

Year 13 A-Level Chemistry Overview

Week	Teacher 1	Teacher 2
1	<p>5.1.1 (a) explanation and use of the terms: <i>rate of reaction</i>, <i>order</i>, <i>overall order</i>, <i>rate constant</i>, <i>half-life</i>, <i>rate-determining step</i></p> <p>5.1.1 (b) deduction of:</p> <p>(i) orders from experimental data</p> <p>(ii) a rate equation from orders of the form: <math>\text{rate} = k[\text{A}]^m[\text{B}]^n</math>, where <math>m</math> and <math>n</math> are 0, 1 or 2</p> <p>5.1.1 (c) calculation of the rate constant, <math>k</math>, and related quantities, from a rate equation including determination of units</p>	<p>6.1.1 (a) the comparison of the Kekulé model of benzene with the subsequent delocalised models for benzene in terms of p-orbital overlap forming a delocalised <math>\pi</math>-system</p>
2	<p>5.1.1 (d) from a concentration–time graph:</p> <p>(i) deduction of the order (0 or 1) with respect to a reactant from the shape of the graph</p> <p>(ii) calculation of reaction rates from the measurement of gradients</p> <p>(e) from a concentration–time graph of a first order reaction, measurement of constant half-life, <math>t_{1/2}</math></p> <p>(f) for a first order reaction, determination of the rate constant, <math>k</math>, from the constant half-life, <math>t_{1/2}</math>, using the relationship: <math>k = \ln 2/t_{1/2}</math></p>	<p>6.1.1 (b) the experimental evidence for a delocalised, rather than Kekulé, model for benzene in terms of bond lengths, enthalpy change of hydrogenation and resistance to reaction</p> <p>6.1.1 (c) use of IUPAC rules of nomenclature for systematically naming substituted aromatic compounds</p>
3	<p>5.1.1 (g) from a rate–concentration graph:</p> <p>(i) deduction of the order (0, 1 or 2) with respect to a reactant from the shape of the graph</p> <p>(ii) determination of rate constant for a first order reaction from the gradient</p> <p>5.1.1 (h) the techniques and procedures used to investigate reaction rates by the initial rates method and by continuous monitoring, including use of colorimetry</p>	<p>6.1.1 (d) the electrophilic substitution of aromatic compounds with:</p> <p>(i) concentrated nitric acid in the presence of concentrated sulfuric acid</p> <p>(ii) a halogen in the presence of a halogen carrier</p> <p>(iii) a haloalkane or acyl chloride in the presence of a halogen carrier (Friedel–Crafts reaction) and its importance to synthesis by formation of a C–C bond to an aromatic ring</p>
4	<p>5.1.1 (i) for a multi-step reaction, prediction of,</p> <p>(i) a rate equation that is consistent with the rate-determining step</p> <p>(ii) possible steps in a reaction mechanism from the rate equation and the balanced equation for the overall reaction</p> <p>(j) a qualitative explanation of the effect of temperature change on the rate of a reaction and hence the rate constant</p>	<p>6.1.1 (f) the explanation of the relative resistance to bromination of benzene, compared with alkenes, in terms of the delocalised electron density of the <math>\pi</math>-system in benzene compared with the localised electron density of the <math>\pi</math>-bond in alkenes</p> <p>6.1.1 (g) the interpretation of unfamiliar electrophilic substitution reactions of aromatic compounds, including prediction of mechanisms</p>

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5	<p>(j) a qualitative explanation of the effect of temperature change on the rate of a reaction and hence the rate constant</p> <p>(k) the Arrhenius equation:</p> <p>(i) the exponential relationship between the rate constant, <math>k</math> and temperature, <math>T</math> given by the Arrhenius equation, <math>k = Ae^{-E_a/RT}</math></p> <p>(ii) determination of <math>E_a</math> and <math>A</math> graphically using:  <math>\ln k = -E_a/RT + \ln A</math> derived from the Arrhenius equation</p>	<p>6.1.1 (h) the weak acidity of phenols shown by the neutralisation reaction with NaOH but absence of reaction with carbonates</p> <p>6.1.1 (i) the electrophilic substitution reactions of phenol:</p> <p>(i) with bromine to form 2,4,6-tribromophenol</p> <p>(ii) with dilute nitric acid to form a mixture of 2-nitrophenol and 4-nitrophenol</p>
6	<p>5.1.2 (a) use of the terms <i>mole fraction</i> and <i>partial pressure</i></p> <p>5.1.2 (b) calculation of quantities present at equilibrium, given appropriate data</p> <p>5.1.2 (c) the techniques and procedures used to determine quantities present at equilibrium</p> <p>5.1.2 (d) expressions for <math>K_c</math> and <math>K_p</math> for homogeneous and heterogeneous equilibria</p> <p>5.1.2 (e) calculations of <math>K_c</math> and <math>K_p</math>, or related quantities, including determination of units</p>	<p>6.1.1 (j) the relative ease of electrophilic substitution of phenol compared with benzene, in terms of electron pair donation to the <math>\pi</math>-system from an oxygen p-orbital in phenol</p> <p>6.1.1 (k) the 2- and 4-directing effect of electron-donating groups (OH, <math>\text{NH}_2</math>) and the 3-directing effect of electron-withdrawing groups (<math>\text{NO}_2</math>) in electrophilic substitution of aromatic compounds</p> <p>6.1.1 (l) the prediction of substitution products of aromatic compounds by directing effects and the importance to organic synthesis</p>
7	<p>5.1.2 (f) (i) the qualitative effect on equilibrium constants of changing temperature for exothermic and endothermic reactions</p> <p>(ii) the constancy of equilibrium constants with changes in concentration, pressure or in the presence of a catalyst</p> <p>5.1.2 (g) explanation of how an equilibrium constant controls the position of equilibrium on changing concentration, pressure and temperature</p> <p>5.1.2 (h) application of the principles in 5.1.2 How far? for <math>K_c</math>, <math>K_p</math> to other equilibrium constants, where appropriate</p>	<p>PAG</p>
8	<p>5.1.3 (a) (i) a Brønsted–Lowry acid as a species that donates a proton and a Brønsted–Lowry base as a species that accepts a proton</p> <p>(ii) use of the term <i>conjugate acid–base pairs</i></p> <p>(iii) monobasic, dibasic and tribasic acids</p> <p>5.1.3 (b) the role of <math>\text{H}^+</math> in the reactions of acids with metals and bases (including carbonates, metal oxides and alkalis), using ionic equations</p>	<p>PAG</p>

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	<p>5.1.3 (c) (i) the acid dissociation constant, <math>K_a</math>, for the extent of acid dissociation (see also 2.1.4 b)</p> <p>(ii) the relationship between <math>K_a</math> and <math>pK_a</math></p>	
9	<p>5.1.3 (d) use of the expression for pH as:  <math>pH = -\log[H^+]</math>  <math>[H^+] = 10^{-pH}</math></p> <p>5.1.3 (e) use of the expression for the ionic product of water, <math>K_w</math></p> <p>5.1.3 (f) calculations of pH, or related quantities, for:                      (i) strong monobasic acids                      (ii) strong bases, using <math>K_w</math></p>	PAG
10	<p>5.1.3 (g) calculations of pH, <math>K_a</math> or related quantities, for a weak monobasic acid using approximations</p> <p>5.1.3 (h) limitations of using approximations to <math>K_a</math> related calculations for 'stronger' weak acids</p>	<p>6.1.2 (a) oxidation of aldehydes using <math>Cr_2O_7^{2-}/H^+</math> (i.e. <math>K_2Cr_2O_7/H_2SO_4</math>) to form carboxylic acids</p> <p>6.1.2 (b) nucleophilic addition reactions of carbonyl compounds with:                      (i) <math>NaBH_4</math> to form alcohols                      (ii) <math>HCN</math> [i.e. <math>NaCN(aq)/H^+(aq)</math>], to form hydroxynitriles</p> <p>6.1.2 (c) the mechanism for nucleophilic addition reactions of aldehydes and ketones with <math>NaBH_4</math> and <math>HCN</math></p>
11	<p>5.1.3 (i) a buffer solution as a system that minimises pH changes on addition of small amounts of an acid or a base</p> <p>5.1.3 (j) formation of a buffer solution from:                      (i) a weak acid and a salt of the weak acid, e.g. <math>CH_3COOH/CH_3COONa</math>                      (ii) excess of a weak acid and a strong alkali, e.g. excess <math>CH_3COOH/NaOH</math></p> <p>5.1.3 (k) explanation of the role of the conjugate acid–base pair in an acid buffer solution, e.g. <math>CH_3COOH/CH_3COO^-</math>, in the control of pH</p> <p>5.1.3 (l) calculation of the pH of a buffer solution, from the <math>K_a</math> value of a weak acid and the equilibrium concentrations of the conjugate acid–base pair; calculations of related quantities</p> <p>5.1.3 (m) explanation of the control of blood pH by the carbonic acid–hydrogencarbonate buffer system</p>	<p>6.1.2 (d) use of 2,4-dinitrophenylhydrazine to:                      (i) detect the presence of a carbonyl group in an organic compound                      (ii) identify a carbonyl compound from the melting point of the derivative</p>

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12	<p>5.1.3 (n) pH titration curves for combinations of strong and weak acids with strong and weak bases, including:</p> <ul style="list-style-type: none"> <li>(i) sketch and interpretation of their shapes</li> <li>(ii) explanation of the choice of suitable indicators, given the pH range of the indicator</li> <li>(iii) explanation of indicator colour changes in terms of equilibrium shift between the HA and A<sup>-</sup> forms of the indicator</li> </ul> <p>5.1.3 (o) the techniques and procedures used when measuring pH with a pH meter</p>	<p>6.1.2 (e) use of Tollens' reagent (ammoniacal silver nitrate) to:</p> <ul style="list-style-type: none"> <li>(i) detect the presence of an aldehyde group</li> <li>(ii) distinguish between aldehydes and ketones, explained in terms of the oxidation of aldehydes to carboxylic acids with reduction of silver ions to silver</li> </ul>
13	<p>5.2.1 (a) explanation of the term <i>lattice enthalpy</i> (formation of 1 mol of ionic lattice from gaseous ions, <math>\Delta_{LE}H</math>) and use as a measure of the strength of ionic bonding in a giant ionic lattice</p> <p>5.2.1 (b) use of the lattice enthalpy of a simple ionic solid (i.e. NaCl, MgCl<sub>2</sub>) and relevant energy terms for:</p> <ul style="list-style-type: none"> <li>(i) the construction of Born–Haber cycles</li> <li>(ii) related calculations</li> </ul> <p>5.2.1 (c) explanation and use of the terms:</p> <ul style="list-style-type: none"> <li>(i) <i>enthalpy change of solution</i> (dissolving of 1 mol of solute, <math>\Delta_{sol}H</math>)</li> <li>(ii) <i>enthalpy change of hydration</i> (dissolving of 1 mol of gaseous ions in water, <math>\Delta_{hyd}H</math>)</li> </ul>	<p>6.1.3 (a) explanation of the water solubility of carboxylic acids in terms of hydrogen bonding</p> <p>6.1.3 (b) reactions in aqueous conditions of carboxylic acids with metals and bases (including carbonates, metal oxides and alkalis)</p>
14	<p>5.2.1 (d) use of the enthalpy change of solution of a simple ionic solid (i.e. NaCl, MgCl<sub>2</sub>) and relevant energy terms (<i>enthalpy change of hydration and lattice enthalpy</i>) for:</p> <ul style="list-style-type: none"> <li>(i) the construction of enthalpy cycles</li> <li>(ii) related calculations</li> </ul> <p>5.2.1 (e) qualitative explanation of the effect of ionic charge and ionic radius on the exothermic value of a lattice enthalpy and enthalpy change of hydration</p>	<p>6.1.3 (c) esterification of:</p> <ul style="list-style-type: none"> <li>(i) carboxylic acids with alcohols in the presence of an acid catalyst (e.g. concentrated H<sub>2</sub>SO<sub>4</sub>)</li> <li>(ii) acid anhydrides with alcohols</li> </ul> <p>6.1.3 (d) hydrolysis of esters:</p> <ul style="list-style-type: none"> <li>(i) in hot aqueous acid to form carboxylic acids and alcohols</li> <li>(ii) in hot aqueous alkali to form carboxylate salts and alcohols</li> </ul>
15	<p>5.2.2 (a) explanation that entropy is a measure of the dispersal of energy in a system which is greater, the more disordered a system</p> <p>5.2.2 (b) explanation of the difference in magnitude of the entropy of a system:</p>	<p>6.1.3 (e) the formation of acyl chlorides from carboxylic acids using SOCl<sub>2</sub></p> <p>6.1.3 (f) use of acyl chlorides in synthesis in formation of esters, carboxylic acids and primary and secondary amides</p>

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	<p>(i) of solids, liquids and gases                      (ii) for a reaction in which there is a change in the number of gaseous molecules                      5.2.2 (c) calculation of the entropy change of a system, <math>\Delta S</math>, and related quantities for a reaction given the entropies of the reactants and products</p>	
16	<p>5.2.2 (d) explanation that the feasibility of a process depends upon the entropy change and temperature in the system, <math>T\Delta S</math>, and the enthalpy change of the system, <math>\Delta H</math>                      5.2.2 (e) explanation, and related calculations, of the free energy change, <math>\Delta G</math>, as: <math>\Delta G = \Delta H - T\Delta S</math> (the Gibbs' equation) and that a process is feasible when <math>\Delta G</math> has a negative value                      5.2.2 (f) the limitations of predictions made by <math>\Delta G</math> about feasibility, in terms of kinetics</p>	<p>6.2.1 (a) the basicity of amines in terms of proton acceptance by the nitrogen lone pair and the reactions of amines with dilute acids, e.g. <math>\text{HC}(aq)</math>, to form salts                      6.2.1 (b) the preparation of:                      (i) aliphatic amines by substitution of haloalkanes with excess ethanolic ammonia and amines                      (ii) aromatic amines by reduction of nitroarenes using tin and concentrated hydrochloric acid</p>
17	<p>5.2.3 (a) explanation and use of the terms <i>oxidising agent</i> and <i>reducing agent</i>                      5.2.3 (b) construction of redox equations using half equations and oxidation numbers                      5.2.3 (c) interpretation and prediction of reactions involving electron transfer</p>	<p>6.2.2 (a) the general formula for an <math>\alpha</math>-amino acid as <math>\text{RCH}(\text{NH}_2)\text{COOH}</math> and the following reactions of amino acids:                      (i) reaction of the carboxylic acid group with alkalis and in the formation of esters (see also 6.1.3 c)                      (ii) reaction of the amine group with acids                      6.2.2 (b) structures of primary and secondary amides</p>
18	<p>5.2.3 (d) the techniques and procedures used when carrying out redox titrations including those involving <math>\text{Fe}^{2+}/\text{MnO}_4^-</math> and <math>\text{I}_2/\text{S}_2\text{O}_3^{2-}</math>                      5.2.3 (e) structured and non-structured titration calculations, based on experimental results of redox titrations involving:                      (i) <math>\text{Fe}^{2+}/\text{MnO}_4^-</math> and <math>\text{I}_2/\text{S}_2\text{O}_3^{2-}</math>                      (ii) non-familiar redox systems</p>	<p>6.2.2 (c) optical isomerism (an example of stereoisomerism, in terms of non-superimposable mirror images about a chiral centre)                      6.2.2 (d) identification of chiral centres in a molecule of any organic compound</p>
19	<p>5.2.3 (f) use of the term <i>standard electrode (redox) potential, <math>E^\ominus</math></i>, including its measurement using a hydrogen electrode                      5.2.3 (g) the techniques and procedures used for the measurement of cell potentials of:                      (i) metals or non-metals in contact with their ions in aqueous solution</p>	<p>6.2.3 (a) condensation polymerisation to form:                      (i) polyesters                      (ii) polyamides                      6.2.3 (b) the acid and base hydrolysis of:                      (i) the ester groups in polyesters                      (ii) the amide groups in polyamides</p>

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	<p>(ii) ions of the same element in different oxidation states in contact with a Pt electrode</p> <p>5.2.3 (h) calculation of a standard cell potential by combining two standard electrode potentials</p>	
20	<p>5.2.3 (i) prediction of the feasibility of a reaction using standard cell potentials and the limitations of such predictions in terms of kinetics and concentration</p> <p>5.2.3 (j) application of principles of electrode potentials to modern storage cells</p> <p>5.2.3 (k) explanation that a fuel cell uses the energy from the reaction of a fuel with oxygen to create a voltage and the changes that take place at each electrode</p>	<ol style="list-style-type: none"> <li>6.2.3 (c) prediction from addition and condensation polymerisation of:             <ol style="list-style-type: none"> <li>the repeat unit from a given monomer(s)</li> <li>the monomer(s) required for a given section of a polymer molecule</li> <li>the type of polymerisation</li> </ol> </li> <li>6.2.4 (a) the use of C–C bond formation in synthesis to increase the length of a carbon chain</li> </ol>
21	<p>5.3.1 (a) the electron configuration of atoms and ions of the d-block elements of Period 4 (Sc–Zn), given the atomic number and charge</p> <p>5.3.1 (b) the elements Ti–Cu as transition elements i.e. d-block elements that have an ion with an incomplete d-sub-shell</p> <p>5.3.1 (c) illustration, using at least two transition elements, of:             <ol style="list-style-type: none"> <li>the existence of more than one oxidation state for each element in its compounds (see also 5.3.1 k)</li> <li>the formation of coloured ions (see also 5.3.1 h, j–k)</li> <li>the catalytic behaviour of the elements and their compounds and their importance in the manufacture of chemicals by industry (see 3.2.2 d)</li> </ol> </p>	<p>6.2.4 (b) formation of C–C≡N by reaction of:             <ol style="list-style-type: none"> <li>haloalkanes with CN<sup>−</sup> and ethanol, including nucleophilic substitution mechanism (see also 4.2.2 c)</li> <li>carbonyl compounds with HCN, including nucleophilic addition mechanism (see also 6.1.2 b–c)</li> </ol> </p>
22	<p>5.3.1 (d) explanation and use of the term <i>ligand</i> in terms of coordinate (dative covalent) bonding to a metal ion or metal, including bidentate ligands</p> <p>5.3.1 (e) use of the terms <i>complex ion</i> and <i>coordination number</i> and examples of complexes with:             <ol style="list-style-type: none"> <li>six-fold coordination with an octahedral shape</li> <li>four-fold coordination with either a planar or tetrahedral shape</li> </ol> </p> <p>5.3.1 (f) types of stereoisomerism shown by complexes, including those associated with bidentate and multidentate ligands:             <ol style="list-style-type: none"> <li><i>cis–trans</i> isomerism e.g. Pt(NH<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (see also 4.1.3 c–d)</li> </ol> </p>	<p>6.2.4 (c) reaction of nitriles from (b):             <ol style="list-style-type: none"> <li>by reduction (e.g. with H<sub>2</sub>/Ni) to form amines</li> <li>by acid hydrolysis to form carboxylic acids</li> </ol> </p> <p>6.2.4 (d) formation of a substituted aromatic C–C by alkylation (using a haloalkane) and acylation (using an acyl chloride) in the presence of a halogen carrier (Friedel–Crafts reaction)</p>

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	<p>(ii) optical isomerism e.g. <math>[\text{Ni}(\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2)_3]^{2+}</math> (see also 6.2.2 c)</p> <p>5.3.1 (g) use of <i>cis</i>-platin as an anti-cancer drug and its action by binding to DNA preventing cell division</p>	
23	<p>5.3.1 (h) ligand substitution reactions and the accompanying colour changes in the formation of:</p> <p>(i) <math>[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}</math> and <math>[\text{CuCl}_4]^{2-}</math> from <math>[\text{Cu}(\text{H}_2\text{O})_6]^{2+}</math></p> <p>(ii) <math>[\text{Cr}(\text{NH}_3)_6]^{3+}</math> from <math>[\text{Cr}(\text{H}_2\text{O})_6]^{3+}</math></p> <p>5.3.1 (i) explanation of the biochemical importance of iron in haemoglobin, including ligand substitution involving <math>\text{O}_2</math> and <math>\text{CO}</math></p> <p>5.3.1 (j) reactions, including ionic equations, and the accompanying colour changes of aqueous <math>\text{Cu}^{2+}</math>, <math>\text{Fe}^{2+}</math>, <math>\text{Fe}^{3+}</math>, <math>\text{Mn}^{2+}</math> and <math>\text{Cr}^{3+}</math> with aqueous sodium hydroxide and aqueous ammonia, including:</p> <p>(i) precipitation reactions</p> <p>(ii) complex formation with excess aqueous sodium hydroxide and aqueous ammonia</p>	<p>6.2.5 (a) the techniques and procedures used for the preparation and purification of organic solids involving use of a range of techniques (see also 4.2.3 a) including:</p> <p>(i) organic preparation use of Quickfit apparatus distillation and heating under reflux</p>
24	<p>5.3.1 (k) redox reactions and accompanying colour changes for:</p> <p>(i) interconversions between <math>\text{Fe}^{2+}</math> and <math>\text{Fe}^{3+}</math></p> <p>(ii) interconversions between <math>\text{Cr}^{3+}</math> and <math>\text{Cr}_2\text{O}_7^{2-}</math></p> <p>(iii) reduction of <math>\text{Cu}^{2+}</math> to <math>\text{Cu}^+</math> and disproportionation of <math>\text{Cu}^+</math> to <math>\text{Cu}^{2+}</math> and <math>\text{Cu}</math></p> <p>5.3.1 (l) interpretation and prediction of unfamiliar reactions including ligand substitution, precipitation, redox</p>	<p>6.2.5 (a) the techniques and procedures used for the preparation and purification of organic solids involving use of a range of techniques (see also 4.2.3 a) including</p> <p>(ii) purification of an organic solid filtration under reduced pressure recrystallisation measurement of melting points</p>
25	<p>5.3.2 (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: <math>\text{CO}_3^{2-}</math>, <math>\text{Cl}^-</math>, <math>\text{Br}^-</math>, <math>\text{I}^-</math>, <math>\text{SO}_4^{2-}</math></p> <p>(ii) cations: <math>\text{NH}_4^+</math>, <math>\text{Cu}^{2+}</math>, <math>\text{Fe}^{2+}</math>, <math>\text{Fe}^{3+}</math>, <math>\text{Mn}^{2+}</math>, <math>\text{Cr}^{3+}</math></p>	<p>6.2.5 (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>6.2.5 (c) multi-stage synthetic routes for preparing organic compounds</p>
26	<p>6.3.2 (a) analysis of a carbon-13 NMR spectrum of an organic molecule to make predictions about:</p> <p>(i) the number of carbon environments in the molecule</p>	<p>6.3.1 (a) interpretation of one-way TLC chromatograms in terms of <math>R_f</math> values</p> <p>6.3.1 (b) interpretation of gas chromatograms in terms of:</p>

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	<p>(ii) the different types of carbon environment present, from chemical shift values</p> <p>(iii) possible structures for the molecule</p> <p>6.3.2 (b) analysis of a high resolution proton NMR spectrum of an organic molecule to make predictions about:</p> <p>(i) the number of proton environments in the molecule</p> <p>(ii) the different types of proton environment present, from chemical shift values</p> <p>(iii) the relative numbers of each type of proton present from relative peak areas, using integration traces or ratio numbers, when required</p> <p>(iv) the number of non-equivalent protons adjacent to a given proton from the spin–spin splitting pattern, using the <math>n + 1</math> rule</p> <p>(v) possible structures for the molecule</p>	<p>(i) retention times</p> <p>(ii) the amounts and proportions of the components in a mixture</p>
27	<p>6.3.2 (c) prediction of a carbon-13 or proton NMR spectrum for a given molecule</p> <p>6.3.2 (d) (i) the use of tetramethylsilane, TMS, as the standard for chemical shift measurements</p> <p>(ii) the need for deuterated solvents, e.g. <math>\text{CDCl}_3</math>, when running an NMR spectrum</p> <p>(iii) the identification of O–H and N–H protons by proton exchange using <math>\text{D}_2\text{O}</math></p>	<p>6.3.1 (c) qualitative analysis of organic functional groups on a test-tube scale;</p> <p>processes and techniques needed to identify the following functional groups in an unknown compound:</p> <p>(i) alkenes by reaction with bromine (see also 4.1.3 f)</p> <p>(ii) haloalkanes by reaction with aqueous silver nitrate in ethanol</p>
28	<p>6.3.2 (e) deduction of the structures of organic compounds from different analytical data including:</p> <p>(i) elemental analysis (see also 2.1.3 c)</p> <p>(ii) mass spectra (see also 4.2.4 f–g)</p> <p>(iii) IR spectra (see also 4.2.4 d–e)</p> <p>(iv) NMR spectra</p>	<p>(iii) phenols by weak acidity but no reaction with <math>\text{CO}_3^{2-}</math> (see also 6.1.1 h)</p> <p>(iv) carbonyl compounds by reaction with 2,4-DNP (see also 6.1.2 d)</p> <p>(v) aldehydes by reaction with Tollens' reagent (see also 6.1.2 e)</p> <p>(vi) primary and secondary alcohols and aldehydes by reaction with acidified dichromate (see also 4.2.1 c, 6.1.2a)</p> <p>(vii) carboxylic acids by reaction with <math>\text{CO}_3^{2-}</math> (see also 6.1.3 b)</p> <p>6.3.1 (c) qualitative analysis of organic functional groups on a test-tube scale;</p> <p>processes and techniques needed to identify the following functional groups in an unknown compound:</p> <p>(i) alkenes by reaction with bromine (see also 4.1.3 f)</p>

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		<p>(ii) haloalkanes by reaction with aqueous silver nitrate in ethanol (see also 4.2.2 a)</p> <p>(iii) phenols by weak acidity but no reaction with <math>\text{CO}_3^{2-}</math> (see also 6.1.1 h)</p> <p>(iv) carbonyl compounds by reaction with 2,4-DNP (see also 6.1.2 d)</p> <p>(v) aldehydes by reaction with Tollens' reagent (see also 6.1.2 e)</p> <p>(vi) primary and secondary alcohols and aldehydes by reaction with acidified dichromate (see also 4.2.1 c, 6.1.2a)</p> <p>(vii) carboxylic acids by reaction with <math>\text{CO}_3^{2-}</math> (see also 6.1.3 b)</p> <p>Consolidation</p>
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