Solutions I: Saturated and Unsaturated Solutions

1. The concentration of dissolved oxygen from the air at 1.0 atm in sea water is 3.1×10^{-4} M at 25°C. Predict the concentration of dissolved oxygen in sea water at a partial pressure O_2 of 1.0 atm (*i.e.*, pure oxygen).

$$c = kP_{O_2} \text{ so } \frac{c_1}{c_2} = \frac{P_1}{P_2} \text{ or } c_1 = c_2 \frac{P_1}{P_2}$$

$$c_{\text{pure } O_2} = 3.1 \times 10^{-4} M \left(\frac{1.0 \text{ atm}}{0.21 \text{ atm}} \right) = 1.5 \times 10^{-3} M$$

2. A solution of KNO_3 is prepared carefully to be 28.0 g of solid dissolved in 200.0 g of water, then slowly cooled to 0.0°C. No crystallization occurs. Is the solution unsaturated, saturated, or supersaturated? ($s^{0°C}_{KNO_3}$ = 13.3 g/100 g H_2O)

$$C = \frac{28.0 \text{ g } KNO_3}{200.0 \text{ g } H_2O} = 0.140 \frac{\text{g } KNO_3}{\text{g } H_2O}$$

since the solubility is $0.133 \frac{\text{g } KNO_3}{\text{g } H_2O}$ the solution is supersaturated.

3. When a seed crystal is added, some solid precipitates from solution (prepared in question 2). Predict the quantity of solid that precipitates.

$$m_{\text{dissolves}} = 0.133 \frac{\text{g } KNO_3}{\text{g } H_2O} \times 200.0 \text{ g } H_2O = 26.6 \text{ g } KNO_3$$

$$m_{\text{precipitated}} = 28.0 \text{ g} - 26.6 \text{ g} = 1.4 \text{ g}$$

4. What is the molal concentration of the solution prepared by dissolving 60.0 g of glucose ($C_6H_{12}O_6$, 180.2 g/mol) in 100.0 mL of water?

$$n_{\text{gluc}} = \frac{60.0 \text{ g gluc}}{180.2 \text{ g/mol}} = 0.3330 \text{ mol gluc}$$

$$C = \frac{0.3330 \text{ mol gluc}}{0.1000 \text{ kg}} = 3.33 \ m$$

5. What quantity of methanol (CH_3OH) must be added to 250.0 g of water to make a 0.25 *m* solution?

$$n = 0.2500 \text{ kg} \times 0.25 \ m = 0.0625 \text{ mol } CH_3OH$$

$$m = 0.0625 \text{ mol} \times 32.04 \text{ g/mol} = 2.00 \text{ g } CH_3OH$$