UNIT 2: CHEMICAL BONDING, APPLICATION OF CHEMICAL REACTIONS AND ORGANIC CHEMISTRY
HIGHER TIER

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (apart from the questions where a level of response mark scheme is applied).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

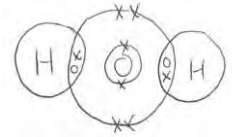
A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statements.

Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)		$2SO_2 + O_2 \leftrightharpoons 2SO_3$ (3) If equation not correct award (1) for each of following SO_2 and O_2 on reactant side SO_3 on product side		3		3	1	
		(ii)		30 % (2) If answer is incorrect award (1) for 86 or 56 read from graph		2		2	2	
		(iii)		$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ (2) If equation not correct award (1) for either of following SO_3 and H_2SO_4 oleum formula based on incorrect reactant hydrogen, sulfur and oxygen atoms only e.g. $H_2S_2O_6$ if sulfuric acid given as H_2SO_3		2		2	1	
	(b)			Copper(II) sulfate turns from <u>blue to white</u> (1) Any one of the following for (1) Crystals become powdery / crumbly Loses its crystalline appearance Dehydrating agent (1)	3			3		3
				Question 1 total	**3**	**7**	**0**	**10**	**4**	**3**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)		Correct transfer of both outer shell potassium electrons to the oxygen atom (1)		1		1		
		(ii)		All four electronic configurations and charges correct (2) Any two correct (1) potassium ions (2,8,8) K^+ oxide ions (2,8) O^{2-}		2		2		
	(b)			 Diagram shows shared pair of electrons between oxygen and both hydrogen atoms (1) Octet of electrons around oxygen atom and only two around both hydrogen atoms (1)		2		2		
	(c)			**C** (1) Conducts electricity in its solid form (1)			2	2		

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(d)			Award (1) each for up to three of following properties **with explanation** Conducts electricity – **free electrons carrying the charge** Malleable / can be hammered into shape / bent into shape – **layers of ions can slide over each other** Ductile / can be drawn into a wire – **layers of ions can slide over each other** High density – **ions are tightly packed** High melting / boiling point – **ions are tightly packed** If no creditworthy explanations given award (1) for two correct properties	3			3		
				Question 2 total	**3**	**5**	**2**	**10**	**0**	**0**

<table>
<tr><th colspan="4" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="6">Marks Available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td>3</td><td>(a)</td><td></td><td></td><td>Bubbles form because a gas, carbon dioxide, is produced ✓</td><td>1</td><td></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td></td><td><table><tr><th>Suggested explanation of where the carbon atoms come from</th><th>Is this correct? Yes/No</th></tr><tr><td>some carbon atoms come from the sugars</td><td>Yes</td></tr><tr><td>some carbon atoms come from the yeast</td><td>No</td></tr><tr><td>some carbon atoms come from the solution</td><td>No</td></tr></table>
Award (1) for all correct answers</td><td></td><td></td><td>3</td><td>3</td><td></td><td></td></tr>
<tr><td></td><td>(c)</td><td></td><td></td><td>Award (1) for each of following

Experiment 2 – no change; no yeast therefore no reaction

Experiment 1 – no change; reaction takes place but gas cannot escape as container is sealed

Experiment 3 – mass decreases; reaction takes place and gas escapes from container</td><td></td><td></td><td>3</td><td>3</td><td></td><td>3</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Question 3 total</td><td>1</td><td>0</td><td>6</td><td>7</td><td>0</td><td>3</td></tr>
</table>

<table>
<tr><th colspan="4" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="6">Marks Available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td>4</td><td>(a)</td><td></td><td></td><td>Iron is more reactive than copper (1)

Displacement reaction occurs / iron displaces the copper (1)

Products – iron(III) oxide and copper (1)
Accept iron oxide</td><td>1

1</td><td>

1</td><td></td><td>3</td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td></td><td>$Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$ (2)

If equation not correct award (1) for $AgNO_3$ and Ag included on appropriate sides</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td></td><td><table><tr><th rowspan="2">Mass of magnesium added (g)</th><th colspan="5">Mass of copper formed (g)</th></tr><tr><th>Student 1</th><th>Student 2</th><th>Student 3</th><th>Mean result</th><th>Theoretical result</th></tr><tr><td>0.10</td><td>0.15</td><td>0.13</td><td>0.14</td><td>0.14</td><td>0.26</td></tr><tr><td>0.15</td><td>0.25</td><td>0.21</td><td>0.23</td><td>0.23</td><td>0.40</td></tr><tr><td>0.20</td><td>0.35</td><td>0.37</td><td>0.28</td><td>0.35</td><td>0.54</td></tr><tr><td>0.25</td><td>0.41</td><td>0.45</td><td>0.39</td><td>0.39</td><td>0.68</td></tr></table>
Both identified</td><td></td><td></td><td>1</td><td>1</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>(ii)</td><td></td><td>The greater the mass of magnesium added, the more copper deposited
Accept more magnesium gives more copper</td><td></td><td>1</td><td></td><td>1</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>(iii)</td><td></td><td>The evidence for this conclusion is strong because:

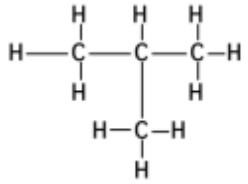
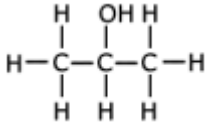
Each student has similar results / results are reproducible
Each student has same pattern in results

Credit for reason</td><td></td><td></td><td>1</td><td>1</td><td></td><td>1</td></tr>
</table>

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(c)	(iv)		Award (1) each for up to two possible issues that would lead to a reduction in the mass of copper Not all magnesium reacted / insufficient stirring / reaction time Magnesium not clean / had reacted before experiment / turned to oxide Not all copper retrieved / copper left behind in beaker / filter			2	2		2
		(v)		0.96 g (1) increase of 0.14 g per 0.05 g magnesium added (1)			2	2	2	
				Question 4 total	**2**	**4**	**6**	**12**	**2**	**5**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)	(i)		Award (2) for any four of following points Award (1) for any two Formed from the remains of marine life / remains sea animals and plants Buried / compacted under sediment (over time) No oxygen Change chemically / turn to oil under heat and pressure Over millions of years	2			2		
		(ii)		Crude oil is heated until it boils / evaporates (1) Compounds with longer chain lengths have higher boiling points / shorter chain lengths have lower boiling points (1) Higher the boiling point the lower down the column the compounds condense (1) Compounds with similar chain lengths condense at similar temperatures and are collected as part of the same fraction (1)	4			4		
	(b)			Energy required (in breaking bonds) = 4722 (2) If incorrect award (1) for identification of bonds broken Energy released (in forming bonds) = 5756 (2) If incorrect award (1) for identification of bonds formed Difference between energy required and energy released is 1034 kJ and more energy given out than taken in therefore the reaction is exothermic and has negative value (1) or Overall energy change = energy required – energy released = 4722 – 5756 = –1034 kJ (1)		5		5	5	
				Question 5 total	**6**	**5**	**0**	**11**	**5**	**0**

<table>
<tr><th colspan="4" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="6">Marks Available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td>6</td><td>(a)</td><td></td><td></td><td>All four names and formulae correct (2)
Any two correct (1)
<table><tr><th>Pair of Compounds</th><th>Family to which the pair of compounds belong</th><th>General molecular formula for the family</th></tr><tr><td>A and C</td><td>Alkanes</td><td>C_nH_{2n+2}</td></tr><tr><td>E and F</td><td>Alkenes</td><td>C_2H_{2n}</td></tr></table></td><td>2</td><td></td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td></td><td>Add bromine water (1)

Stays brown/orange/red/no reaction with C and E turns from brown/orange to colourless (1)</td><td>1</td><td>1</td><td></td><td>2</td><td></td><td>2</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td></td><td>Same molecular formula but different structure</td><td>1</td><td></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td></td><td>  </td><td>1</td><td></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td></td><td>(d)</td><td></td><td></td><td>D has an isomer – no credit for identification alone
  (1) propan-2-ol (1)</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>Question 6 total</td><td>5</td><td>3</td><td>0</td><td>8</td><td>0</td><td>0</td></tr>
</table>

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		Reagent **X** – sodium hydroxide (solution) / NaOH (1) Reagent **Y** – silver nitrate (solution) / $AgNO_3$ (1) Solution **A** – iron(II) sulfate / $FeSO_4$ (1) Solution **B** – ammonium carbonate / $(NH_4)_2CO_3$ (1)	1 1		1 1	4		4
		(ii)		$Na_2CO_3 + 2HNO_3 \rightarrow 2NaNO_3 + H_2O + CO_2$ (2) If equation is not correct award (1) for $NaNO_3$ and H_2O and CO_2 on product side		2		2	1	
	(b)			$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$ (2) If state symbols missing or incorrect award (1) for correct reactants **and** product	1	1		2	2	
				Question 7 total	**3**	**3**	**2**	**8**	**3**	**4**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
8				***Indicative content*** Aluminium oxide heated until molten (cryolite added to lower melting point) Al^{3+} and O^{2-} ions free to move in molten state Al^{3+} ions attracted to cathode where they gain electrons and form atoms $Al^{3+} + 3e^- \rightarrow Al$ Molten aluminium falls to bottom of cell O^{2-} ions attracted to anodes O^{2-} ions lose electrons forming oxygen molecules $2O^{2-} \rightarrow O_2 + 2e^-$ Overall reaction is $2Al_2O_3 \rightarrow 4Al + 3O_2$ **5–6 marks** All key points included, explanation in terms of electron gain/loss, electrode equations and overall equation *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.* **3–4 marks** Reference to aluminium oxide being molten, movement of ions and good attempt at electrode equation(s) or overall equation *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.*	6			6		

				1–2 marks Minimum of three points including two linked points e.g. molten **therefore** ions free to move *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.* **0 marks** *No attempt made or no response worthy of credit.*						
				Question 8 total	**6**	**0**	**0**	**6**	**0**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			0.24 (2) If answer is incorrect award (1) for 0.06 mol **or** Calculated number of mol divided by 0.25		2		2	2	2
	(b)	(i)		Allows more precision in adding acid / acid to be added in smaller quantities (1) End point is identified more accurately identifies / less error in recorded end point (1)	2			2		2
		(ii)		Allow error carried forward from part (a) Mean volume acid = 16.0 (1) n(NaOH) = 0.006 (1) n(H_2SO_4) = 0.003 (1) Concentration = 0.1875 (1) Award (4) for correct answer only Error carried forward throughout	1	1 1 1		4	4	
				Question 9 total	**3**	**5**	**0**	**8**	**6**	**4**