
CHEMISTRY

9701/51

Paper 5 Planning, Analysis and Evaluation

May/June 2016

MARK SCHEME

Maximum Mark: 30

Published

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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9701	51

Question	Expected Answer	Mark
1 (a)	lithium and water being labelled in an arrangement that shows them coming into contact at some time	[1]
	gas syringe OR collection over water, both using a leak-proof connection to the reaction vessel that would collect gas after the reagents have been mixed	[1]
	a valid separation of the two reagents	[1]
(b) (i)	cut (a small piece) AND remove oil	[1]
(ii)	no change/increase in volume OR bubbles (in collector) cease (over water) OR no more gas/hydrogen collected	[1]
(iii)	safety precautions – in a Li/LiOH/H ₂ context Any two from • avoid skin contact/wear gloves/lab coat / use tongs in context of prevention of burns or corrosive contact only • keep piece of lithium/storage vessel/apparatus away from water • ensure unused lithium is all returned to storage vessel or stored under oil • keep away from naked flames/burner/sources of ignition	[2]
(iv)	$(0.1/7 \times 1/2 \times 24\,000) = 171 \text{ cm}^3$ correct unit MUST be present	[1]
(v)	use 200 cm ³ OR 250 cm ³ OR 500 cm ³ - the size must be reasonable and consistent with the volume in b(iv) . correct unit MUST be present	[1]
(c) (i)	use a burette twice or 50 cm ³ pipette twice	[1]
(ii)	lithium/solid has all reacted/disappears/dissolves	[1]

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Question	Expected Answer	Mark
(iii)	pipette / burette / syringe / graduated pipette	[1]
(iv)	repeat the titration until results are within 0.1 cm^3	[1]
(d)	beaker : Effect: (A_r) (appears) more / larger AND Reason: (LiOH) solution more dilute (than expected)	[1]
	Flask: Effect: (A_r) None AND Reason: moles of (LiOH) (put in conical flask) remains the same / volume (i.e. moles) of LiOH not altered	[1]
		[15]

Page 4	Mark Scheme	Syllabus	Paper
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Question	Expected Answer	Mark																						
2 (a)	<table><tr><td>$1/T/K^{-1}$</td><td>$\log_{10}(1/t)$</td></tr><tr><td>3.47×10^{-3}</td><td>-1.92</td></tr><tr><td>3.41×10^{-3}</td><td>-1.76</td></tr><tr><td>3.33×10^{-3}</td><td>-1.56</td></tr><tr><td>3.30×10^{-3}</td><td>-1.45</td></tr><tr><td>3.26×10^{-3}</td><td>-1.25 or -1.26</td></tr><tr><td>3.22×10^{-3}</td><td>-1.28</td></tr><tr><td>3.19×10^{-3}</td><td>-1.18</td></tr><tr><td>3.16×10^{-3}</td><td>-1.08</td></tr><tr><td>3.12×10^{-3}</td><td>-0.95</td></tr><tr><td>3.05×10^{-3}</td><td>-0.90</td></tr></table>	$1/T/K^{-1}$	$\log_{10}(1/t)$	3.47×10^{-3}	-1.92	3.41×10^{-3}	-1.76	3.33×10^{-3}	-1.56	3.30×10^{-3}	-1.45	3.26×10^{-3}	-1.25 or -1.26	3.22×10^{-3}	-1.28	3.19×10^{-3}	-1.18	3.16×10^{-3}	-1.08	3.12×10^{-3}	-0.95	3.05×10^{-3}	-0.90	
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3sf in $1/T$ AND 2 dp in $\log_{10}(1/t)$	[1]																							
(b)	candidate's points plotted correctly from table in 2(a)	[1]																						
	line of best fit drawn	[1]																						

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Question	Expected Answer	Mark
(c)	Two anomalies identified Reasons: Points to the left of the line: the time of disappearance was thought to be later OR the time was stopped too late (after reaction ended) OR the (hydrochloric acid) solution had not reached the temperature of the water bath OR the timer was started early OR magnesium folded up (reduced surface area) Points to the right of the line: the Mg may have been thought to have disappeared earlier than it did OR the timer was started late OR the timer was stopped too early (reaction still going)	[1]
(d) (i)	two co-ordinates in correct x, y format gradient calculated correctly from candidate's stated co-ordinates (the value MUST be negative unless the graph is mis-plotted) value MUST be to 3 significant figures Expected range –2500 to –3500	[1] [1]
(ii)	$-E_A = \text{gradient} \times 0.0191$ OR $-E_A = \text{gradient} \times 0.0191$ then divide by 1000 OR correct transformations correct calculation and sign from candidate's gradient, gradient may be in calculation form, minimum 2 significant figures	[1] [1]

Page 6	Mark Scheme	Syllabus	Paper
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Question	Expected Answer	Mark
(e)	valid answer dependent on candidate's graph, e.g. reliable because most of the points on/close to the line OR unreliable as most points not on the line	[1]
(f)	Student X is correct; reaction time less OR reaction is faster AND percentage error/uncertainty will be greater OR greater error/uncertainty in time/data/recordings	[1]
(g)	reaction time is longer / rate slower AND some of the magnesium is not in contact (with the acid) OR less surface area for reaction (with HCl) OR only the bottom of the magnesium is reacting	[1]
(h)	initial rate lower / slower. AND the concentration of H ⁺ ions is lower / pH higher OR ethanoic acid less dissociated / weaker acid	[1]
		[15]

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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2016	9701	52

Question	Expected answer	Mark
1 (a)	(As the E°_{cell} value increases) ΔH_r decreases or ΔH_r becomes more negative or ΔH_r becomes more exothermic. AND The more reactive the metal then the greater the energy release will be. OR Energy output of both reactions is dependent upon the difference in reactivity (of metals).	[1]
(b)	Independent variable: The (type of) metal Dependent variable: temperature change or rise or increase OR enthalpy change	[1] [1]
(c) (i)	Diagram should indicate a labelled insulated container AND a labelled thermometer in the liquid.	[1]
(ii)	Mass of metal before and after Initial temperature (before metal added) AND Highest temperature (after metal added)	[1] [1]
(iii)	Wear gloves	[1]
(iv)	Moles $\text{CuSO}_4 = 0.025 \text{ mol}$, therefore moles of magnesium = 0.025 mol (minimum) mass $\text{Mg} > (0.025 \times 24.3 =) 0.6075 \text{ g}$ AND mass required value is greater than 0.6075 g	[1] [1]
(v)	Larger surface area AND causes increased rate of reaction	[1]
(vi)	Ensure uniformity of heating (of solution)	[1]

Page 3	Mark Scheme	Syllabus	Paper
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Question	Expected answer	Mark
(d)	$50.0 \times 4.18 \times 58.5 = 12\,226.5 \text{ (J)}$ $\Delta H_r = 12\,226.5 / 0.025 = \frac{489\,000}{1000} = -489$	[1] [1]
(e)	Complete circuit involving labelled voltmeter; labelled salt bridge; two separate solutions; (Solutions are) magnesium sulfate or MgSO_4 with magnesium or Mg rod and copper(II) sulfate CuSO_4 with copper or Cu rod Concentration of solution(s) is 1 mol dm^{-3} or 1 M	[1] [1] [1]
(f)	So that values can be compared	[1]
(g)	Both ΔH_r (Zn) and ΔH_r (Fe) values which are consistent with the prediction in (a).	[1]
		[18]

Page 4	Mark Scheme	Syllabus	Paper
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Question	Expected answer	Mark																						
2 (a)	<table><tr><td>Mass of liquid Y used /g</td><td>Volume of vapour Y / cm³</td></tr><tr><td>0.15</td><td>48</td></tr><tr><td>0.10</td><td>35</td></tr><tr><td>0.21</td><td>72</td></tr><tr><td>0.17</td><td>58</td></tr><tr><td>0.24</td><td>83</td></tr><tr><td>0.09</td><td>31</td></tr><tr><td>0.20</td><td>70</td></tr><tr><td>0.23</td><td>79</td></tr><tr><td>0.12</td><td>41</td></tr><tr><td>0.22</td><td>73</td></tr></table>	Mass of liquid Y used /g	Volume of vapour Y / cm ³	0.15	48	0.10	35	0.21	72	0.17	58	0.24	83	0.09	31	0.20	70	0.23	79	0.12	41	0.22	73	
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(c) (i)	Y evaporates from the (hypodermic) syringe OR Y evaporates before injection OR Y evaporates before weighing / after injection	[1]
(ii)	(Stop evaporation by) Keeping the syringe as cool as possible OR Closing off the needle end to stop evaporation OR Minimising length of time between each weighing	[1]
(d) (i)	correct co-ordinates. correct calculation of the gradient must be three significant figures	[1] [1]
(ii)	Calculation of $M_r = 3.07 \times 10^4 / \text{gradient in 2(d)(i)}$ Answer	[1] [1]
(e)	M_r (from mass spectrum) = 84 OR empirical formula = CH_2 OR ratio of C and H seen as 1:2 Y is C_6H_{12}	[1] [1]
		[12]

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