Solution

1 $CO_{2(g)} + C_{(s)} \rightleftharpoons 2CO_{(g)}$

$t=0$ 0.5 atm

$t=t_{eq}$ $0.5-p$ $2p$

0.2 atm 0.6 atm

$P_T = 0.5-p+2p = 0.5+p = 0.8$

$p = 0.3$ atm

$$K_p = \frac{P_{CO}^2}{P_{CO_2}} = \frac{(0.6)^2}{0.2}$$

$$= \frac{0.6 \times 0.6}{0.2} = 1.8 \text{ atm}$$

2 For Reaction

$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$ $K_c = 4 \times 10^{-4}$ (i)

then K_c for

$NO_{(g)} \rightleftharpoons \frac{1}{2} N_{2(g)} + \frac{1}{2} O_{2(g)}$ (ii)

reaction (ii) $K_{c_2} = \frac{1}{(K_{c_1})^{1/2}}$

$$K_c = \frac{1}{(4 \times 10^{-4})^{1/2}} = \frac{1}{2 \times 10^{-2}}$$

$= 50$

Ques: 3

$$2AB_{3(g)} \rightleftharpoons A_{2(g)} + 3B_{2(g)}$$

$t=0$ Mole	8		
$t = t_{eq}$ Mole	$8-2x$ 4	x 2	$3x$ 6

Mole of $A_2 = x = 2$

$V_L = 1L$

$$K_c = \frac{[A_2][B_2]^3}{[AB_3]^2} = \frac{2(6)^3}{(4)^2}$$

$$K_c = \frac{2 \times 6 \times 6^3 \times 6^3}{4 \times 4}$$

$$K_c = 27$$

: 4

$$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$$

$t=0$ mole	a		
$t = t_{eq}$	$a - a\alpha$	$2a\alpha$	α = Degree of dissociation

$n_T = a + a\alpha$

$P_T = P$

$$K_p = \frac{P_{NO_2}^2}{P_{N_2O_4}} = \frac{\left(\frac{2a\alpha}{a(1+\alpha)}P\right)^2}{\left[\frac{a(1-\alpha)}{a(1+\alpha)}P\right]}$$

$$K_p = \frac{4\alpha^2 P}{1-\alpha^2} = 2 = \frac{4\alpha^2 \times 0.5}{1-\alpha^2}$$

$$\frac{\alpha^2}{1-\alpha^2} = 1 \qquad \alpha = \frac{1}{\sqrt{2}} = 0.707$$

$\alpha\% \simeq 71\%$

Ques:-5 $N_{2(g)} + 2O_{2(g)} \rightleftharpoons 2NO_{2(g)}$ (i) K_1

$2NO_{2(g)} \rightleftharpoons N_{2(g)} + 2O_{2(g)}$ (ii) K_2

$NO_{2(g)} \rightleftharpoons \frac{1}{2} N_{2(g)} + O_{2(g)}$ (iii) K_3

reaction (ii) is reverse of (i)

$$K_2 = \frac{1}{K_1}$$

reaction (iii) is obtained by Multiply by $\frac{1}{2}$ and reversed.

$$K_3 = \frac{1}{\sqrt{K_1}}$$

Ans 4 $$K_1 = \frac{1}{K_2} = \frac{1}{K_3^2}$$

Ques: 6 $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$

t=0 Mole	2	1	
t=teq Mole	2-2x 0.4	1-x 0.2	2x 1.6

Mole of $SO_3 = 2x = 1.6$

$x = 0.8$

Volume = 1L

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} = \frac{(1.6)^2}{(0.4)^2 \times (0.2)}$$

$K_c = 80$

Ques: 7

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \quad K_1 \quad (1)$$

$$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)} \quad K_2 \quad (2)$$

$$H_{2(g)} + \frac{1}{2} O_{2(g)} \rightleftharpoons H_2O_{(g)} \quad K_3 \quad (3)$$

The equilibrium constant for

$$2NH_{3(g)} + \frac{5}{2} O_{2(g)} \rightleftharpoons 2NO_{(g)} + 3H_2O_{(g)} \quad K_4 \quad (4)$$

reaction 4 is obtained by

$$(4) = 2 + 3 \times (3) - 1$$

$$K_4 = \frac{K_2 \times K_3^3}{K_1}$$

Ans: 8 For Reaction

$$A + 2B \rightleftharpoons 2C + D$$

$t=0$ conc.	a	$1.5a$		
$t=t_{eq}$ Conc.	$a-x$ $a/2$	$1.5a-2x$ $a/2$	$2x$ a	x $a/2$

at Eq:-

$$[A] = [B]$$

$$a - x = 1.5a - 2x$$

$$x = a/2$$

$$K_c = \frac{[C]^2[D]}{[A][B]^2} = \frac{[a]^2[a/2]}{[a/2][a/2]^2} = 4$$

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Sol·9 $NH_2COONH_{4(s)} \rightleftharpoons 2NH_{3(g)} + CO_{2(g)}$

at $t = t_{eq}$ mole Ratio of NH_3 & CO_2 is 2 : 1

So pressure Ratio is 2 : 1

$NH_2COONH_{4(s)} \rightleftharpoons 2NH_{3(g)} + CO_{2(g)}$

$2p \qquad p$

$K_p = P_{NH_3}^2 \cdot P_{CO_2}$

$= (2p)^2 p$

$= 4p^3 = 2.9 \times 10^{-5} = 29 \times 10^{-6}$

$p^3 = 7.25 \times 10^{-6}$

$p \simeq 1.94 \times 10^{-2}$

$P_T = 3p$

$= 5.82 \times 10^{-2}$

Soln:10

$SO_{2(g)} + \frac{1}{2} O_{2(g)} \rightleftharpoons SO_{3(g)}$

Relation b/w K_p & K_c

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

$\Delta n_g = \Sigma n_{gas(prod)} - \Sigma n_{gas(React)}$

For the $\rightarrow$ $\Delta n_g = 1 - [1 + \frac{1}{2}] = -\frac{1}{2}$

$K_p = K_c [RT]^{-\frac{1}{2}}$

Solution-11 →

$$A + B \rightleftharpoons C + D \quad ; \quad K_c = 100$$

	A	B	C	D
t=0 (Initially)	1 M	1M	1M	1M
t=teq. (Equilibrium)	1-x	1-x	1+x	1+x

$$Q_{initial} = \left(\frac{[C][D]}{[A][B]}\right) = \frac{1\times1}{1\times1} = 1$$

$Q_{initial}$

$(Q = 1) < (K_c = 100)$

So reaction proceed to forward direction

$$K_c = \frac{[C][D]}{[A][B]}$$

$$= \frac{(1+x)(1+x)}{(1-x)(1-x)}$$

$$\Rightarrow \quad 100 = \left(\frac{1+x}{1-x}\right)^2$$

$$\Rightarrow \quad 10 = \frac{1+x}{1-x}$$

$$\Rightarrow \quad 10 - 10x = 1 + x$$

$$\Rightarrow \quad 11x = 9 \quad \Rightarrow \quad x = \frac{9}{11}$$

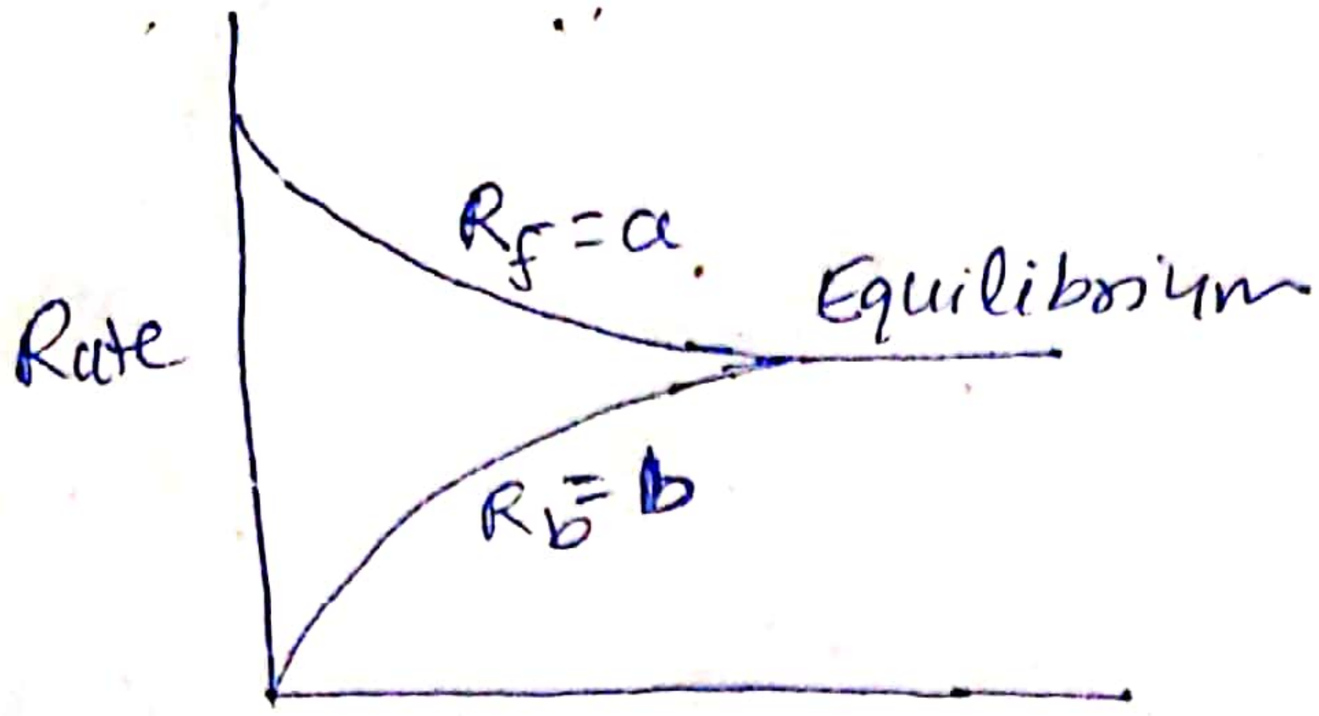
So $[D] = 1 + x = 1 + \frac{9}{11} = \frac{20}{11} = 1.818$

$\Rightarrow$ $\boxed{[D] = 1.818\ M}$ ← mole L^{-1}

Solution-12 → $Fe_2O_3(s) + 3CO(g) \rightleftharpoons 2Fe(l) + 3CO_2(g)$

According Le-Chatelier's principle Addition of any solid matter does not affect equilibrium. So In given option $\boxed{\text{Addition of } Fe_2O_3}$ will not disturb the equilibrium.

(13). We know



(14)

$$X + Y \rightleftharpoons 2Z$$

$t=0$	1	1.5	0.5
Eq	$1-x$	$1.5-x$	$0.5+2x$

Given $(0.5+2x) = 1$

$x = 0.25$

$$K = \frac{(0.5+2x)^2}{(1-x)(1.5-x)}$$

$$K = \frac{1^2}{0.75 \times 1.25} = \frac{16}{15}$$

$\Rightarrow x = .16$.

(15) (a) Temperature is decreased hence for endothermic reaction, equilibrium shift towards reactant

(b) As N_2 gas (inert gas) is added at constant volume, hence no effect on equilibrium.

(16) $N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad K_c = 64$

for reaction

$$2NH_3 \rightleftharpoons \frac{1}{2}N_2 + \frac{3}{2}H_2 \qquad K_c' = \frac{1}{\sqrt{64}}$$

$$K_c' = \frac{1}{8}$$

(17) $Fe_2N(s) + \frac{3}{2}H_2(g) \rightleftharpoons 2Fe(s) + NH_3(g)$

$$\Delta n_g = \left(1 - \frac{3}{2}\right) = -\frac{1}{2}$$

$$\Rightarrow \quad K_p = K_c(RT)^{-1/2}$$

$$\therefore \quad K_c = K_p(RT)^{1/2}$$

(18)

$$A + B \rightleftharpoons C \qquad K^1$$

$$B + C \rightleftharpoons P \qquad K^2$$

$$A \rightleftharpoons P \qquad K = K^1 \cdot K^2$$

J. Adv.

1. $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$

(a) ΔH is depedent on temperature as per ~~Kirchhoff~~. equation

$$\log\left(\frac{K_2}{K_1}\right) = \frac{\Delta H}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

(b) & (c) → Equilibrium constant (K) depends on temperature only.

(d) $\Delta H = (E_{af} - E_{ab})$ and it is independent of catalyst