Chemical equilibrium 7/5/20 2nd sem

What is chemical equilibrium?

Equilibrium means equal on both sides. In case of chemical equilibrium the reaction must be a reversible one. When both forward and backward reaction is stopped it assumes eqm.

Law of mass action — The rate of a reaction is directly proportional to the multiple of active masses of the reactant. It is known as law of mass action. Suppose a reaction

$$A + B \rightleftharpoons C + D$$

$$\text{Rate} = K[A][B]$$

where K - constant
bracket sign indicates active masses.

K_c and K_p and their relationship

Suppose a reaction is of the type

$$aA + bB \underset{K_1}{\overset{K_1}{\rightleftharpoons}} cC + dD$$

where
a moles of A
b moles of B
c moles of C
d moles of D

For forward reaction

$$\text{Rate}_1 = K_1[A]^a[B]^b \quad \text{---} (1)$$

For backward reaction

$$\text{Rate}_2 = K_2[C]^c[D]^d \quad \text{---} (2)$$

At eqm $\text{Rate}_1 = \text{Rate}_2$

$$K_1[A]^a[B]^b = K_2[C]^c[D]^d$$

$$\frac{K_1}{K_1} = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]} \quad \text{---} (3)$$

In case of gaseous state the concentration or active mass replaced by partial pressure

So $$aA + bB \underset{K_1}{\overset{K_1}{\rightleftharpoons}} cC + dD$$

$$K_p = \frac{P_C^c \times P_D^d}{P_A^a \times P_B^b} \quad \text{---} (4)$$

where
P_A → partial pressure of A
P_B " B
P_C " C
P_D " D

8th May
2nd sem

K_p, K_c values and type of equilibrium.

Suppose a reaction $H_2 + I_2 \rightleftharpoons 2HI$

here 1 mole of hydrogen reacts with 1 mole of iodine and produces 2 mole of hydroiodic acid

If initial concentration of reactant = a and concentration of product = x then

$$H_2 + I_2 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} 2HI$$
$$(a-x)\quad (a-x)\quad (x)$$

$$K_p = \frac{[HI]^2}{[H_2][I_2]} = \frac{(xp)^2}{(a-x)p\,(a-x)p}$$

$$= \frac{x_p^2}{(a-x)(a-x)p^2}$$

where p → partial pressure.

$$\boxed{K_p = \frac{x^2}{(a-x)^2}}$$

i.e the reaction does not depend on pressure.

Again $H_2 + I_2 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} 2HI$

$K_p = K_c (RT)^{n_2 - n_1}$ here $n_2 = 2$ (product)

$n_1 = 1+1$ (reactant)

$K_p = K_c (RT)^{2-2}$

$K_p = K_c (RT)^0$

$\therefore \boxed{K_p = K_c}$

That means in $H_2 + I_2 \rightleftharpoons 2HI$ reaction $K_p = K_c$, it says where the reaction is completed in gaseous form or in liquid form, no influence of pressure is found and in all aspect the K_p and K_c bears same value.