CHEM1002 Worksheet 11 – Answers to Critical Thinking Questions

The worksheets are available in the tutorials and form an integral part of the learning outcomes and experience for this unit.

Model 1: The Unit Cell

1. Number of atoms = 8 × ⅛ = 1.

2. Number of atoms = 8 × ⅛ (atoms on corners) + 1 (atom at centre) = 2.

3. Number of atoms = 8 × ⅛ (atoms on corners) + 6 × ½ (atoms on faces) = 4.

Model 2: The Unit Cell and Stoichiometry

1. (a) Number of Cl atoms = 8 × ⅛ (atoms on corners) + 6 × ½ (atoms on faces) = 4.

   (b) Number of Na atoms = 12 × ¼ (atoms on edges) + 1 (atom at centre) = 4.

   (c) Cation : anion = 4 : 4 or 1 : 1. This is consistent with the formula NaCl.

2. (a) Number of Ti atoms = 1 (atom at centre).

   (b) Number of Ca atoms = 8 × ⅛ (atoms on corners) = 1

   (c) Number of O atoms = 6 × ½ (atoms on edges) = 3.

   (d) The formula is $Ca_1Ti_1O_3$ or $CaTiO_3$.

Model 3: The solubility product

1. (a) $AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$; $K_{sp} = [Ag^+(aq)][Cl^-(aq)]$

   (b) $PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2Cl^-(aq)$; $K_{sp} = [Pb^{2+}(aq)][Cl^-(aq)]^2$

2. (a) $[Pb^{2+}(aq)] = x$ and $[Cl^-(aq)] = 2x$.

   (b) $K_{sp} = Pb^{2+}(aq)][Cl^-(aq)]^2 = (x)(2x)^2 = 4x^3$

   If $4x^3 = 1.6 \times 10^{-5}$, then $x = 1.59 \times 10^{-2}$.

   $[Pb^{2+}(aq)] = x = 1.59 \times 10^{-2}$ M and $[Cl^-(aq)] = 2x = 3.17 \times 10^{-2}$ M

3. Molar solubility = $(K_{sp} / 27)^{1/4}$

Model 4: To dissolve or not to dissolve?

1. (a) $[Mg^{2+}(aq)] = 0.050$ M and $[OH^-(aq)] = 0.060$ M

   (b) $Q_{sp} = [Mg^{2+}(aq)]\ [OH^-(aq)]^2 = (0.050)(0.060)^2 = 1.8 \times 10^{-4}$

   (c) $Q_{sp} > K_{sp}$ so $Mg(OH)_2$ (s) precipitate forms.