Cambridge International AS & A Level

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

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Question	Answer	Mark	Total
1 (a)	(see table below)	[1] [1] [1] [1]	[4]

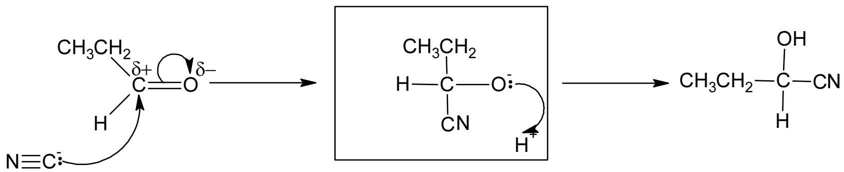
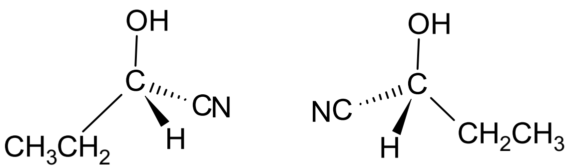
name of element	nucleon number	atomic number	number of protons	number of neutrons	number of electrons	overall charge
boron	10	5	5	5	5	0
nitrogen	15	7	7	8	10	–3
lead	208	82	82	126	80	+2
lithium	6	3	3	3	2	+1

Question	Answer	Mark	Total
(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)	$1s^2 2s^2 2p^6 3s^2 3p^4$	[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]

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)	($\frac{1}{2}Cl_2 + \frac{1}{2}I_2 \rightarrow ICl$) ΔH_f = (½E(Cl_2) + ½E(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]

Question	Answer	Mark	Total
(iii)	2H**P** (or 2HI) → (or ⇌) H_2 + **P**$_2$ (or I_2)	[1]	[1]
(iv)	$Ag^+(aq)$ + **Q**$^-$(aq) (or Cl^-) →Ag**Q**(s) (or AgCl(s))	[1]	
	Ag**Q**(s) / AgCl(s) + $2NH_3(aq)$ → $Ag(NH_3)_2^+(aq)$ + **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]	
	$AlCl_3 + 6H_2O \rightarrow Al(H_2O)_6^{3+} + 3Cl^-$ / $Al(H_2O)_5(OH)^{2+} + H^+ + 3Cl^-$	[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 / 1.92×10^{-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]	