Relationship between Kc, Kp and Kx

Relationship between Kp ,Kc, Kx and Kn

Kp=Equilibrium constant in terms of partial pressure.

Kc=Equilibrium constant in terms of concentration.

Kx=Equilibrium constant in terms of mole fraction.

Kn=Equilibrium constant in terms of number of moles.

Kp and Kc are related as $K_P = K_C (RT)^{\Delta n}$ .....(eq 1)

Relationship between K_P and K_n

$$K_p = \frac{P_C{}^c \times P_D{}^d}{P_A{}^a \times P_B{}^b}$$ .....(eq 2)

From ideal gas equation, $PV=nRT$

$$\Rightarrow P=n(RT/V)$$

Where, **n** is the number of moles

So, $P_A = n_A(RT/v)$, $P_B = n_B(RT/V)$, $P_C = n_C(RT/V)$ and $P_D = n_D(RT/V)$

Replacing equation 2 by the above value we get that,

$$K_p = \frac{[n_C(RT/V)]^c \,.\, [n_D(RT/V)]^d}{[n_A(RT/V)]^a \,.\, [n_B(RT/V)]^b}$$

$$\Rightarrow K_p = \frac{n_C^c \,.\, n_D^d}{n_A^a \,.\, n_B^b} \,.\, (RT/V)^{(c+d)-(a+b)}$$

$\Rightarrow K_p = K_n \cdot (RT/V)^{\Delta n}$

$\Rightarrow K_p = K_n \cdot (P_T/n_T)^{\Delta n}$

Δn=number of gaseous moles of product – number of gaseous moles of reactant

Relation between Kp and Kx

$$K_p = \frac{P_C^{\,c} \times P_D^{\,d}}{P_A^{\,a} \times P_B^{\,b}}.$$

From above (eq….. 2)

Partial pressure(P) = Mole fraction(x) . Total pressure(P_T)

So, $P_A = x_A . P_T$

$P_B = x_B . P$

$P_C = x_C . P_T$

$P_D = x_D . P_T$

Putting the values in whole equation:

$$K_P = \frac{(x_C . P_T)^c . (x_D . P_T)^d}{(x_A . P_T)^a . (x_B . P_T)^b}$$

$$= \frac{x_C^c . x_D^d}{x_A^a . x_B^b} \; P_T^{(c+d)-(a+b)}$$

=> $K_P = K_x (P_T)^{\Delta n}$

Kp=**Kc**$(RT)^n$ where R is the gas constant, T is the Temperature and n is the change in no. of gaseous moles in the **reaction**.

Q1. Calculate $K_{c \text{ and }} K_x$ for the given reaction

$N_2O_4(g)=2NO_2(g)$ **Hints: Kp=0.157**

Q2. a) What is the difference between homogeneous and heterogeneous equilibria?

b) List the examples.

Q3. Under what conditions are the values of KC and KP for a given gas phase equilibrium the same?

Q4. What is the relation between KP KC and KX?