Chemistry

We're really excited that you're thinking about studying Chemistry A-Level. Please read through this document carefully. Before you start your A-Level Chemistry studies, you must complete at least Tasks 1 and 2, which are outlined below. If you want to push yourself a bit further and give yourself a challenge, you can also do Task 3. If you have any questions, just email Dr Jamadar at beckjj@beckfoot.org or Dr Wright at becgdw@beckfoot.org

It is important that you complete these activities to the best of your ability, and when you come across something you don't understand, it is essential that you do your research/revision and find out! Work hard, and good luck!

Transition tasks

1. Year 12 Chemistry Summer homework booklet (Page 3-25)
2. Chemistry AQA transition guide tasks (Page 26-56)
3. Starter for ten – transition skills 1, 2 and 3 documents (Page 56 onwards)

Reading list

Course related

- Best book for you to bridge the gap to AS level: 'Head start to A-Level Chemistry' by CGP. Free e-book available at https://www.amazon.co.uk/Head-Start-level-Chemistry-Level/dp/1782942807
- Essential Maths Skills for AS/A-Level Chemistry by Nora Henry. Hodder Education https://www.whsmith.co.uk/products/essential-maths-skills-for-asa-level-chemistry/nora-henry/paperback/9781471863493.html
- Maths for A Level Chemistry: a course companion by Stephen Doyle. Illuminate Publishing https://www.whsmith.co.uk/products/maths-for-a-level-chemistry-updated-ed/stephen-doyle/paperback/9781908682901.html
- Summer start for A-Level Chemistry is a brilliant resource to help prepare you for starting a demanding course in September and its only £1.99!! https://www.primrosekitten.com/products/summer-start-for-a-level-chemistry

Wider reading

- **Periodic Tales**: The Curious Lives of the Elements – Hugh Aldersey-Williams
- **The Science of Everyday Life**: Why Teapots Dribble, Toast Burns and Light Bulbs Shine – Marty Jopson
- **Bad Science** – Ben Goldacre

Useful websites

- Find out about A-Level Chemistry and the specification we follow at https://www.aqa.org.uk/subjects/science/as-and-a-level/chemistry-7404-7405/introduction

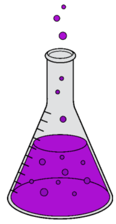
- Those who want to work in the medical field may find this website useful from a past med student: https://www.themedicportal.com/blog/askamedstudent-how-can-i-prepare-for-starting-a-levels%E2%A0%80/

Films and documentaries to watch

- Allery Chemistry on YouTube has some excellent bridging videos from GCSE to A-Level so check them out. There are 6 videos in total https://www.youtube.com/watch?v=kASDUQsSA7o&list=PLX4e2DxFRGQIUvLpjDK9FWTxZUVxP8dFi
- Writing formulae and balanced equations is an essential skill in Chemistry so this video on YouTube is a must: https://www.youtube.com/watch?v=bpmoo0iI7pM
- Hear from a really successful past student who made a short video on how to prepare for A-levels including A-Level Chemistry: https://www.youtube.com/watch?v=dZdQ4OPOsa0

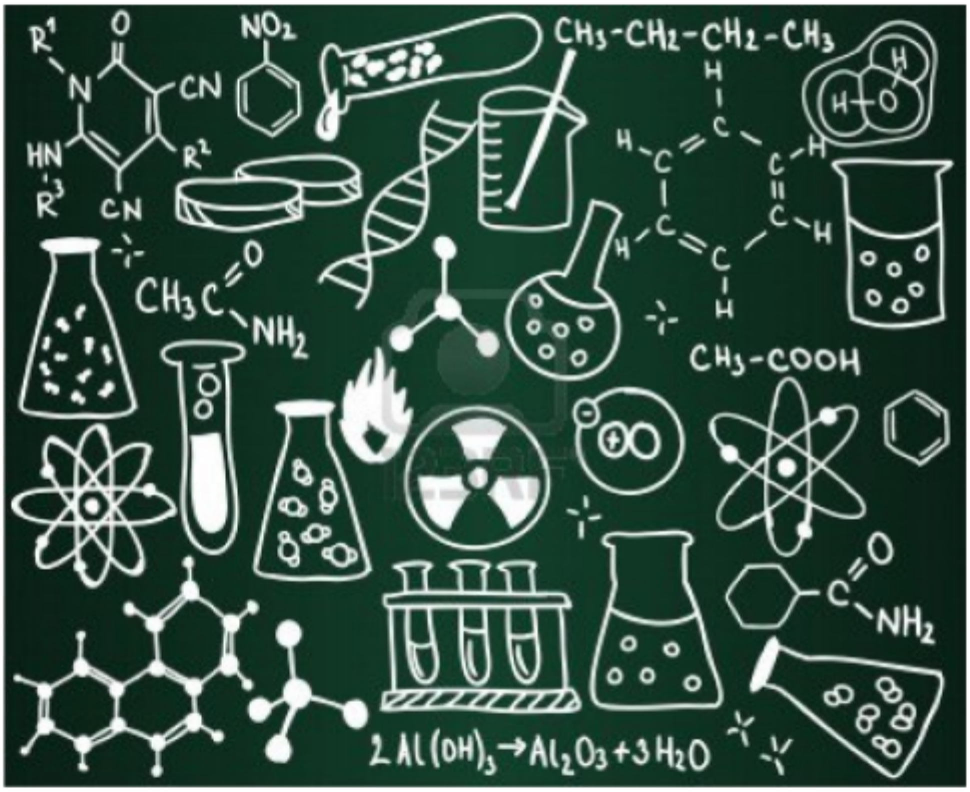
And some interesting extras

- A thread of quicksilver – the history of mercury – https://www.youtube.com/watch?v=t46lvTxHHTA
- 10 weird and wonderful chemical reactions - https://www.youtube.com/watch?v=0Bt6RPP2ANI
- Rough Science – Lots of episodes of this problem-solving show - https://www.youtube.com/watch?v=lUoDWAt259I

Year 12 

CHEMISTRY

Summer 2020 HW booklet



Name:

Form:

Welcome to Chemistry!

To ensure you succeed on the course, you have been asked to complete this homework booklet over the summer.

You need to complete it to the **BEST OF YOUR ABILITY**

If you are stuck, **use the Internet** to help you (almost all the work in here is ***GCSE level*** so you should be able to complete it)

You need to HAND IN this booklet to your CHEMISTRY TEACHER in September.

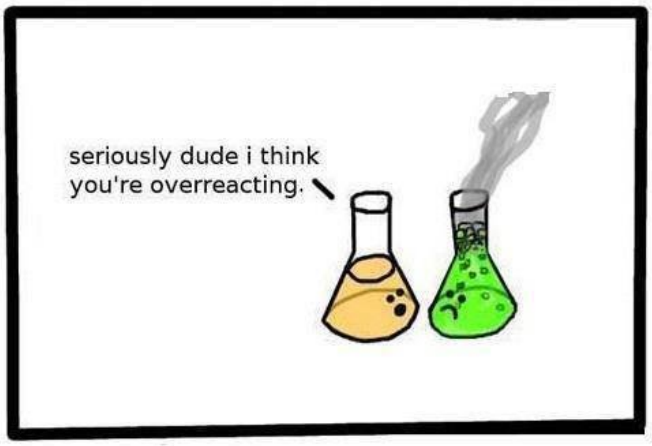
Your lovely chemistry teachers are…
Dr Wright
Dr Jamadar
Mrs Milner
Ms Marriott

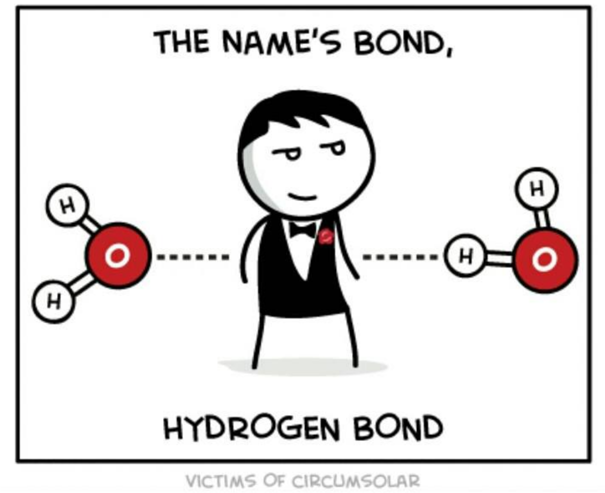
Getting ready for you're A-level Chemistry course in September…

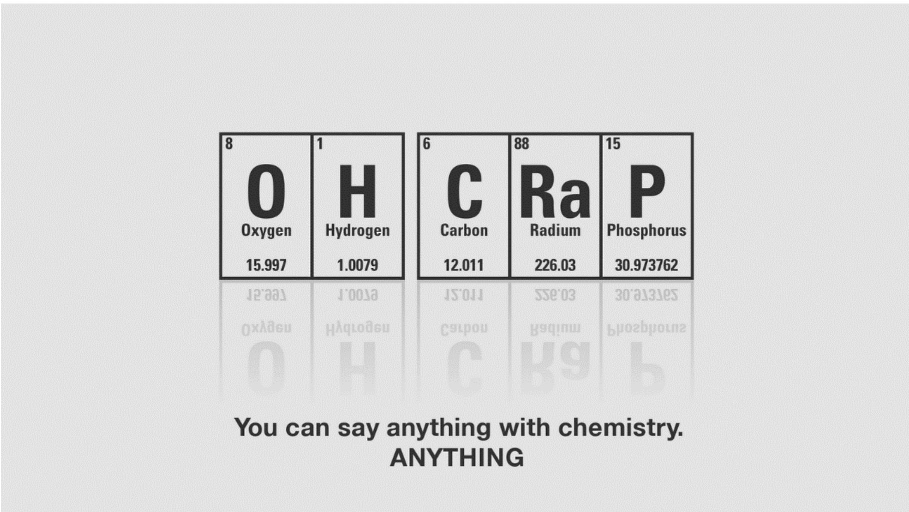
1. Buy a **large lever arch file** – you will place all your ***class work and homework*** in there. A set of ***dividers*** will help keep it organised so buy some of those too. Your teachers will conduct a folder check every term. **The quality of your folder and therefore the work you complete both in class and at home in Year 12 will help inform our UCAS statement and prediction when you make your university applications.**
2. After each lesson, you need to make your ***own notes and go over the work covered***. If you do not, you will **forget the material which will make revising it later considerably less effective**.
3. You will be given an ASSESSMENT FOLDER in which you will keep **all** the assessments and homework you complete. **This will be kept in school**. If you wish to take anything home from it, you will need to take a *photocopy* of it.
4. You will cover a great deal of chemistry content in each lesson and it is difficult stuff so please ***take on board and ACT on the ADVICE your teachers give you***
5. If we find you are struggling from test results or performance in lessons, you will be required to attend INTERVENTION SESSIONS after school. This is for **YOUR BENEFIT** and will ensure you make the **IMPROVEMENTS** to achieve the best grade you can.
6. If at **ANY POINT** (although *earlier the better*), you feel you DON'T UNDERSTAND SOMETHING then ASK YOUR TEACHER to explain it, that is what they are there for!
7. Use your planner to help you ORGANISE yourself so that you know when homework, assessed/required practical's and tests will take place so that you can PREPARE for them
8. There will be a fair amount of **MATHS** in A-level chemistry so make sure you ask for help if this is an area you think you may struggle in – a good (and cheap!) ***maths for chemistry revision guide is available from CGP*** so we recommend you buy it at the start of the year.

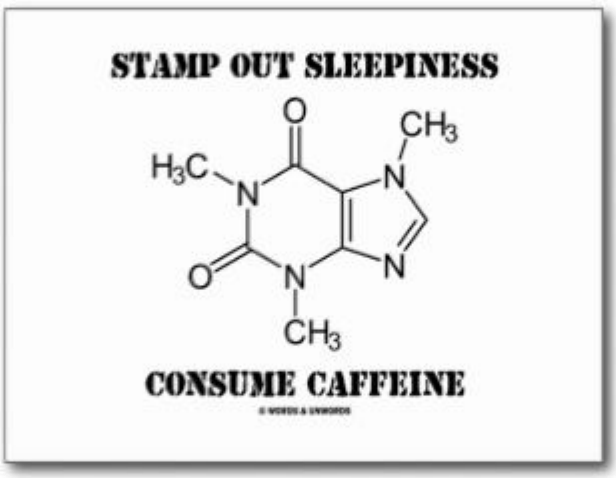
9. MOST OF ALL WE WANT YOU TO ENJOY CHEMISTRY and you are likely to do that if…
   a) You are **INTERESTED** in the subject
   b) You need the subject for a course at **UNIVERSITY** or for a **JOB** at 18
   c) You did well in the subject at **GCSE LEVEL**

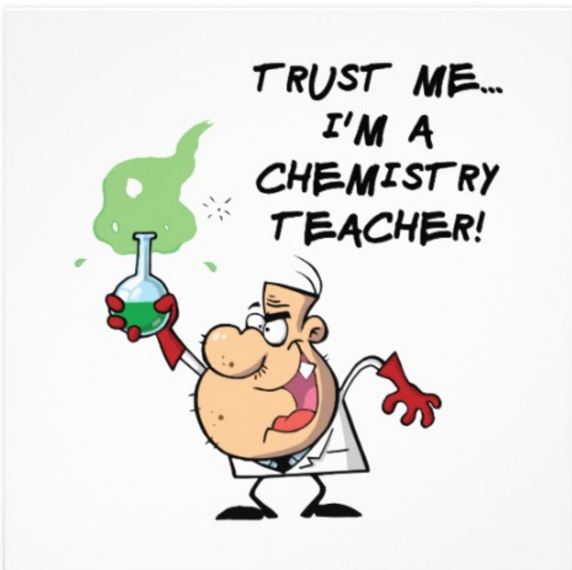
CHEMISTRY IS FUN!!







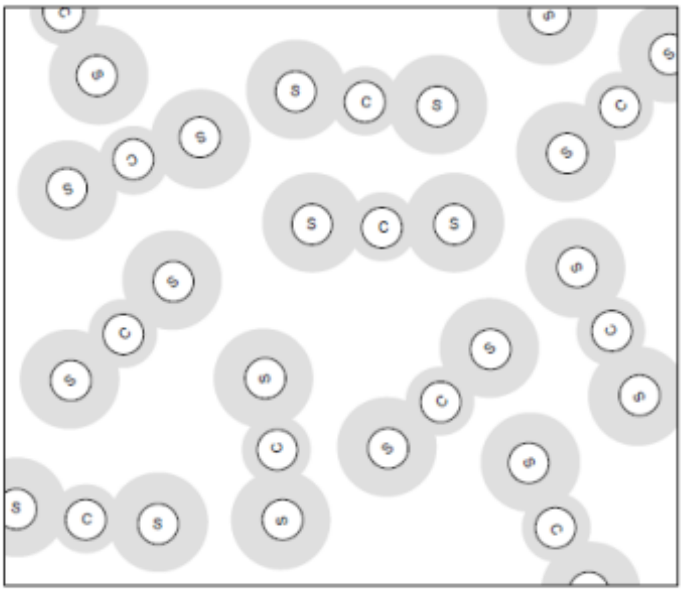




Elements, compounds and mixtures

Task 1 – each of the following diagrams show the particles in a material. *For each diagram, write a) whether you think it represents an element, compound or a mixture* and *b) give reasons why*.

1



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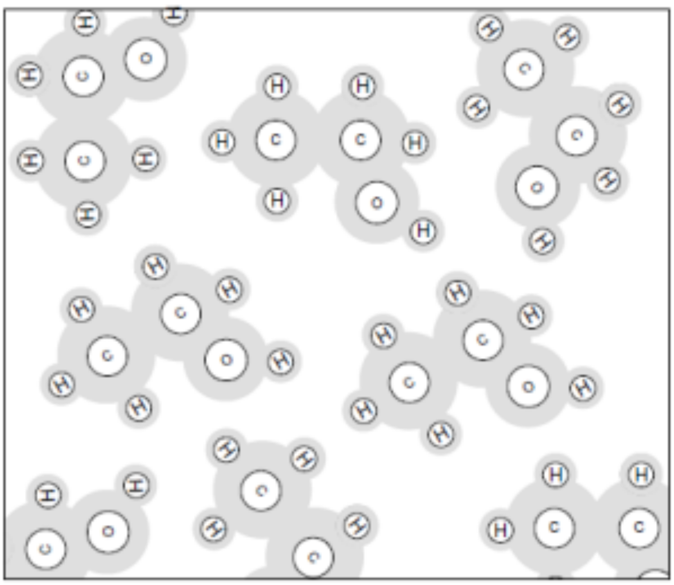

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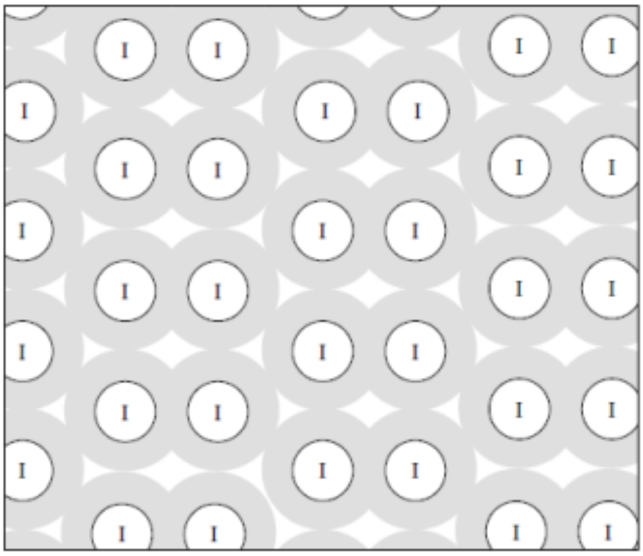

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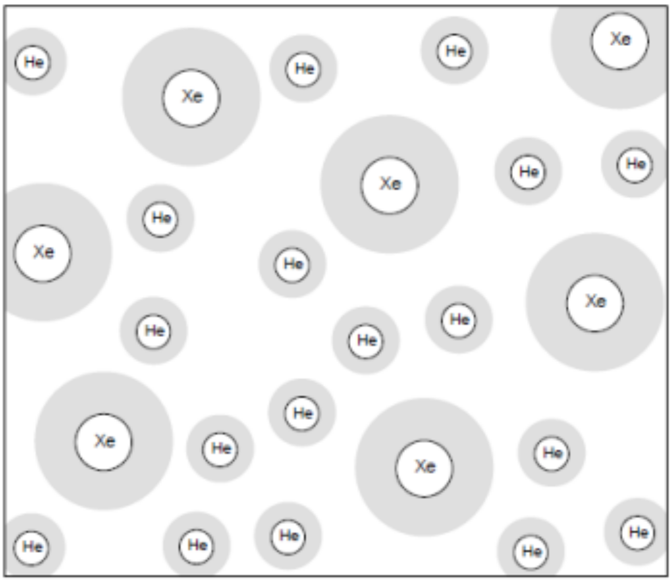


/ 2 marks each = 8 marks total

Task 2: identify each of the following as an element, compound or mixture

a) Crude oil - ___________________________

b) Petrol fraction - ______________________

c) Methane - ______________________

d) Air - ______________________

e) Graphite - _______________________

f) Antimony - ______________________

g) Ethanol - ________________________

/ 7 marks

Atomic structure

Task 3 – complete the table below with the **sub-atomic particles** found in an atom

Particle	Where is it found?	Relative charge	Relative mass

/ 1 mark per row = 3 in total

Task 4 – **Define** the following words:

a) **Mass number -**

____

b) **Atomic number -**

____

c) **Isotope -**

____

/ 3 marks

Task 5 – Complete the number of **protons, neutrons** and **electrons** for the atoms below.

$^{35}_{17}Cl$

protons =

neutrons =

electrons =

$^{65}_{30}Zn$

protons =

neutrons =

electrons =

/ 2 marks

Task 6 – Draw the electron configuration for the following:

a) Sodium atom

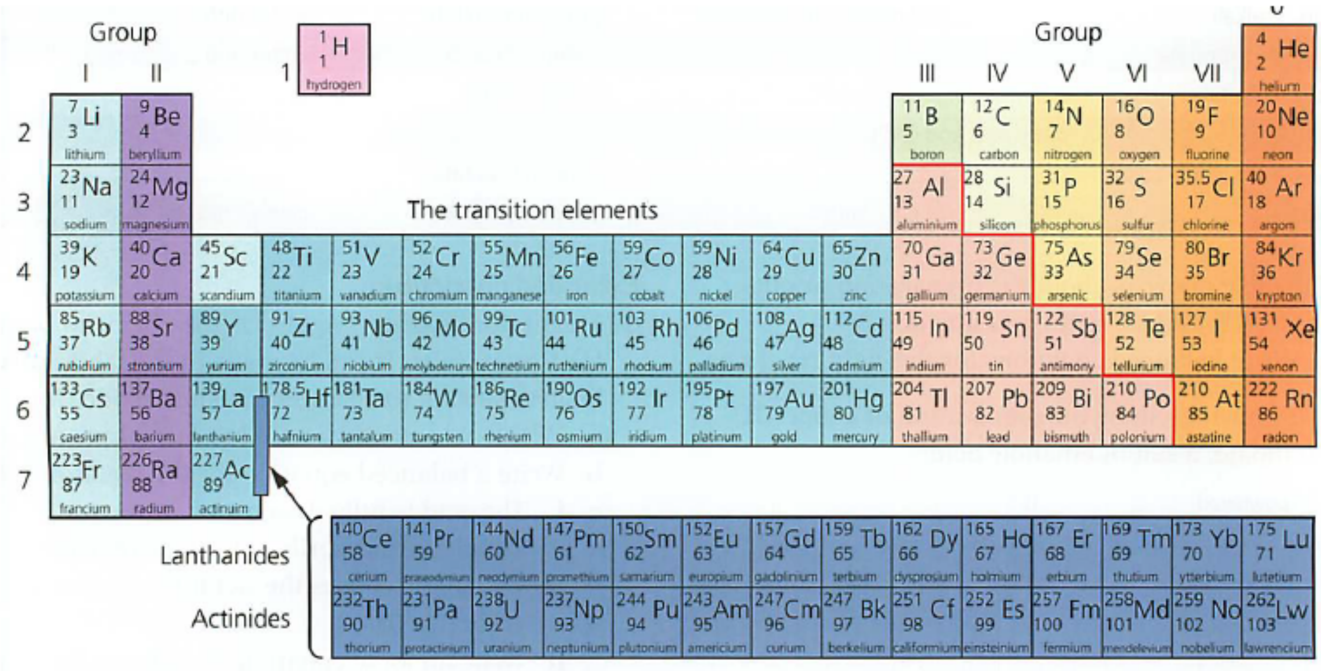
b) Fluorine

c) Cl^-

d) Mg^{2+}

/ 4 marks

The Periodic table – what does it tell you?



Task 7: correctly *match* the sentence halves about the Periodic table

Beginning
a) The elements are in order of their….
b) The transition metals are….
c) The Group 7 elements are called…..
d) The alkali metals are…
e) Groups are columns & tell you…
f) Periods are rows & tell you….

Ending
… the number of electrons in the last shell of the atoms
… in the middle block
…. the number of electron shells the atoms have
…. atomic number
… in Group 1
… halogens

/ 6 marks

Structure & bonding

Q1 – Why do most elements need to bond with others? (1)

Q2 – i) Decide the **TYPE of BONDING** the following substances have. **Choose from** – *covalent; ionic or metallic*

ii) Also, decide the type of **STRUCTURE** – **Choose from** - *giant covalent; simple molecular; giant ionic or giant metallic*

a) Sodium –

b) Magnesium oxide –

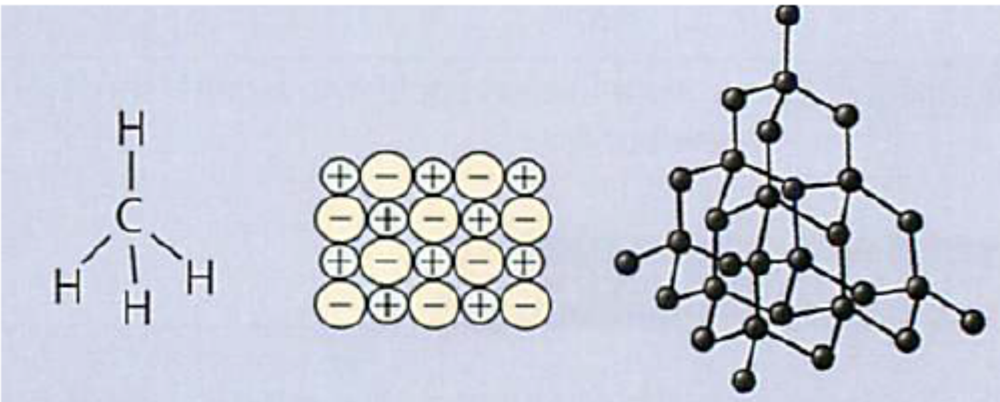
c) Iodine –

d) Diamond –

e) Sulfur dioxide –

/ **10 marks**

Task 8 – *name the* ***type of structure*** *represented in each of these diagrams (3)*



Task 9 – Ionic or covalent bonding? (5)

State whether the following pairs of elements form ionic or covalent compounds when they combine:

(a) sodium and chlorine

(b) hydrogen and oxygen

(c) hydrogen and chlorine

(d) lithium and chlorine

(e) sodium and iodine

Task 10 – Draw **diagrams** to show the bonding arrangement in the following compounds:

a) **Water** (dot and cross diagram) /2

b) **Lithium fluoride** (ion structures) /2

Total tasks 1-10 = 56 marks so far

Task 11 – The table shows some **properties** of different substances

substance	melting point/°C	conductivity of solid	conductivity of liquid	solubility in water
A	–56	does not conduct	does not conduct	insoluble
B	610	does not conduct	conducts	soluble
C	–70	does not conduct	does not conduct	insoluble
D	2310	conducts	conducts	insoluble
E	680	does not conduct	conducts	soluble

Classify each of these substances as metals, giant ionic structures or simple molecular structures.

A –

B –

C –

D –

E –

/ 5 marks

Symbols, formulae and equations

You can work out the formula of a compound by identifying the charges on an ion and using the method below.

Group 1 elements have a +1 charge

Group 2 elements have a +2 charge

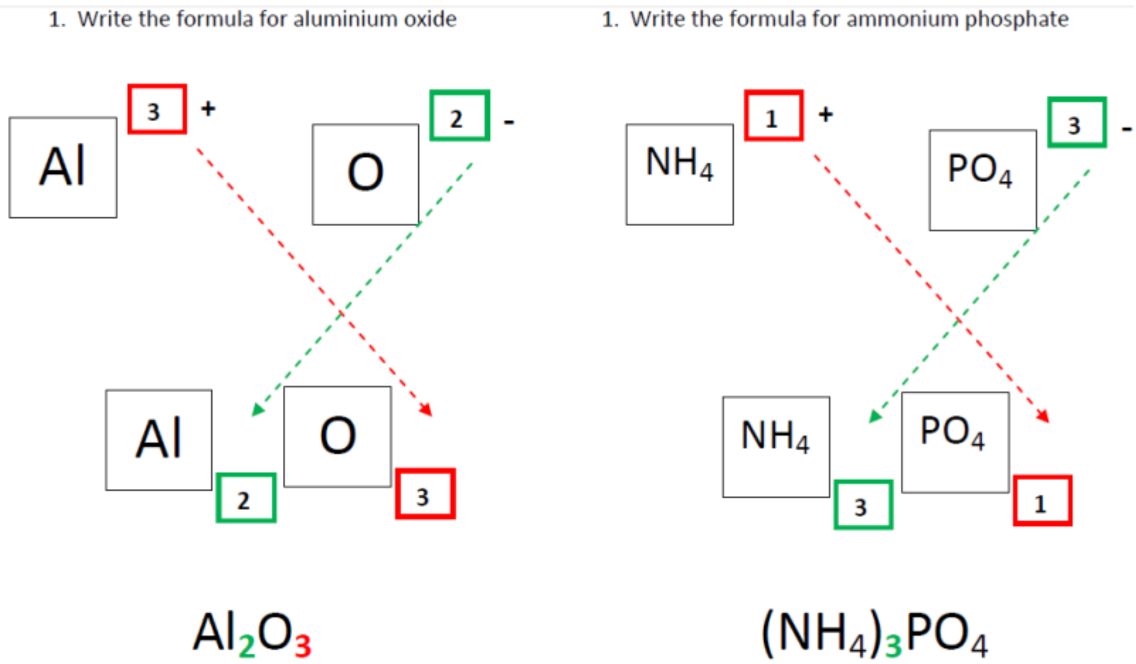
Group 6 elements have a -2 charge

Group 7 elements have a -1 charge

You need to learn the charges on some polyatomic ions, such as sulfate, carbonate and hydroxide ions (see below)

		Carbonate CO_3^{2-}	Hydrogen-carbonate	HCO_3^-
Phosphate	PO_4^{3-}	Sulphate SO_4^{2-}	Nitrate	NO_3^-
		Ammonium NH_4^+	Hydroxide	OH^-

Method of working out the formula:



Task 12 – write the **formulae** for the following compounds using the method above

1. Sodium Chloride
2.Potassium Hydroxide
3.Magnesium Nitrate
4.Copper Iodide
5. Potassium sulphate
6.Aluminium sulphate
7.Ammonium hydroxide
8.lithium oxide
9.Calcium chloride
10.sodium carbonate
11. Ammonium oxide

/ **11 marks**

Balancing equations

Introduction Questions

1. Write the equation for the reaction of sodium and chlorine (diatomic) to form sodium chloride.

2. Write the equation for the reaction of calcium nitride and sodium chloride to produce calcium chloride and sodium nitride.

Information: Subscripts and Coefficients

A subscript is a small number that tells you how many atoms are in a compound. For example, in $CaCl_2$ the two is the subscript and it tells us that there are two chloride ions bonded to one calcium.

A coefficient tells us how many atoms or compounds there are, but in a different way. For example in the expression "3 H_2O" the three is the coefficient. The three tells us that there are three molecules of water present. In the expression "3 H_2O" there are a total of 6 hydrogen atoms and 3 oxygen atoms.

Critical Thinking Questions

3. Verify that in $4Ca_3(PO_4)_2$ there are 32 oxygen atoms present.

4. How many oxygen atoms are in each of the following:

_____ a) Al_2O_3 _____ b) 3 Na_2O _____ c) 4 Na_2SO_4 _____ d) 5 $Mg(NO_3)_2$

Let us consider another example, the equation you wrote in question two above:

$$Ca_3N_2 + NaCl \rightarrow CaCl_2 + Na_3N$$

Notice that none of the atoms are "balanced". There are three calcium atoms on one side and only one on the other. There are two nitrogen atoms on one side and one on the other. How can we fix this? Begin by "balancing" one atom at a time:

1. First, let's balance the calcium atoms by placing a three in front of $CaCl_2$:
$$Ca_3N_2 + NaCl \rightarrow 3\ CaCl_2 + Na_3N$$
2. Next, let's balance the nitrogen atoms, by placing a 2 in front of Na_3N:
$$Ca_3N_2 + NaCl \rightarrow 3\ CaCl_2 + 2\ Na_3N$$
3. Now we will balance the sodium atoms by placing a 6 in front of NaCl.
$$Ca_3N_2 + 6\ NaCl \rightarrow 3\ CaCl_2 + 2\ Na_3N$$
4. Finally, examine the chlorine atoms and notice that they are already balanced.
5. Double check each atom to make sure there are equal numbers of each on both sides of the equation.

When balancing equations you NEVER change subscripts. Only change the coefficients.

Task 12 – Balancing equations 1 (3)

1. $NH_3 + O_2 \rightarrow NO + H_2O$
2. $Na + O_2 \rightarrow Na_2O$
3. $C_4H_8 + O_2 \rightarrow CO_2 + H_2O$

Task 13 – Harder balancing equations 2 (3)

A) _____ $Ca(NO_3)_2$ + _____ Na $\rightarrow$ _____ $NaNO_3$ + _____ Ca

B) _____ $Al_2(CO_3)_3$ + _____ $MgCl_2$ $\rightarrow$ _____ $AlCl_3$ + _____ $MgCO_3$

C) _____ $Ba_3(PO_4)_2$ + _____ Na_2CO_3 $\rightarrow$ _____ Na_3PO_4 + _____ $BaCO_3$

Chemical reactions

Task 14 -

a) *Give 2 differences between a* ***PHYSICAL*** *and* ***CHEMICAL change*** *(2)*

b) *Give 2 examples of a* ***PHYSICAL CHANGE*** *and 2 examples of a* ***CHEMICAL CHANGE*** *(2)*

c) *Decide if the following* ***processes*** *are physical or chemical changes (5)*

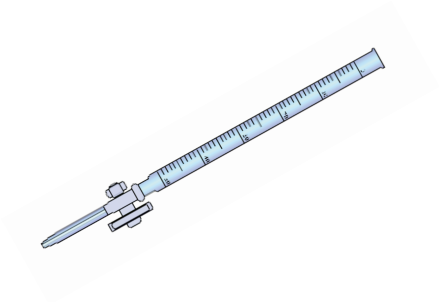
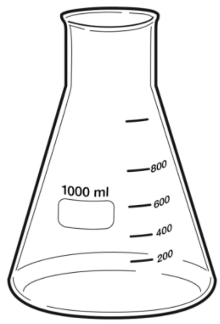
- Fractional distillation of crude oil
- Cracking
- Thermal decomposition of calcium carbonate
- Sodium hydroxide reacting with hydrochloric acid
- Making tea

d) Name the **type of reaction** used to describe the following (6): choose from *reduction, thermal decomposition; displacement, oxidation/combustion; neutralisation; electrical decomposition*

- Rusting -
- Setting methane alight –
- Extraction of aluminium from bauxite –
- Sodium carbonate reacting with sulfuric acid –
- iron nitrate and magnesium metal –
- Heating limestone (calcium carbonate)

INVESTIGATIVE SKILLS

Task 15 – Identify the following pieces of equipment and describe their purpose

Name: Purpose: 	Name: Purpose: 
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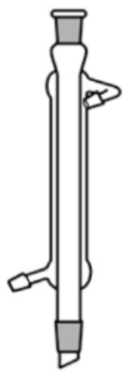
Name: Purpose: 	Name: Purpose: 
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/ 10 marks

Task 16

Write the meaning of the following **keywords** in the context of scientific investigations (12 marks)

a) Independent variable

b) Dependent variable

c) Controlled variables

d) Valid

e) Repeatable results

f) Reproducible results

g) Accurate

h) Precise

i) Percentage error of measurement

j) Systematic error

k) Random error

l) Range of data

Task 17 – Draw a **suitable table** for the following data after reading the information below.

Experiment title: How does the temperature of hydrochloric acid affect the volume of gas produced in 1 minute?

Temperature – 20; 30; 40; 50; 60

Volume of gas produced in 1 minute – 18; 26; 35; 48; 57.

a) Draw your completed **table** below. Make sure your table includes **correct headings with *suitable* units.** /4 marks

b) Draw a suitable **graph** of the data above – ensure **axes are labelled correctly and an appropriate scale** is used / 6 marks

c) Write a CONCLUSION using the data – ***describe*** the graph and try to ***explain*** it using scientific knowledge and understanding. [3]

MATHS SKILLS

Task 18 - Significant figures

Use the Internet to learn the rules for working out the number of significant figures (that is if you do not already know them). **Then complete the task below**.

1. How many significant figures are in each of the following numbers? (12 marks)

_____ a) 0.000015045 _____ b) 4,600,000 _____ c) 2406

_____ d) 0.000005 _____ e) 0.0300001 _____ f) 12,000

2. How many significant figures are there in each of the following numbers?

_____ a) 0.000201000 _____ b) 23,001,000 _____ c) 0.0300

_____ d) 24,000,410 _____ e) 2400.100 _____ f) 0.000021

Standard form

Standard form is used to express very large or very small numbers so that they are more easily understood and managed.

Example: 1200 as 1.2×10^3 or 0.00045 as 4.5×10^{-4}

Task 19 – Write the following numbers in standard form (4 marks)

a) 4 600 000

b) 0.000784

c) 25605

d) 0.0451

Units

Volume – measured in cm^3, dm^3 or m^3

$1\ m^3 = 1000\ dm^3 = 1\ 000\ 000\ cm^3$

Temperature – measured in kelvin (K) and ^oC

$273\ K = 0\ ^oC$

Mass – measured in milligrams (mg), grams (g), kilograms (kg) and in tonnes

1 tonne = 1 000 kg

1 kg = 1 000 g

1g = 1 000 mg

Pressure – measured in pascals (Pa) and kilopascals (kPa)

1 kPa = 1000 Pa

Task 20 - Convert the following (10)

a) 25.0 cm^3 into dm^3 –

b) 0.05 m^3 into cm^3 –

c) 29 ^oC into K –

d) 258 K into ^oC –

e) 320 mg into kg –

f) 450 g into kg –

g) 250 g into tonnes –

h) 1200 Pa into kPa –

i) 45 kPa into Pa –

j) 50 dm^3 into m^3 –

Total tasks 11-20 = 98 marks

Grand total = 154 marks

WELL DONE – all complete!

Transition guide

This resource is to help students make the transition from GCSE to AS or A-level Chemistry.

Contents

You're studying AS or A-level Chemistry, congratulations!

Studying chemistry after your GCSEs really develops your practical and mathematical skills. If you enjoy experimenting in the lab, you'll love it.

At first, you may find the jump in demand from GCSE a little daunting, but if you follow the tips and advice in this guide, you'll soon adapt.

We recommend you keep this somewhere safe, as you may like to refer to the information inside throughout your studies.

Why study A-level Chemistry?

Chemistry students get to investigate a huge range of ideas: the big question you'll ask yourself is 'what is the world made of?' If you choose it as career, you have the potential to help solve all sorts of problems. You could work on a cure for cancer, or you might develop a new food: the possibilities are endless.

Even if you don't decide to work in chemistry, studying it still develops useful and transferable skills for other careers. You'll develop research, problem solving and analytical skills, alongside teamwork and communication. Universities and businesses regard all of these very highly.

Possible degree options

According to bestcourse4me.com, the top five degree courses taken by students who have A-level Chemistry are:

- Chemistry
- Biology
- Pre-clinical medicine
- Mathematics
- Pharmacology.

For more details, go to the bestcourse4me.com website, or UCAS.

Which career appeals to you?

Studying Chemistry at A-level or degree opens up plenty of career opportunities, such as:

- analytical chemist
- chemical engineer
- clinical biochemist
- pharmacologist
- doctor
- research scientist (physical sciences)
- toxicologist
- environmental consultant
- higher education lecturer or secondary school teacher
- patent attorney
- science writer.

Specification at a glance

AS and A-level

Physical chemistry

- Atomic structure
- Amount of substance
- Bonding
- Energetics
- Kinetics
- Chemical equilibria, Le Chatelier's principle and K_c
- Oxidation, reduction and redox equations

Inorganic chemistry

- Periodicity
- Group 2, the alkaline earth metals
- Group 7 (17), the halogens

Organic chemistry

- Introduction to organic chemistry
- Alkanes
- Halogenoalkanes
- Alkenes
- Alcohols
- Organic analysis

A-level only topics

Physical chemistry

- Thermodynamics
- Rate equations
- Equilibrium constant K_p for homogeneous systems
- Electrode potentials and electrochemical cells
- Acids and bases

Inorganic chemistry

- Properties of Period 3 elements and oxides
- Transition metals
- Reactions of ions in aqueous solution

Organic chemistry

- Optical isomerism
- Aldehydes and ketones
- Carboxylic acids and derivatives
- Aromatic chemistry
- Amines
- Polymers
- Amino acids, proteins and DNA
- Organic synthesis
- NMR spectroscopy
- Chromatography

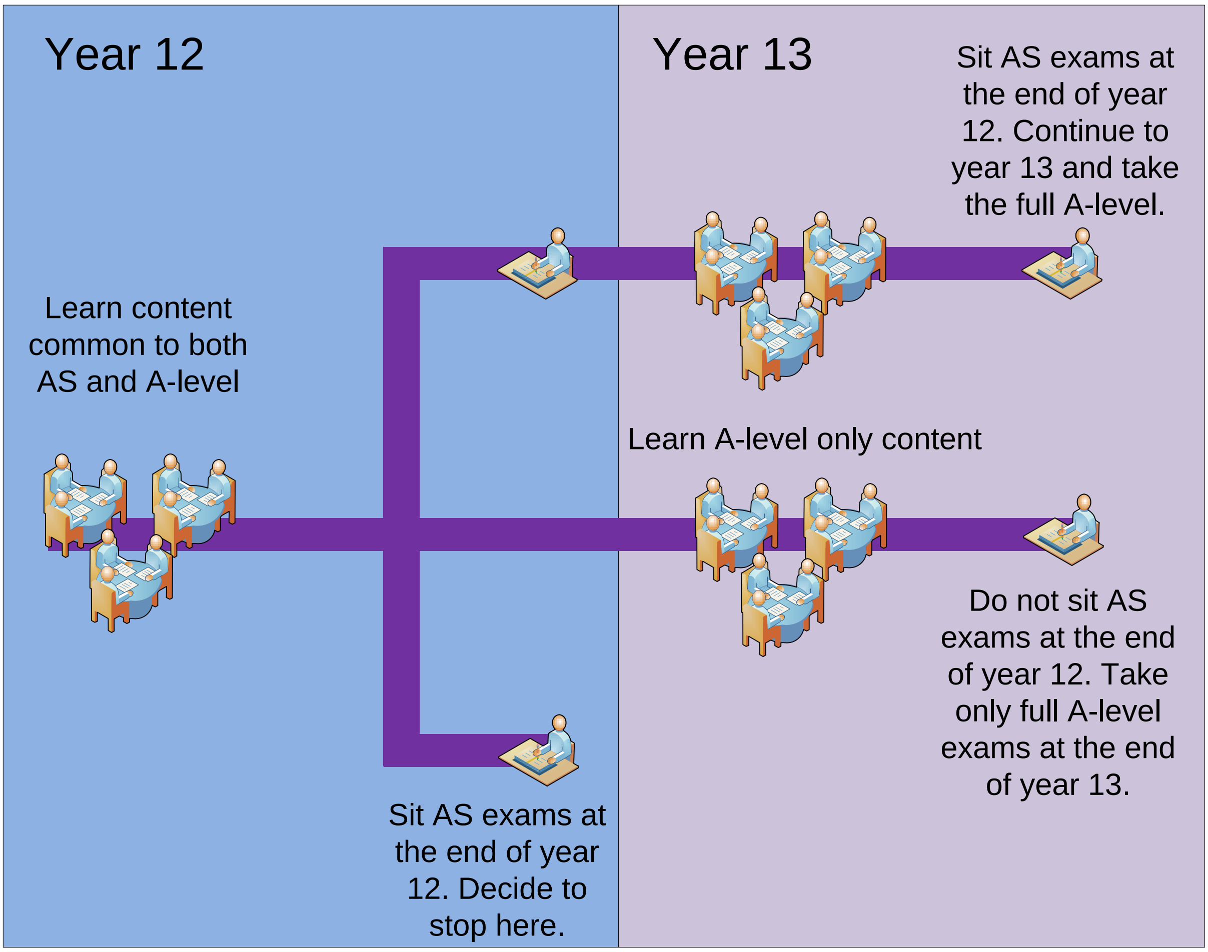
Should you study AS or A-level?

AS and A-level are separate qualifications.

An AS lasts one year. Your exam results don't count towards an A-level, but they're still valuable and AS UCAS points are accepted by higher education institutions.

Despite being separate to an A-level, AS course content is the same as the first year of A-level. If you want to switch from an AS to an A-level, you can. Your teacher will help you decide whether it's the right move for you.

All exams for the AS take place at the end of the one-year course. Exams for the A-level take place at the end of the two-year course.



The assessment for the AS consists of two exams

Paper 1	+	Paper 2
What's assessed • Relevant Physical chemistry topics (sections 3.1.1 to 3.1.4, 3.1.6 and 3.1.7) • Inorganic chemistry (section 3.2.1 to 3.2.3) • Relevant practical skills		What's assessed • Relevant Physical chemistry topics (sections 3.1.2 to 3.1.6) • Organic chemistry (section 3.3.1 to 3.3.6) • Relevant practical skills
How it's assessed • Written exam: 1 hour 30 minutes • 80 marks • 50% of the AS		How it's assessed • Written exam: 1 hour 30 minutes • 80 marks • 50% of the AS
Questions • 65 marks of short and long answer questions • 15 marks of multiple choice questions		Questions • 65 marks of short and long answer questions • 15 marks of multiple choice questions

The assessment for the A-level consists of three exams

Paper 1	Paper 2	Paper 3
What's assessed • Relevant Physical chemistry topics (sections 3.1.1 to 3.1.4, 3.1.6 to 3.1.8 and 3.1.10 to 3.1.12) • Inorganic chemistry (section 3.2) • Relevant practical skills	What's assessed • Relevant Physical chemistry topics (sections • 3.1.2 to 3.1.6 and 3.1.9) • Organic chemistry (section 3.3) • Relevant practical skills	What's assessed • Any content • Any practical skills
How it's assessed • Written exam: 2 hours • 105 marks • 35% of A-level	How it's assessed • Written exam: 2 hours • 105 marks • 35% of A-level	How it's assessed • Written exam: 2 hours • 90 marks • 30% of A-level
Questions • 105 marks of short and long answer questions	Questions • 105 marks of short and long answer questions	Questions • 40 marks of questions on practical techniques and data analysis • 20 marks of questions testing across the specification • 30 marks of multiple choice questions

Places to go for help

1. Our website is a great place to start.

Our AS and A-level Chemistry webpages are aimed at teachers, but you may find them useful too. Information includes:

- The specification – this explains exactly what you need to learn for your exams.
- Practice exam papers.
- Lists of command words and subject specific vocabulary – so you understand the words to use in exams.
- Practical handbooks explain the practical work you need to know.
- Past papers from the old specification. Some questions won't be relevant to the new AS and A-level so please check with your teacher.
- Maths skills support.
- Web resources page with many links to other resources to support study.

2. The Royal Society of Chemistry (RSC)

The RSC do everything from naming new elements and lobbying MPs, to improving funding for research sciences in the UK.

You'll find lots of handy resources on their website.

3. The student room

Join the A-level Chemistry forums and share thoughts and ideas with other students if you're stuck with your homework. Just be very careful not to share any details about your assessments, there are serious consequences if you're caught cheating. Visit thestudentroom.co.uk

4. Textbooks

Our approved textbooks are published by Collins, Hodder and Oxford University Press. Textbooks from other publishers will also be suitable, but you'll need to double check that the content and formula symbols they use match our specification.

5. Revision guides

These are great if you want a quick overview of the course when you're revising for your exams. Remember to use other tools as well, as these aren't detailed enough on their own.

6. YouTube

YouTube has thousands of Chemistry videos. Just be careful to look at who produced the video and why, because some videos distort the facts. Check the author, date and comments – these help indicate whether the clip is reliable. If in doubt, ask your teacher.

7. Magazines

Focus, New Scientist or Philip Allan updates can help you put the chemistry you're learning in context.

Useful information and activities

There are a number of activities throughout this resource. The answers to some of the activities are available on our secure website, e-AQA. Your teacher will be able to provide you with these answers.

Greek letters

Greek letters are used often in science. They can be used as symbols for numbers (such as π = 3.14...), as prefixes for units to make them smaller (eg µm = 0.000 000 001 m) or as symbols for particular quantities (such as λ which is used for wavelength).

The Greek alphabet is shown below.

Α	α	alpha
Β	β	beta
Γ	γ	gamma
Δ	δ	delta
Ε	ε	epsilon
Ζ	ζ	zeta
Η	η	eta
Θ	θ	theta
Ι	ι	iota
Κ	κ	kappa
Λ	λ	lambda
Μ	μ	mu

Ν	ν	nu
Ξ	ξ	ksi
Ο	ο	omicron
Π	π	pi
Ρ	ρ	rho
Σ	ς or σ	sigma
Τ	τ	tau
Υ	υ	upsilon
Φ	φ	phi
Χ	χ	chi
Ψ	ψ	psi
Ω	ω	omega

Activity 1

A lot of English words are derived from Greek ones, but it's difficult to see as the alphabet is so different.

Many of the Greek letters are pronounced like the start of their name. For example, omega is pronounced "o", sigma is pronounced "s" and lambda is pronounced "l".

See if you can work out what the following Greek words mean by comparing the phonetic spelling with similar English words.

Πυθαγόρας
Ωκεανος
μόνος
Τηλε
Τρωγλοδύτης

Name of a mathematician
Atlantic, Pacific or Arctic...
Single
Far or distant
Cave dweller

SI units

Every measurement must have a size (eg 2.7) and a unit (eg metres or °C). Sometimes there are different units available for the same type of measurement, for example ounces, pounds, kilograms and tonnes are all used as units for mass.

To reduce confusion and to help with conversion between different units, there is a standard system of units called the SI units which are used for most scientific purposes.

These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China.

The seven SI base units are:

Physical quantity	Usual quantity symbol	Unit	Abbreviation
mass	m	kilogram	kg
length	l or x	metre	m
time	t	second	s
electric current	I	ampere	A
temperature	T	kelvin	K
amount of substance	N	mole	mol
luminous intensity	(not used at A-level)	candela	cd

All other units can be derived from the SI base units.

For example, area is measured in square metres (written as m^2) and speed is measured in metres per second (written as ms^{-1}).

It is not always appropriate to use a full unit. For example, measuring the width of a hair or the distance from Manchester to London in metres would cause the numbers to be difficult to work with.

Prefixes are used to multiply each of the units. You will be familiar with centi (meaning 1/100), kilo (1000) and milli (1/1000) from centimetres, kilometres and millimetres.

There is a wide range of prefixes. The majority of quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, a distance of 33 000 m would be quoted as 33 km.

The most common prefixes you will encounter are:

Prefix	Symbol	Multiplication factor		
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	μ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

Activity 2

Which SI unit and prefix would you use for the following quantities?

1. The mass of water in a test tube.

2. The time taken for a solution to change colour.

3. The radius of a gold atom.

4. The volume of water in a burette.

5. The amount of substance in a beaker of sugar.

6. The temperature of the blue flame from a Bunsen burner.

Sometimes, there are units that are used that are not combinations of SI units and prefixes.

These are often multiples of units that are helpful to use. For example, one litre is 0.001 m^3.

Activity 3

Rewrite the following in SI units.

1. 5 minutes

2. 2 days

3. 5.5 tonnes

Activity 4

Rewrite the following quantities.

1. 0.00122 metres in millimetres

2. 104 micrograms in grams

3. 1.1202 kilometres in metres

4. 70 decilitres in millilitres

5. 70 decilitres in litres

6. 10 cm^3 in litres

Important vocabulary for practical work

There are many words used in practical work. You will have come across most of these words in your GCSE studies. It is important you are using the right definition for each word.

Activity 5

Join the boxes to link the word to its definition.

Accurate	A statement suggesting what may happen in the future.
Data	An experiment that gives the same results when a different person carries it out, or a different technique or set of equipment is used.
Precise	A measurement that is close to the true value.
Prediction	An experiment that gives the same results when the same experimenter uses the same method and equipment.
Range	Physical, chemical or biological quantities or characteristics.
Repeatable	A variable that is kept constant during an experiment.
Reproducible	A variable that is measured as the outcome of an experiment.
Resolution	This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.
Uncertainty	The interval within the true value can be expected to lie.
Variable	The spread of data, showing the maximum and minimum values of the data.
Control variable	Measurements where repeated measurements show very little spread.
Dependent variable	Information, in any form, that has been collected.

Precise language

It is essential at AS and A-level to use precise language when you write reports and when you answer examination questions. You must always demonstrate that you understand a topic by using the correct and appropriate terms.

For example, you should take care when discussing bonding to refer to the correct particles and interactions between them.

Also, when discussing the interaction between particles in an ionic solid, you would demonstrate a lack of understanding if you referred to the particles as atoms or molecules instead of ions or the interaction between these ions as intermolecular forces rather than electrostatic forces. In this case, use of the incorrect terms would result in the loss of all the marks available for that part of a question.

Take care also to use the word 'chloride' and not 'chlorine' when referring to the ions in a compound such as sodium chloride. The word 'chlorine' should only be used for atoms or molecules of the element.

The periodic table

The periodic table of elements is shown on the back page of this booklet. The A-level course will build on what you've learned in your GCSE studies.

Activity 6

On the periodic table on the following page:

- Draw a line showing the metals and non-metals.
- Colour the transition metals blue.
- Colour the halogens yellow.
- Colour the alkali metals red.
- Colour the noble gases green.
- Draw a blue arrow showing the direction of periods.
- Draw a red arrow showing the direction of groups.
- Draw a blue ring around the symbols for all gases.
- Draw a red ring around the symbols for all liquids.

Key

relative atomic mass
symbol
name
atomic (proton) number

1 (1)	2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (18)
							1.0 **H** hydrogen 1										4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12											27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	96.0 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La** * lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac** † actinium 89	[267] **Rf** rutherfordium 104	[268] **Db** dubnium 105	[271] **Sg** seaborgium 106	[272] **Bh** bohrium 107	[270] **Hs** hassium 108	[276] **Mt** meitnerium 109	[281] **Ds** darmstadtium 110	[280] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

* 58 – 71 Lanthanides	140.1 **Ce** cerium 58	140.9 **Pr** praseodymium 59	144.2 **Nd** neodymium 60	[145] **Pm** promethium 61	150.4 **Sm** samarium 62	152.0 **Eu** europium 63	157.3 **Gd** gadolinium 64	158.9 **Tb** terbium 65	162.5 **Dy** dysprosium 66	164.9 **Ho** holmium 67	167.3 **Er** erbium 68	168.9 **Tm** thulium 69	173.1 **Yb** ytterbium 70	175.0 **Lu** lutetium 71
† 90 – 103 Actinides	232.0 **Th** thorium 90	231.0 **Pa** protactinium 91	238.0 **U** uranium 92	[237] **Np** neptunium 93	[244] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[247] **Bk** berkelium 97	[251] **Cf** californium 98	[252] **Es** einsteinium 99	[257] **Fm** fermium 100	[258] **Md** mendelevium 101	[259] **No** nobelium 102	[262] **Lr** lawrencium 103

Activity 7

Use the periodic table to find the following:

1. The atomic number of: osmium, sodium, lead, chlorine.

2. The relative atomic mass of: helium, barium, europium, oxygen.

3. The number of protons in: mercury, iodine, calcium.

4. The symbol for: gold, lead, copper, iron.

5. The name of: Sr, Na, Ag, Hg.

6. THInK can be written using a combination of the symbols for Thorium, Indium and Potassium (ThInK). Which combinations of element symbols could be used to make the following words?

   AMERICA, FUN, PIRATE, LIFESPAN, FRACTION, EROSION, DYNAMO

Activity 8: research activity

Research either:

The history of the periodic table

OR

The history of models of atomic structure.

Present your findings as a timeline. You should include the work of at least four people. For each, explain what evidence or experiments they used and how this changed the understanding of chemistry.

Relative atomic mass (A_r)

If there are several isotopes of an element, the relative atomic mass will take into account the proportion of atoms in a sample of each isotope.

For example, chlorine gas is made up of 75% of chlorine-35 ${}^{35}_{17}Cl$ and 25% of chlorine-37 ${}^{37}_{17}Cl$.

The relative atomic mass of chlorine is therefore the mean atomic mass of the atoms in a sample, and is calculated by:

$$A_r = \left(\frac{75.0}{100} \times 35\right) + \left(\frac{25.0}{100} \times 37\right) = 26.25 + 9.25 = 35.5$$

Activity 9

1. What is the relative atomic mass of Bromine, if the two isotopes, ^{79}Br and ^{81}Br, exist in equal amounts?

2. Neon has three isotopes. ^{20}Ne accounts for 90.9%, ^{21}Ne accounts for 0.3% and the last 8.8% of a sample is ^{22}Ne. What is the relative atomic mass of neon?

3. Magnesium has the following isotope abundances: ^{24}Mg: 79.0%; ^{25}Mg: 10.0% and ^{26}Mg: 11.0%. What is the relative atomic mass of magnesium?

Harder:

4. Boron has two isotopes, ^{10}B and ^{11}B. The relative atomic mass of boron is 10.8. What are the percentage abundances of the two isotopes?

5. Copper's isotopes are ^{63}Cu and ^{65}Cu. If the relative atomic mass of copper is 63.5, what are the relative abundances of these isotopes?

Relative formula mass (M_r)

Carbon dioxide, CO_2 has 1 carbon atom (A_r = 12.0) and two oxygen atoms (A_r = 16.0). The relative formula mass is therefore

$M_r = (12.0 \times 1) + (16.0 \times 2) = 44.0$

Magnesium hydroxide $Mg(OH)_2$ has one magnesium ion (A_r = 24.3) and two hydroxide ions, each with one oxygen (A_r = 16.0) and one hydrogen (A_r = 1.0).

The relative formula mass is therefore:

$(24.3 \times 1) + (2 \times (16.0 + 1.0)) = 58.3$

Activity 10

Calculate the relative formula mass of the following compounds:

1. Magnesium oxide MgO

2. Sodium hydroxide $NaOH$

3. Copper sulfate $CuSO_4$

4. Ammonium chloride NH_4Cl

5. Ammonium sulfate $(NH_4)_2SO_4$

Common ions

Positive ions (cations)		Negative ions (anions)	
Name	Symbol	Name	Symbol
Hydrogen	H^+	Hydroxide	OH^-
Sodium	Na^+	Chloride	Cl^-
Lithium	Li^+	Bromide	Br^-
Silver	Ag^+	Oxide	O^{2-}
Magnesium	Mg^{2+}	Hydrogencarbonate	HCO_3^-
Calcium	Ca^{2+}	Nitrate	NO_3^-
Zinc	Zn^{2+}	Sulfate	SO_4^{2-}
Aluminium	Al^{3+}	Carbonate	CO_3^{2-}
Ammonium	NH_4^+	Phosphate	PO_4^{3-}

Some elements have more than one charge. For example, iron can form ions with a charge of +2 or +3. Compounds containing these are named Iron(II) and Iron(III) respectively.

Other common elements with more than one charge include:

Chromium(II) and chromium(III)

Copper(I) and copper(II)

Lead(II) and lead(IV)

Activity 11

On the periodic table on the following page, colour elements that form one atom ions (eg Na^+ or O^{2-}) according to the following key:

Charge	Colour
+1	red
+2	yellow
+3	green
-1	blue
-2	brown

Key

relative atomic mass
symbol
name
atomic (proton) number

1 (1)	2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (18)
							1.0 **H** hydrogen 1										4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
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Ionic compounds must have an overall neutral charge. The ratio of cations to anions must mean that there is as many positives as negatives.

For example:

$NaCl$	
Na^{+}	Cl^{-}
+1	-1

MgO	
Mg^{2+}	O^{2-}
+2	−2

$MgCl_2$	
Mg^{2+}	Cl^{-} Cl^{-}
+2	−2

Activity 12

Work out what the formulas for the following ionic compounds should be:

1. Magnesium bromide
2. Barium oxide
3. Zinc chloride
4. Ammonium chloride
5. Ammonium carbonate
6. Aluminium bromide
7. Iron(II) sulfate
8. Iron(III) sulfate

Diatomic molecules

A number of atoms exist in pairs as diatomic (two atom) molecules.

The common ones that you should remember are:

Hydrogen H_2, Oxygen O_2, Fluorine F_2, Chlorine Cl_2, Bromine Br_2, Nitrogen N_2 and Iodine I_2

Common compounds

There are several common compounds from your GCSE studies that have names that do not help to work out their formulas. For example, water is H_2O.

Activity 13: Research activity

What are the formulas of the following compounds?

1. Methane
2. Ammonia
3. Hydrochloric acid
4. Sulfuric acid
5. Sodium hydroxide
6. Potassium manganate(VII)
7. Hydrogen peroxide

Balancing equations

Chemical reactions never create or destroy atoms. They are only rearranged or joined in different ways.

When hydrogen and oxygen react to make water:

hydrogen + oxygen → water

$H_2 + O_2 \rightarrow H_2O$

There are two hydrogen atoms on both sides of this equation, but two oxygen atoms on the left and only one on the right. This is not balanced.

This can be balanced by writing:

$2H_2 + O_2 \rightarrow 2H_2O$

The reactants and products in this reaction are known and you can't change them. The compounds can't be changed and neither can the subscripts because that would change the compounds. So, to balance the equation, a number must be added in front of the compound or element in the equation. This is a coefficient. Coefficients show how many atoms or molecules there are.

Activity 14

Write balanced symbol equations for the following reactions. You'll need to use the information on the previous pages to work out the formulas of the compounds. Remember some of the elements may be diatomic molecules.

1. Aluminium + oxygen → aluminium oxide

2. Methane + oxygen → carbon dioxide + water

3. Aluminium + bromine → aluminium bromide

4. Calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

5. Aluminium sulfate + calcium hydroxide → aluminium hydroxide + calcium sulfate

Harder:

6. Silver nitrate + potassium phosphate → silver phosphate + potassium nitrate

More challenging:

7. Potassium manganate(VII) + hydrochloric acid →

   potassium chloride + manganese(II) chloride + water + chlorine

Moles

A mole is the amount of a substance that contains 6.02×10^{23} particles.

The mass of 1 mole of any substance is the relative formula mass (M_r) in grams.

Examples:
One mole of carbon contains 6.02×10^{23} particles and has a mass of 12.0 g
Two moles of copper contains 12.04×10^{23} particles, and has a mass of 127 g
1 mole of water contains 6.02×10^{23} particles and has a mass of 18 g

The amount in moles of a substance can be found by using the formula:

$$\text{Amount in moles of a substance} = \frac{\text{mass of substance}}{\text{relative formula mass}}$$

Activity 15

Fill in the table.

Substance	Mass of substance	Amount/moles	Number of particles
Helium			18.12×10^{23}
Chlorine	14.2		
Methane		4	
Sulfuric acid	4.905		

Empirical formula

If you measure the mass of each reactant used in a reaction, you can work out the ratio of atoms of each reactant in the product. This is known as the empirical formula. This may give you the actual chemical formula, as the actual formula may be a multiple of this. For example, hydrogen peroxide is H_2O_2 but would have the empirical formula HO.

Use the following to find an empirical formula:

1. Write down reacting masses
2. Find the amount in moles of each element
3. Find the ratio of moles of each element

Example:

A compound contains 2.232 g of ion, 1.284 g of sulfur and 1.920 g of oxygen. What is the empirical formula?

Element	Iron	Sulfur	Oxygen
mass/relative atomic mass	2.232/55.8	1.284/32.1	1.920/16.0
Amount in moles	0.040	0.040	0.120
Divide by smallest value	0.040/0.040	0.040/0.040	0.120/0.040
Ratio	1	1	3

So the empirical formula is $FeSO_3$.

If the question gives the percentage of each element instead of the mass, replace mass with the percentage of an element present and follow the same process.

Activity 16

Work out the following empirical formulas:

1. The smell of a pineapple is caused by ethyl butanoate. A sample is known to contain only 0.180 g of carbon, 0.030 g of hydrogen and 0.080 g of oxygen. What is the empirical formula of ethyl butanoate?

2. Find the empirical formula of a compound containing 0.0578 g of titanium, 0.288 g of carbon, 0.012 g of hydrogen and 0.384 g of oxygen.

3. 300 g of a substance are analysed and found to contain only carbon, hydrogen and oxygen. The sample contains 145.9 g of carbon and 24.32 g of hydrogen. What is the empirical formula of the compound?

4. Another 300 g sample is known to contain only carbon, hydrogen and oxygen. The percentage of carbon is found to be exactly the same as the percentage of oxygen. The percentage of hydrogen is known to be 5.99%. What is the empirical formula of the compound?

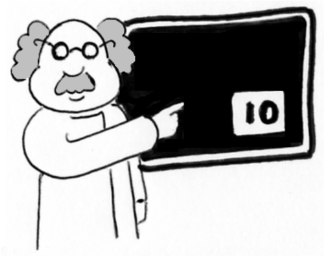
The Periodic Table of the Elements

Key

relative atomic mass
symbol
name
atomic (proton) number

1	2											3	4	5	6	7	0
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	*(18)*
							1.0 **H** hydrogen 1										4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12											27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	96.0 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La** * lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac** † actinium 89	[267] **Rf** rutherfordium 104	[268] **Db** dubnium 105	[271] **Sg** seaborgium 106	[272] **Bh** bohrium 107	[270] **Hs** hassium 108	[276] **Mt** meitnerium 109	[281] **Ds** darmstadtium 110	[280] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

* 58 – 71 Lanthanides	140.1 **Ce** cerium 58	140.9 **Pr** praseodymium 59	144.2 **Nd** neodymium 60	[145] **Pm** promethium 61	150.4 **Sm** samarium 62	152.0 **Eu** europium 63	157.3 **Gd** gadolinium 64	158.9 **Tb** terbium 65	162.5 **Dy** dysprosium 66	164.9 **Ho** holmium 67	167.3 **Er** erbium 68	168.9 **Tm** thulium 69	173.1 **Yb** ytterbium 70	175.0 **Lu** lutetium 71
† 90 – 103 Actinides	232.0 **Th** thorium 90	231.0 **Pa** protactinium 91	238.0 **U** uranium 92	[237] **Np** neptunium 93	[244] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[247] **Bk** berkelium 97	[251] **Cf** californium 98	[252] **Es** einsteinium 99	[257] **Fm** fermium 100	[258] **Md** mendelevium 101	[259] **No** nobelium 102	[262] **Lr** lawrencium 103



STARTER FOR 10...

0.1.1. Balancing equations

Balance the equations below.

1. $.....C + ...O_2 \longrightarrow .....CO$

2. $.....Ba + ...H_2O \longrightarrow .....Ba(OH)_2 + ...H_2$

3. $.....C_2H_6 + ...O_2 \longrightarrow .....CO_2 + ...H_2O$

4. $.....HCl + ...Mg(OH)_2 \longrightarrow .....MgCl_2 + H_2O$

5. $.....N_2 + ...O_2 \longrightarrow .....NO$

6. $.....Fe_2O_3 + ...C \longrightarrow .....Fe + ...CO_2$

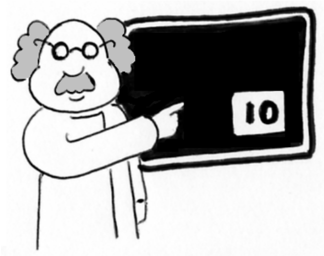
7. $.....CH_3CH_2OH + ...[O] \longrightarrow .....CH_3COOH + ...H_2O$

8. $.....HNO_3 + ...CuO \longrightarrow .....Cu(NO_3)_2 + H_2O$

9. $.....Al^{3+} + ...e^- \longrightarrow .....Al$

10. $.....[Fe(H_2O)_6]^{3+} + ...CO_3^{2-} \longrightarrow .....Fe(OH)_3(H_2O)_3 + ...CO_2 + ...H_2O$

(10 marks)



STARTER FOR 10...

0.1.2. Constructing ionic formulae

1. For each of the following ionic salts, determine the cation and anion present and use these to construct the formula of the salt. (5 marks)

a. Magnesium oxide

b. Sodium sulfate

c. Calcium hydroxide

d. Aluminium oxide

e. Copper(I) oxide

2. When an acid is added to water it dissociates to form H^+ ions (which make it acidic) and an anion. These acidic hydrogen atoms can be used to determine the charge on the anion. Deduce the charge on the anions in the following acids. The acidic H atoms, H^+, have been underlined for you. (5 marks)

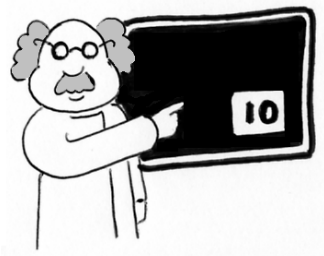
a. $\underline{H}_2SO_3$

b. $\underline{H}NO_3$

c. $\underline{H}_3PO_4$

d. $HCOO\underline{H}$

e. $\underline{H}_2CO_3$



STARTER FOR 10...

0.1.3. Writing equations from text

The following questions contain a written description of a reaction. In some cases the products may be missing as you will be expected to predict the product using your prior knowledge.

For more advanced equations you may be given some of the formulae you need.

For each one, write a balanced symbol equation for the process. (10 marks)

1. The reaction between silicon and nitrogen to form silicon nitride Si_3N_4.

2. The neutralisation of sulfuric acid with sodium hydroxide.

3. The preparation of boron trichloride from its elements.

4. The reaction of nitrogen and oxygen to form nitrogen monoxide.

5. The combustion of ethanol (C_2H_5OH) to form carbon dioxide and water only.

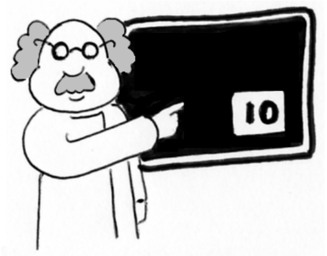
6. The formation of silicon tetrachloride ($SiCl_4$) from SiO_2 using chlorine gas and carbon.

7. The extraction of iron from iron(III) oxide (Fe_2O_3) using carbon monoxide.

8. The complete combustion of methane.

9. The formation of one molecule of ClF_3 from chlorine and fluorine molecules.

10. The reaction of nitrogen dioxide with water and oxygen to form nitric acid.



STARTER FOR 10...

0.2.1. Rearranging equations

1. The amount of substance in moles (n) in a solution can be calculated when the concentration given in mol/dm^3 (c) and volume (v) in cm^3 are known by using the equation:

$$n = \frac{cv}{1000}$$

a. Rearrange this equation making c the subject of the equation. (1 mark)

b. Rearrange this equation making v the subject of the equation. (1 mark)

2. The density of a substance can be calculated from its mass (m) and volume (v) using the equation:

$$d = \frac{m}{v}$$

a. Rearrange this equation so that the mass of a substance can be calculated given its density and volume. (1 mark)

Chemists most commonly work with masses expressed in grams and volumes in cm^3. However, the SI unit for density is kg/m^3.

b. Write an expression for the calculation of density in the SI unit of kg/m^3 when the mass (m) of the substance is given in g and the volume (v) of the substance is given in cm^3. (2 marks)

3. The de Broglie relationship relates the wavelength of a moving particle (λ) with its momentum (p) through Planck's constant (h):

$$\lambda = \frac{h}{p}$$

a. Rearrange this equation to make momentum (p) the subject of the formula. (1 mark)

Momentum can be calculated from mass and velocity using the following equation.

$$p = mv$$

b. Using this equation and the de Broglie relationship, deduce the equation for the velocity of the particle. (2 marks)

4. The kinetic energy (KE) of a particle in a time of flight mass spectrometer can be calculated using the following equation.

$$KE = \frac{1}{2}mv^2$$

Rearrange this equation to make v the subject of the equation. (2 marks)

STARTER FOR 10...

0.2.2. BODMAS (order of operations)

The order of operations for a calculation is very important. If operations are carried out in the wrong order then this could lead to the wrong answer. Most modern calculators will anticipate BODMAS issues when operations are entered but human beings can override the calculator's instincts.

1. Do the following calculations in your head.

(a) $3 + 5 \times 5 =$

(b) $6 \times 6 + 4 =$

(c) $20 – 6 \times 2 =$

(d) $48 – 12 \div 4 =$

(e) $4 + 4 \div 2 =$

(f) $100 – (20 \times 3) =$

(6 marks)

2. The molecular formula of glucose is $C_6H_{12}O_6$. Three students entered the following into their calculators to calculate the relative formula mass of glucose. Repeat their calculations as shown.

(a)

12	×	6	+	1	×	12	+	16	×	6	=

(b)

12	×	6	=	+	1	=	×	12	=	+	16
=	×	6	=								

(c)

(	12	×	6	)	+	(	12	×	1	)	+
(	16	×	6	)	=						

(d) Write a sentence summing up why the answers differ.

(4 marks)

STARTER FOR 10...

0.2.3. Quantity calculus (unit determination)

1. Determine the units of density given that

$$density = \frac{mass(g)}{volume\ (cm^3)}$$

(1 mark)

2. Determine the units of concentration given that

$$concentration = \frac{number\ of\ moles\ (mol)}{volume\ (dm^3)}$$

(1 mark)

3. Pharmacists often calculate the concentration of substances for dosages. In this case the volumes are smaller, measured in cm^3, and the amount is given as a mass in grams. Determine the units of concentration when

$$concentration = \frac{mass\ (g)}{volume\ (cm^3)}$$

(1 mark)

4. Rate of reaction is defined as the *'change in concentration per unit time'*. Determine the units for rate when concentration is measured in mol dm^{-3} and time in seconds.

(1 mark)

5. Pressure is commonly quoted in pascals (Pa) and can be calculated using the formula below. The SI unit of force is newtons (N) and area is m^2.

$$pressure = \frac{force}{area}$$

Use this formula to determine the SI unit of pressure that is equivalent to the Pascal.

(1 mark)

6. Determine the units for each of the following constants (K) by substituting the units for each part of the formula into the expression and cancelling when appropriate. For this exercise you will need the following units [ ] = mol dm^{-3}, rate = mol dm^{-3} s^{-1}, p = kPa.

a. $K_c = \frac{[A][B]^2}{[C]}$

b. $K = \frac{rate}{[A][B]}$

c. $K_p \frac{(pA)^{0.5}}{(pB)}$

d. $K_w = [H^+][OH^-]$

e. $K_a = \frac{[H^+]\,[X^-]}{[HX]}$

STARTER FOR 10...

0.2.4. Expressing large and small numbers

Standard form and scientific form

Large and small numbers are often expressed using powers of ten to show their magnitude. This saves us from writing lots of zeros, expresses the numbers more concisely and helps us to compare them.

In standard form a number is expressed as;

$$\boldsymbol{a \times 10^{n}}$$

where ***a*** is a number between 1 and 10 and ***n*** is an integer.

Eg, 160 000 would be expressed as 1.6×10^{5}

Sometimes scientists want to express numbers using the same power of ten. This is especially useful when putting results onto a graph axis. This isn't true standard form as the number could be smaller than 1 or larger than 10. This is more correctly called **scientific form**.

Eg, 0.9×10^{-2}, 2.6×10^{-2}, 25.1×10^{-2} and 101.6×10^{-2} are all in the same scientific form.

1. Express the following numbers using standard form.

a. 1 060 000
b. 0.001 06
c. 222.2

(3 marks)

2. The following numbers were obtained in rate experiments and the students would like to express them all on the same graph axes. Adjust the numbers to a suitable scientific form.

0.1000	0.0943	0.03984	0.00163

(3 marks)

3. Calculate the following without using a calculator. Express all values in standard form.

a. $\frac{10^{9}}{10^{5}}$

b. $\frac{10^{7}}{10^{-7}}$

c. $\frac{1.2 \times 10^{6}}{2.4 \times 10^{17}}$

d. $(2.0 \times 10^{7}) \times (1.2 \times 10^{-5})$

(4 marks)

STARTER FOR 10...

0.2.5. Significant figures, decimal places and rounding

For each of the numbers in questions 1–6, state the number of significant figures and the number of decimal places.

		Significant figures	Decimal places
1	3.131 88		
2	1000		
3	0.000 65		
4	1006		
5	560.0		
6	0.000 480		

(6 marks)

7. Round the following numbers to (i) 3 significant figures and (ii) 2 decimal places.

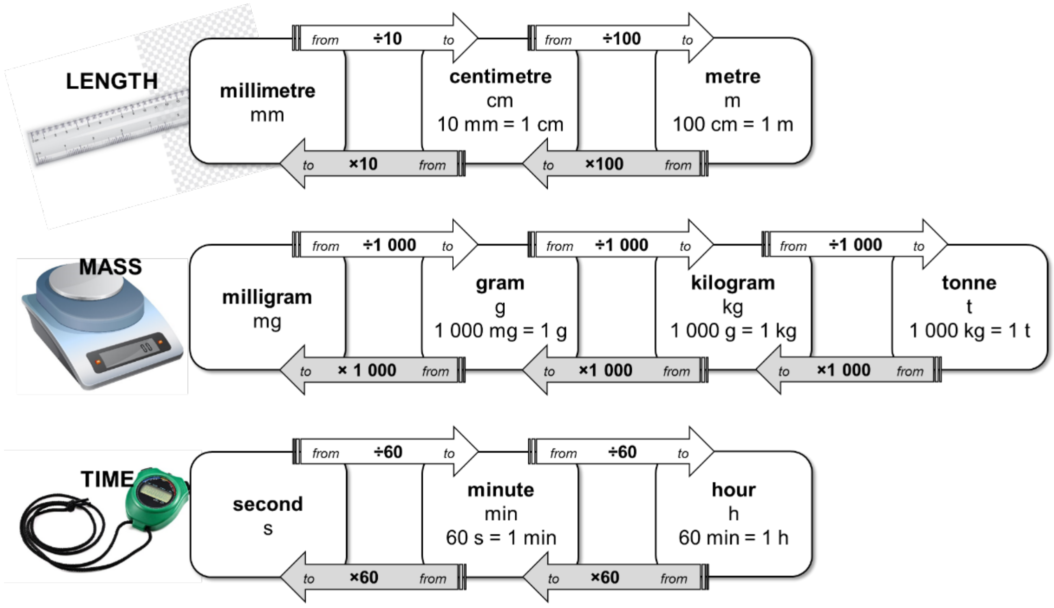
a. 0.075 84
b. 231.456

(4 marks)

STARTER FOR 10...

0.2.6. Unit conversions 1 – Length, mass and time

Mo's teacher has drawn a diagram on the board to help him with converting quantities from one unit into another.



For example, to convert a length in millimetres into units of centimetres, divide by 10, eg 10 mm = 1 cm.

Use the diagram to help with the following unit conversions. (10 marks)

1. A block of iron has a length of 1.2 cm. Calculate its length in millimetres.

2. The width of the classroom is 7200 cm. Calculate its length in metres.

3. A reaction reaches completion after 4½ minutes. Convert this time into seconds.

4. The stop clock reads 2 min 34 s. Convert this time into seconds.

5. A method states that a reaction needs to be heated under reflux for 145 min. Calculate this time in hours and minutes.

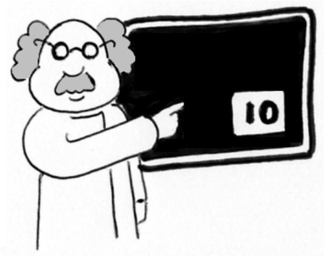
6. A factory produces 15 500 kg of ammonia a day. Calculate the mass of ammonia in tonnes.

7. A paper reports that 0.0265 kg of copper oxide was added to an excess of sulfuric acid. Convert this mass of copper oxide into grams.

8. A packet of aspirin tablets states that each tablet contains 75 mg of aspirin. Calculate the minimum number of tablets that contain a total of 1 g of aspirin.

9. A student measures a reaction rate to be 0.5 g/s. Convert the rate into units of g/min.

10. A factory reports that it produces fertiliser at a rate of 10.44 kg/h. Calculate the rate in units of g/s.



STARTER FOR 10...

0.2.7. Unit conversions 2 – Volume

The SI unit for volume is **metre cubed, m^3**. However as volumes in chemistry are often smaller than 1 m^3, fractions of this unit are used as an alternative.

centimetre cubed, cm^3	**decimetre cubed, dm^3**
centi- *prefix* one hundredth	**deci-** *prefix* one tenth
1 cm = $\frac{1}{100}$ m so,	1 dm = $\frac{1}{10}$ m so,
1 cm^3 = $\left(\frac{1}{100}\right)^3$ m^3 = $\left(\frac{1}{1\,000\,000}\right)$ m^3	1 dm^3 = $\left(\frac{1}{10}\right)^3$ m^3 = $\left(\frac{1}{1\,000}\right)$ m^3

1. Complete the table by choosing the approximate volume from the options in bold for each of the everyday items (images not drawn to scale). (1 mark)

1 cm^3 **1 dm^3** **1 m^3**

			
	drinks bottle	sugar cube	washing machine
Approx. volume			

2. Complete the following sentences; (1 mark)

To convert a volume in **cm^3** into a volume in **dm^3**, divide by.............................

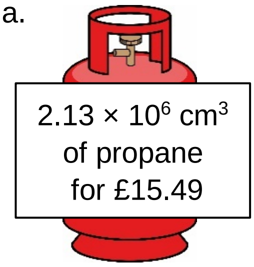
To convert a volume in **cm^3** into a volume in **m^3**, divide by...............................

3.
a. A balloon of helium has a volume of 1600 cm^3. What is its volume in units of dm^3?
b. The technician has prepared 550 cm^3 of HCl(aq). What is its volume in units of m^3?
c. An experimental method requires 1.35 dm^3 of NaOH(aq). What volume is this in cm^3?
d. A swimming pool has a volume of 375 m^3. What volume is this in cm^3?
e. A 12 g cylinder of CO_2 contains 6.54 dm^3 of gas. What volume of gas is this in units of m^3?

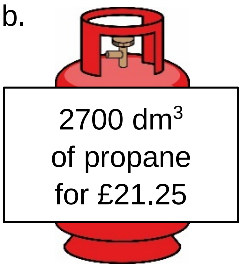
(5 marks)

4. Which cylinder of propane gas is the best value for money? (3 marks)

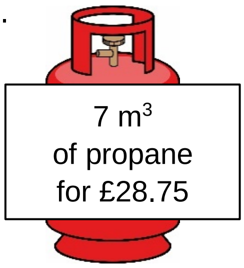
a.



b.



c.



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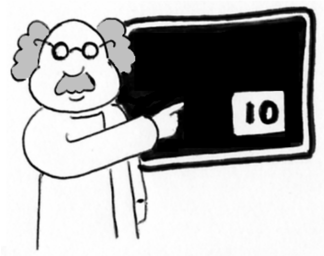

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0.2.8. Moles and mass

One mole of a substance is equal to **6.02×10^{23} atoms**, **ions** or **particles** of that substance. This number is called the **Avogadro constant**.

The value of the Avogadro constant was chosen so that the relative formula mass of a substance weighed out in grams is known to contain exactly 6.02×10^{23} particles. We call this mass its **molar mass**.

We can use the equation below when calculating an amount in moles:

$$\text{amount of substance (mol)} = \frac{\text{mass (g)}}{\text{molar mass (g mol}^{-1}\text{)}}$$

How is a mole similar to a dozen?

Stating the amount of substance in moles is just the same as describing a quantity of eggs in dozens. You could say you had 24 or 2 dozen eggs.

Use the equation above to help you answer the following questions.

1. Calculate the amount of substance, in moles, in: (3 marks)

a. 32 g of methane, CH_4 (molar mass, 16.0 g mol^{-1})

b. 175 g of calcium carbonate, $CaCO_3$

c. 200 mg of aspirin, $C_9H_8O_4$

2. Calculate the mass in grams of: (3 marks)

a. 20 moles of glucose molecules (molar mass, 180 g mol^{-1})

b. 5.00×10^{-3} moles of copper ions, Cu^{2+}

c. 42.0 moles of hydrated copper sulfate, $CuSO_4{\bullet}5H_2O$

3. a. 3.09 g of a transition metal carbonate was known to contain 0.0250 mol.

i. Determine the molar mass of the transition metal carbonate. (1 mark)

ii. Choose the most likely identity for the transition metal carbonate from the list below:

$CoCO_3$ **$CuCO_3$** **$ZnCO_3$** (1 mark)

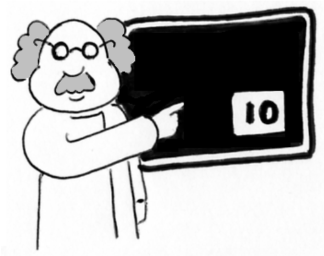
b. 4.26 g of a sample of chromium carbonate was known to contain 0.015 mol.

Which of the following is the correct formula for the chromium carbonate? (2 marks)

$CrCO_3$ **$Cr_2(CO_3)_3$** **$Cr(CO_3)_3$**

BONUS QUESTION

If you had 1 mole of pennies which you could share with every person on earth how much could you give each person? Approximate world population = 7 500 000 000.



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0.2.9. Moles and concentration

To calculate the concentration of a solution we use the equation:

$$\text{concentration (mol dm}^{-3}\text{)} = \frac{\text{amount of substance (mol)}}{\text{volume (dm}^3\text{)}}$$

Use the equation to help you complete each of the statements in the questions below.

1. a. 1.5 mol of NaCl dissolved in 0.25 dm^3 of water produces a solution with a concentration of.................................mol dm^{-3}. (1 mark)

b. 250 cm^3 of a solution of HCl(aq) with a concentration of 0.0150 mol dm^{-3} contains ....moles. (1 mark)

c. A solution with a concentration of 0.85 mol dm^{-3} that contains 0.125 mol has a volume of ....dm^3. (1 mark)

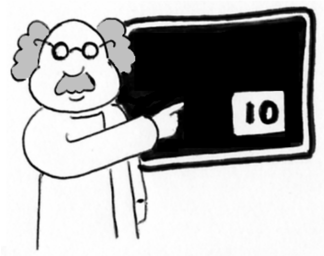
2. In this question you will need to convert between an amount in moles and a mass as well as using the equation above.

Space for working is given beneath each question.

a. 5.0 g of $NaHCO_3$ dissolved in 100 cm^3 of water produces a solution with a concentration of ....mol dm^{-3}. (2 marks)

b. 25.0 cm^3 of a solution of NaOH(aq) with a concentration of 3.8 mol dm^{-3} contains .... g of NaOH. (2 marks)

c. The volume of a solution of cobalt(II) chloride, $CoCl_2$, with a concentration of 1.3 mol dm^{-3} that contains 2.5 g of $CoCl_2$ is ....cm^3. (3 marks)



STARTER FOR 10...

0.3.1. Laboratory equipment

Practical work is a key aspect in the work of a chemist.

To help you plan effective practical work it is important that you are familiar with the common laboratory equipment available to you.

1. For each of the pieces of glassware shown in the images below, state their name and give a possible volume(s).

a. 

Name: ....

Possible volume(s): ....

b. 

Name: ....

Possible volume(s): ....

c. 

Name: ....

Possible volume(s): ....

d. 

Name: ....

Possible volume(s): ....

e. 

Name: ....

Possible volume(s): ....

f. 

Name: ....

Possible volume(s): ....

(6 marks)

2. Name the common laboratory equipment in the images below. (4 marks)

a. 

....

b. 

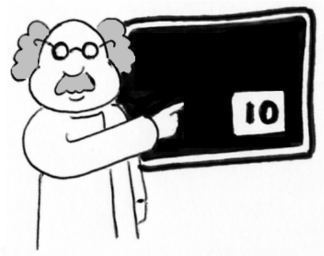
....

c. 

....

d. 

....



STARTER FOR 10...

0.3.2. Recording results

1. A student is looking at endothermic processes. He adds 2.0 g of ammonium nitrate to 50 cm^3 of water and measures the temperature change. He repeats the experiment three times.

His results are shown in the table below.

	Temperature at start	**Temperature at end**	**Temperature change**
Run 1	21.0	–1.1	22.1
Run 2	20	–2	22
Run 3	20.2	2	18.2
Mean			**22.05**

Annotate the table to suggest **five ways** in which the table layout and the recording and analysis of his results could be improved. (5 marks)

2. For each of the experiments described below, design a table to record the results.

Experiment 1: Simon is investigating mass changes during chemical reactions. He investigates the change in mass when magnesium ribbon is oxidised to form magnesium oxide:

$$\text{magnesium} + \text{oxygen} \rightarrow \text{magnesium oxide}$$

He records the mass of an empty crucible. He places a 10 cm strip of magnesium ribbon in the crucible and records the new mass of the crucible. He heats the crucible strongly until all the magnesium ribbon has reacted to form magnesium oxide. He allows the crucible to cool before recording the mass of the crucible and magnesium oxide.

Experiment 2: Nadiya is investigating how the rate of a reaction is affected by concentration. She investigates the reaction between magnesium ribbon and hydrochloric acid.

$$\text{magnesium} + \text{hydrochloric acid} \rightarrow \text{magnesium chloride} + \text{hydrogen}$$

She places 25 cm^3 of hydrochloric acid with a concentration of 0.5 mol dm^{-3} into a conical flask and fits a gas syringe. She adds a 3.0 cm strip of magnesium ribbon and measures the volume of hydrogen gas produced every 20 s for 3 minutes.

She repeats the experiment with hydrochloric acid with concentrations of 1.0 mol dm^{-3} and then 1.5 mol dm^{-3}.

(5 marks)

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0.3.3. Drawing scatter graphs

When you want to find a correlation between two variables it is helpful to draw a scatter graph.

Key points to remember when drawing scatter graphs include:

- The **independent variable** (the variable that is changed) goes on the *x*-axis and the **dependent variable** (the variable you measured) goes on the *y*-axis.
- The plotted points must cover more than half the graph paper.
- The axes scales don't need to start at zero.
- A straight **line** or smooth **curve of best fit** is drawn through the points to show any correlation.

Karina is investigating the relationship between the volume of a gas and its temperature. She injects 0.2 cm^3 of liquid pentane (b.p. 36.1 °C) into a gas syringe submerged in a water bath at 40 °C. After 5 minutes she measures the volume of gas in the syringe. She repeats the experiment three times with the water bath at 40 °C.

She then repeats the experiment for temperatures of 50, 60, 70 and 80 °C.

Her results are shown in the table below:

Temperature / °C	Volume of gas / cm^3			
	Run 1	**Run 2**	**Run 3**	**Mean**
40	40.8	43.1	42.7	**42.2**
50	46.1	46.2	46.9	**46.4**
60	54.7	48.1	48.3	**48.2**
70	49.1	49.6	49.5	**49.4**
80	51.0	47.3	51.0	**51.0**

1. Plot a scatter graph of the volume of the gas against the temperature. (6 marks)

2. Add error bars to show the range of readings used to calculate the mean volume of the gas at each temperature. (2 marks)

3. Draw in a line of best fit. (1 mark)

4. Describe the correlation observed. (1 mark)