

Question Number	Answer	Acceptable answers	Mark
<b>1(a)(i)</b>	cathode Reject anode		<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>1(a)(ii)</b>	<p>A description to include</p> <p>ANODE/IMPURE COPPER/ +VE ELECTRODE</p> <ul style="list-style-type: none"> <li>becomes smaller/ loses mass / loses copper / copper atoms form ions / copper is oxidised / copper (ions) enter solution (1)</li> </ul> <p>CATHODE/ PURE COPPER/ -VE ELECTRODE</p> <ul style="list-style-type: none"> <li>{ red-brown/copper} deposit/ becomes larger / gains mass / gains copper / copper ions are reduced / copper (ions) from solution add to electrode (1)</li> </ul>	<p>allow half equation</p> <p>allow half equation</p>	<b>(2)</b>

Question Number	Answer	Acceptable answers	Mark
<b>1(a)(iii)</b>	<b>D</b> reduction		<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>1(a)(iv)</b>	<p>An explanation linking</p> <p><b>ions</b> / cations / copper ions / anions / sulfate ions (1)</p> <p>(are free to) <u>move</u> (in solution) (1)</p>	<p><b>reject electrons</b> / atoms / molecules</p> <p><b>ignore 'charged particles'</b></p> <p>allow flow</p> <p>2<sup>nd</sup> mark dependent on 1<sup>st</sup> MP</p>	<b>(2)</b>

Question Number	Indicative Content	Mark
<b>QWC</b>	<b>*1(b)</b>	<b>(6)</b>
	<p>A description / explanation including some of the following points marks can be scored from diagrams incorrectly balanced equations can be used as evidence of reaction occurring but po not otherwise credited</p> <p><b>electrolysis process</b></p> <ul style="list-style-type: none"> <li>ions move when current passed</li> <li>negative ions move to anode</li> <li>overall decomposition of water</li> <li><math>2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2</math></li> </ul> <p><b>Anode/ positive electrode</b></p> <ul style="list-style-type: none"> <li>sulphate ions move to anode</li> <li>hydroxide ions move to anode</li> <li>hydroxide ions lose electrons/oxidation</li> <li>hydroxide ions form oxygen</li> <li>half equation: <math>4\text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^-</math></li> <li>half volume gas at this electrode</li> <li>oxygen test: glowing splint in gas relights</li> </ul> <p><b>cathode/ negative electrode</b></p> <ul style="list-style-type: none"> <li>sodium ions move to cathode</li> <li>hydrogen ions move to cathode</li> <li>hydrogen ions gain electrons / reduction</li> <li>hydrogen ions form hydrogen</li> <li>half equation: <math>2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2</math></li> <li>double volume gas at this electrode</li> <li>hydrogen test: lit splint in gas burns/ pops</li> <li>hence double volume of hydrogen gas</li> </ul>	
<b>Level</b>	<b>0</b>	No rewardable content
<b>1</b>	<b>1 - 2</b>	<ul style="list-style-type: none"> <li>a limited description e.g. states which ions go to which electrode</li> <li>the answer communicates ideas using simple language and uses limited scientific terminology</li> <li>spelling, punctuation and grammar are used with limited accuracy</li> </ul>
<b>2</b>	<b>3 - 4</b>	<ul style="list-style-type: none"> <li>a simple explanation e.g. explain formation of one product</li> <li>the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately</li> <li>spelling, punctuation and grammar are used with some accuracy</li> </ul>
<b>3</b>	<b>5 - 6</b>	<ul style="list-style-type: none"> <li>a detailed explanation e.g. explaining formation of BOTH products at electrodes</li> <li>the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately</li> <li>spelling, punctuation and grammar are used with few errors</li> </ul>

Question Number	Answer	Acceptable answers	Mark
<b>2(a)</b>	improves resistance to corrosion	ignore rusting	<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>2(b)</b>	<p>An explanation to include</p> <ul style="list-style-type: none"> <li>• anode dissolves / half equation given / atoms lose electrons /copper becomes ions/copper (atoms) oxidised (1)</li> <li>• copper ions moving from anode to cathode (1)</li> <li>• copper plated on cathode / half equation given / ions gain electrons/copper ions reduced/copper ions form atoms (1)</li> <li>• { difference/0.2g} is impurities (1)</li> <li>• would expect same decrease in mass (as increase) (1)</li> </ul>	<p>ignore references to mass increase of cathode and mass decrease of anode</p> <p>ignore 'impure copper (ions)' for the second marking point</p> <p>allow difference is metal around it eaten away/ impurities/sludge fallen to bottom of container /under anode (1) (there needs to be a reference to the difference in electrode masses for this point)</p>	<b>(3)</b>

Question Number	Answer	Acceptable answers	Mark
<b>2(c)</b>	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^{(-)}$ (2) OR $\text{O}^{2-} \rightarrow \text{O} + 2\text{e}^{(-)}$ (1) $2\text{O} \rightarrow \text{O}_2$ (1)	Unbalanced equation (1)	<b>(2)</b>

Question Number	Indicative Content	Mark
<b>QWC</b>	<p><b>*2(d)</b></p> <p>A description including some of the following points</p> <ul style="list-style-type: none"> <li>• sodium chloride is melted and ions are free to move</li> </ul> <p>at cathode</p> <ul style="list-style-type: none"> <li>• {sodium / positive} ions move to cathode</li> <li>• (sodium) metal forms at cathode</li> <li>• sodium ions gain electrons ...</li> <li>• to form atoms</li> <li>• this is reduction</li> <li>• <math>\text{Na}^+ + \text{e}^- \rightarrow \text{Na}</math></li> </ul> <p>at anode</p> <ul style="list-style-type: none"> <li>• {chloride / negative} ions move to anode</li> <li>• (chlorine) gas forms at anode</li> <li>• chloride ions lose electrons ...</li> <li>• to form atoms</li> <li>• this is oxidation</li> <li>• two chlorine atoms combine to form a chlorine molecule / share electrons</li> <li>• <math>\text{Cl}^- \rightarrow \text{Cl} + \text{e}^- / 2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-</math></li> <li>• <math>2 \text{Cl} \rightarrow \text{Cl}_2</math></li> </ul>	<b>(6)</b>
<b>Level</b>	No rewardable content	
<b>1</b>	<b>1 - 2</b>	<ul style="list-style-type: none"> <li>• a limited description e.g. gives at least one relevant description or explanation</li> <li>• the answer communicates ideas using simple language and uses limited scientific terminology</li> <li>• spelling, punctuation and grammar are used with limited accuracy</li> </ul>
<b>2</b>	<b>3 - 4</b>	<ul style="list-style-type: none"> <li>• a simple description e.g. for anode or cathode gives at least three descriptions or relevant explanations</li> <li>• the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately</li> <li>• spelling, punctuation and grammar are used with some accuracy</li> </ul>
<b>3</b>	<b>5 - 6</b>	<ul style="list-style-type: none"> <li>• a detailed description e.g. for both anode and cathode gives a total of at least five descriptions or relevant explanations</li> <li>• the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately</li> <li>• spelling, punctuation and grammar are used with few errors</li> </ul>

Question Number	Answer	Acceptable answers	Mark
<b>3(a)(i)</b>	toxic / poisonous (gas)	Ignore other words such as harmful / dangerous / smelly / corrosive	<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>3(a)(ii)</b>	A description including the following points <ul style="list-style-type: none"> <li>• (damp blue) litmus (paper) (1)</li> <li>• (turns red then) white / bleaches (1)</li> </ul>	Allow use of any suitable named indicator with correct result eg <ul style="list-style-type: none"> <li>• (damp) universal indicator paper (1)</li> <li>• (turns red then) white (1)</li> </ul> OR <ul style="list-style-type: none"> <li>• (damp) starch iodide paper (1)</li> <li>• (turns) dark blue / black (1)</li> </ul>	<b>(2)</b>

Question Number	Answer	Acceptable answers	Mark
<b>3(a)(iii)</b>	making {poly(chloroethene / PVC / solvents / medicines / agrochemicals / disinfectants}  bleach / sterilising water / killing bacteria	<b>ignore</b> water purification / "swimming pools"  micro-organisms	<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>3(a)(iv)</b>	$2\text{NaCl} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2 + \text{Cl}_2$  correct products (1) balancing of correct formulae (1)	$\text{NaCl} + \text{H}_2\text{O} \rightarrow \text{NaOH} + \frac{1}{2} \text{H}_2 + \frac{1}{2} \text{Cl}_2$	<b>(2)</b>

Question Number	Indicative Content	Mark
<b>QWC *3(b)</b>	<p>A comparison including some of the following points</p> <p><b>Comparing volumes of hydrogen and oxygen</b></p> <ul style="list-style-type: none"> <li>• (in each experiment) volume of hydrogen is twice volume of oxygen</li> <li>• because water molecules contain twice as many hydrogen atoms as oxygen atoms / is H<sub>2</sub>O</li> <li>• overall <math>2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2</math></li> </ul> <p><b>Relating volumes of gases to current and time</b></p> <ul style="list-style-type: none"> <li>• (from experiments 1 and 2) time doubles</li> <li>• (from experiments 1 and 2) volumes of gases double</li> <li>• Volumes of gases are directly proportional to the time for electrolysis / passage of current</li> <li>• (from experiments 1 and 3) as current x 1.5</li> <li>• (from experiments 1 and 3) volumes of gases x 1.5</li> <li>• volumes of gases are directly proportional to the current</li> </ul>	<b>(6)</b>
<b>Level 0</b>	No rewardable content	
<b>1</b>	<b>1 - 2</b>	<ul style="list-style-type: none"> <li>• a limited description of one trend e.g. increased time gives an increased gas volume</li> <li>• the answer communicates ideas using simple language and uses limited scientific terminology</li> <li>• spelling, punctuation and grammar are used with limited accuracy</li> </ul>
<b>2</b>	<b>3 - 4</b>	<ul style="list-style-type: none"> <li>• a simple description e.g. if the time is doubled, the volume of gas is doubled and if the current is increased the volume of gas increases</li> <li>• the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately</li> <li>• spelling, punctuation and grammar are used with some accuracy</li> </ul>
<b>3</b>	<b>5 - 6</b>	<ul style="list-style-type: none"> <li>• a detailed description e.g. volume of hydrogen is twice volume of oxygen and as time doubles, volume of gas doubles or as current x 1.5, volume of gas x 1.5</li> <li>• the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately</li> <li>• spelling, punctuation and grammar are used with few errors</li> </ul>

Question Number	Answer	Acceptable answers	Mark
<b>4(a)</b>	D		<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>4(b)</b>	<p>an explanation linking the following</p> <ul style="list-style-type: none"> <li>decomposition /break down of { compound / substance / electrolyte} (1)</li> <li>using electricity / electrical energy / d.c supply (1)</li> </ul>	<p>do not allow first point if mention of covalent molecule, substance etc.</p> <p>note examples in spec are water and Hydrochloric acid</p>	<b>(2)</b>

Question Number	Answer	Acceptable answers	Mark
<b>4(c)</b>	$\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaOCl} + \text{NaCl} + \text{H}_2\text{O}$ <ul style="list-style-type: none"> <li>reactant formulae (1)</li> <li>product formulae (1)</li> <li>balancing correct formulae (1)</li> </ul>	allow multiples	<b>(3)</b>

Question Number		Indicative Content	Mark
<b>QWC</b>	<b>*4(d)</b>	<p>an explanation linking some of the following:</p> <p><b>cause of acid rain</b></p> <ul style="list-style-type: none"> <li>• burning sulfur</li> <li>• produces sulfur dioxide</li> <li>• escapes into atmosphere</li> <li>• dissolves in rain water</li> <li>• forming acidic solution / sulfurous / sulfuric acid</li> <li>• falls to the ground as acid rain</li> </ul> <p><b>effect of acid rain</b></p> <ul style="list-style-type: none"> <li>• acidification of lakes</li> <li>• kills fish</li> <li>• kills trees / forests</li> <li>• damage / erosion of stonework</li> </ul> <p><b>reduction of damage</b></p> <ul style="list-style-type: none"> <li>• calcium carbonate</li> <li>• from limestone</li> <li>• may be converted into calcium hydroxide</li> <li>• waste gases from power stations</li> <li>• passed through carbonate or hydroxide</li> <li>• removing sulfur dioxide</li> </ul> <p>some of the above points could be made using word or symbol equations</p>	<b>(6)</b>
<b>Level</b>	<b>0</b>	No rewardable content	
<b>1</b>	<b>1 - 2</b>	<ul style="list-style-type: none"> <li>• a limited explanation e.g. when fuels burn the sulfur makes sulfur dioxide that causes acid rain</li> <li>• the answer communicates ideas using simple language and uses limited scientific terminology</li> <li>• spelling, punctuation and grammar are used with limited accuracy</li> </ul>	
<b>2</b>	<b>3 - 4</b>	<ul style="list-style-type: none"> <li>• a simple explanation e.g. when the fuel burns, sulfur impurities make sulfur dioxide which gives acid rain. Acid rain reacts with limestone statues.</li> <li>• the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately</li> <li>• spelling, punctuation and grammar are used with some accuracy</li> </ul>	
<b>3</b>	<b>5 - 6</b>	<ul style="list-style-type: none"> <li>• a detailed explanation e.g. when fuels burn, any sulfur impurities burn to make sulfur dioxide which dissolves in rain to make it more acidic. This rain corrodes metals and limestone. The problem can be solved by removing sulfur from the fuels</li> <li>• the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately</li> <li>• spelling, punctuation and grammar are used with few errors</li> </ul>	