Q1 - 24 June - Shift 1

For a reaction at equilibrium

$$A(g) \rightleftharpoons B(g) + \frac{1}{2}C(g)$$

the relation between dissociation constant (K), degree of dissociation (α) and equilibrium pressure (p) is given by :

(A) $K = \dfrac{\alpha^{\frac{1}{2}} p^{\frac{3}{2}}}{\left(1+\frac{3}{2}\alpha\right)^{\frac{1}{2}}(1-\alpha)}$

(B) $K = \dfrac{\alpha^{\frac{3}{2}} p^{\frac{1}{2}}}{(2+\alpha)^{\frac{1}{2}}(1-\alpha)}$

(C) $K = \dfrac{(\alpha p)^{\frac{3}{2}}}{\left(1+\frac{3}{2}\alpha\right)^{\frac{1}{2}}(1-\alpha)}$

(D) $K = \dfrac{(\alpha p)^{\frac{3}{2}}}{(1+\alpha)(1-\alpha)^{\frac{1}{2}}}$

Space for your notes:

Q2 - 24 June - Shift 2

PCl_5 dissociates as

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

5 moles of PCl_5 are placed in a 200 litre vessel which contains 2 moles of N_2 and is maintained at 600 K. The equilibrium pressure is 2.46 atm. The equilibrium constant K_p for the dissociation of PCl_5 is_____ $\times 10^{-3}$. (nearest integer)

(Given: R = 0.082 L atm K^{-1} mol^{-1} : Assume ideal gas behaviour)

Space for your notes:

Q3 - 25 June - Shift 1

The standard free energy change ($\Delta G°$) for 50% dissociation of N_2O_4 into NO_2 at 27°C and 1 atm pressure is –x J mol^{-1}. The value of x is _____. (Nearest Integer)

[Given : R = 8.31 J K^{-1} mol^{-1}, log 1.33 = 0.1239 ln 10 = 2.3]

Space for your notes:

Q4 - 27 June - Shift 1

$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

In an experiment, 2.0 moles of NOCl was placed in a one-litre flask and the concentration of NO after equilibrium established, was found to be 0.4 mol/L. The equilibrium constant at 30°C is _____ $\times 10^{-4}$.

Space for your notes:

Q5 - 29 June - Shift 2

4.0 moles of argon and 5.0 moles of PCI_5 are introduced into an evacuated flask of 100 litre capacity at 610 K. The system is allowed to equilibrate. At equilibrium, the total pressure of mixture was found to be 6.0 atm. The K_p for the reaction is [Given : $R = 0.082 L\ atm\ K^{-1}\ mol^{-1}$]

(A) 2.25 (B) 6.24

(C) 12.13 (D) 15.24

Space for your notes:

Q6 - 29 June - Shift 2

A box contains 0.90 g of liquid water in equilibrium with water vapour at 27°C. The equilibrium vapour pressure of water at 27°C 32.0 Torr. When the volume of the box is increased, some of the liquid water evaporates to maintain the equilibrium pressure. If all the liquid water evaporates, then the volume of the box must be____ litre. [nearest integer]

(Given: $R = 0.082\ L\ atm\ K^{-1}\ mol^{-1}$)

(Ignore the volume of the liquid water and assume water vapours behave as an ideal gas.)

Space for your notes:

Answer Key

Q1 (B) **Q2** (1107) **Q3** (710) **Q4** (125)

Q5 (A) **Q6** (29)

Q1 (B)

$$\mathbf{A(g)} \rightleftharpoons \mathrm{B(g)} + \frac{1}{2}\mathrm{C\ (g)}$$

Initial : P_i **0** **0**

At eq.: $P_i(1-\alpha)$ $P_i.\alpha$ $P_i\frac{\alpha}{2}$

Now, equilibrium pressure (p) ,

$$P = P_i \times \left(1+\frac{\alpha}{2}\right)$$

$$\therefore\ P_A = \left(\frac{1-\alpha}{1+\frac{\alpha}{2}}\right)P$$

$$P_B = \left(\frac{\alpha}{1+\frac{\alpha}{2}}\right)P$$

$$P_C = \left(\frac{\frac{\alpha}{2}}{1+\frac{\alpha}{2}}\right)P$$

$$\therefore K = \frac{P_c^{\frac{1}{2}} \times P_B}{P_A}$$

$$K = \frac{\alpha^{\frac{3}{2}}p^{\frac{1}{2}}}{(2+\alpha)^{\frac{1}{2}}(1-\alpha)}$$

Q2 (1107)

Given : 2 mole of N_2 gas was present as inert gas.

Equilibrium pressure = 2.46 atm

$$PCl_5(g) \rightleftharpoons PCl_3(g) + C\ell_2(g)$$

t = 0	5	0	0
$t = Eq^m$	5 – x	x	x

from ideal gas equation

$PV = nRT$

$2.46 \times 200 = (5 - x + x + x + 2) \times 0.082 \times 600$

$x = 3$

$$K_P = \frac{n_{PCl_3} \times n_{Cl_2}}{n_{PCl_5}} \times \left[\frac{P_{total}}{n_{total}}\right]$$

$$\frac{3\times 3}{2} \times \frac{2.46}{10} = 1.107 = 1107 \times 10^{-3}$$

Q3 (710)

$$N_2O_4 \rightleftharpoons 2NO_2$$

t = 0 1 mol

t = t (1-0.5) mol 0.5×2 mol

= 0.5 mol 1 mol

$$k_P = \frac{\left(\frac{1}{1.5}\times 1\right)^2}{\left(\frac{0.5}{1.5}\times 1\right)} = \frac{1}{0.75} = \frac{100}{75}$$

$= 1.33$

$$\Delta G^0 = -RT\ell nk_P$$

$$= -8.31 \times 300 \times \ell n(1.33) = -710.45 \text{ J/mol}$$

$= -710$ J/mol.

Q4 (125)

$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

t=0	2M	-	-
$t=t_{eq}$	(2-x)M	x M	$\frac{x}{2}$ M

$\because x = 0.4M$

$\therefore [NOCl]_{eq} = 1.6\ M$

$[NO]_{eq} = 0.4\ M$

$[Cl_2]_{eq} = 0.2\ M$

$$\Rightarrow K_c = \frac{[NO]^2[Cl_2]}{[NOCl]^2} = \frac{[0.4]^2[0.2]}{[1.6]^2}$$

$$K_c = \frac{32}{2.56} \times 10^{-3}$$

$K_c = 12.5 \times 10^{-3}$

$K_c = 125 \times 10^{-4}$

Integer answer is 125

Q5 (A)

$PCl_5 = 5$ mole

$Ar = 4$ mole

$$P_{Total} = \frac{9 \times 0.82 \times 610}{100} = 4.5\,atm$$

$$P_{PCl_5} = \frac{5 \times 4.5}{9} = 2.5\ ;\ P_{Ar} = \frac{4 \times 4.5}{9} = 2$$

$$PCl_5 \rightleftharpoons PCl_3 + Cl_2$$

$2.5 - P \qquad P \qquad P$

$$P_{total} = 2.5 - P + P + P + P_{Ar} = 6$$

$$P = 1.5$$

$$K_p = \frac{1.5 \times 1.5}{1} = 2.25$$

Q6 (29)

$$V = \frac{nRT}{P} = \frac{0.90 \times 0.82 \times 300 \times 760}{18 \times 32} = 29.21$$