

Maths Level 2

Chapter 3

Working with ratio, proportion, formulae and equations

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Maths Level 2

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Chapter 3: Working with ratio, proportion, formulae and equations

Use these free pilot resources to help build your learners' skill base

We are delighted to continue to make available our free pilot learner resources and teacher notes, to help teach the skills learners need to pass Edexcel FS Mathematics, Level 2.

But use the accredited exam material and other resources to prepare them for the real assessment

We developed these materials for the pilot assessment and standards and have now matched them to the final specification in the table below. They'll be a useful interim measure to get you started but the assessment guidance should no longer be used and you should make sure you use the accredited assessments to prepare your learners for the actual assessment.

New resources available for further support

We're also making available new learner and teacher resources that are completely matched to the final specification and assessment – and also providing access to banks of the actual live papers as these become available. We recommend that you switch to using these as they become available.

Coverage of accredited specification and standards

The table below shows the match of the accredited specification to the unit of pilot resources. This table supersedes the pilot table within the teacher notes.

Coverage and Range	Exemplification	Learner Unit
Understand, use and calculate ratio and proportion, including problems involving scale	<ul style="list-style-type: none"> Write a ratio in its simplest form ($a:b$) Scale quantities up or down Calculations with ratios as one unit to another unit scale Use map scales in diagrams Simple direct and inverse proportion Writing fractions as ratios 	E1 Writing a ratio E2 Scaling quantities up or down E3 Calculations with ratio E4 Scale diagrams E5 Estimating using proportion Inverse proportion is covered in our new publishing (see below)
		E6 Remember what you have learned
Understand and use simple formulae and equations involving one- or two-step operations	<ul style="list-style-type: none"> Substitute numbers into a formula Derive a formula in words Changing the subject of a formula Inverse operations Formulae may include brackets 	F1 Applying the BIDMAS rule to evaluate an expression F2 Formulae in symbols F3 Using equations Changing the subject of a formula is covered in our new publishing (see below)
		F4 Remember what you have learned

Where to find the final specification, assessment and resource material

Visit our website www.edexcel.com/fs then:

- **for the specification and assessments:** under **Subjects**, click on **Mathematics (Levels 1–2)**
- **for information about resources:** under **Support**, click on **Published resources**.

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 1050 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 $1050 - 675 = 375$. The order of the ratio is important.

Number of children : number of adults = $675:375$

Dividing both numbers by 25 and then by 3:

$$\frac{675}{375} = \frac{27}{15} = \frac{9}{5}$$

(Note: Red arrows in the original image indicate dividing 675 by 25 to get 27, and 375 by 25 to get 15, then dividing both 27 and 15 by 3 to get 9 and 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 $4 \times 6 = 24$.

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 = $2 \times 60 = 120$ minutes.

Now write the ratio without units:

$$45 : 120$$

Dividing both numbers by 5 and then by 3:

$$\begin{aligned} 45 : 120 \\ = 9 : 24 \\ = 3 : 8 \end{aligned}$$

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?

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?

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

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?

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?

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?

Remember

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

Tip

Make sure the quantities are in the same units.

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.

Example 1: A recipe for eight portions of shortbread takes:

- 150g plain flour
- 100g butter
- 50g 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.

- 75g plain flour
- 50g butter
- 25g 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: 225g plain flour, 150g butter, 75g caster sugar

Tip

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

Tip

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?

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. A recipe for a sponge cake providing eight portions takes:
 - 110g butter
 - 110g caster sugar
 - 110g 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?

 - b How many 250g packs of butter are needed to make 140 portions of sponge cake?

Remember

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.

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 = $3 \times 2 = 6$ litres

Answer: 6 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 = $140 \div 7 = 20$ kg
There is a total of 10 parts (7 parts sand + 3 parts cement)
So the total amount of mortar is $10 \times 20 = 200$ kg

Answer: 200 kg



Tip

Check:
2 parts of red = $2 \times 2 = 4$ litres
 $6 + 4 = 10$ litres.

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?


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

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?

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?

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

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.

$$\text{Length of bonnet on real car} = 20 \times 6 \text{ cm} = 120 \text{ cm}$$

Answer: 120 cm

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.

$$50 \text{ parts represent } 14 \text{ m} = 14 \times 100 \text{ cm} = 1400 \text{ cm}$$

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

Answer: 28 cm

Tip

Check the units given in the answer.

Here, map distances are in cm and real distances in km.

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

Tip

Changing to cm makes the calculation easier.

Try the skill

- 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?

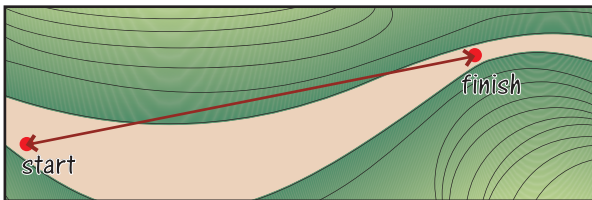
2. A scale diagram of a nursery shows the width of the nursery as 6.5 cm. The scale is 1 : 200.
What is the real width of the nursery, in metres?

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?

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?

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?

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



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

Tip

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.

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

$2.5 \times 1.5 = 3.75$ 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

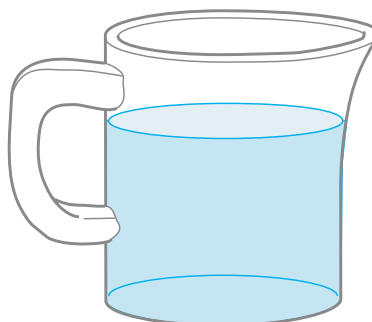
Answer: 7.5 litres

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.



2. A litre of water is poured into a jug.
- What proportion of the jug has been filled?
 - Estimate how much water the jug will hold when filled right to the top.



Tip

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

6 Remember what you have learned

Learn the skill

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

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?

- 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

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?

Tip

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]

- A 2
 B 3
 C 4
 D 5

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 $5.6 \div 88 \times 100$
 B $5.6 \div 100 \times 88$
 C $88 \div 5.6 \times 100$
 D $88 \times 100 \div 5.6$

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

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?

- A 180 g
 B 300 g
 C 288 g
 D 280 g

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, $2 \times [3 + 5] \div 4$ or $3a + 5b$.

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

▶ The BIDMAS rule is:

- ▶ Brackets
- ▶ Indices
- ▶ Division or Multiplication
- ▶ Addition or Subtraction.

Example 1: Evaluate these.

a $12 - 5 \times 4 + 2$ b $(12 - 5) \times 4 + 2$ c $(12 - 5) \times (4 + 2)$

a Multiplication before addition and subtraction.

$$12 - 5 \times 4 + 2 = 12 - 20 + 2 = -6$$

Answer: -6

b Brackets must be worked out first.

$$(12 - 5) \times 4 + 2 = 7 \times 4 + 2 = 28 + 2 = 30$$

Answer: 30

Tip

The symbols $+$, $-$, \times , \div 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.

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

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

Answer: 42

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

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

Remember

Indices are powers:

$$3^2 = 3 \times 3$$

It is a common mistake to say

$$3^2 = 3 \times 2$$

Tip

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

▶ Try the skill

1. Evaluate $6 + 4 \div 2 - 1$

2. Evaluate $(6 + 4) \div 2 - 1$

3. Evaluate $(6 + 4) \div (2 - 1)$

4. Evaluate $6 + 4 \div (2 - 1)$

5. Evaluate $\frac{(10 - 2)}{4}$

6. Evaluate $3 \times 2^2 \times 5$

7. Evaluate $3(5 + 4)$

8. Evaluate $\frac{1}{2}(4^2 - 6)$

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.

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.

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

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

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.

Substituting $C = 45$:

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

$$F = 81 + 32 = 113^\circ\text{F}$$

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

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.

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

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

Remember

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

Tip

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

Tip

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

Tip

Work out the brackets first.

 **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.
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.
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?
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.

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


$$I = \frac{PRT}{100}$$

Calculate the simple interest when £500 is invested for 3 years at a rate of 5%.


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.

 **Challenge question!**

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

 **Challenge question!**

What rate of interest does the bank use?

 **Challenge question!**

What is the cost per unit of electricity?

 **Tip**

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

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:

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

now write it in reverse:

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

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 $20 = \frac{F}{5} - 16$. The flowchart for the formula starts with F :

$$\text{Input } F \longrightarrow \boxed{\div 5} \longrightarrow \boxed{-16} \longrightarrow \text{Output } C$$

Now write it in reverse:

$$\text{Output } F \longleftarrow \boxed{\times 5} \longleftarrow \boxed{+16} \longleftarrow \text{Input } C$$

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

$$72 \longleftarrow 36 \times 5 \longleftarrow 36 \longleftarrow 20$$

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

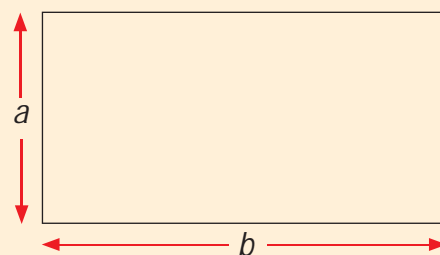
An **equation** is only true for specific values of the variable(s). For example, $500 = 30n + 50$ is only true for $n = 15$

Remember

For the inverse flowchart
+ is inverse to -
 \times is inverse to \div

Example 3: 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. $100 = 30n - 20$

2. $450 = \frac{n}{3} + 10$

3. $250 = 20n + 90$

4. $18 = \frac{n}{4} - 12$

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?

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?

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?

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?

Tip

The inverse of squaring is finding the square root. Use the $\sqrt{\quad}$ symbol on your calculator.

Tip

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

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

Challenge question!

3 Remember what you have learned

Learn the skill

- ▶ A formula is a way of describing a _____ or _____.
- ▶ The BIDMAS rule is:
 - ▶ _____
 - ▶ _____
 - ▶ Division or Multiplication
 - ▶ Addition or Subtraction.
- ▶ Indices are powers, for example, $3^2 = 3 \times \underline{\quad}$.
- ▶ $30n$ means $\underline{\quad} \times n$.
- ▶ A formula is true for _____ values of the variables
- ▶ An equation is only true for _____ 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

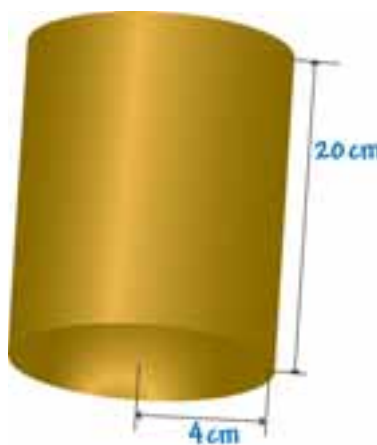
2. The cooking time, T minutes, for a joint of beef weighing w kilograms is given by:
 $T = \frac{105w}{2} + 25$
How long would it take to cook a 4 kilogram joint of beef?

- A 2 hours 35 mins
- B 2 hours 55 mins
- C 3 hours 35 mins
- D 3 hours 55 mins

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 cm³
- B 720 cm³
- C 960 cm³
- D 2 880 cm³

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

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%

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?

- 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?

- 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?

- A 720
 B 920
 C 1020
 D 1120