REVIEW QUESTIONS

Chapter 14

1. Calculate the mass % of the following solutions:
   a) 25 g KCl in 125 g of water

   mass of solution = 25 g + 125 g = 150 g

   $$\% = \frac{25\text{ g}}{150\text{ g}} \times 100 = 17\%$$

   b) 2.0 g of KOH in 20.0 g of water

   mass of solution = 2.0 g + 20.0 g = 22.0 g

   $$\% = \frac{2.0\text{ g}}{22.0\text{ g}} \times 100 = 9.1\%$$

2. How many grams of solute are present in 175 g of 1.80% (m/m) solution of NaCl?

$$175\ \cancel{\text{g solution}} \times \frac{1.80\text{ g NaCl}}{100\ \cancel{\text{g solution}}} = 3.15\text{ g NaCl}$$

3. Calculate the molarity of the following solutions:
   a) 2.0 mol of glucose in 400. mL of solution.

   $$\text{Molarity} = \frac{2.0\text{ mol}}{0.400\text{ L}} = 5.0\text{ M}$$

   b) 4.0 g of KOH in 2.0 L of solution.

   $$4.0\ \cancel{\text{g}}\ \text{KOH} \times \frac{1\text{ mol}}{56.1\ \cancel{\text{g}}} \times \frac{1}{2.0\text{ L}} = 0.036\text{ M}$$

4. Calculate the grams of solute needed to prepare 2.0 L of 1.5 M NaOH solution.

$$2.0\ \cancel{\text{L}} \times \frac{1.5\ \cancel{\text{mol}}}{1\ \cancel{\text{L}}} \times \frac{40.0\text{ g}}{1\ \cancel{\text{mol}}} = 120\text{ g}$$

5. How many grams of $AgNO_3$ are needed to prepare 1500. mL of a 0.240 M solution?

$$1500.\ \cancel{mL} \times \frac{1\ \cancel{L}}{10^3\ \cancel{mL}} \times \frac{0.240\ \cancel{mol}}{1\ \cancel{L}} \times \frac{169.9\ g}{1\ \cancel{mol}} = 61.2\ g$$

6. What volume of 0.300 M KCl will contain 15.3 g of KCl?

$$15.3\ \cancel{g}\ KCl \times \frac{1\ \cancel{mol}}{74.55\ \cancel{g}} \times \frac{1\ \cancel{L}}{0.300\ \cancel{mol}} \times \frac{10^3\ mL}{1\ \cancel{L}} = 684\ mL$$

7. A patient received 2.0 g of NaCl in 8 hours. How many mL of a 0.90% (m/m) NaCl (saline) solution were delivered to the patient? Density of solution is 1.05 g/mL.

$$2.0\ \cancel{g\ NaCl} \times \frac{100\ \cancel{g}\ solution}{0.90\ \cancel{g\ NaCl}} \times \frac{1\ mL}{1.05\ \cancel{g}} = 210\ mL$$

8. Calculate the freezing point of a solution prepared by dissolving 35.0 g of K_2SO_4 in 1000. g of water. ($K_f = 1.86$ °C/m)

$$K_2SO_4 \xrightarrow{H_2O} 2\ K^+ + SO_4^{2-} \qquad i = 3$$

$$\text{mol solute} = 35.0\ \cancel{g} \times \frac{1\ mol}{174.2\ \cancel{g}} = 0.201\ mol$$

$$\text{molality of solution} = \frac{0.201\ mol}{1.000\ kg} = 0.201\ m$$

$$\Delta T_f = i\ m\ K_f = (3)(0.201\ \cancel{m})(1.86\ ^\circ C/\cancel{m}) = 1.12\ ^\circ C$$

$$\text{Freezing point } (T_f) = 0.00 - 1.12 = -1.12\ ^\circ C$$

9. A solution is prepared by dissolving 5.00 g of NaCl in 25.0 g of water.
   a) Calculate the mass % of NaCl in this solution.

$$\% = \frac{5.00\text{ g}}{5.00\text{ g} + 25.0\text{ g}} \text{x}100 = 16.7\%$$

   b) Calculate the molality of this solution.

$$\text{mol NaCl} = 5.00 \cancel{\text{g}} \text{ x } \frac{1\text{ mol}}{58.45 \cancel{\text{g}}} = 0.0855\text{ mol}$$

$$\text{molality} = \frac{0.0855\text{ mol}}{0.0250\text{ kg}} = 3.42\text{ m}$$

   c) Calculate the boiling point and freezing points of this solution.
   K_b=0.512 °C/m and K_f=1.86 °C/m

$$NaCl\,(s) \rightarrow Na^+\,(aq) + Cl^-\,(aq) \qquad i = 2$$

$$\Delta T_b = i\text{ m } K_b = 2\,(3.42\text{ m})(0.512\text{ °C/m}) = 3.50\text{ °C}$$

$$T_b = 100.00 + 3.50 = 103.50\text{ °C}$$

$$\Delta T_f = i\text{ m } K_f = 2\,(3.42\text{ m})(0.1.86\text{ °C/m}) = 12.7\text{ °C}$$

$$T_f = 0.00 - 12.7 = -12.7\text{ °C}$$

10. A solution of antifreeze contains 25% by mass ethylene glycol ($C_2H_6O_2$) in water. Calculate the boiling point and freezing point for this solution.

$$25\% = \frac{25\text{ g } C_2H_6O_2}{100\text{ g sol'n}}$$

$$\text{mol solute} = 25 \cancel{\text{g}} \text{ x } \frac{1\text{ mol}}{62.1 \cancel{\text{g}}} = 0.40\text{ mol}$$

$$\text{mass of solvent} = 100\text{ g} - 25\text{ g} = 75\text{ g}$$

$$\text{molality} = \frac{0.40\text{ mol}}{0.075\text{ kg}} = 5.3\text{ m}$$

$$\Delta T_b = mK_b = (5.3\text{ m})(0.512\ ^\circ\text{C/m}) = 2.7\ ^\circ\text{C} \qquad T_b = 102.7\ ^\circ\text{C}$$

$$\Delta T_f = mK_f = (5.3\text{ m})(1.86\ ^\circ\text{C/m}) = 9.9\ ^\circ\text{C} \qquad T_f = -9.9\ ^\circ\text{C}$$

11. How many grams of ethyl alcohol (C_2H_5OH) are needed to drop the freezing temperature of 2.0 L of water to –10.0 °C? (K_f = 1.86 °C/m; 1 L water = 1 kg)

$$\Delta T_f = 10.0\ ^\circ C$$

$$m = \frac{\Delta T_f}{K_f} = \frac{10.0\ ^\circ C}{1.86\ ^\circ C/m} = 5.38\ m$$

$$m = \frac{\text{mol solute}}{\text{kg solvent}}$$

mol solute = m x kg solvent = 5.38 m x 2.0 kg = $1\underline{0}.76$ mol

$$\text{mass of solute} = 1\underline{0}.76\ \cancel{\text{mol}} \times \frac{46\ \text{g}}{1\ \cancel{\text{mol}}} = 490\ \text{g}$$

12. Which of the following solutions will have the greatest osmotic pressure? Explain.

osmolarity = i x M

0.25 M $C_6H_{12}O_6$	**1 x 0.25 M = 0.25 osmol**
0.15 M NaCl	**2 x 0.15 M = 0.30 osmol**
0.15 M $CaCl_2$	**3 x 0.15 M = 0.45 osmol**

The greater the osmolarity of a solution, the greater its osmotic pressure. Therefore, $CaCl_2$ solution would have the greatest osmotic pressure.

13. Calculate the freezing point of an aqueous solution that boils at 102.5 °C.

$$\Delta T_b = 2.5\ ^\circ C$$

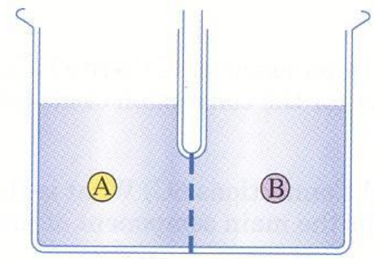
$$m = \frac{\Delta T_b}{K_b} = \frac{2.5\ ^\circ C}{0.512\ ^\circ C/m} = 4.\underline{8}8\ m$$

$$\Delta T_f = m\,K_f = (4.\underline{8}8\ m)(1.86\ ^\circ C/m) = 9.1\ ^\circ C$$

$$T_f = -9.1\ ^\circ C$$

14. Two solutions, A and B, are separated by a semipermeable membrane as shown below. For each case below, determine which side rises due to osmotic pressure.

	A	osmol	B	osmol
a)	0.1M glucose	**0.1**	**0.5M glucose**	**0.5**
b)	**1M NaCl**	**2**	0.5M K_2SO_4	**1.5**
c)	0.5M KCl	**1.0**	0.5M KBr	**1.0**
d)	**0.1M NaCl**	**0.2**	0.1M glucose	**0.1**



In each case, the side with the higher osmolarity rises.

Note that in (c), no side rises since osmolarity is equal in both sides.

15. Complete the equations below when each soluble ionic salt dissolves in water, and determine the ***i*** value for each:

a) $Ca(OH)_2\ (s) \xrightarrow{H_2O} \mathbf{Ca^{2+} + 2\ OH^-}$ $\quad$ $\boldsymbol{i = 3}$

b) $NaC_2H_3O_2\ (s) \xrightarrow{H_2O} \mathbf{Na^+ + C_2H_3O_2^-}$ $\quad$ $\boldsymbol{i = 2}$

c) $NH_4Cl\ (s) \xrightarrow{H_2O} \mathbf{NH_4^+ + Cl^-}$ $\quad$ $\boldsymbol{i = 2}$

d) $Li_2CO_3\ (s) \xrightarrow{H_2O} \mathbf{2\ Li^+ + CO_3^{2-}}$ $\quad$ $\boldsymbol{i = 3}$

e) $Na_3PO_4\ (s) \xrightarrow{H_2O} \mathbf{3\ Na^+ + PO_4^{3-}}$ $\quad$ $\boldsymbol{i = 4}$

16. In winter, after a snowstorm, salt (NaCl) is spread to melt the ice on the road. How many grams of salt must be added to 1000. g of ice to decrease its freezing point to –5.0 °C? (K_f = 1.86 °C/m)

$$\mathbf{NaCl \xrightarrow{H_2O} Na^+ + Cl^-} \qquad \mathbf{i = 2}$$

$$\mathbf{\Delta T_f = i\ m\ K_f} \qquad \mathbf{m = \frac{\Delta T_f}{i\ K_f} = \frac{5.0\ ^\circ\cancel{C}}{2\ (1.86\ m/^\circ\cancel{C})} = 1.3\underline{4}4\ m}$$

$$\mathbf{molality = \frac{mol\ solute}{1.000\ kg}} \qquad \mathbf{mol\ solute = (1.3\underline{4}4\ m)\ (1.000\ kg) = 1.3\underline{4}4\ mol}$$

$$\mathbf{mass\ solute = 1.3\underline{4}4\ \cancel{mol} \times \frac{58.45\ g}{1\ \cancel{mol}} = 78.6\ g}$$

17. For each pair of solutions listed below, determine which will have the higher boiling point:

osmol 3.0 2.0

a) **1.5 M NaCl** and 0.5 M $Al(NO_3)_3$

osmol 4.0 2.0

b) **2.0 M NaOH** and 2.0 M $C_6H_{12}O_6$

osmol 1.2 1.4

c) 0.4 M Na_2CO_3 and **0.7 M KCl**

Solutions with higher osmolarities will have the higher boiling points

18. Both methanol (CH_3OH) and ethylene glycol ($C_2H_6O_2$) are used as antifreeze. Which is more effective–that is, which produces a lower freezing point if equal amounts of each are added to the same amount of water?

Methanol would be more effective as antifreeze because it has a lower molar mass (32.0 g/mol) compared with ethylene glycol (62.1 g/mol), therefore producing more moles per gram of solute.