G12 Chemistry: Class 11 Homework

1. Iodine and bromine react to form iodine monobromide, IBr. **[5 marks]**

$$I_2(g) + Br_2(g) \rightleftharpoons 2IBr(g)$$

At 250°C, an equilibrium mixture in a 2.0 L flask contained 0.024 mol of $I_2(g)$, 0.050 mol of $Br_2(g)$, and 0.38 mol of IBr(g). What is the value of K_{eq} for the reaction at 250°C?

2. At high temperatures, carbon dioxide gas decomposes into carbon monoxide and oxygen gas. At equilibrium, the gases have the following concentrations: $[CO_2(g)]$ = 1.2 mol/L, $[CO(g)]$ = 0.35 mol/L, and $[O_2(g)]$ = 0.15 mol/L. Determine K_{eq} at the temperature of the reaction. **[3 marks]**

3. Phosphorus trichloride reacts with chlorine to form phosphorus pentachloride.

$$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$$

0.75mol of PCl_3 and 0.75mol of Cl_2 are placed in an 8.0L reaction vessel at 500K. What is the equilibrium concentration of the mixture? The value of K_c at 500K is 49. **[7 marks]**

4. Hydrogen gas has several advantages and disadvantages as a potential fuel. Hydrogen can be obtained by the thermal decomposition of water at high temperatures. **[7 marks]**

$$2H_2O(g) \rightleftharpoons 2H_2(g) + O_2(g) \qquad K_{eq} = 7.3 \times 10^{-18} \text{ at } 1000°C?$$

   a) The initial concentration of water in a reaction vessel is 0.055 mol/L. What is the equilibrium concentration of $H_2(g)$ at 1000°C?
   b) Comment on the practicality of the thermal decomposition of water to obtain $H_2(g)$.

5. A chemist was studying the following reaction.

$$SO_2(g) + NO_2(g) \rightleftharpoons NO(g) + SO_3(g)$$

   In a 1.0 L container, the chemist added 1.7×10^{-1} mol of $SO_2(g)$ to 1.1×10^{-1} mol of $NO_2(g)$. The value of K_{eq} for the reaction at a certain temperature is 4.8. What is the equilibrium concentration of $SO_3(g)$ at this temperature? **[5 marks]**

6. In which direction does the equilibrium shift as a result of the change to each homogenous equilibrium system? **[5 marks]**

   a. Adding $Cl_2(g)$: $2Cl_2(g) + O_2(g) \rightleftharpoons 2Cl_2O(g)$

   b. Removing $N_2(g)$: $2NO_2(g) \rightleftharpoons N_2(g) + 2O_2(g)$

   c. Using a catalyst: $CH_4(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

   d. Decreasing the total volume of the reaction container: $2NO_2(g) \rightleftharpoons N_2O_4(g)$

   e. Increasing the temperature: $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$ $\Delta H = -230kJ$

7. Toluene C_7H_8 is an important organic solvent. It is made industrially from methyl cyclohexane.

$$C_7H_{14}(g) \rightleftharpoons C_7H_8(g) + 3H_2(g)$$

   The forward reaction is endothermic. State three different changes to an equilibrium mixture of these reacting gases that would shift the equilibrium toward greater production of toluene. **[3 marks]**

8. Calculate the equilibrium concentrations of N_2O_4 and NO_2 at 25°C in a vessel that contains an initial N_2O_4 concentration of 0.0500M. The equilibrium constant K_{eq} for the reaction is 4.64×10^{-3} at 25°C. **[6 marks]**

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

9. Calculate the equilibrium concentrations at 25°C for the reaction in Question (8) for initial concentrations of $[N_2O_4]$=0.0200M and $[NO_2]$=0.0300M. **[6 marks]**

10. The equilibrium constant K_{eq} for the reaction is 6.9×10^5 at 500K.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$$

A 5.0L reaction vessel at this temperature was filled with 0.060mol of NO, 1.0mol of O_2 and 0.80mol of NO_2. **[7 marks]**

a) Is the reaction mixture at equilibrium? If not, in which direction does the net reaction proceed?
b) What is the direction of the net reaction if the initial amounts are 5.0×10^{-3} mol of NO, 0.20mol of O_2 and 4.0mol of NO_2?