1. $Ba^{2+}_{(g)} + SO_4^{2-}_{(g)} \rightarrow BaSO_{4(s)}$ $\Delta H = -2469$

2. $Ba_{(s)} + S_{(s)} + 2O_{2(g)} \rightarrow BaSO_{4(s)}$ $\Delta H = -1473$

3. $Ba_{(s)} \rightarrow Ba_{(g)}$ $\Delta H = +180$

4. $Ba_{(g)} \rightarrow Ba^{+}_{(g)} + e^-$ $\Delta H = +503$

5. $Ba^{+}_{(g)} \rightarrow Ba^{2+}_{(g)} + e^-$ $\Delta H = +965$

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23 / 24 76.8%

$S(s) + 2O_2(g) + 2e^- \rightarrow SO_4^{2-}(g)$ $\Delta H = \Delta H_f^{\circ}$ of $SO_4^{2-}(g)$

		ΔH
$BaSO_{4(s)}$	$\rightarrow Ba^{2+}_{(g)} + SO_4^{2-}(g)$	+2469
$Ba_{(s)} + S_{(s)} + 2O_{2(g)}$	$\rightarrow BaSO_{4(s)}$	−1473
$Ba_{(g)}$	$\rightarrow Ba_{(s)}$	−180
$Ba^{+}_{(g)} + e^-$	$\rightarrow Ba_{(g)}$	−503
$Ba^{2+}_{(g)} + e^-$	$\rightarrow Ba^{+}_{(g)}$	−965
$S_{(s)} + 2O_{2(g)} + 2e^-$	$\rightarrow SO_4^{2-}$	−652

(e) Aqueous manganese(II) ions show similar chemical properties to aqueous copper(II) ions when reacted separately with NaOH(aq) and with concentrated HC*l*.

(i) Write the ionic equation, and state the type of reaction, for the reaction of $[Mn(H_2O)_6]^{2+}$ with NaOH(aq).

ionic equation $[Mn(H_2O)_6]^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mn(OH)_2(H_2O)_{4(s)} + 2H_2O_{(l)}$

type of reaction ligand displacement / precipitation

[2]

(ii) Write the ionic equation, and state the type of reaction, for the reaction of $[Mn(H_2O)_6]^{2+}$ with concentrated HC*l*.

ionic equation $[Mn(H_2O)_6]^{2+} + Cl^- \rightarrow [MnCl_4]^{2-} + 6H_2O_{(l}$

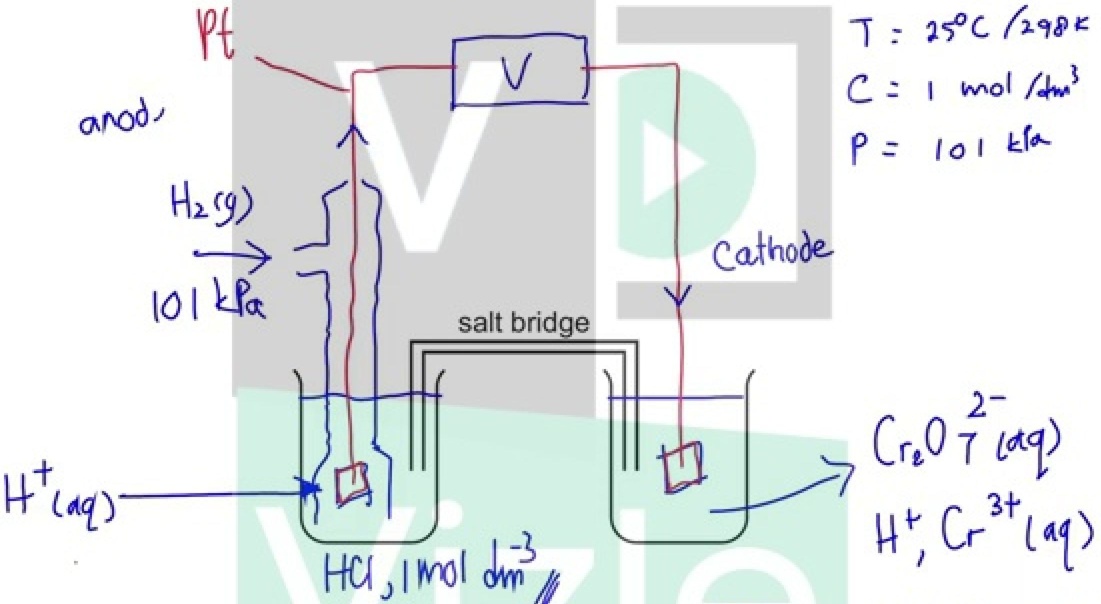
type of reaction ....

[2]

(iii) Table 2.1 lists relevant electrode potentials for some electrode reactions.

Table 2.1

electrode reaction	E°/V



[3]

(iv) The E° of the $Cr_2O_7^{2-}$(aq), H^+(aq)/Cr^{3+}(aq) electrode is +1.33 V. reduction → gain e^-

Label the negative electrode and the direction of electron flow in the external circuit when the current flows in your diagram in **(c)(iii)**. [1]

anode to cathode

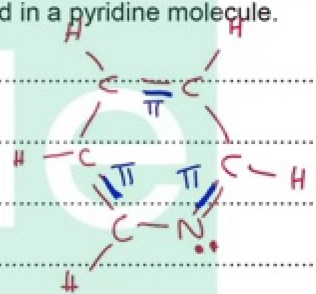
(d) The ligand bipyridine consists of two pyridine rings.

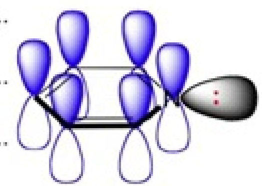
Pyridine, C_5H_5N, and benzene, C_6H_6, have similar planar, cyclic structures.

pyridine

Fig. 4.2

By reference to the hybridisation of the carbon atoms and the nitrogen atom, and orbital overlap, suggest how the σ and π bonds are formed in a pyridine molecule.





[3]

polyanhydride

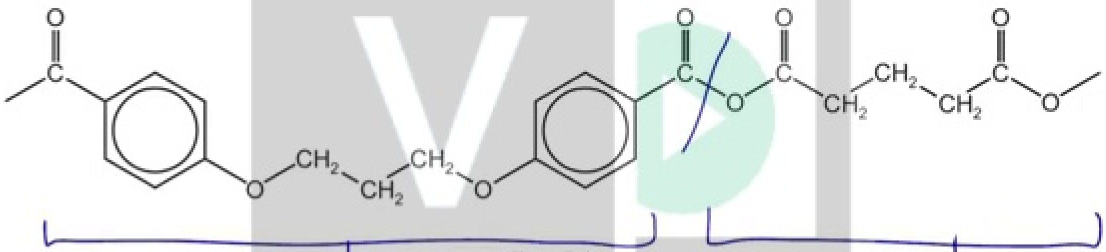
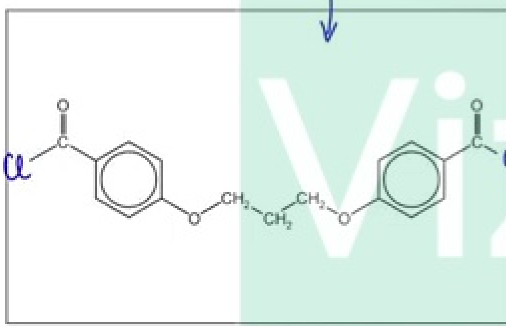
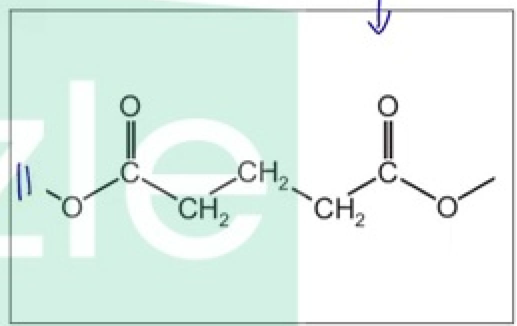


Fig. 5.2

(i) Use Fig. 5.1 and Fig. 5.2 to suggest the structures of the two monomers used to make this polyanhydride.





[2]

The area underneath each peak is proportional to the mass of the respective compound in the mixture.

The concentration of **K** in the mixture is $5.52 \times 10^{-2}\,g\,dm^{-3}$.

Calculate the concentration, in $mol\,dm^{-3}$, of compound **L** in the mixture.
[M_r: **L**, 116]

$$\frac{44}{58} = \frac{5.52 \times 10^{-2}\,g\,dm^{-3}}{[L]} \Rightarrow [L] = 7.28 \times 10^{-2}\,g\,dm^{-3}$$

concentration of **L** = ... $mol\,dm^{-3}$ [1]

[Total: 12]

$$nL = \frac{7.28 \times 10^{-2}\,g}{116\,g\,mol^{-1}} = 6.27 \times 10^{-4}\,mol$$