S-II : Chemical Equilibrium

(1).

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

300 K	1 atm	—	
600 K	2 atm	—	$P \propto T\ (V,n)$
After diss.	$2-0.4$	0.8 atm	$P_T = 2.4$ atm
	$= 1.6$ atm		

% dissociation = 20%

(2).

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

In eqm Pr.	—	$2P$	P
New eqm Pr	—	$3P$	$P-x$

$$(2P)^2\ P = (3P)^2\ (P-x)$$

$$\frac{4}{9}P = P - x$$

$$x = \frac{5}{9}P$$

$$\frac{(P_T)_{New\ eqm}}{(P_T)_{Old\ eqm}} = \frac{4P-x}{3P} = \frac{4P-\frac{5}{9}P}{3P} = \frac{31}{3\times 9} = \frac{31}{27}$$

Ans

(3).

(i) $A \rightleftharpoons nB$

$t=0$	0.6	—
$t=1$	$0.6-0.1$	$0.1n = 0.2$

$\Rightarrow n = 2$

(ii) $K = \dfrac{[B]^2}{[A]} = \dfrac{0.6^2}{0.3} = 1.2\ M$

(iii) $\left(-\dfrac{d[A]}{dt}\right)_{0\ to\ 1} = \dfrac{0.1\ M}{1\ hr}$

(4). (a) $X(s) \rightleftharpoons A(g) + C(g) : K_{P_1}$

$P \quad P$

$2P = 40 \Rightarrow P = 20$

$K_{P_1} = 20 \times 20 = 400 \ mm^2$

$Y(s) \rightleftharpoons B(g) + C(g) : K_{P_2}$

$P \quad P$

$2P = 60 \Rightarrow P = 30$

$K_{P_2} = 30 \times 30 = 900 \ mm^2$

(b) $X(s) \rightleftharpoons A(g) + C(g) : K_{P_1} = 400$

$x \quad (x+y)$

$Y(s) \rightleftharpoons B(g) + C(g) : K_{P_2} = 900$

$y \quad (x+y)$

$K_{P_1} = x(x+y) = 400 \ - - - (1)$

$K_{P_2} = y(x+y) = 900 \ - - - (2)$

eq. (1) / eq. (2) $\Rightarrow \frac{x}{y} = \frac{4}{9}$

(c)

eq. ① + eq. ②

$$(x+y)\ (x+y) = 400 + 900$$

$$(x+y) = \sqrt{1300}$$

$$P_{total} = P_A + P_B + P_C = 2(x+y)$$

$$= 2 \times \sqrt{1300} = 72.15 \text{ mmHg}$$

(5). $NO_2(g) + NO(g) \rightleftharpoons N_2O(g) + O_2(g)$; $K_c = 1$

	NO_2	NO	N_2O	O_2
moles initially	a	a	—	—
at eqbm	$a-x$	$a-x$	x	x

$$K_c = 1 = \frac{x \cdot x}{(a-x)(a-x)};$$

$$\Rightarrow 1 = \frac{x}{a-x} \Rightarrow a = 2x = 2 \times 2.5 = 5$$

also $[N_2O] = \frac{x}{5} = 0.5$

$x = 2.5$

$\Rightarrow (NO + NO_2)$ initial $= a + a = 2a = 2 \times 5 = \underline{10}$

(6). $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$: K_{P_1}

$t=0$; $\quad 9a \qquad 13a \qquad —$

at eqbm: $(9a-x) \quad (13a-3x) = 2P_0 \qquad 2x = P_0$

$\qquad\qquad -y \qquad\quad -2y$

$N_2(g) + 2H_2(g) \rightleftharpoons N_2H_4(g)$: K_{P_2}

$t=0$; $\quad 9a \qquad 13a \qquad —$

at eqbm: $(9a-x-y) \quad (13a-3x-2y) = 2P_0 \quad y$

at eqbm

$P_{total} = P_{N_2} + P_{H_2} + P_{NH_3} + P_{N_2H_4}$

$7P_0 = (9a - x - y) + 2P_0 + P_0 + y$

$\qquad\qquad (P_0/2)$

$\Rightarrow \quad a = 0.5\,P_0$

also $P_{H_2} = 2P_0 = 13a - 3x - 2y$

$\qquad\qquad\qquad\quad 0.5P_0 \quad 0.5P_0$

$\Rightarrow \quad y = 1.5\,P_0$

So at eqbm $\Rightarrow P_{N_2} = 2.5\,P_0$; $P_{N_2H_4} = 1.5\,P_0$

$P_{H_2} = 2P_0$; $P_{NH_3} = P_0$

$$K_{P_1} = \frac{(P_0)^2}{(2.5P_0)\ (2P_0)^3} = \frac{1}{20\ P_0^2}$$

$$K_{P_2} = \frac{(1.5\,P_0)}{(2.5P_0)\ (2P_0)^2} = \frac{3}{20\ P_0^2}$$