how much water the water bottle will hold.



   A ☐ $240\,cm^3$
   B ☐ $720\,cm^3$
   C ☑ $960\,cm^3$
   D ☐ $2\,880\,cm^3$

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4. The formula that converts a temperature in Fahrenheit, F, to the equivalent temperature in Celsius, C, is

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

The temperature in London one morning was 77 degrees Fahrenheit.

What was the temperature in degrees Celsius?

- A ☐ 11°C
- B ☑ 25°C
- C ☐ 59°C
- D ☐ 81°C

$[(77 - 32) \times 5 \div 9]$

5. A shopkeeper buys bracelets for £2.50 each and sells them for £4.50.

$$\text{Percentage profit} = \frac{\text{selling price} - \text{buying price}}{\text{buying price}} \times 100\%$$

What is the shopkeeper's percentage profit?

- A ☐ 44%
- B ☐ 56%
- C ☐ 70%
- D ☑ 80%

Hint, for % you should learn this formula

6. A printer uses the formula $C = 25 + 0.08n$ to work out the cost, C pounds, for printing n leaflets. He charges a customer £53. How many leaflets did he print?

$$\frac{(53 - 25)}{0{\cdot}08}$$

- A ☐ 224
- B ☑ 350
- C ☐ 367
- D ☐ 975

7. A bank uses the formula $I = 0.04P$ to work out the interest, I pounds, when an amount P pounds is invested for one year. What is the amount invested for the year if £32.80 is paid in interest?

$$\frac{32{\cdot}8}{{\cdot}04}$$

- A ☐ £82
- B ☐ £131.20
- C ☑ £820
- D ☐ £1312

8. A mobile phone company uses the formula $C = 12 + 0.06t$ to work out the charge, C pounds, for a customer who makes t minutes of phone calls in a month. What is the number of minutes of calls made in a month where a customer is charged £55.20?

$(55{\cdot}2 - 12) \div {\cdot}06$

- A ☑ 720
- B ☐ 920
- C ☐ 1020
- D ☐ 1120