

## Solubility Product Constant (Ksp)

**Sub-subject:** Chemistry

**Topic:** Solubility Product Constant (Ksp)

### Introduction and Given Data

To calculate the solubility product constant ( $K_{sp}$ ) for bismuth iodide ( $BiI_3$ ), the first step is to convert the given solubility in g/L to mol/L (molarity).

**Given data:**

Compound: Bismuth iodide ( $BiI_3$ )

Solubility:  $7.7 \times 10^{-3}$  g/L

**Formula:**

$$\text{Molarity} = \text{Solubility in g/L} / \text{Molecular weight of compound}$$

**Explanation:** Solubility product constants are calculated using equilibrium concentrations of ions in the solution. The solubility given needs to be converted into molarity for this purpose.

### Calculate the Molar Mass of $BiI_3$

**Formula:**

$$\text{Molar mass of } BiI_3 = \text{Molar mass of Bi} + 3 \times \text{Molar mass of I}$$

Molar masses:

- $Bi = 208.98 \text{ g/mol}$
- $I = 126.90 \text{ g/mol}$

$$\begin{aligned}\text{Molar mass of } BiI_3 &= 208.98 \text{ g/mol} + 3 \times 126.90 \text{ g/mol} \\ &= 208.98 \text{ g/mol} + 380.70 \text{ g/mol} \\ &= 589.68 \text{ g/mol}\end{aligned}$$

**Explanation:** The molar mass of  $BiI_3$  has been computed by adding up the atomic masses of bismuth and three iodine atoms.

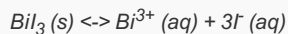
### Convert Solubility to Molarity

**Formula:**

$$\begin{aligned}\text{Molarity of } BiI_3 &= 7.7 \times 10^{-3} \text{ g/L} / 589.68 \text{ g/mol} \\ &= 1.306 \times 10^{-5} \text{ mol/L}\end{aligned}$$

**Explanation:** The given solubility of  $BiI_3$  is converted from grams per liter into moles per liter using its molar mass.

### Write the Dissociation Equation



**Explanation:** The dissociation of bismuth iodide results in one bismuth ion and three iodide ions.

## Express the Concentration of Ions in Terms of the Solubility

From the stoichiometry of the dissolution:

- $[Bi^{3+}] = 1.306 \times 10^{-5} M$
- $[I^-] = 3 (1.306 \times 10^{-5} M) = 3.918 \times 10^{-5} M$

**Explanation:** The concentration of ions is derived from the balanced dissociation reaction, considering each mole of  $BiI_3$  produces one mole of  $Bi^{3+}$  ions and three moles of  $I^-$  ions.

## Calculate the Solubility Product Constant ( $K_{sp}$ )

**Formula:**

$$K_{sp} = [Bi^{3+}][I^-]^3$$

$$\begin{aligned} &= (1.306 \times 10^{-5}) \times (3.918 \times 10^{-5})^3 \\ &= (1.306 \times 10^{-5}) \times (6.018 \times 10^{-14}) \\ &= 7.86 \times 10^{-19} \end{aligned}$$

**Explanation:** The solubility product constant is computed by multiplying the molar concentrations of the dissociated ions, raised to the power of their stoichiometric coefficients from the dissociation equation.

## Final Solution

The solubility product constant (  $K_{sp}$  ) for  $BiI_3$  is  $7.86 \times 10^{-19}$ .

**Explanation:** The final calculated solubility product constant provides insight into the extent to which  $BiI_3$  will dissolve in water under the given conditions, emphasizing the low solubility of the compound due to the small value of  $K_{sp}$ .