Name _____ Date _____ Period _____

Liquids and Concentration Review

1. Compare a polar water molecule with a less-polar molecule, such as formaldehyde, CH_2O. Both liquids are at room temperature and 1 atm.

water a. Which liquid should have a higher surface boiling point?
CH_2O b. Which is more volatile?
water c. Which liquid has a higher surface tension?
CH_2O d. Which diffuses more rapidly?
water e. In which liquid is NaCl, an ionic crystal, likely to be more soluble?

2. The heat of fusion of ice is 6.009 kJ/mol.
   a. How much heat is needed to melt 12.0 g of ice?

$$12.0\text{g } H_2O(s) \times \frac{1\text{ mol}}{18.02\text{g}} \times \frac{6.009\text{ kJ}}{1\text{ mol}} = 4.00\text{ kJ}$$

   b. Determine the heat of fusion of ice in calories/gram.

$$\frac{1.009\text{ kJ}}{\text{mol}} \times \frac{1\text{ mol}}{18.02\text{g}} \times \frac{1000\text{ J}}{1\text{ kJ}} \times \frac{1\text{ g}}{4.18\text{ J}} = 79.78 \text{ calories/gram}$$

3. Freon-11, CCl_3F, has been commonly used in air conditioners. Its heat of vaporization is 24.8 kJ/mol at its normal boiling point of 24°C. How much heat is removed from a room by an air conditioner that evaporates 1.00kg of Freon-11?

$$1.00\text{ kg} \times \frac{1000\text{g}}{1\text{kg}} \times \frac{1\text{ mol}}{137.36\text{g}} \times \frac{24.8\text{ kJ}}{1\text{ mol}} = 181\text{ kJ } CCl_3F$$

4. The heat of molar vaporization of methane, CH_4, is 8.19 kJ/mol; for water, it is 40.79 kJ/mol.
   a. If 2.0×10^{23} molecules of liquid CH_4 are made to boil, how much heat must be supplied? Show your work.

$$2.0 \times 10^{23}\text{ molecules } CH_4 \times \frac{1\text{ mol } CH_4}{6.02 \times 10^{23}\text{ molecules}} \times \frac{8.19\text{ kJ}}{1\text{ mol}} = 2.7\text{ kJ}$$

   b. Based on the molar heat of vaporization data, which is more volatile, CH_4 or H_2O?

CH_4 is more volatile b/c it takes less energy to vaporize.

   c. Which molecule is more polar, CH_4 or H_2O?

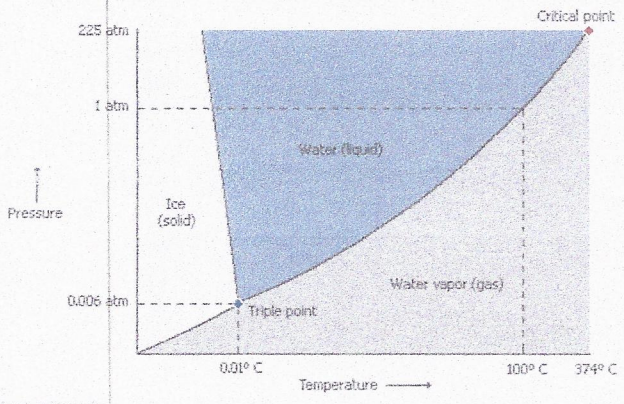
H_2O

5. Methanol has a normal boiling point of 65° C. It is a liquid at conditions of 1 atm and 25° C. A small beaker filled with methanol is placed under a bell jar, and the air is then pumped out. It is observed that under a vacuum the methanol boils readily at 25° C.

Use the kinetic-molecular theory and the concept of equilibrium vapor pressure to account for the lowered boiling point of methanol under a vacuum.

pressure inside the bell jar decreases which lowers the boiling point of the methanol

6. Refer to the phase diagram for water to answer the following questions:



a. Which point represents the conditions under which all three phases coexists?

triple point

b. Based on the diagram, as the pressure on the water system is increased, the melting point of ice ----- (increases, decreases, or stays the same).

decreases

7. Describe the errors made by the following students in making molar solutions.

a. James needs a 0.600 M solution of KCL. He measures out 0.600 g of KCL and adds 1 L of water to the solid. 1L of water added to 0.600g KCl would cause the volume of solution to be larger than 1L, hence decrease molarity

b. Mary needs a 0.02 M solution of NaNO3. She calculates that she needs 2.00 g of $NaNO_3$ for 0.02 mol. She puts this solid into a 1.00 L volumetric flask and fills the flask to the 1.00 L mark.

$0.02\,M = \frac{x}{1\,L}$

$0.02 \text{ moles} = x$

$0.02 \text{ moles } NaNO_3 \times \frac{85.00\,g}{1 \text{ mole}} = 1.7\,g\ NaNO_3$

needs 1.7g and not 2.00 g.

PROBLEMS Show all your work in the space provided.

8. What is the molarity of a solution made by dissolving 2.0 mol of solute in 6.0 L of ~~solvent?~~ solution

$M = \frac{2.0 \text{ mol}}{6.0\,L} = 0.33\,M$

9. CH_3OH is soluble in water. What is the molality of a solution made by dissolving 8.0 g of CH_3OH in 250. g of water?

$\text{molality} = \frac{\text{moles solute}}{\text{kg solvent}}$

$\frac{0.25 \text{ CH}_3\text{OH}}{0.250\ \text{kg } H_2O} = 1.0\,m$

$8.0\,g \times \frac{1 \text{ mole}}{32.04\,g} = 0.25$

10. Marble chips effervesce when treated with acid. This reaction is represented by the following equation:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

To produce a reaction, 25.0 mL of 4.0 M HCl is added to excess CaCO3.

a. How many moles of HCl are consumed in this reaction?

$0.0250\,L\ HCl \times \frac{4.0\ moles}{1\,L} = 0.100\ moles\ HCl$

b. How many liters of CO_2 are produced at STP?

$0.100\ moles\ HCl \times \frac{1\ mol\ CO_2}{2\ mol\ HCl} \times \frac{22.4\,L\ CO_2}{1\ mol} = 1.12\,L\ CO_2$

c. How many grams of $CaCO_3$ are consumed?

$0.100\ moles\ HCl \times \frac{1\ mol\ CaCO_3}{2\ mol\ HCl} \times \frac{100.09\,g}{1\ mol\ CaCO_3} = 5.009\,g\ CaCO_3$

11. 10.0 g of Iodine, $I_2(s)$, dissolved in 1000. g of ethanol, C_2H_5OH.

a. How many grams of solvent are present in 1000. g of this solution?

$10.0g + 1000.g = 1010\,g$ solution

$\frac{1000\,g}{1010\,g\ solution} = \frac{x}{1000.g}$ $\quad x = 990\,g$ solvent

b. 10.0g of I_2 represent how many moles of solute?

$10.0\,g\ I_2 \times \frac{1\ mol\ I_2}{253.82\,g\ I_2} = 0.0394\ mol\ I_2$

c. What is the molality of this 1% solution?

$m = \frac{0.0394\ moles\ I_2}{1\,kg\ C_2H_5OH} = 0.0394\,m$