Mock Exam 1

CHEMISTRY **9701**

Paper 2 AS Structured Questions

MARK SCHEME

Maximum Mark: 81

Published

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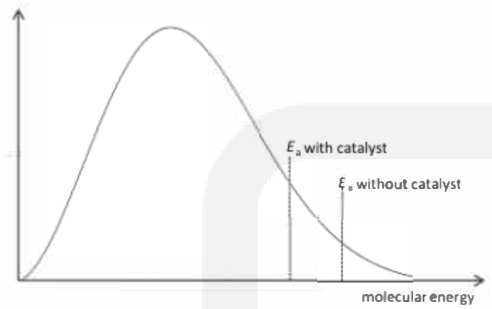
1		3(a)(i)	(Atoms/ ions become larger as) the number of (electron) shells increases (down the group) Increased distance of (outer) electrons (from the nucleus) OR Increased shielding results in weaker (nuclear) attraction / pull	1 1	**2**
		3(a)(ii)	top line / dotted line is atomic radii / bottom line / line with crosses is ionic radii (as atoms bigger than ions) Atom has one more shell (than corresponding ion) (ora) OR Atom loses two electrons / outer (shell) electrons / valency electrons (ora) OR Atom loses electrons and so (nuclear) attraction is stronger OR Nuclear charge in ion is greater than the electron(ic) charge (ora) OR Effective nuclear charge in ion is greater (ora)	1 1	**2**
		(b) (i)	**A** = $Mg(NO_3)_2$ **B** = H_2 **C** = NO_2 OR O_2 **D** = O_2 OR NO_2	[1] [1] [1] [1]	[4]
		(ii)	any Group I carbonate OR ammonium carbonate	[1]	[1]
	(c)	**(b) (i)**	forward and backward reactions occurring <u>at same rate</u> OR <u>the rate of</u> forward and backward reactions are equal	[1]	[1]
		(ii)	M1 = decreased yield of products / less products formed / ora M2 = <u>left</u>-hand side has fewer moles of gas OR equilibrium shifts to the <u>left</u>	[1] [1]	[2]

(d)



[3]

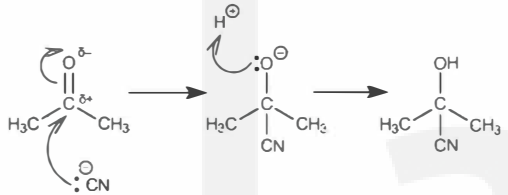
M1 = correct Boltzmann curve [1]

M2, M3 any 2 from: [1]

- line for **both** E_a values or statement in text that catalyst lowers E_a [1]
- (catalyst) increases proportion/number of molecules/particles with energy ≥ activation energy
- so more frequent successful collisions

(e) **(d) (i)** nucleophilic addition [1] [1]

(ii)



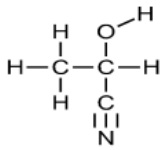
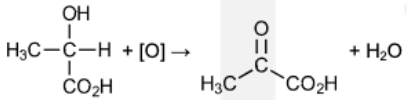
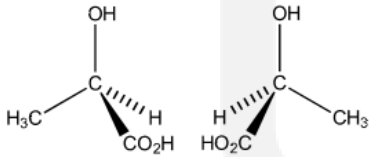
[5]

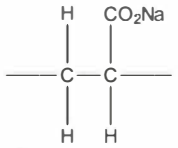
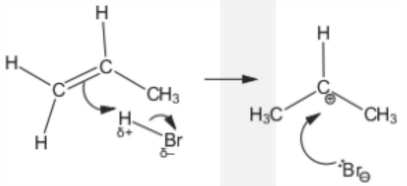
correct dipole on carbonyl [1]
curly arrow from lone pair on CN^- AND from C=O to O [1]
correct intermediate [1]
curly arrow from lone pair on O^- to H^+ [1]
correct product [1]

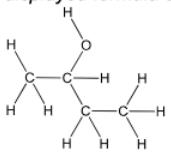
2		2(a)(i)	Enthalpy / energy / heat change when one mole of a substance Burns / combusts / reacts in excess oxygen OR Completely burns / combusts / reacts in oxygen under standard conditions	1 1 1	**3**
		2(a)(ii)	$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$	1	**1**
		2(b)(i)	6813.4 / 6813 / 6810 / 6800 (J)	1	**1**
		2(b)(ii)	–1362.68 / −1362.7 / –1363 / –1360 / –1400 (kJ)	1	**1**
		2(b)(iii)	Any 2 from: heat / energy losses (to air and/or to the container/surroundings) incomplete combustion (volatile) ethanol evaporated ethanol is impure not all energy is lost as heat	 1 1	**2**
		2(c)(i)	$3C(s) + 4H_2(g) + \frac{1}{2}O_2(g) \rightarrow C_3H_7OH(l)$ $3(-393.5) \quad 4 \times (-285.8) \quad -2021.0$ $3CO_2 + 4H_2O$	 1+1 1	**3**
		2(c)(ii)	$\Delta H_f + (-2021.0) = 3(-393.5) + 4(-285.8)$ $\Delta H_f = -302.7$ (kJ mol^{-1})	1 1	**2**

3		**2 (a) (i)**	enthalpy / energy / heat change when one mole of <u>gaseous atoms</u> 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 vd*W*) / 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]
		(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)) Ag**Q**(s) / AgCl(s) + $2NH_3(aq) \rightarrow Ag(NH_3)_2^+(aq)$ + $\mathbf{Q}^-(aq)$ / $Cl^-(aq)$	[1] [1]	[2]

(d)	2(b)(i)	weaker oxidising agents / (relative reactivity as oxidising agents) decreases **down the group**	**1**
	2(b)(ii)	**M1** (structure =) simple / molecular, because it has a low melting / boiling point **M2** (bonding =) covalent, because it is hydrolysed	**2**
(e)	2(c)(i)	**M1** cream ppt / solid **M2** (ppt / solid) partially dissolves in (aqueous) ammonia	**2**

	2(c)(ii)	**M1** *Acid behaviour of H_2SO_4* H_2SO_4 acts as an acid with Cl^- OR acid / base reaction with Cl^- **M2** *Oxidising behaviour of H_2SO_4* H_2SO_4 acts as an oxidising agent with I^- OR H_2SO_4 does not oxidise Cl^- **M3** *Products formed* (for iodide reaction) I_2 / S / SO_2 / H_2S is formed OR (for chloride reaction) (only) HCl is formed OR *Comparison of oxidising strength* H_2SO_4 not strong enough to / cannot oxidise Cl^- (to Cl_2) OR I^- more powerful reducing agent than Cl^-	**3**
4	4(a)(i)		**1**
	4(a)(ii)	dehydration	**1**
	4(a)(iii)		**1**
	4(a)(iv)	$Na_2Cr_2O_7$ / $K_2Cr_2O_7$ **AND** (dilute) H_2SO_4 / $H^+(aq)$ / acidified	**1**
	4(b)(i)	(Molecules that are) non-super(im)posable mirror images	**1**
	4(b)(ii)	 **M1** correct 3-d drawing of one isomer of Q [1] **M2** correct pair of 3-d structures of the optical isomers of Q [1]	**2**

(c)	 OR -$CH_2CH(CO_2Na)$-		**3**
(d)(i)	**M1** I experiences a (greater positive) inductive effect due to more alkyl groups OR I contains more electron donating alkyl groups (than II) [1] **M2** which stabilises the charge / reduces the charge (on the ion/intermediate) OR spreads the charge across the ion / molecule / intermediate [1]		**2**
(d)(ii)	 **M1** curly arrow from double bond to H of H—Br [1] **M2** curly arrow from H—Br bond to Br **AND** correct dipole on H—Br [1] **M3** curly arrow from lone pair on Br^- to C^+ [1]		**3**
(d)(iii)	nucleophilic substitution		**1**

5	5(a)	*displayed formula of butan-2-ol structure with O—H shown* 	**1**
	5(b)(i)	2-bromobutane	**1**
	5(b)(ii)	substitution	**1**
	5(b)(iii)	*reagent* **M1** NaCN or KCN	**1**
		conditions **M2** ethanolic AND heat (under reflux)	**1**
	5(b)(iv)	(1)C_4H_9CN + (1)H^+ + 2H_2O → (1)$C_4H_9CO_2H$ + (1)NH_4^+ ✓✓ *correct organic product showing carboxylic acid functional group* **M1** $C_4H_9CO_2H$ / C_4H_9COOH	**1**
		M2 balanced equation with a $C_5H_{10}O_2$ or equivalent structure as product	**1**
	5(b)(v)	2200–2250 (cm^{-1} due to) C≡N / triple bond between C and N.	**1**