PHYSICAL CHEMISTRY

AVIRAL
JEE | NEET | FOUNDATIONS

DPP No. 32 & 50

Total Marks : 52
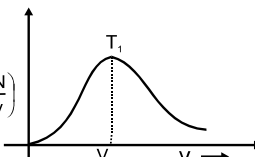
Max. Time : 62 min.

SOLUTION

Hints & Solutions

DPP No. # 32

6. N_2 + $3H_2 \longrightarrow 2NH_3$
Initially a atm   b atm
Finally   a – x   b – 3x   2x
∴ a + b = 1 and   a + b – 2x = 0.75

∴ P_{NH_3} = 2x = 0.25 atm

7. $V_{RMS} = \sqrt{\dfrac{3RT}{M}} = \sqrt{\dfrac{3P}{\rho}} = \sqrt{\dfrac{3 \times 1.2 \times 10^5}{4}}$ = 300 m/s

8. $[(v_{rms})_X]_{546°C} = [(v_{mp})_Y]_{273°C}$

$\sqrt{\dfrac{3RT_x}{M_x}} = \sqrt{\dfrac{2RT_Y}{M_Y}}$ $\dfrac{3 \times 819}{9} = \dfrac{2 \times 546}{M_Y}$

∴ M_Y = 4 amu.

9.   **(C)** Area under the curve $\left(\dfrac{1}{N}\dfrac{dN}{dv}\right)$

$= \displaystyle\int_0^x y dx = \int_0^N \left(\dfrac{1}{N}\dfrac{dN}{dV}\right)dV = \dfrac{1}{N}\int_0^N dN = 1.$

11.   **(C,D)**
If two gases haves identical Max wellian plot then their all the speeds will also be identical.

Hence $\dfrac{T_A}{M_A} = \dfrac{T_B}{M_B}$. Since all the speeds are proportional to $\sqrt{\dfrac{T}{M}}$

for SO_2 – M_1 = 64, T_1 = 600 K ; O_2 – M_2 = 32, T_2 = 300 K $\Rightarrow \dfrac{T_1}{M_1} = \dfrac{T_2}{M_2}$.

DPP No. # 33

1.   (a) V.P. depends on temperature.

3.   Pressure of air = 750 – 100 = 650 mm of Hg
on compressing P_f = Hg 650 × 3 mm of Hg
                   = 1950 mm of Hg
so P_T = (1950 + 100) = 2050 mm of Hg

4. $P_{N_2} + P_{H_2O_{(v)}}$ = 1 atm, ∵ P_{H_2O} = 0.3 atm

$$\therefore \ P_{N_2} = 0.7 \ \text{atm}$$
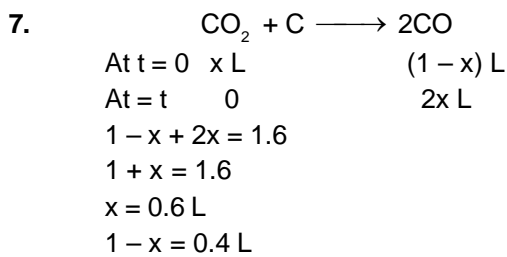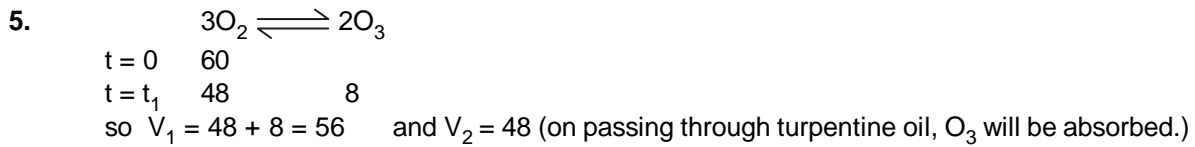
Now new pressure of N_2 in another vessel of volume V/3 at same T is given by :

$$P_{N_2} \times \frac{V_1}{3} = 0.7 \, 0 \times V_1$$

$$\therefore \ P_{N_2} = 2.1 \ \text{atm}$$

Since aqueous tension remains constant, and thus total pressure in new vessel.

$$= P_{N_2} + P_{H_2O} = 2.1 + 0.3 = 2.4 \ \text{atm}.$$

5. $3O_2 \rightleftharpoons 2O_3$
t = 0   60
t = t_1 48   8
so V_1 = 48 + 8 = 56   and V_2 = 48 (on passing through turpentine oil, O_3 will be absorbed.)

7. $CO_2 + C \longrightarrow 2CO$
At t = 0   x L   (1 – x) L
At = t   0   2x L
1 – x + 2x = 1.6
1 + x = 1.6
x = 0.6 L
1 – x = 0.4 L

8.   896 mL.

DPP No. # 34

1. $T_4 < T_3 < T_2 < T_1$

2.   A real gas behaves ideally under conditions of low pressure and high temperature.

3.   Order of Vander waals constant $CO_2 > CH_4 > N_2 > H_2$
$\therefore$ ease of liqufication $CO_2 > CH_4 > N_2 > H_2$

5.* Z for an ideal gas is equal one.

6.   Clearly, from the graph at 80 K = $\dfrac{PV}{RT}$ = 1 and at 60K, Z < 1

7. $Z = \dfrac{PV}{nRT}$ $\Rightarrow$ $n = \dfrac{PV}{ZRT}$

8.   Translational energy   = (3/2) kT
= (3/2) kT = hcR_H ((1/1) – (1/4))

= (3/2) T = 6.626 × 10^{-34} × 2.996 × 10^{10} × 109679 × (3/4) $\dfrac{6.02 \times 10^{23}}{8.315}$

= 118331.1 K
T = 118331.1 × 2/3 = 80000 K.

DPP No. # 35

4.   For very large value of molar volume (V_m)

$\dfrac{a}{V_m}$ and b can be neglected, so gas behaves as Ideal

$\therefore \ PV_m = RT$

5.   At low pressure vander waal's equivalent for a real gas is given as

$$Z = 1 - \frac{a}{RTV}$$

intercept = 1

slop = –ve

7. (i) $Z = \dfrac{PM}{dRT} = \dfrac{2 \times 16}{0.8 \times \dfrac{1}{12} \times 400} = 1.2$

(ii) As Z > 1, so repulsive forces are dominating among gas molecules.

8. At Boyle's temperature, for low pressure regions, Z = 1. However, for high pressure regions, Z > 1.

DPP No. # 36

4. Under low pressure region and below the boyle temperature, Z < 1.
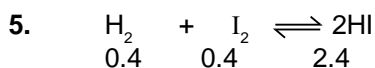
5. Refer class notes.

7.* at very high Pressure $Z = 1 + \dfrac{Pb}{RT}$

$\qquad\qquad Z > 1$

for particular realgas above boyle temp Z > 1.

8. [A – r] ; [B – r,s] ; [C – q] ; [D – r].

DPP No. # 37

5. $\begin{matrix} H_2 & + & I_2 & \rightleftharpoons & 2HI \\ 0.4 & & 0.4 & & 2.4 \end{matrix}$

$K = \dfrac{2.4 \times 2.4}{0.4 \times 0.4} = 36$ (Since volume term is cancelled)

7. Mol. mass of HI = 1 + 127 = 128

64 g HI = 64 / 128 = 0.5 mole

$[HI] = \dfrac{0.5}{2}$ M = 0.25 M

DPP No. # 38
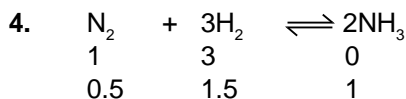
1. $K_p = K_c (RT)^{\Delta n}$

$2K_c = K_c (RT)^{\Delta n}$
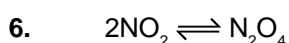
$2 = (RT)^1$

$T = \dfrac{2}{0.0821} = 24.36$ K

4. $\begin{matrix} N_2 & + & 3H_2 & \rightleftharpoons & 2NH_3 \\ 1 & & 3 & & 0 \\ 0.5 & & 1.5 & & 1 \end{matrix}$

$P_{H_2} = \dfrac{1.5}{3}P = P/2$

6. $2NO_2 \rightleftharpoons N_2O_4$

$K_c = \dfrac{[N_2O_4]}{[NO_2]^2} = \left(= \dfrac{mol\,L^{-1}}{(mol L^{-1})^2}, K_c \text{ has unit of } L\,mol^{-1} \right)$

$$K_p = \frac{p_{N_2O_4}}{p_{NO_2}^2} \quad \left(= \frac{atm}{atm^2}, K_p \text{ has unit of } atm^{-1} \right)$$

(Since mole fraction is itself unitless hence, K_x is also unitless)

7.   (i) Molar concentrations :

$$[PCl_5] = \frac{mol}{L} = \frac{1}{2} = 0.5 \text{ mol L}^{-1}$$

$$[PCl_3] = \frac{2}{2} = 1.0 \text{ mol L}^{-1}$$

$$[Cl_2] = \frac{2}{2} = 1.0 \text{ mol L}^{-1}$$

(ii) Mole fractions :
Total moles at equilibrium = 1 + 2 + 2 = 5

$$\therefore \qquad X_{PCl_5} = \frac{n_{PCl_5}}{n_{total}} = \frac{1}{5} = 0.2$$

$$X_{PCl_3} = \frac{n_{PCl_3}}{n_{total}} = \frac{2}{5} = 0.4$$

$$X_{Cl_2} = \frac{n_{Cl_2}}{n_{total}} = \frac{2}{5} = 0.4$$

(iii) Equilibrium constants :

$$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{1 \times 1}{0.5} = 2 \ (mol \ L^{-1})^{-1} = 2 \ L \ mol^{-1}$$
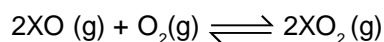
8. $K_C = 4.0$.

9.

$$PCl_3 + Cl_2 \rightleftharpoons PCl_5$$

t = 0   n   n   0
t = teq.   n-y   n-y   y

$$K_p = \frac{y}{(n-y)\ (n-y)} \left[\frac{P}{2n-y} \right]^{-1}$$
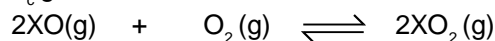
$$K_p = \frac{(2n-y)y}{(n-y)^2 \ P}$$

DPP No. # 39

8.   The equilibrium reaction is

$$2XO \ (g) + O_2(g) \rightleftharpoons 2XO_2 \ (g)$$

since the unit of K_c given is lit/mole.

$$2XO(g) \quad + \quad O_2 \ (g) \quad \rightleftharpoons \quad 2XO_2 \ (g)$$

Initial conc.   1   2   0
Conc. at equilib. $1-2x$ $2-x$ $2x$

$$\therefore \qquad K_c = \frac{[XO_2]^2}{[XO]^2 \ [O_2]} = \frac{(2x)^2}{(1-2x)^2(2-x)} = \frac{4x^2}{(1-2x)^2 \ (2-x)} = \frac{4x^2}{2}$$

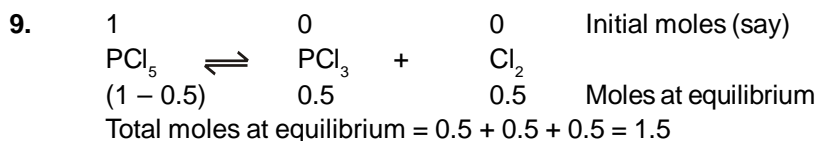Since, the value of equilibrium constant is very small (1×10^{-4}), so 2x can be ignored with respect to 1 and x can be ignored with respect to 2.

$$\therefore \qquad 1 \times 10^{-4} = \frac{4x^2}{2}$$

$$x = 7.07 \times 10^{-3}$$

we can see that the value of x is very small, so the assumtion made was correct as it is within 1.4% of the actual value. Thus, the assumption made is correct and acceptable.
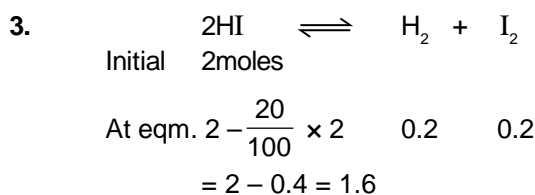
∴   [XO] = 1 – 0.01414 = 0.985 M
         [O_2] = 2 – 0.00707 = 1.992 M
         [XO_2] = 0.0141 M

9.   1   0   0   Initial moles (say)
         PCl_5 $\rightleftharpoons$ PCl_3 + Cl_2
         (1 – 0.5)   0.5   0.5   Moles at equilibrium
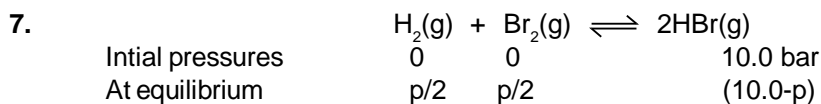   Total moles at equilibrium = 0.5 + 0.5 + 0.5 = 1.5

$$K_p = \frac{p_{PCl_3} \cdot p_{Cl_2}}{p_{PCl_2}} = \frac{\left(\frac{0.5}{1.5}p\right)\left(\frac{0.5}{1.5}p\right)}{\left(\frac{0.5}{1.5}p\right)}$$ (p = total pressure)

or $K_p = \frac{1}{3} \cdot p$ or   p = 3K_p.

DPP No. # 40

3.   2HI $\rightleftharpoons$ H_2 + I_2
         Initial   2moles

         At eqm. $2 - \frac{20}{100} \times 2$ 0.2   0.2

                  = 2 – 0.4 = 1.6

         $K = \frac{[H_2][I_2]}{[HI]} = \frac{0.2 \times 0.2}{(1.6)^2} = \frac{1}{64}$.

7. $H_2(g)$ + $Br_2(g)$ $\rightleftharpoons$ 2HBr(g)
         Intial pressures   0   0   10.0 bar
         At equilibrium   p/2   p/2   (10.0-p)

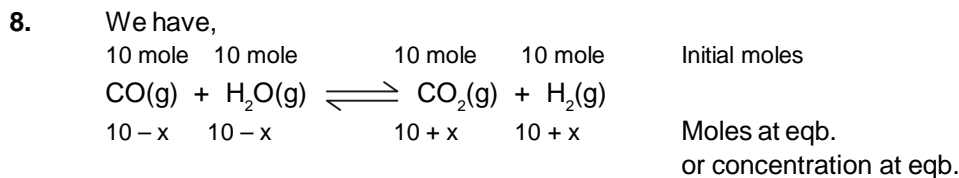$$K_p = \frac{p^2_{HBr}}{p_{H_2} \times p_{Br_2}}$$

$$1.6 \times 10^5 = \frac{(10-p)^2}{(p/2)(p/2)}$$

         Taking square root of both sides

$$4 \times 10^2 = \frac{10-p}{p/2}$$

$$200\,p = 10 - p \; ; \; p = \frac{10}{201} \text{ bar}$$

$p_{H_2} = p/2 = \frac{1}{2}\left(\frac{10}{201}\right)$ bar $= 2.5 \times 10^{-2}$ bar ; $P_{Br_2} = p/2 = 2.5 \times 10^{-2}$ bar ; $P_{HBr} = 10 - p \approx 10$ bar .

8.   We have,
         10 mole   10 mole   10 mole   10 mole   Initial moles
         CO(g) + $H_2O(g)$ $\rightleftharpoons$ $CO_2(g)$ + $H_2(g)$
         10 – x   10 – x   10 + x   10 + x   Moles at eqb.
                                                            or concentration at eqb.
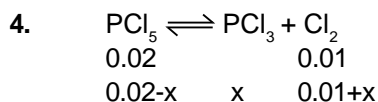   where x is the number of moles of each reactant changed to the products at equilibrium.

         K = $\frac{(10+x)^2}{(10-x)^2}$ = 9/4 (given)   or $\frac{10+x}{10-x}$ = 3/2 ; x = 2

         Mole percent of H_2 (g) at equilibrium = $\frac{10+x}{40}$ × 100 = 30

DPP No. # 41

3.   0.2.

4. $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
0.02   0.01
0.02-x   x   0.01+x

$$D = \frac{PM}{RT}$$

Calculate M_{avg}.

$$\frac{(0.02-x)208.5 + 137.5x + (0.01+x)71}{0.03+x} = M_{avg}.$$

5. $NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$
                            P   P
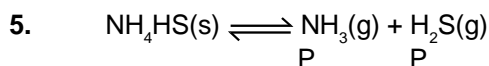
2P = 1.12
P = 0.56
$K_P = P^2 = (0.56)^2 = 0.3136$ atm^2

6. $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$
0.2-x   x   x
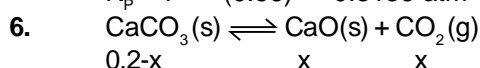
$$K_P = P_{CO_2} = 1$$

$$x = \text{mole of } CO_2 = \frac{PV}{RT}$$

Remaining mass of $CaCO_3 = (0.2-x) \, 100$ g.

7. $[CaO] = \dfrac{\rho_{CaO(s)}}{M_{CaO(s)}} = \dfrac{1.12}{56} \times 1000$

9.* Addition of solids have no effect on equilibrium and temperature favours endothermic direction while increasing pressure will shift equilibrium in backward direction as Δn_g is +ve.

DPP No. # 42

**2.** $K_p = (p_{H_2O})^4 = 2.56 \times 10^{-10}$ atm^4

$\therefore \quad p_{H_2O} = 4 \times 10^{-3}$ atm $= 4 \times 10^{-3} \times 760 = 3.04$ torr.

Partial pressure of water vapour in air $= \dfrac{40}{100} \times 12.5 = 5$

So, the amount of water vapour in air should decrease to decrease value of partial pressure of water vapour from 5 torr to the equilibrium value (3.04 torr).
so, mass of $CuSO_4.5H_2O$ will increase and mass of $CuSO_4.H_2O$ will decrease.

3. (A) As reaction is endothermic therefore it will go in the forward direction hence moles of PbO will increase.
(B) With the increase or decrease of volume partial pressure of the gases will remain same.
(C) Due to the addition of inert gas at constant pressure reaction will proceed in the direction in which more number of gaseous moles are formed.
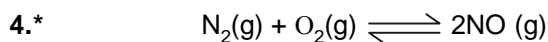
4.* $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$
(A) For changing pressure volume has to be changed, though number of moles of NO(g) do not get changed but its concentration will get changed.
(B) Temperature change will change K_P and hence concentration.
(C) Volume change will change concentration, not the number of moles.
(D) Catalyst does not change equilibrium concentrations.

5.* Number of moles will remain unchanged but due to decreased volume pressure will get increased and also the concentrations.

6. Slope $= -\tan 30° = \dfrac{-1}{\sqrt{3}} = \dfrac{-\Delta H°}{R}$

$\therefore \quad \Delta H° = \dfrac{R}{\sqrt{3}}$

7. As $T \to \infty$, $K = A$

$\therefore \quad \ell nA = \ell nK = 46.06$

$\therefore \quad 2.303 \log_{10} A = 46.06$

$\therefore \quad A = 10^{20}$

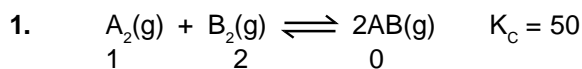**8.** $\Delta H° > O$ $\therefore$ Endothermic reaction

Y – intercept = +ve $\therefore \Delta S° > 0$

for endothermic reaction, as $T\uparrow$, $K\uparrow$.

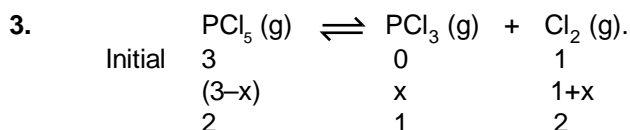The value of equilibrium constant K is unaffected by pressure changes.

DPP No. # 43

1.
$$A_2(g) \ + \ B_2(g) \ \rightleftharpoons \ 2AB(g) \qquad K_C = 50$$

$$\begin{array}{ccc} 1 & 2 & 0 \end{array}$$

$$\begin{array}{ccc} \dfrac{1-x}{3} & \dfrac{2-x}{3} & \dfrac{2x}{3} \end{array}$$

$$50 = \dfrac{\dfrac{2x}{3}\cdot\dfrac{2x}{3}}{\dfrac{1-x}{3}\cdot\dfrac{2-x}{3}} = \dfrac{4x^2}{(1-x)(2-x)} = \dfrac{4x^2}{2-3x+x^2} \qquad \Rightarrow \qquad 100 - 150\,x + 50x^2 = 4x^2$$

$\therefore$ no. of mol of AB $= \dfrac{2x}{3} = 1.868$.

$\therefore$ AB **dhely l & k** $= \dfrac{2x}{3} = 1.868$

2. (i) From the graph $0.3 \times n = 0.6$

       $n = 2$

(ii) $K = (0.6)^2 / 0.3 = 1.2$ mol / L

3.
$$PCl_5(g) \ \rightleftharpoons \ PCl_3(g) \ + \ Cl_2(g).$$

Initial   3   0   1

         (3–x)   x   1+x

         2   1   2

Initial total moles = (3+1) = 4.

Now from Ideal gas equation

       PV = nRT = P × 100 = 4 × 0.082 × 500

       P = 0.082 × 20 = 1.64 atm.

At equilibrium Total mole = 3 – x + x + 1 + x = (4 + x)

       PV = nRT.

2.05 × 100 = (4+x) × 0.082 × 500.

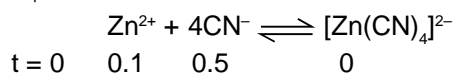2.05 = (4+x) × 0.41.

5 = 4 + x.
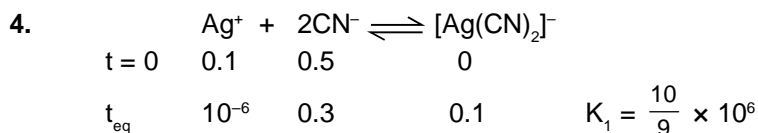
x = 1.

$$\alpha = \dfrac{\text{No. of mole dissociated}}{\text{Initially total mole taken}} = \dfrac{1}{3} = 0.33.$$

$$P_{PCl_5} = \dfrac{2}{5} \times 2.05 \quad ; \qquad P_{PCl_3} = \dfrac{1}{5} \times 2.05 \qquad P_{Cl_2} = \dfrac{2}{5} \times 2.05$$

$$K_P = \dfrac{\left(\dfrac{1}{5}\times 2.05\right)\left(\dfrac{2}{5}\times 2.05\right)}{\left(\dfrac{2}{5}\times 2.05\right)} = [0.41]$$

4.

$$Ag^+ + 2CN^- \rightleftharpoons [Ag(CN)_2]^-$$

t = 0   0.1   0.5   0

t_{eq} 10^{-6} 0.3   0.1 $K_1 = \dfrac{10}{9} \times 10^6$

$$Zn^{2+} + 4CN^- \rightleftharpoons [Zn(CN)_4]^{2-}$$

t = 0   0.1   0.5   0

eq. 10^{-12} 0.1   0.1 $K_2 = \dfrac{0.1}{(0.1)^4 \times 10^{-12}} = 10^{15}$

Substracting two times Ist reaction from IInd reaction, we will get the required reaction, so

$K_{eq} = \dfrac{10^{15}}{\left(\dfrac{10}{9}\right)^2 \times 10^{12}} = \dfrac{10^3 \times 81}{100} = 810$ **Ans. 810**

5.* When some amount of HCl is added to equilibrium, the first eq will shift in backward direction leading to decrease in amount of O_2. Then, the second eq. will shift in backward direction to increase the amount of O_2. Thus, amount of N_2 gas will increase.

DPP No. # 44

4. (i) Molecules move faster for which $\dfrac{T}{M}$ greater obviously H_2 molecule move faster.

5. State function : a, b, c, d, g, h, j   ;   Path function : e, f, i, k

6. Intensive :   a, c, d, f, g, h, i, k   ;   Extensive :   b, e, j, l

7. Open system :   b, f, g, i, j   ;   Closed system : a, c, h ; Isolated system :   d, e

8. Q = 7.5 KJ
$\Delta U = -12$ KJ
$\Delta U = Q + W$
W = $-12 - 7.5 = $ **−19.5 KJ. Ans.**
Now   W = 0,
∴ $\Delta U = Q$ ∴ $Q = \Delta U = $ **− 12 KJ Ans.**

DPP No. # 45

5. $\Delta U_{ab} = Q_{abc} + W_{abc}$
or $\Delta U_{ab} = 100 - 40 = 60$ J
   $\Delta U_{ab} = Q_{aeb} + W_{aeb}$
or $60 = Q_{aeb} - 20$
or $Q_{aeb} = $ **80 J**   **Ans.**

   $\Delta U_{ba} = -60$ J
   $W_{bda} = 30$ J
   $\Delta U_{ba} = Q_{bda} + W_{bda}$
or $Q_{bda} = \Delta U_{ba} - W_{bda}$

or $\boxed{Q_{bda} = -60 - 30 = -90 \text{ J}}$ **Ans.**

Since Q_{bda} is (−)ve ∴ Heat is liberated from the system.

6. 4275 J.

7. 6.66 min. (400 sec)

8. Since $\Delta E = q + w$
         $= 80 - 30 = 50$
So for ADB
         $\Delta E = q + w$

$$50 = q - 10$$
$$q = 60 \text{ J}$$

9. For B to A,
$$\Delta E = -50 \text{ J}$$
$$w = +20 \text{ J}$$
$$q = -50 - 20 = -70$$
heat is liberate.

10. In ADB process, DB process is isochoric so $w_{DB} = 0$
So , $\Delta E_{AD} = q_{AD} + w_{AD}$
$$-40 = q_{AD} + (-10)$$
$$q_{AD} = -30 \text{ J}$$
Now , $q_{AB} = q_{AD} + q_{DB}$
$$60 = -30 + q_{DB}$$
$$q_{DB} = 90 \text{ J}$$

DPP No. # 46

1. $w = P_{ext} \Delta V$
$w = -1.2 \times 32 = -38.4$ lt atm.
$= -38.4 \times 100 \text{ J} = -3840 \text{ J} = -3.84 \text{ kJ}$
$\Delta E = q + w$
so, $q = \Delta E - w = -51 + 3.84 = -47.16$.

6. W = 240 L atm.

7. $\Delta U = \Delta H = 0$ Q= -W

$W = -2.303 \, nRT \log \dfrac{V_2}{V_1}$ $\Rightarrow$ $W = -2.3 \times \dfrac{20}{40} \times 8.3 \times 300 \log \dfrac{10}{5} = -859.05 \text{ J}.$

8. (a) $W = -nRT \ln \dfrac{V_2}{V_1}$

$W = -P_1 V_1 \ln \dfrac{V_2}{V_1} = -14 \times 0.03 \ln \dfrac{0.06}{0.03}$ bar m^3 = $-14 \times 0.7 \times 0.03$ = **– 0.294 bar m³ Ans.**

(b) $P_1 V_1 = P_2 V_2$

∴ $P_2 = \dfrac{P_1 V_1}{V_2} = \dfrac{14 \times 0.03}{0.06} = 7$ bar

∴ $W = -P_{ext} (V_2 - V_1) = -7 (0.06 - 0.03) = -7 \times 0.03 = -0.21$ bar m^3.

Efficiency = $\dfrac{0.21}{0.294}$ = 71.43% **Ans.**

9. (a) F   (b) T   (c) F   (d) T   (e) T

DPP No. # 47

1. The product PV is increasing so temperature will keep or increasing in the process, hence
$\Delta H = \Delta E + \Delta(PV)$ will increase constantly.

2. From graph we know that $V_B > V_A$, so expansion has taken place so w will be with –ve sign and ΔH will be +ve as both ΔE and $\Delta(PV)$ have increased.

3. At A and D the temperatures of the gas will be equal, so
$\Delta E = 0$, $\Delta H = 0$
Now $w = W_{AB} + W_{BC} + W_{CD} = -P_0 V_0 - 2P_0 V_0 \ln 2 + P_0 V_0 = -2P_0 V_0 \ln 2$
and $q = -W = 2 P_0 V_0 \ln 2$

5. Since liquid is expanding against external pressure P_0 hence work done
$$w = -P_0 (4V_0 - V_0) = -3P_0 V_0$$
$$\Delta U = w = -3 P_0 V_0$$
$\Rightarrow$ $\Delta H = \Delta U + P_2 V_2 - P_1 V_1 = -3 P_0 V_0 + 4 P_0 V_0 - 2 P_0 V_0$.

7. γ for $O_2 = 1.44$ γ for He = 1.66.

8. Since, ΔH is a state function, and the final state attained by the gas is same as its initial state, so value of ΔH = 0.

9. $q = q_{AB} + q_{BC} + q_{CD} + q_{DA}$

$= -1R \times 300\ell n2 + 1 \times \dfrac{5R}{2} \times (400 - 300) + 1R \times 400\ell n2 + 1 \times \dfrac{5R}{2} \times (300 - 400)$

($\because q_{AB} = -W_{AB} = -1R \times 300\ell n2$ since process is reversible isothermal for which ΔU = 0).

($\because q_{BC} = \Delta H_{BC} = 1 \times \dfrac{5R}{2} \times (400 - 300)$ since process is reversible isobaric).

($\because q_{CD} = -W_{CD} = 1R \times 300\ell n2$ since process is reversible isothermal for which ΔU = 0).

($\because q_{DA} = \Delta H_{AB} = 1 \times \dfrac{5R}{2} \times (300 - 400)$ since process is reversible isobaric).

So, q = 100 Rℓn2.

10. Since, for a cyclic process, ΔU = 0.
So, W = − q = − 100 Rℓn2.

DPP No. # 48

1. $TV^{\gamma-1}$ = constant

$\gamma = \dfrac{5}{3}$ $\qquad \therefore \qquad \gamma - 1 = \dfrac{2}{3}$

$\therefore \quad 300 \times (8)^{2/3} = 250 \times (V_2)^{2/3} \qquad \Rightarrow \qquad (V_2)^{2/3} = 4.8$

$\Rightarrow \quad V_2 = (4.8)^{3/2} \cong 4.8 \times 2.2 = 10.5$ L

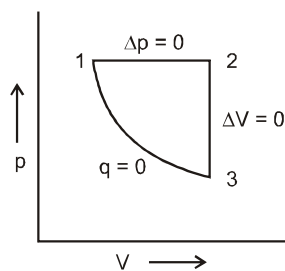**8.** $\gamma_{mix} = \dfrac{n_A C_{P_A} + n_B C_{P_B}}{n_A C_{V_A} + n_B C_{V_B}} = \dfrac{2(4R) + 4(5R/2)}{2(3R) + 4(3R/2)} = \dfrac{18R}{12R} = \dfrac{3}{2}$

$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1} \qquad\qquad (\gamma = \gamma_{mix} = 1.5)$

$\therefore \quad T_2 = 320 \left(\dfrac{2}{8}\right)^{1.5-1} = 320 \times \dfrac{1}{2} = 160$ K

$\therefore \quad W = \dfrac{nR}{\gamma - 1}(T_2 - T_1) = \dfrac{6R}{1.5 - 1}(160 - 320) = -1920\,R = 1920 \times 2 = -3840$ calories.

9. The process can be described on a p-V diagram as

At 1 : p = 10 atm $\qquad$ T = 400 K $\qquad$ V = V_1
At 2 : p = 10 atm $\qquad$ T = 800 K $\qquad$ V = $V_2 = 2V_1$
At 3 : p = ? $\qquad\qquad$ T = T_3 $\qquad\quad$ V = $V_3 = V_2 = 2V_1$
Therefore,
$\quad W_{12} = -p\Delta V = -nRT = -400$ R
$\quad W_{23} = 0 \qquad\qquad\qquad\qquad [\because \Delta V = 0]$
Between 3 and 1 ; $TV^{\gamma-1}$ = constant
$\quad T_3 (2V_1)^{\gamma-1} = 400(V_1)^{\gamma-1}$

$$\Rightarrow \quad T_3 = 400 \left(\frac{1}{2}\right)^{2/3} = 252 \text{ K}$$

$$\Rightarrow \quad W_{31} = \Delta E_{31} = nC_V(T_1 - T_3) = \frac{3}{2} R(400 - 252) = 222 \text{ R}$$

$$\Rightarrow \quad W_{12-31} = W_{12} + W_{23} + W_{31} = -178 \text{ R}$$

10. $W = -\int P dV$

$$= -\int \frac{K}{V^n} dV = -\frac{K}{1-n}\left[V^{-n+1}\right]_{V_1}^{V_2} \quad = \frac{K}{n-1}[V_2^{1-n} - V_1^{1-n}]$$

$$= \frac{P_1 V_1^n}{n-1}\left[V_2^{1-n} - V_1^{1-n}\right] \quad = \frac{P_1 V_1^{n+1-n}}{n-1}\left[\left(\frac{V_2}{V_1}\right)^{1-n} - 1\right]$$

DPP No. # 49

1. Standard molar enthalpy of formation (ΔH^o_f) of element in their stable state of agregation is zero.
$\therefore \qquad \Delta H^o_f (O_2, g) = 0$

4. Some of the heat is used to vaporise the H_2O (ℓ)
$\therefore \qquad x_1 > x_2$

5. $CS_2(\ell) + 3O_2(g) \longrightarrow CO_2(g) + 2SO_2(g)$; $\qquad \Delta H^o_{rxn.} = 5 \times -215 = -1075 \text{ kJ}$
$\Delta H^o_{rxn.} = \Delta H^o_f(CO_2) + 2 \times \Delta H^o_f(SO_2) - \Delta H^o_f(CS_2)$
$\Delta H^o_{rxn.} = (-393.5 - 2 \times 296.8) - (-1075)$
$\Delta H^o_{rxn.} = 87.9$

6. Refer Class notes.
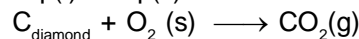
8. Eq (i) + Eq (ii)
$C_{diamond} + O_2(s) \longrightarrow CO_2(g)$
$\Delta H = \Delta H_1 + \Delta H_2$

DPP No. # 50

2. Since it is neutralisation of a weak acid with strong base.

3. enthalpy of dissociation = $(13.7 - 3)$ KCal = 10.7 KCal

6. $n_{CH_4} = \frac{280}{22.4}$

$\therefore \qquad \Delta H_{obntained} = \frac{240 \times 280}{22.4} \text{ KCal}$

$\therefore \qquad m = \frac{240 \times 280}{22.4 \times 2 \times 1 \times 180} \text{ kg} = 8.33 \text{ kg.}$

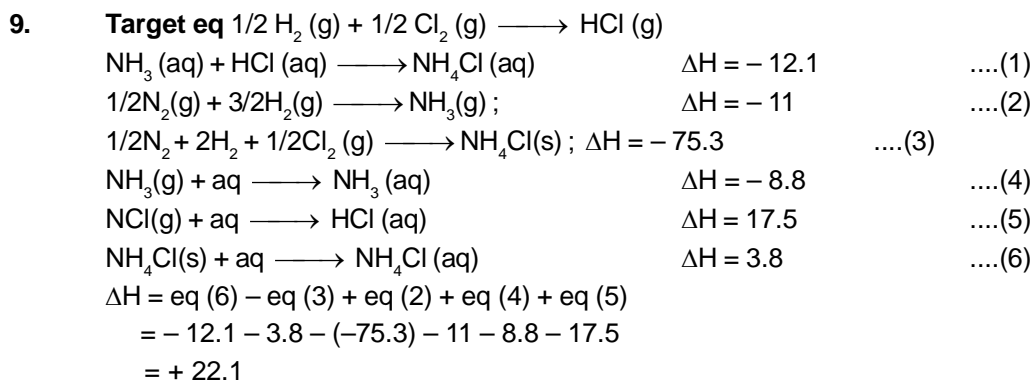**7.** Heat generated = $C_T \Delta T = 1260 \times 0.667$ cal.

$\therefore \qquad n_{CH_4} = \frac{1260 \times 0.667}{210 \times 10^3}$
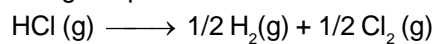
$n_{total} = \frac{PV}{RT} = 4 \times 10^{-2} \qquad \therefore \qquad mol\% = \frac{4 \times 10^{-3}}{4 \times 10^{-2}} \times 100\% = 10\%$ Ans.

8. $\Delta H_2 - 24 = -0.024 \times (523 - 473)$ Cal/g.
$\therefore \qquad \Delta H_2 = 22.8$ Cal/g.

9. **Target eq** $1/2\ H_2\ (g) + 1/2\ Cl_2\ (g) \longrightarrow HCl\ (g)$

$NH_3\ (aq) + HCl\ (aq) \longrightarrow NH_4Cl\ (aq)$ $\qquad \Delta H = -12.1$ $\qquad$ ....(1)

$1/2 N_2(g) + 3/2 H_2(g) \longrightarrow NH_3(g)$; $\qquad \Delta H = -11$ $\qquad$ ....(2)

$1/2 N_2 + 2H_2 + 1/2 Cl_2\ (g) \longrightarrow NH_4Cl(s)$; $\Delta H = -75.3$ $\qquad$ ....(3)

$NH_3(g) + aq \longrightarrow NH_3\ (aq)$ $\qquad \Delta H = -8.8$ $\qquad$ ....(4)

$NCl(g) + aq \longrightarrow HCl\ (aq)$ $\qquad \Delta H = 17.5$ $\qquad$ ....(5)

$NH_4Cl(s) + aq \longrightarrow NH_4Cl\ (aq)$ $\qquad \Delta H = 3.8$ $\qquad$ ....(6)

$\Delta H =$ eq (6) $-$ eq (3) $+$ eq (2) $+$ eq (4) $+$ eq (5)

$\quad = -12.1 - 3.8 - (-75.3) - 11 - 8.8 - 17.5$

$\quad = +22.1$

from this we get equation

$\qquad HCl\ (g) \longrightarrow 1/2\ H_2(g) + 1/2\ Cl_2\ (g)$

$\therefore\ \Delta H$ of target eq $= -\Delta H = -22.1$ Kcal Ans.