

Mark Scheme Summer 2009

GCE

GCE Chemistry (8CH01)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the mark scheme

1 / means that the responses are alternatives and either answer should receive full credit.

2 () means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

3 [] words inside square brackets are instructions or guidance for examiners.

4 Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.

5 OWTTE means or words to that effect

6 ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- show clarity of expression
- construct and present coherent arguments
- demonstrate an effective use of grammar, punctuation and spelling.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated "QWC" in the mark scheme BUT this does not preclude others.

6CH01/01

Section A

Question Number	Correct Answer	Reject	Mark
1	A		1

Question Number	Correct Answer	Reject	Mark
2	C		1

Question Number	Correct Answer	Reject	Mark
3	C		1

Question Number	Correct Answer	Reject	Mark
4	B		1

Question Number	Correct Answer	Reject	Mark
5	D		1

Question Number	Correct Answer	Reject	Mark
6	B		1

Question Number	Correct Answer	Reject	Mark
7	B		1

Question Number	Correct Answer	Reject	Mark
8	D		1

Question Number	Correct Answer	Reject	Mark
9	A		1

Question Number	Correct Answer	Reject	Mark
10	A		1

Question Number	Correct Answer	Reject	Mark
11	B		1

Question Number	Correct Answer	Reject	Mark
12	A		1

Question Number	Correct Answer	Reject	Mark
13	C		1

Question Number	Correct Answer	Reject	Mark
14	B		1

Question Number	Correct Answer	Reject	Mark
15	A		1

Question Number	Correct Answer	Reject	Mark
16	B		1

Question Number	Correct Answer	Reject	Mark
17	D		1


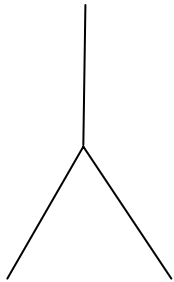
Question Number	Correct Answer	Reject	Mark
18	C		1

Question Number	Correct Answer	Reject	Mark
19	C		1

Question Number	Correct Answer	Reject	Mark
20	D		1

Section B

Question Number	Correct Answer	Reject	Mark
21 (a)(i)	Easier to transport / easier to store / less space / less volume needed for storage / easier to handle / easier to transfer <i>IGNORE</i> references to "safety" Accept Denser/cheaper to transport OWTTE	Just "cost"	1

Question Number	Correct Answer	Reject	Mark
21 (a)(ii)	<p>skeletal formula (1)</p>  <p>Name: butane (1) Stand alone</p> <p>skeletal formula (1)</p>  <p>Name: methylpropane OR 2-methylpropane (1) <i>IGNORE</i> incorrect punctuation [e.g. extra/missing hyphens, etc.] Stand alone</p> <p><i>IGNORE</i> displayed formulae if also given with skeletal formulae</p> <p>if 2 correct displayed formulae are given max 1 out of 2 for the structures</p>		4

Question Number	Correct Answer	Reject	Mark
21 (a)(iii)	(Structural) isomers		1

Question Number	Correct Answer	Reject	Mark
21 (b)(i)	$\text{Cl}_2 \rightarrow \text{Cl}\cdot + \text{Cl}\cdot /$ $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot \quad (1)$ (U.V.) light / sunlight (1) Must show the dots · <i>IGNORE</i> any subsequent propagation steps in (b)(i)	heat alone	2

Question Number	Correct Answer	Reject	Mark
21 (b)(ii)	$\text{C}_3\text{H}_8 + \text{Cl}\cdot \rightarrow \text{C}_3\text{H}_7\cdot + \text{HCl} \quad (1)$ $\text{C}_3\text{H}_7\cdot + \text{Cl}_2 \rightarrow \text{C}_3\text{H}_7\text{Cl} + \text{Cl}\cdot \quad (1)$ Must show the dots ·		2

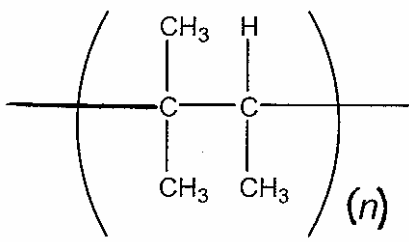
Question Number	Correct Answer	Reject	Mark
21 (b)(iii)	$\text{C}_3\text{H}_7\cdot + \text{Cl}\cdot \rightarrow \text{C}_3\text{H}_7\text{Cl}$ OR $\text{Cl}\cdot + \text{Cl}\cdot \rightarrow \text{Cl}_2$ OR $\text{C}_3\text{H}_7\cdot + \text{C}_3\text{H}_7\cdot \rightarrow \text{C}_6\text{H}_{14}$ Must show dots in termination step		1

Question Number	Correct Answer	Reject	Mark
21 (c)(i)	Alkene / triene Accept Diene Carbon-carbon double bond		1

Question Number	Correct Answer	Reject	Mark
21 (c)(ii)	<p>From: Red / brown / orange / yellow or combinations of these colours</p> <p>To: colourless <i>both colours needed</i></p>	"clear" instead of colourless	1

Question Number	Correct Answer	Reject	Mark
21 (c)(iii)	Electrophilic (1) addition (1)		2

Question Number	Correct Answer	Reject	Mark
21 (c)(iv)	<p>Calculation:</p> <p>0.01 mol myrcene reacts with 0.03 mol H₂</p> <p>OR</p> <p>1 mol myrcene reacts with 3 mol H₂ (1)</p> <p>Structural formula:</p> <p>(CH₃)₂CH(CH₂)₃CH(CH₃)CH₂CH₃</p> <p>OR</p> $ \begin{array}{cccccccc} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & & \\ \text{H}_3\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & & & & \\ & \text{CH}_3 & \text{H} & \text{H} & \text{H} & \text{CH}_3 & \text{H} & \text{H} \end{array} $ <p>(1)</p> <p>Accept Fully displayed formula/skeletal formula</p> <p>Mark calculation and structural formula independently.</p>		2

Question Number	Correct Answer	Reject	Mark
21 (d)	 <p>repeat unit (1) continuation bonds shown (but these bonds do not have to cut through the brackets) (1) <i>n</i> not essential <i>IGNORE</i> the position of "<i>n</i>" relative to the repeat unit (e.g. can be written as a superscript)</p>		2

Question Number	Correct Answer	Reject	Mark																					
22 (a)(i)	<table border="1" data-bbox="295 1025 798 1854"> <thead> <tr> <th>Energy change</th> <th>Letter</th> <th>$\Delta H/\text{kJ mol}^{-1}$</th> </tr> </thead> <tbody> <tr> <td>Lattice energy for sodium chloride</td> <td>E</td> <td>-775</td> </tr> <tr> <td>Enthalpy change of atomization of sodium</td> <td>C</td> <td>+109</td> </tr> <tr> <td>Enthalpy change of atomization of chlorine</td> <td>A</td> <td>+121</td> </tr> <tr> <td>First ionization energy of sodium</td> <td>B</td> <td>+494</td> </tr> <tr> <td>First electron affinity of chlorine</td> <td>F</td> <td></td> </tr> <tr> <td>Enthalpy change of formation of sodium chloride</td> <td>D</td> <td>-411</td> </tr> </tbody> </table> <p>6 correct letters (3) 5 or 4 correct letters (2) 3 or 2 correct letters (1) 1 or 0 correct letters (0)</p>	Energy change	Letter	$\Delta H/\text{kJ mol}^{-1}$	Lattice energy for sodium chloride	E	-775	Enthalpy change of atomization of sodium	C	+109	Enthalpy change of atomization of chlorine	A	+121	First ionization energy of sodium	B	+494	First electron affinity of chlorine	F		Enthalpy change of formation of sodium chloride	D	-411		3
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Question Number	Correct Answer	Reject	Mark
22 (a)(ii)	Expression such as: $D = C + B + A + F + E$ $- 411 = + 109 + 494 + 121 + F + (- 775)$ $F = - 411 - 109 - 494 - 121 + 775$ (1) Answer: $F = -360 \text{ (kJ mol}^{-1}\text{)} \text{ (1)}$ <i>Check empty box in 22(a)(i), as answer may be written there.</i> Answer must follow from working Correct answer only (2) Correct answer with some consistent working (2)		2

Question Number	Correct Answer	Reject	Mark
22 (b)(i)	(Bonding in NaCl) 100% ionic OR almost completely ionic OR no covalent character/(very) little covalent character	'Molecule' (0)	1

Question Number	Correct Answer	Reject	Mark
22 (b)(ii) QWC	AgI has (a degree of) covalent character (1) due to polarization or distortion (of the anion) (1)		2

Question Number	Correct Answer	Reject	Mark
22 (c) QWC	<p>Any two of the following:</p> <ul style="list-style-type: none"> (outermost) electron further from the nucleus/atoms get bigger/more shells (outermost) electron more shielded (by inner shells of e⁻) (force of) attraction between nucleus and (outermost) electron decreases (down the Group) OR (outermost) electron held less strongly (down the Group) OR (outermost) electron becomes easier to remove (down the Group) <p><i>IGNORE</i> any references to (effective) nuclear charge or more protons.</p>	"ions" get bigger (down Group)	2

Question Number	Correct Answer	Reject	Mark												
23 (a)	<table border="1"> <thead> <tr> <th>element</th> <th>structure</th> <th>bonding</th> </tr> </thead> <tbody> <tr> <td>sodium</td> <td>Giant</td> <td>metallic</td> </tr> <tr> <td>silicon</td> <td>Giant (atomic)/ macromolecular/ giant molecular</td> <td>covalent</td> </tr> <tr> <td>sulfur</td> <td>simple / small molecules OR (simple) molecular OR S₈ molecules</td> <td>covalent or van der Waals' forces/ London forces/ intermolecular forces/dispersion forces/induced- dipole forces</td> </tr> </tbody> </table> <p><i>IGNORE</i> the word "lattice" OR "crystalline"</p> <p>6 boxes correct (3) 5,4 boxes correct (2) 3,2 boxes correct (1) 1,0 boxes correct (0)</p>	element	structure	bonding	sodium	Giant	metallic	silicon	Giant (atomic)/ macromolecular/ giant molecular	covalent	sulfur	simple / small molecules OR (simple) molecular OR S ₈ molecules	covalent or van der Waals' forces/ London forces/ intermolecular forces/dispersion forces/induced- dipole forces		3
element	structure	bonding													
sodium	Giant	metallic													
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sulfur	simple / small molecules OR (simple) molecular OR S ₈ molecules	covalent or van der Waals' forces/ London forces/ intermolecular forces/dispersion forces/induced- dipole forces													

Question Number	Correct Answer	Reject	Mark
23 (b)	<p>Si : covalent bonds / many bonds / strong bonds (between atoms) (1)</p> <p>S : weak forces /van der Waals' forces/London forces/dispersion forces/intermolecular forces/induced-dipole forces (1) (need to be overcome)</p>	<p>any reference to intermolecular forces in Si</p> <p>suggestion that covalent bonds are broken</p>	2

Question Number	Correct Answer	Reject	Mark
23 (c) QWC	<p>Cations/ions decrease in size (from Na⁺ to Al³⁺)</p> <p>OR</p> <p>charge increases/charge density on (cat)ions increases/ "effective nuclear charge" increases (from Na⁺ to Al³⁺) (1)</p> <p>more e⁻ (per atom in 'sea' of delocalized electrons) / more delocalized electrons</p> <p>OR</p> <p>(force of) attraction between (cat)ions/nucleus and (delocalised) electrons increases (from Na to Al) (1)</p> <p><i>IGNORE</i> "nuclear charge increases" / "increasing no. of protons"</p>	<p>atoms decrease in size</p> <p>any mention of "molecules" / "covalent bonds" / "van der Waals' forces" / "ionic bonds" (0) overall</p>	2

Question Number	Correct Answer	Reject	Mark
23 (d)(i) QWC	<ul style="list-style-type: none"> Add MgO to acid/react MgO with acid/dissolve MgO in acid (1) <p>[NOTE: mention of heating not required. IGNORE water bath/reflux]</p> <ul style="list-style-type: none"> Filter (1) Heat/boil filtrate /MgSO₄ solution (until volume reduced by half) (1) Leave to cool/leave to crystallise/evaporate slowly/leave to evaporate (1) <p>(decant / filter / pick out crystals, then) Leave to dry/pat dry/dry between filter papers/put in an oven/put in a desiccator/dry the crystals (1)</p> <p>IGNORE any washing of crystals immediately prior to drying them</p>	<p>Just "warm" the filtrate/MgSO₄ solution</p> <p>Use of a desiccant (added to crystals)</p>	5

Question Number	Correct Answer	Reject	Mark
23 (d)(ii)	Rinse with (plenty of) water /use a damp cloth or damp (paper) towel / add a (named) weak alkali (e.g. solid or aqueous sodium hydrogencarbonate)	Any named strong alkali/just "strong alkali"	1

Question Number	Correct Answer	Reject	Mark
23 (e)(i)	Insoluble strontium sulfate/insoluble SrSO ₄ (forms on the strontium carbonate)		1

Question Number	Correct Answer	Reject	Mark
23 (e)(ii)	$\text{Sr}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{SrSO}_4(\text{s})$ species (1) state symbols (1) 2nd mark is cq on first mark $\text{Sr}^{2+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq}) + 2\text{Na}^{+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{SrSO}_4(\text{s}) + 2\text{Cl}^{-}(\text{aq}) + 2\text{Na}^{+}(\text{aq})$ scores (1) $\text{SrCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{SrSO}_4(\text{s}) + 2\text{NaCl}(\text{aq})$ scores (1)		2

Question Number	Correct Answer	Reject	Mark
24 (a)(i)	$\frac{2.90}{58} = 0.05(00) \text{ (mol)}$ correct answer only (1)		1

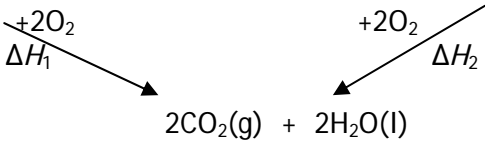
Question Number	Correct Answer	Reject	Mark
24 (a)(ii)	$200 \times 4.18 \times 58.2 = 48655 \text{ (J) OR } 48.655 \text{ kJ (1)}$ for correct $\Delta T(1)$ <i>IGNORE</i> sf <i>IGNORE</i> signs at this stage		2

Question Number	Correct Answer	Reject	Mark
24 (a)(iii)	$-\frac{48655}{0.0500} = -973\,100 \text{ (J mol}^{-1}\text{)}$ $= -973 \text{ kJ mol}^{-1} \text{ (3 s.f.)}$ $/ -973000 \text{ J mol}^{-1} \text{ (3 s.f.)}$ answer (1) sign and units (1) [Do not award sign and units mark if units given are just "kJ" or just "J"] three sig figs (1) <i>CQ on (a)(i) & (ii)</i>		3

Question Number	Correct Answer	Reject	Mark
24 (b)(i)	Heat loss/energy loss Accept Incomplete combustion OWTTE <i>IGNORE</i> "experimental error" / "departure from standard conditions"	Anything related to "average values" (0)	1

Question Number	Correct Answer	Reject	Mark
24 (b)(ii)	Difference: less exothermic / less negative <i>IGNORE</i> "higher" if written with less exothermic/less negative Accept just "lower" / "less" (1) Justification: energy taken in to form gas/energy required to form gas/energy needed to form gas/takes heat in to form gas/heat required to form gas Or reverse argument (1) <i>Mark these two points independently</i>	Just "higher" (0) Just "H ₂ O(g) is not water's standard state"	2

Question Number	Correct Answer	Reject	Mark
24 (c)(i)	Enthalpy / energy / heat (energy) change (when) one mole of a substance/one mole of a compound (1) is formed from its elements (in their most stable states) (1) 298K / 25°C / a stated temperature AND 1 atm pressure/100 kPa (1) <i>IGNORE</i> any references to concentration	"energy required" OR "energy released" "one mole of product(s)" is formed from its reactants room temperature/rtp	3

Question Number	Correct Answer	Reject	Mark
24 (c)(ii)	<p data-bbox="300 297 675 331">Cycle or formula expression</p> <div style="text-align: center;">  </div> $\Delta H_f^\theta = \Delta H_1 - \Delta H_2$ $= (2 \times -394) + (2 \times -286) - (-870)$ $= -490 \text{ (kJ mol}^{-1}\text{)}$ <ul style="list-style-type: none"> <li data-bbox="344 757 775 824">• correct expression or cycle (1) <li data-bbox="344 824 775 943">• evidence for doubling both ΔH_c^θ [C] and ΔH_c^θ [H₂] (1) <li data-bbox="344 981 775 1014">• answer (1) <p data-bbox="292 1048 719 1108">Correct answer with no working scores full marks</p>		3

6CH02/01

Section A

Question Number	Correct Answer	Reject	Mark
1	C		1

Question Number	Correct Answer	Reject	Mark
2	B		1

Question Number	Correct Answer	Reject	Mark
3	A		1

Question Number	Correct Answer	Reject	Mark
4	D		1

Question Number	Correct Answer	Reject	Mark
5	C		1

Question Number	Correct Answer	Reject	Mark
6	A		1

Question Number	Correct Answer	Reject	Mark
7	B		1

Question Number	Correct Answer	Reject	Mark
8	D		1

Question Number	Correct Answer	Reject	Mark
9	B		1

Question Number	Correct Answer	Reject	Mark
10 (a)	A		1

Question Number	Correct Answer	Reject	Mark
10 (b)	C		1

Question Number	Correct Answer	Reject	Mark
11	D		1

Question Number	Correct Answer	Reject	Mark
12	C		1

Question Number	Correct Answer	Reject	Mark
13	B		1

Question Number	Correct Answer	Reject	Mark
14	D		1

Question Number	Correct Answer	Reject	Mark
15	C		1

Question Number	Correct Answer	Reject	Mark
16	A		1

Question Number	Correct Answer	Reject	Mark
17	C		1

Question Number	Correct Answer	Reject	Mark
18	A		1

Question Number	Correct Answer	Reject	Mark
19	B		1

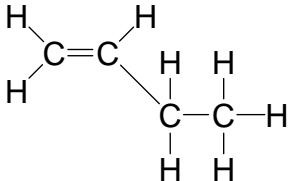
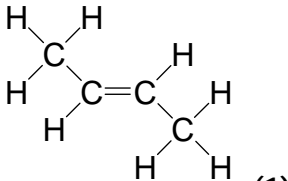
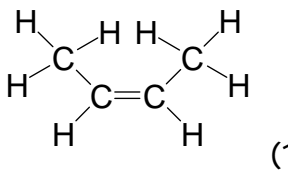
Section B

Question Number	Correct Answer	Reject	Mark
20 (a)(i)	<p>Reaction 1 - (nucleophilic) substitution (1)</p> <p>Reaction 2 - elimination (1)</p>		2

Question Number	Correct Answer	Reject	Mark
20 (a)(ii) QWC	<p>Reaction 1 - Water can behave as a nucleophile /water can donate a lone pair (from oxygen)/water has a lone pair/water forms an OH^- ion (1)</p> <p>And attack (positive) carbon (originally attached to Cl)/bonds to the carbon/bonds to the carbocation (1)</p> <p>Reaction 2 - behaves as a base (1)</p> <p>and accepts a hydrogen ion/proton / donates e^- pair to H/removes a proton/removes a hydrogen ion/removes a H^+ (1)</p> <p>In each case a correctly drawn mechanism could get (2)</p>	Removes a H atom	4

Question Number	Correct Answer	Reject	Mark
20 (b)(i)	<p>Heterolytic (fission)</p> <p>Notes Accept phonetic/incorrect spelling as long as the word is recognisable</p>		1

Question Number	Correct Answer	Reject	Mark
20 (b)(ii)	<p>Butyl group less electron releasing/butyl group has less of a (positive) inductive effect (1)</p> <p>so less stable (positive charge on) carbocation (1)</p> <p>OR</p> <p>1- chlorobutane is a primary halogenoalkane/the carbon only has 1 other C attached (1)</p> <p>So forms a less stable carbocation (1)</p> <p>OR</p> <p>Primary carbocation is less stable than a tertiary carbocation (2)</p> <p>OR</p> <p>Water/OH^- can attack C on 1° chloroalkane more easily (so no need to form cation) OWTTE / 1° chloroalkane reacts via $\text{S}_\text{N}2$ mechanism/C-O bond forms before C-Cl breaks (1)</p> <p>As the carbon attacked is not surrounded by bulky groups OWTTE (1)</p>	Negative inductive effect	2

Question Number	Correct Answer	Reject	Mark
20 (c)	<p>Hydrogen (ion) can be eliminated from C on either side (of C attached to Cl)/double bond can form between 1st and 2nd or 2nd and 3rd carbon OWTTE (1)</p> <p>OR</p> <p>double bond can't rotate (so methyl group and hydrogens can be fixed in position) to form E and Z isomers / geometric isomers/cis and trans/stereoisomers/or named in diagrams OWTTE (1)</p> <p>allow descriptions in terms of cis and trans</p> <div style="text-align: center;">  <p>(1)</p> </div> <div style="text-align: center;">  <p>(1)</p> </div> <div style="text-align: center;">  <p>(1)</p> </div> <p>Methyl and ethyl groups do not need to be fully displayed</p> <p>Structural formulae/skeletal formulae For all 3 (2) For 2 (1) For 1 (0)</p> <p>For an incorrect haloalkane structure that can form 3 isomers including cis/trans (2 max) (eg 2-chloropentane)</p>		4

Question Number	Correct Answer	Reject	Mark
20 (d)	<p>(Slower) as C-F bond is stronger (than C-Cl)/fluorine bonds more strongly/fluorine holds the carbon more strongly</p> <p>OR</p> <p>Slower as F⁻ is a poorer leaving group (than Cl⁻) (1)</p> <p>Use sodium hydroxide /NaOH/ potassium hydroxide /KOH/ hydroxide ions (1)</p> <p>As OH⁻ is a stronger nucleophile / OH⁻ has a full negative charge/ more strongly attracted to C^{δ+} /OH⁻ has more lone pairs (than water)/ OH⁻ is more negative than water (1)</p>	Alkali Hydroxide	3

Question Number	Correct Answer	Reject	Mark
21 (a)(i)	<p>Hydrogen bonding Hydrogen bond(s) H bonding H bond(s)</p> <p>Notes Accept phonetic/incorrect spelling as long as the word is recognisable</p>	<p>Not "hydrogen" on its own Dipole-dipole bond Permanent dipole-dipole bond Covalent bond van der Waals' (forces) Temporary dipole-dipole Induced dipole-dipole London forces</p> <p>Any correct answer in conjunction with an incorrect response, eg hydrogen dipole-dipole bond.</p>	1

Question Number	Correct Answer	Reject	Mark
21 (a)(ii)	<p>(Fluorine atom) is more electronegative (1)</p> <p>Because it has less shielding / (bonding) electrons closer to the nucleus/ smaller /has less shells (so greater pull from nucleus on bonding electrons) (1)</p> <p>so HF has a (greater) dipole moment/H^{δ+} on HF (greater than on HBr)/HF is (more) polar (1)</p>		3

Question Number	Correct Answer	Reject	Mark
21 (a)(iii)	Between 150 - 180 (K) Accept a range within the range e.g. '150-170'	°C	1

Question Number	Correct Answer	Reject	Mark
21 (b)(i)	Because propanone has both polar and non polar characteristics/can form both London forces and H bonds/can form London forces and dipole-dipole forces OWTTE (1) London forces can be described as Van der Waals VDW Temporary dipole-dipole Instantaneous dipole-induced dipole		1

Question Number	Correct Answer	Reject	Mark
21 (b)(ii)	Water: Hydrogen bonds with the (oxygen of the) carbonyl group/H bonds to the oxygen (1) Octane: London forces with methyl groups/carbon chain/CH groups/H atoms (1) Both forces given allow (1)	Carbon atoms	2

Question Number	Correct Answer	Reject	Mark
22 (a)(i)	Use of heat (1) To break down (a reactant)/one reactant into more than one product (1)		2

Question Number	Correct Answer	Reject	Mark
22 (a)(ii)	$\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$ Allow correct multiples		1

Question Number	Correct Answer	Reject	Mark
22 (a)(iii)	<p>Group 2 carbonates are more (thermally) stable as you go down the group (1)</p> <p>as the cations get bigger/charge density gets less/cation has more shells (1)</p> <p>So have less of a polarising effect/distortion on the carbonate (ion)/less of a weakening effect on C-O (1)</p> <p>2nd and 3rd marks cq on first</p>	<p>Metal gets bigger/element gets bigger</p> <p>Carbonate molecule</p>	3

Question Number	Correct Answer	Reject	Mark
22 (b)(i)	orange	<p>Yellow</p> <p>Any colour in conjunction with orange</p>	1

Question Number	Correct Answer	Reject	Mark
22 (b)(ii)	$(18.0/1000 \times 0.100) = 1.8 \times 10^{-3}$ $/0.0018/2 \times 10^{-3}/0.002$ <i>IGNORE</i> sf and units even if incorrect		1

Question Number	Correct Answer	Reject	Mark
22 (b)(iii)	$(50/1000 \times 0.100) = 5 \times 10^{-3}$ (1) <p>[If candidate fails to divide by 1000 in both (b)(ii) and b(iii) penalise only once]</p> <p>Moles HCl reacted = 3.2×10^{-3} (can get first mark here if 5×10^{-3} not shown above) So moles CaO = 1.6×10^{-3} (1)</p> <p><i>IGNORE</i> sf</p> <p>Allow TE from b (ii)</p>		2

Question Number	Correct Answer	Reject	Mark
22 (b)(iv)	<p>Mass CaO = $(1.6 \times 10^{-3} \times 56.1)$ = 0.0898 g (1)</p> <p>% purity = $0.0898/0.121 \times 100 = 74.2\%$ (1)</p> <p>OR</p> <p>Allow % calculated in terms of moles e.g moles of CaO should be $0.121 \times 56.1 = 0.0021568$ (mol) (1)</p> <p>% purity = $0.0016/0.0021568 = 74.2\%$ (1)</p> <p>Accept = $(1.6 \times 10^{-3} \times 56)$ = 0.0896 g (1)</p> <p>% purity = $0.0896/0.121 \times 100 = 74.0\%$ (1)</p> <p>Allow TE of incorrect moles of CaO from (b)(iii)</p> <p>Allow TE from incorrect mass of CaO if answer is $\leq 100\%$</p> <p>0.09 g and 74.4% is 1 out of 2 (rounding too soon)</p>	Any % purity without 3 sf for second mark	2

Question Number	Correct Answer	Reject	Mark
22 (c)(i)	<p>(Clean) nichrome/platinum wire/ceramic rod/silica/nickel/chrome rod (1)</p> <p>(In conc.) HCl/HCl(aq)/dilute HCl (1)</p> <p>Heat/place in (blue Bunsen) flame (1)</p>	<p>Metal loop/inoculating loop/glass rod/silver/spatula</p> <p>Place in yellow Bunsen flame/burn</p>	3

Question Number	Correct Answer	Reject	Mark
22 (c)(ii)	Barium/Ba/Ba ²⁺		1

Question Number	Correct Answer	Reject	Mark
23 (a)	H bond between appropriate O and H atom (1) Angle of 180° between molecules (1) 2 nd mark is dependent on first Compounds other than ethanol showing correct H bond and angle (1 max)	O---H-O if not in a straight line	2

Question Number	Correct Answer	Reject	Mark
23 (b)	Incorrect water flow through condenser (1) so takes longer to collect product / lower amount of product collected / inner tube in condenser could crack / backflow of water due to gravity/air bubbles/inefficient cooling/condenser does not fill up with water (1) Thermometer bulb too high (1) so incorrect boiling point reading/product collected at incorrect temp OWTTE (1) Sealed apparatus (1) so risk of explosion/pressure build up (1) 2 nd mark in each pair dependent on 1 st mark 1 st mark can be obtained by circling correct point on diagram or by description Circle for 3 rd error must cover joint to collection flask and/or delivery adaptor If the whole apparatus is circled to indicate sealed 2 marks could be awarded if the problem of the pressure build up is explained Circling the whole apparatus with no or incorrect explanation = 0 marks		6

Question Number	Correct Answer	Reject	Mark
23 (c)	$(0.005 \times 2) / 20.10 \times 100 = 0.05 / 0.04975 (\%)$ <i>IGNORE</i> sf		1

Question Number	Correct Answer	Reject	Mark
23 (d)	Suitable drying agent e.g anhydrous magnesium sulfate/anhydrous sodium sulfate/calcium oxide (1) Accept anhydrous calcium chloride silica (gel) Add to ethanol (leave) and then filter/Add to ethanol (leave) and then decant (1) Mark independently	Concentrated sulfuric acid OR Sodium and potassium hydroxide Anhydrous copper sulfate Anhydrous cobalt chloride	2

Question Number	Correct Answer	Reject	Mark
23 (e)	Add PCl_5 /phosphorous(v)chloride/ phosphorous pentachloride (1) Misty fumes (of HCl) seen/steamy fumes/fumes that form white smoke with NH_3 /fumes that turn blue litmus red (1) OR Add Na (to dried ethanol) (1) Bubbles (of H_2) seen/fizzing/effervescence (1) OR Add acidified (sodium) dichromate((VI))/ $\text{Cr}_2\text{O}_7^{2-}$ and H^+ (1) Blue/green colour observed (1) OR Add acidified (potassium) manganate((VII))/ MnO_4^- & H^+ (1) Loss of (purple) colour/colour fades/decolourises (1) 2 nd mark dependent on sensible attempt at test reagent	PCl_3 White smoke on its own White fumes on its own	2

Question Number	Correct Answer	Reject	Mark
23 (f)(i) QWC	<p>A fuel (derived from a plant) that takes in as much CO₂ (as it forms/grows) (1) as is released during its production /combustion/when used (1)</p> <p>OR</p> <p>A fuel (such as hydrogen) that produces no CO₂ when burnt (1) Nor in its production/processing (1)</p>		2

Question Number	Correct Answer	Reject	Mark
23 (f)(ii) QWC	<p>2 specific reasons e.g</p> <ul style="list-style-type: none"> • energy used to heat/distil (ethanol water mixture after fermentation) may require burning a fuel/energy • energy required to manufacture fertilisers (to grow plants for biofuels in good yield) • energy required to manufacture insecticides (to grow plants for biofuels in good yield) • energy required to transport fuel to the power plant • biofuels less effective at absorbing CO₂ than (rain)forests/trees <p style="text-align: right;">(2)</p> <p>2 well reasoned effects on society e.g</p> <ul style="list-style-type: none"> • use of food crops to produce biofuels reduces food supply • (use of land) for biofuels reduces biodiversity • use of land to grow biofuels leads to reduced food supply • leads to deforestation/leads to habitat loss • new jobs created to grow crops on new farmland • increased price of car/car service due to engine modifications • less CO₂ so less global warming • less SO₂ so less acid rain • less SO₂ so less respiratory illnesses e.g asthma <p style="text-align: right;">(2)</p> <p>Choice of most sustainable biofuel with appropriate reasoning e.g</p> <ul style="list-style-type: none"> • elephant grass as it requires little/no energy to process before it is burnt • elephant grass grows very quickly • elephant grass is a high yield crop • Any of the fuels can be burnt using existing technology <p style="text-align: right;">(1)</p>		5

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