

Year 12 Chemistry A-Level Overview

Week	Teacher 1	Teacher 2
1	<p>2.1.1 (a) isotopes as atoms of the same element with different numbers of neutrons and different masses</p> <p>2.1.1 (b) atomic structure in terms of the numbers of protons, neutrons and electrons for atoms and ions, given the atomic number, mass number and any ionic charge</p> <p>2.1.1 (c) explanation of the terms <i>relative isotopic mass</i> (mass compared with 1/12th mass of carbon-12) and <i>relative atomic mass</i> (weighted mean mass compared with 1/12th mass of carbon-12), based on the mass of a ^{12}C atom, the standard for atomic masses</p>	<p>2.2.1 (a) the number of electrons that can fill the first four shells</p> <p>2.2.1 (b) atomic orbitals, including:</p> <ul style="list-style-type: none"> (i) as a region around the nucleus that can hold up to two electrons, with opposite spins (ii) the shapes of s- and p-orbitals (iii) the number of orbitals making up s-, p- and d-sub-shells, and the number of electrons that can fill s-, p- and d-sub-shells
2	<p>2.1.1 (d) use of mass spectrometry in:</p> <ul style="list-style-type: none"> (i) the determination of relative isotopic masses and relative abundances of the isotope, (ii) calculation of the relative atomic mass of an element from the relative abundances of its isotopes <p>2.1.1 (e) use of the terms <i>relative molecular mass</i>, M_r, and <i>relative formula mass</i> and their calculation from relative atomic masses</p>	<p>2.2.1 (c) filling of orbitals:</p> <ul style="list-style-type: none"> (i) for the first three shells and the 4s and 4p orbitals in order of increasing energy (ii) for orbitals with the same energy, occupation singly before pairing <p>2.2.1 (d) deduction of the electron configurations of:</p> <ul style="list-style-type: none"> (i) atoms, given the atomic number, up to $Z = 36$ (ii) ions, given the atomic number and ionic charge, limited to s- and p-blocks up to $Z = 36$
3	<p>2.1.2 (a) the writing of formulae of ionic compounds from ionic charges, including:</p> <ul style="list-style-type: none"> (i) prediction of ionic charge from the position of an element in the periodic table (ii) recall of the names and formulae for the following ions: NO_3^-, CO_3^{2-}, SO_4^{2-}, OH^-, NH_4^+, Zn^{2+} and Ag^+ <p>2.1.2 (b) construction of balanced chemical equations (including ionic equations), including state symbols, for reactions studied and for unfamiliar reactions given appropriate information</p>	<p>2.2.2 (a) ionic bonding as electrostatic attraction between positive and negative ions, and the construction of '<i>dot-and-cross</i>' diagrams</p> <p>2.2.2 (b) explanation of the solid structures of giant ionic lattices, resulting from oppositely charged ions strongly attracted in all directions e.g. NaCl</p> <p>2.2.2 (c) explanation of the effect of structure and bonding on the physical properties of ionic compounds, including melting and boiling points, solubility and electrical conductivity in solid, liquid and aqueous states</p>

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	<p>2.1.3 (a) explanation and use of the terms:</p> <p>(i) <i>amount of substance</i></p> <p>(ii) <i>mole</i> (symbol 'mol'), as the unit for amount of substance</p> <p>(iii) the <i>Avogadro constant</i>, N_A (the number of particles per mole, $6.02 \times 10^{23} \text{ mol}^{-1}$)</p> <p>(iv) <i>molar mass</i> (mass per mole, units g mol^{-1})</p> <p>(v) <i>molar gas volume</i> (gas volume per mole, units $\text{dm}^3 \text{ mol}^{-1}$)</p>	
4	<p>2.1.3 (b) use of the terms:</p> <p>(i) <i>empirical formula</i> (the simplest whole number ratio of atoms of each element present in a compound)</p> <p>(ii) <i>molecular formula</i> (the number and type of atoms of each element in a molecule)</p> <p>2.1.3 (c) calculations of empirical and molecular formulae, from composition by mass or percentage compositions by mass and relative molecular mass</p>	<p>2.2.2 (d) covalent bond as the strong electrostatic attraction between a shared pair of electrons and the nuclei of the bonded atoms</p> <p>2.2.2 (e) construction of '<i>dot-and-cross</i>' diagrams of molecules and ions to describe:</p> <p>(i) single covalent bonding</p> <p>(ii) multiple covalent bonding</p> <p>(iii) dative covalent (coordinate) bonding</p> <p>2.2.2 (f) use of the term <i>average bond enthalpy</i> as a measurement of covalent bond strength</p>
5	<p>2.1.3 (d) the terms <i>anhydrous</i>, <i>hydrated</i> and <i>water of crystallisation</i> and calculation of the formula of a hydrated salt from given percentage composition, mass composition or based on experimental results</p> <p>2.1.3 (e) calculations, using amount of substance in mol, involving:</p> <p>(i) mass</p> <p>(ii) gas volume</p> <p>(iii) solution volume and concentration</p>	<p>2.2.2 (g) the shapes of, and bond angles in, molecules and ions with up to six electron pairs (including lone pairs) surrounding the central atom as predicted by electron pair repulsion, including the relative repulsive strengths of bonded pairs and lone pairs of electrons</p> <p>2.2.2 (h) electron pair repulsion to explain the following shapes of molecules and ions: linear, non-linear, trigonal planar, pyramidal, tetrahedral and octahedral</p>
6	<p>2.1.3 (f) the ideal gas equation: $pV = nRT$</p> <p>2.1.3 (g) use of stoichiometric relationships in calculations</p>	<p>2.2.2 (i) electronegativity as the ability of an atom to attract the bonding electrons in a covalent bond; interpretation of Pauling electronegativity values</p> <p>2.2.2 (j) explanation of:</p> <p>(i) a polar bond and permanent dipole within molecules containing covalently-bonded atoms with different electronegativities</p>

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		(ii) a polar molecule and overall dipole in terms of permanent dipole(s) and molecular shape
7	<p>2.1.3 (h) calculations to determine:</p> <p>(i) the percentage yield of a reaction or related quantities</p> <p>(ii) the atom economy of a reaction</p> <p>2.1.3 (i) the techniques and procedures required during experiments requiring the measurement of mass, volumes of solutions and gas volumes</p> <p>2.1.3 (j) the benefits for sustainability of developing chemical processes with a high atom economy</p>	<p>2.2.2 (k) intermolecular forces based on permanent dipole–dipole interactions and induced dipole– dipole interactions</p> <p>2.2.2 (l) hydrogen bonding as intermolecular bonding between molecules containing N, O or F and the H atom of –NH, –OH or HF</p>
8	<p>2.1.4 (a) the formulae of the common acids (HCl, H₂SO₄, HNO₃ and CH₃COOH) and the common alkalis (NaOH, KOH and NH₃) and explanation that acids release H⁺ ions in aqueous solution and alkalis release OH⁻ ions in aqueous solution</p> <p>2.1.4 (b) qualitative explanation of strong and weak acids in terms of relative dissociations</p> <p>2.1.4 (c) neutralisation as the reaction of:</p> <p>(i) H⁺ and OH⁻ to form H₂O</p> <p>(ii) acids with bases, including carbonates, metal oxides and alkalis (water-soluble bases), to form salts, including full equations</p>	<p>2.2.2 (m) explanation of anomalous properties of H₂O resulting from hydrogen bonding, e.g.:</p> <p>(i) the density of ice compared with water</p> <p>(ii) its relatively high melting and boiling points</p> <p>2.2.2 (n) explanation of the solid structures of simple molecular lattices, as covalently bonded molecules attracted by intermolecular forces, e.g. I₂, ice</p> <p>2.2.2 (o) explanation of the effect of structure and bonding on the physical properties of covalent compounds with simple molecular lattice structures including melting and boiling points, solubility and electrical conductivity.</p>
9	<p>2.1.4 (d) the techniques and procedures used when preparing a standard solution of required concentration and carrying out acid–base titrations</p>	<p>3.1.1 (a) the periodic table as the arrangement of elements:</p> <p>(i) by increasing atomic (proton) number</p> <p>(ii) in periods showing repeating trends in physical and chemical properties (periodicity)</p> <p>(iii) in groups having similar chemical properties</p> <p>3.1.1 (b) (i) the periodic trend in electron configurations across Periods 2 and 3 (see also 2.2.1 d)</p> <p>(ii) classification of elements into s-, p- and d-blocks</p>

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<p>10</p>	<p>2.1.4 (e) structured and non-structured titration calculations, based on experimental results of familiar and non-familiar acids and bases</p> <p>PAG - Titrations</p>	<p>3.1.1 (c) first ionisation energy (removal of 1 mol of electrons from 1 mol of gaseous atoms) and successive ionisation energy, and:</p> <p>(i) explanation of the trend in first ionisation energies across Periods 2 and 3, and down a group, in terms of attraction, nuclear charge and atomic radius</p> <p>(ii) prediction from successive ionisation energies of the number of electrons in each shell of an atom and the group of an element</p> <p>3.1.1 (d) explanation of:</p> <p>(i) metallic bonding as strong electrostatic attraction between cations (positive ions) and delocalised electrons</p> <p>(ii) a giant metallic lattice structure, e.g. all metals</p>
<p>11</p>	<p>2.1.5 (a) rules for assigning and calculating oxidation number for atoms in elements, compounds and ions</p> <p>2.1.5 (b) writing formulae using oxidation numbers</p> <p>2.1.5 (c) use of a Roman numeral to indicate the magnitude of the oxidation number when an element may have compounds/ions with different oxidation numbers</p>	<p>3.1.1 (e) explanation of the solid giant covalent lattices of carbon (diamond, graphite and graphene) and silicon as networks of atoms bonded by strong covalent bonds</p> <p>3.1.1 (f) explanation of physical properties of giant metallic and giant covalent lattices, including melting and boiling points, solubility and electrical conductivity in terms of structure and bonding</p> <p>3.1.1 (g) explanation of the variation in melting points across Periods 2 and 3 in terms of structure and bonding</p>
<p>12</p>	<p>2.1.5 (d) oxidation and reduction in terms of:</p> <p>(i) electron transfer</p> <p>(ii) changes in oxidation number</p> <p>2.1.5 (e) redox reactions of metals with acids to form salts, including full equations</p> <p>2.1.5 (f) interpretation of redox equations in (e), and unfamiliar redox reactions, to make predictions in terms of oxidation numbers and electron loss/gain</p>	<p>4.1.1 (a) application of IUPAC rules of nomenclature for systematically naming organic compounds</p> <p>4.1.1 (b) interpretation and use of the terms:</p> <p>(i) <i>general formula</i> (the simplest algebraic formula of a member of a homologous series) e.g. for an alkane: C_nH_{2n+2}</p> <p>(ii) <i>structural formula</i> (the minimal detail that shows the arrangement of atoms in a molecule) e.g. for butane: $CH_3CH_2CH_2CH_3$ or $CH_3(CH_2)_2CH_3$</p>

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13	<p>3.1.2 (a) the outer shell s^2 electron configuration and the loss of these electrons in redox reactions to form $2+$ ions 3.1.2 (b) the relative reactivities of the Group 2 elements Mg \rightarrow Ba shown by their redox reactions with: (i) oxygen (ii) water (iii) dilute acids</p>	<p>4.1.1 (a) application of IUPAC rules of nomenclature for systematically naming organic compounds</p> <p>(iii) <i>displayed formula</i> (the relative positioning of atoms and the bonds between them) e.g. for ethanol: (iv) <i>skeletal formula</i> (the simplified organic formula, shown by removing hydrogen atoms from alkyl chains, leaving just a carbon skeleton and associated functional groups) e.g. for butan-2-ol:</p>
14	<p>3.1.2 (c) the trend in reactivity in terms of the first and second ionisation energies of Group 2 elements down the group 3.1.2 (d) the action of water on Group 2 oxides and the approximate pH of any resulting solutions, including the trend of increasing alkalinity</p>	<p>4.1.1 (c) interpretation and use of the terms: (i) <i>homologous series</i> (a series of organic compounds having the same functional group but with each successive member differing by CH_2) (ii) <i>functional group</i> (a group of atoms responsible for the characteristic reactions of a compound) (iii) <i>alkyl group</i> (of formula $\text{C}_n\text{H}_{2n+1}$) (iv) <i>aliphatic</i> (a compound containing carbon and hydrogen joined together in straight chains, branched chains or non-aromatic rings) (v) <i>alicyclic</i> (an aliphatic compound arranged in non-aromatic rings with or without side chains) (vi) <i>aromatic</i> (a compound containing a benzene ring) (vii) <i>saturated</i> (single carbon-carbon bonds only) and <i>unsaturated</i> (the presence of multiple carbon-carbon bonds, including $\text{C}=\text{C}$, $\text{C}\equiv\text{C}$ and aromatic rings)</p>
15	<p>3.1.2 (e) uses of some Group 2 compounds as bases, including equations, for example (but not limited to): (i) $\text{Ca}(\text{OH})_2$ in agriculture to neutralise acid soils (ii) $\text{Mg}(\text{OH})_2$ and CaCO_3 as 'antacids' in treating indigestion</p>	<p>4.1.1 (c) interpretation and use of the terms: (i) <i>homologous series</i> (a series of organic compounds having the same functional group but with each successive member differing by CH_2) (ii) <i>functional group</i> (a group of atoms responsible for the characteristic reactions of a compound) (iii) <i>alkyl group</i> (of formula $\text{C}_n\text{H}_{2n+1}$) (iv) <i>aliphatic</i> (a compound containing carbon and hydrogen joined together in straight chains, branched chains or non-aromatic rings)</p>

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		<p>(v) <i>alicyclic</i> (an aliphatic compound arranged in non-aromatic rings with or without side chains)</p> <p>(vi) <i>aromatic</i> (a compound containing a benzene ring)</p> <p>(vii) <i>saturated</i> (single carbon–carbon bonds only) and <i>unsaturated</i> (the presence of multiple carbon–carbon bonds, including C=C, C≡C and aromatic rings)</p> <p>4.1.1 (d) use of the general formula of a homologous series to predict the formula of any member of the series</p>
16	<p>3.1.3 (a) existence of halogens as diatomic molecules and explanation of the trend in the boiling points of Cl₂, Br₂ and I₂, in terms of induced dipole–dipole interactions (London forces)</p> <p>3.1.3 (b) the outer shell s²p⁵ electron configuration and the gaining of one electron in many redox reactions to form 1– ions</p>	<p>4.1.1 (e) explanation of the term <i>structural isomers</i> (compounds with the same molecular formula but different structural formulae) and determination of possible structural formulae of an organic molecule, given its molecular formula</p> <p>4.1.1 (f) the different types of covalent bond fission: (i) homolytic fission (in terms of each bonding atom receiving one electron from the bonded pair, forming two radicals) (ii) heterolytic fission (in terms of one bonding atom receiving both electrons from the bonded pair)</p>
17	<p>3.1.3 (c) the trend in reactivity of the halogens Cl₂, Br₂ and I₂, illustrated by reaction with other halide ions</p> <p>3.1.3 (d) explanation of the trend in reactivity shown in (c), from the decreasing ease of forming 1– ions, in terms of attraction, atomic radius and electron shielding</p>	<p>4.1.1 (g) the term <i>radical</i> (a species with an unpaired electron) and use of ‘dots’ to represent species that are radicals in mechanisms</p> <p>4.1.1 (h) a ‘curly arrow’ described as the movement of an electron pair, showing either heterolytic fission or formation of a covalent bond</p> <p>4.1.1 (i) reaction mechanisms, using diagrams, to show clearly the movement of an electron pair with ‘curly arrows’ and relevant dipoles</p>
18	<p>3.1.3 (e) explanation of the term <i>disproportionation</i> as oxidation and reduction of the same element, illustrated by: (i) the reaction of chlorine with water as used in water purification (ii) the reaction of chlorine with cold, dilute aqueous sodium hydroxide, as used to form bleach</p>	<p>4.1.2 (a) alkanes as saturated hydrocarbons containing single C–C and C–H bonds as σ-bonds (overlap of orbitals directly between the bonding atoms); free rotation of the σ-bond</p>

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	<p>(iii) reactions analogous to those specified in (i) and (ii)</p> <p>3.1.3 (f) the benefits of chlorine use in water treatment (killing bacteria) contrasted with associated risks (e.g. hazards of toxic chlorine gas and possible risks from formation of chlorinated hydrocarbons)</p>	<p>4.1.2 (b) explanation of the tetrahedral shape and bond angle around each carbon atom in alkanes in terms of electron pair repulsion (see also 2.2.2 g–h)</p> <p>4.1.2 (c) explanation of the variations in boiling points of alkanes with different carbon-chain length and branching, in terms of induced dipole–dipole interactions (London forces)</p>
19	<p>3.1.3 (g) the precipitation reactions, including ionic equations, of the aqueous anions Cl^-, Br^- and I^- with aqueous silver ions, followed by aqueous ammonia, and their use as a test for different halide ions</p>	<p>4.1.2 (d) the low reactivity of alkanes with many reagents in terms of the high bond enthalpy and very low polarity of the σ-bonds present</p> <p>4.1.2 (e) complete combustion of alkanes, as used in fuels, and the incomplete combustion of alkane fuels in a limited supply of oxygen with the resulting potential dangers from CO</p> <p>4.1.2 (f) the reaction of alkanes with chlorine and bromine by radical substitution using ultraviolet radiation, including a mechanism involving homolytic fission and radical reactions in terms of initiation, propagation and termination</p>
20	<p>3.1.4 (a) qualitative analysis of ions on a test-tube scale; processes and techniques needed to identify the following ions in an unknown compound:</p> <p>(i) anions:</p> <ul style="list-style-type: none"> • CO_3^{2-}, by reaction with $\text{H}^+(\text{aq})$ forming $\text{CO}_2(\text{g})$ (see 2.1.4 c) • SO_4^{2-}, by precipitation with $\text{Ba}^{2+}(\text{aq})$ • Cl^-, Br^-, I^- (see 3.1.3 g) <p>(ii) cations:</p> <p>NH_4^+, by reaction with warm $\text{NaOH}(\text{aq})$ forming NH_3</p>	<p>4.1.2 (g) the limitations of radical substitution in synthesis by the formation of a mixture of organic products, in terms of further substitution and reactions at different positions in a carbon chain</p> <p>4.1.3 (a) alkenes as unsaturated hydrocarbons containing a $\text{C}=\text{C}$ bond comprising a π-bond (sideways overlap of adjacent p-orbitals above and below the bonding C atoms) and a σ-bond (overlap of orbitals directly between the bonding atoms) (see also 4.1.2 a); restricted rotation of the π-bond</p> <p>4.1.3 (b) explanation of the trigonal planar shape and bond angle around each carbon in the $\text{C}=\text{C}$ of alkenes in terms of electron pair repulsion</p>

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21	PAG – Identifying Unknowns	<p>4.1.3 (c) (i) explanation of the terms:</p> <ul style="list-style-type: none"> • <i>stereoisomers</i> (compounds with the same structural formula but with a different arrangement in space) • <i>E/Z isomerism</i> (an example of stereoisomerism, in terms of restricted rotation about a double bond and the requirement for two different groups to be attached to each carbon atom of the C=C group) • <i>cis–trans isomerism</i> (a special case of <i>E/Z</i> isomerism in which two of the substituent groups attached to each carbon atom of the C=C group are the same) <p>(ii) use of Cahn–Ingold–Prelog (CIP) priority rules to identify the <i>E</i> and <i>Z</i> stereoisomers</p> <p>4.1.3 (d) determination of possible <i>E/Z</i> or <i>cis–trans</i> stereoisomers of an organic molecule, given its structural formula</p>
22	<p>3.2.1 (a) explanation that some chemical reactions are accompanied by enthalpy changes that are exothermicΔH, negative) or endothermicΔH, positive)</p> <p>3.2.1 (b) construction of enthalpy profile diagrams to show the difference in the enthalpy of reactants compared with products</p> <p>3.2.1 (c) qualitative explanation of the term <i>activation energy</i>, including use of enthalpy profile diagrams</p>	<p>4.1.3 (e) the reactivity of alkenes in terms of the relatively low bond enthalpy of the pi-bond</p> <p>4.1.3 (f) addition reactions of alkenes with:</p> <ul style="list-style-type: none"> (i) hydrogen in the presence of a suitable catalyst, e.g. Ni, to form alkanes (ii) halogens to form dihaloalkanes, including the use of bromine to detect the presence of a double C=C bond as a test for unsaturation in a carbon chain (iii) hydrogen halides to form haloalkanes (iv) steam in the presence of an acid catalyst, e.g. H_3PO_4, to form alcohols <p>4.1.3 (g) definition and use of the term <i>electrophile</i> (an electron pair acceptor)</p>
23	<p>3.2.1 (d) explanation and use of the terms:</p> <ul style="list-style-type: none"> (i) <i>standard conditions</i> and <i>standard states</i> (physical states under standard conditions) 	<p>4.1.3 (h) the mechanism of electrophilic addition in alkenes by heterolytic fission</p> <p>4.1.3 (i) use of Markownikoff's rule to predict formation of a major organic product in addition reactions of H–X to unsymmetrical alkenes,</p>

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	<p>(ii) <i>enthalpy change of reaction</i> (enthalpy change associated with a stated equation, $\Delta_r H$)</p> <p>(iii) <i>enthalpy change of formation</i> (formation of 1 mol of a compound from its elements, $\Delta_f H$)</p> <p>(iv) <i>enthalpy change of combustion</i> (complete combustion of 1 mol of a substance, $\Delta_c H$)</p> <p>(v) <i>enthalpy change of neutralisation</i> (formation of 1 mol of water from neutralisation, $\Delta_{neut} H$)</p>	<p>e.g. H–Br to propene, in terms of the relative stabilities of carbocation intermediates in the mechanism</p>
24	<p>3.2.1 (e) determination of enthalpy changes directly from appropriate experimental results, including use of the relationship: $q = mc\Delta T$</p> <p>3.2.1 (f) (i) explanation of the term <i>average bond enthalpy</i> (breaking of 1 mol of bonds in gaseous molecules)</p> <p>(ii) explanation of exothermic and endothermic reactions in terms of enthalpy changes associated with the breaking and making of chemical bonds</p> <p>(iii) use of average bond enthalpies to calculate enthalpy changes and related quantities</p>	<p>4.1.3 (j) addition polymerisation of alkenes and substituted alkenes, including:</p> <p>(i) the repeat unit of an addition polymer deduced from a given monomer</p> <p>(ii) identification of the monomer that would produce a given section of an addition polymer</p>
25	<p>3.2.1 (g) Hess' law for construction of enthalpy cycles and calculations to determine indirectly:</p> <p>(i) an enthalpy change of reaction from enthalpy changes of combustion</p> <p>(ii) an enthalpy change of reaction from enthalpy changes of formation</p> <p>(iii) enthalpy changes from unfamiliar enthalpy cycles</p> <p>3.2.1 (h) the techniques and procedures used to determine enthalpy changes directly and indirectly</p>	<p>4.1.3 (k) the benefits for sustainability of processing waste polymers by:</p> <p>(i) combustion for energy production</p> <p>(ii) use as an organic feedstock for the production of plastics and other organic chemicals</p> <p>(iii) removal of toxic waste products, e.g. removal of HCl formed during disposal by combustion of halogenated plastics (e.g. PVC)</p> <p>4.1.3 (l) the benefits to the environment of development of biodegradable and photodegradable polymers</p>

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26	PAG – Enthalpy / Hess' Law	4.2.1 (a) (i) the polarity of alcohols and an explanation, in terms of hydrogen bonding, of the water solubility and the relatively low volatility of alcohols compared with alkanes (see also 2.2.2 I and 4.1.2 c) (ii) classification of alcohols into primary, secondary and tertiary alcohols
27	3.2.2 (a) the effect of concentration, including the pressure of gases, on the rate of a reaction, in terms of frequency of collisions 3.2.2 (b) calculation of reaction rate from the gradients of graphs measuring how a physical quantity changes with time	4.2.1 (b) combustion of alcohols 4.2.1 (c) oxidation of alcohols by an oxidising agent, e.g. $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ (i.e. $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4$), including: (i) the oxidation of primary alcohols to form aldehydes and carboxylic acids; the control of the oxidation product using different reaction conditions (ii) the oxidation of secondary alcohols to form ketones (iii) the resistance to oxidation of tertiary alcohols
28	3.2.2 (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 3.2.2 (d) (i) explanation of the terms <i>homogeneous</i> and <i>heterogeneous</i> 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 3.2.2 (e) the techniques and procedures used to investigate reaction rates including the measurement of mass, gas volumes and time	PAG 5.3 Oxidation of Ethanol

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29	<p>3.2.2 (f) qualitative explanation of the Boltzmann distribution and its relationship with activation energy</p> <p>3.2.2 (g) explanation, using Boltzmann distributions, of the qualitative effect on the proportion of molecules exceeding the activation energy and hence the reaction rate, for:</p> <p>(i) temperature changes</p> <p>(ii) catalytic behaviour</p>	<p>4.2.1 (d) elimination of H₂O from alcohols in the presence of an acid catalyst (e.g. H₃PO₄ or H₂SO₄) and heat to form alkenes</p> <p>4.2.1 (e) substitution with halide ions in the presence of acid (e.g. NaBr/H₂SO₄) to form haloalkanes</p> <p>4.2.2 (a) hydrolysis of haloalkanes in a substitution reaction:</p> <p>(i) by aqueous alkali</p> <p>(ii) by water in the presence of AgNO₃ and ethanol to compare experimentally the rates of hydrolysis of different carbon– halogen bonds</p>
30	<p>3.2.3 (a) explanation that a dynamic equilibrium exists in a closed system when the rate of the forward reaction is equal to the rate of the reverse reaction and the concentrations of reactants and products do not change</p> <p>3.2.3 (b) Le Chatelier's principle and its application for homogeneous equilibria to deduce qualitatively the effect of a change in temperature, pressure or concentration on the position of equilibrium</p> <p>3.2.3 (c) explanation that a catalyst increases the rate of both forward and reverse reactions in an equilibrium by the same amount resulting in an unchanged position of equilibrium</p>	<p>4.2.2 (b) definition and use of the term <i>nucleophile</i> (an electron pair donor)</p> <p>4.2.2 (c) the mechanism of nucleophilic substitution in the hydrolysis of primary haloalkanes with aqueous alkali</p> <p>4.2.2 (d) explanation of the trend in the rates of hydrolysis of primary haloalkanes in terms of the bond enthalpies of carbon–halogen bonds (C–F, C–Cl, C–Br and C–I)</p>
31	<p>3.2.3 (d) the techniques and procedures used to investigate changes to the position of equilibrium for changes in concentration and temperature</p> <p>3.2.3 (e) explanation of the importance to the chemical industry of a compromise between chemical equilibrium and reaction rate in deciding the operational conditions</p>	<p>4.2.2 (e) production of halogen radicals by the action of ultraviolet (UV) radiation on CFCs in the upper atmosphere and the resulting catalysed breakdown of the Earth's protective ozone layer, including equations to represent:</p> <p>(i) the production of halogen radicals</p> <p>(ii) the catalysed breakdown of ozone by Cl• and other radicals e.g. •NO</p>

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32	<p>3.2.3 (f) expressions for the equilibrium constant, K_c, for homogeneous reactions and calculations of the equilibrium constant, K_c, from provided equilibrium concentrations</p> <p>3.2.3 (g) estimation of the position of equilibrium from the magnitude of K_c</p>	<p>4.2.3 (a) the techniques and procedures for:</p> <p>(i) use of Quickfit apparatus including for distillation and heating under reflux</p> <p>(ii) preparation and purification of an organic liquid including:</p> <ul style="list-style-type: none"> • use of a separating funnel to remove an organic layer from an aqueous layer • drying with an anhydrous salt (e.g. $MgSO_4$, $CaCl_2$) • re-distillation
33	<p>4.2.4 (a) infrared (IR) radiation causes covalent bonds to vibrate more and absorb energy</p> <p>4.2.4 (b) absorption of infrared radiation by atmospheric gases containing C=O, O–H and C–H bonds (e.g. CO_2, H_2O and CH_4), the suspected link to global warming and resulting changes to energy usage</p> <p>4.2.4 (c) use of an infrared spectrum of an organic compound to identify:</p> <p>(i) an alcohol from an absorption peak of the O–H bond</p> <p>(ii) an aldehyde or ketone from an absorption peak of the C=O bond</p> <p>(iii) a carboxylic acid from an absorption peak of the C=O bond and a broad absorption peak of the O–H bond</p>	<p>4.2.3 (b) for an organic molecule containing several functional groups:</p> <p>(i) identification of individual functional groups</p> <p>(ii) prediction of properties and reactions</p> <p>4.2.3 (c) two-stage synthetic routes for preparing organic compounds</p>
34	<p>4.2.4 (d) interpretations and predictions of an infrared spectrum of familiar or unfamiliar substances using supplied data</p> <p>4.2.4 (e) use of infrared spectroscopy to monitor gases causing air pollution (e.g. CO and NO from car emissions) and in modern breathalysers to measure ethanol in the breath</p>	Consolidation . Practical Catch Up
35	<p>4.2.4 (f) use of a mass spectrum of an organic compound to identify the molecular ion peak and hence to determine molecular mass</p> <p>4.2.4 (g) analysis of fragmentation peaks in a mass spectrum to identify parts of structures</p>	Consolidation . Practical Catch Up

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