Daily Tutorial Sheet-11	Numerical Value Type

126.(21%) $N_2 + O_2 \rightleftharpoons 2NO$

Initial mole $a \quad (100-a) \quad 0$

Mole at eq. $(a-x) \quad (100-a-x) \quad 2x$

Given, $\frac{2x}{100} = \frac{1.8}{100} \quad \therefore \quad x = 0.9$

Also, $K_p = K_c = \frac{[NO]^2}{[N_2][O_2]} = \frac{(2x)^2}{(a-x)(100-a-x)} = 2.1\times10^{-3}$

$a = 79\% \qquad 100 - a = 21\%$

127.(17.72%) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

Mole before equilibrium $1 \quad 3 \quad 0$

Mole after equilibrium $(1-x) \quad 3(1-x) \quad 2x$

$$K_p = \frac{(2x)^2}{(1-x)\left[3(1-x)\right]^3} \times \left[\frac{4-2x}{P}\right]^2; \qquad K_p = \frac{16x^2\times(2-x)^2}{27(1-x)^4\times P^2}$$

Or $1.6\times10^{-5} = \frac{16x^2\times(2-x)^2}{27(1-x)^4\times(200)^2}$

$$\frac{x^2(2-x)^2}{(1-x)^4} = \frac{1.6\times10^{-5}\times27\times(200)^2}{16} = 1.08$$

$$\frac{x(2-x)}{(1-x)^2} = 1.039 \quad \Rightarrow \quad x = 0.301$$

Mole of NH_3 formed $= 2\times0.301 = 0.602$

Total mole at equilibrium $= 4 - 2\times0.301 = 3.398$

% of NH_3 at equilibrium $= \frac{0.602}{3.398}\times100 = 17.72\%$

128.(0.125) $HI(g) \rightleftharpoons \frac{1}{2}H_2(g) + \frac{1}{2}I_2(g)$

Initial mole $1 \quad 0 \quad 0$

Mole at equilibrium $(1-\alpha) \quad \frac{\alpha}{2} \quad \frac{\alpha}{2}$

Where, α is degree of dissociation: let volume of container be V litre. Also, $\alpha = 0.2$, i.e., 20%

$\Delta n = 0$

$$K_p = K_c = \frac{(\alpha/2V)^{1/2}(\alpha/2V)^{1/2}}{\left[(1-\alpha)/V\right]} = \frac{\alpha}{2(1-\alpha)}$$

$$K_p = K_c = \frac{0.2}{2\times(1-0.2)} = 0.125$$

129.(0.64) $N_2O_4 \rightleftharpoons 2NO_2$

Pressure at equilibrium $0.28 \quad 1.1$

$$K_p = \frac{(P'_{NO_2})}{(P'_{N_2O_4})} = \frac{(1.1)^2}{0.28} = 4.32\,\text{atm}$$

If volume of container is doubled, i.e., pressure becomes half, the reaction will also procced in the direction where the reaction shows an increase in mole. i.e., decomposition of N_2O_4 is favoured.

$$N_2O_4 \rightleftharpoons 2NO_2$$

New pressure at equilibrium $\left[\frac{0.28}{2} - p\right] \qquad \left[\frac{1.1}{2} + 2p\right]$

Where, N_2O_4 equivalent to pressure P is used up in doing so.

Again, $K_p = \frac{[(1.1/2) + 2P]^2}{[(0.28/2) - P]} = 4.32 \quad \Rightarrow \quad P = 0.045$

$P_{N_2O_4}$ at new equilibrium $= 0.14 - 0.045 = 0.095\,atm$

P_{NO_2} at new equilibrium $= 0.55 + 2 \times 0.045 = 0.64\,atm$

130.(4.54)

$$PCl_5 \rightleftharpoons PCl_3 + Cl_2$$

Initial mole	1	0	0
Mole at eq.	$1 - 0.4$	0.4	0.4

Total mole at equilibrium $= 1 - 0.4 + 0.4 + 0.4 = 1.4$

Also, $\frac{\text{Normal molar mass of } PCl_5}{\text{Exp. molar mass of } PCl_5} = 1 + \alpha = 1.4$

$$\frac{208.5}{\text{Exp. molar mass of } PCl_5} = 1.4$$

Exp. Molar mass of PCl_5

Or Molar mass of mixture $= \frac{208.5}{1.4}$

Now using, $PV = \frac{w}{m}RT$ for mixture

$$d = \frac{w}{V} = \frac{Pm}{RT} = \frac{1 \times 208.5}{1.4 \times 0.082 \times 400} = 4.54\,g/litre$$

131.(1) $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = -30 - 300 \times (-0.1) = -30 + 30 = 0$

$\Delta G^\circ = 2.303\,RT \log K_p$

$K_p = 1$

132.(2) $2A(g) + nB(g) \rightleftharpoons 3C(g)$

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

$\left(\frac{0.0105}{0.45}\right) = (0.0821 \times 523)^{\Delta n}$

$\Delta n = -1$

$\Delta n = 3 - (2 + n) = -1$

$n = 2$

133.(1)

$$AB_2(g) \rightleftharpoons AB(g) + B(g)$$

P	0	0
$P - P'$	P'	P'

Given $P = 6\,atm \quad \Rightarrow \quad P + P' = 8\,atm \quad \Rightarrow \quad K_P = \frac{2 \times 2}{4} = 1$

134.(0.45) $A(s) \rightleftharpoons X(g) + 2Y(g)$

$P_1 \quad 2P_2 + 2P_1$

$B(s) \rightleftharpoons X(g) + 2Y(g)$

$P_1 \quad 2P_2 + 2P_1$

$B(s) \rightleftharpoons Z + 2Y(g)$

$P_1 \quad 2P_2 + 2P_1$

Thus, $\frac{K_{p_1}}{K_{p_2}} = \frac{P_1 \times (2P_1 + 2P_2)^2}{P_2 (2P_1 + 2P_2)^2} = \frac{P_1}{P_2} = \frac{9 \times 10^{-3}}{4.5 \times 10^{-3}} = 2$

$P_1 = 2P_2$

Also, $K_{p_1} = 9 \times 10^{-3} = P_1 \times (2P_1 + 2P_2)^2 = P_1 \times (2P_1 + P_1)^2 = 9P_1^3$

$P_1 = 0.1\,atm,\ P_2 = 0.05\,atm,$

$P_T = 2P_1 + 2P_2 + P_1 + P_2 = 3(P_1 + P_2) = 3 \times 0.15 = 0.45\,atm$

135.(5.24) Let a mole of glycerine be added

$H_3BO_3 + \text{Glycerine} \rightleftharpoons \text{Complex}$

$1 \quad a \quad 0.8$

$0.2 \quad (a - 0.8)$

$K_c = \frac{[\text{Complex}]}{[H_3BO_3]\,[\text{glycerine}]} = 0.90 \text{ or } \frac{0.8}{0.2 \times (a - 0.8)} = 0.90$

$(a - 0.8) = \frac{4}{0.9} = 4.44 \quad \Rightarrow \quad a = 4.44 + 0.8 = 5.24$

136.(50) K_p is independent of initial concentration as $\Delta n_g = 0$.

137.(0.32) $A + 2B \rightleftharpoons 2C + D$

$a \quad \frac{3}{2}a \quad 0 \quad 0$

$(a - x) \quad \left(\frac{3}{2}a - 2x\right) \quad 2x \quad x$

Given, $a - x = 2x \quad \Rightarrow \quad x = \frac{a}{3}$

Now, $K_c = \frac{[C]^2[D]}{[A][B]^2} = \frac{\left(\frac{2a}{3}\right)^2 \times \frac{a}{3}}{\left(a - \frac{a}{3}\right)\left(\frac{3a}{2} - \frac{2a}{3}\right)^2} = 0.32$

138.(200) $K_p = \frac{P_{CH_3OH}}{P_{CO} \times P_{H_2}^2} = \frac{2}{1 \times (0.1)^2} = 200\,atm^{-2}$

139.(0.11) $NH_4HS(s) \rightleftharpoons NH_2(g) + H_2(g)$

Before eq. $\quad 0.5 \quad 0$

After eq. $\quad 0.5 + P \quad P$

$P_T = 0.84 = 0.5 + P + P$

$K_P = P'_{NH_3} \times P_{H_2S} = (0.5 + 0.17) \times 0.17 = 0.11\,atm^2$

140.(53.85)

Equilibrium constant K_c for backward reaction is

$$K_c = \frac{K_b}{K_f} = \frac{2.1\times10^{-3}}{3.9\times10^{-5}} = 53.85 \text{ litre mol}^{-1}$$