



## DPP-6 [Degree of Dissociation]

### Chapter: Chemical Equilibrium

*“Koi tera effort nahi dekh raha? Koi baat nahi. Par kal tera result sab dekhenge. — Weird Chemist.”*

===== GROUP 1 — TOTAL MOLES =====

**Q1.** The dissociation of  $\text{CO}_2$  can be expressed as  $2\text{CO}_2 \rightleftharpoons 2\text{CO} + \text{O}_2$ . If the 2 mol of  $\text{CO}_2$  is taken initially and 40% of the  $\text{CO}_2$  is dissociated completely. What is the total number of moles at equilibrium :-

- (1) 2.4
- (2) 2.0
- (3) 1.2
- (4) 5

**Q2.** In  $\text{A}_3(\text{g}) \rightleftharpoons 3\text{A}(\text{g})$  reaction, the initial concentration of  $\text{A}_3$  is "a" mol  $\text{L}^{-1}$ . If x is degree of dissociation of  $\text{A}_3$ . The total number of moles at equilibrium will be :-

- (1)  $\frac{a - ax}{3}$
- (2)  $\frac{a}{3} - x$
- (3)  $\left(\frac{a - ax}{2}\right)$
- (4)  $a + 2ax$

**Q3.** 4 mol of  $\text{PCl}_5$  are heated at constant temperature in closed container. If degree of dissociation for  $\text{PCl}_5$  is 0.5 then calculate total number of moles at equilibrium

- (1) 4.5
- (2) 6
- (3) 3
- (4) 4

===== GROUP 2 — DIRECT DISSOCIATION =====

**Q4.** For the reaction :  $\text{P} \rightleftharpoons \text{Q} + \text{R}$ . Initially 2 mol of P was taken. Up to equilibrium 0.5 mol of P was dissociated. What would be the degree of dissociation :-

- (1) 0.5
- (2) 1
- (3) 0.25
- (4) 4.2

**Q5.** At a certain temperature, only 50% HI is dissociated at equilibrium in the reaction  $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$  The equilibrium constant for the reaction is :-

- (1) 0.25
- (2) 1.0
- (3) 3.0
- (4) 0.5

**Q6.** If  $\frac{2}{9}$  of 1 mol of HI is dissociates, the equilibrium constant of disintegration of acid

at same temperature will be

- (1) 64
- (2)  $\frac{1}{64}$
- (3) 49
- (4)  $\frac{1}{49}$

**Q7. One mole of  $\text{PCl}_5$  is heated in a closed container of one litre capacity. At equilibrium, 20%  $\text{PCl}_5$  is not dissociated. What should be the value of  $K_c$  ?**

- (1)  $(3.2)^{-1}$
- (2) 3.2
- (3) 2.4
- (4) 42

===== GROUP 3=====FORMULA ( -Kp) =====

**Q8. If the amount of dissociation is  $\sqrt{0.5}$ , the value of  $K_p$  for the reaction  $\text{N}_2\text{O}_3 \rightleftharpoons \text{NO} + \text{NO}_2$  will be**

- (1) equal to the pressure of the system
- (2)  $\frac{2}{8}$  of the pressure of the system
- (3)  $\frac{8}{3}$  of the pressure of the system
- (4) 5 times of the pressure of the system

**Q9. For the reaction,  $\text{N}_2\text{O}_3 \rightleftharpoons \text{NO} + \text{NO}_2$ , the value of equilibrium constant  $K_p$  at fixed temperature is 4. What will be the amount of dissociation at same temperature and 5 atmospheric pressure ?**

- (1)  $\frac{1}{3}$
- (2)  $\frac{2}{3}$
- (3)  $\frac{3}{7}$
- (4)  $\frac{2}{9}$

**Q10. For  $\text{N}_2\text{O}_3 \rightleftharpoons \text{NO} + \text{NO}_2$ , if total pressure is P atm and amount of dissociation is 50%, the value of  $K_p$  will be**

- (1) 3P
- (2) 2P
- (3)  $\frac{P}{3}$
- (4)  $\frac{P}{2}$

**Q11. If 8 mol of  $\text{PCl}_5$  heated in a closed vessel of 10 L capacity and 25% of its dissociates into  $\text{PCl}_3$  and  $\text{Cl}_2$  at the equilibrium then value of  $K_p$  will be equal to :-**

- (1) P/30
- (2) P/15
- (3) 2/3P
- (4) 3/2P

**Q12. In a 0.25 L tube dissociation of 4 mol of NO is take place. If its degree of dissociation is 10%. The value of  $K_p$  for reaction  $2 \text{NO} \rightleftharpoons \text{N}_2 + \text{O}_2$  is :-**

- (1)  $\frac{1}{(18)^2}$

(2)  $\frac{1}{(8)^2}$

(3)  $\frac{1}{16}$

(4)  $\frac{1}{32}$

Q13. At 60° C initial pressure 1 atm of N<sub>2</sub>O<sub>4</sub> is 50% dissociated into NO<sub>2</sub> then K<sub>p</sub> is :-

(1) 1.33 atm

(2) 2 atm

(3) 2.67 atm

(4) 3 atm

Q14. Two sample of HI each of 5 g were taken separately into vessels of volume 5 and 10 litres respectively at 27°C. The extent of dissociation of HI will be :-

(1) More in 5 litre vessel

(2) More in 10 litre vessel

(3) Equal in both vessel

(4) None of these

Q15. What will be the amount of dissociation, if the volume is increased 16 times of initial volume in the reaction PCl<sub>5</sub> ⇌ PCl<sub>3</sub> + Cl<sub>2</sub> ?

(1) 4 times

(2)  $\frac{1}{4}$  times

(3) 2 times

(4)  $\frac{1}{5}$  times

Q16. The dissociation equilibrium of a gas AB<sub>2</sub> can be represented as : 2AB<sub>2</sub>(g) ⇌ 2AB(g) + B<sub>2</sub>(g). The degree of dissociation is 'x' and is small compared to 1. The expression relating the degree of dissociation (x) with equilibrium constant K<sub>p</sub> and total pressure P is :

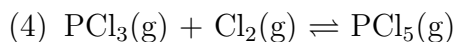
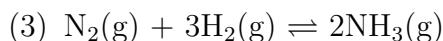
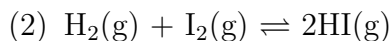
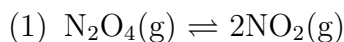
(1)  $(2K_p/P)^{1/3}$

(2)  $(2K_p/P)^{1/2}$

(3)  $(K_p/P)$

(4)  $(2K_p/P)$

Q17. For which of the following reaction the degree of dissociation (α) and equilibrium constant (K<sub>p</sub>) are related as  $K_p = \frac{4\alpha^2 P}{(1 - \alpha^2)}$  :-



Q18. The values of K<sub>p1</sub> and K<sub>p2</sub> for the reactions X ⇌ Y + Z ——— (1) A ⇌ 2B ——— (2) are in ratio of 9:1. If degree of dissociation of X and A be equal, then total pressure at equilibrium (1) and (2) are in the ratio :

(1) 1:9

(2) 36:1

(3) 1:1

(4) 3:1

# JEE

## Group-1: Finding $K_P$ / $K_C$

- Q19. In a 2 litre vessel, 2 moles of  $\text{PCl}_5$  were introduced. At equilibrium 50%  $\text{PCl}_5$  was dissociated. Total number of moles at equilibrium are:
- (A) 2.0  
(B) 3.0  
(C) 4.0  
(D) 1.0
- Q20. At a certain temperature, only 50% HI is dissociated into  $\text{H}_2$  and  $\text{I}_2$  at equilibrium. The equilibrium constant is:
- $2\text{HI}_{(g)} \rightleftharpoons \text{H}_{2(g)} + \text{I}_{2(g)}$  [JEE(Main) 2014 Online (09-04-14), 4/120]
- (1) 1.0  
(2) 3.0  
(3) 0.5  
(4) 0.25
- Q21. For the reaction  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ ,  $K_C = 50$ . The degree of dissociation of HI at this temperature is :
- (A) 0.2  
(B) 0.1  
(C) 0.5  
(D) 0.7
- Q22. The degree of dissociation of HI at 700 K is 20%. The equilibrium constant  $K_C$  for the reaction  $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$  is :
- (A) 0.0625  
(B) 0.04  
(C) 0.25  
(D) 0.5
- Q23. The value of  $K_P$  for the equilibrium reaction  $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$  is 2. The percentage dissociation of  $\text{N}_2\text{O}_4$  at a pressure of 0.5 atm is [JEE-MAINS(online)-12]
- (1) 71  
(2) 50  
(3) 88  
(4) 25
- Q24. The degree of dissociation of  $\text{PCl}_5$  is 0.2 at  $200^\circ\text{C}$  and at 4 atm total pressure. The  $K_P$  is :
- (A) 0.36  
(B) 0.25  
(C) 0.20  
(D) 0.16
- Q25. At  $250^\circ\text{C}$  and 0.5 atm,  $\text{PCl}_5$  is 60% dissociated into  $\text{PCl}_3$  and  $\text{Cl}_2$ .  $K_P$  for the reaction is :

- (A) 0.23
- (B) 0.21
- (C) 0.33
- (D) 0.51

**Q26.** In a 0.25 litre tube dissociation of 4 moles of NO takes place. If its degree of dissociation is 10%. The value of  $K_P$  for reaction  $2\text{NO} \rightleftharpoons \text{N}_2 + \text{O}_2$  is:

- (1)  $\frac{1}{(18)^2}$
- (2)  $\frac{1}{(8)^2}$
- (3)  $\frac{1}{16}$
- (4)  $\frac{1}{32}$

**Q27.** For the reaction  $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$ , degree of dissociation is 20%. The partial pressure of HI(g) at equilibrium will be (Total pressure = 800 mm) :

- (A) 533 mm
- (B) 400 mm
- (C) 666 mm
- (D) 733 mm

**Q28.** At 731 K,  $K_P = 50$  for the reaction  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ . The degree of dissociation of HI at this temperature is :

- (A) 0.8
- (B) 0.5
- (C) 0.4
- (D) 0.2

**Q29.** For the reaction  $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$ , the degree of dissociated ( $\alpha$ ) of HI(g) is related to equilibrium constant  $K_P$  by the expression

- (A)  $\frac{1 + 2\sqrt{K_P}}{2}$
- (B)  $\frac{\sqrt{1 + 2K_P}}{2K_P}$
- (C)  $\frac{2}{\sqrt{1 + 2K_P}}$
- (D)  $\frac{2\sqrt{K_P}}{1 + 2\sqrt{K_P}}$

**Q30.** The degree of dissociation of  $\text{SO}_3$  is  $\alpha$  at equilibrium pressure  $p^0$ .  $K_P$  for  $2\text{SO}_3(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$  is:

- (A)  $\frac{p^0 \alpha^3}{2(1 - \alpha)^3}$
- (B)  $\frac{p^0 \alpha^3}{(2 + \alpha)(1 - \alpha)^2}$
- (C)  $\frac{p^0 \alpha^2}{2(1 - \alpha)^2}$
- (D) None of these

**Q31.** For the dissociation reaction  $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ , the degree of dissociation ( $\alpha$ ) in terms of  $K_P$  and total equilibrium pressure P is:

- (A)  $\alpha = \sqrt{\frac{4p + K_P}{K_P}}$

$$(B) \alpha = \sqrt{\frac{K_P}{4p + K_P}}$$

$$(C) \alpha = \sqrt{\frac{K_P}{4p}}$$

(D) None of these

**Q32.** The equilibrium constants  $K_{p1}$  and  $K_{p2}$  for the reactions  $X \rightleftharpoons 2Y$  and  $Z \rightleftharpoons P + Q$ , respectively are in the ratio of 1 : 9. If the degree of dissociation of X and Z be equal then the ratio of total pressures at these equilibria is [AIEEE 2008, 3/105]

(1) 1 : 1

(2) 1 : 3

(3) 1 : 9

(4) 1 : 36

**Q33.** At constant temperature, the equilibrium constant ( $K_P$ ) for the decomposition reaction  $N_2O_4 \rightleftharpoons 2NO_2$  is expressed by  $K_P = \frac{4x^2 P}{1 - x^2}$ . Which of the following statement is true? [JEE 2001]

(A)  $K_P$  increases with increase of P

(B)  $K_P$  increases with increase of x

(C)  $K_P$  increases with decrease of x

(D)  $K_P$  remains constant with change in P or x

## Group-2: Finding Pressure / Partial Pressure / Total Moles

**Q34.** Phosphorus pentachloride dissociates as follows, in a closed reaction vessel,  $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$  If total pressure at equilibrium of the reaction mixture is P and degree of dissociation of  $PCl_5$  is x, the partial pressure of  $PCl_3$  will be- [AIEEE-2006]

$$(1) \left( \frac{2x}{1-x} \right) P$$

$$(2) \left( \frac{x}{x-1} \right) P$$

$$(3) \left( \frac{x}{1-x} \right) P$$

$$(4) \left( \frac{x}{x+1} \right) P$$

**Q35.** At total equilibrium pressure  $P_1$  and  $P_2$ ,  $N_2O_4$  is dissociated to 33.33% and 50% respectively. The ratio  $\frac{P_1}{P_2}$  will be:

$$(A) \frac{3}{8}$$

$$(B) \frac{4}{3}$$

$$(C) \frac{8}{3}$$

$$(D) \frac{3}{4}$$

**Q36.** Consider the reaction,  $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$  The equilibrium constant of the above reaction is  $K_P$ . If pure ammonia is left to dissociate, the partial pressure of ammonia at equilibrium is given by (Assume that  $P_{NH_3} \ll P_{total}$ ) [JEE-MAINS(Jan)-19]

- (1)  $\frac{3 K_P^2 P^2}{4^4}$   
 (2)  $\frac{1}{16} K_P^2 P^2$   
 (3)  $\frac{1}{4} K_P^2 P^2$   
 (4)  $\frac{3}{16} K_P^2 P^2$

**Q37.** Two samples of HI, each of 5 g, were taken separately into vessels of volumes 5 L and 10 L respectively at 27°C. The extent of dissociation of HI will be:

- (A) More in 5 litre vessel  
 (B) More in 10 litre vessel  
 (C) Equal in both vessels  
 (D) None of these

### Group–3: Effect of Pressure / Volume on Equilibrium

**Q38.** Consider the following equilibrium in a closed container:  $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$   
 At a fixed temperature, the volume of the reaction container is halved. For this change, which of the following statements holds true regarding the equilibrium constant ( $K_P$ ) and degree of dissociation ( $\alpha$ )? [JEE 2002]

- (A) Neither  $K_P$  nor  $\alpha$  changes  
 (B) Both  $K_P$  and  $\alpha$  change  
 (C)  $K_P$  changes, but  $\alpha$  does not change  
 (D)  $K_P$  does not change, but  $\alpha$  changes

**Q39.** Degree of dissociation of  $\text{PCl}_5$  is approximately related to pressure (given  $\alpha \ll 1$ ) by:

- (A)  $\alpha \propto p$   
 (B)  $\alpha \propto \frac{1}{\sqrt{p}}$   
 (C)  $\alpha \propto \frac{1}{p^2}$   
 (D)  $\alpha \propto \frac{1}{p^4}$

**Q40.** Pure ammonia is placed in a vessel at a temperature where its dissociation constant is appreciable. At equilibrium: [NSEC–2001]

- (A) concentration of ammonia does not change with pressure.  
 (B) its degree of dissociation,  $\alpha$  does not change with pressure.  
 (C)  $K_P$  does not change significantly with pressure.  
 (D) concentration of hydrogen is less than that of nitrogen.

### Group–4: Finding Degree of Dissociation ( $\alpha$ )

**Q41.** Gaseous  $\text{N}_2\text{O}_4$  dissociates into gaseous  $\text{NO}_2$  according to the reaction  $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$  at 300 K and 1 atm pressure, the degree of dissociation of  $\text{N}_2\text{O}_4$  is 0.2. If one mole of  $\text{N}_2\text{O}_4$  gas is contained in a vessel, then the density of the equilibrium mixture is: [JEE(Main) 2015 Online (10-04-15)]

- (1) 3.11 g/L
- (2) 4.56 g/L
- (3) 1.56 g/L
- (4) 6.22 g/L

**Q42.** If 40%  $\text{PCl}_5$  is dissociated in the gas phase, the ratio of volume of  $\text{PCl}_3$  and  $\text{PCl}_5$  present at equilibrium is :

- (A) 2 : 3
- (B) 3 : 2
- (C) 3 : 5
- (D) 2 : 5

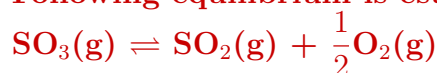
**Q43.** The density of equilibrium mixture in a closed vessel containing  $\text{PCl}_5$  and  $\text{PCl}_3$  gases is 7 g/L at  $250^\circ\text{C}$ . The degree of dissociation of  $\text{PCl}_5$  is (molecular wt. of  $\text{PCl}_5 = 208.5$ ) :

- (A) 0.5
- (B) 0.2
- (C) 0.3
- (D) 0.4

**Q44.** The density of an equilibrium mixture of  $\text{PCl}_5$ ,  $\text{PCl}_3$  and  $\text{Cl}_2$  at  $250^\circ\text{C}$  is 11.2 g/L. If the molecular weight of  $\text{PCl}_5$  is 208.5, the degree of dissociation of  $\text{PCl}_5$  is :

- (A) 0.2
- (B) 0.4
- (C) 0.5
- (D) 0.6

**Q45.** Following equilibrium is established at  $727^\circ\text{C}$ :



At equilibrium pressure is 1.2 atm and density of mixture is 0.9 g/L. The degree of dissociation of  $\text{SO}_3(\text{g})$  is :

[Given:  $R = 0.08 \text{ atm-L-mol}^{-1} \text{ K}^{-1}$ ]

- (A)  $\frac{1}{3}$
- (B)  $\frac{2}{3}$
- (C)  $\frac{1}{4}$
- (D)  $\frac{1}{5}$