Cambridge International AS & A Level

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CHEMISTRY **9701/22**

Paper 2 AS Level Structured Questions **May/June 2016**

MARK SCHEME

Maximum Mark: 60

Published

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<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th><th>Total</th></tr>
<tr><td>1 (a)</td><td>
<table>
<tr><th>name of element</th><th>nucleon number</th><th>atomic number</th><th>number of protons</th><th>number of neutrons</th><th>number of electrons</th><th>overall charge</th></tr>
<tr><td>boron</td><td>10</td><td>5</td><td>5</td><td>5</td><td>5</td><td>0</td></tr>
<tr><td>nitrogen</td><td>15</td><td>7</td><td>7</td><td>8</td><td>10</td><td>–3</td></tr>
<tr><td>lead</td><td>208</td><td>82</td><td>82</td><td>126</td><td>80</td><td>+2</td></tr>
<tr><td>lithium</td><td>6</td><td>3</td><td>3</td><td>3</td><td>2</td><td>+1</td></tr>
</table>
</td><td>[1]
[1]
[1]
[1]</td><td>[4]</td></tr>
<tr><td>(b) (i)</td><td>Group 17 / VII / 7

AND

big (owtte) increase / big difference / big gap / big jump / jump in increase / jump in difference after 7th IE</td><td>[1]</td><td>[1]</td></tr>
<tr><td>(ii)</td><td>increases across period due to increasing attraction (of nucleus for electrons)

due to increasing nuclear charge / atomic / proton number AND constant / similar shielding / same (outer) shell / energy level</td><td>[1]

[1]</td><td>[2]</td></tr>
<tr><td>(iii)</td><td>$1s^2 2s^2 2p^6 3s^2 3p^4$</td><td>[1]</td><td>[1]</td></tr>
<tr><td>(c) (i)</td><td>(100 − 99.76 − 0.04=) 0.2</td><td>[1]</td><td>[1]</td></tr>
<tr><td>(ii)</td><td>$\frac{0.2x + (99.76 \times 16) + (0.04 \times 17)}{100} = 16.0044$

x = 18</td><td>[1]

[1]</td><td>[2]</td></tr>
<tr><td></td><td></td><td colspan="2">[Total 11]</td></tr>
</table>

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Question	Answer	Mark	Total
2 (a) (i)	enthalpy / energy / heat change when one mole of gaseous atoms is produced	[1]	
	from the element in its standard state	[1]	
	under standard conditions	[1]	[3]
(ii)	fluorine and chlorine are gases / bromine liquid and iodine solid OR as ΔH_{at} for bromine / iodine also includes changes of state	[1]	[1]
(iii)	($\frac{1}{2}Cl_2 + \frac{1}{2}I_2 \rightarrow ICl$) $\Delta H_f = (\frac{1}{2}E(Cl_2) + \frac{1}{2}E(I_2)) - E(ICl)$ OR $E(ICl) = (151/2) + (242/2) + 24$	[1]	
	$E(ICl) = (+)\ 220.5 / 221$	[1]	[2]
(b) (i)	stronger / more / greater id–id / London / dispersion forces	[1]	
	due to increasing numbers of electrons	[1]	[2]
(ii)	(intermolecular forces in HF are) hydrogen bonds (which are) stronger (than vd*W*) / more energy needed to separate molecules	[1] [1]	[2]
	OR		
	HF much more polar / F much more electronegative Intermolecular forces in HF stronger (than in HCl, HBr, HI)	[1] [1]	
(c) (i)	**P** = iodine / I_2 / I; **Q** = chlorine / Cl_2 / Cl	[1]	[1]
(ii)	weaker H–**P** than H–**Q** bond ORA / easier /less energy to break H–**P** than H–**Q** ORA	[1]	
	due to greater distance / shielding of nucleus from bond pair ORA	[1]	[2]

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Question	Answer	Mark	Total
(iii)	2H**P** (or 2HI) → (or ⇌) H_2 + $\mathbf{P}_2$ (or I_2)	[1]	[1]
(iv)	$Ag^+(aq)$ + $\mathbf{Q}^-(aq)$ (or Cl^-) →Ag**Q**(s) (or AgCl(s))	[1]	
	Ag**Q**(s) / AgCl(s) + $2NH_3(aq)$ → $Ag(NH_3)_2^+(aq)$ + $\mathbf{Q}^-(aq)$ / $Cl^-(aq)$	[1]	[2]
(d) (i)	no of Cl increases <u>by one</u> each time / matches group number	[1]	
	due to increasing number of valence/outer(most/shell) electrons / oxidation number / valency (of Mg, Al, Si)	[1]	[2]
(ii)	$MgCl_2$ (+aq) → Mg^{2+} + $2Cl^-$	[1]	
	$AlCl_3$ + $6H_2O$ → $Al(H_2O)_6^{3+}$ + $3Cl^-$ / $Al(H_2O)_5(OH)^{2+}$ + H^+ + $3Cl^-$	[1]	
	$SiCl_4$ + $2H_2O$ → SiO_2 + $4H^+$ + $4Cl^-$	[1]	[3]
		[Total 21]	
3 (a)	$Cr_2O_7^{2-}$ + $8H^+$ + $3H_2C_2O_4$ → $2Cr^{3+}$ + $6CO_2$ + $7H_2O$ M1 = species M2 = balancing	[1] [1]	[2]
(b) (i)	(0.02 × 32.0/1000 =) 6.40×10^{-4}	[1]	[1]
(ii)	($6.4 \times 10^{-4} \times 3$ =)1.92×10^{-3}	[1]	[1]
(iii)	(0.242 / 1.92×10^{-3} =) 126(.0)	[1]	[1]
(iv)	(126 – 90 = 36; 36 / 18 = 2 hence) x = 2	[1]	[1]
		[Total 6]	

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Question	Answer	Mark	Total
4 (a)	$CH_3CH_2CH_2COOH$ $(CH_3)_2CHCOOH$ / $CH_3CH(CH_3)COOH$	[1] [1]	[2]
(b) (i)	Two from 1. $CH_3CH_2COOCH_3$ 2. $CH_3COOCH_2CH_3$ 3. $HCOOCH_2CH_2CH_3$	[1] [1]	[2]
(ii)	correct acid + alcohol for either ester 1. methanol + propanoic acid 2. ethanol + ethanoic acid 3. propan-1-ol + methanoic acid (conc)H_2SO_4 / (conc)H_3PO_4 AND heat / warm / reflux	[1] [1]	[2]
(c)	Peak at 1710–1750 (for ester) due to C(=)O Peak at 1500–1680 (for **X**) due to C(=)C / alkene Peak at 3200–3650 (for **X**) due to (alcohol) O(–)H	[1] [1] [1]	[3]
		[Total 9]	
5 (a) (i)	acidified / H^+ AND potassium / sodium dichromate	 [1]	[1]
(ii)	distillation (rather than reflux) (ensures aldehyde escapes) to avoid further oxidation / to avoid forming acid / as reflux causes further oxidation	[1] [1]	[2]

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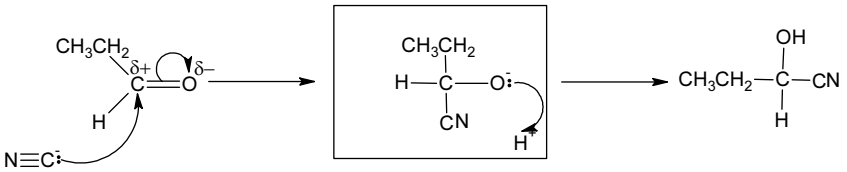
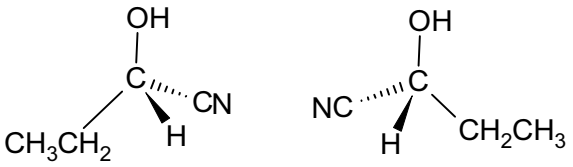
Question	Answer	Mark	Total
(b)	reaction 3 – (conc) H_2SO_4 / (conc) H_3PO_4 or Al_2O_3 / pumice / porcelain / porous pot / ceramic AND heat reaction 4 – KBr / NaBr with (conc) H_2SO_4 or (red)P and Br_2 / PBr_3 AND heat	[1] [1]	[2]
(c) (i)	 M1 = lone pair on C of CN^- AND curly arrow from lone pair to carbonyl carbon M2 = dipole on C=O AND curly arrow to O from = M3 = intermediate with negative charge M4 = lone pair and curly arrow to H^+	[1] [1] [1] [1]	[4]
(ii)		[1+1]	[2]

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Question	Answer	Mark	Total
(iii)	attack / attach from either side / above or below / from two directions because the carbonyl / molecule is planar / trigonal / flat / because of the shape of the molecule OR product is chiral / has a chiral carbon / has a carbon attached to four different groups / has a chiral centre / is asymmetric (equal) chance of forming either (of the two optical isomers) / mechanism doesn't distinguish between the two (optical isomers) / able to form either / chance of forming / able to form 50:50 OR because the carbonyl / molecule is planar / trigonal / flat OR because of the shape of the molecule (equal) chance of forming either (of the two optical isomers) / mechanism doesn't distinguish between the two (optical isomers) / able to form either / chance of forming / able to form 50:50	[1] [1]	[2]
		[Total 13]	

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