

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

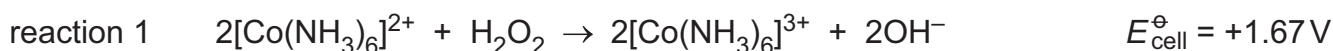
electrode reaction	$E^\ominus / \text{V}$
$\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 + \text{H}_2\text{O} + \text{e}^- \rightleftharpoons \text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2 + \text{OH}^-$	-0.56
$\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+0.40

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.

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.....  
.....  
.....  
.....  
..... [3]

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



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

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

[Total: 8]