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M17/4/CHEMI/SP2/ENG/TZ2/XX/M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2017

Chemistry

Standard level

Paper 2

11 pages

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

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<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>1</td><td>c</td><td>i</td><td>
<table>
<tr><th>Flask containing</th><th>Colour of solution</th><th>Product formula</th></tr>
<tr><td>Na_2O</td><td rowspan="2">blue
AND
yellow ✓</td><td>NaOH ✓</td></tr>
<tr><td>P_4O_{10}</td><td>H_3PO_4 ✓</td></tr>
</table>
</td><td>Do not accept name for the products.
Accept “$Na^+ + OH^-$” for NaOH.
Ignore coefficients in front of formula.</td><td>3</td></tr>
<tr><td>1.</td><td>c</td><td>ii</td><td>«molten» Na_2O has mobile ions/charged particles AND conducts electricity ✓
«molten» P_4O_{10} does not have mobile ions/charged particles AND does not conduct electricity/is poor conductor of electricity ✓</td><td>Do not award marks without concept of mobile charges being present.
Award [1 max] if type of bonding or electrical conductivity correctly identified in each compound.
Do not accept answers based on electrons.
Award [1 max] if reference made to solution.</td><td>2</td></tr>
<tr><td>1.</td><td>d</td><td></td><td>electrons in discrete/specific/certain/different shells/energy levels ✓
energy levels converge/get closer together at higher energies
OR
energy levels converge with distance from the nucleus ✓</td><td>Accept appropriate diagram for M1, M2 or both.
Do not give marks for answers that refer to the lines in the spectrum.</td><td>2</td></tr>
</table>

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Question			Answers	Notes	Total
2.	a	i	$Sn^{2+}(aq) \rightarrow Sn^{4+}(aq) + 2e^-$ ✓	*Accept equilibrium sign.* *Accept* $Sn^{2+}(aq) - 2e^- \rightarrow Sn^{4+}(aq)$.	**1**
2.	a	ii	$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 3Sn^{2+}(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l) + 3Sn^{4+}(aq)$ ✓	*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	« $[K_2Cr_2O_7] = \frac{13.239\text{ g}}{294.20\text{ g mol}^{-1} \times 0.100\text{ dm}^3}$ =» $0.450\text{ «mol dm}^{-3}$» ✓		**1**
2.	b	iii	$n(Sn^{2+}) = \text{«}0.450\text{ mol dm}^{-3} \times 0.01324\text{ dm}^3 \times \frac{3\text{ mol}}{1\text{ mol}}$ =» 0.0179 «mol» ✓ « $[Sn^{2+}] = \frac{0.0179\text{ mol}}{0.0100\text{ dm}^3}$ =» 1.79 «mol dm^{-3}» ✓	*Award **[2]** for correct final answer.*	**2**

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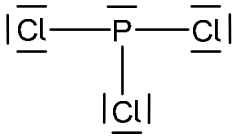
Question			Answers	Notes	Total
3.	a	i	«K_c» $= \frac{[PCl_3][Cl_2]}{[PCl_5]}$ ✓		1
3.	a	ii	decrease in temperature ✓ endothermic «reaction» ***AND*** **«**equilibrium**»** shifts to the left/reactants ***OR*** endothermic «reaction» ***AND*** K_c decreases ***OR*** endothermic «reaction» ***AND*** concentration of PCl_5 increased/concentration of PCl_3 and Cl_2 decreased ***OR*** **«**equilibrium**»** shifts in exothermic direction ✓	*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:*  ✓ *Molecular geometry:* trigonal/triangular pyramidal ✓	*Penalize missing lone pairs once only between this question and 4(b).* *Accept any combination of lines, dots or crosses to represent electrons.* *Do not apply ECF.*	2

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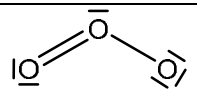
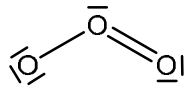
Question			Answers	Notes	Total
4.	a	i	triple bond in nitrogen «molecule» ***AND*** single bond in hydrazine ✓ triple bond stronger than single bond **OR** more shared «pairs of» electrons make bond stronger/attract nuclei more ✓	*Accept bond enthalpy values from data booklet (158 and 945 kJ mol^{-1}).*	**2**
4.	a	ii	hydrogen bonding **«**between molecules, dinitrogen tetraoxide does not**»** ✓		**1**
4.	a	iii	*N_2H_4: –2* ***AND*** *N_2O_4: +4* ✓		**1**
4.	a	iv	N_2H_4 ***AND*** oxidized/oxidation state increases ***OR*** N_2H_4 ***AND*** loses hydrogen ***OR*** N_2H_4 ***AND*** reduces/removes oxygen from N_2O_4 ✓	*Accept "N_2H_4* ***AND*** *gives electrons «to N_2O_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**

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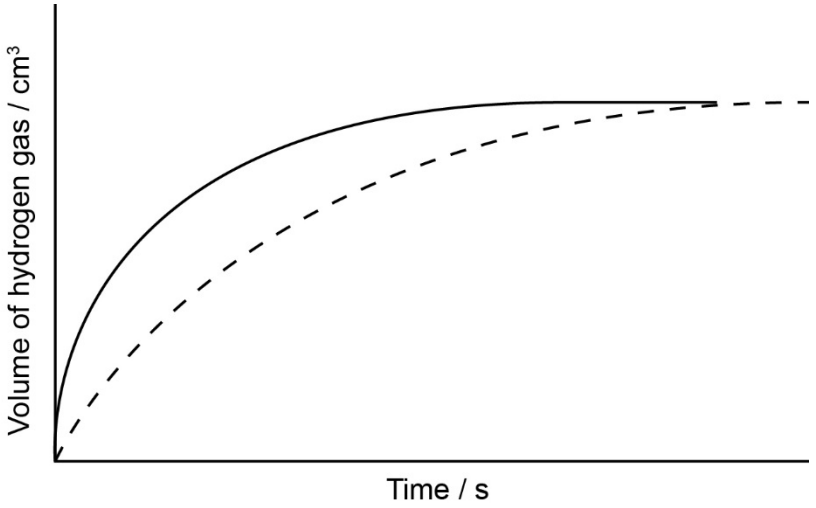
Question			Answers	Notes	Total
5.	a	i	concentration of acid decreases ***OR*** surface area of magnesium decreases ✓	*Accept "less frequency/chance/rate/ probability/likelihood of collisions".* *Do **not** accept just "less acid" or "less magnesium".* *Do **not** accept "concentrations of reagents decrease".*	**1**
5.	a	ii	 curve starting from origin with steeper gradient ***AND*** reaching same maximum volume ✓		**1**
5.	b		«$E_{a(rev)} = 226 + 132 =$» 358 «kJ» ✓	*Do not accept –358.*	**1**
5.	c		$2NO_2(g) + H_2O(l) \rightarrow HNO_3(aq) + HNO_2(aq)$ ***OR*** $4NO_2(g) + 2H_2O(l) + O_2(g) \rightarrow 4HNO_3(aq)$ ✓	*Accept ionised forms of the acids.*	**1**

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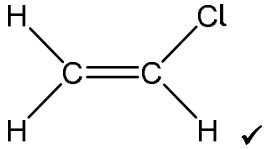
Question			Answers	Notes	Total
6.	a		*Initiation:* $Cl-Cl \rightarrow Cl\bullet + Cl\bullet$ ✓ *Propagation:* $Cl\bullet + CH_4 \rightarrow Cl-H + \bullet CH_3$ ✓ $Cl-Cl + \bullet CH_3 \rightarrow Cl-CH_3 + Cl\bullet$ ✓	*Do not penalize missing electron dot on radicals if consistent throughout.* *Accept Cl_2, HCl and CH_3Cl without showing bonds.* *Do **not** accept hydrogen radical, $H\bullet$ or H, but apply ECF to other propagation steps.*	**3**
6.	b		hexane ***AND*** hex-1-ene ✓	*Accept "benzene **AND** hexane **AND** hex-1-ene".*	**1**
6.	c		$H_2C{=}CHCl$ ***OR***  ✓	*Accept "CH_2CHCl" or "$CHClCH_2$".* *Do **not** accept "C_2H_3Cl".*	**1**

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Question			Answers	Notes	Total
7.	a	i	water/H_2O ✓	*Accept "hydroxide ion/OH^-".*	1
7.	a	ii	<table><tr><th>Acid</th><th></th><th>Base</th></tr><tr><td>HOCl</td><td>***AND***</td><td>OCl^-</td></tr><tr><td>***OR***</td><td></td><td></td></tr><tr><td>H_2O</td><td>***AND***</td><td>OH^- ✓</td></tr></table>		1
7.	b	i	«0.100 mol dm^{-3} × 0.0250 dm^3» = 0.00250 «mol» ✓		1
7.	b	ii	«$M = \frac{0.510\,g}{0.00250\,mol}$ =» 204 «g mol^{-1}» ✓		1
7.	b	iii	«$1.00 \times 10^{-14} = [H^+] \times 0.100$» 1.00×10^{-13} «mol dm^{-3}» ✓		1

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Question			Answers	Notes	Total
8.	a	i	$\Delta H = 177.0 - \frac{189.2}{2} - 285.5$ **«**kJ**»** ✓ **«**ΔH =**»** – 203.1 **«**kJ**»** ✓	*Accept other methods for correct manipulation of the three equations.* *Award **[2]** for correct final answer.*	**2**
8.	a	ii	203.1 **«**kJ**»** = 0.850 **«**kg**»** × 4.18 **«**kJ kg^{-1} K^{-1}**»** × ΔT **«**K**»** ***OR*** **«**ΔT =**»** 57.2 **«**K**»** ✓ **«**T_{final} = (57.2 + 21.8) °C =**»** 79.0**«**°C**»** / 352.0 **«**K» ✓ *If 200.0 kJ was used:* 200.0 **«**kJ**»** = 0.850 **«**kg**»** × 4.18 **«**kJ kg^{-1} K^{-1}**»** × ΔT **«**K**»** ***OR*** **«**ΔT =**»** 56.3 **«**K**»** ✓ **«**T_{final} = (56.3 + 21.8) °C =**»** 78.1 **«**°C**»** / 351.1 «K» ✓	*Award **[2]** for correct final answer.* *Units, if specified, must be consistent with the value stated.*	**2**
8.	b		$C_6H_4(OH)_2^+$ ✓	*Accept "molecular ion".* *Do **not** accept "$C_6H_4(OH)_2$" (positive charge missing).*	**1**
8.	c		**«**highest *m*/*z***»** 108 ✓	*Only accept exactly 108, not values close to this.*	**1**