

2 (a) Iron can form stable ions in the +2 and +3 oxidation states.

Explain why transition elements have variable oxidation states.

.....
 [1]

(b) Aqueous solutions of iron(II) salts contain the complex ion $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$.

Define complex ion.

.....
 [1]

(c) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ can be converted into $[\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2]$.

(i) Suggest a suitable reagent for this conversion. State the type of reaction.

reagent

type of reaction [1]

(ii) $[\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2]$ is a green precipitate that turns brown on standing in air.

Table 2.1 shows electrode potentials for some electrode reactions.

Table 2.1

electrode reaction	$E^\ominus / \text{V}$
$\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 + \text{H}_2\text{O} + \text{e}^- \rightleftharpoons \text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2 + \text{OH}^-$	-0.56
$\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+0.40

Use the information in Table 2.1 to explain why $[\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2]$ turns brown on standing in air.

Include an equation for this reaction.

.....

 [3]

(d) The complex $[\text{Co}(\text{NH}_3)_6]^{2+}$ reacts with hydrogen peroxide as shown.



Calculate $\Delta G^\ominus$, in kJ mol^{-1} , for reaction 1.

$\Delta G^\ominus = \dots\dots\dots \text{kJ mol}^{-1}$ [2]

[Total: 8]