Marks
8

- The concentration of iron in the ocean is one of the primary factors limiting the growth rates of some basic life forms. Write the chemical equation for the dissolution reaction of $Fe(OH)_3$ in water.

$Fe(OH)_3(s) \rightleftharpoons Fe^{3+}(aq) + 3OH^-(aq)$

What is the solubility of $Fe(OH)_3$ in mol L^{-1}? K_{sp} ($Fe(OH)_3$) is 2.8×10^{-39} at 25 °C.

From the chemical equation, $K_{sp} = [Fe^{3+}(aq)][OH^-(aq)]^3$.

If x mol of $Fe(OH)_3$ dissolve in one litre, then $[Fe^{3+}(aq)] = x$ and $[OH^-(aq)] = 3x$. Hence,

$$K_{sp} = (x)(3x)^3 = 27x^4 = 2.8 \times 10^{-39}$$

$$x = 1.0 \times 10^{-10} \text{ M}$$

Answer: **1.0×10^{-10} M**

Before the Industrial Revolution, the concentration of $OH^-(aq)$ in the oceans was about 1.6×10^{-6} M. What pH corresponds to this concentration at 25 °C?

If $[OH^-] = 1.6 \times 10^{-6}$ M, then be definition

$$pOH = -\log_{10}[OH^-(aq)] = -\log_{10}(1.6 \times 10^{-6}) = 5.8$$

As pH + pOH = 14.0,

$$pH = 14.0 - 5.8 = 8.2$$

Answer: **pH = 8.2**

What is the solubility of $Fe(OH)_3$ in mol L^{-1} at this pH?

As $[OH^-(aq)] = 1.6 \times 10^{-6}$ M and $K_{sp} = [Fe^{3+}(aq)][OH^-(aq)]^3$:

$$[Fe^{3+}(aq)] = K_{sp} / [OH^-(aq)]^3$$
$$= 2.8 \times 10^{-39} / (1.6 \times 10^{-6})^3 \text{ M}$$
$$= 6.8 \times 10^{-22} \text{ M}$$

Answer: **6.8×10^{-22} M**

ANSWER CONTINUES OVER THE PAGE

Industrialisation has led to an increase in atmospheric CO_2. Predict the effect that this has had on the amount of $Fe^{3+}(aq)$ in sea water and briefly explain your answer.

Dissolved CO_2 reacts with water to form H_2CO_3 which is slightly acidic.

$$H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$$

The increase in $[H^+(aq)]$ results in a decrease in $[OH^-(aq)]$ and hence (from Le Chatelier's principle) more $Fe(OH)_3(s)$ will dissolve.