Chemical Equilibrium

1. Introduction to Equilibrium, Equilibrium Constant

Q 1. An example of a reversible reaction is

(A) $Pb(NO_3)_2 + 2NaI \rightarrow PbI_2(s) + 2NaNO_3$

(B) $AgNO_3 + HCl \rightarrow AgCl + HNO_3$

(C) $2Na(s) + H_2O(\ell) \rightarrow 2NaOH + H_2(g)$

(D) $KNO_3 + NaCl \rightarrow KCl + NaNO_3$

Q 2. Which of the following reaction is an example of irreversible reaction?

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

(B) $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$

(C) $Mg(s) + H_2O(I) \rightleftharpoons Mg(OH)_2 + H_2(g)$

(D) None of these

Q 3. The experimental curve obtained when the rate of a reaction is plotted against the concentration of the reactant, appears parallel to the concentration axis after sometime in a reaction. It indicates that

(A) the reaction is stopped

(B) equilibrium is established

(C) concentration of the reactant is negligible

(D) the reaction is complex

Q 4. Chemical equilibrium is dynamic because

(A) the equilibrium attained quickly

(B) the concentration of the reactants and products become same at equilibrium

(C) the concentration of reactants and products are constant but different

(D) both forward and backward reactions occur at equilibrium with the same speed

Q 5. Which of the following statements is false in case of equilibrium state?

(A) There is no change in properties with time

(B) It is dynamic in nature

(C) It can be attained from either side of reaction

(D) It can be attained from the side of reactants only

Q 6. A chemical reaction $A \rightleftharpoons B$ is said to be in equilibrium when

(A) Complete conversion of A to B has occurred

(B) Conversion of A to B is only 50% complete

(C) Only 10% conversion of A to B has occurred

(D) The rate of transformation of A to B is just equal to rate of transformation of B to A

Q 7. K_1 and K_2 are the rate constants of forward and backward reactions. The equilibrium constant K_C of the reaction is

(A) $K_1 + K_2$ (B) $K_1 - K_2$

(C) $\frac{K_1}{K_2}$ (D) $\frac{K_1 + K_2}{K_1 - K_2}$

Q 8. In a chemical equilibrium, the equilibrium constant is found to be 2.5. If the rate constant of backward reaction is 3.2×10^{-2}, the rate constant of forward reaction is

(A) 8.0×10^{-2} (B) 4.0×10^{-2}

(C) 3.5×10^{-2} (D) 7.6×10^{-3}

Q 9. In the reaction,

$C_2H_4(g) + H_2(g) \rightleftharpoons C_2H_6(g)$,

The equilibrium constant can be expressed in units of

(A) lit $^{-1}$.mol^{-1} (B) mol^2.lit $^{-2}$

(C) lit.mol^{-1} (D) mol. Lit $^{-1}$

Q 10. Equilibrium constant of a chemical reaction depends on

(A) Temperature (B) Pressure

(C) constant of species (D) volume of vessel

Q 11. Equilibrium position of a chemical reaction has

(A) unique value at a given condition

(B) Infinite set of values at a given condition

(C) Two set of values at a given condition

(D) depends on type of reaction

Q 12. The active mass of NaOH in solution containing 4g pure NaOH in 500 ml is

(A) 0.20 M (B) 0.25 M

(C) 0.10 M (D) None of these

Q 13. The active mass of $Ca(OH)_2$ in a solution containing 50g $Ca(OH)_2$ with 80 % purity in 200 ml solution, is

(A) 250/74 M (B) 50/74 M

(C) 100/74 M (D) None of these

Q 14. Which of the following is not a general characteristic of equilibria involving physical processes? **[NCERT Examplar]**

(A) Equilibrium is possible only in a closed system at a given temperature

(B) All measurable properties of the system remain constant

(C) All the physical processes stop at equilibrium

(D) The opposing processes occur at the same rate and there is dynamic but stable condition

Q 15. The equilibrium constant expression for a gas reaction is, **[NCERT]**

$$K_c = \frac{[NH_3]^4[O_2]^5}{[NO]^4[H_2O]^6}$$

Write the balanced chemical equation corresponding to this expression.

2. Properties of K_{eqb}, Type of K_{eqb}, Reaction Quotient

Q 1. The equilibrium constant (K_C) for the reaction $2HCl(g) \rightleftharpoons H_2(g)+Cl_2(g)$ is 4×10^{-34} at 25°C. What is the equilibrium constant for the reaction; $\frac{1}{2}H_2(g)+\frac{1}{2}Cl_2(g) \rightleftharpoons HCl(g)$

(A) 2×10^{-17} (B) 2.5×10^{33}

(C) 5×10^{6} (D) None of these

Q 2. One mole of $N_2O_4(g)$ at 300 K is kept in a closed container under one atm. It is heated to 600 K when 20% by mass of $N_2O_4(g)$ decomposes to $NO_2(g)$. The resultant pressure is

(A) 1.2 atm (B) 2.4 atm

(C) 2.0 atm (D) 1.0 atm

Q 3. The equilibrium constant for the reaction $SO_3(g) \rightleftharpoons SO_2(g)+\frac{1}{2}O_2(g)$; $K_c = 4.9\times10^{-2}$.

The value of K_C for the reaction **[AIEEE 2006]** $2SO_2(g)+O_2(g) \rightleftharpoons 2SO_3(g)$ will be

(A) 416 (B) 2.40×10^{-3}

(C) 9.8×10^{-2} (D) 4.9×10^{-2}

Q 4. For the following three reaction (i), (ii) and (iii) equilibrium constant are given **[AIEEE 2008]**

(i) $CO(g)+H_2O(g) \rightleftharpoons CO_2(g)+H_2(g); K_1$

(ii) $CH_4(g)+H_2O(g) \rightleftharpoons CO(g)+3H_2(g); K_2$

(iii) $CH_4(g)+2H_2O(g) \rightleftharpoons CO_2(g)+4H_2(g); K_3$

Which of the following relation is correct ?

(A) $K_3.K_2^3 = K_1^2$ (B) $K_1\sqrt{K_2} = K_3$

(C) $k_2k_3 = k_1$ (D) $k_3 = k_1k_2$

Q 5. Given:

$N_2(g)+3H_2(g) \rightleftharpoons 2NH_3(g); K_1$

$N_2(g)+O_2(g) \rightleftharpoons 2NO(g); K_2$

$H_2(g)+O_2(g) \rightleftharpoons H_2O(g); K_3$

The equilibrium constant for,

$2NH_3(g)+\frac{8}{2}O_2(g) \rightleftharpoons 2NO(g)+3H_2O(g)$

will be **[CBSE PMT/AIIMS]**

(A) $K_1K_2K_3$ (B) $\frac{K_1K_2}{K_3}$

(C) $\frac{K_1K_3^2}{K_2}$ (D) $\frac{K_2K_3^3}{K_1}$

Q 6. The value of K_P for the reaction $H_2(g)+I_2(g) \rightleftharpoons 2HI(g)$ is 50. What is the value of K_C

(A) 30 (B) 40 (C) 50 (D) 70

Q 7. $\frac{K_P}{K_C}$ for the gaseous reaction

(I) $2A+3B \rightleftharpoons 2C$

(II) $2A \rightleftharpoons 4B$

(III) $A+B+2C \rightleftharpoons 4D$

Would be respectively

(A) $(RT)^{-3},(RT)^{2},(RT)^{0}$

(B) $(RT)^{-3},(RT)^{-2},(RT)^{-1}$

(C) $(RT)^{-3},(RT)^{2},(RT)$

(D) None of the above

Q 8. The equilibrium constant K_C for the decomposition of PCl_5 is 0.625 mole/lit at 300°C. Then the value of K_P is

(A) 2.936 atm (B) 0.0625 atm

(C) 6.25 atm (D) 0.00625 atm

Q 9. For the reaction

$2NO_2(g) \rightleftharpoons 2NO(g)+O_2(g)$

$\left(Kc=1.8\times10^{-6} \text{ at } 184°C\right)$

$(R=0.08314 \text{ kJ/mol.K})$. When K_p and K_c are compared at 184°C it is found that

(A) $K_p > K_c$ (B) $K_p < K_c$

(C) $K_p = K_c$

(D) Whether K_p is greater than, less than or equal to K_c depends upon the total gas pressure

Q 10. For the relationship $K_p = K_c(RT)^{\Delta n}$

What would be the value of Δn for the reaction?

[NCERT Examplar]

$NH_4Cl(s) \rightleftharpoons NH_3(g)+HI(g)$

(A) 1 (B) 0.5 (C) 1.5 (D) 2

Q 11. Consider heterogeneous reaction

$NH_4HS(s) \rightleftharpoons NH_3(g)+H_2S(g)$ what will be value of k_p if P_{NH_3} and P_{H_2S} are partial pressures of NH_3 and H_2S respectively at equilibrium

(A) $P^2_{NH_3}P_{H_2S}$ (B) $P_{NH_3}.P_{H_2S}$

(C) $\dfrac{P_{NH_3}}{P_{H_2S}}$ (D) $\dfrac{P_{NH_3[NH_4HS]}}{P_{H_2S}}$

Q 12. The equilibrium constant for the reaction

$Zn(s)+CO_2(g) \rightleftharpoons ZnO(s)+CO(g)$ is

(A) $\dfrac{P_{CO}}{P_{CO_2}}$ (B) $\dfrac{[ZnO]}{[Zn]}$

(C) $\dfrac{P_{ZnO}P_{CO}}{P_{Zn}P_{CO_2}}$ (D) $\dfrac{P_{Zn}P_{CO_2}}{P_{ZnO}P_{CO_2}}$

Q 13. For the reaction,

$C(s)+CO_2(g) \rightleftharpoons 2CO(g)$ the partial pressure of CO_2 and CO are 2.0 and 4.0 atm respectively at equilibrium. The K_p for the reaction is

(A) 0.5 (B) 4.0

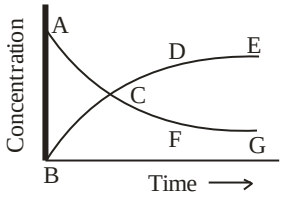
(C) 8.0 (D) 32.0

Q 14. The equilibrium constant K_C for the reaction $P_4(g) \rightleftharpoons 2P_2(g)$ is 1.4 at 400°. Suppose that 3 moles of $P_4(g)$ and 2 moles of $P_2(g)$ are mixed in 2 litre container at 400°C. What is the value of reaction quotient (Q) ?

(A) $\dfrac{3}{2}$ (B) $\dfrac{2}{3}$

(C) 1 (D) None of these

Q 15. $N_2O_4 \rightleftharpoons 2NO_2, K_c = 4$. This reversible reaction is studied graphically as shown in figure. Select the correct statements out of I, II and III



I. Reaction quotient has maximum value at point A

II. Reaction proceeds left to right at a point when $[N_2O_4]=[NO_2]=0.1M$

III. $K_C = Q$ when point D or F is reached

(A) I, II (B) II, III

(C) I, III (D) I, II, III

Q 16. For the reaction $A+B \rightleftharpoons 3C$ at 25°, a3 litre vessel contains 1, 2, 4 moles of A, B and C respectively. Predict the direction of the reaction of the reaction if

(A) K_C for the reaction is 10

(B) K_C for the reaction is 15

(C) K_C for the reaction is 10.66

Q 17. The value of K_c for the reaction $2A \rightleftharpoons B+C$ is 2×10^{-3}. At a given time, the composition of reaction mixture is $[A]=[B]=[C]=3\times10^{-4}M$. In which direction the reaction will proceed? **[NCERT Solved]**

Q 18. The reaction,
$CO(g)+3H_2(g) \rightleftharpoons CH_4(g)+H_2O(g)$ is at equilibrium at 1300 K in a 1L flask. It also contains 0.30 mol of CO, 0.10 mol of H_2 and 0.02 mol of H_2O & an unknown amount of CH_4 in the flask. Determine the concentration of CH_4 in the mixture. K_c = 3.90. **[NCERT]**

3. Solving Equilibrium Problems, Degree of Dissociation

Q 1. For the reaction $A \rightleftharpoons B$; if keq >1

(A) [B] is always greater than [A]
(B) [B] is always less than [A]
(C) [B] is greater than [A], at equilibrium
(D) [B] is less than [A], at equilibrium

Q 2. For equilibrium reaction, if Keqb < 10^{-3} then
(A) Equilibrium constant of reactant is much larger than equilibrium constant of products
(B) Equilibrium constant of reactant is much smaller than equilibrium constant of products
(C) Equilibrium constant of reactant is comparable to larger than equilibrium constant of products
(D) Can't predict

Q 3. In the reaction, $H_2(g)+I_2(g) \rightleftharpoons 2HI(g)$ the concentration of H_2, I_2 and HI at equilibrium are 8.0, 3.0 and 28.0 moles per liters respectively. What will be the equilibrium constant?

(A) 30.61 (B) 32.66
(C) 29.40 (D) 20.90

Q 4. For the reaction **[AIIMS 2017]**
$CO_2(g)+H_2(g) \rightleftharpoons CO(g)+H_2O(g)$
If initial concentration of H_2 & CO are equal and X mol/lit is the H_2 consumed at equilibrium, the correct expression of Kp is

(A) $\frac{x^2}{(1-x)^2}$ (B) $\frac{x^2}{(2+x)^2}$
(C) $\frac{x^2}{1-x^3}$ (D) $\frac{(1+x)^2}{(1-x)^2}$

Q 5. Two moles of ammonia was introduced in an evacuated vessel of 1 litre capacity. At high temperature the gas undergoes partial dissociation according to the equation
$2NH_3(g) \rightleftharpoons N_2(g)+3H_2(g)$
At equilibrium the concentration of ammonia was found to be 1 mole/lit. What is the value of K?

(A) $\frac{3}{4}=0.75mol^2$ (B) $\frac{3}{2}=1.5mol^2$
(C) $\frac{27}{16}=1.7mol^2$ (D) $\frac{27}{64}=0.42mol^2$

Q 6. 1 mol of A is mixed with 2.2 mol of B and the mixture is kept in a one litre flask till the equilibrium. $A+2B \rightleftharpoons 2C+D$ is reached. At equilibrium 0.2 mol of C is formed. Calculate the equilibrium constant for the above reaction.

(A) 1×10^{-4} (B) 1×10^{-3}
(C) 4×10^{-4} (D) 4×10^{-3}

Q 7. In the reaction, $A+B \rightleftharpoons C+D$
The initial concentration of A is double the initial concentration of B. At equilibrium the concentration of B was found to be one third of the concentration of C. The value of equilibrium constant is

(A) 1.8 (B) 1.008
(C) 0.0028 (D) 0.08

Q 8. The K_P value for the reaction; $H_2+I_2 \rightleftharpoons 2HI$, at 460°C is 49. If the initial pressure of H_2 and I_2 is 0.5 atm respectively, determine the partial pressure of HI gas at equilibrium.

Q 9. A sample of HI (g) is placed in flask at a pressure of 0.2 atm. At equilibrium the partial pressure of HI (g) is 0.04 atm. What is K_p for the given equilibrium? **[NCERT]**

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

Q 10. At 899 K, What is the equilibrium concentration of C_2H_6 when it is placed in a flask at 4.0 atm pressure and allowed to come to equilibrium according to the reaction? **[NCERT]**

$$C_2H_6(g) \rightleftharpoons C_2H_4(g) + H_2(g); K_p = 0.04$$

Q 11. For a gas reaction, $3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$, the partial pressures of H_2 and N_2 are 0.4 and 0.8 atmosphere, respectively. The total pressure of the entire system is 2.8 atmosphere. What will be the value of K_p if all the concentration are given in atmosphere ? [standard state = 1 atm]

(A) 32 (B) 20
(C) 50 (D) 80

Q 12. One mole of ammonium carbamate dissociate as shown below at 500 K

$$NH_3COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$$

If the pressure exerted by the released gases is 3.0 atm, the value of K_p is [Standard state = 1 atm]

(A) 7 (B) 3
(C) 4 (D) 8

Q 13. For the reaction $A(g) + B(g) \rightleftharpoons C(g) + D(g)$, the degree of dissociation α would be

(A) $\frac{\sqrt{K}}{\sqrt{K}+1}$ (B) $\sqrt{K}+1$
(C) $\sqrt{K} \pm 1$ (D) $\sqrt{K}-1$

Q 14. For the reaction: $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$; the degree of dissociation (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) $\sqrt{\frac{2K_p}{1+2K_p}}$ (D) $\frac{2\sqrt{K_p}}{1+2\sqrt{K_p}}$

Q 15. For the reaction at equilibrium

$$CO_2(g) + H_2(g) \rightleftharpoons CO(g) + H_2O(g)$$

[P – total pressure and x = degree of dissociation]

(A) P_{CO_2} and P_{H_2} is equal to $\left[\frac{1-x}{2}\right]P$

(B) P_{CO} and P_{H_2} is equal to $\left[\frac{1-x}{2}\right]P$

(C) P_{H_2} and P_{H_2O} is equal to $\left[\frac{x}{2}\right]P$

(D) P_{CO_2} and P_{H_2O} is equal to $\left[\frac{x}{2}\right]P$

Q 16. At a given temperature the following reaction is allowed to reach equilibrium in a vessel of volume V_1 litre. The degree of dissociation is α_1. If by keeping the temperature fixed the volume of the reaction vessel is doubled (assuming the degrees of dissociation to be small) the new degree of dissociation shall be

$$PCl_5 \rightleftharpoons PCl_3 + Cl_2$$

(A) $2\alpha_1$ (B) $\sqrt{\frac{\alpha_1}{2}}$
(C) $\sqrt{2\alpha_1}$ (D) $\sqrt{2}\alpha_1$

Q 17. The equilibrium constant K_p for the reaction $A \rightleftharpoons 2B$ is related to degree of dissociation α of A and total pressure P as

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

Q 18. 13.8g of N_2O_4 was placed in a 1 L reaction vessel at 400 K and allowed to attain equilibrium $N_2O_4(g) \rightleftharpoons 2NO_2(g)$. **[NCERT Solved]**

The total pressure at equilibrium was found to be 9.15 bar. Calculate K_c, K_p & partial pressure at eqb.

Q 19. At a given temperature, A compound $AB_2(g)$ dissociates as $AB_2(g) \rightleftharpoons 2AB(g) + B_2(g)$

With degree of dissociation 'x' which is small as compare to unity. The expression for Kp, in terms of 'x' and total Pressure 'P' is

(A) $\frac{Px^3}{2}$ (B) $\frac{Px^2}{3}$

(C) $\frac{Px^3}{3}$ (D) $\frac{Px^2}{2}$

Q 20. The dissociation of N_2O_4 is carried out at constant volume and temperature T. The degree of dissociation of N_2O_4 is

(A) $\frac{P_{eq} - P_{in}}{P_{in}}$ (B) $\left[\frac{K_p}{4P + K_p}\right]^{1/2}$

(C) Depend on initial amount of N2O4

(D) All of the above

Q 21. The value of $K_c = 4.24$ at 800 K for reaction,

$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

Calculate equilibrium concentrations of CO_2, H_2, CO and H_2O at 800 K, If only CO and H_2O are present initially at concentrations of 0.10 M each. **[NCERT Solved]**

Q 22. One mole of $N_2O_4(g)$ at 300 K is kept in a closed container under one atm. It is heated to 600K when 20% by mass of $N_2O_4(g)$ decomposes to $NO_2(g)$. The resultant pressure is

(A) 1.2 atm (B) 2.4 atm

(C) 2.0 atm (D) 1.0 atm

Q 23. Ammonia under a pressure of 15 atm at 27^0C is heated to 347^0C in a closed vessel in presence of a catalyst. Under these conditions NH_3 is partially decomposed according to the equation,

$2NH_3 \rightleftharpoons N_2 + 3H_2$

The vessel is rigid whereas the pressure increases to 50 atm. calculate the percentage of NH_3 actually decomposed?

(A) 61.3 % (B) 39.7 %

(C) 52.4 % (D) 47.6 %

Q 24. $A \rightleftharpoons 2B, K_p; C \rightleftharpoons D + E; K_p$. If degrees of dissociation of A and C are same and $K_p = 2K_p$, then the ratio of total pressure $p/p' = ?$ [Here P and P' are equilibrium pressure of 'A' and C respectively]

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

Q 25. The $CaCO_3$ is heated in a closed vessel of volume 1 litre at 600 K to form CaO and CO_2. The minimum weight of $CaCO_3$ required to establish the equilibrium

$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$

$(K_p = 2.25atm)$

(A) 2g (B) 4.57 g

(C) 10g (D) 100g

4. Solving Problems in Range I, II & III of K_{eqb}

Q 1. For the reaction at 700 K

$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

Equilibrium constant is 5.10. Calculate the equilibrium concentration of CO(g) at equilibrium if 1 mole each of component is mixed with each other in 1 lit flask

(A) 0.613 M (B) 0.713 M

(C) 0.513 M (D) 1.387 M

Q 2. For the reaction: $H_2(g) + F_2(g) \rightleftharpoons 2HF(g)$; $K_{eq} = 1.15 \times 10^2$ Find equilibrium constant of HF if 3 mole each of reactants & products are mixed in 1.5 lit flask

(A) 2.472 M (B) 5.056 M

(C) 4.056M (D) None of these

Q 3. Find equilibrium constant of HCl in the reaction

$H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$: $K_{eqb} = 1.15 \times 10^2$. If 1 mole H_2 & 2 mole Cl_2 are mixed in 1 lit Hark

(A) 0.968 M (B) 0.484 M
(C) 1.936 M (D) None of these

Q 4. For the reaction

$H_2(g)+I_2(g) \rightleftharpoons 2HI(g): k_p = 1\times10^2$

If partial pressure of H_2, I_2 & HI at initial conditions are 0.005 atm, 0.01 atm & 0.5 atm respectively then P_{H_2} at equilibrium is

(A) 0.00455 atm (B) 0.00405 atm
(C) 0.429 atm (D) None of these

Q 5. The value of K_p for the reaction, $CO_2(g)+C(s) \rightleftharpoons 2CO(g)$ is 3.0 at 1000 K. If initially $P_{CO_2} = 0.48$ bar and $P_{CO} = 0$ bar and pure graphite is present, calculate the equilibrium partial pressures of CO and CO_2.

[NCERT Solved]

Q 6. At a certain temperature and total pressure of 10^5 Pa, iodine vapour contains 40% by volume of I atoms $I_2(g) \rightleftharpoons 2I(g)$ Calculate K_p for equilibrium. **[NCERT]**

Q 7. One of the reaction that takes place in producing steel from iron ore is the reduction of iron (II) oxide by carbon monoxide to give iron & CO_2.

$FeO(s)+CO(g) \rightleftharpoons Fe(s)+CO_2(g);$

$K_p = 0.265$ atm at 1050K. **[NCERT]**

What are the equilibrium partial pressures of CO and CO_2 at 1050 K if the initial partial pressures are: $p_{co} = 1.4$ atm & $p_{co_2} = 0.8 = 0.80$ atm?

Q 8. 3.00 mol of PCl_5 kept in 1L closed reaction vessel was allowed to attain equilibrium at 380 K. Calculate composition of the mixture at equilibrium. $K = 1.80$ **[NCERT Solved]**

Q 9. At 700 K, equilibrium constant for the reaction. $H_2(g)+I_2(g) \rightleftharpoons 2HI(g)$ is 54.8. If 0.5 mol L^{-1} of HI (g) is present at eqb at 700 K, what are the concentration of H_2(g) and I_2(g) assuming that we initially started with HI(g) & allowed it to reach equilibrium at 700 K? **[NCERT]**

Q 10. A sample of pure PCl_5 was introduced into an evacuated vessel at 473 K. After equilibrium was attained, concentration of PCl_5 was found to be 0.5×10^{-1} mol.L^{-1}. If value of K_C is 8.3×10^{-3}, what are the concentrations of PCl_3 and Cl_2 at equilibrium ? **[NCERT]**

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

Q 11. For the reaction

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

$K = 1\times10^{-3}$ M. If 2 mole each of component are mixed in 2 lit flask, then equilibrium constant of $PCl_3(g)$ is

(A) 2.16×10^{-2} M (B) 3.16×10^{-2} M
(C) 3.16×10^{-3} (D) 2.16×10^{-3} M

Q 12. For the equilibrium reaction

$CH_3COOH(aqs) \rightleftharpoons CH_3COO^-(aqs)+H^+(aqs)$

$; K = 1.8\times10^{-5}$ M If 0.5 mole of CH_3COOH is takes in 1 lit flask, find $[H^+]$ at equilibrium

(A) 3×10^{-3} M (B) 9×10^{-6} M
(C) 3×10^{-2} M (D) None of these

Q 13. For the equilibrium reaction

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

$K = 1.6\times10^{-5}$ M. If 2 mole of $NaCl(g)$ is kept in 2 lit flask, find equilibrium constant of Cl_2

(A) 0.018 M (B) 0.028 M
(C) 0.032 M (D) 0.016 M

Q 14. Reaction between N_2 and O_2 takes place as follows ? **[NCERT]**

$2N_2(g)+O_2(g) \rightleftharpoons 2N_2O(g)$

If a mixture of 0.482 mol N_2 and 0.933 mol of O_2 is placed in a 10 L reaction vessel and allowed to form N_2O at a temperature for which $K_c = 2.0\times10^{-37}$, determine the composition of equilibrium mixture.

Q 15. The equilibrium constant for the following reaction is 1.6×10^{5} at 1024K. **[NCERT]**

$$H_2(g)+Br_2(g) \rightleftharpoons 2HBr(g)$$

Find the equilibrium pressure of all gases if 10.0 bar of HBr is introduced into a sealed container at 1024 K.

Q 16. Hot copper turning can be used as oxygen getter for inert gas supplies by slowly passing the gas over the turning at 600 K.

$$2Cu(s)+\frac{1}{2}O_2(g) \rightleftharpoons Cu_2O(s);K_p=7.5\times10^{10}atm^{-1/2}$$

The number of molecules per litre left after equilibrium has reached are

(A) 2.17 (B) 2.17×10^{23}

(C) 3.61×10^{24} (D) 1.78×10^{22}

Q 17. A 1M solution of glucose reaches dissociation equilibrium according to the equation given below: $6HCHO \rightleftharpoons C_6H_{12}O_6$

What is the concentration of HCHO at equilibrium, if equilibrium constant is 6×10^{22}

(A) $1.6\times10^{-8}M$ (B) $3.2\times10^{-6}M$

(C) $3.2\times10^{-4}M$ (D) $1.6\times10^{-4}M$

Q 18. $H_2(g)$ with Pressure 0.2 atm is passed over red hot $Cus(s)$ & kept at 500 K. The reaction is

$$CuO(s)+H_2(g) \rightleftharpoons Cu(s)+H_2O(g)$$

The equilibrium constant $K_p=1.6\times10^{9}$. Find the partial pressure of $H_2(g)$

(A) $1.25\times10^{-10}atm$ (B) $1.25\times10^{-9}atm$

(C) $2.5\times10^{-10}atm$ (D) $2.5\times10^{-9}atm$

5. Vapour density & Density of Eqb. Mixture

Q 1. The vapour density of PCl_5 is 62. The degree of dissociation of PCl_5 at this temperature will be

(A) 6.8% (B) 68%

(C) 46 % (D) 4 %

Q 2. The vapour density of N_2O_4 at a certain temperature is 30. The percentage dissociation of N_2O_4 at this temperature is

(A) 55.5% (B) 60%

(C) 70% (D) 53.3%

Q 3. An unknown compound A dissociates at 500°C to give products as follows

$$A(g) \rightleftharpoons B(g)+C(g)+D(g)$$

Vapour density of the equilibrium mixture is 50 when it dissociates to the extent to 10%. What will be the molecular weight of Compound A

(A) 120 (B) 130

(C) 134 (D) 140

Q 4. For the reaction $N_2O_4 \rightleftharpoons 2NO_2$, if degrees of dissociation of N_2O_4 are 25%, 50% 75% and 100%, the gradation of observed vapour densities is

(A) $d_1>d_2>d_3>d_4$

(B) $d_4>d_3>d_2>d_1$

(C) $d_1=d_2=d_3=d_4$

(D) None

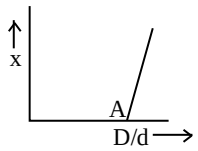
Q 5. Consider reaction $2A \rightleftharpoons 3B+2C$. This equilibrium is attained by taking A only. If initial vapour density is D_i and final vapour density at equilibrium is D_f. What is α for this reaction?

(A) $\frac{D_i-D_f}{D_f}$ (B) $\frac{2}{3}\frac{D_i-D_f}{D_f}$

(C) $\frac{3}{2}\frac{D_i-D_f}{D_f}$ (D) $\frac{1}{2}\frac{D_i-D_f}{D_f}$

Q 6. Before equilibrium is set-up for the chemical reaction $N_2O_4 \rightleftharpoons 2NO_2$, vapour density d of the gaseous mixture was measured. If D is the theoretical value of vapour density, variation of x

with D/d is by the graph. What is value of D/d at point A?



Q 7. 40% of a mixture of 0.2 mol of N_2 and 0.6 mol of H_2 react to give NH_3 according to the equation: $N_2(g)+3H_2(g) \rightleftharpoons 2NH_3(g)$ at constant temperature and pressure. Then the ratio of the final volume to the initial volume of gases are

(A) 4:5 (B) 5:4
(C) 7:10 (D) 8:5

Q 8. In $XY_2(g) \rightleftharpoons XY(g)+Y(g)$ [Standard state = 1mm of Hg]. Initial pressure of XY_2 is 600 mm Hg. The total pressure at equilibrium is 800 mm Hg. Assuming volume of system to remain constant, the value of K_p is

(A) 50 (B) 100
(C) 200 (D) 400

Q 9. The degree of dissociation is 0.4 at 400 K & 1.0 atm for the gaseous reaction $PCl_5 \rightleftharpoons PCl_3+Cl_2$. Assuming ideal behavior of all the gases, calculate the density of equilibrium mixture at 400 K and 1.0 atm (relative atomic mass of P = 31.0 and Cl = 35.5)

(A) 4.54 g/lit (B) 2.54 g/lit
(C) 3.54 g/lit (D) None of these

Q 10. For the reaction,

$F_2(g) \rightleftharpoons 2F(g); K_p = 1.4\times10^{-2}\,atm$

Density of $F_2(g)$ at 4 atm & 100 K is

(A) 2.01 g/lit (B) 1.79 g/lit
(C) 2.79 g/lit (D) 0.79 g/lit

Q 11. Density of an equilibrium mixture of N_2O_4 and NO_2 at 1 atm and 384 K is 1.84 g/lit. Equilibrium constant K_p of the following reaction is

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$ **[AIIMS 2016]**

(A) 1.98 atm (B) 2.09 atm
(C) 2.36 atm (D) 1.48 atm

6. Le – Chatelier's Principle

Q 1. The reversible reaction

$[Cu(NH_3)_4]^{2+}+SO_3^{2-} \rightleftharpoons [Cu(NH_3)_3SO_3]+NH_3$

Is at equilibrium. What would not happen if ammonia is added

(A) $[SO_3^{2-}]$ would increase

(B) $[Cu(NH_3)_3SO_3]$ would increase

(C) The value of Keqb would not change

(D) $[Cu(NH_3)_4]^{2+}$ would increase

Q 2. Consider the following reactions at equilibrium and determine which of the indicated changes will cause the reaction to proceed to the right

(A) $CO+3H_2 \rightleftharpoons CH_4+H_2O(g);(\text{add } CH_4)$

(B) $N_2(g)+3H_2(g) \rightleftharpoons 2NH_3(g);(\text{remove } NH_3)$

(C) $N_2(g)+F_2(g) \rightleftharpoons 2HF(g);(\text{add } F_2)$

(D) $BaO(s)+SO_3(g) \rightleftharpoons BaSO_4(s);(\text{add BaO})$

Q 3. Following two equilibrium is simultaneously established in a container at constant volume

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

$COCl_2(g) \rightleftharpoons CO(g)+Cl_2(g)$

If some CO(g) is introduced in the container at constant volume, then at new equilibrium the concentration of

(A) PCl_5 is greater (B) PCl_3 remain unchanged
(C) PCl_5 is less (D) Cl_2 is greater

Q 4. Following two equilibrium is simultaneously established in a container

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

$CO(g)+Cl_2(g) \rightleftharpoons CoCl_2(g)$

If some Ni(s) is introduced in the container forming $Ni(CO)_4$ (g) then at new equilibrium

(A) PCl_3 concentration will increase
(B) PCl_3 concentration will decrease
(C) Cl_2 concentration will remain same
(D) CO concentration will remain same

Q 5. Which of the following information can be obtained on the basis of Le-chatelier's principle?

[CBSE PMT 1992]

(A) dissociation constant of a weak acid
(B) Entropy change in a reaction
(C) Equilibrium constant of a chemical reaction
(D) shift in equilibrium position on changing value of a constant

Q 6. In the equilibrium reaction

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

The constant of NH_3 when $NH_4Cl(s)$ is added in large excess

(A) decreases (B) increases
(C) Remain constant (D) a or b both

Q 7. $KMnO_4$ an be prepared from K_2MnO_4 as per reaction,

$$3MnO_4^{2-} + 2H_2O \rightleftharpoons 2MnO_4^- + MnO_2 + 4OH^-$$

The reaction can go to completion by removing OH^- ions by adding **[CBSE PMT 2013]**

(A) HCl (B) KOH (C) CO_2 (D) SO_2

Q 8. In a vessel containing N_2, H_2 and NH_3 at equilibrium, some helium gas is introduced so that total pressure increase while temperature and volume remain constant. According to Le Chatelier's principle, the dissociation of NH_3

(A) increase (B) decreases
(C) remains unaltered (D) changes unpredictably

Q 9. On adding inert gas to the equilibrium $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ at constant pressure. The degree of dissociation will remain

(A) Unchanged (B) Decreased
(C) Increased (D) None of these

Q 10. For the reaction;

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g),$$

at a given temperature, the equilibrium amount of $CO_2(g)$ can be increased by

(A) Adding a suitable catalyst
(B) Adding an inert gas
(C) Decreasing the volume of the container
(D) Increasing the amount of CO(g)

Q 11. A cylinder provided with a piston has some PCl_5 which is in equilibrium with PCl_3 and Cl_2. The system is compressed with the help of piston. Indicate the correct statement:

(A) some more PCl_5 will decompose
(B) the system remains unaffected
(C) PCl_3 and Cl_2 will combine to form PCl_5
(D) explosion occurs

Q 12. At constant temperature, the equilibrium constant (K_p) for the decomposition reaction, $N_2O_4 \rightleftharpoons 2NO_2$, is expressed by $K_p = \frac{(4x^2P)}{(1-x^2)}$, where P = Pressure, x= extent of decomposition. Which one of the following statement is true

(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 & x

Q 13. Consider the following reactions. In which cases is the product formation favoured by decreased pressure?

(A) $CO_2(g) + C(s) \rightleftharpoons 2CO(g); \Delta H^\circ = +172.5kJ$
(B) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g); \Delta H^\circ = -91.8kJ$
(C) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g); \Delta H^\circ = 181kJ$
(D) $2H_2O(g) \rightleftharpoons 2H_2(g) + O_2(g); \Delta H^\circ = 484.6kJ$

(A) 2,3 (B) 3,4
(C) 2,4 (D) 1,4

Q 14. The reaction in which the yield of the products can not be increased by the application of high pressure is

(A) $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$
(B) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
(C) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$
(D) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

Q 15. A system at equilibrium is described by the equation of fixed temperature T.

$$SO_2Cl_2(g) \rightleftharpoons SO_2(g) + Cl_2(g)$$

If total pressure is increased by decreasing volume then at equilibrium

(A) Concentration of SO_2Cl_2 (g) increase
(B) Concentration of SO_2 (g) increases
(C) Concentration of Cl_2 (g) increases
(D) Concentration of all gases increases

Q 16. **Assertion (A):** Adding inert gas to dissociation equilibrium of N_2O_4 at constant temperature & pressure increases the dissociation.
Reason (R): Due to the addition of inert gas molar concentration of reactants and products decreases. **[AIIMS 2015]**
(A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is not the correct explanation of A
(C) A is true but R is false
(D) Both A and R are false

Q 17. Which of the following reactions will get affected by increasing the pressure? Also, mention whether change will cause the reaction to go into forward or backward direction. **[NCERT]**

(i) $COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$

(ii) $CH_4(g) + 2S_2(g) \rightleftharpoons CS_2(g) + 2H_2S(g)$

(iii) $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$

(iv) $2H_2(g) + CO(g) \rightleftharpoons CaO(s) + CO_2(g)$

(v) $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$

Q 18. **Assertion (A):** In the dissociation of PCl_5 at constant pressure and temperature the addition of helium at equilibrium increases the dissociation of PCl_5.
Reason (R): Helium removes Cl_2 from the field of action. **[NCERT Examplar]**
(A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is not the correct explanation of A
(C) A is true but R is false
(D) Both A and R are false

7. Le – Chatelier's Principle, Temperature Effect

Q 1. Favourable conditions for manufacture of ammonia by the reaction
$N_2 + 3H_2 \rightleftharpoons 2NH_3; \Delta H = -21.9$ kcal are

(A) Low temperature, low pressure and catalyst
(B) Low temperature, high pressure and catalyst
(C) High temperature, low pressure and catalyst
(D) High temperature, high pressure and catalyst

Q 2. The Haber's process for the manufacture of ammonia is usually carried out at about 500°C. If a temperature of about 250°C was used instead of 500°C
(A) No ammonia would be formed at all
(B) The percentage of ammonia in the equilibrium mixture would be too low
(C) A catalyst would be of no use at all at this temperature
(D) The rate of formation of ammonia would be too slow

Q 3. Of the following which change will shift the reaction towards formation of the product? **[AIIMS 2004]**
$I_2(g) \rightleftharpoons 2I(g); \Delta H_r^o(298K) = +150KJ$
(A) Increase in concentration of I_2
(B) Decrease in concentration of I_2
(C) Increase in temperature
(D) Increase in total pressure

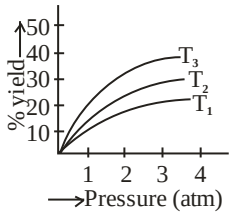
Q 4. For the equilibrium,
$2NO_2(g) \rightleftharpoons N_2O_4(g) + 14.6$ kcal. An increase of temperature will
(A) Favour the formation of N_2O_4
(B) Favour the decomposition of N_2O_4
(C) Not affect the equilibrium
(D) Stop the reaction

Q 5. The equilibrium constants for the reaction,
$A_2 \rightleftharpoons 2A$ at 500 K & 700 K are 1×10^{-10} & 1×10^{-5}. The given reaction is **[CBSE PMT 96]**
(A) exothermic (B) slow
(B) endothermic (D) fast

Q 6. The preparation of $SO_3(g)$ by reaction

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

Is an exothermic reaction. If the preparation follows the following temperature pressure relationship for its % yield, then for temperature T_1, T_2 and T_3. The correct option is



(A) $T_3 > T_2 > T_1$ (B) $T_1 > T_2 > T_3$

(C) $T_1 = T_2 = T_3$

(D) Nothing could be predicted about temperature through given information

Q 7. When hydrochloric acid is added to cobalt nitrate solution at room temperature, the following reaction takes place and the reaction mixture becomes blue. On cooling the mixture it becomes pink. On the basis of this information mark the correct answer. **[NCERT Examplar]**

$$\underset{\text{(Blue)}}{\left[Co(H_2O_6)\right]^{3+}(aq)+4Cl^- \rightleftharpoons} \left[CoCl_4\right]^{2-}(aq)+6H_2O(\ell)$$

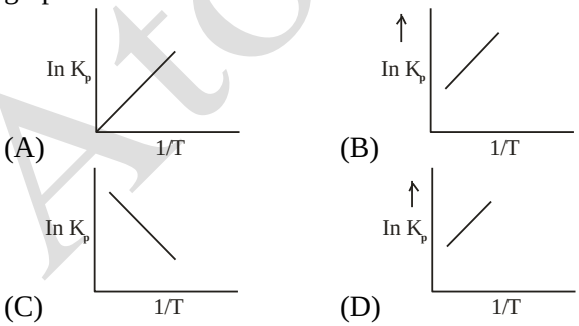
(A) $\Delta H > 0$ for the reaction

(B) $\Delta H < 0$ for the reaction

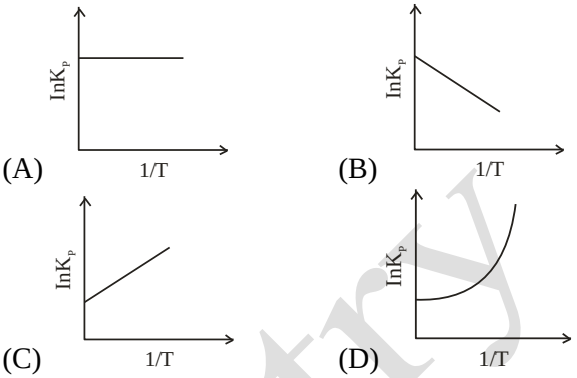
(C) $\Delta H = 0$ for the reaction

(D) The sign of ΔH connect be predicted on the basis of this information

Q 8. An exothermic reaction is represented by the graph



Q 9. An endothermic reaction is represented by the graph



Q 10. If the enthalpy of a reversible reaction is 8.314 kJ/mol over the temperature range 400 K to 500 K. Therefore the value of in (K_{500}/K_{400}) for the reaction is

(A) 0.5 (B) 1

(B) 2.5 (D) 0.25

Q 11. For the reaction $F_2(g) \rightleftharpoons 2F(g); \Delta H°$

If $K_p(760°) = 2\times10^{-5}$ & $K_p(960°) = 4\times10^{-3}$ atm. $\Delta H°$ for the above reaction is

(A) 18.46 KJ (B) 8.46 KJ

(C) –18.46 KJ (D) –8.46 KJ

Q 12. If temp of a reaction is increased from 27°C to 127°C its equilibrium decreases to 1/2 of its initial value. The value of ΔH is

(A) 829 R (B) –829R

(C) –715R (D) +715R

Q 13. In the melting of ice, which one of the conditions will be more favourable

(A) High temperature and high pressure

(B) Low temperature and low pressure

(C) Low temperature and high pressure

(D) High temperature and Low pressure

Q 14. Which of the following statements is incorrect? **[NCERT Examplar]**

(A) In equilibrium mixture of ice and water kept in perfectly insulated flask, mass of ice and water does not change with time

(B) The intensity of red colour increases when oxalic acid is added to a solution containing iron (III) nitrate and potassium thiocyanate

(C) On addition of catalyst the equilibrium constant value is not affected

(D) Equilibrium constant for a reaction with negative ΔH value decreases as the temperature increases

Q 15. Densities of diamond and graphite are 3.5 and 2.3 g/ml respectively. Increase of pressure on the equilibrium $C_{diamond} \rightleftharpoons C_{graphite}$

(A) Favours backward reaction
(B) Favours forward reaction
(C) Have no effect
(D) Increase the reaction rate

Q 16. Decrease in the pressure for the following equilibria: $H_2O(s) \rightleftharpoons H_2O(l)$ result in the

(A) formation of more $H_2O(s)$
(B) formation of more $H_2O(l)$
(C) increase in melting point of $H_2O(s)$
(D) decrease in melting point of $H_2O(s)$

Q 17. Decrease in the temperature for the following equilibria: $H_2O(s) \rightleftharpoons H_2O(l)$ result in the

(A) formation of more H_2O (s)
(B) formation of more $H_2O(l)$
(C) increase in melting point of $H_2O(s)$
(D) decrease in melting point of $H_2O(s)$

8. Free Energy & Equilibrium Relation

Q 1. A large positive value of $\Delta G°$ corresponds to which of these ?
(A) small positive K (B) small negative K
(C) large positive K (D) large negative K

Q 2. The equilibrium constant for a reaction is 1×10^{20} at 300 K. The standard free energy change for this reaction is
(A) –115 kJ (B) +115 kJ
(C) +1665 kJ (D) –1665 kJ

Q 3. At equilibrium $K_p = 1$, then;
(A) $\Delta G° = 0$ (B) $\Delta G° = +ve$
(C) $\Delta G° = -ve$ (D) $\Delta G° = +ve$ or $-ve$

Q 4. Hydrolysis of sucrose gives equilibrium constant K_c for the reaction is 2×10^{13} at 300 K. calculate ΔG^{Θ} (Joule/Mol) at 300 K
(A) 7.64×10^{4} (B) 7.64×10^{-4}
(C) -7.64×10^{-4} (D) -7.64×10^{4}

Q 5. Using the gibb's free energy change, ΔG^{Θ} = +63.3 KJ for the following reaction **[CBSE PMT 2014]**

$$Ag_2CO_3(s) \rightleftharpoons 2Ag^+(aqs) + CO_3^{2-}(aqs)$$

The Ksp (equilibrium constant) of Ag_2CO_3 (s) in water at 25^0C is (R = 8.314 J/mol.K)
(A) 3.2×10^{-26} (B) 8.0×10^{-12}
(C) 2.9×10^{-3} (D) 7.9×10^{-2}

Q 6. In an equilibrium reaction for which $\Delta G° = 0$, the equilibrium constant K should be equal to
(A) 0 (B) 1
(C) 2 (D) 10

Q 7. $Ag_2CO_3(s) \rightleftharpoons 2Ag^+(aqs) + CO_3^{2-}(aqs)$

For above reaction, $\Delta G°$ (standard Gibb's free energy) will be

(A) $\Delta G° = -RT\ \ell n \dfrac{1}{P_{CO_2}}$

(B) $\Delta G° = -RT\ \ell n P_{CO_2}$

(C) $\Delta G° = -2RT\ \ell n P_{CO_2}$

(D) None of these

Q 8. For the reaction at 300K

$$A(g) \rightleftharpoons V(g) + S(g)$$

$\Delta_r H^0 = -30 kJ/mol, \Delta_r S = -0.1 kJ.K^{-1}.\ mol^{-1}$

What is the value of equilibrium constant ?
(A) 0 (B) 1
(C) 10 (D) None of these

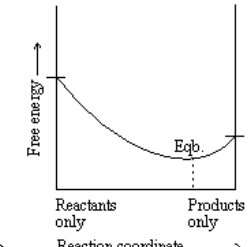
Q 9. Solid $Ca(HCO_3)_2$ decomposes as

$$Ca(HCO_3)_2(s) \rightleftharpoons CaCO_3(s) + CO_2(g) + H_2O(g)$$

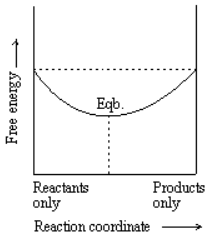
If the total pressure is 0.2 bar at 420 K, what is the standard free energy change for the given reaction $(\Delta_r G°)$?

(A) 840 kJ/mol (B) 3.86 kJ/mol
(C) 6.98 kJ/mol (D) 16.083 kJ/mol

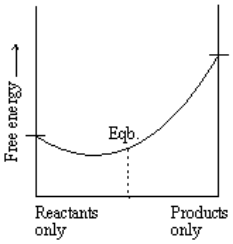
Q 10. Which of the following curves represents a very rare standard reaction at equilibrium?



(A)



(B)



(C) (D) All are equally probable

Q 11. Calculate the equilibrium ratio of C to A if 2.0 moles each of A and B were allowed to come to equilibrium at 300 K

$A + B \rightleftharpoons C + D; \Delta G^0 = 460 cal$

(A) 0.579 (B) 0.679
(C) 0.379 (D) 0.479

Q 12. Calculate $\Delta H°$ for the reaction

$2A(g) + B(g) \rightleftharpoons A_2B(g)$

For which $\Delta S° = 5.0$ J/K, $K = 1.0 \times 10^{-10}$ & T = 300 K

(A) 63.8 kJ/mol (B) 127.6 kJ/mol
(C) 31.9 kJ/mol (D) None of these

Q 13. Which of the following options will be correct for the stage of half completion of the reaction $A \rightleftharpoons B$? **[NCERT Examplar]**

(A) $\Delta G^{\Theta} = 0$ (B) $\Delta G^{\Theta} > 0$
(C) $\Delta G^{\Theta} < 0$ (D) $\Delta G^{\Theta} = -RT \ln K$

Answer Key

1. Introduction to Equilibrium, Equilibrium Constant

(1). D (2). C (3). B
(4). D (5). D (6). D
(7). C (8). A (9). C
(10). A (11). B (12). A
(13). B (14). C
(15). $4NO + 6H_2O \rightarrow 4NH_3 + 5O_2$

2. Properties of K_{eqb}, Type of K_{eqb}, Reaction Quotient

(1). D (2). B (3). A
(4). D (5). D (6). C
(7). A (8). A (9). A
(10). D (11). B (12). A
(13). C (14). B (15). B
(16). A. Backward, B. Forward, C. Equilibrium
(17). Reverse direction (18). 5.85×10^{-2}

3. Solving Equilibrium Problems , Degree of Dissociation, Equilibrium Problems

(1). C (2). A (3). B
(4). A (5). C (6). B
(7). A (8). 7/9 atm (9). 4.0
(10). 3.62 atm (11). C (12). C
(13). A (14). D (15). A
(16). D (17). A (18). 2.586
(19). A (20). D
(21). $[H_2] = [CO_2] = 0.067$ M.
$[H_2O] = [CO] = 0.033$ M
(22). B (23). A (24). A
(25). B

4. Solving Problems in Range I, II & III of K_{eqb}

(1). A (2). B (3). C
(4). B
(5). $P_{CO} = 0.66$ bar, $P_{CO2} = 0.15$ bar
(6). $K_p = 2.67\times10^4\,Pa$
(7). $P_{CO} = 1.739$, $P_{CO2} = 1.461$
(8). $[PCl_3] = [Cl_2] = 1.59$ M, $[PCl_5] = 1.41$ M
(9). 0.0675 M
(10). $[PCl_3] = 0.02$ M, $[Cl_2] = 0.02$M
(11). B (12). A (13). D
(14). $[N_2] = 0.042$ M, $[O_2] = 0.0933$ M,
$[N_2O] = 6.6\times10^{-21}M$
(15). $P_{H2} = P_{Br2} = 0.025$ bar, $P_{HBr} = 10$ bar
(16). A (17). D (18). B

5. Vapour density & Density of Eqb. Mixture

(1). B (2). B (3). A
(4). A (5). B (6). B
(7). A (8). B (9). A
(10). B (11). B

6. Le – Chatelier's Principle

(1). B (2). A (3). C
(4). B (5). D (6). A
(7).C (8). C (9). C
(10). D (11). C (12). D
(13). D (14). C (15). D
(16). A
(17). Backward, No change, Backward
forward, Backward
(18). D

7. Le – Chatelier's Principle, Temperature Effect

(1). B (2). D (3). C
(4). B (5). B (6). B
(7). A (8). B (9). B
(10). A (11). A (12). A
(13). A (14). B (15). A
(16). A,C (17). A

8. Free Energy & Equilibrium Relation

(1). A (2). A (3). A
(4). D (5). B (6). B
(7). B (8). B (9). D
(10). B (11). B (12). A
(13). A