Daily Tutorial Sheet - 15	Level-3

159.(2) $N_2O_4 \rightleftharpoons 2NO_2$

$$\begin{array}{cc} 1 & 0 \\ 1-\alpha & 2\alpha \end{array}$$

$$K_p = \frac{\left(\frac{2\alpha}{1+\alpha}p\right)^2}{\left(\frac{1-\alpha}{1+\alpha}p\right)} \qquad P = 1\,atm$$

$$\frac{(VD)_{initial}}{(VD)_{equili}} = \frac{1+\alpha}{1} \quad \Rightarrow \quad (VD)_i = \frac{M_{N_2O_4}}{2}$$

$$(VD)_{equili} = \frac{dRT}{2p} \quad \Rightarrow \quad K_p = K_c\,(RT)^{\Delta ng}$$

160.(2)

$$\begin{array}{lcccc} & A(g) & + \ B(g) & \rightleftharpoons C(g) & + \ D(g) \\ \text{Initially} & 1 & 1 & 0 & 0 \\ & 1-x & 1-x & x & x \end{array}$$

$$K_p = \frac{x^2}{(1-x)^2}$$

$$\Delta G^\circ = -RT\,\ell n\,K_p$$

$$\frac{-830}{-RT} = \ell n\,K_p$$

$$\frac{830}{2.303\,RT} = \log K_p$$

$$10^{\frac{830}{2.303\,RT}} = K_p \quad \Rightarrow \quad \sqrt{10^{\frac{830}{2.303\,RT}}} = \frac{x}{(1-x)}$$

$$\Rightarrow \quad \sqrt{10^{\frac{830}{2.303\,RT}}} = \frac{[C]}{[A]}$$

161.(0.64 atm⁻¹)

Moles of nitric oxide $= \dfrac{0.46 \times 250 \times 10^{-3}}{0.082 \times 350} = 4 \times 10^{-3}$

Moles of oxygen $= \dfrac{0.86 \times 100 \times 10^{-3}}{0.082 \times 350} = 3 \times 10^{-3}$

After the completion of first reaction,

Moles of oxygen left $= 10^{-3}$, moles of NO_2 left $= 4 \times 10^{-3}$

$$\begin{array}{lcl} 2NO_2(g) & \rightleftharpoons N_2O_4 & \\ 4 \times 10^{-3} & 0 & \text{initial} \\ 4 \times 10^{-3}(1-x) & 4 \times 10^{-3}(x/2) & \text{equilibrium} \end{array}$$

Total moles at equilibrium $= 4 \times 10^{-3}\left[(1-x)+(x/2)\right]+10^{-3}$

$$0.37 \times 350 \times 10^{-3} = 10^{-3}\,(4-4x+2x+1) \times 0.082 \times 350$$

On solving we get, x = 0.2439

Partial pressure of $NO_2 = \frac{3\times 0.37}{4.5} = 0.25$

and Partial pressure of $N_2O_4 = \frac{0.5\times 0.37}{4.5} = 0.04$

$\therefore \quad K_P = \frac{0.04}{0.25\times 0.25} = 0.64\,atm^{-1}$

162.(314.64 mm Hg)

$P = \frac{275}{760} = 0.3618\,atm$

$P_{NH_3} = P_{HI} = \frac{0.3618}{2} = 0.181\,atm$

(i) $NH_4I(s) \rightleftharpoons NH_3(g) + HI(g), \quad K_P = (0.181)^2 = 0.033\,atm^2$

$(0.181)+p \quad (0.181+p-p') \quad$ At equilibrium

(ii) $2HI(g) \rightleftharpoons H_2(g) + I_2(s), \quad K_P = 0.015$

$(0.181+p-p') \quad p'/2 \quad p'/2 \quad$ At equilibrium

$0.33 = (0.181+p)(0.181+p-p')$ .... (1)

$0.015 = \frac{p'^2}{4(0.181+p-p')^2}$ .... (2)

On solving equation (1) and (2), we get $p' = 0.04\,atm$ and $p = 0.026\,atm$

Hence, total pressure = 2(0.181+p) = 0.414 = 314.64 mm Hg

163.(20/3)

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

At equilibrium $\quad 2\,mol \quad 2\,mol \quad 2\,mol$

Total pressure = 30.3975 kPa = 3 atm = P (say)

$$K_P = \frac{P_{PCl_3}\times P_{Cl_2}}{P_{PCl_5}} = \frac{\frac{P}{3}\times\frac{P}{3}}{\frac{P}{3}}$$

$K_P = \frac{P}{3} = 1$ .... (1)

When chlorine is added to the system. The system will try to nullify the effect and hence formation of PCl_5 will be preferred.

Since, P and T are constant

$\frac{V_1}{V_2} = \frac{n_1}{n_2} = n_1 = 6 \qquad [\because V_1 = V, V_2 = 2V]$

$\therefore \quad n_2 = 12\,moles$

Say, 'a' moles of Cl_2 were added

	PCl_2	$\rightleftharpoons$	PCl_3	+	Cl_2
Initial	2		2		2
Final	$2+x$		$2-x$		$2+a-x$

$n_T - 12 = 6 + a - x$

$\therefore \quad a - x = 6$

$$K_p = \frac{\frac{2+ax-x}{12} \times \frac{2-x}{12}}{\frac{2+x}{12}} \times P = \frac{(2+a-x)(2-x)}{4(2+x)} = 1 \qquad \text{........ (2)}$$

Solving equations (1) and (2), we get

$$a = \frac{20}{3} \text{ moles}$$

Hence, $\frac{20}{3}$ moles of Cl_2 was added.

164.(0.3327 atm /(gm/L)

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

Since $\quad PV = nRT = \frac{w}{M}RT$

$$M = \frac{wRT}{PV} = \frac{\rho RT}{P}$$

$\therefore \quad$ V.D.(d) $= \frac{\rho RT}{2P}$

	$PCl_5(g)$	$\rightleftharpoons$	$PCl_5(g)$	+	$Cl_2(g)$
Initial	C		0		0
At eqm.	$C(1-\alpha)$		$C\alpha$		$C\alpha$

$$\frac{\text{Total moles at equilibrium}}{\text{Total initial moles}} = \frac{\text{Initial vapour density}}{\text{Vapour density at equlibrium}}$$

$$\frac{C(1+\alpha)}{C} = \frac{D}{d} \quad \Rightarrow \quad 1+\alpha = \frac{M/2}{\rho RT/2P} = \frac{PM}{\rho RT}$$

$\therefore \quad \alpha = \frac{PM}{\rho RT} - 1$

If $\quad d = 62, \frac{M}{2} = \frac{208.5}{2} = 104.25$

$$\alpha = \frac{104.25-62}{62} = 0.68$$

$\therefore \quad \frac{P}{\rho} = \frac{(1+\alpha)RT}{M} = 0.3327 \text{ atm}/(\text{gm}/\text{L})$