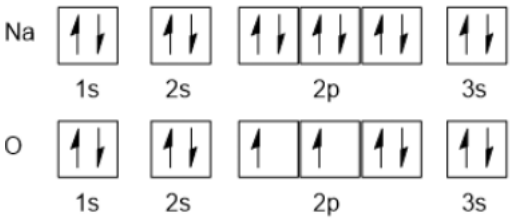
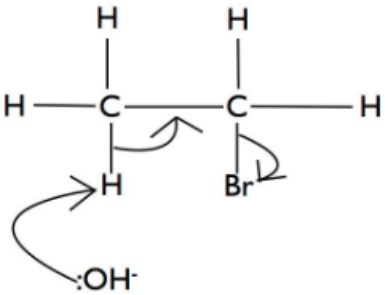


AQA A Level Chemistry

Y12 Content

Full List of AS Content



- 3.1.1 Atomic structure (Paper 1)
- 3.1.2 Amount of substance (Paper 1 and 2)
- 3.1.3 Bonding Paper 1 and 2
- 3.1.4 Energetics Paper 1 and 2
- 3.1.5 Kinetics Paper 2
- 3.1.6 Chemical equilibria, LeChatelier's principle and Kc Paper 1 and 2
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Assessments

Paper 1
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
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

Paper 2
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
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

3.1.1 Atomic Structure Paper 1

Content	Checklist
Appreciate that knowledge and understanding of atomic structure has evolved over time, giving some examples.	
Recall an atom consists of a nucleus containing protons and neutrons surrounded by electrons.	
Know relative charges and relative masses of subatomic particles, ie: Protons: +1 relative charge, 1 relative mass Neutrons: 0 relative charge, 1 relative mass Electrons: -1 relative charge, 1/1836 relative mass	
Understand what's meant by mass number (A) and atomic number (Z).	
Determine the number of fundamental particles in atoms and ions using mass number, atomic number and charge.	
Explain the existence of isotopes	
To define atoms and ions in terms of protons, neutrons and electrons.	
Explain how a TOF mass spectrometer works (ionisation, acceleration, ion drift, ion detection, data analysis) and some of its simple uses.	
The mass spectrometer gives accurate information about relative isotopic mass and also about the relative abundance of isotopes	
Know mass spectrometry can be used to identify elements.	
Know mass spectrometry can be used to determine relative molecular mass.	
Interpret simple mass spectra	
Calculate relative atomic mass from isotopic abundance, limited to mononuclear ions	
Find the relative formula mass of compounds from mass spectroscopy data.	
Describe the electron structure of atoms and ions.	
Give the electron structure of atoms and ions up to Z=36 in terms of s, p and d sub-shells	
Write equations for ionisation energy (first and successive)	
Define first ionisation energy	
Write equations for first and successive ionisation energies	
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 shells.	

3.1.2 Amount of Substance Paper 1 and 2

Content	Checklist
Define relative atomic mass (A_r)	
Define relative molecular mass (M_r) in terms of ^{12}C.	
Determine relative molecular mass (M_r) of a substance using relative atomic mass (A_r) values.	
Know the term relative formula mass will be used for ionic compounds.	
The Avogadro constant as the number of particles in a mole.	
The mole as applied to electrons, atoms, molecules, ions, formulas and equations.	
Do calculations using moles for solids and solutions, and using the Avogadro constant.	
Know the unit for concentration of a substance in solution (mol dm^{-3}).	
Know that we use mass of substance, M_r, and amount in moles.	
Know that we use concentration, volume and amount of substance in a solution.	
Carry out calculations with the ideal gas equation, including rearranging the ideal gas equation to find unknown quantities (pV=nRT).	
Empirical formula is the simplest whole number ratio of atoms of each element in a compound.	
Know molecular formula is the actual number of atoms of each element in a compound.	
Know the relationship between empirical and molecular.	
Carry out calculations: • To find empirical formula from data giving composition by mass or percentage by mass. • To find molecular formula from the empirical formula and relative molecular mass.	
Write balanced full and ionic equations.	
Use equations to calculate masses, percentage yields, atom economies, volumes of gases, concentrations & volumes of solutions.	
Understand the importance of processes having a high atom economy for society and industry.	
Carry out calculations for reactions involving: • masses, • percentage yields, • atom economies, • volumes of gases, • concentrations & volumes of solutions	
Give economic, ethical and environmental advantages for society and industry of 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 Paper 1 and 2

Content	Checklist
Describe the structure of ionic compounds	
Explain the properties of ionic compounds using an understanding of ionic bonding	
Predict the formula of simple ions based on the position of the element in the Periodic Table and knowledge of common compound ions	
Write the formula of ionic compounds.	
Understand covalent bonding, including co-ordinate bonds.	
Describe the nature of covalent bonds, including co-ordinate and multiple bonds	
Represent molecules by diagrams where lines represent each covalent bond, with an arrow to represent a co-ordinate bond	
Describe the structure of molecular substances.	
Explain the properties of molecular substances.	
Understand and describe the nature of metallic bonding.	
Describe the structure of metals	
Explain the properties of metals.	
Understand the structure of ionic, molecular, giant covalent (macromolecular) and metallic substances.	
Describe and explain how properties relate to type of structure and bonding in ionic, molecular, giant covalent and metallic substances, for melting/boiling points and conductivity	
Describe in detail and draw the structures of diamond, graphite, ice, iodine, magnesium and sodium chloride.	
Explain the energy changes associated with changes of state.	
Work out, name and sketch the shape of molecules and ions.	
Explain using VSEPR theory why molecules and ions have the shapes that they do, including the effect on the bond angles of the greater repulsion by lone (non-bonding) pairs.	
Define and understand the concept of electronegativity (the power of an atom to attract the pair of electrons in a covalent bond).	
Understand why some covalent bonds are polar and deduce whether a bond is polar. Use partial charges to show that a bond is polar.	
Understand why some molecules are polar and deduce whether a molecule has a permanent dipole.	
Explain why some molecules with polar bonds do not have a permanent dipole.	
Understand that there are three types of intermolecular force, induced dipole-dipole (van der Waals', dispersion, London) forces, permanent dipole-dipole forces, and hydrogen bonds.	

Explain how each of the intermolecular forces arise	
Explain how the melting and boiling points of molecular substances are influenced by the strength of these intermolecular forces	
Explain the anomalous nature of ice, and how its low density can be explained through a knowledge of hydrogen bonding.	

3.1.4 Energetics Paper 1 and 2

Content	Checklist
Know that reactions can be either exothermic, negative sign that releases energy, or endothermic, positive sign that takes in energy	
Define enthalpy change: the heat energy change measured under conditions of constant pressure.	
Know standard enthalpy changes refer to standard conditions	
Define standard conditions: 100 kPa and a stated temperature eg ΔH_{298}^{θ}	
Define standard enthalpy changes of combustion, $\Delta_c H^{\theta}$, and formation, $\Delta_f H^{\theta}$	
Recall the equation for heat change in a reaction: $q = mc\Delta T$	
Know the units for $q = mc\Delta T$	
Calculate ΔH for reactions using calorimetry experiment data.	
Use $q = mc\Delta T$ to calculate the molar enthalpy change for a reaction	
Understand Hess's law.	
Use Hess's law to calculate enthalpy changes using enthalpies of formation and combustion.	
Find ΔH for a reaction using Hess's law and calorimetry, then present data in appropriate ways	
Understand the term mean bond enthalpy.	
Use mean bond enthalpies to calculate an approximate value of ΔH for reactions in the gaseous phase	
Understand that bond enthalpies are mean values across a range of compounds containing that bond	
Explain why values from mean bond enthalpy calculations differ from those determined using Hess's law	

Required practical 2
Measurement of an enthalpy change.

3.1.5 Kinetics Paper 2

Content	Checklist
Know that reactions only occur when collisions take place when there's sufficient energy between particles	
Define activation energy	
Explain why most collisions don't lead to a reaction	
Explain that reactions can only take place when particles collide with energy greater than or equal to the activation energy (collision theory).	
Draw and interpret Maxwell–Boltzmann distribution curves of molecular energies in gases.	
Understand how and why temperature affects the rate of chemical reactions, using Maxwell Boltzmann distributions.	
Use the Maxwell Boltzmann distribution to explain why a small temperature increase can lead to a large increase in rate	
Define the term rate of reaction	
Understand how and why concentration and pressure affect the rate of chemical reactions.	
Explain how and why pressure of gases affects the rate of reactions.	
A catalyst is a substance that increases the rate of a chemical reaction without being changed in chemical composition or amount.	
Catalysts work by providing an alternative reaction route of lower activation energy.	
Use a Maxwell–Boltzmann distribution to help explain how a catalyst increases the rate of a reaction involving a gas.	

Required practical 3

Investigation of how the rate of a reaction changes with temperature.

3.1.6 Equilibria and Kc Paper 1 and 2

Content	Checklist
Understand that many chemical reactions are reversible.	
Describe what is meant the term dynamic equilibrium.	
Know that reversible reactions at equilibrium: • Forward and reverse reactions are at the same rate.	
• The concentration of reactants and products are constant.	
Understand Le Chatelier's principle.	
Appreciate Le Chatelier's principle can be used to predict the effects of changes in temperature, pressure and concentration on the position of equilibrium in homogeneous reactions.	
Explain why a catalyst doesn't affect the position of equilibrium.	
Use Le Chatelier's principle to predict qualitatively the effect of changes in temperature, pressure and concentration on the position of equilibrium	
Explain how changes in temperature, pressure and concentration affect the position of a system at equilibrium	
Explain why compromise conditions of temperature and pressure may be used for a reversible reaction in an industrial process.	
Understand the equilibrium constant Kc is deduced from the equation from reversible reactions.	
Write an expression for Kc for a homogeneous equilibrium, including its units.	
The concentration, in mol dm^{-3}, of a species X involved in the expression for Kc is represented by [X]	
Know the value of the equilibrium constant is not affected either by changes in concentration or addition of a catalyst.	
Calculate the moles and concentration of reagents at equilibrium.	
Calculate the value of Kc, including units.	
The value of the equilibrium constant is not affected either by changes in concentration of the addition of a catalyst.	
Calculate the value of Kc from the equilibrium concentrations for a homogeneous system at constant temperature.	
Predict the qualitative effects of changes of temperature on the value of Kc.	

3.1.7 Redox Paper 1

Content	Checklist
Understand redox reactions involve a transfer of electrons from the reducing agent to the oxidising agent	
Know oxidation is losing electrons, or gaining oxygen.	
Know reduction is gaining electrons, or losing oxygen.	
Reducing agents are electron donors. Oxidising agents are electron acceptors.	
Understand the terms oxidising agents and reducing agents.	
Appreciate the change in the oxidation state of an element in a compound or ion is used to identify the element that has been oxidised or reduced in a given reaction.	
Know the rules for assigning oxidation states.	
Determine oxidation states.	
Work out the oxidation state of an element in a compound or ion from the formula	
Write redox half equations, identifying the oxidation and reduction processes in redox reactions.	
Combine redox half equations to produce overall redox equations	
Identify reduction and oxidation processes.	

3.2.1 Periodicity Paper 1

Content	Checklist
Recall the Periodic Table provides chemists with a structured organisation of the known chemical elements from which they can make sense of their physical and chemical properties	
Know how to classify an element in s, p, d or f blocks from the position in the periodic table.	
Classify an element as an s, p, d or f block element using its electron structure	
Describe and explain the trends across Period 3 (Na-Ar) in: • atomic radius,	
• first ionisation energy,	
• melting points	
Explain the melting point of the elements in terms of their structure and bonding.	
Explain the trends in atomic radius and first ionisation energy.	

3.2.2 Group 2 Alkaline Earth Metals Paper 1

Content	Checklist
From Mg-Ba, know and explain trends in: • atomic radius,	
• first ionisation energy,	
• and melting point.	
Explain the melting point of the elements in terms of their structure and bonding.	
Explain the trends in atomic radius and first ionisation energy.	
Understand how the trends in the solubilities of the hydroxides and the sulphates of Group 2 elements are linked to their use.	
Know the role of Mg in the extraction of Ti from $TiCl_4$.	
Describe and write equations for the reactions of Mg–Ba with water	
Know the relative solubilities of Group 2 sulphates and hydroxides in water.	
$Mg(OH)_2$ is sparingly soluble	
$BaSO_4$ is insoluble	
Know uses of • $Mg(OH)_2$ and $BaSO_4$ in medicine	
• Acidified $BaSO_4$ in testing for sulphate ions	
• $Ca(OH)_2$ in agriculture	
• Mg in the extraction of Ti	
• $CaO/CaCO_3$ in removing SO_2 from flue gases	
Explain why $BaCl_2$ solution is used to test for sulphate ions and why it is acidified	

3.2.3 Group 17: Halogens Paper 1

Content	Checklist
Describe and explain the trends down Group 7 in electronegativity.	
Describe and explain the trend in the boiling point of halogens in terms of their structure and bonding.	
Know the trend in oxidising ability of the halogens down the group, including displacement reactions of halide ions in aqueous solution.	
Know the trend in reducing ability of the halide ions, including the reactions of solid sodium halides with concentrated sulfuric acid.	
Describe and explain how halide ions can be identified using acidified silver nitrate and the solubility of silver halides in ammonia.	
Know trend in solubility of the silver halides in ammonia.	
Explain why silver nitrate solution is used to identify halide ions.	
Explain why the silver nitrate used is acidified.	
Explain why ammonia solution is added.	
Know the reactions of chlorine with water	
Know the reaction of chlorine with water to form chloride ions and chlorate(I) ions.	
Know the reaction of chlorine with water to form chloride ions and oxygen	
Know how and why chlorine is used in water treatment.	
Evaluate advantages and disadvantages of adding chemicals to water.	
Appreciate that the benefits to health of water treatment by chlorine outweigh its toxic effects.	
Know the reaction of chlorine with cold, dilute, aqueous NaOH and uses of the solution formed.	

Required practical 4

Carry out simple test-tube reactions in aqueous solution to identify:

- Cations (Group 2, NH_4^+)
- Anions (Group 7 (halide), OH^-, CO_3^{2-}, SO_4^{2-})

3.3.1 Introduction to Organics Paper 2

Content	Checklist
Understand the different types of formulas used in organic chemistry.	
Define and show examples of: • Empirical formula	
• General formula	
• Molecular formula	
• Structural formula	
• Display formula	
• Skeletal formula	
Describe the characteristics of a homologous series (a series of compounds containing the same functional group).	
Know the IUPAC rules for nomenclature	
Draw the skeletal, displayed and structural formulas and name organic molecules with chains and rings with up to six carbon atoms each, using IUPAC rules	
For both free radical and curly arrow mechanisms, write/draw the mechanisms, and understand what they represent.	
Know the unpaired electron in a radical is represented by a dot.	
Write balanced equations for the steps in a free-radical mechanism (curly arrows not required for radical mechanisms).	
Understand the concept of the curly arrow (arrows repreent movement of electron pairs).	
Draw mechanisms with curly arrow diagrams (electrophilic addition, nucleophilic addition and nucleophilic substitution).	
Know the formation of a covalent bond is shown by a curly arrow that starts from a lone electron pair or from another covalent bond.	
And the breaking of a covalent bond is shown by a curly arrow starting from the bond.	
Define and understand the difference between structural and stereoisomerism.	
Understand the three types of structural isomerism: chain, position and functional group.	
E-Z isomerism is a form of stereoisomerism and occurs as a result of restricted rotation about the planar carbon- carbon double bond.	
Understand and explain the cause/origin of *E-Z* isomerism.	
Draw the structural formulas and name *E-Z* isomers using Cahn-Ingold-Prelog (CIP) priority rules.	
Draw the structures of chain, position and functional group isomers and name them.	

3.3.2 Alkanes Paper 2

Content	Checklist
Recall alkanes are the main constituent of crude oil, which is an important raw material for the chemical industry	
Recall that Alkanes are saturated hydrocarbons.	
Define saturated hydrocarbon	
Know that petroleum is a mixture consisting mainly of alkane hydrocarbons that can be separated by fractional distillation.	
Explain how the alkanes in crude oil are separated by fractional distillation.	
Recall cracking involves breaking C–C bonds in alkanes	
Understand thermal cracking takes place at high pressure and high temperature and produces a high percentage of alkenes (mechanism not required).	
Catalytic cracking takes place at a slight pressure, high temperature and in the presence of a zeolite catalyst	
Catalytic cracking is used mainly to produce motor fuels and aromatic hydrocarbons	
Explain the economic reasons for cracking alkanes	
Write equations for the complete and incomplete combustion of alkanes.	
Understand the internal combustion engine produces a number of pollutants including NO, CO, carbon and unburned hydrocarbons.	
Gaseous pollutants from internal combustion engines can be removed using catalytic converters.	
Recall combustion of hydrocarbons containing sulphur leads to sulphur dioxide that causes air pollution	
Explain why sulphur dioxide can be removed from flue gases using calcium oxide or calcium carbonate.	
Write an equation for the reaction of methane with chlorine	
Explain the methane-chlorine reaction as a free-radical substitution mechanism involving initiation, propagation and termination steps	
Represent the unpaired electron in the mechanism in a radical using a dot.	

3.3.3 Halogenoalkanes Paper 2

Content	Checklist
Halogenoalkanes are much more reactive than alkanes.	
Draw and name halogenoalkanes.	
Understand halogenoalkanes contain polar bonds	
Know halogenoalkanes undergo substitution reactions with the nucleophiles OH^- , CN^- and NH_3	
From the above reactions, outline the nucleophilic substitution mechanisms of these reactions.	
Explain why the carbon-halogen bond enthalpy influences the rate of reaction.	
Explain the relative rate of reaction of halogenoalkanes.	
Explain the role of the reagent as both nucleophile and base.	
Write equations and mechanisms for elimination reaction of halogenoalkanes using OH^-	
Understand the concurrent nature of elimination and substitution when halogenoalkanes react with OH^-	
Understand the different roles of the OH^- in these reactions.	
Know Ozone, that's formed naturally in upper atmosphere, is beneficial since it absorbs ultraviolet radiation.	
Know 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	
Appreciate chemists have now developed alternative chlorine-free compounds.	
Use equations to explain how chlorine atoms catalyse decomposition of ozone Eg $Cl\bullet + O_3 \rightarrow ClO\bullet + O_2$ and $ClO\bullet + O_3 \rightarrow 2O_2 + Cl\bullet$	
Understand the mechanism for the depletion of ozone by chlorine free radicals	
Evaluate the role of chemists in the introduction of legislation to ban the use of CFCs as solvents and refrigerants and to find alternative chlorine free compounds.	

3.3.4 Alkenes Paper 2

Content	Checklist
Alkenes are unsaturated hydrocarbons	
Define unsaturated hydrocarbon	
Draw alkenes	
Understand in alkenes' bonding, the high electron density of the carbon-carbon double bond leads to attack on these molecules by electrophiles.	
Write equations and mechanisms for reactions of alkenes with HBr, H_2SO_4 and Br_2 (electrophilic addition).	
Explain the formation of major and minor products of unsymmetrical alkenes by reference to the relative stabilities of primary, secondary and tertiary carbocation intermediates.	
Recall the test for unsaturation with bromine water	
Describe what a polymer is.	
Know addition polymers are formed from alkenes and substituted alkenes.	
Identify the repeating unit of an addition polymer given the monomer structure and vice versa.	
Draw repeating units from monomers, and sections of polymer chains	
Draw the structure of the monomer from a section of the polymer	
Name polymers from the name of the monomer	
Appreciate that knowledge and understanding of the production and properties of polymers has developed over time	
Give some uses of poly(chloroethene) PVC and how plasticisers can change its properties.	
Explain why addition polymers are unreactive	
Explain the nature of the intermolecular forces between poly-alkene molecules.	

3.3.5 Alcohols Paper 2

Content	Checklist
Know alcohols have many scientific, medicinal and industrial uses	
Understand alcohols are produced industrially by hydration of alkenes in the presence of an acid catalyst.	
Write equations and give conditions for the production of alcohols by hydration of alkenes	
Outline the mechanism for formation of ethanol from reaction of ethene with steam with an acid catalyst	
Know ethanol can be produced by the reaction of ethene and steam using a phosphoric acid catalyst.	
Ethanol is produced industrially by fermentation of glucose. It is separated by fractional distillation and used as a biofuel.	
Write an equation, give and justify conditions for the production of ethanol by fermentation of glucose.	
Define biofuel	
Evaluate ethanol as a biofuel, including environmental and ethical issues	
Show, using equations, how ethanol made by fermentation can be regarded as carbon neutral, but that in reality it is not.	
Classify alcohols as primary, secondary or tertiary.	
Identify products, and write equations, for oxidation reactions of alcohols, using [O} as the oxident.	
Use chemical tests to distinguish aldehydes and ketones, including Fehling's solution and Tollens' reagent.	
Explain how the method used to oxidise a primary alcohol determines whether an aldehyde or carboxylic acid is obtained.	
Know primary alcohols can be oxidised to aldehydes which can be further oxidised to carboxylic acids.	
Know secondary alcohols can be oxidised to ketones.	
Know tertiary alcohols are not easily oxidised.	
Know that acidified potassium dichromate(VI) is a suitable oxidising agent.	
Alkenes can be formed from alcohols by acid-catalysed elimination reactions.	
Understand how addition polymers can be made from alkenes made this way without using monomers derived from crude oil.	
Write equations and mechanisms for the elimination of water from alcohols.	

Required practical 5

Distillation of a product from a reaction.

3.3.6 Organic Analysis Paper 2

Content	Checklist
Carry out test-tube reactions in the specification to distinguish alcohols, aldehydes, alkenes and carboxylic acids, and interpret the observations from these reactions to identify the functional group.	
Mass spectrometry can be used to determine the molecular formula of a compound.	
Use precise atomic masses and the precise molecular mass to determine the molecular formula of a compound.	
Bonds in a molecule absorb infrared radiation at characteristic wavenumbers.	
Use infrared spectra and the Chemistry Data Sheet to identify particular bonds, and therefore functional groups, and also to identify impurities.	
Understand how the "fingerprint" region of a spectrum can be used to identify a molecule by comparison of spectra.	
understand the link between absorption of infrared radiation by bonds in CO_2, methane and water vapour and global warming	

Required practical 6

Tests for alcohol, aldehyde, alkene and carboxylic acid.