

Quadrant II – Transcript and Related Materials

Programme:	Bachelor of Science (First Year)
Subject:	Chemistry
Paper Code:	CHC-102
Paper Title:	Physical Chemistry and Organic Chemistry
Unit:	Chemical Equilibrium
Module Name:	Relationships between K_p , K_c and K_x for reactions involving ideal gases.
Module No:	13
Name of the Presenter:	Ms. Ankita M. Vernekar

Notes:

Relation between K_p , K_c and K_x

Consider general reaction:



$$K_p = \frac{p_C^c \cdot p_D^d}{p_A^a \cdot p_B^b}$$

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

$$K_x = \frac{X_C^c \cdot X_D^d}{X_A^a \cdot X_B^b}$$

In an ideal gaseous mixture, each component obeys Daltons law of partial pressure, i.e., $P_i = X_i P$

Where P is total pressure and P_i is partial pressure of the i^{th} component with mole fraction X_i in the mixture.

For the reaction:



We have,

$$P_A = X_A P$$

$$P_B = X_B P$$

$$P_C = X_C P$$

$$P_D = X_D P$$

$$K_x = \frac{X_C^c \cdot X_D^d}{X_A^a \cdot X_B^b}$$

$$K_p = \frac{p_C^c \cdot p_D^d}{p_A^a \cdot p_B^b} = \left(\frac{X_C^c \cdot X_D^d}{X_A^a \cdot X_B^b} \right) P^{(c+d)-(a+b)}$$

$$K_p = K_x (P)^{\Delta n}$$

$$\Delta n = (c+d) - (a+b)$$

Relation between K_p and K_c :

For an ideal gaseous mixture

$$P_i V = n_i RT$$

$$P_i = \left(\frac{n_i}{V} \right) RT$$

$$P_i = C_i RT$$

Where $C_i = \left(\frac{n_i}{V} \right)$ is molar concentration of the i^{th} component in the mixture of total volume V .

Hence

$$P_A = C_A RT$$

$$P_B = C_B RT$$

$$P_C = C_C RT$$

$$P_D = C_D RT$$

$$K_p = \frac{p_C^c \cdot p_D^d}{p_A^a \cdot p_B^b}$$

$$K_p = \left(\frac{C_C^c \cdot C_D^d}{C_A^a \cdot C_B^b} \right) (RT)^{(c+d)-(a+b)}$$

$$K_p = K_c (RT)^{\Delta n}$$

How K_p , K_x and K_c are related?

$$K_p = K_x (P)^{\Delta n}$$

$$K_p = K_c (RT)^{\Delta n}$$

$$K_p = K_x (P)^{\Delta n} = K_c (RT)^{\Delta n}$$

If $\Delta n = 0$ i.e. $c+d = a+b$ (number of moles of product is equal to number of moles of reactant)

$$\text{Then } K_p = K_x = K_c$$