

Markscheme

May 2017

Chemistry

Standard level

Paper 2

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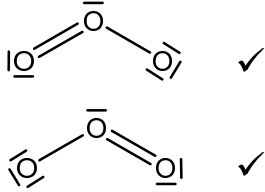
Question			Answers	Notes	Total
1.	a	i	$n(\text{Ag}) = \ll \frac{3.275 \text{ g}}{107.87 \text{ g mol}^{-1}} \Rightarrow 0.03036 \ll \text{mol} \gg$ <p>AND</p> $n(\text{O}) = \ll \frac{3.760 \text{ g} - 3.275 \text{ g}}{16.00 \text{ g mol}^{-1}} = \frac{0.485}{16.00} \Rightarrow 0.03031 \ll \text{mol} \gg \checkmark$ $\ll \frac{0.03036}{0.03031} \approx 1 \text{ / ratio of Ag to O approximately } 1 : 1, \text{ so} \gg$ <p>AgO ✓</p>	<p>Accept other valid methods for M1.</p> <p>Award [1 max] for correct empirical formula if method not shown.</p>	2
1.	a	ii	<p>temperature too low</p> <p>OR</p> <p>heating time too short</p> <p>OR</p> <p>oxide not decomposed completely ✓</p> <p>heat sample to constant mass «for three or more trials» ✓</p>	<p>Accept "not heated strongly enough".</p> <p>If M1 as per markscheme, M2 can only be awarded for constant mass technique.</p> <p>Accept "soot deposition" (M1) and any suitable way to reduce it (for M2).</p> <p>Accept "absorbs moisture from atmosphere" (M1) and "cool in dessicator" (M2).</p> <p>Award [1 max] for reference to impurity AND design improvement.</p>	2
1.	b		<p>A_r closer to 107/less than 108 «so more ^{107}Ag»</p> <p>OR</p> <p>A_r less than the average of (107 + 109) «so more ^{107}Ag» ✓</p>	<p>Accept calculations that gives greater than 50% ^{107}Ag.</p>	1

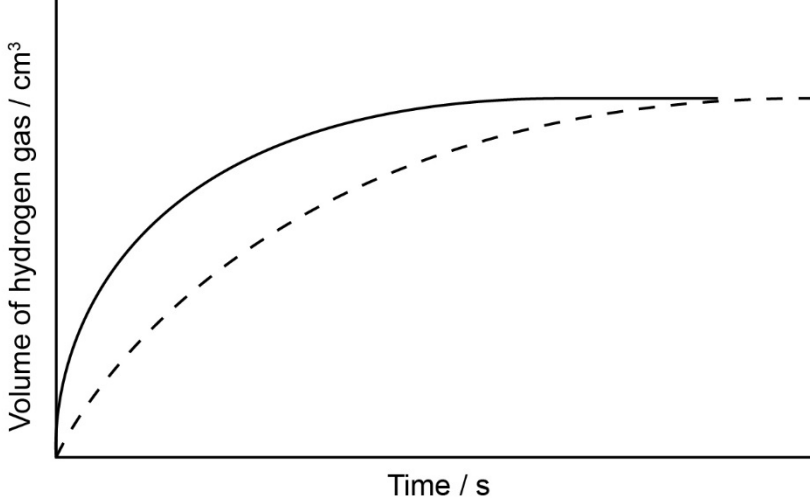
Question			Answers			Notes	Total
1	c	i	Flask containing	Colour of solution	Product formula	<p><i>Do not accept name for the products.</i></p> <p><i>Accept "Na⁺ + OH⁻" for NaOH.</i></p> <p><i>Ignore coefficients in front of formula.</i></p>	3
			Na ₂ O	blue	NaOH ✓		
			P ₄ O ₁₀	yellow ✓	H ₃ PO ₄ ✓		
1.	c	ii	<p>«molten» Na₂O has mobile ions/charged particles AND conducts electricity ✓</p> <p>«molten» P₄O₁₀ does not have mobile ions/charged particles AND does not conduct electricity/is poor conductor of electricity ✓</p>			<p><i>Do not award marks without concept of mobile charges being present.</i></p> <p><i>Award [1 max] if type of bonding or electrical conductivity correctly identified in each compound.</i></p> <p><i>Do not accept answers based on electrons.</i></p> <p><i>Award [1 max] if reference made to solution.</i></p>	2
1.	d		<p>electrons in discrete/specific/certain/different shells/energy levels ✓</p> <p>energy levels converge/get closer together at higher energies</p> <p>OR</p> <p>energy levels converge with distance from the nucleus ✓</p>			<p><i>Accept appropriate diagram for M1, M2 or both.</i></p> <p><i>Do not give marks for answers that refer to the lines in the spectrum.</i></p>	2

Question			Answers	Notes	Total
2.	a	i	$\text{Sn}^{2+}(\text{aq}) \rightarrow \text{Sn}^{4+}(\text{aq}) + 2\text{e}^{-}$ ✓	Accept equilibrium sign. Accept $\text{Sn}^{2+}(\text{aq}) - 2\text{e}^{-} \rightarrow \text{Sn}^{4+}(\text{aq})$.	1
2.	a	ii	$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^{+}(\text{aq}) + 3\text{Sn}^{2+}(\text{aq}) \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l}) + 3\text{Sn}^{4+}(\text{aq})$ ✓	Accept equilibrium sign.	1
2.	b	i	«13.239 g ± 0.002 g so percentage uncertainty» 0.02 «%» ✓	Accept answers given to greater precision, such as 0.0151 %.	1
2.	b	ii	« $[\text{K}_2\text{Cr}_2\text{O}_7] = \frac{13.239 \text{ g}}{294.20 \text{ g mol}^{-1} \times 0.100 \text{ dm}^3} \Rightarrow 0.450 \text{ mol dm}^{-3}$ » ✓		1
2.	b	iii	$n(\text{Sn}^{2+}) = \text{«}0.450 \text{ mol dm}^{-3} \times 0.01324 \text{ dm}^3 \times \frac{3 \text{ mol}}{1 \text{ mol}} \Rightarrow 0.0179 \text{ mol}\text{»}$ ✓ $\text{«}[\text{Sn}^{2+}] = \frac{0.0179 \text{ mol}}{0.0100 \text{ dm}^3} \Rightarrow 1.79 \text{ mol dm}^{-3}\text{»}$ ✓	Award [2] for correct final answer.	2

Question			Answers	Notes	Total
3.	a	i	$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} \checkmark$		1
3.	a	ii	decrease in temperature \checkmark endothermic «reaction» AND «equilibrium» shifts to the left/reactants OR endothermic «reaction» AND K_c decreases OR endothermic «reaction» AND concentration of PCl_5 increased/concentration of PCl_3 and Cl_2 decreased OR «equilibrium» shifts in exothermic direction \checkmark	Do not accept “temperature change”. Accept “ ΔH positive” in place of “endothermic”. Accept “products” instead of “ PCl_3 and Cl_2 ”.	2
3.	b		Lewis structure: $\begin{array}{c} \overline{\text{Cl}} - \overline{\text{P}} - \overline{\text{Cl}} \\ \\ \overline{\text{Cl}} \end{array} \checkmark$ Molecular geometry: trigonal/triangular pyramidal \checkmark	Penalize missing lone pairs once only between this question and 4(b). Accept any combination of lines, dots or crosses to represent electrons.	2

Do not apply ECF.

Question			Answers	Notes	Total
4.	a	i	triple bond in nitrogen «molecule» AND single bond in hydrazine ✓ triple bond stronger than single bond OR more shared «pairs of» electrons make bond stronger/attract nuclei more ✓	Accept bond enthalpy values from data booklet (158 and 945 kJ mol ⁻¹).	2
4.	a	ii	hydrogen bonding «between molecules, dinitrogen tetraoxide does not» ✓		1
4.	a	iii	N ₂ H ₄ : -2 AND N ₂ O ₄ : +4 ✓		1
4.	a	iv	N ₂ H ₄ AND oxidized/oxidation state increases OR N ₂ H ₄ AND loses hydrogen OR N ₂ H ₄ AND reduces/removes oxygen from N ₂ O ₄ ✓	Accept "N ₂ H ₄ AND gives electrons «to N ₂ O ₄ »".	1
4.	b			Accept any combination of lines, dots or crosses to represent electrons. Do not penalize missing lone pairs if already done in 3b. Do not accept structure that represents 1.5 bonds.	2

Question			Answers	Notes	Total
5.	a	i	concentration of acid decreases OR surface area of magnesium decreases ✓	Accept "less frequency/chance/rate/probability/likelihood of collisions". Do not accept just "less acid" or "less magnesium". Do not accept "concentrations of reagents decrease".	1
5.	a	ii	 <p>Volume of hydrogen gas / cm³</p> <p>Time / s</p> <p>curve starting from origin with steeper gradient AND reaching same maximum volume ✓</p>		1
5.	b		$\ll E_{a(\text{rev})} = 226 + 132 \Rightarrow 358 \ll \text{kJ} \gg$ ✓	Do not accept -358.	1
5.	c		$2\text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{HNO}_3(\text{aq}) + \text{HNO}_2(\text{aq})$ OR $4\text{NO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g}) \rightarrow 4\text{HNO}_3(\text{aq})$ ✓	Accept ionised forms of the acids.	1

Question		Answers	Notes	Total
6.	a	<p><i>Initiation:</i></p> $\text{Cl}-\text{Cl} \rightarrow \text{Cl}\cdot + \text{Cl}\cdot \quad \checkmark$ <p><i>Propagation:</i></p> $\text{Cl}\cdot + \text{CH}_4 \rightarrow \text{Cl}-\text{H} + \cdot\text{CH}_3 \quad \checkmark$ $\text{Cl}-\text{Cl} + \cdot\text{CH}_3 \rightarrow \text{Cl}-\text{CH}_3 + \text{Cl}\cdot \quad \checkmark$	<p>Do not penalize missing electron dot on radicals if consistent throughout.</p> <p>Accept Cl_2, HCl and CH_3Cl without showing bonds.</p> <p>Do not accept hydrogen radical, $\text{H}\cdot$ or H, but apply ECF to other propagation steps.</p>	3
6.	b	hexane AND hex-1-ene \checkmark	Accept "benzene AND hexane AND hex-1-ene".	1
6.	c	$\text{H}_2\text{C}=\text{CHCl}$ <p>OR</p> $\begin{array}{c} \text{H} & & \text{Cl} \\ & \diagdown & / \\ & \text{C}=\text{C} & \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array} \quad \checkmark$	<p>Accept "CH_2CHCl" or "CHClCH_2".</p> <p>Do not accept "$\text{C}_2\text{H}_3\text{Cl}$".</p>	1

Question			Answers	Notes	Total								
7.	a	i	water/H ₂ O ✓	Accept "hydroxide ion/OH ⁻ ".	1								
7.	a	ii	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Acid</th> <th style="width: 50%;">Base</th> </tr> </thead> <tbody> <tr> <td>HOCl AND</td> <td>OCl⁻</td> </tr> <tr> <td>OR</td> <td></td> </tr> <tr> <td>H₂O AND</td> <td>OH⁻ ✓</td> </tr> </tbody> </table>	Acid	Base	HOCl AND	OCl ⁻	OR		H ₂ O AND	OH ⁻ ✓		1
Acid	Base												
HOCl AND	OCl ⁻												
OR													
H ₂ O AND	OH ⁻ ✓												
7.	b	i	«0.100 mol dm ⁻³ × 0.0250 dm ³ » = 0.00250 «mol» ✓		1								
7.	b	ii	« $M = \frac{0.510\text{g}}{0.00250\text{mol}} \Rightarrow 204$ «g mol ⁻¹ » ✓		1								
7.	b	iii	«1.00 × 10 ⁻¹⁴ = [H ⁺] × 0.100» 1.00 × 10 ⁻¹³ «mol dm ⁻³ » ✓		1								

Question			Answers	Notes	Total
8.	a	i	$\Delta H = 177.0 - \frac{189.2}{2} - 285.5 \text{ «kJ» } \checkmark$ $\text{«}\Delta H \Rightarrow \text{» } - 203.1 \text{ «kJ» } \checkmark$	Accept other methods for correct manipulation of the three equations. Award [2] for correct final answer.	2
8.	a	ii	$203.1 \text{ «kJ»} = 0.850 \text{ «kg»} \times 4.18 \text{ «kJ kg}^{-1} \text{ K}^{-1}\text{»} \times \Delta T \text{ «K»}$ <p>OR</p> $\text{«}\Delta T \Rightarrow \text{» } 57.2 \text{ «K» } \checkmark$ $\text{«}T_{\text{final}} = (57.2 + 21.8) \text{ }^\circ\text{C} \Rightarrow 79.0 \text{ }^\circ\text{C} \text{ / } 352.0 \text{ «K» } \checkmark$ <p>If 200.0 kJ was used:</p> $200.0 \text{ «kJ»} = 0.850 \text{ «kg»} \times 4.18 \text{ «kJ kg}^{-1} \text{ K}^{-1}\text{»} \times \Delta T \text{ «K»}$ <p>OR</p> $\text{«}\Delta T \Rightarrow \text{» } 56.3 \text{ «K» } \checkmark$ $\text{«}T_{\text{final}} = (56.3 + 21.8) \text{ }^\circ\text{C} \Rightarrow 78.1 \text{ }^\circ\text{C} \text{ / } 351.1 \text{ «K» } \checkmark$	Award [2] for correct final answer. Units, if specified, must be consistent with the value stated.	2
8.	b		$\text{C}_6\text{H}_4(\text{OH})_2^+ \checkmark$	Accept "molecular ion". Do not accept " $\text{C}_6\text{H}_4(\text{OH})_2$ " (positive charge missing).	1
8.	c		$\text{«highest } m/z \text{» } 108 \checkmark$	Only accept exactly 108, not values close to this.	1