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General Chemistry Review
Chapter 13 :
Chemical Equilibrium
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Chapter 13 – Chemical Equilibrium

⇒ **The Equilibrium Constant:**

- **K** is the equilibrium expression in terms of concentrations.
- **K_p** is the equilibrium expression in terms of the partial pressures of the gaseous constituents of the reaction

⇒ **Consider The Following Equilibria:**



⇒ **The Relationship Between K and K_p**

$$K_p = K(RT)^{\Delta n_g}$$

$$\Delta n_g = n_g (P) - n_g (R)$$



Using the value of K_p (3.9×10^4) from the previous example, **calculate the value of K at 35°C.**

$$K_p = K(RT)^{\Delta n_g}$$

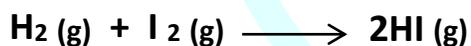
$$3.9 \times 10^4 = K(0.0821 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K} \times 308\text{K})^{2-4}$$

$$K = 2.5 \times 10^7$$

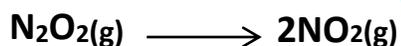
Note: $K_p < K$ (Δn_g is negative)

- $K_p = K(RT)^{\Delta n_g}$; $\Delta n_g = n_g(\text{P}) - n_g(\text{R})$

- $K_p = K$ when $\Delta n_g = 0$



- $K_p > K$ when $\Delta n_g > 0$



- If the equilibrium **lies to the right** (toward the products), the value for **K** is **Larger than 1**.
- If the equilibrium **lies to the left** (towards the reactants), the value for **K** is **Smaller than 1**.

⇒ Calculations:

At equilibrium: [C] = 3.0M

	$A_{(g)}$	+ 2 $B_{(g)}$	$C_{(g)}$
Initially:	8	10	0
Change:	-3	-6	+3
At equilibrium:	5	4	3

$$K = \frac{[C]}{[B]2[A]} = \frac{3}{4^2 \cdot 5} = 0.0375$$

Calculate K_p at 25 °C?

If the Initial concentrations are: 10.0 M Fe^{3+} and 8.00 M SCN^- , **What is the equilibrium concentration of $FeSCN^{2+}$ ($K=0.33333$)** The equilibrium reaction is shown below:

	$Fe^{3+}_{(aq)}$	+ $SCN^{-}_{(aq)}$	$FeSCN^{2+}_{(aq)}$
Initially:	10.0 M	8.0 M	0
At Equilibrium.:	(10.0 - x)	(8.0 - x)	x

$$K = \frac{x}{(8.0-x)(10.0-x)} = 0.3333 \quad 5.00 \text{ M } FeSCN^{2+}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

It is found that $x=5M$ so, At eq.: $[Fe^{3+}] = 10 - 5 = 5$, $[SCN] = 8 - 5 = 3$, $[FeSCN] = 5$

⇒ **Reaction Quotient, Q:**

- **Q = K;** The system is at equilibrium. No shift will occur.
 - **Q > K;** The system shifts to the **left. After equilibrium** ←
 - Consuming products and forming reactants, until equilibrium is achieved.
 - **Q < K;** The system shifts to the **right. Before equilibrium** →
 - Consuming reactants and forming products, to attain equilibrium.
- **Consider the reaction represented by the equation:**



- **Consider the following initial concentrations**

	Fe³⁺	SCN⁻	FeSCN⁺²	Q
Q1:	9.00 M	5.00 M	1.00 M	0.0222
Q2:	3.00 M	2.00 M	5.00 M	0.8333
Q3:	2.00 M	9.00 M	6.00 M	0.3333

K = 0.3333

Find the equilibrium concentrations for all species.

⇒ **Le Châtelier's Principle:**

- 1. Concentration:** The system will shift away upon addition of any component that is a part of the system. If a component is removed, the opposite effect occurs.
- 2. Temperature:** K will change depending upon the temperature.
(endothermic – energy is a reactant; exothermic – energy is a product).
- 3. Pressure effect at constant temperature,** pressure that is due to a volume change (volume pressure): Favor the reaction that decreases the number of gas molecules.
- 4. Addition of inert gas** does not affect the equilibrium position.