1021SCG Chemistry 1A – Module 3: Physicochemical Concepts
Week 11

References and resources: Blackman, Bottle, Schmid, Mocerino and Wille, 3rd Edn., Chapters 7 and 10, Sections 7.4-7.8, 10.1-10.4

Learning Objectives

You should be able to:

- Appreciate the concepts of describing the structure solid matter
- Appreciate the use of X-ray diffraction to probe the structure of solid matter
- Appreciate and explain amorphous solids, crystal imperfections, ceramics
- Define the terms:

  mass percentage (a mass ratio: $w = \frac{mass\,of\,component}{total\,mass\,of\,solution} \cdot 100\,\%$)

  parts per million (a mass ratio: $w = \frac{mass\,of\,component}{total\,mass\,of\,solution} \cdot 10^6$)

  mole fraction ($x = \frac{molar\,amount\,of\,component}{total\,molar\,amount\,of\,all\,components}$)

  molar concentration (also called molarity: $c = \frac{molar\,amount\,of\,solute}{volume\,of\,solution}$)

  and be able to calculate the concentration of a substance in any of these terms.
- Understand the effect of pressure on solubility (Henry's law)
- Understand the concepts of solubility and solubility product, and be able to calculate concentrations of solutions and mixtures
- Predict formation of precipitates in mixtures of electrolytes

Workshop and Study Questions

1. When describing the spatial packing of atoms, they are often approximated as spheres. The maximum portion of space that can be filled with identical spheres is 74% and such packings are called close-packed arrangements.
(a) How many close-packed arrangements are possible for matter in the solid state? What are their names?
(b) How can the packing arrangement be characterised for the different packings in (a)?

2. Which quantities are related by the Bragg equation? How does the use of the Bragg equation in X-ray diffraction allow insights into the structure of solid matter?

3. What is the difference between crystalline and amorphous solids?

4. Fish need at least 4 ppm dissolved O_2 for survival.
(a) What is this concentration in mol l^{-1}?
(b) What partial pressure of O_2 above the water is needed to obtain this concentration at 10 °C? (The Henry's law constant for O_2 at this temperature is $1.71 \cdot 10^{-3}$ mol l^{-1} atm^{-1}.)

5. The solubility of TlI (thallium(I) iodide) in water at 20°C is $1.8 \cdot 10^{-5}$ mol l^{-1}. Calculate the solubility product for TlI.

6. The solubility product of $Fe(OH)_3$ is $1.6 \cdot 10^{-39}$ at 25 °C.
(a) What is the molar solubility of $Fe(OH)_3$?
(b) What is the mass solubility of $Fe(OH)_3$ (in g l^{-1})?

7. Determine whether or not a precipitate of $NiCO_{3(s)}$ will form if 100.0 ml of 1.0 mM $Ni(NO_3)_{2(aq)}$ is mixed with 100.0 ml of 2.0 mM $Na_2CO_{3(aq)}$ at 25 °C. The solubility product of $NiCO_3$ at this temperature is $1.3 \cdot 10^{-7}$.

8. Calculate the molar solubility of AgI in 0.20 M NaI solution at 25 °C. The solubility product of AgI at this temperature is $8.3 \cdot 10^{-17}$.