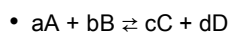


Introduction to Equilibrium

Equilibrium

- Chemical equilibrium – occurs when the [reactants] & [products] stop _____
- Equilibrium reactions are always denoted by _____

Equilibrium Expressions

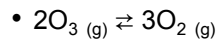


- $K_c =$

- K_c = equilibrium constant
- [] = concentration in molarity
- K_c is always the same at a specific temperature
- Solids & liquids do not have a [] & will therefore be left out of the K_c expressions

Equilibrium Expressions

- Write the equilibrium expressions for the following reactions...



Equilibrium Expressions

- Write the equilibrium expressions for the following reactions...
- $\text{H}_2(g) + \text{I}_2(g) \rightleftharpoons 2\text{HI}(g)$

Equilibrium Expressions

- Write the equilibrium expressions for the following reactions...
- $\text{FeO}(s) + \text{H}_2(g) \rightleftharpoons \text{Fe}(s) + \text{H}_2\text{O}(g)$

Heterogeneous / Homogeneous

- The reaction is _____ if all of the states are the same
- _____ if any of the states are different

Look at the last 3 reactions

- Tell if they are heterogeneous or homogeneous
- $2\text{O}_3(g) \rightleftharpoons 3\text{O}_2(g)$
- $\text{H}_2(g) + \text{I}_2(g) \rightleftharpoons 2\text{HI}(g)$
- $\text{FeO}(s) + \text{H}_2(g) \rightleftharpoons \text{Fe}(s) + \text{H}_2\text{O}(g)$

Equilibrium Constant in Terms of Pressure

- When the reactants & products are gases the k_{eq} will be in partial pressures not molarity
- K_p when using pressure
- $aA + bB \rightleftharpoons cC + dD$
- $K_p =$

Switching between k_c & k_p

- $K_p = k_c(RT)^{\Delta n}$
- $R = 0.0821$
- $T =$ temperature in Kelvin
- $\Delta n =$ change in moles
(# moles products - # moles reactants)

Switching between k_c & k_p

- $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
- Calculate k_p at $300^\circ C$ if $k_c = 9.60$

Magnitude of K_{eq}

- Will either be big or small
- Value of K_c will determine if the products or reactants are favored
- $CO + Cl_2 \rightleftharpoons COCl_2$
- $K_c = \frac{[COCl_2]}{[CO][Cl_2]} = 4.57 \times 10^9$

K_c is greater than 1

Therefore the [products] is greater than the [reactants]

So products are favored

Magnitude of K_{eq}

- $K_c > 1$ are favored
- $K_c < 1$ are favored

Magnitude of K_{eq}

- $N_2 (g) + O_2 (g) \rightleftharpoons 2NO (g)$
- $K_c = \frac{[NO]^2}{[N_2][O_2]} = 1 \times 10^{-30}$
- What is favored...products or reactants???

Direction of Equilibrium & k

- Equilibrium reactions occur in both directions
- $N_2 (g) + 3H_2 (g) \rightleftharpoons 2NH_3 (g)$
- $K_c =$
- $2NH_3 (g) \rightleftharpoons N_2 (g) + 3H_2 (g)$
- $K_c =$

Direction of Equilibrium & k

- The equilibrium constant in one direction is the _____ of the one in the reverse reaction
- $N_2O_4 \rightleftharpoons 2NO_2$ $K_c = 0.212$
- What is the K_c of ...
- $2NO_2 \rightleftharpoons N_2O_4$

Calculating Equilibrium Constants

- A mixture of N_2 gas and H_2 gas produce NH_3 gas and are allowed to come to equilibrium at 472°C . The equilibrium mixture was analyzed and found to contain 0.1207 M H_2 , 0.0402 M N_2 , & 0.00272 M NH_3 . Calculate K_c .

Calculating Equilibrium Constants

- $2\text{NO}_2\text{Cl} \rightleftharpoons 2\text{NO}_2 + \text{Cl}_2$
- At equilibrium the
- $[\text{NO}_2\text{Cl}] = 0.00106\text{ M}$
- $[\text{NO}_2] = 0.0108\text{ M}$
- $[\text{Cl}_2] = 0.00538\text{ M}$
- Calculate K_c

Calculating Equilibrium Constants

- $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
- $K_p = 1.45 \times 10^{-5}$
- At equilibrium $P_{\text{H}_2} = 0.928\text{ atm}$ & $P_{\text{N}_2} = 0.432\text{ atm}$. What is the P_{NH_3} ?

Calculating Equilibrium Constants

- $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$ $K_p = 0.497$
- At equilibrium $P_{\text{PCl}_5} = 0.860\text{ atm}$,
 $P_{\text{PCl}_3} = 0.350\text{ atm}$.
- Calculate P_{Cl_2}