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: 7.7×10^{-3} g/L

Formula:

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

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:
$Molar\ mass\ of\ BiI_3 = Molar\ mass\ of\ Bi + 3 \times Molar\ mass\ of\ I$

Molar masses:

- $Bi = 208.98\ g/mol$
- $I = 126.90\ g/mol$

$Molar\ mass\ of\ BiI_3 = 208.98\ g/mol + 3 \times 126.90\ g/mol$
$= 208.98\ g/mol + 380.70\ g/mol$
$= 589.68\ g/mol$

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:

$$Molarity\ of\ BiI_3 = \frac{7.7 \times 10^{-3}\ \text{g/L}}{589.68\ \text{g/mol}}$$

$= 1.306 \times 10^{-5}\ mol/L$

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

$BiI_3\ (s) <-> Bi^{3+}\ (aq) + 3I^-\ (aq)$

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:

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

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:

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

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

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 7.86×10^{-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}.