
CHEMISTRY

9701/22

Paper 2 AS Level Structured Questions

March 2017

MARK SCHEME

Maximum Mark: 60

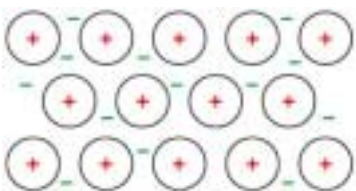
Published

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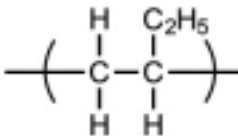
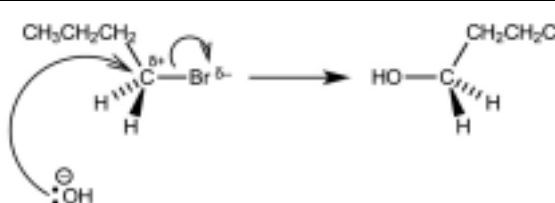
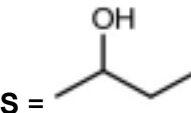
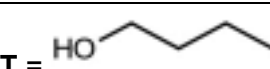
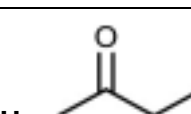
Question	Answer	Marks							
1(a)(i)	<table border="1"> <tr> <td>max O.N.</td> <td>+1</td> <td>(+)2</td> <td>(+)3</td> <td>(+)5</td> <td>(+)6</td> <td>+7</td> </tr> </table>	max O.N.	+1	(+)2	(+)3	(+)5	(+)6	+7	1
max O.N.	+1	(+)2	(+)3	(+)5	(+)6	+7			
1(a)(ii)	(from Na to Cl) nuclear charge increases	1							
	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)	$P_4 + 5O_2 \rightarrow P_4O_{10} / 2P_2O_5$	1							
1(b)(ii)	any 2 from: <ul style="list-style-type: none"> • yellow / green colour (of chlorine gas) disappears • white flame • white solid • solid melts 	2							
1(b)(iii)	phosphoric(V) acid	1							
1(c)(i)		2							
	<p>diagram showing regular arrangement of (positive) ions surrounded by / sea of (delocalised) electrons</p>		1 1						
1(c)(ii)	any 2 from: <ul style="list-style-type: none"> • 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 border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th>HCl</th> <th>O_2</th> <th>Cl_2</th> <th>H_2O</th> </tr> </thead> <tbody> <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> </tbody> </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
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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)	$\begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{N} \equiv \text{C} - & \text{C} - & \text{C} - & \text{C} - \text{H} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$	1
3(a)(ii)	reaction 1 = HCl(aq)	1
	reaction 2 = (conc.) NaOH/KOH AND ethanol	1

Question	Answer	Marks
3(a)(iii)	 <p>C–C backbone with dangling bonds rest of structure</p>	2 1 1
3(b)	 <p>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)</p>	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)	<p>S = </p> <p>T = </p> <p>U = </p>	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