Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/22**

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

MARK SCHEME

Maximum Mark: 60

Published

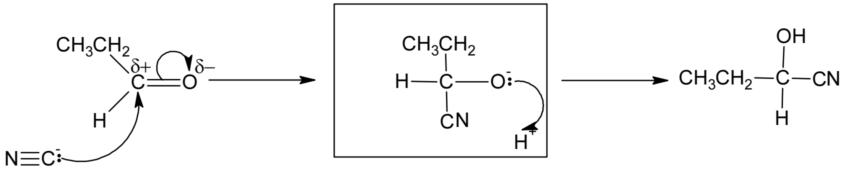
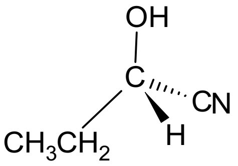
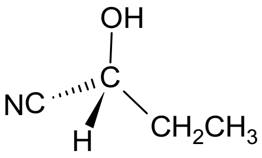
This document consists of **7** printed pages.

<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>

Question	Answer	Mark	Total
2 (a) (i)	enthalpy / energy / heat change when one mole of gaseous atoms is produced from the element in its standard state under standard conditions	[1] [1] [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 $E(ICl) = (151/2) + (242/2) + 24$ E(ICl) = (+) 220.5 / 221	[1] [1]	[2]
(b) (i)	stronger / more / greater id–id / London / dispersion forces due to increasing numbers of electrons	[1] [1]	[2]
(ii)	(intermolecular forces in HF are) hydrogen bonds (which are) stronger (than vdW) / more energy needed to separate molecules OR HF much more polar / F much more electronegative Intermolecular forces in HF stronger (than in HCl, HBr, HI)	[1] [1] [1] [1]	[2]
(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 due to greater distance / shielding of nucleus from bond pair ORA	[1] [1]	[2]

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

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]

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]

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]	