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 mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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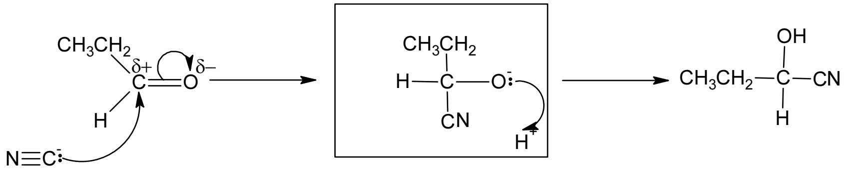
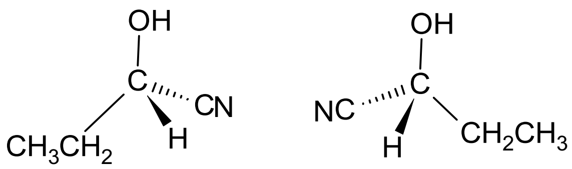
Question	Answer	Mark	Total
1 (a)	(table below)	[1] [1] [1] [1]	[4]
(b) (i)	Group 17 / VII / 7 AND big (owtte) increase / big difference / big gap / big jump / jump in increase / jump in difference after 7th IE	[1]	[1]
(ii)	increases across period due to increasing attraction (of nucleus for electrons) due to increasing nuclear charge / atomic / proton number AND constant / similar shielding / same (outer) shell / energy level	[1] [1]	[2]
(iii)	$1s^22s^22p^63s^23p^4$	[1]	[1]
(c) (i)	(100 – 99.76 – 0.04=) 0.2	[1]	[1]
(ii)	$\frac{0.2x + (99.76 \times 16) + (0.04 \times 17)}{100} = 16.0044$ x = 18	[1] [1]	[2]
			[Total 11]

name of element	nucleon number	atomic number	number of protons	number of neutrons	number of electrons	overall charge
boron	10	5	5	5	5	0
nitrogen	15	7	7	8	10	–3
lead	208	82	82	126	80	+2
lithium	6	3	3	3	2	+1

Question	Answer	Mark	Total
2 (a) (i)	enthalpy / energy / heat change when one mole of <u>gaseous atoms</u> 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 HC*l*, HBr, HI)	[1] [1]	
(c) (i)	**P** = iodine / I_2 / I; **Q** = chlorine / Cl_2 / C*l*	[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]

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 by one 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]	
	$AlCl_3 + 6H_2O \rightarrow Al(H_2O)_6^{3+} + 3Cl^-$ / $Al(H_2O)_5(OH)^{2+} + H^+ + 3Cl^-$	[1]	
	$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4H^+ + 4Cl^-$	[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 × 32.0/1000 =) 6.40×10^{-4}	[1]	[1]
(ii)	($6.4 \times 10^{-4} \times 3$ =)1.92×10^{-3}	[1]	[1]
(iii)	($0.242 / 1.92 \times 10^{-3}$ =) 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]	