

Chemistry B (Salters)

Advanced GCE A2 H435

Advanced Subsidiary GCE AS H035

Mark Schemes for the Units

January 2010

HX35/MS/R/10J

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MARK SCHEME FOR THE UNITS

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F331 Chemistry for Life

Question			Expected Answers	Marks	Additional Guidance
1	(a)	(i)	skeletal ✓	1	ALLOW recognisable spellings
		(ii)	2,2,4-trimethylpentane ✓✓	2	IGNORE gaps, dashes, hyphens, commas pentane✓ rest ✓
		(iii)	ring structure / arene / cyclic OR short(er) molecule ✓	1	ALLOW small
	(b)	(i)	burn measured mass / amount of fuel / octane ✓ measure temp rise ✓ of a fixed volume / mass / amount of water ✓ use - energy transferred = mass of water x specific heat capacity (of water) x temp rise ✓ scale up to one mole of fuel / octane used / AW ✓	5	ALLOW measure starting and finishing temperature / mass of octane / fuel DO NOT ALLOW just 'final' temp. recorded IGNORE reference to solution ALLOW $q / \text{energy} = mc\Delta T$ or $mc\theta$ allow 'm' as mass of water unless conned eg ALLOW answer divided by moles burnt

Question	Expected Answers	Marks	Additional Guidance	
(ii)	<p>any two from 4:</p> <p>heat loss to surroundings / air / effect of draughts; etc ✓</p> <p>heat losses to calorimeter / apparatus; ✓</p> <p>incomplete combustion of fuel / lack of (enough) oxygen; ✓</p> <p>evaporation of fuel (from wick); ✓</p>	2	<p>DO NOT ALLOW 'not standard conditions' / reference to data book values / AW</p> <p>DO NOT ALLOW 'enthalpy may escape'</p> <p>IGNORE evaporation of water / measurement error / human error</p>	
(c)	(i)	<p>ΔH_1 = enthalpy (<i>change</i>) of formation (of octane) ✓</p> <p>ΔH_2 = enthalpy (<i>change</i>) of combustion of <i>eight moles of carbon</i> / (<i>enthalpy (change) of formation of eight moles of carbon dioxide</i>) ✓</p> <p>ΔH_3 = enthalpy (<i>change</i>) of combustion of <i>nine moles of hydrogen</i> / (<i>enthalpy (change) of formation of nine moles of water</i>) ✓</p> <p>ΔH_4 = enthalpy (<i>change</i>) of combustion of octane ✓</p>	4	<p>ALLOW omission of the words 'enthalpy change of...'</p> <p>IGNORE references to oxygen</p> <p>ALLOW appropriate symbols eg ΔH_f</p> <p>ALLOW ΔH_2 and ΔH_3 in either order. Score one out of two if numbers of moles not mentioned</p> <p>ALLOW ΔH_2 / ΔH_3 in terms of enthalpy changed of formation of 8 moles CO_2 and 9 moles of H_2O.</p> <p>DO NOT ALLOW any rearrangement of ΔH_1 etc</p>
	(ii)	answer = -248 ✓	1	
Total		16		

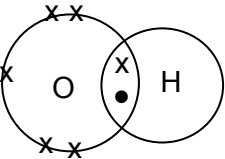
Question		Expected Answers			Marks	Additional Guidance																															
2	(a) (i)	<table border="1"> <thead> <tr> <th rowspan="2">property</th> <th colspan="3">type of emission</th> </tr> <tr> <th>α</th> <th>β</th> <th>γ</th> </tr> </thead> <tbody> <tr> <td>relative charge</td> <td>+2</td> <td>-1</td> <td>0</td> </tr> <tr> <td>relative mass</td> <td>4</td> <td>0.00055</td> <td>0</td> </tr> <tr> <td>nature</td> <td>helium nucleus</td> <td>(nuclear) electron / correct symbol</td> <td>very high frequency electromagnetic radiation</td> </tr> <tr> <td>range in air</td> <td>(few) cms / mm</td> <td>few metres</td> <td>very long</td> </tr> <tr> <td>stopped by</td> <td>tissue paper</td> <td>metal foil</td> <td>Lead / aluminium / thick metal (sheet) / concrete</td> </tr> <tr> <td>deflection by an electric field</td> <td>low</td> <td>High / big / large</td> <td>none</td> </tr> </tbody> </table> <p style="text-align: center;"> ✓ ✓ ✓ </p>			property	type of emission			α	β	γ	relative charge	+2	-1	0	relative mass	4	0.00055	0	nature	helium nucleus	(nuclear) electron / correct symbol	very high frequency electromagnetic radiation	range in air	(few) cms / mm	few metres	very long	stopped by	tissue paper	metal foil	Lead / aluminium / thick metal (sheet) / concrete	deflection by an electric field	low	High / big / large	none	3	<p>One mark for each column:</p> <p>ALLOW none / dashes for 0's</p> <p>ALLOW 'short' for 'few cms'</p> <p>DO NOT ALLOW 'Not very far' / AW (too vague)</p> <p>DO NOT ALLOW medium for β deflection</p> <p>DO NOT ALLOW neutral for γ deflection</p>
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	(b) (i)	${}_{42}^{99}\text{Mo} \rightarrow {}_{-1}^0\beta + {}_{43}^{99}\text{Tc}$ ✓✓			2	<p>top line ✓</p> <p>bottom line ✓</p> <p>ALLOW one mark for completely correct beta or Tc if other is wrong</p>																															
	(ii)	<p>same atomic number ✓</p> <p>different mass number ✓</p>			2	<p>OR</p> <p>atoms of the same element ✓</p> <p>with different numbers / more / less of neutrons ✓</p>																															

Question		Expected Answers	Marks	Additional Guidance
	(c) (i)	difficult to detect very small amounts of Ar-40 formed K-40 decayed / dating errors very large when so little decay has taken place / AW ✓	1	DO NOT ALLOW answers that talk only in terms of 'not even finished one half life'
	(ii)	Ar ⁺ (allow Ar ²⁺) ✓	1	ALLOW with <u>correct</u> mass / atomic numbers DO NOT ALLOW wrong symbol
	(iii)	peak / bar / line at (mass numbers) 36, 38 and 40 ✓ size / height of peak related to abundance ✓	2	mass numbers needed to score
	(iv)	(energy lost as) electrons go from higher to lower levels ✓ relationship of energy to frequency / wavelength ✓ gives a (specific) line(s) ✓ energy gaps / levels different for different elements ✓ QWC – wavelength / frequency / frequencies must be spelled correctly	4	eg E = hf or in words mention of lines scores a mark CON one mark if spelling incorrect
		Total	15	

Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)	(hydrocarbon) contains no <u>benzene</u> rings / not an arene ✓	1	DO NOT ALLOW contains no rings
		(ii)	<u>fractional</u> distillation ✓	1	
		(iii)	$C_{25}H_{52} + 38O_2 \rightarrow 25CO_2 + 26H_2O$ ✓	1	
(b)	(i)	unburnt hydrocarbon / $C_{25}H_{52}$ ✓	1	ALLOW paraffin wax ALLOW CO ALLOW smaller hydrocarbon	
	(ii)	carbon monoxide ✓ carbon / soot ✓	2	ALLOW water IGNORE oxides of nitrogen	
(c)	(i)	C_3H_6 ✓	1	order of elements immaterial	
	(ii)	110-130° ✓ 3 areas of electron density ✓ around central C ✓ areas of electron density / pairs repel as far apart as possible / minimize energy ✓	4	DO NOT ALLOW 3 'atoms' or 'electron pairs' ALLOW names or descriptions of electron groups eg double bond ALLOW clear diagram or description DO NOT ALLOW repel as much as possible TAKE CARE repel and 'as far apart' run together for only one mark ALLOW bonds (but not atoms) repel	
		(iii)	catalysts and reactants in different (physical) states ✓	1	
		(iv)	contain hole(s) / channels / porous / gaps / rings ✓ can trap branched / let through straight isomers ✓	2	
			Total	14	

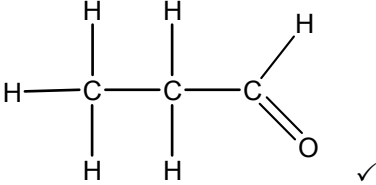
Question	Expected Answers	Marks	Additional Guidance
4 (a)	mass number = 1 ✓ atomic number = 0 ✓	2	
(b) (i)	moles of Be = 1.75/9 (0.19) ✓ moles of Cu = 98.25/63.5 (1.55) ✓	2	all usual ecf's apply (allow working to more / less sig. figs.) Max 1 if unit other than moles put in
(ii)	11 scores all three ✓✓✓ total no. of moles = 1.74 ✓ %Be = 0.19/1.74 x 100 ✓ (=10.919) Sig. figs. separate mark based on a followable calculation ✓	3	ALLOW ecf's from (b)(i) ALLOW sig. figs. mark for a (wrong) calculation based on some given figures
(c)	Delocalised electrons ✓ Regular array of cations / positive ions / residues ✓ Labels but any used must be correct ✓	3	<i>First two points can be on diagram or labels</i> <i>minimum of five cations shown (can touch)</i> ALLOW positive atoms DO NOT ALLOW positive nucleus or positive metal
(d)	$\begin{array}{c} \text{xx} \\ \text{x Cl x} \\ \text{xx} \end{array} \quad \text{Be} \quad \begin{array}{c} \text{xx} \\ \text{x Cl x} \\ \text{xx} \end{array}$ 'correct' pairs on Be ✓ 3 <u>pairs</u> on Cl ✓	2	DO NOT ALLOW ionic structure

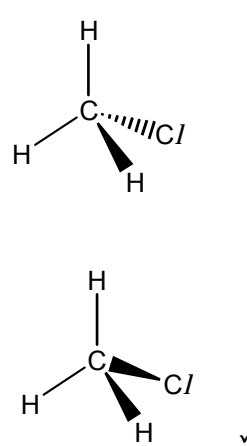
Question	Expected Answers	Marks	Additional Guidance
(e)	melting point (is different) ✓ (melting point) is higher in ionic compounds ✓ AND <i>Any one of:</i> ionic compounds conduct electricity when in <u>solution / molten</u> ✓ OR ionic compounds (generally) <u>water</u> soluble / ora / AW ✓	3	ALLOW ORA throughout DO NOT ALLOW references to ionic solids / covalent gases liquids ALLOW boiling point Must be a comparison for 2 nd mark Incorrect chemical explanation CON 2 nd mark eg reference to bond strengths DO NOT ALLOW just 'conduct electricity'
	Total	15	

Question	Expected Answers	Marks	Additional Guidance
(ii)	464 x 1000 ✓ Energy value/6.02 x 10 ²³ AND a correct evaluation (= 7.71 x 10 ⁻¹⁹ J) ✓	2	One mark is for converting from kJ to J (ie: multiplying by 1000) The other is for dividing their energy value by 6.02 x 10 ²³ (the Avogadro constant) ALLOW 2 or more sig. figs. but rounding must be correct. In order to score the second mark, there must be a correct evaluation of their expression. A completely correct answer on its own scores both marks.
(iii)	Answer to (c)(ii)/6.63 x 10 ⁻³⁴ ✓ = 1.16 x 10 ¹⁵ ✓ 3 sig. fig. ✓	3	DO NOT ALLOW the second mark for evaluating any other expression (eg: answer to (c)(ii) x 6.63 x 10 ⁻³⁴) ALLOW sig. fig. mark for any 3 sig. fig. answer that follows from any calculation (even if their evaluation of their calculation is incorrect). A completely correct answer on its own scores all marks, including the sig. fig. mark.
(d) (i)	(A particle) with one (or more) unpaired electron(s). ✓	1	Answer must be in the context of an electron as part of some sort of particle. IGNORE 'free' or 'lone' or single electron.
(ii)		2	Any symbols can be used to represent the electrons (including the same symbol for all electrons). Candidate does not have to draw circles for electron shells. Non-bonding electrons do not have to be shown in pairs. It MUST be clear that a pair of electrons (with any symbols) is being shared between the H and the O for the first mark. IGNORE any inner electron shells.

Question		Expected Answers	Marks	Additional Guidance
	(iii)	propagation ✓ one radical is used and replaced by another / AW ✓	2	ALLOW there is a radical on both sides of the equation. Mark independently.
(e)		SiO ₂ : giant covalent / network solid / lattice / whole structure held together by covalent bonds / diagram ✓ CO ₂ : simple molecular / molecules / O=C=O / AW ✓ <i>comparison of forces</i> : <u>weak</u> intermolecular bonds (or forces) in CO ₂ / less energy needed to separate molecules / bonds in SiO ₂ are stronger than CO ₂ intermolecular bonds (or forces) ✓	3	IGNORE 'intermolecular bonds' in SiO ₂ / giant molecule / giant structure Marks can be given for a labelled / annotated diagram IGNORE 'covalent'. Any type of intermolecular bonds can be named and can be abbreviated. It must be clear that the intermolecular bonds in CO ₂ are being discussed, not the covalent bonds.
(f)	(i)	0.008 / 8 x 10 ⁻³ ✓	1	

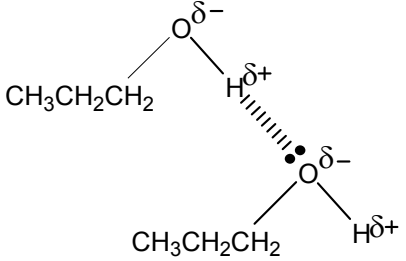
Question	Expected Answers	Marks	Additional Guidance
	<p>(ii) Any four points from:</p> <p>1 Sun emits UV ✓</p> <p>2 Earth absorbs some of the energy (from the Sun) / heats up ✓</p> <p>3 Earth radiates emits / re-emits IR ✓</p> <p>4 (CO₂) absorbs IR radiation ✓</p> <p>5 making <u>bonds</u> vibrate (more) ✓</p> <p>6 turned into kinetic energy that raises the temperature / transfers kinetic energy to thermal energy or heat or it warms the atmosphere or Earth. ✓</p> <p>7 some CO₂ molecules radiate IR (which warms Earth) ✓</p> <p>AND</p> <p>more CO₂ molecules means more radiation is absorbed / more CO₂ means greater temperature increase / enhancing the greenhouse effect / causing global warming / warming the atmosphere / Earth / planet more ✓</p> <p>QWC - mark for connection of ideas: idea of linking IR absorption to vibrations of bonds / increase in temperature (marking point 4 linked to 5 or 6) ✓</p>	6	<p>IGNORE other types of radiation from the Sun.</p> <p>DO NOT ALLOW Earth reflects IR in point 3.</p> <p>Award marks for points 5 and 6 if the wrong frequency range of radiation is given as being absorbed in 4. (eg candidate states CO₂ absorbs UV).</p>
(g)	(i) aldehyde(s) ✓	1	ALLOW alkanal(s)
	(ii) CO + C ₂ H ₄ + H ₂ → CH ₃ CH ₂ CHO ✓✓	2	<p>ALLOW C₃H₆O or full structural formula for propanal.</p> <p>Completely correct scores both marks.</p> <p>Correct formula for ethane / correctly identifies H₂ as the additional reagent scores one mark.</p>

Question	Expected Answers	Marks	Additional Guidance
(iii)	 <p>✓</p>	1	
Total		29	

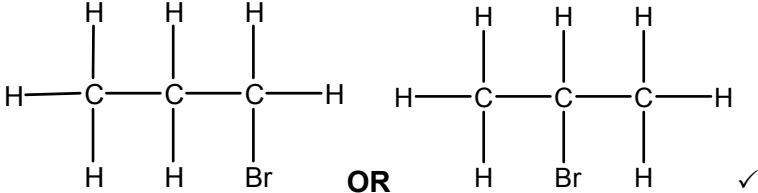
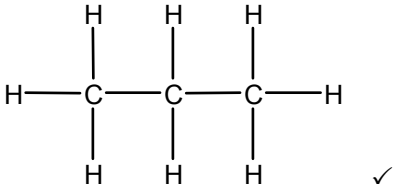
Question		Expected Answers	Marks	Additional Guidance
2	(a)	Bromoalkane(s) / halogenoalkane(s) ✓	1	ALLOW halokane(s) / haloalkane(s) / halogenoalkane
	(b) (i)	$\text{CH}_3\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{Br} + \text{H}_2\text{O}$ ✓✓ Right hand side ✓ Left hand side ✓	2	ALLOW CH_4O / BrH / BrCH_3 IGNORE state symbols
	(ii)	Nucleophilic ✓ Substitution ✓	2	Any clear indication scores the mark eg: circled. If more than two choices indicated, each extra response CONS a correct answer.
	(c) (i)	Amine(s) ✓	1	ALLOW small spelling error.
	(ii)	CH_3NH_2 / CH_5N ✓	1	
	(d)	$\delta+$ on C and $\delta-$ on Cl ✓	1	IGNORE $\delta+$ on Hs. DO NOT ALLOW $\delta-$ on Hs
	(e)	 <p>OR</p> <p>bond angle 109° ✓</p>	2	ALLOW other 3-D representations of the molecule. ALLOW chlorine in any position. Diagram needs to be as shown on the left or one bond in the plane, with two going into the plane of the page and one coming out (or vice versa). DO NOT ALLOW two bonds in the same plane at 180° . ACCEPT bond angle values in the range $100 - 112^\circ$

Question	Expected Answers	Marks	Additional Guidance
(f)	<p>Any <i>two</i> from:</p> <ol style="list-style-type: none"> 1. chloromethane is not broken down / unreactive in the troposphere / lower atmosphere ✓ 2. but is broken down / photodissociated (in the stratosphere) / AW by ✓ 3. high energy UV / high frequency UV ✓ 4. (breakdown of chloromethane) producing chlorine atoms / chlorine radicals ✓ <p>AND</p> <p>(products of chloromethane) <u>catalyse</u> ozone breakdown / AW ✓</p> <p>C–Br bond is weaker (than C–C) ORA ✓</p> <p>so can be broken in the <u>troposphere</u> / molecule reacts in the <u>troposphere</u> / reacts before reaching the stratosphere ✓</p>	5	<p>ALLOW ‘radiation’ for ‘UV’</p> <p>Points 2 and 4 can be scored from a reaction equation.</p> <p>QWC: To gain this mark, candidate must use the word catalyst or a derivative of it, spelled correctly and used in a grammatically correct way (eg: do not award for ‘it catalyse the breakdown of ozone’).</p> <p>ALLOW ‘catalyze’.</p>
(g) (i)	(concentration) values were low ✓	1	Answers need to show that values were less and not just different from the expected ones.
	Total	15	

Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)	addition ✓	1	DO NOT ALLOW additional.
		(ii)	propene ✓ $\begin{array}{c} \text{H} & \text{H} & \text{H} \\ & & \\ \text{H}-\text{C}-\text{C}=\text{C}-\text{H} \\ \\ \text{H} \end{array}$ ✓	2	ALLOW prop-1-ene DO NOT ALLOW prop-2-ene Mark independently. No ecf for the second mark.
	(b)	(i)	bromine (water) ✓	1	ALLOW Br ₂
		(ii)	(from) brown / orange / yellow ✓ (to) colourless ✓	2	ALLOW any combination of these colours, but no others for the first mark (eg no mark for red / brown). DO NOT ALLOW clear for the second answer
	(c)		$\begin{array}{c} \text{CH}_3 & \text{CH}_3 \\ & \\ \text{C}=\text{C} \\ & \\ \text{H} & \text{H} \end{array}$ (Z) ✓ $\begin{array}{c} \text{CH}_3 & \text{H} \\ & \\ \text{C}=\text{C} \\ & \\ \text{H} & \text{CH}_3 \end{array}$ (E) ✓	2	Name and structure required for the mark in each case Correct structures with names swapped round scores 1 mark. Diagrams do not have to show correct bond angles. A correct representation of but-2-ene scores 1.
	(d)		instantaneous (dipole) - induced dipole ✓	1	ALLOW temporary dipole–induced temporary dipole / van der Waals forces
	(e)	(i)	low flexibility / resistant to chemical attack / does not react with water / unreactive / not prone to stress fractures / high <u>tensile</u> strength / abrasion resistant / impermeable / insoluble / rigid ✓	1	IGNORE strong, hard, durable, tough, malleable, dense, high melting point, can be moulded or remoulded. ALLOW waterproof or 'will not wear away'.
		(ii)	bags ✓	1	IGNORE food wrap / cling film / packaging.
Total				11	

Question	Expected Answers	Marks	Additional Guidance
4 (a) (i)	 <p>hydrogen bond between correct atoms ✓</p> <p>lone pair on relevant O in line with H bond ✓</p> <p>partial charges shown, δ^- on each O and δ^+ on each H ✓</p> <p>O–H–O straight ✓</p>	4	<p>Hydrogen bond can be shown in other forms, but not as a solid line.</p> <p>Second mark, but NOT third mark, can be scored if the hydrogen bond is between incorrect atoms.</p>
	<p>(ii) Any three from:</p> <ol style="list-style-type: none"> 1. intermolecular bond in propene is instantaneous dipole-induced dipole ✓ 2. hydrogen bonds / intermolecular bonds (in propan-1-ol) are stronger than those in propene (ORA) ✓ 3. intermolecular bonds must be broken for the liquid to boil ✓ 4. more <u>energy</u> is needed to break them (ORA) ✓ <p>AND</p> <p>QWC - mark for connection of ideas: idea of linking strength of intermolecular bonds to amount of energy needed to break them ✓</p>	4	<p>ALLOW van der Waals'</p> <p>DO NOT ALLOW harder / easier</p> <p>DO NOT ALLOW 'higher temperature' for 'more energy'.</p>

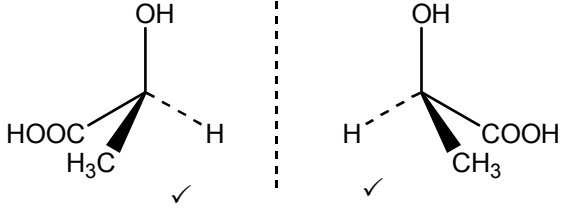
Question	Expected Answers	Marks	Additional Guidance								
(b)	Elimination ✓	1	<p>ALLOW any indication of chosen answer (eg: circling).</p> <p>DO NOT ALLOW the mark if more than one answer has been chosen.</p>								
(c)	<table border="1" data-bbox="353 379 1124 657"> <thead> <tr> <th data-bbox="353 379 743 414">reagent</th> <th data-bbox="743 379 1124 414">conditions</th> </tr> </thead> <tbody> <tr> <td data-bbox="353 414 743 518">sulfuric / phosphoric acid ✓</td> <td data-bbox="743 414 1124 518">heat / reflux ✓ concentrated ✓</td> </tr> <tr> <td colspan="2" data-bbox="353 518 1124 550">OR</td> </tr> <tr> <td data-bbox="353 550 743 657">alumina / silica / pumice / porous pot ✓</td> <td data-bbox="743 550 1124 657">heat ✓ with (propan-1-ol) vapour ✓</td> </tr> </tbody> </table>	reagent	conditions	sulfuric / phosphoric acid ✓	heat / reflux ✓ concentrated ✓	OR		alumina / silica / pumice / porous pot ✓	heat ✓ with (propan-1-ol) vapour ✓	3	<p>ALLOW correct formula for reagent.</p> <p>ALLOW temperatures over 100°C for the heat mark</p> <p>Sulfuric acid AND alumina: CON reagent mark (but can still score condition marks). Clear alternatives (ie: sulfuric acid OR alumina) scores the mark.</p> <p>ALLOW c. for concentrated. Aqueous / water CONs the concentrated mark.</p> <p>The conditions marks may only be awarded if candidate has written an appropriate reagent, even if they have made a small mistake, eg: sulfuric without acid, or wrong formula (like AIO)</p> <p>(Concentrated) sulfuric acid with dichromate and heat scores zero.</p> <p>IGNORE references to pressure conditions.</p>
reagent	conditions										
sulfuric / phosphoric acid ✓	heat / reflux ✓ concentrated ✓										
OR											
alumina / silica / pumice / porous pot ✓	heat ✓ with (propan-1-ol) vapour ✓										
(d)	<p>rate of forward reaction = rate of back reaction ✓</p> <p>concentrations of reactants and products remain constant / closed system ✓</p>	2	<p>IGNORE references to steady state.</p>								
(e)	(i)	2	<p>MUST mention equilibrium for the second mark.</p> <p>Mark independently.</p>								
	(ii)	2	<p>MUST mention equilibrium for the second mark.</p> <p>Mark independently.</p>								

Question	Expected Answers	Marks	Additional Guidance
(f)	<p>Any three from:</p> <ol style="list-style-type: none"> 1. increased pressure increases number of particles per unit of volume ✓ 2. more collisions occur ✓ 3. (more collisions) per unit of time ✓ 4. rate increases/gets faster ✓ 	3	<p>ALLOW 'particles are closer together' for the first point DO NOT ALLOW 'reactants are closer together'.</p> <p>More frequent collisions / collisions occur more often covers two points ✓✓ IGNORE more likely to collide / greater chance of collisions in point 2.</p>
(g) (i)	 <p style="text-align: center;">OR</p>	1	<p>ALLOW any clear representations of a structural formula, eg: CH₃CHBrCH₃</p>
(ii)		1	<p>ALLOW CH₃CH₂CH₃</p>
(h)	platinum ✓	1	ALLOW Pt.
	Total	10	

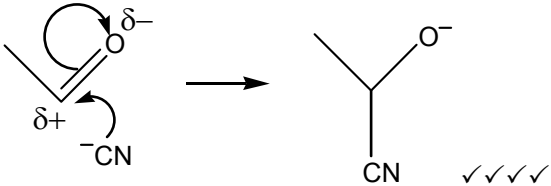
Question	Expected Answers	Marks	Additional Guidance
5 (a)	Chemical that: causes another chemical to be oxidised / is itself reduced / decreases in oxidation state / is an electron acceptor / removes electrons from another chemical ✓ O_2 / (potassium) manganate(VII) ✓ AND either (Oxidises) iron from oxidation state +2 / Fe(II) ✓ to +3 / Fe(III) ✓ OR (Manganese reduced) from Mn(VII) / +7 / manganate(VII) ✓ to Mn(IV) / +4 / manganese(IV) oxide ✓	4	ALLOW 'chemical that oxidises another chemical' / oxidising agent. IGNORE references to change in pH. ALLOW permanganate / MnO_4^- / $KMnO_4$ Fe^{2+} to Fe^{3+} scores 1.
(b)	$Al^{3+}(aq) + 3HCO_3^-(aq) \rightarrow Al(OH)_3(s) + 3CO_2(g/aq)$ ✓✓✓ Correct species ✓ Balanced ✓ State symbols ✓	3	Second and third marks depend on the first. ALLOW $Al^{3+}(aq) + HCO_3^-(aq) \rightarrow Al(OH)_3(s)$ for one mark, if no other mark is scored (IGNORE any other chemicals)
(c)	Calcium hydroxide / calcium oxide ✓ Sodium carbonate ✓ Hydrogencarbonate ✓	3	IGNORE a correct oxidation state for Ca and Na ALLOW 'hydrogen carbonate' but NOT 'bicarbonate'
(d)	Calcium ions more highly charged or more positive (than sodium ions) / mention of Ca^{2+} <u>and</u> Na^+ ✓ so are more strongly attracted to the negative charge on the resin / $(R)COO^-$ / anion groups ✓	2	IGNORE references to reactivity. DO NOT ALLOW just 'attracted to the resin'.

Question	Expected Answers	Marks	Additional Guidance
(e)	moles Ca^{2+} = $(800/1000) \times 0.002$ (=0.0016) ✓ moles Na^+ = $2 \times$ moles Ca^{2+} (= 0.0032) ✓ mass Na^+ = moles Na^+ \times 23 = $(0.0032 \times 23 = 0.0736 / 0.074)$ (g) ✓	3	Mass Na^+ = 0.0368 / 0.037 scores 2.
(f)	<i>Any five points from:</i> 1. kills bacteria / kills pathogens / disinfectant ✓ 2. cheap compared to other water treatment chemicals. ✓ 3. Cl_2 or chlorine is a gas, making it difficult to contain / it spreads easily. ✓ 4. toxic / poisonous ✓ 5. causes respiratory problems / breathing problems ✓ 6. forms by-products / THMs that are suspected carcinogens ✓ 7. dissolves in rivers / local water supplies ✓ 8. forming bleach and acid ✓ 9. (bleach and acid) kill life forms in the water ✓	5	DO NOT ALLOW just 'cheap'. Answer must have 'gas' and either 'difficult to contain' or 'spreads easily' to gain the mark. ALLOW Cl_2 / chlorine is a gas so needs a strong container. IGNORE 'difficult to store / difficult to transport' DO NOT ALLOW harmful / irritant / dangerous instead of toxic. Answer must have 'by-products / THMs' and 'suspected carcinogens' to gain the mark.
	Total	20	

F334 Chemistry of Materials

Question	Expected Answers	Marks	Additional Guidance
1 (a)	2-hydroxypropanoic acid ✓✓	2	mark independently 2-hydroxy ✓ DO NOT ALLOW hydroxyl propanoic acid ✓ ALLOW if propan- and -oic are separated.
(b) (i)	(enantiomers are) isomers whose structures are <u>mirror images</u> of one another ✓ and are <u>non-superimposable</u> ✓	2	mark independently mirror images ✓ non-superimposable ✓ IGNORE references to 4 different groups around a C atom, optical isomerism, various chiral words & rotation of plane polarised light
(ii)		2	3D structure correct for one isomer ✓ DO NOT ALLOW 90 or 180 degree angles between the two bonds in the plane of the paper mirror-image correct (must have 4 bonds around the C) ✓ ALLOW ecf for non 3D structure with four different groups only IGNORE the way the groups are bonded to carbon eg -OH or -HO, same for COOH & CH ₃
(c) (i)	P = C Q = A R = B ✓	1	

Question	Expected Answers	Marks	Additional Guidance
(ii)	<p>P = (C) does not fizz / does not react / with Na_2CO_3 AND so no $-\text{COOH}$ group present / AW ✓</p> <p>Q = no phenol group (in A), so FeCl_3 remains yellow / AW ✓</p> <p>R = (B has) both phenol & carboxylic acid (COOH) (so will turn FeCl_3 purple and will fizz with Na_2CO_3) / AW ✓</p> <p>The words in brackets are only needed if tests not discussed for P & Q.</p>	3	<p>if answers to (i) are incorrect/no response award 1 mark for correct answers for having both tests for phenol and carboxylic acid:</p> <p><i>ie:</i></p> <p>purple solution = phenol AND acids fizz with carbonate ✓</p> <p>IGNORE P is C as it turns FeCl_3 purple</p> <p>IGNORE Q is A as it fizzes & is therefore a carboxylic acid</p>
(d)	<p>C ✓</p> <p>because: (broad) peak at around 3250 (cm^{-1}) indicates <u>alcohol or phenol</u> / OH / hydroxyl group ✓</p> <p>no peak at 1700–1725 (cm^{-1}) so no <u>C=O</u> (in $-\text{COOH}$) present ✓</p>	3	<p>IGNORE any reference to carboxylic acid for the 3250 peak ALLOW a range around 3250</p> <p>Peaks may be identified on the diagram</p> <p>IGNORE all other peaks</p>
(e) (i)	<p>nucleophilic addition ✓✓</p>	2	<p>nucleophilic ✓</p> <p>addition ✓</p> <p>mark independently</p>

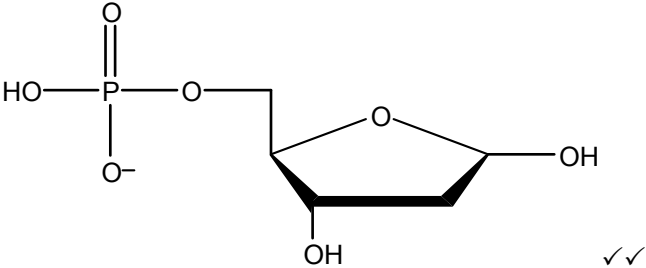
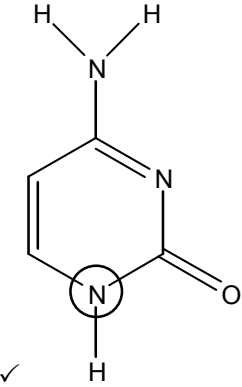
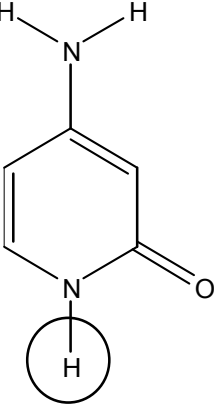
Question	Expected Answers	Marks	Additional Guidance
(ii)		4	<p>'curly' arrow showing attack by CN^- at C=O carbon ✓ DO NOT ALLOW arrow starting from N of CN^- / single-headed arrows but give 1 mark if both are single headed but otherwise correct</p> <p>C=O bond polarised correctly ✓</p> <p>curly arrow showing movement of double bond ✓</p> <p>final structure correct ALLOW any correct structural formula not just skeletal ✓ O MUST be -ve</p> <p>IGNORE any further reaction showing O^- gaining H^+</p>
(iii)	<p>the rate determining step (slow step) does not involve water ✓ (since) water does not appear in the rate equation / water is zero order ✓</p> <p>Since water / H^+ required to form product it must react in a subsequent (fast) step/there must be at least 2 steps in the reaction / AW ✓</p> <p>OR</p> <p>the rate determining step (slow step) <u>only</u> involves ethanal & cyanide ✓</p> <p>(because only) ethanal & cyanide appear in the rate equation ✓</p> <p>and so <u>water</u> must react in a subsequent step ✓</p>	3	

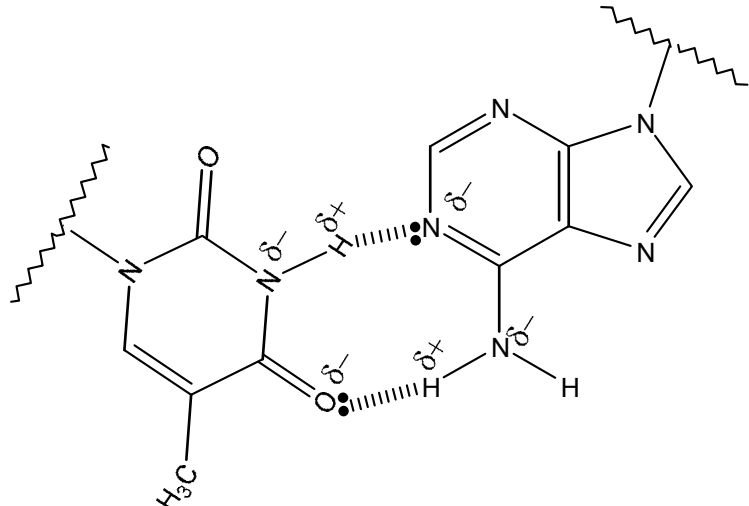
Question	Expected Answers	Marks	Additional Guidance
(f) (i)	reaction 1.1 has a higher atom economy than reaction 1.2 ✓ because it is an addition reaction / only one product is formed whereas in reaction 1.2 hydrolysis / condensation occurs / atoms are wasted / lost / two 'products' are formed / co-products are also formed / AW ✓	2	ALLOW comparison of percentage atom economy eg reaction 1.1 has 100% economy, reaction 1.2 does not. IGNORE any reference to substitution / elimination for reaction 1.2 / by-product
(ii)	reduce / cut down on / less / little waste (products) ✓ costs of are kept to a minimum / less energy used ✓	2	ALLOW cost effective
Total		26	

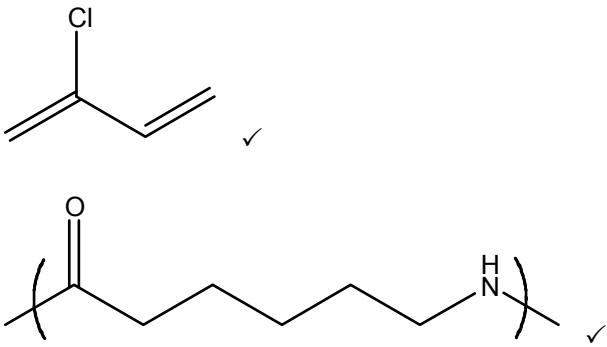
Question	Expected Answers	Marks	Additional Guidance
2 (a)	<p>Fe^{3+} will oxidise Cu / ORA OR Cu loses electrons to form Cu^{2+} / ORA ✓</p> <p>because electrode potential of Fe^{3+} / (Fe^{2+}) is more positive / ORA (involves the Copper half-cell) OR Uses E_{cell} calculation to show reaction is feasible ✓</p> <p>$\text{Cu} + 2\text{Fe}^{3+} \rightarrow \text{Cu}^{2+} + 2\text{Fe}^{2+}$ ✓</p>	3	<p>ALLOW Fe(III) and Cu(II)</p> <p>DO NOT ALLOW electronegativity or higher / lower or larger / smaller</p> <p>IGNORE state symbols</p>
(b) (i)	<p>Pt electrode for Fe^{3+} / Fe^{2+} half cell ✓</p> <p>in Fe^{3+} / Fe^{2+} ✓</p> <p>Cu electrode in Cu^{2+} ✓</p> <p>salt bridge labelled and in solutions ✓</p> <p>conditions: 1 mol dm^{-3} and 298K / 25°C ✓</p>	5	<p>ALLOW CuSO_4 etc. instead of Cu^{2+}</p> <p>ALLOW 1 molar / 1M</p>
(ii)	0.43 V ✓	1	IGNORE any sign
(c) (i)	Copper(I) iodide ✓	1	<p>DO NOT ALLOW copper iodide</p> <p>ALLOW Copper I iodide</p>

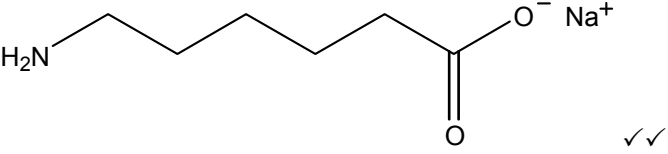
Question	Expected Answers	Marks	Additional Guidance
(ii)	1. moles of thiosulfate = $0.200 \times (20.5/1000) = \mathbf{0.0041}$ ✓ 2. (moles of iodine (I_2) = $0.5 \times$ answer from 1 (0.0041) and moles of $Cu^{2+}(aq)$ in $25.0 \text{ cm}^3 = 2 \times \mathbf{0.5} \times$ answer from 1 (0.0041)) = 0.0041 ✓ 3. moles of $Cu^{2+}(aq)$ in $250 \text{ cm}^{-3} = 10 \times$ answer from 1 (0.0041) = 0.0410 ✓ 4. mass of Cu in coin = answer from 3 (0.0410) x 63.5 = 2.6035 g ✓ 5. % of Cu in coin = (answer from 4 (2.6035)/3.47) x 100 = 75.0 ✓ 6. (3 sig. figs.) ✓	6	75.0 with no / incomplete working scores 6 marks. The marks are awarded for the working out given in bold: If final answer is incorrect please annotate marks given with ticks AND crosses where errors have occurred eg missing out step 3. 1. moles of thiosulfate = 0.0041 moles 2. correct moles of $Cu^{2+}(aq)$ in 25.0 cm^3 ecf from 1 ✓ 3. moles of $Cu^{2+}(aq)$ in $250 \text{ cm}^{-3} = \mathbf{10} \times$ moles of thiosulfate ✓ 4. mass of Cu in coin = moles of $Cu^{2+}(aq)$ in $250 \text{ cm}^{-3} \times \mathbf{63.5}$ ✓ 5. % of Cu in coin = mass of Cu in coin x 100 ✓ 6. correct/incorrect answer MUST be given to 3 sig figs. ✓ Steps 3 & 4 may be in a different order
(d) (i)	(transmits) Blue ✓ $Cu^{2+}(aq)$ absorb red / orange light ✓ QWC – absorb(s) / absorbing / absorption / absorbance / absorbed One of these words has to be used to gain the second mark and spelling must be correct	2	IGNORE pale, deep or light etc. referring to blue, reflects DO NOT ALLOW green ALLOW complementary colour / specific frequencies / wavelengths of light are absorbed DO NOT ALLOW all other frequencies / colour / AW Use of 'emit' is a CON for the 2 nd mark

Question	Expected Answers	Marks	Additional Guidance
(ii)	Ligand substitution ✓ $[\text{CuCl}_4]^{2-}$ ✓	2	ALLOW ligand replacement / displacement / exchange or complex formation The charge is required ALLOW $[\text{Cu}(\text{H}_2\text{O})_2\text{Cl}_4]^{2-}$
(iii)	<i>Any five from a-f: ✓✓✓✓✓</i> a. make up standard solutions / of known concentrations (of $\text{Cu}^{2+}(\text{aq})$) b. choose a suitable filter / set the colorimeter to a suitable wavelength c. zero colorimeter with water / solvent / AW d. measure absorbance / absorption of standard solutions / AW e. plot calibration curve f. measure unknown AND g. QWC read off concentration from calibration curve / AW ✓	6	IGNORE transmittance
Total		26	


Question	Expected Answers	Marks	Additional Guidance
3 (a) (i)		2	<p>the link between phosphate group and any –OH group on the sugar <i>ie P-O-CH₂-C</i> (in ring next to –O-) or P-O-C (in ring) depending which -OH group is used ✓ correct linkage (P-O-CH₂-C) and rest of structure correct ✓</p>
(ii)	Water / H ₂ O and condensation (reaction) ✓	1	
(iii)		1	<p>ALLOW </p> <p>ALLOW if the N-H group is circled</p>
(iv)	lone pair (of electrons) on N / amine (group) ✓ accepts a proton / H ⁺ ✓	2	

Question	Expected Answers	Marks	Additional Guidance
(b)		3	2 hydrogen bonds correct ✓ DO NOT ALLOW more than 2 bonds correct polarities (all 3) on one group of atoms ✓ lone pair on the N OR O ✓
(c)	two strands (not three) ✓ phosphate groups on the outside (not on the inside) ✓ bases face into the centre (not the outside) ✓	3	ALLOW double helix IGNORE phosphate backbone
(d)	for removal: infringement of personal liberty / AW / 'fingerprint' not unique only probability / techniques used not foolproof / law / type of government might change changing accessibility / AW ✓ against removal: helps to solve many crimes, particularly 'cold' crimes / 'innocent until proved guilty' / AW ✓ future research into disease	2	IGNORE hacking into database / leakage of data (NOTE: probability may only be 1 in 20 for some population groups)
Total		14	

Question	Expected Answers	Marks	Additional Guidance
4 (a)		2	1 mark for each structure correct DO NOT ALLOW missing H atoms if structural formulae are drawn
(b) (i)	there are (two) different groups on each carbon of a C=C in neoprene ✓ these groups can not rotate about the double bond ✓	2	May be shown in a diagram ALLOW restricted / limited rotation about the double bond
(ii)	(less trans linkages) will make the chains less linear / less regular / less ordered / ORA ✓ so they can not line up / be arranged so regularly / closely and the crystallinity will be reduced ✓	2	ALLOW chains have a kink / are more randomly arranged Note: 1 st mark is for shape of chain, 2 nd mark is for relative arrangement of chains.
(c)	– <u>CONH</u> group / <u>NH</u> group / <u>amide</u> group allows nylon to form hydrogen bonds with water molecules ✓ no hydrogen bonding in neoprene ✓ water molecules will force chains further apart / chains will not fit as closely together / AW ✓ chains less crystalline / weaker intermolecular forces so T_g will be lowered ✓	4	IGNORE chains sliding over each other

Question	Expected Answers	Marks	Additional Guidance
(d)		2	6 carbon atoms and -NH_2 group ✓ -COO^- ✓ ALLOW skeletal or any equivalent / alternative structural formula DO NOT ALLOW structures with missing H atoms
Total		12	

Question	Expected Answers	Marks	Additional Guidance
5 (a) (i)	$3\text{H}_2\text{S} + 2\text{MnO}_4^- + 2\text{H}^+ \rightarrow 2\text{MnO}_2 + 3\text{S} + 4\text{H}_2\text{O}$	1	all 4 numbers MUST be correct
(ii)	oxidation state = +4 ✓	1	DO NOT ALLOW 4+ OR 4
(b) (i)	iron(III) hydroxide ✓	1	DO NOT ALLOW iron hydroxide / Fe(OH) ₃
(ii)	$\text{Fe}^{3+}(\text{aq}) + 3\text{OH}^{-}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s})$	2	equation correct ✓ state symbols correct ✓ ALLOW ecf for iron(II) hydroxide in (i)
(c) (i)	The large excess of ethanedioate and acid means that their concentrations were virtually constant during the reaction / concentrations hardly changed / concentrations were high so little effect on rate / AW ✓	1	'A large excess of ethanedioate and acid' by itself does not get the mark IGNORE 'excess ethanedioate and acid not limit the rate of reaction' / AW <i>Look for concentration in answer</i>
(ii)	One of the following: Method 1 half-lives determination of at least two half-lives, 13-15 s ✓ half-life constant ✓ first order ✓ OR <i>Method 2 finding rate at different concentrations</i> calculation of at least two rates ✓ rate is proportional to concentration ✓ first order ✓	3	Two values for half-life MUST be given Working must be shown as either a calculation or by lines on graph.

Question	Expected Answers	Marks	Additional Guidance
(iii)	<p style="text-align: center;">3d 4s</p> 	1	
(d)	<p>One from the following:</p> <p>loss of CO₂ / CO₂ produced ✓ by weighing / gas collection / measuring milkiness of lime-water ✓</p> <p>OR</p> <p>titration of MnO₄⁻ ✓ with (standard) Fe²⁺(aq) ✓</p> <p>OR</p> <p>titration of H⁺(aq) decrease ✓ with OH⁻ / CO₃²⁻(aq) ✓</p> <p>OR</p> <p>measure pH change ✓ H⁺ ions used in the reaction ✓</p>	2	<p>The two parts are marked independently</p> <p>ALLOW gas for CO₂ and measuring volume for gas collection</p>
	Total	12	

Grade Thresholds

Advanced GCE Chemistry B (Salters) (H035 H435)
January 2010 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A	B	C	D	E	U
F331	Raw	60	41	36	31	26	21	0
	UMS	90	72	63	54	45	36	0
F332	Raw	100	74	67	60	54	48	0
	UMS	150	120	105	90	75	60	0
F334	Raw	90	65	58	51	44	37	0
	UMS	90	72	63	54	45	36	0

Specification Aggregation Results

Overall threshold marks in UMS (ie after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
H035	300	240	210	180	150	120	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
H035	12.9	37.1	61.7	83.6	97.4	100.0	823

823 candidates aggregated this series

For a description of how UMS marks are calculated see:
<http://www.ocr.org.uk/learners/ums/index.html>

Statistics are correct at the time of publication.

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