GCSE Chemistry Maths Skills

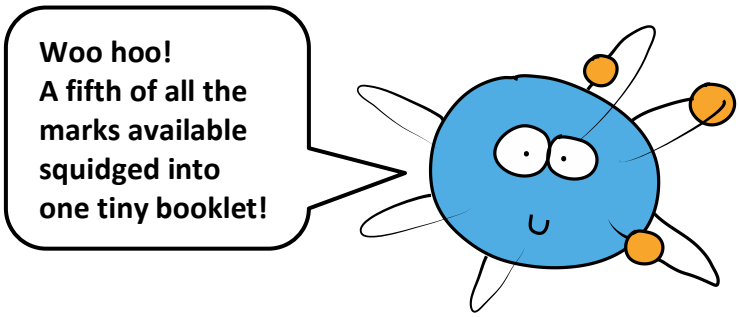
A minimum of 20% of your GCSE paper will consist of maths questions.

Objectives

1	**Arithmetic and Numerical Computation**			
a	Write and use numbers in decimal form			
b	Write and use numbers in standard form			
c	Use ratios, fractions and percentages			
d	Make estimates for the results of simple calculations			
2	**Handling Data**			
a	Write numbers to an appropriate number of significant figures			
b	Calculate the mean average for a set of results			
c	Construct or use data from frequency tables, histograms, bar charts and diagrams			
d	Make order of magnitude calculations			
3	**Algebra**			
a	Understand the symbols: =, <, <<, >>, >, ~, ∝			
b	Change the subject of an equation			
c	Substitute numerical values into equations using appropriate units			
4	**Graphs**			
a	Plot a graph of two variables using data from an experiment or other source			
b	Use a graph to extract numerical data			
c	Understand that y = mx + c represents a linear relationship			
d	Determine the slope and intercept of a linear graph			
e	Draw and use the slope of a tangent to a curve as a measure of rate of change			
5	**Geometry and Trigonometry**			
a	Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects			
b	Calculate the areas of triangles and rectangles			
c	Calculate the surface area of a cube			
d	Calculate the volume of a cube			

How to Use this Booklet:

1. Use the learning objectives on this page as a checklist. The columns on the right are so you can RAG, (Red, Amber, Green) or tick off the objectives at different stages of your revision journey.
2. Read through each section carefully so that you understand it. Use the QR codes to visit useful websites.
3. Learn the parts in the grey boxes by heart – testing yourself will help with this!
4. Try all of the questions in each section. Make sure you show your working.



1. Arithmetic and Numerical Computation

a. Write and Use Numbers in Decimal Form

Sometimes, rather than rounding off to the nearest whole number, you might need to be a little more accurate. You might need to include some of the digits after the decimal point.

In these cases, we can round off the number up to a certain number of decimal places.

Do not confuse this with rounding off using significant figures, as this is slightly different!

Remember

5 or more, we '**round up**'.
4 or less, it stays as it is.

Write the following numbers to two decimal places

a. 0.3453 _____

b. 34.56 _____

c. 548.003 _____

Write the following numbers to three decimal places

a. 0.983 _____

b. 354.12984 _____

c. 1.78200 _____

b. Write and Use Numbers in Standard Form

Standard form is very useful when writing really big or really small numbers.

In standard form, a number is always written as: $A \times 10^n$

A is always between 1 and 10. n tells us how many places to move the decimal point.

Example : Write 15 000 000 in standard index form.

Solution

15 000 000 = 1.5 × 10 000 000

This can be rewritten as:

1.5 × 10 × 10 × 10 × 10 × 10 × 10 × 10

= 1. 5 × 10^7

Write the following numbers in standard form

a. 0.000034 _____

b. 3540000000 _____

c. 0.00045 _____

Convert the following from ordinary numbers to standard form

a. 4.5 x 10^{-3} _____

b. 4.5 x 10^3 _____

c. 9.54 x 10^6 _____

c. Use ratios, fractions and percentages

A ratio is a simple way to compare amounts of something. Recipes, for example, are often given as ratios.

If pastry is 2 parts flour to 1 part fat, then there are 3 parts (2 + 1) altogether. Two thirds of the pastry is flour; one third fat.

Ratios are similar to fractions; they can both be simplified by finding common factors. Always try to divide by the highest common factor.

a. There are 15 moles of iron and 12 moles of oxygen in an iron ore. What is the ratio of iron to oxygen? Give your answer in its simplest form.

_____

b. A compound contains 1.2kg of titanium and 750g of chlorine. What is the ratio by mass of titanium to chlorine? Give your answer in its simplest form.

_____

A fraction is a part of a whole, for example ½. Equivalent fractions are fractions that look different but show the same amount. Improper fractions have numerators that are higher than the denominator, while mixed fractions contain whole numbers and fractions.

a. Circle the fraction that IS NOT equivalent: : $\frac{1}{3}$ $\frac{2}{6}$ $\frac{6}{14}$ $\frac{4}{12}$

Simplify the following fractions:

a. $\frac{30}{42}$ _____

b. $\frac{4}{12}$ _____

c. $\frac{45}{60}$ _____

Convert the following into decimals, (you can use a calculator – just divide the numerator by the denominator).

a. $\frac{3}{4}$ _____

b. $\frac{3}{8}$ _____

c. $\frac{12}{16}$ _____

To find a fraction of a quantity:

- Divide the quantity by the denominator
- Multiply the answer you get by the numerator

a. When extracting aluminium from bauxite the mass of aluminium produced will be only $\frac{2}{7}$ of the original mass of the bauxite. If a company starts with 50tonnes of bauxite how many tonnes of aluminium should they expect to obtain?

_____

Per cent means 'out of 100'. If 90 per cent of the population owns a mobile phone, this means 90 out of every 100 people have one. The symbol '%' means per cent.

A percentage is a fraction of 100.

30% (30 in each 100) as a fraction is $^{30}/_{100}$

30% as a decimal is 0.3.

a. A student heats up 12g of copper using a Bunsen burner. The mass increases by 9% as oxygen bonds with the copper to form copper oxide. What is the final mass of the product formed?

_____

b. An alloy is produced using 12g of tin, 34g of lead and 32g of iron. What percentage of the alloy is tin?

_____

2. Handling Data

a. Write numbers to an appropriate number of significant figures

We have already looked at decimal places, another method of giving an approximated answer is to round off using **significant figures.**

The word significant means: having meaning.

With the number **368249**, the **3** is the most significant digit, because it tells us that the number is **3 hundred thousand** and something. It follows that the 6 is the next most significant, and so on.

With the number **0.0000058763**, the **5** is the most significant digit, because it tells us that the number is **5 millionths and something**. The 8 is the next most significant, and so on.

- All non-zero numbers (1,2,3-9) are significant.
- Zeros between non-zero numbers are significant.
- Leading zeros are not significant.
- Zeros trailing a number containing a decimal place are all significant.
- Zeros trailing a number without a decimal place *may* be significant.

Give the following to 3 significant figures

a. 30455	b. 3540000000	c. 0.000450
_____	_____	_____
d. 4.599	e. 467040	f. 9.50474
_____	_____	_____

b. Calculate a Mean

The mean is the average of a set of numbers.
Add up all the numbers and divide by how many numbers there are.

REMEMBER: to always exclude any anomalous results from your calculations.

a. Rosie carried out a titration. Calculate the mean titre value from her results below:

Titre	1	2	3	4
Volume (cm^3)	23.5	23.4	24.0	23.3

---

c. Construct or use data from frequency tables, histograms, bar charts and diagrams

a. Sarah wanted to know the length of time ferrets lived for in captivity so she could compare it to that in the wild. She made a frequency chart of all the ferrets living at Bristol zoo over the past 25years. Calculate the mean lifespan of the ferrets.

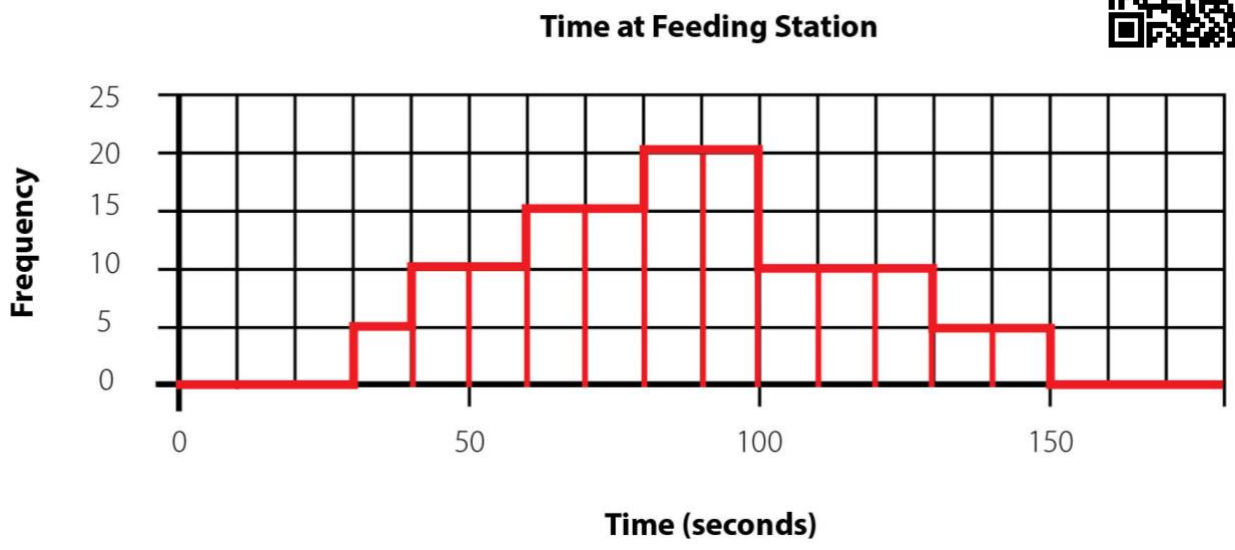
Age	Frequency
1	0
2	0
3	1
4	0
5	0
6	1
7	0
8	2
9	4
10	8
11	4
12	3

To find the sum of all the ages, calculate:
(3 x 1) + (6 x 1) + (8 x 2) + (9 x 4) + (10 x 8) + (11 x 4) + (12 x 3) = 221

The total number of ferrets is 1 + 1 + 2 + 4 + 8 + 4 +3 = 23

221 / 23 = 9.6

b. The histogram shows the time in seconds that individual birds spend at a feeding station. How many birds spend less than 1 minute at the feeding station.



d. Make Order of Magnitude Calculations

Orders of magnitude allow us to compare very large and very small values to each other.

An order of magnitude is a division or multiplication by 10. Each division or multiplication by ten is termed an order of magnitude. The actual length may be approximated, as it is the relative difference that is important.

The order of magnitude of a number is the number of powers of 10 contained in the number.

The order of magnitude of 10 is 1. The order of magnitude of 1 000 is 3.

Two numbers can be said to have the same order of magnitude if the large one divided by the small one is less than 10.

This means that 56 and 18 have the same order of magnitude, but 560 and 18 do not.

a. A sunflower measuring 4 mm grows to 40 cm over 4 weeks. Explain in words how many times bigger the sunflower is after the 4 weeks.

_____

b. A course particle has a diameter of 1×10^{-6}. A nanoparticle has a diameter of 1×10^{-9}. Calculate how much bigger the course particle is than the nanoparticle.

_____

b. The mass of one molecule of water is 2.99×10^{-23} g. Estimate how many molecules of water there are in 1 g of water.

_____

3. Algebra

a. Understand the Symbols: =, <, <<, >>, >, ~, ∝

= Is equal to, equals e.g. x = y, means x is the same as y
< Is less than e.g. x < y, means x is less than y
<< Is significantly less than e.g. x < y, means x is a lot less than y
> Is greater than e.g. x > y, means x is greater than y
>> Is significantly greater than e.g. x < y, means x is a lot greater than y
~ ?????????????
∝ Proportional

Use the symbols: Understand the symbols: =, <, <<, >>, >, ~ between the following sets of numbers:

A	5		12		20
B	4		6		70
C	½		0.5		1
D	78.9		6.3		5.9

b. Change the Subject of an Equation

The subject of an equation is the symbol sat by itself on one side of the equation e.g. for the equation below x is the subject of the equation.

x = y + 3

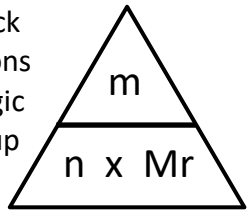
If we wanted to calculate a value for y we would need to rearrange the equation to make y the subject of the equation. To do this we will need to change some terms to the opposite side of the equation, when we do this we have to remember to change its operation to do the inverse or opposite e.g. in this example we need to move 3 to the other side of the equation, at present we are adding three, the opposite of this is subtracting it so:
x – 3 = y

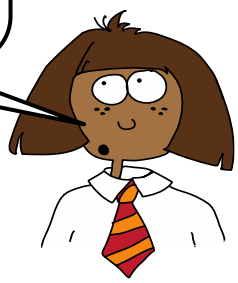
a. Rearrange the equation **n = m / Mr** to work out the mass in grams of 3 moles of salt, (Mr of NaCl = 58.5). **NOTE:** In the examinations you will be expected to remember the equation **n = m / Mr** by heart.

_____

_____

If you get really stuck rearranging equations you can draw a magic triangle and cover up the term you wish to find out.





b. Rearrange the equation **c = n / v** to work out the number of moles of potassium sulphate dissolved in 25cm^3 of water to make a 0.5moldm^{-3} solution. **NOTE:** In the examinations you will be expected to remember the equation **c = n / v** by heart.

_____

c. Substitute numerical values into equations using appropriate units

a. A chemical reaction produces 300cm^3 of carbon dioxide gas at room temperature and pressure. Calculate the number of moles of gas produced using the equation:

Convert from cm^3 to dm^3
÷ 1000

$$n = \frac{\text{volume of gas (dm}^3\text{)}}{24\text{dm}^3}$$

_____

b. The percentage atom economy for a reaction is calculated using:

$$\frac{\text{Relative formula mass of desired products from equation}}{\text{Sum of relative formula mass of all reactants from the equation}} \times 100$$

The equation for the reaction of copper carbonate and sulphuric acid is:

$$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$$

Relative formula masses:
$CuSO_4$ = 159.5,
$CuCO_3$ = 123.5,
H_2SO_4 = 98.0

Calculate the percentage atom economy for making copper sulphate from copper carbonate.

_____

_____

4. Graphs

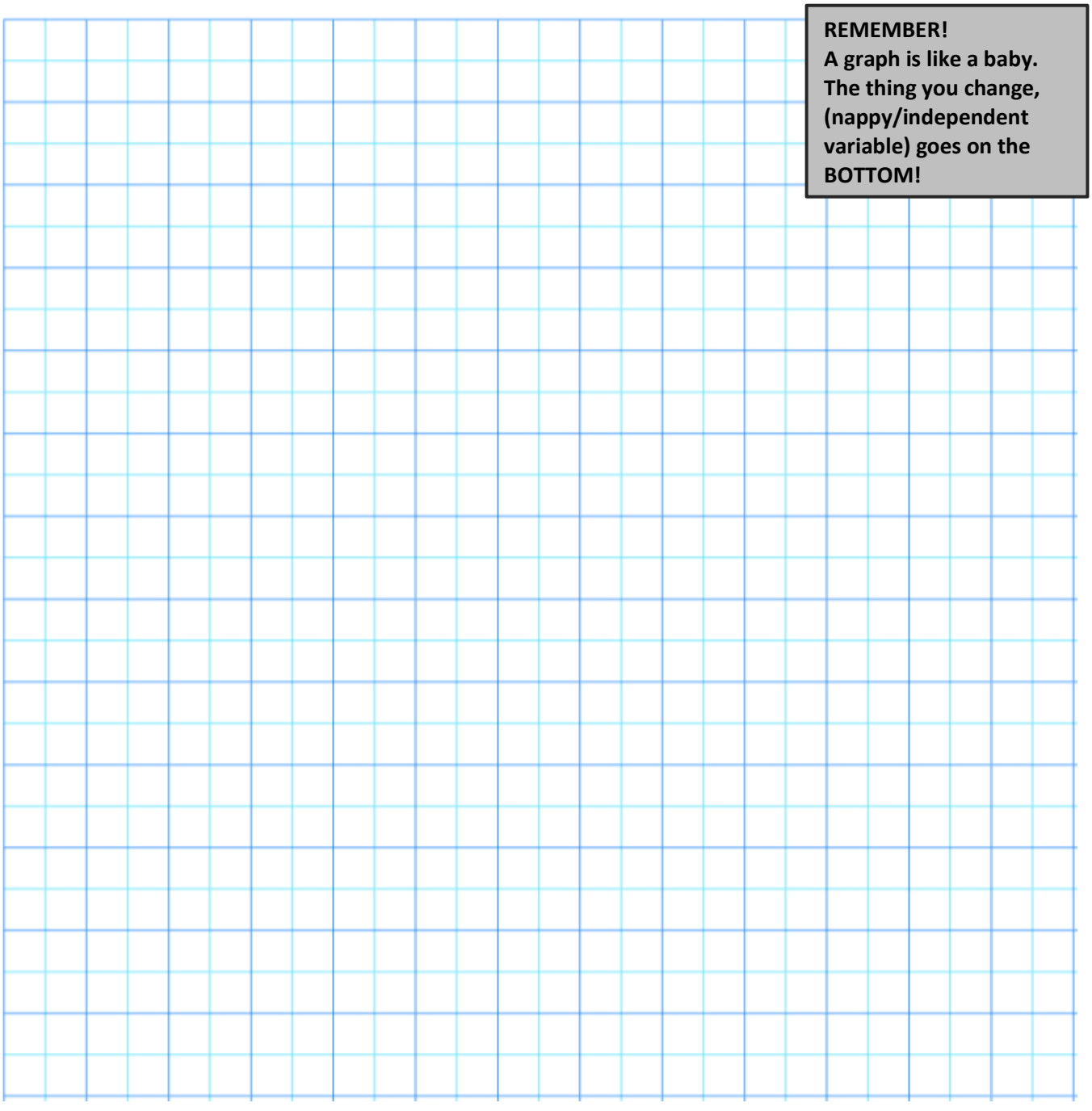
a. Plot a Graph of Two Variables Using Data from an Experiment or Other Source

Check List for an Awesome Graph:

Label the axis of the graph including units.
Plot the points in the correct place using a small 'x'.
Choose appropriate scales for the graph, (that can involve more complex axis, such as those with a break in the y axis or negative numbers) allow the graph to take up at least 2/3 of the graph paper provided.
Give the graph a title.
Draw a line or curve of best fit ignoring anomalous results.

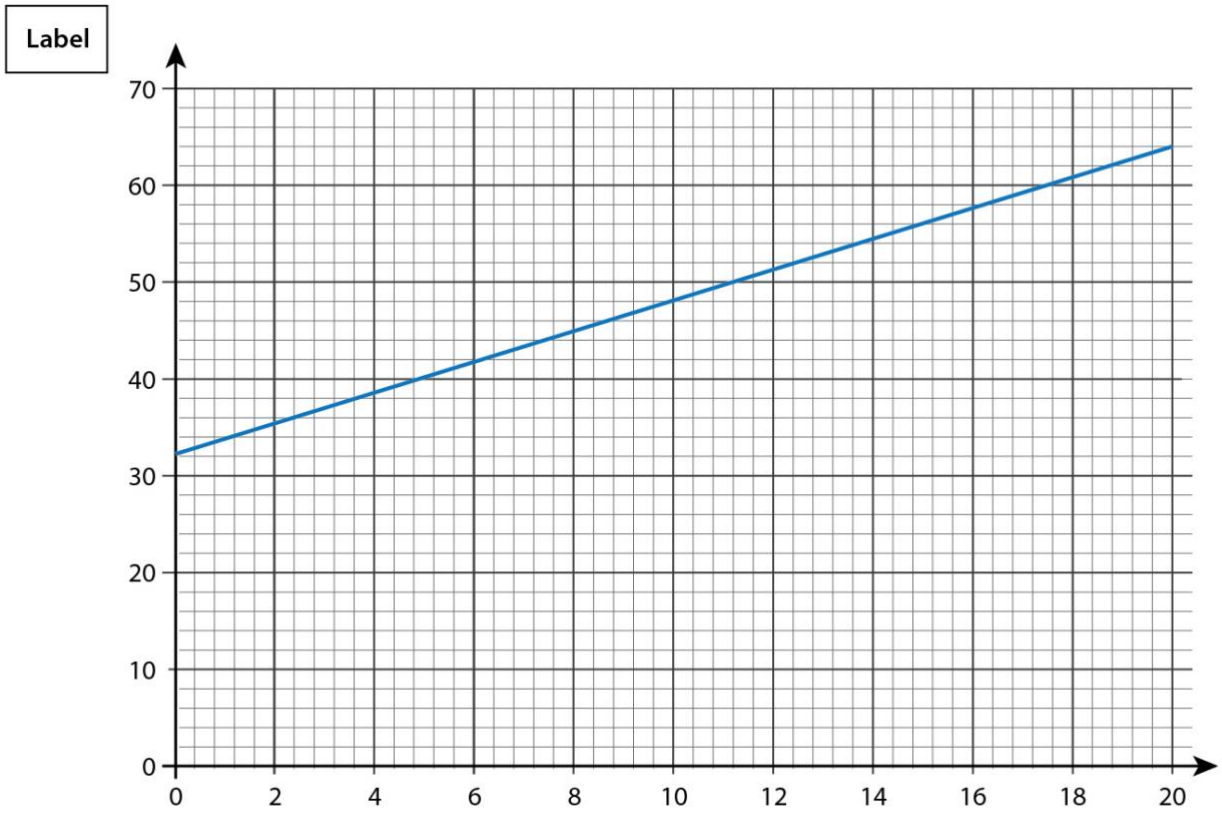
a. A student titrated hydrochloric acid with 25cm^3 of sodium hydroxide. They recorded the pH as they added the acid. Plot a titration curve of their results.

Volume of acid added (cm^3)	0	5	10	15	20	25	30	35	40	45	50
pH	12.5	12.3	12.2	12.0	11.6	7.0	1.8	1.5	1.2	1.0	1.0



b. Use a graph to extract numerical data

The line on the graph can be used to help convert temperatures from degrees Celsius to Degrees Fahrenheit and vice versa. Use it to answer the questions below.



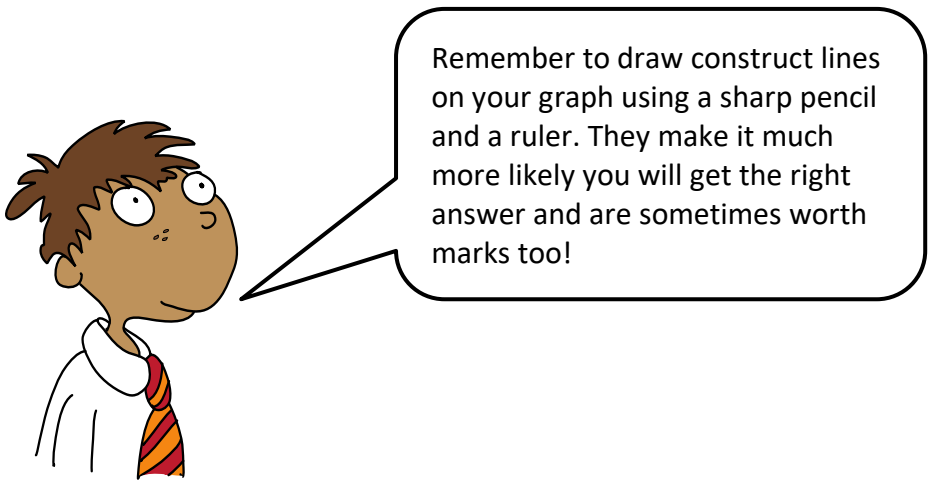
Water freezes at 0°C and also at 32°F.

a. Write down the label for the vertical axis.

_____

b. Use the graph to change 14°C to degrees Fahrenheit.

_____



c. Understand that y = mx + c represents a linear relationship and d. Determine the Slope and Intercept of a Linear Graph

The equation for a straight line on a graph, made up of an x term, a y term and a number can be written as:

y + mx + c

The slope of the line is known as the **gradient** and is represented by **m** in the equation.

The point at which the line **intercepts the y-axis** is the **c** in the equation

a. Use the graph below to find the value of y when x = 2.

_____

b. What is the y- intercept for the line?

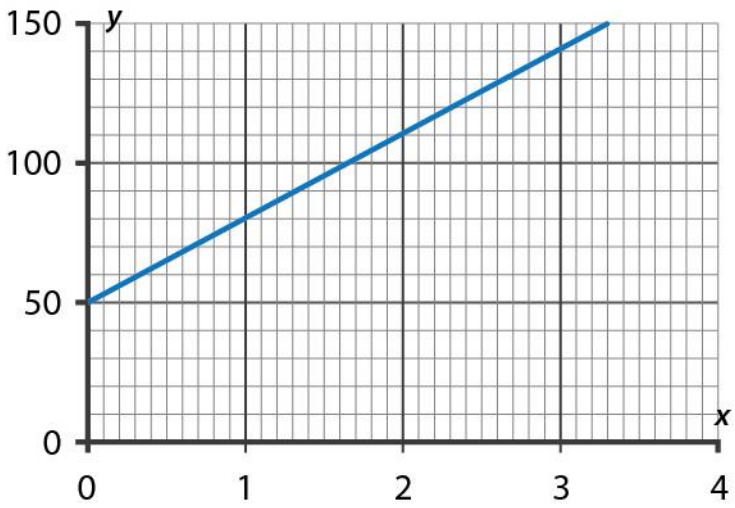
_____

c. State the gradient for the line.

_____

An x-intercept is where the graph crosses the x-axis.

A y-intercept is where the graph crosses the y-axis.



The gradient of a straight line graph can be calculated by choosing any two points on a line and drawing a right angle triangle line as the hypotenuse. Use the scale on each axis to find the triangle's:

- vertical length
- horizontal length

Work out the **vertical length ÷ horizontal length**

d. The table of values below is for the straight line graph $v = 3+2t$. Work out the missing values.

t	0	3		30
v			19	

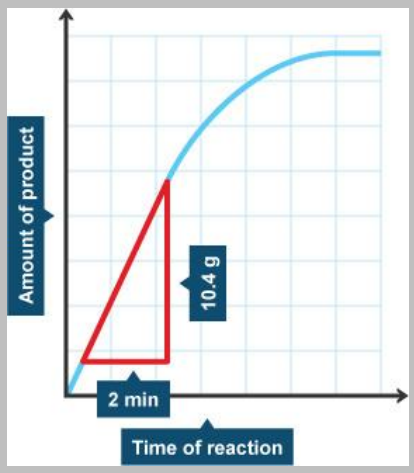
e. Write down the gradient of the graph of $y = 7x - 2$.

_____

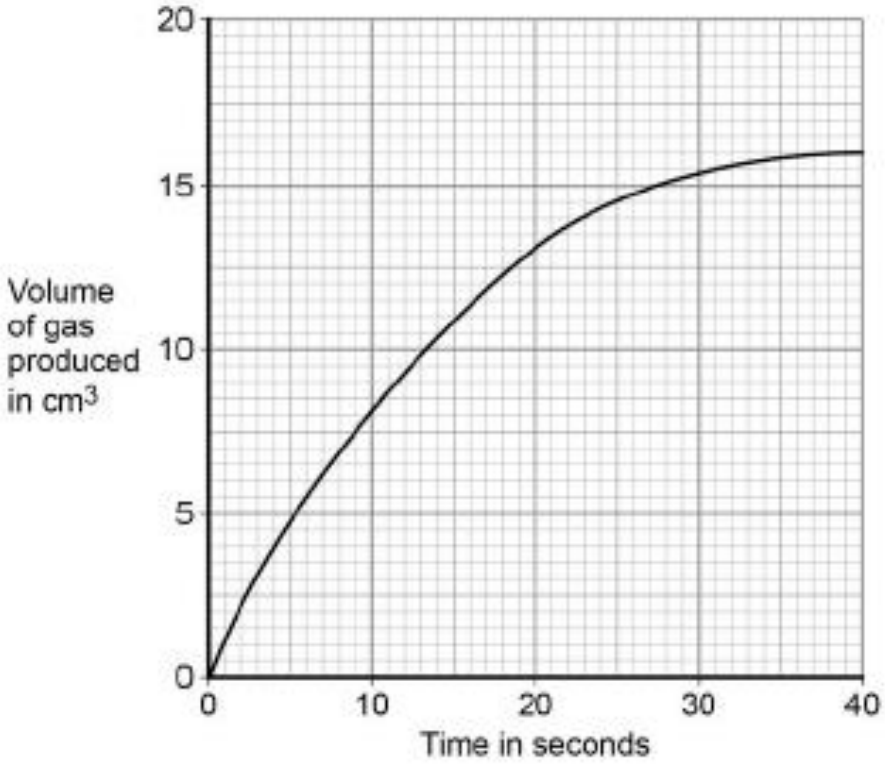
e. Draw and Use the Slope of a Tangent to a Curve as a Measure of Rate of Change

The rate of reaction can be calculated from the gradient of a graph of amount of product against time of reaction:

1. Draw a tangent to the curve (a straight line that represents the gradient at that point).
2. Draw a vertical line and horizontal line to form a right-angled triangle with the line from step 1.
3. Read off the change in amount of product (the vertical line in your triangle).
4. Read off the change in time (the horizontal line in your triangle).
5. Calculate the gradient. This will be the answer from step 3 divided by answer from step 4.



a. The graph shows the volume of gas produced against time for the reaction between magnesium and ethanoic acid.



Draw a tangent to the curve at 20 seconds.
Detemine the rate of reaction at 20 seconds by calculating the gradient of the tangent.
Give the unit.

_____

_____

5. Geometry and Trigonometry

a. Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects

You are expected to recognise all of the following structures and be able to draw graphite and graphene too:

Graphite consists of a layered lattice of carbon molecules that are bonded in hexagons. This is possible because the hexagon shape *tessellates* the plane.

Diamond molecules form bonds between in a tetrahedron shape (special triangular based pyramid). This is a regular (all sides the same) 3 dimensional shape whose sides are equilateral triangles and there are four of them.

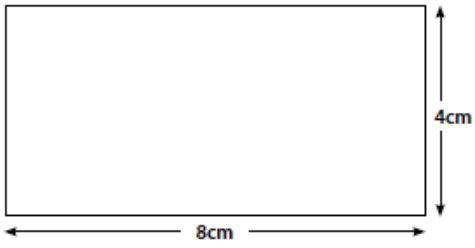
The `Bucky-Ball' has 12 faces that are pentagons and 8 faces that are hexagons.

b. Calculate the Areas of Triangles and Rectangles

To find the area of a **rectangle** multiply its length by its width.

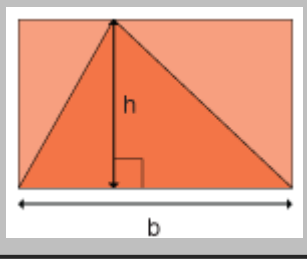
area = length x width

a. Calculate the area of the rectangle shown.

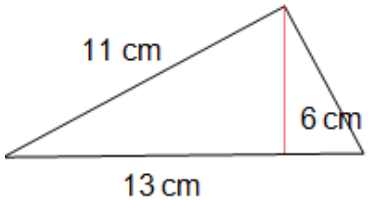


To find the area of a **triangle** multiply its base by the perpendicular height and divide the answer by two.

area = $\frac{\text{base x height}}{2}$



b. Calculate the area of the triangle shown.



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c. Calculate the Surface Area of a Cube

Find the area of one side of the cube; in the same way you would calculate the area of a rectangle.

area = length x width

Multiply the answer by 6, (because a cube has six sides).

c. Calculate the Volume of a Cube

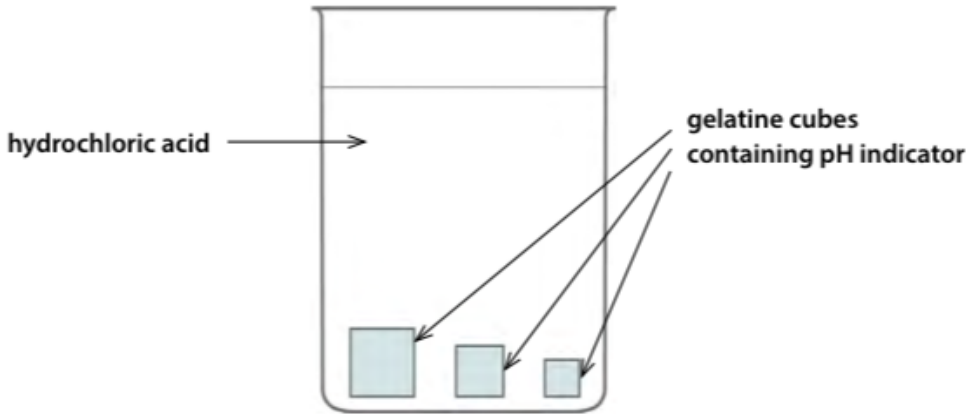
Multiply the height, by the width by the length.

Volume = height x width x length.

Technically for a cube these should all be equal, so you could just cube the length.

a. Some students investigate the effect of the ratio of surface area: volume on the rate of diffusion in animal cells. They use hydrochloric acid and gelatine cubes stained blue with pH indicator.

They put different size cubes into a beaker of hydrochloric acid and time how long it takes for the cubes to completely change colour.



This table shows their results.

Length of 1 side of cube in cm	Surface area: volume ration in cm	Time to completely change colour in seconds
1	.....	132
2	3	328
3	2	673

Calculate the surface area: volume ratio for the cube with sides of 1cm.

_____

_____