PHYSICAL CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

# DPP No. 43

Total Marks : 29

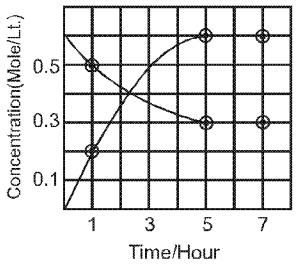
Max. Time : 33 min.

**Topic : Chemical Equilibrium**

| Type of Questions | | M.M., Min. |
|---|---|---|
| Subjective Questions ('–1' negative marking) Q.1 to Q.4 | (4 marks, 5 min.) | [16, 20] |
| Multiple choice objective ('–1' negative marking) Q.5 | (4 marks, 4 min.) | [4, 4] |
| Comprehension ('–1' negative marking) Q.6 to Q.8 | (3 marks, 3 min.) | [9, 9] |

**1.** The equilibrium constant of the reaction $A_2$ (g) + $B_2$ (g) $\rightleftharpoons$ 2 AB (g) at 100° C is 50. If a one litre flask containing one mole of $A_2$ is connected to a two litre flask containing two moles of $B_2$, how many moles of AB will be formed at 373 K ?

**2.** The progress of reaction : A(g) $\rightleftharpoons$ nB(g)
with time, is presented in fig. given below. Determine :




(i) the value of n (ii) the equilibrium constant, $K_C$ and

**3.** One mole of $Cl_2$(g) and 3 moles of $PCl_5$(g) are placed in a 100 litre vessel heated to 227°C.The equilibrium pressure is 2.05 atm. Assuming ideal behaviour, calculate the degree of dissociation of $PCl_5$(g) and $K_P$ for the reaction, $PCl_5$ (g) $\rightleftharpoons$ $PCl_3$ (g) + $Cl_2$ (g).

**4.** When equal volumes of 0.2 M $AgNO_3$ and 1 M KCN solutions were mixed then at equilibrium, concentration of $Ag^+$ was found to be $10^{-6}$ M. While when equal volumes of 0.2 M $Zn(NO_3)_2$ solution and of 1 M KCN solution were mixed then at equilibrium, concentration of $Zn^{2+}$ ion was found to be $10^{-12}$ M. Then find the equilibrium constant $K_C$ of following reaction : $2[Ag(CN)_2]^-$ (aq.) + $Zn^{2+}$ (aq.) $\rightleftharpoons$ $[Zn(CN)_4]^{2-}$ (aq.) + $2Ag^+$ (aq.).

**5.*** Consider two equilibrium $2Cl_2(g) + 2H_2O(g) \rightleftharpoons 4HCl(g) + O_2(g)$ and $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ simultaneously established in a closed vessel. When some amount of HCl is added at equilibrium, which of the following statements is correct :

(A) amount of $N_2$ gas will decrease. (B) amount of $N_2$ gas will increase.
(C) amount of $O_2$ gas will decrease. (D) nothing can be said with certainty.

**Comperhension # (Q.6 to Q.8)**

Solid $NH_4I$ rapidly decompose as follows : $NH_4I$ (s) $\rightleftharpoons$ $NH_3$ (g) + HI (g)
At equilibrium, total pressure = 0.5 atm.
Now, HI starts decomposing as follows : 2HI (g) $\rightleftharpoons$ $H_2$(g) + $I_2$ (g)

At final equilibrium, partial pressure of $H_2$ = $\frac{3}{16}$ atm.

Now answer the following questions :

**6.** Calculate new total pressure :
(A) 0.9 atm (B) 1 atm (C) 0.6 atm (D) 0.5 atm

**7.** Calculate $K_p$ for the reaction 2HI(g) $\rightleftharpoons$ $H_2$(g) + $I_2$(g) :
(A) $\frac{9}{4}$ (B) $\frac{9}{8}$ (C) $\frac{9}{16}$ (D) None of these

**8.** Partial pressure of HI at equilibrium is :
(A) 0.05 atm (B) 0.1 atm (C) 0.15 atm (D) 0.125 atm

# Answer Key

## DPP No. # 43

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1.** | 1.868<br>810 | **2.** | (i) 2, (ii) 1.2 mol/L | **3.** | $\alpha = 0.33$, $K_p = 0.41$ atm. | **4.** | |
| **5.*** | (BC) | **6.** | (B) | **7.** | (A) | **8.** | (D) |

# Hints & Solutions

## DPP No. # 43

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

1 2 0

$\frac{1-x}{3}$ $\quad \frac{2-x}{3}$ $\quad \frac{2x}{3}$

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

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

$\therefore$ AB की मोल संख्या $= \frac{2x}{3} = 1.868$

**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

$PV = nRT = P \times 100 = 4 \times 0.082 \times 500$

$P = 0.082 \times 20 = 1.64$ atm.

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

$PV = nRT.$

$2.05 \times 100 = (4+x) \times 0.082 \times 500.$

$2.05 = (4+x) \times 0.41.$

$5 = 4 + x.$

$x = 1.$

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

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

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

**4.**

| | $Ag^+$ | + $2CN^-$ | $\rightleftharpoons$ $[Ag(CN)_2]^-$ | |
|---|---|---|---|---|
| t = 0 | 0.1 | 0.5 | 0 | |
| $t_{eq}$ | $10^{-6}$ | 0.3 | 0.1 | $K_1 = \frac{10}{9} \times 10^6$ |
| | $Zn^{2+}$ | + $4CN^-$ | $\rightleftharpoons$ $[Zn(CN)_4]^{2-}$ | |
| t = 0 | 0.1 | 0.5 | 0 | |
| eq. | $10^{-12}$ | 0.1 | 0.1 | $K_2 = \frac{0.1}{(0.1)^4 \times 10^{-12}} = 10^{15}$ |

Substracting two times I$^{st}$ reaction from II$^{nd}$ reaction, we will get the required reaction, so

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

**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.