CH302H – Principles of Chemistry II: Honors
Fall 2016, Unique 49420

Homework, Week 4

1. The water-gas shift reaction is an important industrial source of pure $H_2(g)$ for ammonia synthesis:

$$CO(g) + H_2O(g) \leftrightarrow H_2(g) + CO_2(g)$$

What would happen to the equilibrium concentration of each species if you increase the total pressure of the system by a factor of 100?

2. Under certain conditions, water vapor dissociates into $H_2(g)$ and $O_2(g)$. At 2100 K and 1 bar, the equilibrium constant for the dissociation reaction is twice as large as at 2000 K and 1 bar. Determine the enthalpy of the dissociation reaction, assuming it is constant over this temperature range.

3. Dimethyl ether can be made from the dimerization of methanol:

$$2\ CH_3OH(g) \rightarrow (CH_3)_2O(g) + H_2O(g)$$

Describe, both quantitatively and qualitatively, the optimum conditions of pressure and temperature to make as much of this chemical as possible.

4. A flask is filled with 1.32 atm of $H_2(g)$ and 1.14 atm of $I_2(g)$, sealed, and heated to 600 K, where they react to form HI(g).

a) Write the stoichiometrically balanced reaction.

b) Write the equilibrium constant expression for the reaction in part a).

c) How much $H_2(g)$, $I_2(g)$, and HI(g) are present at equilibrium?

d) What fraction of the $I_2(g)$ originally introduced to the flask has reacted when equilibrium is reached?

5. Write the equilibrium expressions for the following reactions.

a) $8\ H_2(g) + S_8(s) \rightarrow 8H_2S(g)$

b) $C(s) + H_2O(l) + Cl_2(g) \rightarrow COCl_2(g) + H_2(g)$

c) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

d) $3\ C_2H_2(g) \rightarrow C_6H_6(l)$

6. Given the following two reactions, with equilibrium constants K_1 and K_2:

Reaction 1: $XeF_6(g) + H_2O(g) \rightarrow XeOF_4(g) + 2\ HF(g)$
Reaction 2: $XeO_4(g) + XeF_6(g) \rightarrow XeOF_4(g) + XeO_3F_2(g)$

Determine the equilibrium constant for the following reaction:

$XeO_4(g) + 2\ HF(g) \rightarrow XeO_3F_2(g) + H_2O(g)$

In terms of K_1 and K_2.