Worksheet 9

March 4th, 2022

Collaborations are encouraged and students must report all collaborators on each assignment. All external sources (websites, books) must be cited. An *extra credit* (*EC*) problem will be available per assignment. Please submit a completed homework on-time to receive *EC* and no partial *EC* (all parts must be correct) will be given out. Additional problems are listed at the end of each assignment. This week's assignment is due *Monday, March 14th at 10:30am.*

1. **Concentrations of Solutions** An car antifreeze mixture is made by mixing equal volumes of ethylene glycol (d = 1.114 g/mL, molar mass 62.07 g/mol) and water (d = 1.000 g/mL) at 20.0°C. The density of the solution is 1.070 g/mL. Determine the mass percent, molarity, molality, and mole fraction.

2. **Henry's Law** The Henry's law says that the amount of dissolved gas in a given volume of solvent at equilibrium is proportional to the partial pressure of the gas.

$$c(\text{solute}) = k_H P(\text{solute}) \tag{1}$$

The minimum mass concentration of oxygen O_2 required for fish life is 4.0 mg/L. Henry's constant for O_2 is 1.2×10^{-3} mol/(L atm). Report results to 2 significant figures.

(a) Assume the density of lake water to be 1.00 g/mL and express this concentration in parts per million (milligrams of O_2 per kilogram of water mg/kg).

(b) What is the minimum partial pressure of O_2 that would supply the minimum mass concentration of oxygen in water to support fish life at 20.°C.

(c) What is the minimum atmospheric pressure that would give this partial pressure, assuming that oxygen exerts about 21% of the atmospheric pressure?

3. **Raoult's Law**

4. **Freezing Point Depression** When 1.32g of a nonpolar solute was dissolved in 50.0g of phenol, the latter's freezing point was lowered by 1.454°C. Calculate the molar mass of the solute. Phenol $K_f = 7.40°/m$

5. **Colligative Properties of Solution** Two beakers, one containing 0.10 m NaCl(aq) and the other containing 0.010 m $AlCl_3$(aq), are placed inside a bell jar and sealed. The beakers are left unitl the water vapor has come to equilibrium with any liquid in the container. The levels of the liquid in each beaker at the beginning of the experiment are the same, as pictured in Fig. 1. Draw the levels of the liquid in each beaker after quilibrium has been reached. Explain your reasoning.

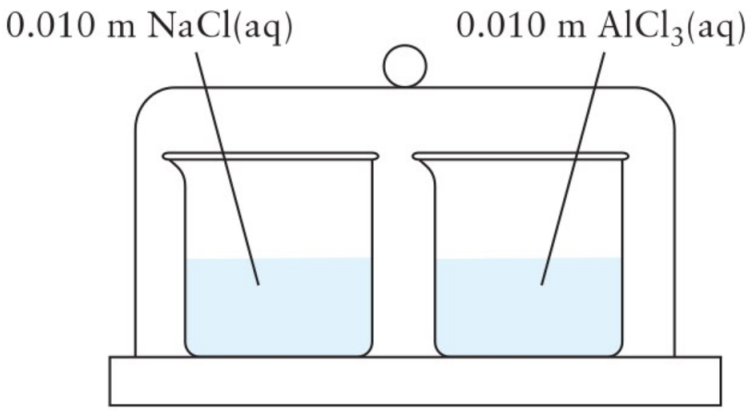

Figure 1: 0.010 m NaCl and 0.010 m $AlCl_3$ are separated in equal sized containers.

6. **Solid Structures** Determine the number of atoms per unit cell, see Fig. 2.

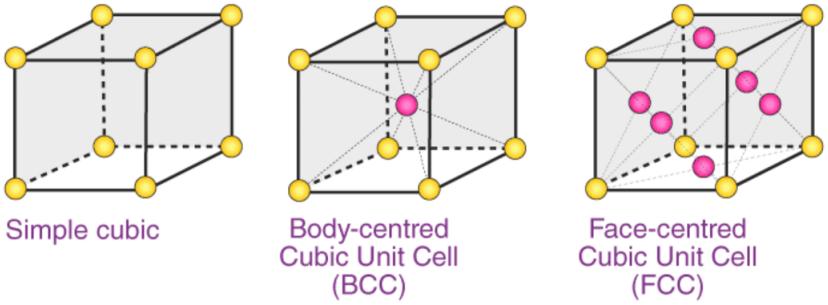

Figure 2: Various solid structures

Optional Additional Problems: Ch. 12 - odd problems $25-47, 79-85$; Ch. 13 - odd problems $25-35, 47-55, 65-93$