

# Electrolysis

## Mark Scheme 1

<b>Level</b>	GCSE (9-1)
<b>Subject</b>	Combined Science: Trilogy - Chemistry
<b>Exam Board</b>	AQA
<b>Topic</b>	5.4 Chemical Changes
<b>Sub-Topic</b>	Electrolysis
<b>Difficulty Level</b>	Silver Level
<b>Booklet</b>	Mark Scheme 1

**Time Allowed:** 58 minutes

**Score:** /58

**Percentage:** /100

**Grade Boundaries:**

<b>M1.(a)</b>	electrolysis	1
(b)	Cathode – hydrogen	1
	Anode – bromine	1
(c)	copper ions are positive	1
	so the copper ions are attracted to the negative cathode <i>allow so the copper ions gain electrons from the cathode to form copper atoms</i>	1
		<b>[5]</b>
<b>M2.(a)</b>	Ionic	1
(b)	electrolyte	1
(c)	because the ions are free to flow	1
(d)	because potassium is higher in the reactivity series than hydrogen	1

so it is less easily discharged than hydrogen

1

(e) because water is covalent / molecular / contains molecules

1

so there are no free electrons to move **or** does not have an overall electrical charge

1

(f) conductivity of the solution increases with concentration

1

in a linear relationship **or** directly proportional

1

[9]

**M3.(a)** (i) points correctly plotted (  $\pm \frac{1}{2}$  small square)

*four points = 2 marks*

*three points = 1 mark*

**Max 2**

straight line of best fit using full range of points from 0,0

1

(ii) any **one** from:

*must explain why the point is below the line*

- the solution may not have been properly stirred
- the electrodes may have been a larger distance apart
- the drop of sodium chloride may have been a smaller volume / smaller

*allow not enough sodium chloride added*

*allow smaller amount of sodium chloride*

*do **not** allow too few drops added*

*ignore the student may have misread the conductivity meter*

1

(iii) any **one** from:

- the volume of pure water  
*allow amount*
- the concentration (of the solutions added)
- the volume (of the drops) of solution added  
*ignore number of drops*
- the distance between the electrodes
- the same electrodes **or** electrodes made of the same material
- same depth **or** surface area of electrodes in the water
- constant power supply  
*ignore current*
- stirred

1

(b) (i) because (pure) water is covalent / molecular (simple) **or** contains molecules

1

therefore (pure) water has no free / mobile electrons **or** ions

*molecules do not have a charge **or** molecules do not contain ions gains 2 marks*

1

(ii) because there are ions in sodium chloride  
*allow Na<sup>+</sup> and / or Cl<sup>-</sup>(ions) **or** ionic bonding.*  
*Ignore particles other than ions for MP1.*

1

which can move **or** carry the current / charge

*MP2 must be linked to ions only.*

1

- (iii) Hydrogen  
*allow  $H_2$  /  $H$*

1  
[10]

- M4.(a) (i) because they are positively charged  
*accept they are positive /  $H^+$*   
*accept oppositely charged **or** opposites attract*  
  
ignore they are attracted

1

- (ii) gains one / an electron  
*accept  $H^+ + e^- \rightarrow H$  or multiples*  
*allow gains electrons*

1

- (b) 3 bonding pairs

1

- 1 lone pair  
*accept 2 non-bonding electrons on outer shell of nitrogen*

1

- (c) (i) hydroxide /  $OH^-$   
*do **not** accept sodium hydroxide*

1

- (ii)  $H^+ + OH^- \rightarrow H_2O$   
*ignore state symbols*  
*ignore word equation*

1

- (d) Marks awarded for this answer will be determined by the Quality of

Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Reference material.

**0 marks**No relevant content.

**Level 1 (1-2 marks)**There are basic descriptions of advantages or disadvantages of the electrolysis cells.

**Level 2 (3-4 marks)**There are clear descriptions of environmental or economic advantages or disadvantages of the electrolysis cells. Comparisons may be implied.

**Level 3 (5-6 marks)**There are detailed descriptions of environmental and economic advantages and disadvantages, comparing the electrolysis cells.

### Examples of chemistry points made in the response:

Accept converse where appropriate.

- mercury cell is more expensive to construct
- mercury is recycled but membranes must be replaced
- mercury is toxic but membrane / polymer is not
- removing traces of mercury from waste is expensive
- mercury cell uses more electricity
- mercury cell produces chlorine that is purer
- mercury cell produces higher concentration / better quality of sodium hydroxide (solution)

6

[12]

**M5.(a)** (i) aluminium oxide  
*ignore (III) after aluminium*

1

(ii) (because it provides) heat / energy (to overcome activation energy)

1

(b) (i) contains only one sort of atom

1

(ii) the atoms (in cast iron) are different sizes

*any mention of molecules, maximum 1 mark*

*accept layers are distorted **or** structure is disrupted*

1

which prevents the layers / rows sliding

*accept an answer in terms of pure iron being softer than cast iron for both marks*

1

(c) (i) because aluminium is more reactive than carbon

*'it' = aluminium must be a comparison between the elements*

**or**

because aluminium is above carbon in the reactivity series

*do **not** accept any comparison of the reactivity of aluminium and iron*

1

(ii) reduces / lowers the temperature for the process **or** lowers the operating temperature **or** allows ions to move

*ignore any temperature values*

*allow reduces the (effective) melting point (of  $Al_2O_3$ )*

1

(iii) 3

*accept multiples*

1

- (iv) electrons are gained (by  $\text{Al}^{3+}$ )

*ignore any numbers*

*ignore any reference to oxygen*

1

- (v) electrodes are made of carbon

*allow graphite / coke*

1

oxygen is produced (at the positive electrode / anode)

*accept  $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$*

1

so the electrodes react with the oxygen / are oxidised

1

producing carbon dioxide (gas)

*accept  $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$  for marking points 3 and 4.*

1

[13]

**M6.(a)** any **two** from:

- copper / ores are running out / harder to find
- there are no / very small amounts of high-grade copper ores left
- copper metal is in demand
- copper is expensive
- now economical to extract copper from low-grade ores  
*it = copper*  
*allow new methods of extraction e.g. bioleaching and phytomining*  
*allow high-grade ores are running out for 2 marks*

2



- (b) (i) large amounts / 98% of rock to dispose of as waste  
*accept contains toxic (metal) compounds / bioleacher*

**or** waste rock takes up a lot of space

1

- (ii) (copper sulfide reacts with oxygen to) produce sulfur dioxide /  $\text{SO}_2$   
*allow (sulfur reacts with oxygen to) produce sulfur dioxide /  $\text{SO}_2$*

1

that causes acid rain

*allow description of effects of acid rain **or** sulfur dioxide*

*if no other mark awarded allow  $\text{CO}_2$  produced which causes global warming **or**  $\text{CO}_2$  produced by burning fuel or heating the furnace for 1 mark*

1

- (iii) any **one** from:

- large amounts of fuels / energy used (for the furnace and electrolysis)

*allow large amounts of electricity needed*

*ignore high temperature / electrolysis unqualified*

- (the extraction has) many steps / stages / processes  
*allow (extraction) is a long process / takes a lot of time*

- large amounts of ore / material have to be mined  
*allow ores contain a low percentage of copper*

1

- (iv) (copper ions move towards) the negative electrode / *cathode*

1

because copper ions /  $\text{Cu}^{2+}$  are positively charged **or** are oppositely charged **or** copper ions need to gain electrons

*allow because metal ions are positive **or** opposites attract*

1

- (v) (growing) plants

