PROBLEM 9 *At temperature T, a compound $AB_2(g)$ dissociates according to the reaction : $2AB_2(g) \rightleftharpoons 2AB(g) + B_2(g)$ with a degree of dissociation 'x' which is small compared to unity. Deduce the expression for 'x' in terms of the equilibrium constant K_P and the total pressure P.* **(IIT 1994)**

Solution

	$2AB_2(g)$	$\rightleftharpoons$	$2AB(g)$	$+ B_2(g)$
Mole before dissociation	1		0	0
Mole after dissociation	$(1-x)$		x	$\frac{x}{2}$

Total mole at equilibrium $(\Sigma n) = 1 - x + x + \frac{x}{2} = 1 + \frac{x}{2}$

Now, $$K_P = \frac{n_{B_2} \times (n_{AB})^2}{(n_{AB_2})^2} \times \left[\frac{P}{\Sigma n}\right]^{\Delta n}$$

$$K_P = \frac{\frac{x}{2} \cdot (x)^2}{(1-x)^2} \times \left[\frac{P}{1+\frac{x}{2}}\right]^1$$

$$K_P = \frac{x^3 P}{2} \qquad \left[\because \quad x \text{ is small}, \therefore\ 1 - x \approx 1 \text{ and } 1 + \frac{x}{2} \approx 1\right]$$

or $$x = \sqrt[3]{\frac{2K_P}{P}}$$

PROBLEM 13 *In an equilibrium* $A + B \rightleftharpoons C + D$; *A and B are mixed in a vessel at temperature T. The initial concentration of A was twice the initial concentration of B. After the equilibrium has reached, concentration of C was thrice the equilibrium concentration of B. Calculate* K_C.

SOL

PROBLEM 17 *60 mL of H_2 and 42 mL of I_2 are heated in a closed vessel. At equilibrium the vessel contains 28 mL HI. Calculate degree of dissociation of HI.*

SOL

PROBLEM 23 *The degree of dissociation of HI at a particular temperature is 0.8. Calculate the volume of 2 M $Na_2S_2O_3$ solution required to neutralise the iodine present in a equilibrium mixture of a reaction when 2 mole each of H_2 and I_2 are heated in a closed vessel of 2 litre capacity.*

SOL

PROBLEM 28 *An equilibrium mixture of*

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

present in a vessel of one litre capacity at 815°C was found by analysis to contain 0.4 mole of CO, 0.3 mole of H_2O, 0.2 mole of CO_2 and 0.6 mole of H_2.

(a) Calculate K_C.

(b) If it is derived to increase the concentration of CO to 0.6 mole by adding CO_2 to the vessel, how many mole must be added into equilibrium mixture at constant temperature in order to get this change?

SOL

PROBLEM 31 *At a certain temperature, K_C for*

$$SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$$

is 16. If we take one mole of each of all the four gases in one litre container, what would be the equilibrium concentrations of NO and NO_2?

SOL

PROBLEM 37 *The K_P for the reaction $N_2O_4 \rightleftharpoons 2NO_2$ is 640 mm at 775 K. Calculate the percentage dissociation of N_2O_4 at equilibrium pressure of 160 mm. At what pressure, the dissociation will be 50%?*

(Roorkee 1997)

SOL

PROBLEM 41 *N_2O_4 dissociates as $N_2O_4 \rightleftharpoons 2NO_2$. At 55°C and one atmosphere, % decomposition of N_2O_4 is 50.3%. At what P and same temperature, the equilibrium mixture will have the ratio of $N_2O_4 : NO_2$ as 1:8?*

SOL

PROBLEM 45 *Prove* $\alpha = \sqrt{\left(\frac{K_P}{P + K_P}\right)}$ *for* $PCl_5 \rightleftharpoons PCl_3 + Cl_2$;
where α *is degree of dissociation at temperature when equilibrium constant is* K_P.

SOL

PROBLEM 90 *Ammonium carbamate dissociates as* $NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$. *In a closed vessel containing ammonium carbamate in equilibrium, ammonia is added such that partial pressure of* NH_3 *now equals to the original total pressure. Calculate the ratio of total pressure now to the original pressure.*

SOL

PROBLEM 116 *For gaseous reaction* $A + B \rightleftharpoons C$, *the equilibrium concentration of A and B at a temperature are* 15 *mol litre*$^{-1}$. *When volume is doubled the reaction has equilibrium concentration of A as* 10 *mol litre*$^{-1}$. *Calculate:*

(*a*) K_C

(*b*) *concentration of C in original equilibrium.*

SOL

When heated Ammonium Carbamate decomposes as follows $NH_2COONH_4(s) = 2NH_3 + CO_2$ At a certain temperature the equilibrium Pressure of the system is 0.318 atm. K_p for the reaction is

a) 0.128 b) 0.426 c) 4.76×10^{-3} d) none

SOL

(9) $AB_3 \rightleftharpoons AB_2 + \frac{1}{2} B_2$ the initial presure of AB_3 is 800 torr and the total presure developed at equllibrium is 900 torr. What fraction of AB_3 is dissociated.

a) 10 %. b) 20%. c) 25%. d) 80%.

SOL

for the reaction $XCO_{3(s)} = XO_{(s)} + CO_{2(g)}$ $K_p = 1.642$ atm at 727°c. if 4 moles of $XCO_{3(s)}$ was put into a 50 litre container and heated to 727°c what mole %. of XCO_3 remains unreacted at equilibrium

a) 20 b) 25 c) 50 d) none of these

SOL

One mole of N_2 is mixed with 2 moles of H_2 in a 4 Litre vessel. if 50% of N_2 is converted to NH_3 by the following reaction.

$N_2 + 3H_2 = 2NH_3$ what will be the value of K_c for the following equilibrium

$NH_3 = \frac{1}{2}N_2 + \frac{3}{2}H_2$

SOL

For which of the following reactions. the degree of dissociation cannot be calculated. from the VD data

1) $2HI \rightleftharpoons H_2 + I_2$

2) $2NH_3 = N_2 + 3H_2$

3) $2NO \rightleftharpoons N_2 + O_2$

4) $PCl_5 = PCl_3 + Cl_2$

① I & III 2) II & IV 3) I & III 4) III & IV

SOL

At a certain temperature, 2 moles of carbon monoxide and 3 moles of chlorine were allowed to reach equilibrium according to the reaction $CO + Cl_2 \rightleftharpoons COCl_2$ in a 5 lit vessel. At equilibrium if one mole of CO is present, then equilibrium constant for the reaction is:

(A) 2 (B) 2.5 (C) 3.0 (D) 4

SOL

A definite amount of solid NH_4HS is placed in a flask already containing ammonia gas at a certain temperature and 0.50 atm pressure. NH_4HS decomposes to give NH_3 and H_2S and at equilibrium total pressure in flask is 0.84 atm. The equilibrium constant for the reaction is:

(A) 0.30
(B) 0.18
(C) 0.17
(D) 0.11

SOL

For the reaction:

$$CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g),\ K_p/K_C \text{ is:}$$

(A) RT

(B) $(RT)^{-1}$

(C) $(RT)^{-1/2}$

(D) $(RT)^{1/2}$

SOL