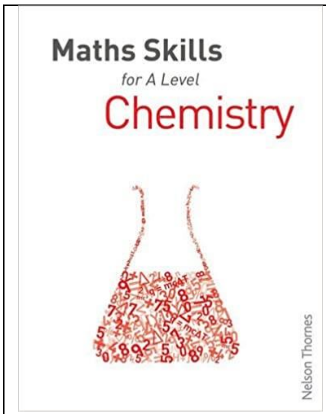
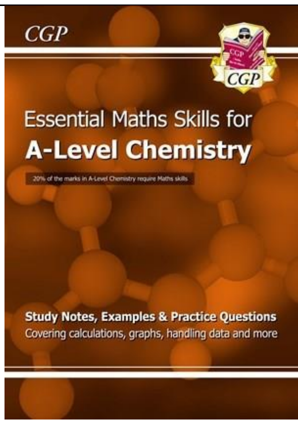
6th Form Transition Pack

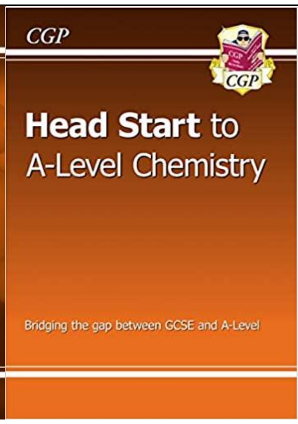
QUALIFICATION	A-Level Chemistry
Teacher Name(s)	Mrs K Parker Mrs G Welsh (Y12) Mrs D Coyne (Y13)
Contact email(s)	k.parker@holyfamilyhighschool.co.uk g.welsh@holyfamilyhighschool.co.uk d.coyne@holyfamilyhighschool.co.uk
Exam board and link	AQA www.aqa.org.uk
Specification details	7405
Recommended online learning We recommend you use Cornell Notes to prepare for your new course. Please see these videos to help you develop the technique: **https://youtu.be/WtW9IyE04OQ** **You can use this note taking skill to help you to make notes when you are looking at the websites and watching the online tutorials**	https://boostrevision.com/courses/head-start-to-a-level-chemistry/ www.senecalearning.com www.mrerintoul.co.uk https://drclays-alevelchemistry.com/a-level-resources-page/ http://m.franklychemistry.co.uk/ http://www.a-levelchemistry.co.uk/ http://www.docbrown.info/ http://www.a-levelnotes.co.uk/aqa-chemistry-notes.html

Recommended reading list

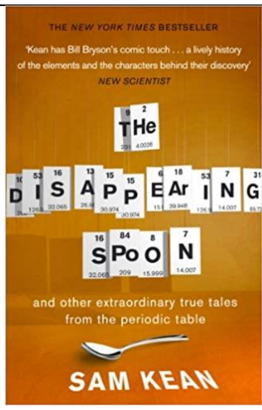


by Dan McGowan





Free by CGP books - Amazon



By Sam Kean!

WE ALSO RECOMMEND TRYING SOME OF THE FOLLOWING WIDER READING BOOKS:

Akhavan, Jacqueline
• The chemistry of explosives

Aldridge, Susan
• Magic molecules – how drugs work

Atkins, P. W. (Peter)
• Four laws that drive the universe
• The periodic kingdom – a journey into the land of the chemical elements

Ball, Philip • Elegant solutions: ten beautiful experiments in chemistry
• H2O – a biography of water
• The ingredients – a guided tour of the elements
• Stories of the invisible – a guided tour of the molecules

Beckett, S. T.
• The science of chocolate

Berson, Jerome A.
• Chemical creativity: ideas from the work of Woodward, Huckel, Meerwein and others

Brock, W. H.
• The Fontana history of chemistry

Coultate, T. P.
• Food – the chemistry of its components

Emsley, John
• The Consumer's Good Chemical Guide: Separating Facts from Fiction about Everyday Products
• Better looking, better living, better loving: how chemistry can help you achieve life's goals
• The elements of murder

Goldacre, Ben
• Bad science

McGee, Harold
• On food and cooking – the science and lore of the kitchen

McGrayne, Sharon Bertsch
• Prometheans in the lab – chemistry and the making of the modern world

Parry, Vivienne
• The truth about hormones

Pond, Caroline M.
• The fats of life (sic)

Pybus, David & Sell, Charles
• The chemistry of fragrances

Rhodes, Richard
• The making of the atomic bomb

Roesky, Herbert W. & Möckel, Klaus
• Chemical curiosities: spectacular experiments and inspired quotes

Russell, Michael S.
• The chemistry of fireworks

Sacks, Oliver
• Uncle Tungsten – memories of a chemical boyhood Selinger, Ben • Chemistry in the market place

WHAT'S A LEVEL CHEMISTRY ABOUT?

A level Chemistry studies the material world, and through chemistry we can describe and explain questions such as: "what happens when sugar dissolves in tea?"; "why is mercury a liquid at room temperature?"; "how do we make plastics?"; "what can we do about global warming?"; "how and why will I be affected if oil runs out?".

From baking a cake to recharging a mobile phone, chemistry is involved in everything we do; and our lives are inextricably influenced by many aspects of chemistry. Chemistry will continue to be at the forefront of responding the needs of society; with chemists central to making advances in designing new materials, efficient energy use, drug development, and technology, to name but a few.

A level Chemistry courses cover a wide variety of basic concepts such as the structure of the atom; the interaction of matter and energy; how to control reactions; patterns in the Periodic Table; understanding carbon-based molecules.

WHAT SORT OF WORK IS INVOLVED?

In all these topics, you will need to learn facts and build a body of knowledge but also to understand and apply the ideas. Many topics include calculations and so you should feel comfortable rearranging equations and using numbers. Importantly, chemistry is a hands-on science and you will carry out experiments on a regular basis. This is to consolidate your theory work, but also provide you with the opportunity to use new apparatus and build your skills and confidence to complete safe and accurate practical work.

WHAT BACKGROUND DO I NEED?

A level Chemistry requires an interest in the subject and an enthusiasm and commitment to work hard. You will need to develop your abilities to work independently and take responsibility for your own progress. Usually, students have studied the subject at GCSE, and ideally, you will have at least a 6 or 7 in GCSE science (combined or separate sciences) and usually in mathematics. You will also need to be able to write effective English using scientifically accurate vocabulary. Each applicant’s case is considered individually.

WHERE CAN IT LEAD?

Chemistry A level is a highly respected A level, with its broad variety of tested skills, and it is a good choice for many degrees and careers. Chemistry has been described as the ‘central science’ and is often combined with either physics or biology. It is a compulsory choice for anyone wishing to pursue medicine, dentistry and veterinary science, as well as chemistry-based degrees, such as pharmacy, pharmacology, and biochemist

ASSESSMENT

The course is linear, meaning that the A level exams take place at the end of the second year and any internal or AS exams taken at the end of the first year do not contribute to the overall grade of the A level.

There are 3 written papers, two of which question particular topics from the two years, whilst the third is more 'synoptic' (asking questions which cut across several topics) and has a greater emphasis on the understanding of practical work you have developed during the course.

In addition to these three papers which decide your A level grade, you will also need to complete 12 core practicals which your teachers assess. The practical mark is published as an endorsement to your A level grade.

SUBJECT CONTENT

3.1 Physical chemistry

3.1.1 Atomic structure 3.1.2 Amount of substance

3.1.3 Bonding 3.1.4 Energetics

3.1.5 Kinetics

3.1.6 Chemical equilibria, Le Chatelier's principle and K_c

3.1.7 Oxidation, reduction and redox equations

3.1.8 Thermodynamics (A-level only)

3.1.9 Rate equations (A-level only)

3.1.10 Equilibrium constant K_p for homogeneous systems (A-level only)

3.1.11 Electrode potentials and electrochemical cells (A-level only)

3.1.12 Acids and bases (A-level only)

3.2 Inorganic chemistry

3.2.1 Periodicity 3.2.2 Group 2, the alkaline earth metals

3.2.3 Group 7(17), the halogens

3.2.4 Properties of Period 3 elements and their oxides (A-level only)

3.2.5 Transition metals (A-level only)

3.2.6 Reactions of ions in aqueous solution (A-level only)

3.3 Organic chemistry

3.3.1 Introduction to organic chemistry

3.3.2 Alkanes 3.3.3 Halogenoalkanes 3.3.4 Alkenes

3.3.5 Alcohols 3.3.6 Organic analysis

3.3.7 Optical isomerism (A-level only)

3.3.8 Aldehydes and ketones (A-level only)

3.3.9 Carboxylic acids and derivatives (A-level only)

3.3.10 Aromatic chemistry (A-level only) 3.3.11 Amines (A-level only)

3.3.12 Polymers (A-level only)

3.3.13 Amino acids, proteins and DNA (A-level only)

3.3.14 Organic synthesis (A-level only)

3.3.15 Nuclear magnetic resonance spectroscopy (A-level only)

3.3.16 Chromatography (A-level only)

You will study the AS topics in Year 12 and the A level only topics in Year 13.

You are likely to be entered for the AS exams (there are 2 of them!) at the end of Year 12.

You will also do 3 exams at the end of Year 13 and the topics on the papers include all the AS and all the A level content

If you Google 'AQA A level Chemistry specification' you will be able to download the full document for yourself

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

THE LANGUAGE OF MEASUREMENT

The following subject specific vocabulary provides definitions to learn, of key terms used in our AS and A-level Science specifications.

Accuracy

A measurement result is considered accurate if it is judged to be close to the true value.

Calibration

Marking a scale on a measuring instrument.

This involves establishing the relationship between indications of a measuring instrument and standard or reference quantity values, which must be applied.

For example, placing a thermometer in melting ice to see whether it reads 0 °C, in order to check if it has been calibrated correctly.

Data

Information, either qualitative or quantitative, that has been collected.

Errors

See also uncertainties.

measurement error

The difference between a measured value and the true value.

anomalies

These are values in a set of results which are judged not to be part of the variation caused by random uncertainty.

random error

These cause readings to be spread about the true value, due to results varying in an unpredictable way from one measurement to the next.

Random errors are present when any measurement is made and cannot be corrected. The effect of random errors can be reduced by making more measurements and calculating a new mean.

systematic error

These cause readings to differ from the true value by a consistent amount each time a measurement is made.

Sources of systematic error can include the environment, methods of observation or instruments used.

Systematic errors cannot be dealt with by simple repeats. If a systematic error is suspected, the data collection should be repeated using a different technique or a different set of equipment, and the results compared.

zero error

Any indication that a measuring system gives a false reading when the true value of a measured quantity is zero, eg the needle on an ammeter failing to return to zero when no current flows.

A zero error may result in a systematic uncertainty.

Evidence

Data which has been shown to be valid.

Fair test

A fair test is one in which only the independent variable has been allowed to affect the dependent variable.

Hypothesis

A proposal intended to explain certain facts or observations.

Interval

The quantity between readings, eg a set of 11 readings equally spaced over a distance of 1 metre would give an interval of 10 centimetres.

Precision

Precise measurements are ones in which there is very little spread about the mean value.

Precision depends only on the extent of random errors – it gives no indication of how close results are to the true value.

Prediction

A prediction is a statement suggesting what will happen in the future, based on observation, experience or a hypothesis.

Range

The maximum and minimum values of the independent or dependent variables; important in ensuring that any pattern is detected.

For example a range of distances may be quoted as either:

'From 10 cm to 50 cm'

or

'From 50 cm to 10 cm'

Repeatable

A measurement is repeatable if the original experimenter repeats the investigation using same method and equipment and obtains the same results.

Reproducible

A measurement is reproducible if the investigation is repeated by another person, or by using different equipment or techniques, and the same results are obtained.

Resolution

This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.

Sketch graph

A line graph, not necessarily on a grid, that shows the general shape of the relationship between two variables. It will not have any points plotted and although the axes should be labelled they may not be scaled.

True value

This is the value that would be obtained in an ideal measurement.

Uncertainty

The interval within which the true value can be expected to lie, with a given level of confidence or probability, eg “the temperature is 20 °C ± 2 °C, at a level of confidence of 95%.

Validity

Suitability of the investigative procedure to answer the question being asked. For example, an investigation to find out if the rate of a chemical reaction depended upon the concentration of one of the reactants would not be a valid procedure if the temperature of the reactants was not controlled.

Valid conclusion

A conclusion supported by valid data, obtained from an appropriate experimental design and based on sound reasoning.

TO GET YOU STARTED….!

It is vitally important that you continue to revise your GCSE between now and September. You have many resources to support your learning e.g. GCSE POD, revision guides, websites, apps, past papers, lesson notes etc.

Some BBC bitesize links for you to bridge knowledge gaps from AQA GCSE combined science to AQA GCSE Chemistry – these will be built on in the course.

BBC Bitesize Chemistry GCSE https://www.bbc.co.uk/bitesize/examspecs/z8xtmnb
Transition metals - AQA
Calculations in chemistry (Higher) - AQA recap
Atom economy, percentage yield and gas calculations - AQA
Titrations - AQA
Chemical cells - AQA
Reversible reactions - AQA
More organic chemistry - AQA
Fertilisers - AQA
Practical skills recap
https://www.bbc.co.uk/bitesize/topics/zq6h2nb Bonding, structure and the properties of matter

The following pages are designed by the AQA exam board, as a transition pack to bridge the gap between GCSE and A level.

USEFUL INFORMATION AND ACTIVITIES

There are several 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 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 (e.g. 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 ºC). 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.

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.

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	2											3	4	5	6	7	0
							1.0 **H** hydrogen 1										*(18)* 4.0 **He** helium 2
(1)	*(2)*											*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	
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	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(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

1	2											3	4	5	6	7	0
							1.0 **H** hydrogen 1										(18) 4.0 **He** helium 2
(1)	(2)											(13)	(14)	(15)	(16)	(17)	
6.9 **Li** lithium 3	9.0 **Be** beryllium 4		**Key** relative atomic mass **symbol** name atomic (proton) number									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	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(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						

	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

* 58 – 71 Lanthanides

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

2											3	4	5	6	7	0
																(18)
						1.0 **H** hydrogen 1										4.0 **He** helium 2
(2)											(13)	(14)	(15)	(16)	(17)	
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.3 **lg** esium 2	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(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
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