

Measures of central tendency and spread

Measures of central tendency

A measure of central tendency is a single value that attempts to describe a set of data by identifying its central position. **Mean, median and mode** are measures of central tendency:

- The mean is an **arithmetic average** found by adding together the values and dividing the total by the number of values in the data set.
- The median is the **middle value** when the data is ordered.
- The mode is the **most common** value in the data set.

The number of goals that were scored in 7 football matches are recorded. Find the mean number of goals scored.

1 3 4 6 6 7 8

To determine the mean, divide the total sum by the total number of items in the data set.

$$1 + 3 + 4 + 6 + 6 + 7 + 8 = 35$$

$$35 \div 7 = 5$$

The mean is 5 goals per game.

Find the median of this data set showing the number of goals scored in 7 football matches.

1 6 7 4 6 8 3

To find the median, put the numbers in **ascending** or **descending** order, and find the **middle value** by crossing out the numbers at each end of the data set.

~~1~~ ~~3~~ ~~4~~ 6 ~~6~~ ~~7~~ ~~8~~

The median is 6 goals.

Find the median of the data set.

9 9 9 10 10 14 15 16 19 20

To find the median of a data set that has an even number of values, find the two middle numbers, add the two numbers together and divide the total by 2.

~~9~~ ~~9~~ ~~9~~ ~~10~~ 10 14 ~~15~~ ~~16~~ ~~19~~ ~~20~~

$$10 + 14 = 24$$

$$24 \div 2 = 12$$

Median = 12

Find the mode of this data set showing the number of goals scored in 7 football matches.

1 3 4 6 6 7 8

To find the mode, look for the value that occurs the most often (i.e. the value that repeats more than any other value).

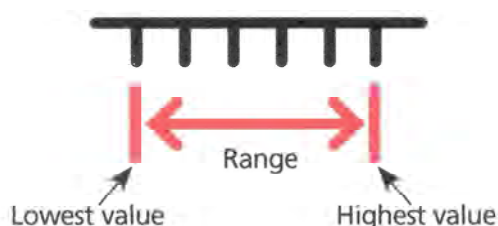
6 is the only value that is repeated in this data set.

The mode is 6 goals.

It is possible to have more than one mode or no mode at all.

Measuring the spread of data

The range measures the **spread** of the data set. To find the range, work out the difference between the highest and lowest values in the data set.



Find the range of this data set showing the number of goals scored in 7 football matches.

1 3 4 6 6 7 8

Range = highest value – lowest value

$$\text{Range} = 8 - 1$$

$$\text{Range} = 7 \text{ goals}$$

Measures of central tendency and spread

Measures of central tendency

- 1 The number of hours that 5 students spent studying in one week was recorded as follows:

10 5 3 5 7

- a) Work out the mean.

.....

- b) Work out the median.

.....

- c) Work out the mode.

.....

- 2 The shoe sizes of 8 students were recorded as follows:

3 3 5 4 3 4 7 3

- a) Work out the mean.

.....

- b) Work out the median.

.....

- c) Work out the mode.

.....

Measuring the spread of data

- 3 The number of hours that 5 students spent studying in one week was recorded as follows:

10 5 1 5 7

- Work out the range.

.....

- 4 The shoe sizes of 8 students were recorded as follows:

3 3 5 4 3 4 7 3

- Work out the range.

.....



Frequency tables

Data types and frequency tables

Data is a set of information that can be analysed. Data can be collected by using tables, which makes it easier to read and understand.

Qualitative data is data that describes something (e.g. colour of hair; colour of eyes).

Quantitative data is data that is numerical (e.g. height; shoe size).

There are two types of quantitative data:

- **Discrete** data can only take certain values (e.g. the number of people in a room; the number of pages in a book).
- **Continuous** data can take any value (e.g. the time taken to run a race; the mass of an object).

A **grouped** frequency table is used to organise and simplify a large set of data into smaller groups. A frequency table containing **ungrouped** data has data that has not been put into categories or simplified.

The heights of 16 students were recorded in centimetres. Organise the heights into a grouped frequency table.

159 140 145 149 150 134 144 151
155 144 157 141 158 146 132 160

Height, h cm	Frequency
$130 < h \leq 140$	3
$140 < h \leq 150$	7
$150 < h \leq 160$	6
Total = 16	

The line underneath the 'less than' symbols means 'less than or equal to'. Notice that a height of 140 cm is included in the first group.

The test scores of 21 students were recorded. Organise the test scores in an ungrouped frequency table.

6 10 10 9 7 8 7 9 9 5 6 8 7
9 8 10 9 7 9 10 5

Test score	Tally	Frequency
5		2
6		2
7		4
8		3
9		6
10		4
		Total = 21

The **mean**, **median**, **mode** and **range** can be calculated from a frequency table.

$$\begin{aligned} \text{Mean} &= \frac{\text{sum of all values}}{\text{number of values}} \\ &= \frac{(5 \times 2) + (6 \times 2) + (7 \times 4) + (8 \times 3) + (9 \times 6) + (10 \times 4)}{21} \\ &= 8 \end{aligned}$$

$$\begin{aligned} \text{Median} &= \frac{21 + 1}{2} = 11\text{th value} \\ &= 8 \end{aligned}$$

The **mode** is the most common value. This is the test score with the highest frequency.

The **mode** is 9.

$$\begin{aligned} \text{Range} &= \text{highest score} - \text{lowest score} \\ &= 10 - 5 = 5 \end{aligned}$$

If the total frequency is odd, find the median by calculating $(n + 1) \div 2$, where n is the number of values in the data set and the result is the position of the middle number.

Two-way frequency tables

A two-way frequency table is used to display data from two different categories.

Remember to include the totals for both categories in a two-way frequency table.

Primary and secondary students were asked if they eat breakfast in the mornings before school. 38 students in primary had breakfast. 12 students in primary did not have breakfast. 22 students in secondary had breakfast. 28 students in secondary did not have breakfast. Record these results in a two-way frequency table.

	Breakfast	No breakfast	Total
Primary	38	12	50
Secondary	22	28	50
Total	60	40	100

Frequency tables

Data types and frequency tables

- 1 Here is a list of the colours of cars in a car park:

green, blue, green, red, red, green, yellow,
yellow, blue, red, green, yellow, yellow,
yellow, red, green, blue, red, red, yellow,
green, yellow, green, blue, yellow, blue,
blue, red, green, blue, yellow

- a) Is this data quantitative or qualitative?

Colour	Tally	Frequency
Total =		

- b) Display this data in a frequency table.

- 2 Here are the speeds of 20 vehicles, to the nearest mph:

45 65 72 48 74 67 68
46 56 53 58 68 72 64
62 49 72 55 67 51

Complete the grouped frequency table:

Speed, x mph	Tally	Frequency
$40 < x \leq 50$		
$50 < x \leq 60$		
$60 < x \leq 70$		
$70 < x \leq 80$		
Total =		

- 3 Here are the temperatures at midday for 7 days (in $^{\circ}\text{C}$):

23, 24, 24, 23, 24, 25, 21

- a) Display this data in an ungrouped frequency table.
b) What is the mean of this data? _____
c) What is the median of this data? _____
d) What is the mode of this data? _____
e) What is the range of this data? _____

Temperature	Tally	Frequency
21°C		
22°C		
23°C		
24°C		
25°C		
Total =		

Two-way frequency tables

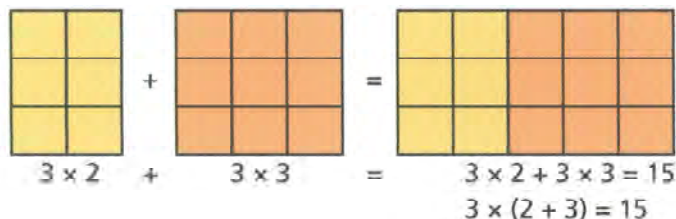
- 4 Students were asked what they ate for breakfast and lunch.
26 students who had porridge for breakfast had a sandwich for lunch.
14 students who had toast for breakfast had a sandwich for lunch.
10 students who had porridge for breakfast had a hot meal for lunch.
20 students who had toast for breakfast had a hot meal for lunch.

Complete the two-way frequency table:

	Sandwich	Hot meal	Total
Porridge			
Toast			
Total			

Expanding brackets using the distributive law

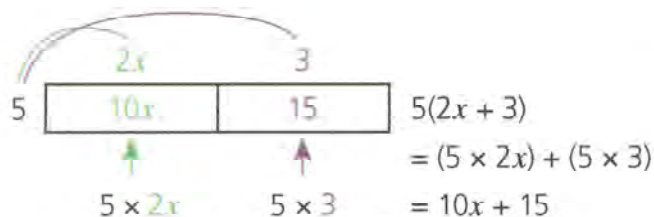
The **distributive law** says that the product of two numbers multiplied together is equal to the product of those numbers split into groups (**partitioned**).



The distributive law can be shown without visual aids by **expanding the bracket**.

$$\begin{aligned}
 3(2 + 3) &= (3 \times 2) + (3 \times 3) \\
 &= 6 + 9 \\
 &= 15
 \end{aligned}$$

The same rule applies when there are variables inside or outside the brackets. $5(2x + 3)$ can be expanded using an area model. Draw a large rectangle partitioned into smaller rectangles and find the area of each.



To expand a pair of brackets with more than two terms, you must multiply by each term.

To expand $4(2x + 3y - 8)$, multiply 4 by each term in the bracket.

$$\begin{array}{c}
 \begin{array}{|c|c|c|} \hline 4 \times 2x & 4 \times 3y & 4 \times -8 \\ \hline \end{array} \\
 4(2x + 3y - 8) \\
 = 8x + 12y - 32
 \end{array}$$

Multiply what is outside the brackets by everything inside the brackets.

When expanding brackets, remember that:

- multiplying or dividing two negative numbers gives a positive number $- \times - = +$
- multiplying or dividing a negative and a positive gives a negative number $- \times + = -$
- adding a negative number is the same as subtracting $+ \times - = -$
- subtracting a negative number is the same as adding $- \times - = +$

Expand $3m(2 - 7n)$

Multiply $3m$ by each term inside the bracket and carry the negative sign through to the answer.

$$\begin{aligned}
 3m(2 - 7n) &= (3m \times 2) + (3m \times -7n) \\
 &= 6m - 21mn
 \end{aligned}$$

Solving equations with brackets

To solve an equation with one pair of brackets, decide whether it will be easier to expand the brackets first or to divide by the number in front of the brackets.

Solve for k : $3(k - 5) = 6$

$$\begin{array}{l}
 3 \times k + 3 \times -5 = 6 \\
 3k - 15 = 6 \\
 +15 \quad +15 \\
 3k = 21 \\
 \div 3 \quad \div 3 \\
 k = 7
 \end{array}
 \qquad
 \begin{array}{l}
 3(k - 5) = 6 \\
 \div 3 \quad \div 3 \\
 k - 5 = 2 \\
 +5 \quad +5 \\
 k = 7
 \end{array}$$

To check, substitute $k = 7$ into $3(k - 5) = 6$
 $3(7 - 5) = 3 \times 2 = 6$ ✓

If an equation has more than one pair of brackets, expand all the brackets and simplify before solving.

Solve $3(2j - 4) + 2(j + 3) = 26$

First expand both brackets.

$$\begin{array}{l}
 3(2j - 4) + 2(j + 3) = 26 \\
 = (3 \times 2j) + (3 \times -4) + (2 \times j) + (2 \times 3) \\
 = 6j - 12 + 2j + 6 = 26 \\
 8j - 6 = 26 \\
 +6 \quad +6 \\
 8j = 32 \\
 \div 8 \quad \div 8 \\
 j = 4
 \end{array}$$

Solving equations with brackets

Expanding brackets using the distributive law

- 1 Expand each expression and simplify where possible by combining like terms.

a) $3(2k - 4) + 5k$

b) $8(2m - 4)$

c) $4(2x + 3y - 5)$

Solving equations with brackets

- 2 Solve the following equations.

a) $3(k - 5) = 12$

$k = \dots\dots\dots$

b) $2x + 3(4 - x) = 10$

$x = \dots\dots\dots$

- 3 Solve the following equations.

a) $2(x + 3) + 4(x - 5) = 10$

$x = \dots\dots\dots$

b) $5(y - 2) = 3(y - 2) + 2$

$y = \dots\dots\dots$

Using bar models (when all terms are positive)

A bar model doesn't work as well when there are negative terms. In that case, it is best to use algebra tiles.

x	x	x	x	x	1
x	x	1	1	1	1

x	x	x	x	x	1
x	x	1	1	1	1

This leaves $3x = 6$, or $1x = 2$, so the answer is $x = 2$.

It doesn't matter if the variables are on the left or the right, as long as they are all on the same side.

x	x	x	x	x	x
x	x	x			
-1	-1		1	1	1
			1	1	

The diagram illustrates the transformation of a 3x3 matrix into a 3x3 identity matrix using row operations. The left matrix has diagonal elements 1, 1, 1 and off-diagonal elements -1, -1, -1. The right matrix is the identity matrix. Arrows indicate the row operations: $R_2 = R_2 + R_1$ and $R_3 = R_3 + R_1$.

x	1	1	1
x	1	1	1
x	1	1	1

$$\begin{array}{r} 3x \div 3 = 9 \div 3 \\ x = 3 \end{array}$$

$$3 \times 3 + 7 = 9 + 7 = 16 \checkmark$$

Similarly, you could subtract 6 from both sides first or divide each term by 2 first and you would arrive at the same answer.

Solving equations with variables on both sides

Using bar models (when all terms are positive)

- 1 Draw bar models and solve the following equations.

a) $2x + 8 = 3x + 6$

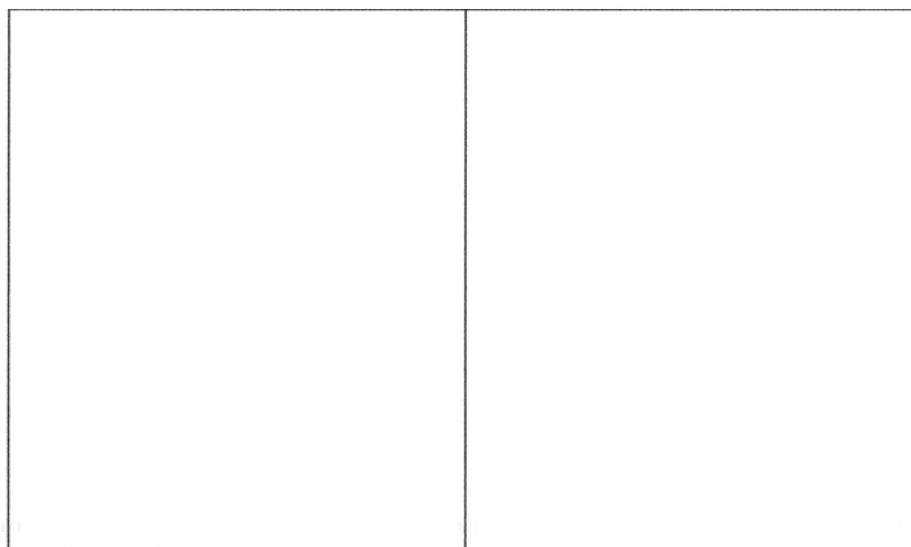
b) $3b + 5 = 4b + 1$

$x = \dots\dots\dots$

$b = \dots\dots\dots$

Using algebra tiles (when terms are positive and/or negative)

- 2 Show the equation $4x + 6 = 6x - 4$ using algebra tiles. Then use the tiles or your preferred method to solve the equation. If you do not have algebra tiles to hand, you can cut up bits of paper and label them.



$x = \dots\dots\dots$

Solving without visual aids

- 3 Solve each of the following equations. Show your working.

a) $2x + 6 = 5x - 15$

$x = \dots\dots\dots$

b) $3x - 4 = 20 - x$

$x = \dots\dots\dots$

Rearranging formulae

The subject of a formula

The subject of a formula is the variable that is isolated, usually to the left of the equals sign.

Identify the subject in each formula.

a) $A = \frac{b \times h}{2}$

A is the subject. The formula shows how the base and height of a triangle are related to the area.

b) $P = 2w + 2l$

P is the subject. The formula shows how the length and width of a parallelogram are related to the perimeter.

It is sometimes useful to rearrange the formula to **change the subject** to a different variable.

Suppose you know the area and height of a triangle and want to find the base. It would be easier if b was the subject of the formula.

How to rearrange formulae

Rearranging formulae is just like solving equations. Use inverse operations to 'undo' the formula so that a different variable is isolated.

You can think of formulae as function machines and work backwards to rearrange the subject. To draw a function machine, think about which variable is the input and which variable is the output. To find the input from the output, work backwards using inverse operations.

Function machine:

input $\rightarrow$ $\times 3$ $\rightarrow$ $+ 4$ $\rightarrow$ output

Reverse function machine:

input $\leftarrow$ $\div 3$ $\leftarrow$ $- 4$ $\leftarrow$ output

The formula for the area of a triangle is $A = \frac{bh}{2}$. To rearrange the formula to make the base, b , the subject, think about the operations that are required and apply the inverses.

base $\rightarrow$ $\times$ height $\rightarrow$ $\div 2$ $\rightarrow$ area

base $\leftarrow$ $\div$ height $\leftarrow$ $\times 2$ $\leftarrow$ area

To show this algebraically, think about undoing each operation to isolate b .

$$A = \frac{bh}{2}$$

Multiply both sides by 2 to 'undo' the fraction.

$$A \times 2 = \frac{bh}{2} \times 2$$

$$2A = bh$$

Simplify.

$$\div h \quad \div h$$

Divide both sides by h to solve for b .

$$2A \div h = b$$

$$b = \frac{2A}{h}$$

Rewrite the formula to have the b term (the new subject) on the left-hand side.

Inverse operations

Addition +	$\leftrightarrow$	Subtraction -
Multiplication $\times$	$\leftrightarrow$	Division $\div$
Powers (e.g. x^2 , x^3)	$\leftrightarrow$	Roots (e.g. $\sqrt{x}$, $\sqrt[3]{x}$)

Think of rearranging formulae as the same as solving equations. Get the new subject of the formula on its own by using inverse operations.

Rearrange the formula $V = \pi r^2 h$ to make r the subject.

Using a function machine:

$r \rightarrow$ squared $\rightarrow$ $\times \pi$ $\rightarrow$ $\times h$ $\rightarrow$ V

Reverse function machine:

$r \leftarrow$ square root $\leftarrow$ $\div \pi$ $\leftarrow$ $\div h$ $\leftarrow$ V

Algebraically: $V = \pi r^2 h$
 $\div \pi h \quad \div \pi h$

Divide both sides by πh to isolate the r term.

$$\frac{V}{\pi h} = r^2$$

Take the square root of both sides to 'undo' r^2 .

$$\sqrt{\frac{V}{\pi h}} = \sqrt{r^2}$$

Rewrite the formula to have the r term on the left-hand side.

$$r = \sqrt{\frac{V}{\pi h}}$$

Rearranging formulae

The subject of a formula

1 Write down the subject of each formula.

a) $P = sl$

.....

b) $A = \pi r^2$

.....

c) $C = 30h + 45$

.....

How to rearrange formulae

2 You are given the formula $P = sl$, where P is the perimeter of a regular polygon, s is the number of sides and l is the side length.

a) Rearrange the formula to make l the subject.

.....

b) Find the length of each side of a 12-sided polygon with perimeter of 108 cm.

.....

3 You are given the formula $A = \pi r^2$, where A is the area of a circle and r is the radius.

a) Rearrange the formula to make r the subject.

.....

b) Find the radius of a circle with area $225\pi \text{ cm}^2$.

.....

4 You are given the formula $C = 30h + 45$, where C is the charge in £ for a DJ and h is the number of hours worked by the DJ.

a) Rearrange the formula to make h the subject.

.....

b) Find the number of hours worked by the DJ if the charge was £135.

.....

Solving multi-step equations 1

Solving one- and two-step equations

Equations are solved using **inverse operations**.

The **one-step equation** $x + 2 = 5$ can be solved as follows:

$$\begin{array}{r} x + 2 = 5 \\ -2 \quad -2 \\ \hline x = 3 \end{array}$$

The process is the same for solving **two-step equations**, except you must first isolate the unknown term (usually the variable x) on one side of the equation. It does not matter which side the unknown term is on.

Inverse operations

Addition +	$\Leftrightarrow$	Subtraction -
Multiplication $\times$	$\Leftrightarrow$	Division $\div$
Powers (e.g. x^2 , x^3)	$\Leftrightarrow$	Roots (e.g. $\sqrt{x}$, $\sqrt[3]{x}$)

Solve the equation $3x - 8 = 10$

$$3x - 8 = 10$$

$$+8 \quad +8$$

$$3x = 18$$

$$\div 3 \quad \div 3$$

$$x = 6$$

Use inverse operations to isolate x . The inverse of -8 is $+8$, so add 8 to both sides.

Now use inverse operations to find the value of x . $3x$ means 3 times x , and the inverse of multiplication is division, so divide both sides by 3.

When solving an equation, carry out the same operation to both sides at each step.

Solving equations with variables on both sides

To solve equations with variables on both sides, isolate the unknown term to one side.

Solve $2x + 8 = 4x - 2$

Subtracting $2x$ from both sides leaves a positive x term, whereas subtracting $4x$ from both sides would leave a negative x term. So it is easier to subtract $2x$.

$$2x + 8 = 4x - 2$$

$$-2x \quad -2x$$

$$8 = 2x - 2$$

$$+2 \quad +2$$

$$10 = 2x$$

$$\div 2 \quad \div 2$$

$$5 = x$$

$$x = 5$$

Subtract $2x$ from both sides.

Use inverse operations to isolate x .

To find the value of x , divide both sides by 2.

The answer is usually written with x on the left-hand side.

Solve $7y - 5 = 5y + 3$

$$7y - 5 = 5y + 3$$

$$-5y \quad -5y$$

$$2y - 5 = 3$$

$$+5 \quad +5$$

$$2y = 8$$

$$\div 2 \quad \div 2$$

$$y = 4$$

Subtract $5y$ from both sides.

Add 5 to both sides.

Divide both sides by 2.

Solving equations with brackets

When an equation has brackets, first expand them, then simplify and proceed to solve the equation as normal.

Solve $2(3x + 8) - 3(x + 4) = 10$

$$2(3x + 8) - 3(x + 4) = 10$$

First expand $2(3x + 8) = 6x + 16$ and $-3(x + 4) = -3x - 12$

$$(6x) + (16) - (3x) - (12) = 10$$

$$3x + 4 = 10$$

$$-4 \quad -4$$

$$3x = 6$$

$$\div 3 \quad \div 3$$

$$x = 2$$

Combine like terms.

The inverse of $+4$ is -4 , so subtract 4 from both sides.

$3x$ means $3 \times x$, so divide both sides by 3.

Solving multi-step equations 1

Solving one- and two-step equations

1 Solve each equation.

a) $7x + 9 = 51$

b) $6x - 9 = 21$

$x =$

$x =$

Solving equations with variables on both sides

2 Solve each equation.

a) $2x + 8 = 4x - 4$

b) $6x - 1 = 15 - 2x$

$x =$

$x =$

Solving equations with brackets

3 Solve each equation.

a) $3(x - 5) + 2(9 - x) = 10$

b) $6x + 7(2x - 3) = 19$

$x =$

$x =$

Solving multi-step equations 2

Solving equations when the coefficient is negative

When the coefficient of x (or other variable) is negative, manipulate the equation so that the coefficient is positive.

If you have a negative x term in the final step, multiply by -1 to find the value of x .

Solve $10 - 2x = 4$

$$\begin{aligned} 10 - 2x &= 4 \\ +2x & \quad +2x \\ 10 &= 4 + 2x \\ -4 & \quad -4 \\ 6 &= 2x \\ \div 2 & \quad \div 2 \\ x &= 3 \end{aligned}$$

Manipulate the equation so that $2x$ is isolated on one side and is a positive value.

The answer is usually written with x on the left-hand side.

Solving equations with one fraction

When solving equations with fractions, remember that a fraction is another way of writing division. For example, $\frac{x}{3}$ means $x \div 3$ and $\frac{4}{x}$ means $4 \div x$.

When an equation has just one fraction, simply multiply both sides by the denominator.

When solving equations with fractions and integers, you can either:

- multiply each term by the denominator of the fraction, **or**
- leave the fraction as it is and multiply at the end.

Solve $\frac{4x-2}{5} = 2$

$$\begin{aligned} \frac{4x-2}{5} \times 5 &= 2 \times 5 \\ 4x - 2 &= 10 \\ +2 & \quad +2 \\ 4x &= 12 \\ \div 4 & \quad \div 4 \\ x &= 3 \end{aligned}$$

To 'undo' the fraction, multiply by the denominator.

Solve $4 + \frac{x}{3} = 8$

Method 1: Multiply each term by the denominator first.

$$\begin{aligned} (4 \times 3) + (\frac{x}{3} \times 3) &= (8 \times 3) \\ 12 + x &= 24 \\ -12 & \quad -12 \\ x &= 12 \end{aligned}$$

Method 2: Isolate the x term first.

$$\begin{aligned} 4 + \frac{x}{3} &= 8 \\ -4 & \quad -4 \\ \frac{x}{3} &= 4 \\ \times 3 & \quad \times 3 \\ x &= 12 \end{aligned}$$

Solving equations with fractions on both sides

When an equation has a fraction on both sides, first find the lowest common multiple (LCM) of the two denominators, then multiply by the LCM to 'undo' them.

Solve $\frac{3x+1}{2} = \frac{5x+5}{4}$

$$\begin{aligned} \frac{3x+1}{2} \times 4 &= \frac{5x+5}{4} \times 4 \\ \frac{(3x+1) \times 2}{\cancel{2}} &= \frac{(5x+5) \times \cancel{4}}{\cancel{4}} \\ 2(3x+1) &= 5x+5 \\ 6x+2 &= 5x+5 \\ -2 & \quad -2 \\ 6x &= 5x+3 \\ -5x & \quad -5x \\ x &= 3 \end{aligned}$$

The LCM of 2 and 4 is 4. Multiply both sides by 4.

Expand the brackets.

Solving multi-step equations 2

Solving equations when the coefficient is negative

- 1 A student is trying to solve the equation $4 - 3x = -2$.
The student has made a mistake. Rewrite the solution correctly.

$$\begin{array}{r} 4 - 3x = -2 \\ -4 \quad -4 \end{array}$$

$$3x = -6$$

$$x = -2$$

Solving equations with one fraction

- 2 Solve each equation.

a) $\frac{3k-2}{4} = 4$

b) $2 + \frac{x+1}{3} = 5$

$k =$

$x =$

Solving equations with fractions on both sides

- 3 Solve the equation.

$$\frac{3-2m}{2} = \frac{m+2}{6}$$

$m =$

Using graphs to solve problems

Reading values from a graph

To read a graph, look at:

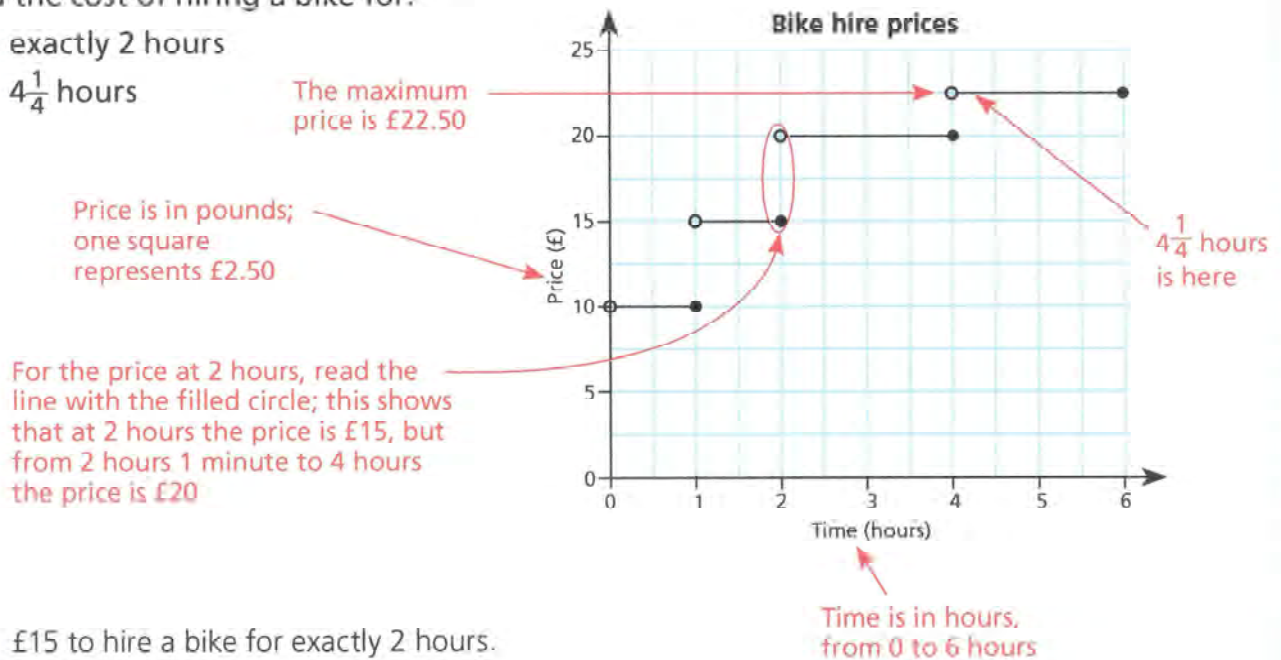
- the title – what is the graph about?
- the axis labels – what does each axis show you?
- the numbers on the axes – what is the scale and what does one square on each axis represent?

This graph shows the cost of hiring a bike.

Find the cost of hiring a bike for:

a) exactly 2 hours

b) $4\frac{1}{4}$ hours



a) £15 to hire a bike for exactly 2 hours.

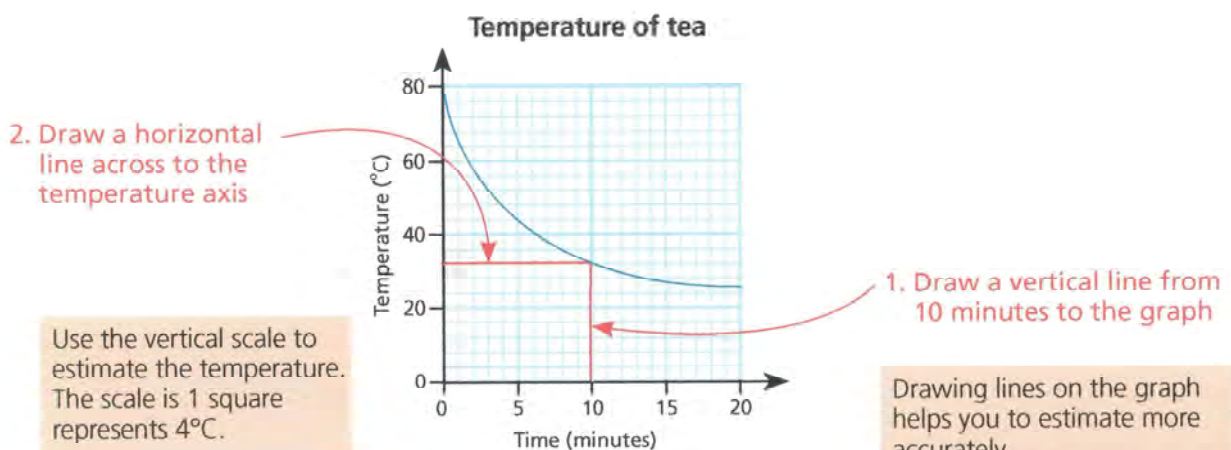
b) £22.50 to hire a bike for $4\frac{1}{4}$ hours.

Estimating values from a graph

When the graph does not pass exactly through grid points, you need to estimate the value.

The graph shows the temperature of a cup of tea.

Estimate the temperature of the tea after 10 minutes.



The temperature of the tea is about 32°C after 10 minutes.

Using graphs to solve problems

Reading values from a graph

1 Here is a graph of postage prices.

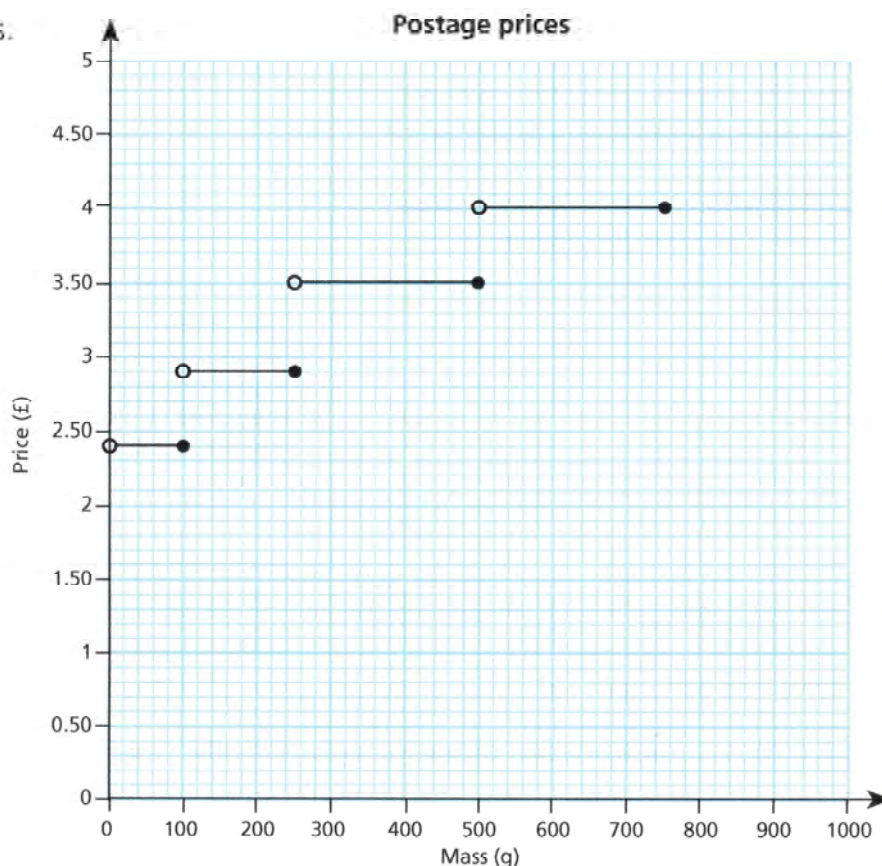
a) Use the graph to find the postage price for:

i) a 150 g letter

ii) a 700 g parcel

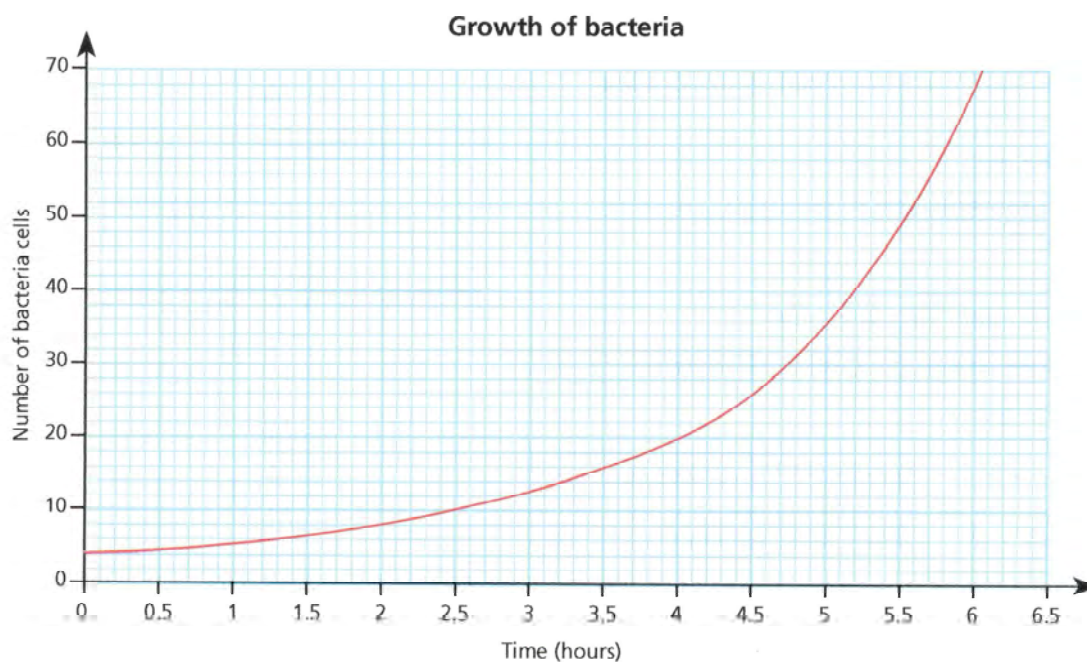
b) It costs £4.70 to post a parcel weighing more than 750 g and up to and including 1000 g.

Draw a line on the graph to show this.



Estimating values from a graph

2 The graph shows the number of bacteria cells in a sample.



a) Estimate the number of bacteria cells after 5.25 hours.

b) Estimate the time when there are 30 bacteria cells.