

Electrolysis

Mark Scheme 4

Level	IGCSE(9-1)
Subject	Chemistry
Exam Board	Edexcel IGCSE
Module	Single Award (Paper 2C)
Topic	Principles of Chemistry
Sub-Topic	Electrolysis
Booklet	Mark Scheme 4

Time Allowed: 66 minutes

Score: /55

Percentage: /100

Grade Boundaries:

9	8	7	6	5	4	3	2	1
>90%	80%	70%	60%	50%	40%	30%	20%	10%

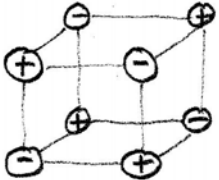
Question number	Answer	Notes	Marks
1 (a)	ethanol/it is more volatile/evaporates more quickly/more easily/evaporates in a shorter time	Accept has a <u>lower</u> boiling point (than water) Ignore reference to melting point(s) Accept reverse arguments for water	1
1 (b) i	0.3(0) (g)		1
	ii some copper did not stick to (negative) electrode/cathode some copper removed during washing/drying OR positive electrode/anode impure formed (anode) sludge	Accept some copper dropped off Any two for 1 each	2

Question number	Answer	Notes	Marks
1 (c) i	<p>all 9 points plotted correctly to nearest gridline</p> <p>straight line of best fit</p> <p>ii point at (7.40, 0.20) circled</p> <p>iii no charge/current/electricity passed AND no copper deposited/no change in mass/no electrolysis</p> <p>iv line is straight / fixed gradient AND goes through origin</p> <p>v graph line extrapolated to (at least) 0.55 correct value from candidate graph</p>	<p>Deduct 1 mark for each error Award these marks if points too faint to be seen under correct line Ignore point at 0.55</p> <p>Must be drawn with a ruler Must go through origin Ignore extrapolation beyond (16,0.5)</p> <p>OWTTE, eg charge = 0, so mass (increase) = 0 Ignore references to direct proportion</p> <p>Ignore re-statements of the information given in the question, eg the greater the charge, the greater the mass (increase)</p> <p>Probably 17.4 - 17.8 M2 not dependent on extrapolation</p>	
		Total_t	12

Question number			Answer	Notes	Marks
2	a	(i)	M1 arrow pointing towards negative electrode	Accept by X / on wire / by power supply (as long as pointing in correct direction)	1
		(ii)	M1 hydrogen / H ₂	Ignore H	1
		(iii)	M1 $4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + (1)\text{O}_2 + 4\text{e}^-$	Accept fractions and multiples Accept e in place of e ⁻ Accept equation with - 4e ⁻ on LHS	1
	b	(i)	M1 18 ÷ 24000	If division by 24 in place of 24000, no M1 but award M2 for 0.75 No marks for any calculation involving 35.5 or 71 Correct final answer scores 2 marks	1
			M2 0.00075 / 7.5 × 10 ⁻⁴		1
		(ii)	M1 (b)(i) × 96500 × 2	CQ on (b)(i)	1
			M2 Answer in range 140 - 145 using 0.00075	Correct final answer scores 2 marks Accept answer in range 70 - 72.4 for 1 out of 2 No marks if no use of 96500 or no use of answer from (b)(i)	1

Question number			Answer	Notes	Marks
2	c	(i)	M1 bromine / Br / Br ₂	Reject bromide / Br ⁻	1
		(ii)	M1 reduction <u>and</u> oxidation (at the same time)	Accept oxidisation Ignore oxygenation Accept loss <u>and</u> gain of electron(s) Reject loss of electrons by chlorine (molecules) / gain of electrons by bromide (ions) Reject reduction is loss of electrons / oxidation is gain of electrons Ignore references to other reaction types, eg displacement / reversible Ignore references to atoms / ions / molecules / elements	1

Question number			Answer	Notes	Marks	
2	d	(i)	M1	reversible / can go in both directions / (both) forward and reverse reactions can occur	Accept just reference to reverse direction, eg reaction goes backwards / reaction goes in opposite direction Ignore equilibrium	1
		(ii)	M1	shifts to right / moves in forward direction / favours forward reaction/direction	Accept more PCl_5 / product (formed) Ignore references to rates M1 can be awarded in explanation part	1
			M2	fewer moles/molecules (of gas) on right / more moles/molecules (of gas) on left / 2 moles/molecules on left and 1 on right / favours side with fewer moles/molecules	Accept particles, but not atoms, in place of molecules Ignore references to pressure, volume and le Chatelier's principle Do not award M2 if M1 if shift is to left or no change	1
					Total 12 marks	

Question number		Answer	Notes	Marks
3	(a)		<p>M1 for front face all correct</p> <p>M2 for rear face all correct</p> <p>M2 DEP on M1</p> <p>Do not penalise X in place of +</p> <p>Ignore symbols such as K and Cl</p> <p>Do not penalise use of Na⁺ in place of K⁺</p>	2
	(b)	<p>(i) M1 (damp blue/red) litmus (paper)</p> <p>M2 bleached / goes colourless / goes white</p> <p>(ii) $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$</p> <p>OR</p> <p>$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$</p>	<p>Ignore red as intermediate colour</p> <p>Accept use of universal indicator (paper) / pH paper</p> <p>M1 for H₂O on lhs AND H₂ and OH⁻ on rhs and no other formulae</p> <p>M1 for H⁺ on lhs AND H₂ on rhs and no other formulae</p> <p>M2 for e⁽⁻⁾ and balancing of correct equation</p> <p>Accept</p> <p>M1 $\text{H}^+ + \text{e}^- \rightarrow \text{H}$</p> <p>M2 $2\text{H} \rightarrow \text{H}_2$</p> <p>M2 DEP on M1</p> <p>Ignore state symbols</p>	2

		(iii)	M1 alkaline / alkali formed M2 OH ⁻	Accept pH above 7 Ignore names Mark independently	2
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Question number			Answer	Notes	Marks
3	(c)	(i)	$0.0250 \div 2 / 0.0125$ (mol)		1
		(ii)	M1 24×0.0125 OR 24000×0.0125 M2 $0.3(0) \text{ dm}^3 / 300 \text{ cm}^3 / 0.0003(0) \text{ m}^3$	CQ on (c)(i) Unit needed for M2 Accept 1 or more significant figures Correct final answer with no working scores (2)	2
				Total for Question 3	11

Question number	Answer	Accept	Reject	Marks
4 (a)(i)	(damp / moist) litmus paper bleaches / turns white OR (damp / moist) starch-iodide paper turns blue / black (allow observation mark only for starch-iodine paper)	decolourised / loses its colour		1 1
(ii)	OR (bubble through) (potassium) iodide solution (solution) turns brown (ignore the starting colour) hydrogen	orange / orange-brown / red-brown $H_2 / H^2 / H2 / h_2 / h^2 / h2$	yellow / red H / 2H / h / 2h	1
(b)	(solution is) alkali(ne) / hydroxide ions (present) / OH^- ignore references to sodium ions	sodium hydroxide / NaOH (is present)	any other named ion or substance	1

Question number	Answer	Accept	Reject	Marks
4 c) (i)	(10 / 2) = 5			1
	(ii)	12000 cm ³		1
	= 120 dm ³ (units required)			1
	mark part (ii) consequentially on part (i)			
	award second mark only for use of 22.4			
	Final answer must be to 2 or more sig fig			
			Total	7

Question number			Answer	Notes	Marks
5	a	(i)	M1 Iron(III) oxide	Accept Iron oxide / ferric oxide Ignore formula whether right or wrong	1
		(ii)	M1 calcium carbonate	Ignore formula whether right or wrong	1
	b	(i)	M1 A		1
		(ii)	M1 E		1
		(iii)	M1 B		1
		(iv)	M1 C		1
	c		M1 slag	Accept calcium silicate Ignore formula	1
	d	(i)	M1 aluminium/it is more reactive than iron/carbon OR above iron/carbon in reactivity series OR cannot be reduced by/does not react with carbon (monoxide) OR cannot be displaced by carbon	Comparison with iron or carbon must be stated or implied, eg not just aluminium is (very/too) reactive Accept reverse argument for iron	1
		(ii)	M1 (cost of) electricity	Accept keeping electrolyte molten Accept high current Ignore energy Ignore references to electrode replacement	1

Question number			Answer	Notes	Marks
5	e		M1 electrode(s) / to conduct electricity	Accept cathode / anode	1
	f		M1 $\text{Al}^{3+} + 3\text{e} \rightarrow \text{Al}$	M1 for both aluminium formulae on correct sides of equation M2 for both oxygen formulae on correct sides of equation M3 for balancing both equations even if one or both reversed	3
			M2 $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e} / 2\text{O}^{2-} - 4\text{e} \rightarrow \text{O}_2$		
			M3		
				Accept in either order	
					Total 13 marks