
CHEMISTRY

9701/22

Paper 2 AS Level Structured Questions

March 2017

MARK SCHEME

Maximum Mark: 60

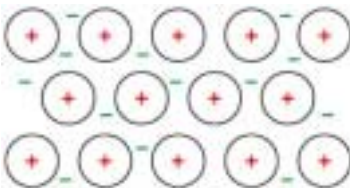
Published

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.

Cambridge will not enter into discussions about these mark schemes.

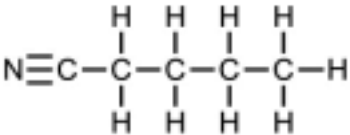
Cambridge is publishing the mark schemes for the March 2017 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

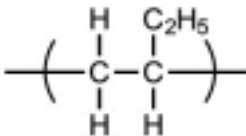
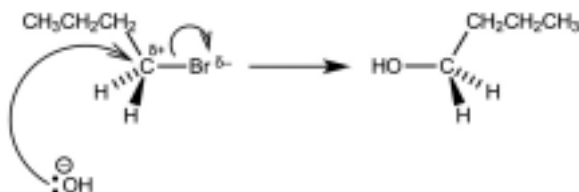
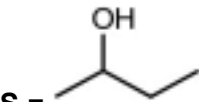
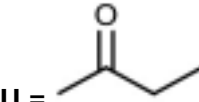
Question	Answer	Marks							
1(a)(i)	<table><tr><td>max O.N.</td><td>+1</td><td>(+)2</td><td>(+)3</td><td>(+)5</td><td>(+)6</td><td>+7</td></tr></table>	max O.N.	+1	(+)2	(+)3	(+)5	(+)6	+7	1
max O.N.	+1	(+)2	(+)3	(+)5	(+)6	+7			
1(a)(ii)	(from Na to Cl) nuclear charge increases	1							
	electrons are in the same shell / have same shielding	1							
	greater / stronger attraction (of electrons to nucleus)	1							
1(a)(iii)	Mg ²⁺ AND S ²⁻	1							
	ion of Mg / Mg ²⁺ has one fewer shell (than ion of S / S ²⁻)	1							
1(b)(i)	P ₄ + 5O ₂ → P ₄ O ₁₀ / 2P ₂ O ₅	1							
1(b)(ii)	any 2 from: • yellow / green colour (of chlorine gas) disappears • white flame • white solid • solid melts	2							
1(b)(iii)	phosphoric(V) acid	1							
1(c)(i)	 <u>diagram</u> showing regular arrangement of (positive) ions surrounded by / sea of (delocalised) electrons	2 1 1							
1(c)(ii)	any 2 from: • high melting / boiling / sublimation point • electrical / thermal insulator • hard / rigid • retains strength at high temperature / pressure	2							

Question	Answer	Marks
1(c)(iii)	M1 % abundance of fourth isotope $= 100 - (0.185 + 0.251 + 88.450) = 11.114$	1
	M2 $\frac{(0.185 \times 135.907) + (0.251 \times 137.906) + (88.450 \times 139.905) + (11.114 \times \text{RIM})}{100}$ $= 140.116$ $\therefore (140.116 \times 100) - 12434.35 = 1577.246 = 11.114 \times \text{RIM}$	1
	M3 $\text{RIM} = \frac{1577.246}{11.114} = 141.915$	1

Question	Answer	Marks
2(a)(i)	bond in which the centres of positive and negative charges do not coincide OR electron distribution is asymmetric / unequal OR two (bonded) atoms are partially charged	1
2(a)(ii)	HF has the strongest (permanent) dipole–dipole / van der Waals' (forces) / HF has hydrogen bonding	1
	requires more energy to overcome (than weaker (permanent) dipole–dipole / van der Waals' forces between other hydrogen halides)	1
2(a)(iii)	thermal stability of the hydrogen halides decreases down group (17)	1
	larger (halogen) atoms / atomic radius (down group) / increased shielding	1
	bond energies decrease / less energy required to break H–X	1
2(b)(i)	M1 base is Cl^- AND conjugate acid is HCl OR base is HSO_4^- AND conjugate acid is H_2SO_4	1
	M2 $\text{Cl}^- / \text{HSO}_4^-$ / base is a proton acceptor OR $\text{HCl} / \text{H}_2\text{SO}_4$ / (conjugate) acid has one more H^+	1
2(b)(ii)	H_2SO_4 is (too strong) an oxidising agent	1
	I_2 would be formed instead	1

Question	Answer	Marks																									
2(c)(i)	$\Delta_r H = \Delta_r H\{\text{products}\} - \Delta_r H\{\text{reactants}\} = 2 \times (-242) - 4 \times (-92)$	1																									
	$= -116$ (sign AND answer)	1																									
2(c)(ii)	heterogeneous (catalyst)	1																									
	provides an alternative reaction pathway of lower activation energy	1																									
2(c)(iii)	reaction is exothermic	1																									
	(increased temperature) shifts equilibrium to the left AND decreases yield of products (Cl_2 and/or H_2O)/less product formed	1																									
2(c)(iv)	<table><tr><td></td><td>HCl</td><td>O_2</td><td>Cl_2</td><td>H_2O</td></tr><tr><td>initial number of moles</td><td>1.60</td><td>0.500</td><td>0</td><td>0</td></tr><tr><td>M1 eqm number of moles</td><td>$1.60 - 2 \times 0.600 = 0.400$</td><td>$0.500 - \frac{1}{2} \times 0.600 = 0.200$</td><td>0.600</td><td>0.600</td></tr><tr><td>M2 mole fraction</td><td></td><td></td><td>$\frac{0.600}{1.80}$</td><td></td></tr><tr><td>M3 partial pressure</td><td></td><td></td><td>$\frac{0.600}{1.80} \times p_{\text{tot}} = 5.00 \times 10^4$</td><td></td></tr></table>		HCl	O_2	Cl_2	H_2O	initial number of moles	1.60	0.500	0	0	M1 eqm number of moles	$1.60 - 2 \times 0.600 = 0.400$	$0.500 - \frac{1}{2} \times 0.600 = 0.200$	0.600	0.600	M2 mole fraction			$\frac{0.600}{1.80}$		M3 partial pressure			$\frac{0.600}{1.80} \times p_{\text{tot}} = 5.00 \times 10^4$		3
	HCl	O_2	Cl_2	H_2O																							
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2(c)(v)	$K_p = \frac{(3.6 \times 10^4)^2 \times (3.6 \times 10^4)^2}{(4.8 \times 10^4)^4 \times 3.0 \times 10^4} = 1.05 \times 10^{-5}$	1																									
	units = Pa^{-1}	1																									
2(c)(vi)	K_p would not change	1																									

Question	Answer	Marks
3(a)(i)		1
3(a)(ii)	reaction 1 = HCl(aq)	1
	reaction 2 = (conc.) NaOH/KOH AND ethanol	1

Question	Answer	Marks
3(a)(iii)	 C–C backbone with dangling bonds rest of structure	2 1 1
3(b)	 lone pair on O AND curly arrow from O to C of C–Br dipole on C–Br AND curly arrow from C–Br to Br product (butan-1-ol)	3 1 1 1
3(c)(i)	(electrophilic) addition	1
3(c)(ii)	S has CH ₃ CHOH OR methyl / CH ₃ group next to CHOH	1
3(c)(iii)	positive inductive effect of more alkyl groups / more alkyl groups donate electron density	1
	secondary carbocation / secondary intermediate is more stable (than primary)	1
3(c)(iv)	S =  T =  U = 	1 1 1
3(c)(v)	CH ₃ CHOHCH ₂ CH ₃ + [O] → CH ₃ COCH ₂ CH ₃ + H ₂ O	1
3(d)(i)	methyl pentanoate	1
3(d)(ii)	(compound V is) spectrum X	1
	spectra X and Z show a C=O (stretch) at 1730 (cm ⁻¹)	1
	spectra Y and Z show O–H (stretches) above 2500 (cm ⁻¹)	1
	V has a C=O (bond) and no O–H (bond)	1