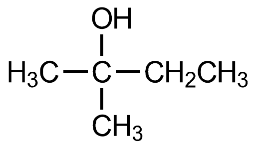
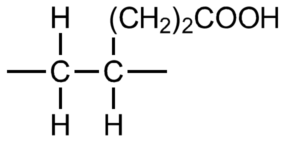
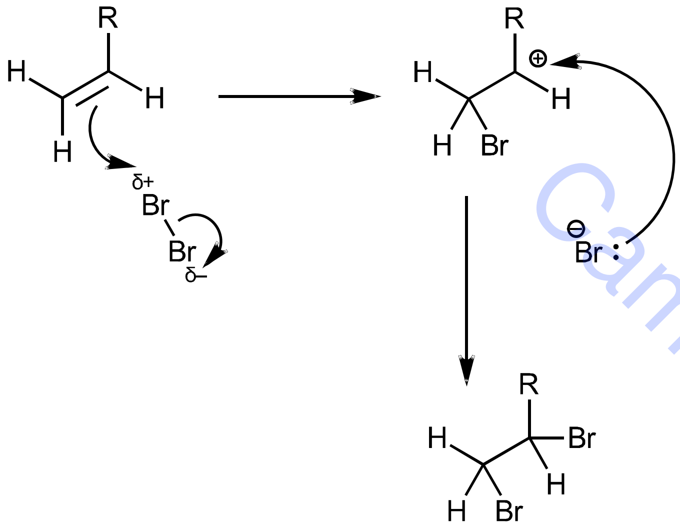
Question	Answer	Marks
1(a)(i)	$CaO + H_2O \rightarrow Ca(OH)_2$	**1**
1(a)(ii)	OH^- / hydroxide	**1**
1(b)	**M1** (decreasing melting point down the group because) lower forces of attraction / weaker bonds (between cations and anions / oxide / O^{2-}) **M2** larger cations and constant charge OR decreasing charge density of cation (down group)	**2**
1(c)	high(er) activation energy / heating overcomes activation energy	**1**
1(d)	180(°)	**1**
1(e)(i)	reacts with / behaves as both acid and base	**1**
1(e)(ii)	$BeO + 2OH^- + H_2O \rightarrow Be(OH)_4^{2-}$	**1**
1(f)(i)	**M1** equal rates of forward and backward reactions **M2** closed system **OR** macroscopic properties unchanging	**2**
1(f)(ii)	**M1** $\begin{array}{llll} & Cl_2 & O_2 & \\ \text{initial} & x & 0 & \text{mol} \\ \text{equilibrium} & 0.3x & 0.35x & \text{mol} \\ \textbf{mol fraction} & \mathbf{\frac{6}{13}} & \mathbf{\frac{7}{13}} & \end{array}$ **M2** $K_p = \dfrac{100\,000 \times \frac{7}{13}}{(100\,000 \times \frac{6}{13})^2} = 2.53 \times 10^{-5}$ **M3** Pa^{-1}	**3**

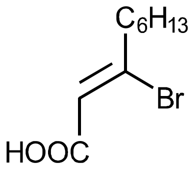
Question	Answer	Marks
1(g)(i)	–1	**1**
1(g)(ii)	**M1** (enthalpy / energy change) when one mole of a compound / substance is formed **M2** from its elements in their standard states	**2**
1(g)(iii)	$-(-602 + -188) + (\Delta H_f [MgO_2] + -286) = -96$ $\Delta H_f[MgO_2] = -600$ (kJ mol^{-1})	**2**
1(g)(iv)	$-(-600) - (+602) = -2$ (kJ mol^{-1})	**1**

Question	Answer	Marks
2(a)	darker / stronger / deeper down the group	**1**
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**
2(c)(i)	**M1** cream ppt / solid **M2** (ppt / solid) partially dissolves in (aqueous) ammonia	**2**

Question	Answer	Marks
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**
2(d)(i)	**M1** increases (down the group) because of increasing VdW **M2** because of increasing number of electrons	**2**
2(d)(ii)	**M1** less stable (down the group) / decreases **M2** lower H–Hal bond enthalpy / energy	**2**
2(e)(i)	in the same phase / state	**1**
2(e)(ii)	$C_2H_5CH(OH)C_2H_5 + HCl \rightarrow C_2H_5CH(Cl)C_2H_5 + H_2O$	**1**
2(e)(iii)	 $H_3C-\overset{OH}{\underset{CH_3}{C}}-CH_2CH_3$	**1**
2(e)(iv)	substitution	**1**

Question	Answer	Marks
3(a)(i)	**M1** acidified / H^+ $Cr_2O_7^{2-}$ / (potassium / sodium) dichromate OR manganate(VII) / MnO_4^- / $KMnO_4$ **M2** (heat under) reflux	**2**
3(a)(ii)	nucleophilic addition	**1**
3(a)(iii)	yellow / orange / red ppt / solid	**1**
3(a)(iv)	it does not have four different (groups of) atoms attached to (central) carbon OR it does not have a chiral carbon / centre OR it has two identical / COOH groups attached to (central) carbon OR mirror image is super(im)posable	**1**
3(a)(v)	**M1** hydrolysis **M2** esterification / condensation	**2**
3(b)(i)	**M1** no. of mol $O_2 = \dfrac{1.00\times10^5\times1.06\times10^{-3}}{(8.31\times850)}$ **M2** no. of mol of nitroglycerine = $4\times0.0150 = 0.0600$ (mol) **M3** mass of nitroglycerine = $0.0600\times227 = 13.6(2)$ (g)	**3**
3(b)(ii)	$1.06\times29 = 30.7(4)\ dm^3$	**1**
3(c)(i)	$C_5H_8O_2$	**1**

Question	Answer	Marks
3(c)(ii)	 $-\overset{H}{\underset{H}{C}}-\overset{(CH_2)_2COOH}{\underset{H}{C}}-$	1
3(c)(iii)	 **M1** curly arrow from C=C double bond to Br **M2** correct dipole in Br_2 **AND** curly arrow from Br—Br to $Br^{\delta-}$ **M3** correct intermediate **AND** curly arrow from lone pair on Br^- to C^+ **M4** correct product	4

Question	Answer	Marks
3(d)(i)	**M1**  **M2** (two) different groups on each C atom in the C=C / end of the C=C double bond **M3** no / restricted rotation about C=C	**3**
3(d)(ii)	H_2 / hydrogen	**1**
3(d)(iii)	**M1 / M2** *absorptions seen in both spectra (any two):* (same) both show an absorption at 1680–1730 (cm^{-1}) because of C=O (same) both show an absorption at 1040–1300 (cm^{-1}) because of C–O (same) both show an absorption at 2500–3000 (cm^{-1}) because of RCO_2–H / O–H in RCO_2H / carboxyl(ic acid) **M3** *absorption only seen in spectrum of* **T***:* (different) **T** shows an absorption at 1500–1680 (cm^{-1}) because of C=C (different) **T** shows an absorption at 3000–3100 (cm^{-1}) because of (C=)C–H	**3**