Marks 4

- The presence of iron in inorganic qualitative analysis is detected by the precipitation of the hydroxide using a buffer of pH 8. The solubility product constant of $Fe(OH)_3$ is 4×10^{-38} M^4 and that of $Fe(OH)_2$ is 4×10^{-15} M^3. Is it more sensible to try and detect the presence of Fe^{2+} ions or Fe^{3+} ions? Show all working and then give a reason for your answer.

Using $pOH = -\log_{10}([OH^-(aq)])$ and $pH + pOH = 14.0$:

$pOH = (14.0 - 8.0) = 6.0$ and
$[OH^-(aq)] = 1 \times 10^{-6}$ M

The solubility equilibria and products are :

$Fe(OH)_2(s) \rightleftharpoons Fe^{2+}(aq) + 2OH^-(aq) \quad K_{sp}(Fe(OH)_2) = [Fe^{2+}(aq)][OH^-(aq)]^2$

$Fe(OH)_3(s) \rightleftharpoons Fe^{3+}(aq) + 3OH^-(aq) \quad K_{sp}(Fe(OH)_3) = [Fe^{3+}(aq)][OH^-(aq)]^3$

Hence,

$$[Fe^{2+}(aq)] = \frac{K_{sp}(Fe(OH)_2)}{[OH^-(aq)]^3} = \frac{(4 \times 10^{-15})}{(1.0 \times 10^{-6})^2} = 4 \times 10^{-3} \text{ M}$$

$$[Fe^{2+}(aq)] = \frac{K_{sp}(Fe(OH)_3)}{[OH^-(aq)]^3} = \frac{(4 \times 10^{-38})}{(1.0 \times 10^{-6})3} = 4 \times 10^{-20} \text{ M}$$

As $Fe(OH)_2(s)$ $Fe(OH)_3(s)$ dissolves to give 1 $Fe^{2+}(aq)$ and 1 $Fe^{3+}(aq)$, these are also the molar solubilities.

The solubility of $Fe(OH)_3$ is much lower so it will precipitate at much lower iron concentrations. It is therefore easier to detect Fe^{3+}.

Marks 2

- Name the following complexes.

$[Cr(OH_2)_6](NO_3)_3$	**hexaaquachromium(III) nitrate**
$[CoBr_2(en)_2]Cl$	**dibromidobis(ethylenediamine)cobalt(III) chloride**

en = ethylenediamine = $NH_2CH_2CH_2NH_2$