Name Answer Key Hour _____

Equilibrium Calculations

Honors Chemistry

1. Write the expression and calculate the K_{eq}: $SO_3(g) + H_2O(g) \rightleftharpoons H_2SO_4(l)$
   - $[SO_3] = 0.400\text{-}M$, $[H_2O] = 0.480\text{-}M$, $[H_2SO_4] = 0.600\text{-}M$

$$K_{eq} = \frac{1}{[SO_3]^1 \times [H_2O]^1} = \frac{1}{[.40]^1 \times [.48]^1} = 5.21$$

2. Write the expression and calculate the K_{eq}: $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$
   - $[H_2] = 0.010\text{-}M$, $[Cl_2] = 0.010\text{-}M$, $[HCl] = 0.0001\text{-}M$

$$K_{eq} = \frac{[HCl]^2}{[H_2]^1 \times [Cl_2]^1} = \frac{[.0001]^2}{[.01]^1 \times [.01]^1} = .0001$$

3. Write the expression and calculate the K_{eq}: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
   - $[N_2] = 0.044\text{-}M$, $[H_2] = 0.012\text{-}M$, $[NH_3] = 0.0034\text{-}M$

$$K_{eq} = \frac{[NH_3]^2}{[N_2] \times [H_2]^3} = \frac{[.0034]^2}{[.044]^1 \times [.012]^3} = 152.0$$

4. Write the expression and calculate the K_{eq}: $2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$
   - $[CO] = 0.5\text{-}M$, $[O_2] = 0.5\text{-}M$, $[CO_2] = 2.5\text{-}M$

$$K_{eq} = \frac{[CO_2]^2}{[CO]^2 \times [O_2]} = \frac{[2.5]^2}{[.5]^2 \times [.5]} = 50$$

5. Write the expression and calculate the K_{eq}: $PCl_5(s) + H_2O(g) \rightleftharpoons 2HCl(g) + POCl_3(g)$
   - a 2.0-L flask contains 0.075 mol of PCl_5, 0.050 mol of H_2O, 0.750 mol of HCl, and 0.500 mol of $POCl_3$

$$K_{eq} = \frac{[HCl]^2 \times [POCl_3]}{[H_2O]} = \frac{[.375]^2 \times [.25]^1}{[.025]} = 1.41$$

Find M

$HCl = .375\text{-}M$

$POCl_3 = .25\text{-}M$

$H_2O = .025\text{-}M$

6. At 25°C, the K_{eq}= 798 for the following reaction: $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$
   - Calculate the equilibrium concentration of $[O_2]$ in a container of $[SO_2]$ = 4.20-*M* and $[SO_3]$ =11.0-*M*

$$K_{eq} = \frac{[SO_3]^2}{[SO_2]^2 \times [O_2]} \qquad 798 = \frac{[11.0]^2}{[4.20]^2 \times [O_2]} \qquad O_2 = \frac{[11.0]^2}{798 \times [4.20]^2}$$

$O_2 = .0086\text{-}M$

7. At 100°C, the K_{eq}=680 for a the following reaction: $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$
   - Calculate the equilibrium concentration of $[SO_3]$ in a 4.0-L container with 0.6 mol of SO_2 and 0.6 mol of O_2

Molarity

SO_3 = ?

SO_2 = .15-M

O_2 = .15-M

$$680 = \frac{[SO_3]^2}{[.15]^2 \times [.15]} \qquad [SO_3]^2 = 680 \times [.15]^2 \times [.15]$$

$[SO_3]^2 = 2.295$

$SO_3 = 1.51\text{-}M$

8. At 250°C, the K_{eq}= 55.6 for the following reaction: $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
   - Calculate the equilibrium concentration of [HI] in a container of $[H_2]$ = 0.20-*M* and $[I_2]$ =0.20-*M*

$$55.6 = \frac{[HI]^2}{[H_2] \times [I_2]} = \frac{[HI]^2}{[.2] \times [.2]} \qquad [HI]^2 = 55.6 \times [.2] \times [.2]$$

$[HI]^2 = 2.224$

$HI = 1.49\text{-}M$

9. At a certain temperature, the K_{eq}=14 for the following reaction: $H_2(g) + S(s) \rightleftharpoons H_2S(g)$
   - Calculate the equilibrium concentration of $[H_2]$ in a 2.0-L container with 0.6 mol of H_2s and 1.4 mol of S

Molarity

H_2S = .3-M

S = Solid

$$14 = \frac{[H_2S]}{[H_2]} = \frac{[.3]}{[H_2]} \qquad [H_2] = \frac{[.3]}{14}$$

$H_2 = .02\text{-}M$

10. At 100°C, the K_{eq}=1.47 x 10^{-3} for a the following reaction: $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$
    - Calculate the equilibrium concentration of $[SO_3]$ in a 2.0-L container with 4.0 mol of SO_2 and 5.0 mol of O_2

Molarity

SO_3 = ?

SO_2 = 2.0-M

O_2 = 2.5-M

$$1.47 \times 10^{-3} = \frac{[SO_2]^2 \times [O_2]}{[SO_3]^2} = \frac{[2.0]^2 \times [2.5]}{[SO_3]^2} \qquad [SO_3]^2 = \frac{[2.0]^2 \times [2.5]}{1.47 \times 10^{-3}}$$

$[SO_3]^2 = 6802.7$

$SO_3 = 82.5\text{-}M$