2018-Spring semester: General Chemistry (034.020-005): Chapter 9 and 10 Practice

Due by 9:30 am on 2018-5-24

1. Which do you expect to have the higher vapor pressure at room temperature, (a) ammonia (NH_3), or phosphine (PH_3) (b) tetrabromomethane (CBr_4) or tetramchloromethane (CCl_4) (c) CH_3CHO or $CH_sCH_2CH_3$? Why?

2. The enthalpy of vaporization of tetrachloromethane (CCl_4) is 33.05 kJ/mol, and its vapor pressure at 57.8 °C.is 405 Torr. What is the vapor pressure of tetrachloromethane at 25.0 °C?

3. You have made up a solution of known **molarity** but now realize that you need to know the **molality** instead. Find the **molality** of sucrose, $C_{12}H_{22}O_{11}$, in 1.06 M $C_{12}H_{22}O_{11}$(aq), which is known to have density 1.130 g/ml.

4. Calculate (a) the molality of chloride ions in an aqueous solution of magnesium chloride in which x_{MgCl2} = 0.0120 (b) the molality of 6.75 g of sodium hydroxide dissolved in 325 g of water (c) molality of 15.00 M HCl (aq) with a density of 1.0745 g/cm^3.

5. At 25 °C, the vapor pressure of pure benzene is P_1^o = 0.1252 atm. Suppose 6.40 g of naphthalene, $C_{10}H_8$, is dissolved in 78.0 g of benzene (C_6H_6). Calculate the vapor pressure of benzene over the solution, assuming ideal behavior.

6. The osmotic pressure of 3.0 g of polystyrene dissolved in enough benzene to produce 150 mL of solution was 1.21 kPa at 25 °C. Calculate the average molar mass of the sample of polystyrene.

7. A sample of ozone, O_3, amounting to 0.10 mol, is placed in a sealed container of volume 1.0 L and the reaction $2\ O_3\ (g) \rightarrow 3\ O_2\ (g)$ is allowed to reach equilibrium. Then 0.50 mol O_3 is placed in a second container of volume 1.0 L at the same temperature and allowed to reach equilibrium. Without doing any calculations, predict which of the following will be different in the two containers at equilibrium and which will be the same? (a) amount of O_2 (b) partial pressure of O_2 (c) the ratio P_{O2}/P_{O3} (d) the ratio $(P_{O2})^3/(P_{O3})^2$ (e) the ratio $(P_{O3})^2/(P_{O2})^3$.

8. Calculate the reaction Gibbs free energy of $I_2\ (g) \rightarrow 2I\ (g)$ at 1200. K (K=6.8) when the partial pressures of I_2 and I are 0.13 bar and 0.98 bar, respectively. Also indicate whether the reaction mixture is likely to form reactants or to form product or is at equilibrium.

9. For the reaction $H_2\ (g) + I_2\ (g) \rightleftharpoons 2HI\ (g)$, K = 160 at 500 K. An analysis of a reaction mixture at 500 K showed that it had the composition P_{H2} = 0.20 bar, P_{I2} = 0.10 bar, and P_{HI} = 0.10 bar. When you calculate the reaction quotient (Q), is the reaction mixture at equilibrium? If not, is there a tendency to form more reactants or more products?

10. Sulfuryl chloride (SO_2Cl_2) is a colorless liquid that boils at 69 °C. Above this temperature, the vapors dissociate into sulfur dioxide and chlorine: $SO_2Cl_2\ (g) \rightleftharpoons SO_2\ (g) + Cl_2\ (g)$ This reaction is slow at 100 °C, but it is accelerated by the presence of some $FeCl_3$ (which does not affect the final position of the equilibrium). In an experiment, 3.174 g of SO_2Cl_2 (l) and a small amount of solid $FeCl_3$ are put into an evacuated 1.000 L flask, which is then sealed and heated to 100 °C. The total pressure in the flask at that temperature is found to be 1.30 atm.

(a) Calculate the partial pressure of each of the three gases present.

(b) Calculate the equilibrium constant at this temperature.