Worksheet 4

1. At 298 K, F_3SSF (*g*) decomposes partially to SF_2 (*g*). At equilibrium, the partial pressure of SF_2 (*g*) is 1.1×10^{-4} atm and the partial pressure of F_3SSF is 0.0484 atm.
(a) Write a balanced equilibrium equation to represent this reaction.
(b) Compute the equilibrium constant corresponding to the equation you wrote.

2. Isopropyl alcohol can dissociate into acetone and hydrogen via the following reaction

$$(CH_3)_2CHOH\ (g) \leftrightharpoons (CH_3)_2CO\ (g) + H_2\ (g)$$

At 179°C, the equilibrium constant for this dehydrogenation reaction is 0.444.
(a) If 10.00 g of isopropyl alcohol is placed in a 10.00-L vessel and heated to 179°C, what is the partial pressure of acetone when equilibrium is attained?
(b) What fraction of isopropyl alcohol is dissociated at equilibrium?

3. The equilibrium constant the reaction

$$H_2S\ (g) + I_2\ (g) \leftrightharpoons 2\ HI\ (g) + S\ (s)$$

at 110°C is equal to 0.0023. Calculate the reaction quotient *Q* for each of the following conditions and determine whether solid sulfur is consumed or produced as the reaction comes to equilibrium.
(a) $P_{I2} = 0.461$ atm; $P_{H2S} = 0.050$ atm; $P_{HI} = 0.0$ atm
(b) $P_{I2} = 0.461$ atm; $P_{H2S} = 0.050$ atm; $P_{HI} = 9.0$ atm

4. Methanol is made via the exothermic reaction

$$CO\ (g) + 2\ H_2\ (g) \rightharpoonup CH_3OH\ (g)$$

Describe how you would control the temperature and pressure to maximize the yield of methanol.

5. Barium nitride vaporizes slightly at high temperature as it undergoes the dissociation

$$Ba_3N_2\ (s) \leftrightharpoons 3\ Ba\ (g) + N_2\ (g)$$

At 1000 K the equilibrium constant is 4.5×10^{-19}. At 1200 K the equilibrium constant is 6.2×10^{-12}.
(a) Estimate $\Delta H°$ for the reaction.
(b) The equation is rewritten as

$$2\ Ba_3N_2\ (s) \leftrightharpoons 6\ Ba\ (g) + 2\ N_2\ (g)$$

Now the equilibrium constant is 2.0×10^{-37} at 1000 K and 3.8×10^{-23} at 1200 K. Estimate $\Delta H°$ of *this* reaction.

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6. At 300°C the equilibrium constant for the reaction

$$PCl_5\,(g) \leftrightharpoons PCl_3\,(g) + Cl_2\,(g)$$

is K = 11.5.
(a) Calculate the reaction quotient *Q* if initially P_{PCl3} = 2.0 atm, P_{Cl2} = 6.0 atm, and P_{PCl5} = 1.0 atm. State whether the reaction proceeds to the right or to the left as equilibrium is approached.
(b) Calculate P_{PCl3}, P_{Cl2}, and P_{PCl5} at equilibrium.
(c) If the volume of the system is then increased, will the amount of PCl_5 present increase or decrease?

7. A treatment recommended in case of accidental swallowing of ammonia-containing cleanser is to drink large amounts of diluted vinegar. Write an equation for the chemical reaction on which this procedure depends.

8. Zinc oxide is amphoteric. Write balanced chemical equations for its reactions with an aqueous solution of hydrochloric acid and with an aqueous solution of sodium hydroxide. (Note: The hydroxide complex ion of zinc is $[Zn(OH)_4]^{2-}$)

9. The concentration of OH^- in a solution of household bleach is 3.6×10^{-2} M. Calculate the pH of the bleach.

10. At body temperature (98.6°F = 37.0°C), K_w has the value 2.4×10^{-14}. If the pH of blood is 7.4 under these conditions, what are the concentrations of H_3O^+ and OH^-?

11. Niacin (C_5H_4NCOOH), one of the B vitamins, is an acid.
(a) Write an equation for its equilibrium reaction with water.
(b) The K_a for niacin is 1.5×10^{-5}. Calculate the K_b for its conjugate base.
(c) Is the conjugate base of niacin a stronger or a weaker base than pyridine, C_5H_5N?

12. Vitamin C is ascorbic acid ($HC_6H_7O_6$), for which K_a is 8.0×10^{-5}. Calculate the pH of a solution made by dissolving a 500-mg tablet of pure vitamin C in water and diluting to 100 mL.

13. Methylamine is a weak base for which K_b is 4.4×10^{-4}. Calculate the pH of a solution made by dissolving 0.070 mol of methylamine in water and diluting to 800.0 mL.

14. A 75.00 mL portion of a solution that is 0.0460 M in $HClO_4$ is treated with 150.00 mL of 0.0230 M KOH (*aq*). Is the pH of the resulting mixture greater than, less than, or equal to 7.0? Explain.