DPP-7 [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 CO_2 can be expressed as $2CO_2 \rightleftharpoons 2CO + O_2$. If the 2 mol of CO_2 is taken initially and 40% of the 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 $A_3(g) \rightleftharpoons 3A\ (g)$ reaction, the initial concentration of A_3 is "a" mol L^{-1}. If x is degree of dissociation of 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 PCl_5 are heated at constant temperature in closed container. If degree of dissociation for 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 : $P \rightleftharpoons Q + R$. 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 $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ The equilibrium constant for the reaction is :-**

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

Q6. **If 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 PCl_5 is heated in a closed container of one litre capacity. At equilibrium, 20% 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 $N_2O_3 \rightleftharpoons NO + NO_2$ 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, $N_2O_3 \rightleftharpoons NO + NO_2$, the value of equilibrium constant Kp 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) $\frac{7}{9}$
(4) $\frac{2}{4}$

Q10. **For $N_2O_3 \rightleftharpoons NO + NO_2$, 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 PCl_5 heated in a closed vessel of 10 L capacity and 25% of its dissociates into PCl_3 and Cl_2 at the equilibrium then value of Kp 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 Kp for reaction $2\,NO \rightleftharpoons N_2 + O_2$ 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_2O_4 is 50% dissociated into NO_2 then Kp 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 $PCl_5 \rightleftharpoons PCl_3 + Cl_2$?

(1) 4 times

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

(3) 2 times

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

Q16. The dissociation equilibrium of a gas AB_2 can be represented as : $2AB_2(g) \rightleftharpoons 2AB(g) + B_2(g)$. The degree of dissociation is 'x' and is small compared to 1. The expression relating the degree of dissociation (x) with equilibrium constant Kp 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_p) are related as $K_p = \frac{4\alpha^2 P}{(1-\alpha^2)}$:-

(1) $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

(2) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

(3) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

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

Q18. The values of K_{p1} and K_{p2} for the reactions $X \rightleftharpoons Y + Z$ ——— (1) $A \rightleftharpoons 2B$ ——— (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 PCl_5 were introduced. At equilibrium 50% 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 H_2 and I_2 at equilibrium. The equilibrium constant is:**

$2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}$ [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 $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$, $K_C = 50$. 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 $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ is :**

(A) 0.0625
(B) 0.04
(C) 0.25
(D) 0.5

Q23. **The value of K_P for the equilibrium reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ is 2. The percentage dissociation of N_2O_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 PCl_5 is 0.2 at 200°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°C and 0.5 atm, PCl_5 is 60% dissociated into PCl_3 and 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 $2NO \rightleftharpoons N_2 + O_2$ is:**

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

Q27. **For the reaction $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$, 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 $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$. 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 $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$, the degree of dissociated (α) of HI(g) is related to equilibrium constant K_P by the expression**

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

Q30. **The degree of dissociation of SO_3 is α at equilibrium pressure p^0. K_P for $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ 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 $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, the degree of dissociation (α) in terms of K_P and total equilibrium pressure P is:**

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

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

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

(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 $K_P = \dfrac{4x^2P}{1-x^2}$. 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) $\left(\dfrac{2x}{1-x}\right)P$

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

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

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

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

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

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

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

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

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) $\frac{3}{4}\frac{K_P^2 P^2}{4}$
(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: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ 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 (α)? [JEE 2002]

(A) Neither K_P nor α changes
(B) Both K_P and α change
(C) K_P changes, but α does not change
(D) K_P does not change, but α changes

Q39. Degree of dissociation of 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, α 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 (α)

Q41. Gaseous N_2O_4 dissociates into gaseous NO_2 according to the reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ at 300 K and 1 atm pressure, the degree of dissociation of N_2O_4 is 0.2. If one mole of N_2O_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% PCl_5 is dissociated in the gas phase, the ratio of volume of PCl_3 and 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 PCl_5 and PCl_3 gases is 7 g/L at 250°C. The degree of dissociation of PCl_5 is (molecular wt. of PCl_5 = 208.5) :

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

Q44. The density of an equilibrium mixture of PCl_5, PCl_3 and Cl_2 at 250°C is 11.2 g/L. If the molecular weight of PCl_5 is 208.5, the degree of dissociation of PCl_5 is :

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

Q45. Following equilibrium is established at 727°C:

$SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$

At equilibrium pressure is 1.2 atm and density of mixture is 0.9 g/L. The degree of dissociation of $SO_3(g)$ is :

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

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