Using a calculator

Component Knowledge

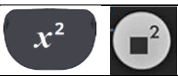
- Know the various positions and key functions
- Be able to use the calculator for index calculations
- Be able to use the calculator to find the square/cube root of a number
- Be able to use the negative number and fraction functions in calculations

Key Vocabulary

Brackets	Used to assist in setting out the order of operations for a calculation
Indices	Also known as powers, e.g. $3^2 = 9$
Negative	Having a value less than zero, not to be mistaken for subtraction

Key buttons

It is vital that you know how to use it properly and confidently. Being familiar with the layout of your own scientific calculator will help save time, allowing you to concentrate on the maths you're working on.

	Pressing the SHIFT button means you will select the instruction written above the next button you press, rather than what is written on the button itself.
	The replay button has four arrows on it and allows you to direct your cursor on-screen. It's really useful if you enter a large calculation incorrectly, as you can use the arrows to go back and insert or remove characters. Replay also allows you to move between the numerator and denominator when you're working with fractions, or to move out of a root or index.
	The delete button erases characters; when you press it, the character to the left of the cursor will be erased. It can be useful to fix a calculation, when used with the replay button.
	The Ans button can be used to put an answer you have just found back into your next calculation.
	This button allows you to square numbers.
	This button allows you to write a number to **any** power e.g. 4^5
	This button allows you to square root numbers. **SHIFT** followed by this button, allows you to find **any** root.
	This button allows you to calculate using fractions. **SHIFT** followed by this button, allows you to write a **mixed number**.
	This button allows you to change to format of your answer- from a fraction to a decimal and vice versa.
	You should input negative numbers into your calculator using (-). **NOTE**: When inputting a negative number which is raised to a power, you should write them in brackets.

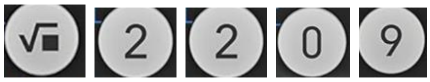
Examples of using a calculator

Find the value of 86^2

Type 

The answer is 7396.

Find the value of $\sqrt{2209}$

Type 

The answer is 47.

Find the value of $\frac{2}{5}$ of 990

Type 

The answer is 396.

Convert $2\frac{4}{5}$ to a decimal.

Type SHIFT 

The answer is 2.8.

Online clips

M757

Index Laws

Component Knowledge

- To be able to apply the different index laws
- To be able to calculate negative indices
- To be able to calculate fractional indices

Key Vocabulary

Index notation	A way of writing numbers or letters that have been multiplied by themselves a number of times
Square number	The product of a number multiplied by itself
Cube number	The product of a number multiplied by itself three times.
Root	The inverse of a square number is a square root. The inverse of a cube number is a cube root
Reciprocal	1 divided by the number

Multiplication law

When multiplying the terms, we add the powers together

$$3^7 \times 3^5 = 3^{7+5} = 3^{12}$$

$$x^3 \times x^4 = x^{3+4} = x^7$$

The base number does not change

Division law

When dividing the terms, we subtract the powers.

$$2^7 \div 2^3 = 2^{7-3} = 2^4$$

Divides can only be written as fractions

$$\frac{5^{11}}{5^2} = 5^{11-2} = 5^9$$

$$\frac{y^5}{y^{-1}} = y^{5--1} = y^6$$

Subtracting a negative is the same as adding

Brackets law

$$(4^5)^3 = 4^{5\times3} = 4^{15}$$

When raising to the power we multiply the powers together

$$(2x^4)^3 = 2^3 \times x^{4\times3} = 8x^{12}$$

Facts

$$p = p^1$$

$$y^0 = 1$$

$$456^0 = 1$$

Anything to the power of zero is equal to 1

Index Laws – You can only use index laws when the base number is the same.

$$2^3 \times 4^5 \neq 8^{15}$$

Negative indices

A negative power performs the reciprocal

$$x^{-a} = \frac{1}{x^a}$$

Example

$$2^{-3} = \frac{1}{2^3} = \frac{1}{8}$$

Fractional

The denominator of a fractional power acts as a “root. The numerator of a fractional power acts as a normal power.

General rule

$$x^{\frac{a}{b}} = \left(\sqrt[b]{x}\right)^a$$

$$64^{\frac{2}{3}} = \left(\sqrt[3]{64}\right)^2 = 4^2 = 16$$

Changing the base

Write

$$(4)^3 \text{ as a power of } 2$$

$4 = 2^2$, so

$$(4)^3 = (2^2)^3 = 2^6$$

Example

Given that

$$3 \times \sqrt{27} = 3^n$$

Find the value of n

$$27 = 3^3$$

$$3 \times \sqrt{3^3}$$

$$3^1 \times (3^3)^{\frac{1}{2}}$$

A square root can be changed to the power of $\frac{1}{2}$

$$3^1 \times 3^{\frac{3}{2}} = 3^{1+\frac{3}{2}} = 3^{\frac{5}{2}}$$

Online clips

M135, M608, M150, M120 X647, X783

Standard form

Component Knowledge

- Identify numbers in standard form
- Write an ordinary number in standard form
- Write a standard form number as an ordinary number

Key Vocabulary

Power/index	A notation and word used to show repeated multiplication of the same number
Standard form	A method of writing numbers that uses multiplication with powers of 10
Integer	Whole number

Multiplying by powers of 10

The Positive Powers of 10

$10^1 = 10$

$10^2 = 100$

$10^3 = 1000$

$10^4 = 10000$

$10^5 = 100000$

Q 2.5×10^4

Step 1 Work out 10^4 $\quad 10^4 = 10000$

Step 2 Multiply $\quad 2.5 \times 10000$

Each digit is shifted 4 places values higher

10,000	1,000	100	10	1	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$
				2	5		
2	5	0	0	0			

A 25,000

The power of 10 indicates how many place values each digit is increased/decreased in value (move left for positive powers of 10, and move right for negative powers)

The Negative Powers of 10

$$10^{-2} = \frac{1}{10^2} = \frac{1}{100}$$

$10^{-1} = 0.1$

$10^{-2} = 0.01$

$10^{-3} = 0.001$

$10^{-4} = 0.0001$

$10^{-5} = 0.00001$

Q 62000×10^{-4}

Step 1 Work out 10^4 $\quad 10^{-4} = 0.0001$

Step 2 Multiply $\quad 62000 \times 0.0001$

$= 62000 \div 10000$

10,000	1,000	100	10	1	$\frac{1}{1}$	$\frac{1}{10}$	$\frac{1}{100}$
6	2	0	0	0			
				6	2		

A 6.2

Writing in standard form

Ordinary Form	Standard Form
200	2×10^2
3,500	3.5×10^3

A number: $1 \leqslant x < 10$ — Integer power of 10

Any (positive) number can be written in standard form: **a number greater than or equal to 1 but less than 10, multiplied by an integer power of 10**

Why is 12×10^2 **not** in standard form?

12 is greater than

$1 \leq x < 10$ so we need to convert it into standard form.

$=12 \times 10^2$

$=12 \times 100$

$=1200$

$=$ <u>1.2×10^3</u>

a) 5,430,000

(6 places)

5,430,000

$= 5.43 \times 10^6$

b) 0.00608

(3 places)

0.00608

$= 6.08 \times 10^{-3}$

Writing standard form as ordinary numbers

5.23×10^4

$= 5.23 \times 10 \times 10 \times 10 \times 10$

$= 5.23 \times 10{,}000$

$= 52{,}300$

Remember that multiplying by a power of 10 has the effect of increasing/decreasing the place value of each digit

4860×10^{-2} → **48.6**

0.0486×10^4 → **486**

48.6×10^{-1} → **4.86**

<u>Online clips</u>

M719, M678

Standard form

-Arithmetic

Component Knowledge

- Write an ordinary number in standard form
- Write a standard form number as an ordinary number
- Perform arithmetic operations on standard form numbers, giving the answer in standard

Key Vocabulary

Power/index	Shows how many times to multiply the same number by itself.
Standard form	A method of writing numbers that uses multiplication with powers of 10.

Adding and Subtracting with Standard Form

Q

Calculate the following giving your answer in ordinary form:
$(3.6 \times 10^4) + (4.2 \times 10^7)$

Step 1 Write each in ordinary form

$3.6 \times 10^4 \rightarrow 36{,}000$

$4.2 \times 10^7 \rightarrow 42{,}000{,}000$

Step 2 Add with column addition

$$\begin{array}{r} 42000000 \\ +\quad 36000 \\ \hline 42036000 \end{array}$$

A 42,036,000

You can leave the answer in ordinary form ...

Q

Calculate the following giving your answer in standard form:
$(3.6 \times 10^6) - (1.4 \times 10^6)$

Step 1 Write each in ordinary form

$3.6 \times 10^6 \rightarrow 3{,}600{,}000$

$1.4 \times 10^6 \rightarrow 1{,}400{,}000$

Step 2 Subtract with column subtraction

$$\begin{array}{r} 3600000 \\ -\ 1400000 \\ \hline 2200000 \end{array}$$

Step 3 Give your answer in standard form

A 2.2×10^6

... unless the question asks for answer in standard form too

Multiplying and dividing with standard form

$$2 \times 10^3 \quad \times \quad 4 \times 10^4$$

$$2 \times 4 \quad \times \quad 10^3 \times 10^4$$

$$8 \quad \times \quad 10^7$$

$$= 8 \times 10^7$$

$$5 \times 10^2 \quad \times \quad 3 \times 10^6$$

$$5 \times 3 \quad \times \quad 10^2 \times 10^6$$

$$15 \quad \times \quad 10^8$$

$$= 1.5 \times 10^9$$

Remember the rules of indices:

- Add powers when multiplying (and the base numbers are the same)
- Subtract powers when dividing

If after calculating the first number is not in standard form, rewrite so it is. For example, write $15 = 1.5 \times 10$. So, $1.5 \times 10 \times 10^8 = 1.5 \times 10^9$

$$8 \times 10^5 \quad \div \quad (2 \times 10^3)$$

$$8 \div 2 \quad \times \quad 10^5 \div 10^3$$

$$4 \quad \times \quad 10^2$$

$$= 4 \times 10^2$$

$$3 \times 10^6 \quad \div \quad (6 \times 10^3)$$

$$3 \div 6 \quad \times \quad 10^6 \div 10^3$$

$$0.5 \quad \times \quad 10^3$$

Not in standard form

$$= 5 \times 10^2$$

Not in standard form

<u>Online clips</u>

M719, M678,, U264, U290, U161

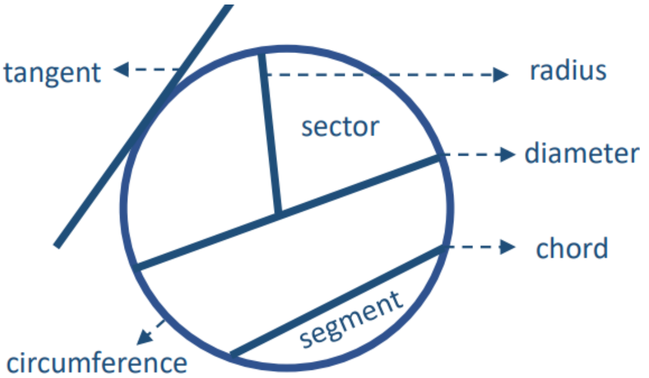
Circles

Component Knowledge

- Identify parts of a circle
- Calculate the area of a circle
- Calculate the circumference of a circle
- Find the area of a sector
- Find arc length

Key Vocabulary

Circle	A 2 dimensional shape made by drawing a curve that is always the same distance from the centre
Radius	The distance from the centre to the circumference of a circle
Diameter	The distance from one point on a circle through the centre to another point on the circle
Circumference	The distance around the edge of a circle
Tangent	A line that just touches a curve at a point, matching the curve's slope at that point
Chord	A line segment connecting two points on a curve
Arc	Part of the circumference of a circle
Sector	A "pie slice" part of a circle – the area between two radiuses and the connecting arc of a circle
Segment	The smallest part of a circle made when it is cut by a line



Formula to remember

$$\textbf{Radius} = \frac{diameter}{2}$$

$$\textbf{Diameter} = 2 \times radius$$

$$\textbf{Area} = \pi \times radius^2$$

$$\textbf{Circumference} = \pi \times diameter$$

$$\textbf{Arc length} = \frac{\theta}{360} \times \pi \times diameter$$

$$\textbf{Area of a sector} = \frac{\theta}{360} \times \pi \times r^2$$

Sectors / Fraction of areas

Sectors		Fraction of areas
Semi-circle		Area $= \pi \; x \; r^2 \; x \; \frac{180°}{360°}$
Quarter-circle		Area $= \pi \; x \; r^2 \; x \; \frac{90°}{360°}$
30°		Area $= \pi \; x \; r^2 \; x \; \frac{30°}{360°}$
165°		Area $= \pi \; x \; r^2 \; x \; \frac{165°}{360°}$
283°		Area $= \pi \; x \; r^2 \; x \; \frac{283°}{360°}$

What is Pi?

Pi is the ratio between the circumference of a circle and its diameter

Pi is denoted by the Greek symbol π

The value of Pi is approximately 3.14159265……

Example 1

Calculate the **area** of a circle with a **radius** of 5cm

$\textbf{Area} = \pi \times radius^2$

$= \pi \times 5^2$

$= 78.5cm^2$

Example 2

Calculate the **circumference** of a circle with a **radius** of 12cm

$\textbf{Circumference} = \pi \times diameter$

$= \pi \times 24$

$= 75.4cm$

Example 3

Calculate the **area of a sector** with a **radius** of 7cm and an angle of 50°

$\textbf{Area of a sector} = \frac{\theta}{360} \times \pi \times r^2$

$= \frac{50}{360} \times \pi \times 7^2$

$= 21.4cm^2$

Example 4

Calculate the **arc length of a sector** with a radius of 11cm and an angle of 75°

$\textbf{Arc length} = \frac{\theta}{360} \times \pi \times diameter$

$= \frac{75}{360} \times \pi \times 22$

$= 14.4cm$

Example 5

Calculate the **area** of a semicircle with a **diameter** of 8cm

$\textbf{Area} = \pi \times 4^2$

$= \pi \times 4^2$

$= 50.27cm^2$

This answer is the area of the full circle so we need to half it to find the area of the semicircle

$= 25.13cm^2$

Example 6

Calculate the **perimeter** of a semicircle with a **diameter** of 8cm

$\textbf{Circumference} = \pi \times diameter$

$= \pi \times 8$

$= 25.13cm$ (full circle) = 12.57 (curved edge of semicircle

Total perimeter = curved edge + straight edge

$= 12.57 + 8 = 20.57cm$

Online clips

M595, M169, M280, M231, M430

Fractions, decimals, & Percentages

Component Knowledge

- Convert between simple fractions, decimals and percentages.
- Order fractions, decimals and percentages by converting.

Key Vocabulary

Fraction	Made up of a numerator (top) and denominator (bottom). Compares parts in question to total number of parts.
Integer	Whole number
Ascending order	Place numbers in order from smallest to largest
Descending order	Place numbers in order from largest to smallest
Percentage (percent)	'Out of' (per) one hundred (cent)
Decimal	Comparable number to a fraction or mixed number, written using place value, e.g. $\frac{2}{5} = 0.4$, or $3\frac{3}{4} = 3.75$

Convert % to fraction:

$$\%\ \text{"means out of } 100\text{"} = \frac{}{100}$$

$$eg\ 65\% = \frac{65}{100}\ simplify\ where\ possible$$

$$= \frac{65}{100} = \frac{13}{20} \quad (\div 5 \text{ top and bottom})$$

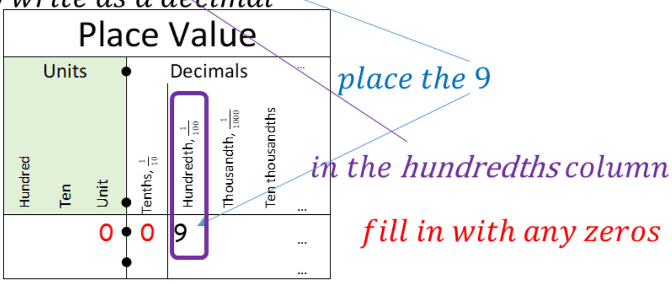
Convert % to fraction to decimal:

$$Convert\ to\ fraction\ out\ of\ 100, \frac{}{100}$$

$$as\ \%\ \text{"means out of } 100\text{"} = \frac{}{100}$$

$$eg\ 9\% = \frac{9}{100}\ use\ place\ value\ table$$

to write as a decimal



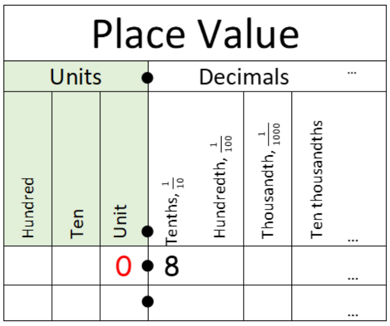
Convert decimal to a fraction

Use place value to convert to fraction out of 10, 100, 1000, etc

$$eg\ 0.8 = \frac{8}{10}$$

then simplify where possible

$$eg\ \frac{8}{10}\ becomes\ \frac{4}{5}$$



Convert decimal to a fraction to a percentage

Use place value to convert to fraction out of 10, 100, 1000, etc

$$eg\ 0.126 = \frac{126}{1000}$$

% means out of 100 so convert to equivalent

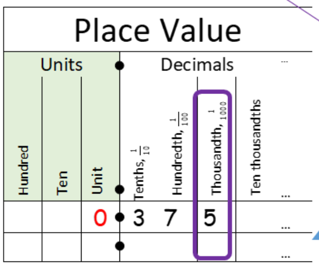
$$fraction\ out\ of\ 100 = \frac{}{100}$$

$$eg\ \frac{126}{1000}\ becomes\ \frac{12.6}{100} = 12.6\%$$

Convert fraction to decimal

$Convert\ to\ fraction\ out\ of\ 10, 100, 1000, etc" = \frac{}{10}\ or\ \frac{}{100}\ or\ \frac{}{1000}$
$then\ use\ place\ value\ to\ write\ as\ a\ fraction$

$eg\ \frac{3}{8} = \frac{\times}{10} = \frac{\times}{100} = \frac{375}{1000}$



place the end digit

in the thousandths column

fill in with any zeros

Convert fraction to percentage

$Convert\ to\ fraction\ out\ of\ 10, 100, 1000, etc" =$

$\frac{}{10}\ or\ \frac{}{100}\ or\ \frac{}{1000}$

$eg\ \frac{3}{200} = \frac{\times}{10} = \frac{\times}{100} = \frac{15}{1000}$

$then\ write\ as\ an\ equivalent\ fraction\ "out\ of\ 100"as\ percentage$

$eg\ \frac{15}{1000} = \frac{1.5}{100}$ ($\div 10$ top and bottom) $once\ \ "out\ of\ 100"\ write\ as\ a\ percentage = 1.5\%$

Ordering FDP

To be able to order FDP, we need to write them all in the same format.

Example: Order from smallest to largest $\frac{1}{4}$ 0.19 0.3 26% $\frac{1}{5}$

You can choose to convert them all into fractions, decimals or percentages as long as you convert them all into the same.

Changing them to percentages:

$\frac{1}{4} = 25\%$ 0.19 = 19% 0.3 = 30% $\frac{1}{5} = 20\%$

25%, 19%, 30%, 26%, 20%

Rewrite the list with the numbers all in the same format.

From smallest to biggest:

19%, 20%, 25%, 26%, 30%

Answer:

0.19, $\frac{1}{5}$, $\frac{1}{4}$, 26%, 0.3

Make sure you write your answer using the original numbers in the question.

Online clips

M958, M264, M553

Recurring Decimals

Component Knowledge

- To be able to convert recurring decimals to fractions with one or more recurring digits.
- To be able to convert a recurring decimal (with non-recurring and recurring digits)

Key Vocabulary

Recurring Decimal	It is a decimal fraction in which a figure or group of figures is repeated indefinitely, as in 0.666… or as in 1.851851851…. It is denoted by a dot above the recurring parts. E.g. $0.\dot{6} = 0.666\ldots$ or $0.\dot{3}\dot{4} = 0.343434\ldots$

When there are no non-recurring digits after the decimal point:

To convert a recurring decimal to a fraction, use the following steps

a) Name out decimal (write as x = ….)
b) Identify the number of places that are recurring
c) Multiply by a power of 10 to move the recurring part past the decimal. (This should make the recurring parts line up).
d) Subtract x from the new power of x to cancel out the decimal part.
e) Then divide to leave x in a fractional form and simplify if possible.

Convert $0.\dot{5}$ to a fraction.

Let $x = 0.\dot{5}$,

$10x = 5.\dot{5}$

$9x = 5$

$\div 9$

$x = \frac{5}{9}$

How could we remove the recurring parts?

$$\begin{array}{r} 5.\dot{5} \\ -\ 0.\dot{5} \\ \hline \end{array}$$

Convert $0.\dot{4}2\dot{7}$ to a fraction.

Let $x = 0.\dot{4}2\dot{7}$,

$1000x = 427.\dot{4}2\dot{7}$

$999x = 427$

$\div 999$

$x = \frac{427}{999}$

$$\begin{array}{r} 427.\dot{4}2\dot{7} \\ -\ 0.\dot{4}2\dot{7} \\ \hline \end{array}$$

How could we remove the recurring parts?

Convert $2.\dot{4}\dot{8}$ to a fraction.

Let $x = 2.\dot{4}\dot{8}$,

How could we remove the recurring parts?

$100x = 248.\dot{4}\dot{8}$

$$\begin{array}{r} 248.\dot{4}\dot{8} \\ -\ 2.\dot{4}\dot{8} \\ \hline \end{array}$$

$99x = 246$

$\div 99$

$x = \frac{246}{99} = 2\frac{48}{99}$

When there is a non-recurring digit after the decimal point:

Use the same steps as previously however we will need to multiply x two separate ways, once by a power of 10 to move the non-recurring digits before the decimal point and secondly by a different power of 10 to move the recurring digits before the decimal point. (Again all recurring digits should line up in the two equations.)

Convert $0.7\dot{2}$ to a fraction.

Let $x = 0.7\dot{2}$,

$100x = 72.\dot{2}$

$10x = 7.\dot{2}$

$90x = 65$

$\div 90$

$x = \frac{65}{90} = \frac{13}{18}$

How could we remove the recurring parts?

$72.\dot{2} - 7.\dot{2}$

Convert $0.4\dot{8}\dot{1}$ to a fraction.

Let $x = 0.4\dot{8}\dot{1}$,

$1000x = 481.\dot{8}\dot{1}$

$10x = 4.\dot{8}\dot{1}$,

$99x = 477$

$\div 99$

$x = \frac{477}{990} = \frac{53}{110}$

How could we remove the recurring parts?

$481.\dot{8}\dot{1} - 4.\dot{8}\dot{1}$

Online clips

M701, M922

Percentages

Component Knowledge

- To be able to calculate percentages of amounts with a multiplier.
- To be able to calculate percentage increases and decreases.
- To be able to calculate simple interest

Key Vocabulary

Percentage	Parts per 100. The unit is %.
Increase	Make bigger.
Decrease	Make smaller.
Multiplier	Decimal used to calculate percentages with a calculator.
Simple Interest	The amount of interest is fixed over a period of time.

Percentage of an amount – non calculator

Calculate 15% of 250

Find 10% by dividing by 10

250 ÷ 10 = 25

Find 5% by halving the 10% value

25 ÷ 2 = 12.5

Add the 10% and the 5% value together

25 + 12. 5 = 37.5

Percentage of an amount – using a multiplier

When we have a calculator we can use a multiplier; this is a decimal equivalent of the percentage.

80% of 120: 80% = 0.80

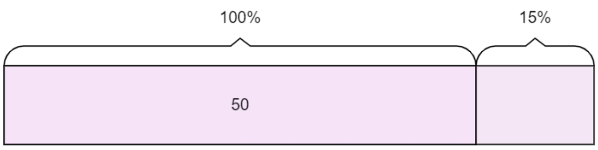
80% of 120 = 0.80 x 120 = 96

33% of 90: 33% = 0.33

33% of 90 = 0.33 x 90 = 29.70

Percentage increase using a multiplier

Increase 50 by 15%



15% = 0.15 convert percentage to a decimal

0.15 + 1 = 1.15 add to 1 as we are adding on to 100%

50 x 1.15 = 57.5 now multiply

Percentage decrease using a multiplier

Decrease 70 by 25%

25% = 0 .25 convert percentage to a decimal

1 – 0.25 = 0.75 subtract from 1 we are decreasing

70 x 0.75 = 52.5 now multiply

Calculating an original amount

Sinead buys a watch. 20% VAT is added to the price of the watch. Sinead then has to pay a total of £60 What is the price of the watch with no VAT added?

120 % = £60 original amount (100%) + 20%

120% = 1.2 convert percentage to a decimal

£60 ÷1.2 = £50 divide new amount by multiplier

Original cost of watch = £50

The population of an island has decreased by 40% over 50 years. The population in 2018 was 360 What was the population in 1968?

60% = 360 original amount (100%) – 40%

60% = 0.6 convert percentage to a decimal

360 ÷ 0.6 = 600 divide new amount by multiplier

Population in 1968 = 600

Percentage Change

Percentage change = $\frac{change}{original}$ x 100

Change = New amount - Original amount

The population of an island in 2017 was 30,000. In 2018, the population was 31,500. Calculate the percentage increase.

Difference in populations

Percentage change = $\frac{31500-30000}{30000}$ x 100

Original population

Percentage change = $\frac{1500}{30000}$ x 100

Percentage change = 5%

Percentage profit = $\frac{sales-cost}{cost}$ x 100

Keira buys a coffee table for £120 and sells it for £204. Work out her percentage profit.

Percentage profit = $\frac{204-120}{120}$ x 100

Percentage profit = $\frac{84}{120}$ x 100

Percentage profit = 70%

Simple Interest

To calculate simple interest we start by calculating the percentage and multiplying it by the period of time.

Example: £250 is in a bank account which is paying 5% simple interest per year. How much would be in the account at the end of 3 years?

5% = 0.05

0.05 x 250 = £12.50 find the amount of interest per year

3 x £12.50 = £37.50 3 years X amount of interest per year

£250 + £37.50 = £287.50 add the total interest to the original amount

Online clips

M437, M905, M476, M533, M528, M235

Compound interest and depreciation

Component Knowledge

- Use percentage multipliers
- Calculate compound interest and depreciation
- Understand growth and decay

Key Vocabulary

Multiplier	Decimal used to calculate percentages with a calculator
Growth/Increase	When an amount goes up
Depreciation/Decay	When an amount goes down
Simple interest	The amount of interest is fixed over a period of time
Compound interest	The interest earned over time will continue to increase
Annum	This word usually replaces the word year (per annum = per year)

Key Concepts

Multipliers are used to increase or decrease an amount by a particular percentage

Percentage increase:
Value x (1 + percentage as a decimal)
Percentage decrease:
Value x (1 – percentage as a decimal)

These questions are not always about money in a bank or house/car prices.
Growth and decay problems might be to do with populations, atmospheric pressure, height or radioactivity.

Eg: 2 months ago you had 3 mice, you now have 18.

You can use the compound interest formula to find that the population is growing by 144% every month!

Calculating compound interest

E.g.

Anya invests £200 at 3% **compound interest**. How much does she have after 5 years?

$$Value \times (1 + decimal\ multiplier)^{time}$$

Substituting into the formula:

value = £200, decimal multiplier = 3% =0.03, time = 5 (years)

$$£200 \times (1 + 0.03)^5$$

$$£200 \times (1.03)^5 = \underline{£231.85}$$

Calculating depreciation

E.g.

A car is valued at £850. The car depreciates by 15% per year. What is it worth after 4 years?

$$Value \times (1 - decimal\ multiplier)^{time}$$

Substituting into the formula:

value = £850, decimal multiplier = 15% =0.15, time = 4 (years)

$$£850 \times (1 - 0.15)^4$$

$$£850 \times (0.85)^4 = \underline{£443.71}$$

Online clips

U332, U988

Column vectors

Component knowledge

- Understand that vectors are a way of showing the magnitude (size) and direction an object moves (translates).
- Represent vectors
- Add, subtract and multiply vectors

Key Vocabulary

Vector	A vector has magnitude (size) and direction
Magnitude	Size of an object- can be a distance or quantity
Scalar	A scalar on has a magnitude (size) and no direction
Constant	A variable that remains the same

Vectors

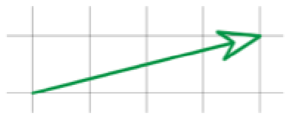
Vectors are often written as column vectors

Left or right ↘ $\begin{pmatrix} 3 \\ -4 \end{pmatrix}$

Up or down ↗

Positive values are right and up. Negative values are left and down.
This is 3 right and 4 down.

This is the vector $\begin{pmatrix} 4 \\ 1 \end{pmatrix}$



It goes 4 units right and 1 unit up.

Add/subtract vectors:

$$\begin{pmatrix} 8 \\ 4 \end{pmatrix} - \begin{pmatrix} 3 \\ 6 \end{pmatrix} = \begin{pmatrix} 5 \\ -2 \end{pmatrix}$$

Multiply vectors by a constant

$$3\begin{pmatrix} 4 \\ 7 \end{pmatrix} = \begin{pmatrix} 12 \\ 21 \end{pmatrix}$$

Column Vectors: Scalar Multiplication

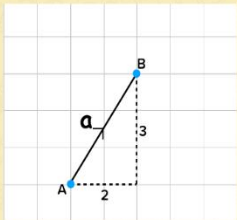
Remember

A vector has a length and a direction

$$\overrightarrow{AB} = \mathbf{a} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$$

x → 2 units right

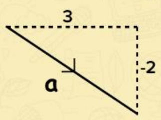
y → 3 units up

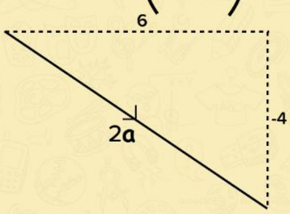


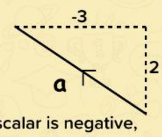
Remember

A vector can be multiplied by a scalar to give another vector.
The resulting vector will be parallel to the original.

$$\mathbf{a} = \begin{pmatrix} 3 \\ -2 \end{pmatrix} \quad 2\mathbf{a} = \begin{pmatrix} 2 \times 3 \\ 2 \times -2 \end{pmatrix} \quad -\mathbf{a} = \begin{pmatrix} -1 \times 3 \\ -1 \times -2 \end{pmatrix}$$







If the scalar is negative, the direction of the vector is reversed.

Online clips

U632, U903, U564

Transformations

Component Knowledge

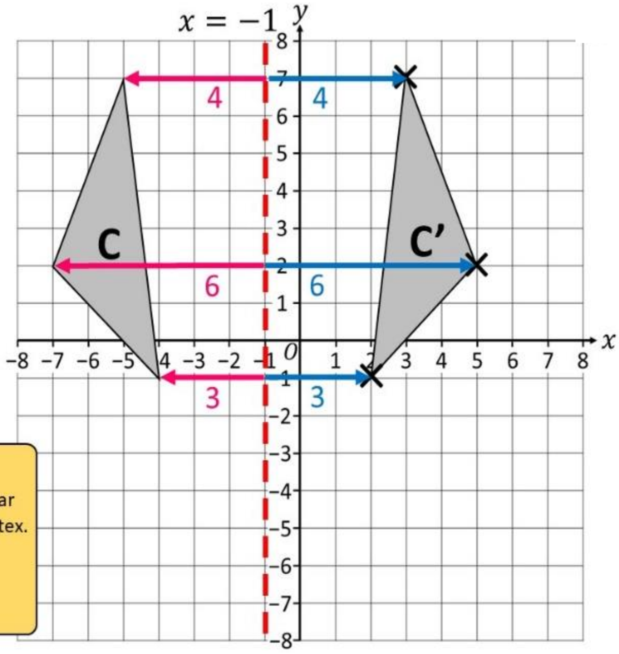
- Rotate, reflect and translate a shape.
- Describe a rotation, reflection and translation.

Key Vocabulary

Rotation	The turning of a shape around a fixed point.
Reflection	An image of a shape as it would be seen in a mirror.
Perpendicular	At a right angle to a point or line.
Translation	Moving every point by the same distance in a given direction.
Vertex	Corner of a shape- where two lines meet in a polygon.

Reflection:

Reflect shape **C** in the line $x = -1$. Label the new shape **C'**.



1) Plot the line.
2) Count squares perpendicular from the line to each vertex.
3) Plot each vertex an equal distance away on the opposite side.

Information needed to perform a reflection:

- Mirror line. This usually an equation e.g. y=2, x= -2.

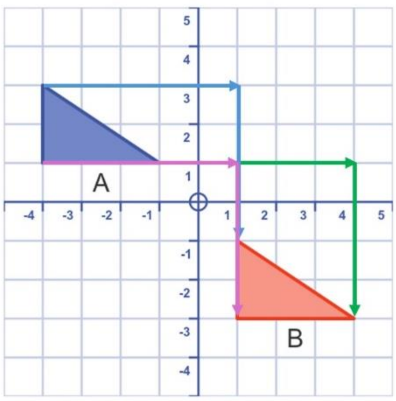
Translation:

Translate shape A by the vector $\begin{pmatrix} 5 \\ -4 \end{pmatrix}$

Move each vertex 5 right.

$$\begin{pmatrix} 5 \\ -4 \end{pmatrix}$$

Move each vertex 4 down.

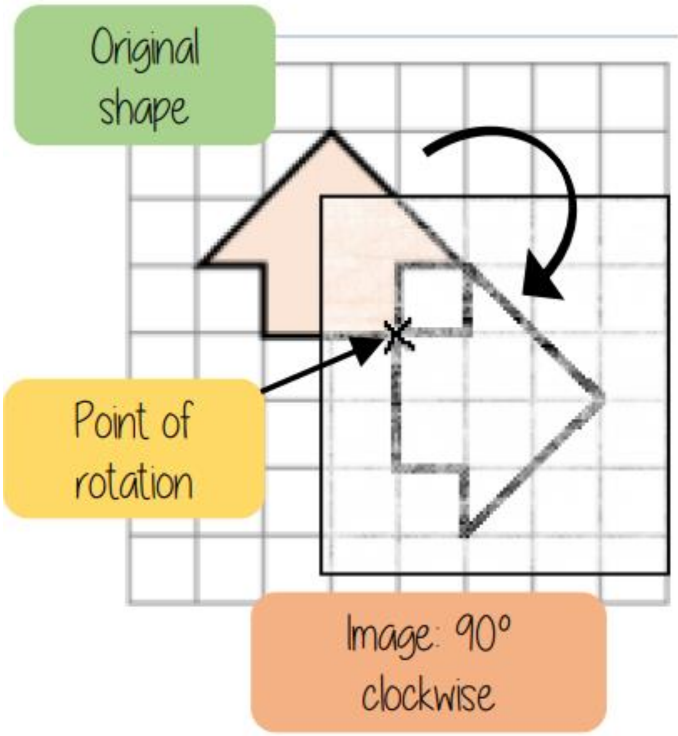


$\begin{pmatrix} x \\ y \end{pmatrix}$ — x: Positive-Right, Negative - Left; y: Positive-Up, Negative - Down

Information needed to perform a reflection:

- Vector. This is usually as a column vector e.g. $\begin{pmatrix} 3 \\ -7 \end{pmatrix}$

Rotation:



1. Trace the original shape (mark the point of rotation)

2. Keep the point in the same place and turn the tracing paper

3. Draw the new shape

Clockwise   Anti-Clockwise

Information needed to perform a rotation:

- Centre of rotation. This is usually a co-ordinate.
- Direction of rotation. Either Clockwise or anti-clockwise.
- Degrees of rotation. 90˙ or 180˙ or 270˙
- Tracing paper.

Online clips

M910, M290, M139

Reading Map Scales

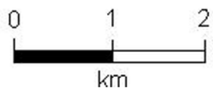
Component Knowledge

- To be able to measure and calculate real-life distances using a map scale.

Key Vocabulary

Map	A diagrammatic representation of an area of land or sea showing physical features, cities, roads, etc.
Scale	The ratio that defines the relation between the actual distance and it's model.
Ratio	A relationship between values comparing one part to another
Proportion	To enlarge something by a common ratio
Distance	The length of space between 2 points
Key	A set of instructions used for reading a map
Grid	A network of lines that cross each other in series of squares

Scale can be shown on a map in different ways

Scale Line		A scale line on a map shows that 1cm on a map is equal to 1km in real life. Sometimes it can also be shown in miles.
Ratio	**1:25,000**	Ratio can be shown in different ways on a map. You will need to check this. If there are no units, you need to assume they are the same e.g. 1 : 25,000 means 1cm on the diagram = 25,000cm in real life.

Scale Drawing

- Scale drawing allows us to draw large objects on a smaller scale while keeping them accurate.
- All scale drawings must have a scale written on them. Scales are usually expressed as ratios.
- Example: 1cm : 100cm
- The ratio 1cm:100cm means that for every 1cm on the scale drawing the length will be 100cm in real life

A map has a scale of 1cm : 4 kilometres. The actual distance between two cities is 52 kilometres. What is the distance between the cities on the map?

$$52 \div 4 = 13$$

$$\textit{Map distance} = 13\ cm$$

Map Directions

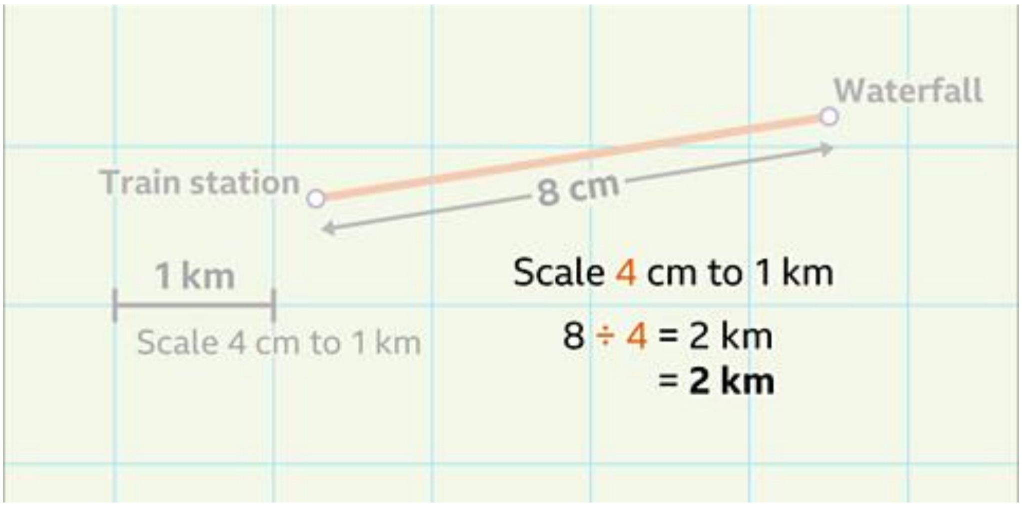
- North
- East
- South
- West

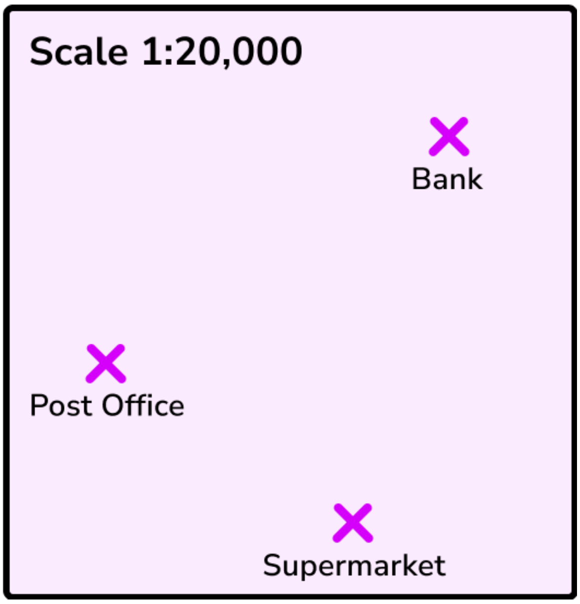
A map has a scale of 1cm : 10 miles. The distance between two towns on the map is 3.5 cm. How far apart are the towns in real-life?

$$3.5 \times 10 = 35$$

$$\textit{Actual distance} = 35\ miles$$

Examples





If we measure the actual distance between the Post Office and Supermarket, we get a length of 4.2cm.

We then use the scale of 1:20,000 to find the real/actual distance.

4.2 x 20,000 = 84,000 cm. This is not a sensible unit to use.

We then convert 84,000 cm to metres by dividing by 100.

84,000 cm = 840 m. This is now a sensible unit to use.

Online clip

M112

Loci

Component Knowledge

- Construct bisectors of angles and line segments.
- Construct circles with given radii and centres.
- Solve simple geometric problems by constructing a suitable locus.
- Solve multi-step locus problems by constructing suitable sequences of loci.

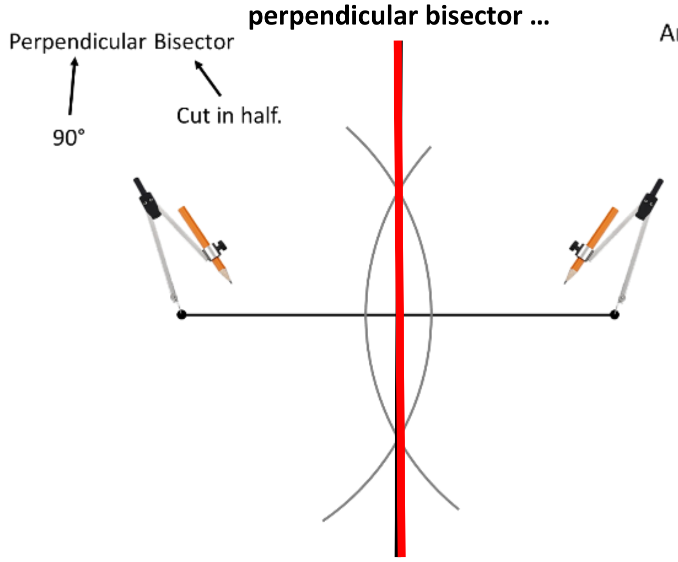
Key Vocabulary

Locus	The set of points that satisfy a condition. The plural of locus is *loci.*
Perpendicular	Two lines are perpendicular if the angle of intersection is 90°.
Bisector	A line that intersects another line at midpoint; or the vertex of an angle to halve it..

Basic locus constructions

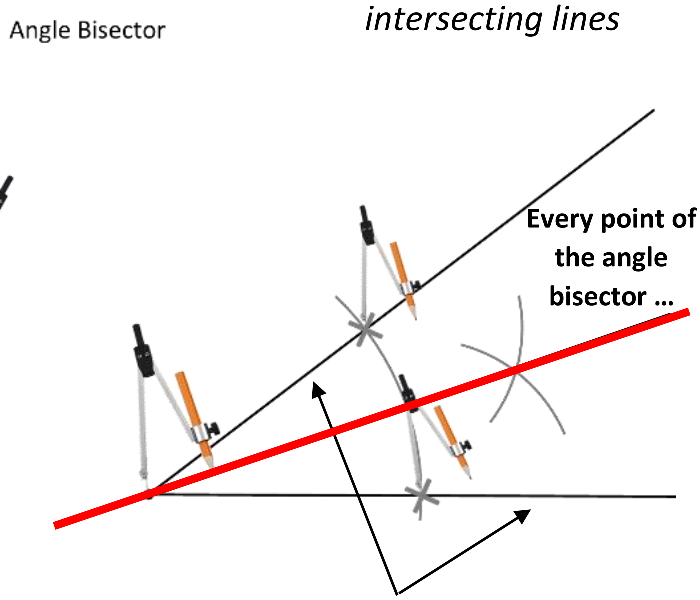
The locus of points equidistant from two given points

Every point of the perpendicular bisector …



… is equidistant from both edges incident at the vertex

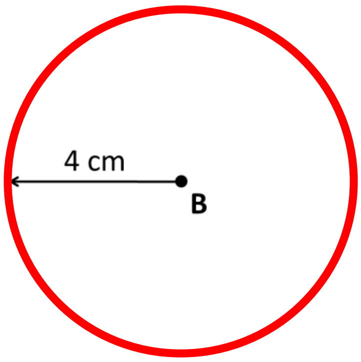
The locus of points equidistant from two intersecting lines



Every point of the angle bisector …

… is equidistant from both edges incident at the vertex

The locus of points at a given distance from a point



Every point of the circumference of a circle is the same distance from the centre (4cm in this example)

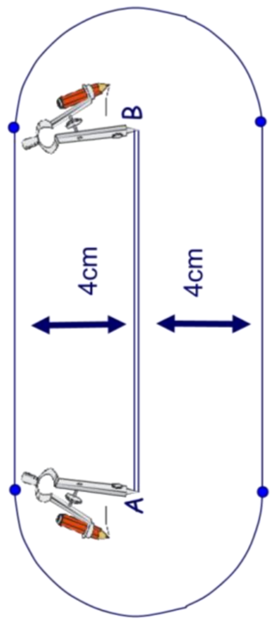
Finding loci using basic constructions

The locus of points from a line segment

Step 1) Take your compass and open it up to **4cm** wide using your ruler.

Step 2) Place compass on one end of the line segment and draw a semi-circular arc of radius **4cm**. Repeat at the other end.

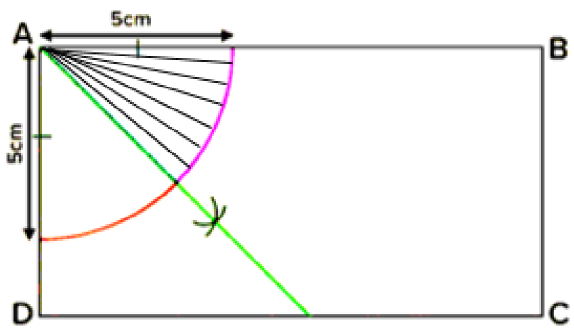
Step 3) Draw 2 lines parallel to AB by joining up the arcs with a straight line using your ruler.



Q

Shade the area which is:

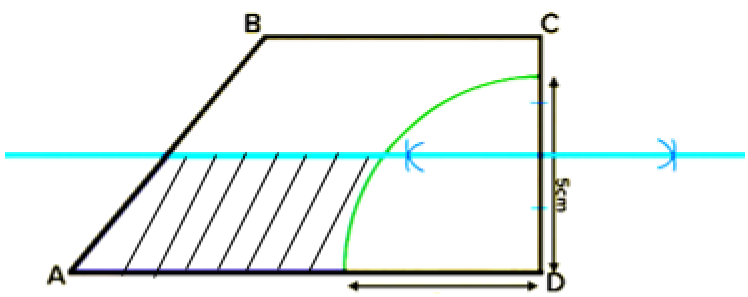
- Less than 5cm from A → Circle at point A
- Nearer AB than AD → Angle bisector of ∠DAB



Q

Shade the area which is:

- Nearer AD than BC → Perpendicular bisector of CD
- More than 5cm from point D → Circle at point D



Online clips

M253, M232, M239