SIXTH FORM BRIDGING WORK

Get Ready for *Chemistry*

Getting organised: Make sure you have set up a Learning Folder (see Sixth Form file check for content). The PLCs (Personal Learning Checklists) should be at the front.

Subject mind-set and BIG picture thinking…

Why is the World as it is, why is this Universe habitable and how do you make perfect yorkshire pudding…

Please complete the following tasks ahead of starting the Sixth Form:

Work to complete

Chemistry A' Level Transition Skills Booklet

Recommended text books

AQA Chemistry year 1 and AS. Oxford University press. ISBN 978 019 835181 8 AQA Chemistry year 2 A level. Oxford University press. ISBN 978 019 835771 1 Course Related Additional Reading.

Calculations in AS/A level Chemistry. By Jim Clark. ISBN 0582 41127 0 An excellent guide to the mathematical aspects of chemistry. Highly recommended.

CGP Head Start to A Level Chemistry

https://www.cgpbooks.co.uk/Student/books_a_level_chemistry_aqa.book_CBR71 A book designed to help with the significant step up from GCSE to A level. CGP Revision guides and workbooks.

https://www.cgpbooks.co.uk/Student/books_a_level_chemistry_aqa.book_CARQB71 A useful set of learning aids.

Chemistry In Context. By Hill and Holman. ISBN 978 017 448276 5. A very useful book which provides excellent background information to the A level syllabus

Recommended websites you should be familiar with

Chemguide. https://www.chemguide.co.uk/ Probably the best A level chemistry website out there.
Alevelchemistry. http://www.a-levelchemistry.co.uk/ Good notes and an excellent range of worksheets.
Periodic Table Of Videos http://www.periodicvideos.com/ Resources from the university of Nottingham.
Royal Society Of Chemistry http://www.rsc.org/?gclid=EAIaIQobChMIttLryenL2wIVzbztCh2J_Ab2EAAYASAAEgIl qvD_BwE A wide range of resources.
Chemtube 3D http://www.chemtube3d.com/ALevel.html Useful animations for organic chemistry

Catalyst https://www.stem.org.uk/catalyst A magazine aimed at students aged 16-19. Wider Reading. A (purely optional) selection of books from the wider world

Related magazines

Teach Chemistry | RSC Education

Chemistry Archives | Science News for Students

All journals A–Z (rsc.org)

New Scientist | Science news and science articles from New Scientist

Recommended books & revision guides (Download the exam board recommended reading list)

Wider Reading.
A (purely optional) selection of books from the wider world of chemistry.
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

Possible places to visit

Science Museum

Year 12 Chemistry Checklist

Notes	☹	😐	☺	Revision

Physical Chemistry 1

3.1.1 Atomic structure
3.1.1.1 Fundamental particles

(a) Appreciate that knowledge and understanding of atomic structure has evolved over time.					
(b) Know protons, neutrons and electrons: relative charge and relative mass.					
(c) An atom consists of a nucleus containing protons and neutrons surrounded by electrons.					

3.1.1.2 Mass number and isotope

(a) Know the Mass number (A) and atomic (proton) number (Z)					
(b) Determine the number of fundamental particles in atoms and ions using mass number, atomic number and charge.					
(c) Explain the existence of isotopes.					
(d) Use mass spectrometry can be used to identify elements and show how mass spectrometry can be used to determine relative molecular mass.					
(e) Calculate relative atomic mass from isotopic abundance, limited to mononuclear ions.					

3.1.1.3 Electron configuration

(a) Explanation electron configurations of atoms and ions up to Z = 36 in terms of shells and sub-shells (orbitals) s, p and d.					
(b) Define first ionisation energy.					
(c) Write equations for first and successive ionisation energies.					
(d) Explain how first and successive ionisation energies in Period 3 (Na–Ar) and in Group 2 (Be–Ba) give evidence for electron configuration in sub-shells and in shell.					

3.1.2 Amount of substance
3.1.2.2 The mole and the Avogadro constant

(a) Define relative atomic mass (Ar): Relative atomic mass in terms of ^{12}C.					
(b) Define relative molecular mass (Mr): Relative molecular mass in terms of ^{12}C.					
(c) Know the Avogadro constant as the number of particles in a mole and caary out calculation using the constant to determine the number of particles in a substance.					
(d) Know the mole as applied to electrons, atoms, molecules, ions, formulas and equations.					
(e) Know the concentration of a substance in solution, measured in mol dm^{-3}.					
(f) Using mass of substance, Mr, concentration and volume to calculate the amount of a substance.					

3.1.2.3 The ideal gas equation

(a) Know the ideal gas equation $pV = nRT$ with the variables in SI units.					
(b) Rearrange equations, covert and derive units.					
(c) Use the ideal gas equation to carry out calculations.					

3.1.2.4 Empirical and molecular formula

(a) Know empirical formula is the simplest whole number ratio of atoms of each element in a compound.					
(b) Calculate empirical formula from data giving composition by mass or percentage by mass.					
(c) Know the molecular formula is the actual number of atoms of each element in a compound.					
(d) Calculate molecular formula from the empirical formula and relative molecular mass.					

3.1.2.5 Balanced equations and associated calculations

(a) Write balanced equations for reactions studied.					
(b) Balance equations for unfamiliar reactions when reactants and products are specified.					
(c) Use balanced equations to calculate: Mass, Volume of gas, percentage yield, percentage atom economy, concentrations and volumes for reactions in solution.					
(d) Recall economic, ethical and environmental advantages for society and for industry of developing chemical processes with a high atom economy.					
Required practical 1 **Make up a volumetric solution and carry out a simple acid–base titration.**					

3.1.3 Bonding

3.1.3.1 – 3.1.3.3 Ionic, covalent and metallic bonding

(a) Know Ionic bonding involves electrostatic attraction between oppositely charged ions in a lattice.					
(b) Recall the formulas of compound ions eg sulfate, hydroxide, nitrate, carbonate and ammonium.					
(c) Predict the charge on a simple ion using the position of the element in the Periodic Table and construct formulas for ionic compounds.					
(d) Know a single covalent bond contains a shared pair of electrons and multiple bonds contain multiple pairs of electrons.					
(e) A co-ordinate (dative covalent) bond contains a shared pair of electrons with both electrons supplied by one atom.					
(f) Represent covalent bonding using diagrams, dot-cross, a covalent bond using a line, a co-ordinate bond using an arrow.					
(g) Recall metallic bonding involves attraction between delocalised electrons and positive ions arranged in a lattice.					

3.1.3.4 Bonding and physical properties

(a) Know the four types of crystal structure; ionic, metallic, macromolecular (giant covalent) and simple molecular.					
(b) Recall structures of the following crystals as examples of these four types of crystal structure, diamond, graphite, ice, iodine, magnesium, sodium chloride.					
(c) Relate the melting point and conductivity of materials to the type of structure and the bonding present.					
(d) Explain the energy changes associated with changes of state.					
(e) Draw diagrams to represent these structures involving specified numbers of particles.					

3.1.3.5 Shapes of simple molecules and ions

(a) Recall bonding pairs and lone (non-bonding) pairs of electrons as charge clouds that repel each other.					
(b) Recall Pairs of electrons in the outer shell of atoms arrange themselves as far apart as possible to minimise repulsion.					
(c) Recall Lone pair–lone pair repulsion is greater than lone pair–bond pair repulsion, which is greater than bond pair–bond pair repulsion.					
(d) Explain the effect of electron pair repulsion on bond angles.					
(e) Explain the shapes of, and bond angles in, simple molecules and ions with up to six electron pairs (including lone pairs of electrons) surrounding the central atom.					
(f) Know that electronegativity as the power of an atom to attract the pair of electrons in a covalent bond.					
(g) Recall the electron distribution in a covalent bond between elements with different electronegativities will be unsymmetrical. This produces a polar covalent bond, and may cause a molecule to have a permanent dipole.					
(h) Use partial charges to show that a bond is polar and explain why some molecules with polar bonds do not have a permanent dipole.					

3.1.3.6 Bond polarity

(a) State electronegativity as the power of an atom to attract the pair of electrons in a covalent bond.					
(b) Use partial charges to show that a bond is polar					
(c) Explain why some molecules with polar bonds do not have a permanent dipole.					

3.1.3.7 Forces between molecules

(a) Know the forces between molecules including; permanent dipole–dipole forces, induced dipole–dipole (van der Waals, dispersion, London) forces and hydrogen bonding.					
(b) Explain the existence of these forces between familiar and unfamiliar molecules.					
(c) Explain how melting and boiling points are influenced by these intermolecular forces.					

3.1.4 Energetics

3.1.4.1 Enthalpy change

(a) Explanation that some chemical reactions are accompanied by enthalpy changes that are exothermic (ΔH, negative) or endothermic (ΔH, positive).					
(b) Construction of enthalpy profile diagrams to show the difference in the enthalpy of reactants compared with products.					
(c) Enthalpy change (ΔH) is the heat energy change measured under conditions of constant pressure.					
(d) Recall standard enthalpy changes refer to standard conditions ie 100 kPa and a stated temperature (eg $\Delta H298^{\ominus}$).					
(e) Define standard enthalpy of combustion ($\Delta cH^{\ominus}$) and standard enthalpy of formation ($\Delta fH^{\ominus}$).					

3.1.4.2 Calorimetry and measuring Enthalpy change

(a) Recall the heat change, q, in a reaction is given by the equation $q = mc\Delta T$ where m is the mass of the substance that has a temperature change ΔT and a specific heat capacity c.					
(b) Use this equation to calculate the molar enthalpy change for a reaction and use this equation in related calculations.					
(c) Measurement of an enthalpy change for the following: dissolution of potassium chloride, dissolution of sodium carbonate, neutralising NaOH with HCl, displacement reaction between $CuSO_4$ + Zn and combustion of alcohols.					

Required practical 2 **Measurement of an enthalpy change.**					

3.1.4.3 – 3.1.4.4 Hess's Law and bond enthalpies

(a) Use Hess' law for construction of enthalpy cycles and calculations to determine indirectly: (i) an enthalpy change of reaction from enthalpy changes of combustion (ii) an enthalpy change of reaction from enthalpy changes of formation (iii) enthalpy changes from unfamiliar enthalpy cycles					
(b) Calculate mean bond enthalpies: (i) define the term mean bond enthalpy (ii) use mean bond enthalpies to calculate an approximate value of ΔH for reactions in the gaseous phase (iii) explain why values from mean bond enthalpy calculations differ from those determined using Hess's law					

3.1.5 Kinetics

3.1.5.1 - 3.1.5.4 Collision theory, Rate of reaction and Maxwell-Boltzmann distribution

(a) The effect of concentration, including the pressure of gases, on the rate of a reaction, in terms of frequency of collisions					
(b) Calculation of reaction rate from the gradients of graphs measuring how a physical quantity changes with time					
(c) Explanation of the role of a catalyst: (i) in increasing reaction rate without being used up by the overall reaction (ii) in allowing a reaction to proceed via a different route with lower activation energy, as shown by enthalpy profile diagrams.					
(d) (i) Explanation of the terms *homogeneous* and *heterogeneous* catalysts (ii) explanation that catalysts have great economic importance and benefits for increased sustainability by lowering temperatures and reducing energy demand from combustion of fossil fuels with resulting reduction in CO_2 emissions.					
(e) The techniques and procedures used to investigate reaction rates including the measurement of mass, gas volumes and time.					
(f) Qualitative explanation of the Boltzmann distribution and its relationship with activation energy.					
(g) Explanation, using Boltzmann distributions, of the qualitative effect on the proportion of molecules exceeding the activation energy and hence the reaction rate, for: (i) temperature changes (ii) catalytic behavior.					
Required practical 3 **Investigation of how the rate of a reaction changes with temperature.**					

3.1.6 Chemical equilibria

3.1.6.1 – 3.1.6.2 Chemical equilibria, Le Chatelier's principle and Kc

(a) Recall that in a reversible reaction at equilibrium: the forward and reverse reactions proceed at equal rates, the concentrations of reactants and products remain constant.					
(b) Use Le Chatelier's principle to predict qualitatively the effect of changes in temperature, pressure and concentration on the position of equilibrium.					
(c) Explain why, for a reversible reaction used in an industrial process, a compromise temperature and pressure may be used.					
(d) Know the equilibrium constant Kc is deduced from the equation for a reversible reaction. The concentration, in mol dm^{-3}, of a species X involved in the expression for Kc is represented by [X]. The value of the equilibrium constant is not affected either by changes in concentration or addition of a catalyst.					

(e) Construct an expression for Kc for a homogeneous system in equilibrium.					
(f) Calculate a value for Kc from the equilibrium concentrations for a homogeneous system at constant temperature.					
(g) Perform calculations involving Kc.					
(h) Predict the qualitative effects of changes of temperature on the value of Kc.					

3.1.7 Oxidation, reduction and redox equations

(a) State oxidation is the process of electron loss and oxidising agents are electron acceptors. Reduction is the process of electron gain and reducing agents are electron donors.					
(b) Work out the oxidation state of an element in a compound or ion from the formula.					
(c) Write half-equations identifying the oxidation and reduction processes in redox reactions.					
(d) Combine half-equations to give an overall redox equation.					

Year 12 Chemistry Checklist

Notes	☹	😐	☺	Revision

Inorganic Chemistry 1

3.2.1 Periodicity
3.2.1.1 Classification

	Notes	☹	😐	☺	Revision
(a) State an element is classified as s, p, d or f block according to its position in the Periodic Table, which is determined by its proton number.					

3.2.1.2 Trends in the properties of elements (period 3)

	Notes	☹	😐	☺	Revision
(a) Explain the trends in atomic radius and first ionisation energy.					
(b) Explain the melting point of the elements in terms of their structure and bonding.					
(c) Give the reasons for these trends in terms of the structure of and bonding in the elements.					

3.2.2 Group 2, the alkaline earth metals
3.2.1 Physical properties, solubility's and uses of group 2

	Notes	☹	😐	☺	Revision
(a) State and explain the trends in atomic radius, first ionisation energy and melting point of the elements Mg–Ba.					
(b) Identify the reactions of the elements Mg–Ba with water, including writing and balancing equations.					
(c) Describe the use of magnesium in the extraction of titanium from $TiCl_4$.					
(d) Know the relative solubilities of the hydroxides of the elements Mg–Ba in water and identify $Mg(OH)_2$ as sparingly soluble.					
(e) Know the relative solubilities of the sulfates of the elements Mg–Ba in water and identify BaSO4 as insoluble.					
(f) State the use of acidified $BaCl_2$ solution to test for sulfate ions and explain why it is acidified.					
(g) State the use of BaSO4 in medicine and the use of CaO or $CaCO_3$ to remove SO_2 from flue gases.					

3.2.3 Group 7(17), the halogens
3.2.3.1 Trends in properties

	Notes	☹	😐	☺	Revision
(a) Explain the trend in electronegativity.					
(b) Explain the trend in the boiling point of the elements in terms of their structure and bonding.					
(c) Identify the trend in oxidising ability of the halogens down the group, including displacement reactions of halide ions in aqueous solution by performing a series of reactions.					
(d) Explain why (i) silver nitrate solution is used to identify halide ion (ii) the silver nitrate solution is acidified (iii) ammonia solution is added.					

3.2.3.2 Uses of chlorine and chlorate(I)

(a) State the reaction of chlorine with water to form chloride ions and chlorate(I) ions.					
(b) State the reaction of chlorine with water to form chloride ions and oxygen.					
(c) Describe the use of chlorine in water treatment.					
(d) Appreciate that the benefits to health of water treatment by chlorine outweigh its toxic effects.					
(e) The reaction of chlorine with cold, dilute, aqueous NaOH and uses of the solution formed.					
Required practical 4 **Carry out simple test-tube reactions to identify: (i) cations – Group 2, NH_4^+ (ii) anions – Group 7 (halide ions), OH^-, CO_3^{2-}, SO_4^{2-}**					

Year 12 Chemistry Checklist

	Notes	☹	😐	☺	Revision

Organic chemistry 1

3.3.1 Introduction to organic chemistry

(a) Know the different representations for Organic compounds by: (i) empirical formula (ii) molecular formula (iii) general formula (iv) structural formula (v) displayed formula (vi) skeletal formula.					
(b) Define and explain the characteristics of a homologous series, a series of compounds containing the same functional group.					
(c) Use IUPAC rules for nomenclature. (i) Apply IUPAC rules for nomenclature to name organic compounds limited to chains and rings with up to six carbon atoms each. (ii) apply IUPAC rules for nomenclature to draw the structure of an organic compound from the IUPAC name limited to chains and rings with up to six carbon atoms each.					
(d) Draw structural, displayed and skeletal formulas for given organic compounds.					

3.3.1.2 Reaction mechanisms

(a) Explain and draw the mechanism for Free-radical mechanisms including; (i) the unpaired electron in a radical is represented by a dot (ii) the use of curly arrows is not required for radical mechanisms (iii) the formation of a covalent bond is shown by a curly arrow that starts from a lone electron pair or from another covalent bond (iv) the breaking of a covalent bond is shown by a curly arrow starting from the bond.					
(b) Write balanced equations for the steps in a free-radical mechanism.					

3.3.1.3 Isomerism

(a) Know the different forms of isomerism (i) Structural isomerism (ii) Stereoisomerism (iii) E–Z isomerism					
(b) Apply Cahn–Ingold–Prelog (CIP) priority rules to E-Z isomers.					
(b) You must be able to • define the term structural isomer • draw the structures of chain, position and functional group isomers • define the term stereoisomer • draw the structural formulas of E and Z isomers • apply the CIP priority rules to E and Z isomers					

3.3.2 Alkanes

3.3.2.1 Fractional distillation of crude oil

(a) Know the difference between saturated and unsaturated hydrocarbons.						
(b) Explain that petroleum is a mixture consisting mainly of alkane hydrocarbons that can be separated by fractional distillation.						
(c) Explain the process of fraction distillation and relate to the physical properties of the hydrocarbons.						

3.3.2.2 Modification of alkanes by cracking

(a) Know Cracking involves breaking C–C bonds in alkanes.					
(b) Recall Thermal cracking takes place at high pressure and high temperature and produces a high percentage of alkenes (mechanism not required).					
(c) Catalytic cracking takes place at a slight pressure, high temperature and in the presence of a zeolite catalyst and is used mainly to produce motor fuels and aromatic hydrocarbons (mechanism not required).					
(d) Explain the economic reasons for cracking alkanes.					

3.3.2.3 Combustion of alkanes

(a) State alkanes are used as fuels, explain the difference between complete and incomplete combustion, giving equations where appropriate.					
(b) Know the internal combustion engine produces a number of pollutants including NOx, CO, carbon and unburned hydrocarbons.					
(c) These gaseous pollutants from internal combustion engines can be removed using catalytic converters.					
(d) explain why sulfur dioxide can be removed from flue gases using calcium oxide or calcium carbonate.					

3.3.2.4 Chlorination of alkanes

(a) Know the reaction of methane with chlorine.					
(b) Explain this reaction as a free-radical substitution mechanism involving initiation, propagation and termination steps.					

3.3.3 Halogenoalkanes

3.3.3.1 Nucleophilic substitution

(a) Know halogenoalkanes undergo substitution reactions with the nucleophiles OH^-, CN^- and NH_3					
(b) Outline the nucleophilic substitution mechanisms of these reactions.					
(c) Explain why the carbon–halogen bond enthalpy influences the rate of reaction.					

3.3.3.2 Elimination

(a) The concurrent substitution and elimination reactions of a halogenoalkane (eg 2-bromopropane with potassium hydroxide).					
(b) Explain the role of the reagent as both nucleophile and base.					
(c) Outline the mechanisms of these reactions.					

3.3.3.3 Ozone depletion

(a) Know Ozone, formed naturally in the upper atmosphere, is beneficial because it absorbs ultraviolet radiation. Chlorine atoms are formed in the upper atmosphere when ultraviolet radiation causes C–Cl bonds in chlorofluorocarbons (CFCs) to break. Chlorine atoms catalyse the decomposition of ozone and contribute to the hole in the ozone layer.					
(b) use equations, such as the following, to explain how chlorine atoms catalyse decomposition of ozone: $Cl\bullet + O_3 \rightarrow ClO\bullet + O_2$ and $ClO\bullet + O_3 \rightarrow 2O_2 + Cl\bullet$.					
(c) Appreciate that results of research by different groups in the scientific community provided evidence for legislation to ban the use of CFCs as solvents and refrigerants. Chemists have now developed alternative chlorine-free compounds.					

3.3.4 Alkenes

3.3.4.1 Structure, bonding and reactivity

(a) Know alkenes are unsaturated hydrocarbons.					
(b) Explain bonding in alkenes involves a double covalent bond, a center of high electron density.					

3.3.4.2 Addition reactions of alkenes

(a) Know the electrophilic addition reactions of alkenes with HBr, H_2SO_4 and Br_2.					
(b) Outline the mechanisms for these reactions.					
(c) Explain the formation of major and minor products by reference to the relative stabilities of primary, secondary and tertiary carbocation intermediates.					

3.3.4.3 Addition polymers

(a) Know addition polymers are formed from alkenes and substituted alkenes.					
(b) Draw the repeating unit from a monomer structure.					
(c) Draw the repeating unit from a section of the polymer chain.					
(c) Draw the structure of the monomer from a section of the polymer.					
(d) Explain why addition polymers are unreactive.					
(e) Explain the nature of intermolecular forces between molecules of polyalkenes.					

3.3.5 Alcohols

3.3.5.1 Alcohol production

(a) Explain the meaning of the term biofuel.					
(b) Justify the conditions used in the production of ethanol by fermentation of glucose.					
(c) Write equations to support the statement that ethanol produced by fermentation is a carbon-neutral fuel and give reasons why this statement is not valid.					
(d) Outline the mechanism for the formation of an alcohol by the reaction of an alkene with steam in the presence of an acid catalyst.					
(e) Discuss the environmental (including ethical) issues linked to decision making about biofuel use.					

3.3.5.2 Oxidation of alcohols

(a) Know alcohols are classified as primary, secondary and tertiary. Primary alcohols can be oxidised to aldehydes which can be further oxidised to carboxylic acids. Secondary alcohols can be oxidised to ketones. Tertiary alcohols are not easily oxidised. Acidified potassium dichromate(VI) is a suitable oxidising agent.					
(b) Write equations for these oxidation reactions (equations showing [O] as oxidant are acceptable).					
(c) Explain how the method used to oxidise a primary alcohol determines whether an aldehyde or carboxylic acid is obtained.					
(d) Use chemical tests to distinguish between aldehydes and ketones including Fehling's solution and Tollens' reagent.					

3.3.5.3 Elimination

(a) Know alkenes can be formed from alcohols by acid-catalysed elimination reactions. Alkenes produced by this method can be used to produce addition polymers without using monomers derived from crude oil.					
(b) Outline the mechanism for the elimination of water from alcohols.					
Required practical 5 **Distillation of a product from a reaction.**					

3.3.6 Organic analysis

3.3.6.1 Identification of functional groups by test-tube reactions

(a) Know the reactions of functional groups listed in the specification.					
(b) Identify the functional groups using reactions in the specification.					
Required practical 6 **Tests for alcohol, aldehyde, alkene and carboxylic acid.**					

3.3.6.2 Mass spectrometry

(a) Use mass spectrometry to determine the molecular formula of a compound.					
(b) Identification of the molecular ion peak.					
(c) Interpretation of the mass spectrum of a compound.					

3.3.6.3 Infrared spectroscopy

(a) Explain how bonds in a molecule absorb infrared radiation at characteristic wavenumbers.					
(b) Know ‘fingerprinting’ allows identification of a molecule by comparison of spectra.					
(c) Use infrared spectra and the Chemistry Data Sheet or Booklet to identify particular bonds, and therefore functional groups, and also to identify impurities.					
(d) The link between absorption of infrared radiation by bonds in CO2, methane and water vapour and global warming.					

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

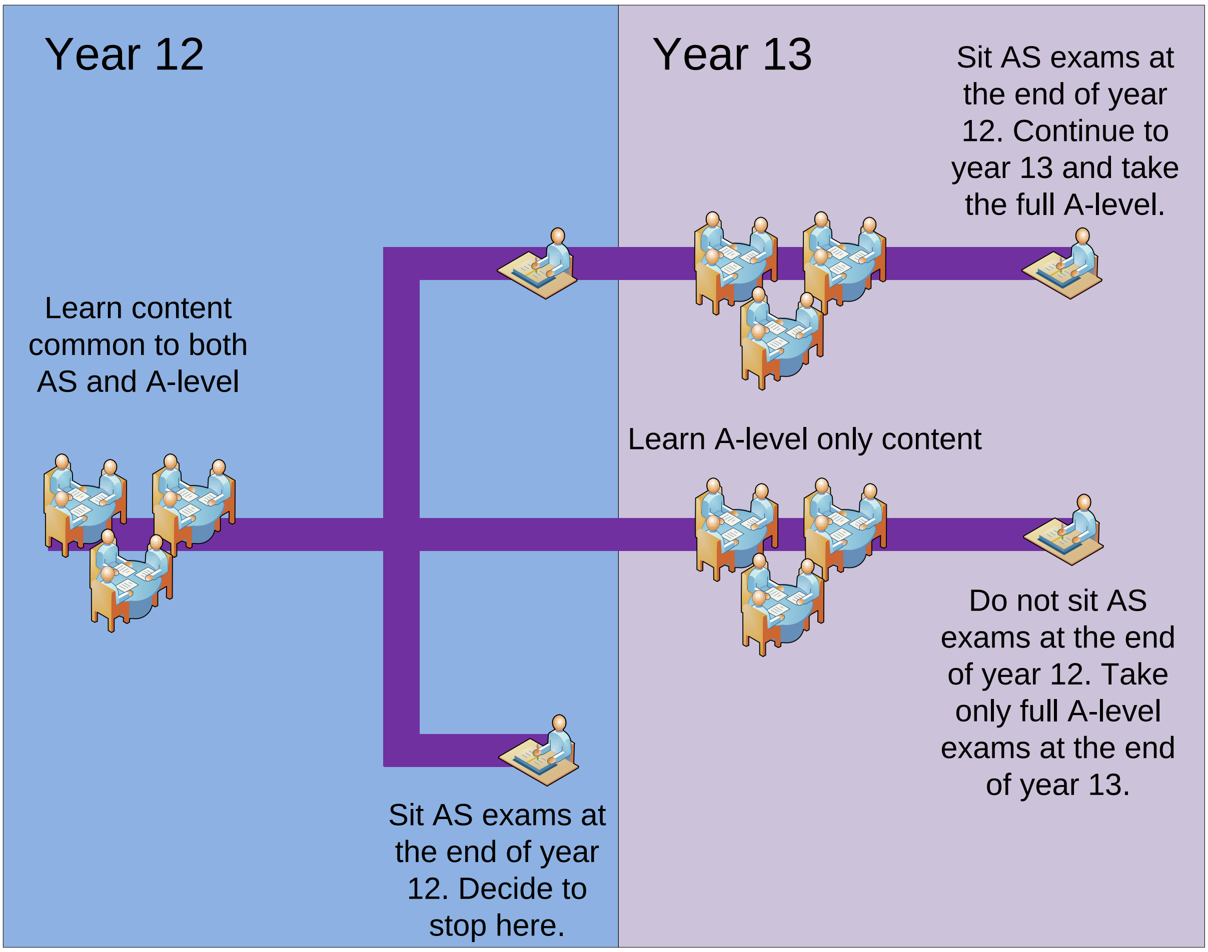
Should you study AS or A-level?

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	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

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

<table>
<tr><th colspan="2">$MgCl_2$</th></tr>
<tr><td rowspan="2">Mg^{2+}</td><td>Cl^-</td></tr>
<tr><td>Cl^-</td></tr>
<tr><td>+2</td><td>−2</td></tr>
</table>

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
							1.0 **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

A-Level Chemistry Reading List 2018/19

AQA course text books are supplied. However owning your own copy allows additional notes to be added and reduces the need to carry books. These books are.
AQA Chemistry year 1 and AS. Oxford University press. ISBN 978 019 835181 8
AQA Chemistry year 2 A level. Oxford University press. ISBN 978 019 835771 1

Course Related Additional Reading.

Calculations in AS/A level Chemistry. By Jim Clark. ISBN 0582 41127 0 An excellent guide to the mathematical aspects of chemistry. Highly recommended.

CGP Head Start to A Level Chemistry
https://www.cgpbooks.co.uk/Student/books_a_level_chemistry_aqa.book_CBR71
A book designed to help with the significant step up from GCSE to A level.

CGP Revision guides and workbooks.
https://www.cgpbooks.co.uk/Student/books_a_level_chemistry_aqa.book_CARQB71
A useful set of learning aids.

Chemistry In Context. By Hill and Holman. ISBN 978 017 448276 5.
A very useful book which provides excellent background information to the A level syllabus.

Course Related Websites

Chemguide. https://www.chemguide.co.uk/ Probably the best A level chemistry website out there.

Alevelchemistry. http://www.a-levelchemistry.co.uk/ Good notes and an excellent range of worksheets.

Periodic Table Of Videos http://www.periodicvideos.com/ Resources from the university of Nottingham.

Royal Society Of Chemistry
http://www.rsc.org/?gclid=EAIaIQobChMIttLryenL2wIVzbztCh2J_Ab2EAAYASAAEgIIqvD_BwE A wide range of resources.

Chemtube 3D http://www.chemtube3d.com/ALevel.html Useful animations for organic chemistry

Catalyst https://www.stem.org.uk/catalyst A magazine aimed at students aged 16-19.

Wider Reading.

A (purely optional) selection of books from the wider world of chemistry.

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

Title of publication	Where to find it	Links to course
Broadcast media		
BBC iPlayer	https://www.bbc.co.uk/iplayer/episode/b00q2mk5/chemistry-a-volatile-history-1-discovering-the-elements	Looks at the history of chemistry. Good links to organic chemistry, biology and medicine.
BBC iPlayer	https://www.bbc.co.uk/iplayer/episode/p02vmx6x/colour-the-spectrum-of-science-1-colours-of-earth	Looks at the role of molecules, light and the perception of colour
BBC iPlayer	https://www.bbc.co.uk/iplayer/episode/m000hbdk/how-to-make-series-1-3-headphones	Development of material science and design technology
BBC iPlayer	https://www.bbc.co.uk/iplayer/episode/p06qj389/the-planets-series-1-5-into-the-darkness-ice-worlds	Astrophysics, astrochemistry and the development of new technology which leads to innovation
	https://www.bbc.co.uk/iplayer/episode/m000qplx/royal-institution-christmas-lectures-2020-planet-earth-a-users-guide-3-up-in-the-air	Ideas about science and the lives of influentual scientists
Podcasts		
BBC Sounds	https://www.bbc.co.uk/sounds/play/p0995bv0	Infinite Monkey Cage. Topical science discussion show from BBC Radio 4
BBC Sounds	https://www.bbc.co.uk/sounds/play/p039786l	Journey into the centre of the atom
BBC Sounds	https://www.bbc.co.uk/sounds/play/b00stcgv	Brief history of mathematics and how it drives science
BBC Sounds	https://www.bbc.co.uk/sounds/play/m000cn05	In their element. A series about different elements of the periodic table and their uses
BBC Sounds	https://www.bbc.co.uk/sounds/play/p033jwsh	Physics made simple. The physics of materials and concepts which underpin science

	Online media	
	https://www.newscientist.com/	Topic articles about the latest discoveries and current affairs. Relatively cheap web/app only subscription
	https://www.rsc.org/	Royal Society of Chemistry. Hugh quantity of interesting and useful articles, books and websites
	http://www.periodicvideos.com/	A periodic table with a link to a video about each element
	Books	
	https://www.independent.co.uk/extras/indybest/arts-books/non-fiction-books/best-popular-science-books-new-best-selling-physics-genetics-young-adults-a7533706.html	10 most popular science books
	https://www.goodreads.com/shelf/show/chemistry	10 most popular science books
	https://www.aqa.org.uk/subjects/science/as-and-a-level-chemistry-textbooks	Recommended textbooks supporting A' Level Chemistry. These can be obtained secondhand from many resellers at very low prices. We buy in CGP text books for students at cost price in September