1. $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

t = 0 1 mol

t = ∞ 1–0.3 0.3 0.3

Total moles at equilibrium (साम्य पर कुल मोल) = 1.3

2. $K_C = \left[\frac{1}{1/8}\right]^2 = 64$

4. ∵ reaction is exothermic so an increasing temperature it shift to backward (अभिक्रिया उष्माक्षेपी है अत: ताप बढने पर यह पश्च दिशा में जायेगी।)

7. $K_P = \frac{P_{CO}^2}{P_{CO_2}} = \frac{8^2}{4} = 16$

8. Greater value of K_C more is equilibrium favourable to products.

(K_C का अधिक मान होने पर साम्य उत्पाद की ओर होगा।)

11. (1) $CO + H_2O \overset{K}{\rightleftharpoons} CO_2 + H_2$

(2) $2CO + O_2 \overset{K_1}{\rightleftharpoons} 2CO_2$

(3) $2H_2 + O_2 \overset{K_2}{\rightleftharpoons} 2H_2O$

By subtraction (2) – (3) we get :

$2H_2O + 2CO \rightleftharpoons 2CO_2 + 2H_2$

Dividing by (2) ;

$H_2O + CO \rightleftharpoons CO_2 + H_2O$

$K = \left(\frac{K_1}{K_2}\right)^{1/2}$

12. Changing concentration does not change K_C (सान्द्रता परिवर्तन पर K_C परिवर्तित नहीं होता है)

$PCl_5 \rightleftharpoons PCl_3 + Cl_2$

t = 0 1M

t = ∞ 1–0.4 0.4 0.4

$K_C = \frac{0.4 \times 0.4}{0.6} = 0.267$

14. $A(g) + B(g) \rightleftharpoons 2C(g)$

t = 0 3M 1M

t = ∞ $3-\frac{1}{3}$ $1-\frac{1}{3}$ $\frac{2}{3}$

$K_C = \frac{\left(\frac{2}{3}\right)^2}{\left(\frac{8}{3}\right)\left(\frac{2}{3}\right)} = \frac{1}{4}$

15. Pure solids of added do not change state of equilibrium.

(मिलाये गये ठोस साम्यवस्था को परिवर्तित नहीं करते हैं)

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

a a

a(1–α) a(1–α) aα aα

$\frac{\alpha^2}{(1-\alpha)^2} = 9 \Rightarrow \alpha = 0.75$

19. $K_C = \frac{1.5^2}{1.5^2} = 1$

20. (1) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

(2) $N_2 + O_2 \rightleftharpoons 2NO$

(3) $H_2 + \frac{1}{2}O_2 \rightleftharpoons H_2O$

(4) $2NH_3 + \frac{5}{2}O_2 \rightleftharpoons 2NO + 3H_2O$

(5) = (2) + 3(3) – (1)

i.e. $K_4 = \frac{K_2K_3^3}{K_1}$

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

t = 0 3n n 0 0

t = ∞ 3n–x n – x x x

n–x = x → x = $\frac{n}{2}$ i.e.$[D]_{eq.} = \frac{n}{2}$

22. $K_C = \frac{K_1}{K_2} = \frac{b+x}{\alpha - x}$

23. $K_P = K_C (RT)^1$ $K_C = \frac{0.03}{(0.0821 \quad 700)^1}$

25. $K_C = \frac{0.33 \quad 0.33}{0.67 \quad 0.67} = \frac{1}{4}$

26. $SO_3 + CO \rightleftharpoons SO_2 + CO_2$

t = 0 2M 2M 2M 2M

t = ∞ 2+x 2 + x 2 – x 2 – x

27. $N_2 + O_2 \rightleftharpoons 2NO$

0.01M 0.02M 0.03M

$K_C = \frac{0.03^2}{0.01 \quad 0.02} = 4.5$

Let a moles of O_2 be added (माना O_2 के a मोल मिलाये गये है)

$N_2 + O_2 \rightleftharpoons 2NO$

0.01–x 0.02+a–x 0.03 + 2x

0.03+2x = 0.04

⇒ x = 0.005

i.e., $4.5 = \frac{(0.04)^2}{(0.015+a)(0.005)}$

Moles of O_2 added = a $100 = \frac{101}{18}$

28. $2NH_3 \rightleftharpoons N_2 + 3H_2$

T=300 K 15 atm

T=573 K $\frac{15}{300}(573)$ atm

$\frac{15}{300}(573)\ [1+\alpha) = 40.11 \Rightarrow \alpha = 0.4$

29. $2SO_3 \rightleftharpoons 2SO_2 + O_2$

$P(1-\alpha)$ $P\alpha$ $\frac{P\alpha}{2}$

$P\left[1+\frac{\alpha}{2}\right] = P_0$

$K_P = \frac{(P^2\alpha^2)\left(P\frac{\alpha}{2}\right)}{P^2(1-\alpha^2)} = \frac{P_0\alpha^3}{(2+\alpha)(1-\alpha)^2}$

32. By adding inert gas at constant pressure reaction shifts to increase number of gaseous molecules ∴ to left.

(नियत दाब पर अक्रिय गैस मिलाने पर अभिक्रिया गैसीय अणु की बड़ी हुयी संख्या की ओर प्रतिस्थापित होती हैं)

37. Slope of plot (ग्राफ का ढाल) $= \frac{-\Delta H^\circ}{2.303R} = 1$

$\Rightarrow \quad \Delta H = -2.303 \quad 2 = 4.606$ cal.

CHEMICAL EQUILIBRIUM — EXERCISE # 2

1. Greater value of K_C more is extent
(K_C का मान अधिक तो मात्रा अधिक)
(I) $K_C = 0.01$, (II) $K_C = 1$, (III) $K_C = 10^4$

2. $K_C = 9 = \frac{(2/V)^2}{(2/V)^3(2/V)}$; $V = 6L$

3. (1) $S + S^{-2} \rightleftharpoons S_2^{-2}$ $K_1 = 12$

(2) $2S + S^{-2} \rightleftharpoons S_3^{-2}$ $K_2 = 132$

Subtracting (2) – (1)

$\Rightarrow \quad S + S_2^{-2} \rightleftharpoons S_3^{-2}$ $K_3 = \frac{132}{12} = 11$

4. $K_P = K_C\ (0.0821 \quad T)^1$

$T = \frac{1}{0.0821} = 12 - 19$ K

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

1 atm 3 atm

1–x 3–3x 2x

$\Rightarrow \quad 4 - 2x = 3 \quad \Rightarrow \quad x = \frac{1}{2}$

$K_P = \frac{(1)^2}{(1/2)(3/2)^3}$

6. For dissocation of NH_3 (NH_3 के वियोजन के लिए)

$K_P^1 = \frac{1}{K_P} = 0.5 \quad 1.5^3$

$N_2O_4 \rightleftharpoons 2NO_2$

$2(1 - 0.2)$ $2 \quad 0.4$

Total pressure (कुल दाब) = 1.6 + 0.8 = 2.4 atm

7. $\frac{(VD)_i}{(VD)_f} = \frac{n_f}{n_i}$

$N_2O_4 \rightleftharpoons 2NO_2$

t = 0 a

t = ∞ a(1 – α) 2aα

$\frac{46}{30} = \frac{a(1+\alpha)}{a} \quad \Rightarrow \quad \alpha = 0.533$

10. $N_2O_5 \rightleftharpoons N_2O_3 + O_2$

4 – x x – y x + y

$K_C = 2.5$

$N_2O_3 \rightleftharpoons N_2O + O_2$

x – y y y + x

x + y = 2.5

$\frac{(x+y)(x-y)}{4-x} = 2.5$

solving y = 0.334 M

17. $Hg\ (\ell) \rightleftharpoons Hg(g)$ $\Delta G = 31$ kJ/mol

To start boiling $P_{Hg} = K_P$

When $\Delta G = -RT \ln K_P$

$\Rightarrow \quad 31 \quad 10^3 = -8.31 \quad 298 \ln K_P$

$K_P = 10^{-5.44}$

18. $\Delta_r G = -33 \quad 10^3 + 8.314 \quad 298 \quad \ln \frac{(0.02)^2}{3^3 \quad 1}$

$\Delta_r G = -60.5$ kJ/mol

19. (ii) $H_2 + I_2 \rightleftharpoons 2HI$

$\frac{0.5}{7} - x \quad \frac{0.5}{7} - x \quad 2x$

$\frac{(2x)^2}{\left(\frac{0.5}{7} - x\right)^2} = 49$

Total pressure (कुल दाब) $P_T = \frac{0.5}{7} \quad 0.0821 \quad 700$

(iv) Partial pressure (आंशिक दाब) of
HI = (2x) (0.0821) 700 = 6.385 atm

21. $A \rightleftharpoons \frac{n}{3}B + \frac{2n}{3}C$

t=0 a

t=∞ a(1–α) aα(n/3) aα(2n/3)

$\frac{D}{d} = \frac{a[1-\alpha+n\alpha]}{a} \qquad \alpha = \frac{D-d}{d(n-1)}$

23. Adding inert gas at constant volume does not affect state of equilibrium
(नियत आयतन पर अक्रिय गैस के योग पर साम्यावस्था प्रभावित नहीं होती है)

26. $N_2 + 3H_2 \rightleftharpoons 2NH_3$ as the reaction is exothermic so more NH_3 will be obtained at lower temperature.
($N_2 + 3H_2 \rightleftharpoons 2NH_3$ क्योंकि अभिक्रिया उष्माक्षेपी है अत: निम्न ताप पर अधिक NH_3 प्राप्त होगी।)

CHEMICAL EQUILIBRIUM — EXERCISE # 3

COMPREHENSION # 1

1. $CaSO_4.2H_2O(s) \rightarrow CaSO_4.\frac{1}{2}H_2O(s) + \frac{3}{2}H_2O(g)$

$\Delta H = \frac{3}{2}(-241.8) + (-1575) - (-2021)$

For 1 kg $CaSO_4.2H_2O = \frac{\Delta H}{172} \quad 100 = 484$ kJ

2. $\Delta S = \frac{3}{2}(188.6) + 130.5 - 194$

$\Delta G = \Delta H - (298)\,\Delta S = -8.314 \quad 298 \ln (P_{H_2O})^{3/2}$

$\Rightarrow \quad P_{H_2O} = 8.1 \quad 10^{-3}$ bar

CHEMICAL EQUILIBRIUM — EXERCISE # 4[A]

1.(b) $2NH_3 \rightleftharpoons N_2 + 3H_2$
3 atm 2 atm 1 atm
$Q_p = 2/9 < K_P$
$\therefore$ shifts in forward direction (अग्र दिशा में विस्थापित)

6. $CH_4 + 2H_2S \rightleftharpoons CS_2 + 4H_2$
t=0 0.2M 0.4M 0.3M 0.3M

$Q_c = \frac{(0.3)(0.3)^4}{(0.2)(0.4)^2} > K_C$

$\therefore$ shifts backward (पश्च विस्थापित)

7. $N_2 + 3H_2 \rightleftharpoons 2NH_3$
0.036M 0.15M CM

$\frac{C^2}{(0.036)(0.15)^3} = 0.29$

8. $N_2 + O_2 \rightleftharpoons 2NO$
1.4 – x 1.4 – x 2x

$\Rightarrow \frac{(2x)^2}{(1.4-x)^2} = 1.7 \quad 10^{-3}$

9. $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
0.16 – x x x

$\Rightarrow \frac{x^2}{0.16-x} = 5.8 \quad 10^{-2}$

10. $ClF_3 \rightleftharpoons ClF + F_2$
1.47 – x x x

$\Rightarrow \frac{x^2}{1.47-x} = 0.14$

11. $N_2O_4 \rightleftharpoons 2NO_2$
$P_0(1-0.25)$ $0.5\,P_0$ $P_0(1+0.25)=1.5$

$K_P = \frac{[0.5P_0]^2}{P_0(0.75)} \qquad P_0 = \frac{1.5}{1.25}$ atm

$= \frac{0.25}{0.75} \quad \frac{1.5}{1.25}$

12. $N_2O_4 \rightleftharpoons 2NO_2 \qquad P_0(1+\alpha) = 0.5$

$P_0(1-\alpha) \qquad 2P_0\alpha \qquad \frac{4P_0\alpha^2}{1-\alpha} = 0.667$

14. $PCl_5 \rightleftharpoons PCl_3 + Cl_2 \Rightarrow 1.1 \quad P_0 = 4 \Rightarrow P_0 = \frac{4}{1.1}$ atm

$P_0(1-0.1) \quad 0.1P_0 \quad 0.1P_0 \quad K_P = \frac{0.01P_0}{0.9} = \frac{P_0}{90} = \frac{4}{99}$ atm

For 20% dissociation (20% वियोजन के लिए)
$P_0^1(1-0.2) \quad 0.2P_0^1 \quad 0.2P_0^1 \Rightarrow 1.2\,P_0^1 = P_T$

$\frac{0.04P_0^1}{0.8} = \frac{4}{99}$

15. $N_2 + 3H_2 \rightleftharpoons 2NH_3$
t = 0 16 atm 48 atm

t = ∞ 16 – x 48 – 3x $2x \Rightarrow \frac{2x}{64-2x} = \frac{1}{3}$

$\Rightarrow x = 8$

$K_P = \frac{16^2}{8(24)^3}$

16. $N_2O_4 \rightleftharpoons 2NO_2 \qquad P_0(1+\alpha) = 5$

$P_0(1-\alpha) \qquad 2P_0\alpha \qquad 1+\alpha = \frac{92}{69}$

$\Rightarrow \quad KP = \frac{4P_0\alpha^2}{1-\alpha}$

17. $N_2O_4 \rightleftharpoons 2NO_2$

t=0 a mol $\quad \frac{a(1+\alpha)}{a}=\frac{46}{30} \Rightarrow \alpha = \frac{8}{15}$

t=∞ a(1 – α) $\quad 2a\alpha$

19. $NH_2COONH_4(g) \rightleftharpoons 2NH_3(g) + CO_2(g)$

Initial equilibrium $\quad 2P \quad P$

$\Rightarrow K_P = 4P^3, \; P_T = 3P$

Final equilibrium $\quad 3P \quad P^1$

$\Rightarrow (3P)^2 P^1 = 4P^3 \Rightarrow \quad P^1 = \frac{4P}{9}$

Ratio (अनुपात) $\frac{P_{T^1}}{P_T}=\frac{31}{27} \quad P_T{}^1=3P+\frac{4P}{9}=\frac{3/P}{9}$

20. Let n moles each of CO_2 & CaO be formed

(माना CO_2 व CaO प्रत्येक के n मोल बने है)

$0.04 \quad 0.821 = n(0.0821)\ (1000)$

21. $(P_{H_2O})^6 = 6.4 \quad 10^{85}$

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

t = 0 $\quad$ 0.2 mol

t = ∞ $\quad$ 0.2 (1–0.75)0.2 $\quad$ 0.75 $\quad$ 0.2 $\quad$ 0.75

$K_P = P_{CO_2} \Rightarrow K_P(15) = (0.2 \quad 0.75) \quad (0.0821) \ (1000)$

30. At equilibrium $\quad$ [A] = 0.3 M [B] = 0.6 M

Initally $\quad$ [A] = 0.6 M

(i) $\quad A \rightleftharpoons nB$

t = 0 0.6 $\quad 0$

t = ∞ 0.3 $\quad 0.6=0.3n \Rightarrow n = 2$

(ii) $K_C = \frac{0.6^2}{0.3}$

(iii) Initial rate $= \frac{\Delta[A]}{\Delta t}=\frac{0.6-0.5}{1} = 0.1 \text{ M hr}^{-1}$

32. At 300 K ; $\quad K_1 = \frac{2\times10^{-2}}{4\times10^{-3}} = 5$

At 400 K ; $\quad K_2 = \frac{4\times10^{-2}}{16\times10^{-4}} = 25$

$\log \frac{K_2}{K_1}=\frac{\Delta H}{2.303\times8.314}\left[\frac{1}{300}-\frac{1}{400}\right]$

36. $K_P = 0.313$ atm $\quad K_C = \frac{0.313}{(0.0821\times298)^1}$

39. $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$

$\quad 1.2-x \quad x \quad x$

$\frac{x^2}{1.2-x} = 3 \quad 10^{-2}$

41. $\alpha^- \rightleftharpoons \beta^-$

a(1 – 0.6) $\quad$ 0.6 a

$K_C = \frac{0.6}{0.4} = 1.5$

$\Delta G = -8.314 \quad 298 \ln 1.5$ J/mol

43. 0

44. $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

$P_0(1-\alpha) \quad P_0\alpha \quad P_0\alpha$

$1.78 = \frac{P_0\alpha^2}{1-\alpha}$

$P_0(1 + \alpha) = 1$

$M_{avg} = \frac{208.5}{1+\alpha}$

$d_{mix} = \frac{\left[1\times\frac{208.5}{1+\alpha}\right]}{0.0821\times523}$

46. $nA \rightleftharpoons A_n$

$1 - x \quad \frac{x}{n}$

$\frac{PV}{RT} = 1 - x + \frac{x}{n}$

$K_C = \frac{\frac{x}{nv}}{\left[\frac{1-x}{V}\right]^n} = \frac{xV^{n-1}}{n(1-x)^n}$

$K_C \simeq \frac{xV^{n-1}}{n(1-nx)}$

$\Rightarrow \quad nK_C - nK_Cx = xv^{n-1}$

$\Rightarrow \quad x = \frac{nK_C}{V^{n-1}}$

i.e. $\quad \frac{PV}{RT} = 1 - \frac{nK_C}{V^{n-1}} + \frac{K_C}{V^{n-1}}$

$\frac{PV}{RT} = \left[1 - \frac{(n-1)K_C}{V^{n-1}}\right]$

47. $A(g) \rightleftharpoons B(g) + C(g)$

$1 - x \quad x \quad x - y$

$C(g) \rightleftharpoons D(g) + E(g)$

$x - y \quad y \quad y$

$1 - x + x + x - y + 2y = 2$

$\Rightarrow \quad x + y = 1$

$\frac{x-y}{x}=\frac{1}{5} \Rightarrow 5x - 5y = x \; ; \; \frac{x}{y}=\frac{5}{4}$

1.(i) $CO + 2H_2 \rightleftharpoons CH_3OH$

$t = 0$ 0.15 a 0

$t = \infty$ 0.15–x a – 2x x = 0.08

Total moles finally(अन्त में कुल मोल)

$= 0.15 + a - 2(0.08)$

$= a - 0.01$

$\Rightarrow$ 8.5 (2.5) = (a – 0.01) (0.0821) (750)

a = 0.355

Hence at equilibrium(अतः साम्य पर),[CO] = 0.07M, $[H_2]$ = 0.195 M $[CH_3OH]$ = 0.08

$$\therefore K_C = \frac{0.08/2.5}{\left(\frac{0.195}{2.5}\right)^2\left(\frac{0.07}{2.5}\right)}$$

(ii) Total moles (कुल मोल) = 0.15 + 0.355 = 0.505

P(2.5) = (0.505) (0.0821) 750

P = 12.43 atm

2. Let initial pressure of N_2 be 9P and of H_2 be 13P (माना N_2 का प्रारम्भिक दाब 9P व H_2 का 13P है।)

$N_2 + 3H_2 \rightleftharpoons 2NH_3$ K_{P1}

9P–X–Y 13P–3X–2Y 2X

$N_2 + 2H_2 \rightleftharpoons N_2H_4$ K_{P2}

9P–X–Y 13P – 3X – 2Y Y

$9P-X-Y+13P-3X-2Y+2X+Y=7P_0$ ... (1)

$2X = P_0$ ... (2)

$13P - 3X - 2Y = 2P_0$ ... (3)

Solving $x = P_0/2$ $Y = 3P_0/2$ $P = P_0/2$

$$K_{P1} = \frac{(P_0)^2}{(4.5P_0 - 0.5P_0 - 1.5P_0)(6.5P_0 - 1.5P_0 - 3P_0)^3}$$

$$= \frac{P_0^2}{(2.5P_0)(8P_0^3)} = \frac{1}{20P_0^2}$$

and $K_{P2} = \frac{3}{20P_0^2}$

3.(a) $NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$

2P P

3P = 0.116

$$K_P = 4P^3 = 4\left(\frac{0.116}{3}\right)^3$$

4. Let equilibrium concentration of C be a M.

(माना C की साम्य सान्द्रता a M है)

$$K_C = \frac{(4^2)(a)}{3} = \frac{16a}{3} \quad ...(1)$$

on doubling volume all concentration are halved and equilibrium shifts forward

(आयतन दुगुना करने पर सभी सान्द्रता आधी हो जाती है तथा सामय पीछे विस्थापित हो जाता है)

$A \rightleftharpoons 2B + C$

3/2 – X 2+2X a/2 + X

Given : $2 + 2X = 3 \Rightarrow X = 1/2$

$$K_C = \frac{(3)^2\left(\frac{a}{2}+\frac{1}{2}\right)}{\left(\frac{3}{2}-\frac{1}{2}\right)} \quad ... (2)$$

From (1) & (2), $\frac{16a}{3} = \frac{9(a+1)}{2}$

$\Rightarrow$ 32a = 27a + 27

$\Rightarrow$ 5a = 27

a = 5.4

$$K_C = \frac{9(3.2)}{(1)} = 28.8$$

5. $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

$1 - \alpha$ 2α

Average molar mass, $M_{average}$ ($M_{\text{औसत}}$ औसत मोलर द्रव्यमान) $= \frac{1.8 \quad 0.0821 \quad 346}{1} = 51.1$

$$\frac{92}{51.1} = 1 + \alpha \quad \Rightarrow \quad \alpha = 0.8$$

$$P_{N_2O_4} = \left(\frac{1-\alpha}{1+\alpha}\right)(l) \qquad P_{N_2}\left(\frac{2\alpha}{1+\alpha}\right)(l)$$

$$K_P = \frac{4\alpha^2/(1+\alpha)^2}{1-\alpha/1+\alpha} = \frac{4\alpha^2}{1-\alpha^2} \; ; \; K_C = K_P(RT)^{-1}$$

6. $H_2(g) + S(s) \rightleftharpoons H_2S(g)$

0.2 – x x

$K_P = K_C = 6.8 \quad 10^{-2}$

$$\frac{x}{0.2-x} = 6.8 \quad 10^{-2} \quad \Rightarrow \quad x = 0.012$$

P_{H_2S} = (x) RT = 0.012 (0.0821) (363)

7.(a) $CO_2(g) + C(g) \rightleftharpoons 2CO(g)$ K_P = 10atm

P_0–x 2x

$$\frac{4x^2}{P_0 - x} = 10 \; \& \; P_0 + x = 4$$

(b) Let total pressure be P atm (माना कुल दाब P atm है)

$P_{CO_2} = 0.06\ P$ $P_{CO_2} = 0.94\ P$

$$K_P = 10 = \frac{(0.94P)^2}{0.06P} \Rightarrow P = 0.08 \text{ atm}$$

8. $K_P = 1.1^2/0.28$ atm

On doubling volume (आयतन दुगुना करने पर)

$N_2O_4 \rightleftharpoons 2NO_2$

0.14–x 0.55+2x

$$\frac{(0.55+2x)^2}{0.14-x} = \frac{1.1^2}{0.28}$$

9. $2HI \rightleftharpoons H_2 + I_2$

$1-0.8 \quad 0.4 \quad 0.4$

$K_C = \frac{0.4 \quad 0.4}{0.2^2} = 4$

Let x mol of H_2 & I_2 react (माना H_2 व I_2 के x मोल क्रिया करते हैं)

$4 = \frac{(0.135-x)^2}{(2x)^2}$

$I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$

$(0.135-x) \quad 1.5\ M$

If V L of hypo are used (यदि हाइपो के V L प्रयुक्त हुए)

$(0.135 - x) \quad 2 = 1.5\ V$

Let initially a mole I_2 & (1.5 a) mol H_2 be present (माना प्रारम्भ में a मोल I_2 व (1.5 a) मोल H_2 उपस्थित होते हैं)

10. $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

$1.5\ a - x \quad a - x \quad 2x$

$\frac{a-x}{2x} = \frac{1}{18} \Rightarrow 9a - 9x = x$

$x = 9a/10$

$K_C = \frac{[2(9a/10)]^2}{\left(1.5a - \frac{9a}{10}\right)(a - 9a/10)} = \frac{81 \quad 4}{6 \quad 1} = 54$

11. $CO + H_2O \rightleftharpoons CO_2 + H_2$

$1-x \quad 5-x \quad x \quad 1+x$

$\frac{x(1+x)}{(1-x)(5-x)} = 7.3$ Solving x = 0.938

12. $\frac{r_{mix}}{r_{Kr}} = \sqrt{\frac{M_{Kr}}{M_{avg.}}} = 1.16$

Solving, M average $= \frac{83.8}{1.16^2}$

$\frac{71}{M_{avg.}} = 1 + \alpha.$

$K_P = \frac{4\alpha^2}{1-\alpha^2}$

$\Rightarrow K_C = \frac{K_P}{(0.0821)(1473)} = 6.3 \quad 10^{-4}$

13. $X(s) \rightleftharpoons A(g) + C(g) \quad K_p = 400\ mm^2$

$Y(s) \rightleftharpoons B(g) + C(g) \quad K_p = 900\ mm^2$

$y \quad y + x$

$x(x + y) = 400$

$y(x + y) = 900$

(b) Mole ratio of A & B (A व B का मोल अनुपात)$= \frac{x}{y} = \frac{4}{9}$

(c) Total pressure (कुल दाब)$= 2\ (x + y)$

14. M average $= \frac{12.8 \times 0.0821 \times 1000}{1.642} = 64$

$SO_3 \rightleftharpoons SO_2 + 1/2\ O_2$

$t = 0 \quad 1$

$t = \infty \quad 1-\alpha \quad \alpha \quad \alpha/2$

$\frac{80}{64} = 1 + \alpha/2 \Rightarrow \alpha = 0.5$

15. At 288 K, $M_{avg.} = \frac{3.62 \times 0.0821 \times 288}{1}$

$\frac{92}{M_{avg.}} = 1 + \alpha \Rightarrow K_{P1} = \frac{4\alpha^2}{1-\alpha^2}$

Similarly at 348K, M'/avg.$= \frac{1.84 \times 0.0821 \times 348}{1}$

$\frac{92}{M'avg} = 1 + \alpha' \Rightarrow K_{P_2} = \frac{4\alpha'^2}{1-\alpha'^2}$

$\log \frac{K_{P_2}}{K_{P_1}} = \frac{\Delta H^\circ}{2.303R}\left[\frac{1}{288} - \frac{1}{348}\right]$

18. $N_2 + 3H_2 \rightleftharpoons 2NH_3$

$t=0 \quad 60atm \quad 20atm$

$t=\infty \quad 60-x \quad 20atm \quad 2x$

$\frac{2x}{80-2x} = \frac{1}{10} \Rightarrow 20x = 80 - 2x \Rightarrow x = \frac{80}{22}$

$\Rightarrow K_P = \frac{\left[2\left(\frac{80}{22}\right)\right]^2}{\left[60 - \frac{80}{22}\right]\left[20 - \frac{240}{22}\right]^3}$

19. $-16.5 \quad 10^3 = -8.314 \quad 298 \quad 2.303 \log K_1$

$K_2 = K_1^2$

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

let initial pressure of NO be p and of NO_2 be 2p

20. $2NO_2 \rightleftharpoons N_2O_4. \quad K_p = 6.8$

$P-2x-y \quad x$

$NO + NO_2 \rightleftharpoons N_2O_3$

$P-2x-y \quad 2p-y \quad y$