- $BaSO_4$ is used as a contrast agent for X-ray images of intestines. What is the solubility product constant, K_{sp}, for $BaSO_4$, given that a maximum of 1.2×10^{-3} g dissolves in 500 mL of water. **4**

The formula mass of $BaSO_4$ is:

137.34 (Ba) + 32.07 (S) + 4 × 16.00 (O) = 233.44 g mol^{-1}

A mass of 1.2×10^{-3} g therefore corresponds to:

$$\text{number of moles} = \frac{\text{mass}}{\text{formula mass}} = \frac{1.2 \times 10^{-3}\ \text{g}}{233.44\ \text{g mol}^{-1}} = 5.14 \times 10^{-6}\ \text{mol}$$

The equation for the dissolution is:

$$BaSO_4(s) \rightleftharpoons Ba^{2+}(aq) + SO_4^{2-}(aq)$$

If 5.14×10^{-6} mol dissolves, then the number of moles of $Ba^{2+}(aq)$ and $SO_4^{2-}(aq)$ will also be 5.14×10^{-6} mol. As these amounts are present in 500 mL of water:

$$[Ba^{2+}(aq)] = [SO_4^{2-}(aq)] = \frac{\text{number of moles}}{\text{volume}} = \frac{5.14\times10^{-6}\ \text{mol}}{0.500\ \text{L}} = 1.03 \times 10^{-5}\ \text{M}$$

Finally, the solubility product constant is:

$$K_{sp} = [Ba^{2+}(aq)][SO_4^{2-}(aq)] = (1.03 \times 10^{-5})(1.03 \times 10^{-5}) = 1.1 \times 10^{-10}$$

Answer: **1.1×10^{-10}**

Ba^{2+} ions are toxic. Comment on the suitability of $BaSO_4$ as a contrast agent.

As $BaSO_4$ has a very low solubility, $[Ba^{2+}(aq)]$ will be low and so very few of the toxic Ba^{2+} are actually dissolved into the blood stream.

What advantage would there be in administering $BaSO_4$ as a slurry which also contains 0.5 M Na_2SO_4?

The equilibrium,

$$BaSO_4(s) \rightleftharpoons Ba^{2+}(aq) + SO_4^{2-}(aq)$$

will be shifted to the left by the addition of additional SO_4^{2-} from Na_2SO_4. This is an example of Le Châtelier's principle and is called the 'common ion effect'.

By shifting the reaction to the left, even less $BaSO_4$ will dissolve, reducing $[Ba^{2+}(aq)]$ to:

$$[Ba^{2+}(aq)] = K_{sp} / [SO_4^{2-}(aq)] = (1.1 \times 10^{-11})/(0.5) = 2 \times 10^{-10}\ \text{M}$$

This can be compared to the much higher value of 1×10^{-5} M calculated above.