Topic: Chemical Equilibrium

Q.1 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.2 When 1 mole H_2O(g) and 1 mole CO(g) are heated at 1000ºC in a closed vessel of 5 litre, it was found that 40% of H_2O react at equilibrium, according to

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

K_c of the reaction will be -

(A) 0.444 (B) 0.555

(C) 0.666 (D) 0.786

Q.3 In a dilute solution there are two equilibria

KCl (s) $\rightleftharpoons$ K^+ + Cl^- ... $K_1 = 10^x$

Ag^+ + Cl^- $\rightleftharpoons$ AgCl (s) ... $K_2 = 10^y$

The equilibrium, constant for the reaction

$Ag^+ + KCl_{(s)} \rightleftharpoons K^{\oplus} + AgCl_{(s)}$

in dilute solution is -

(A) 10^{x+y} (B) 10^{x-y}

(C) 10^y (D) $(10^x)^y$

Q.4 $CaCO_3$(s) $\rightleftharpoons$ CaO(s) + CO_2(g).

For above reaction, ΔGº (standard Gibb's free energy) will be :

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

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

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

(D) none of these

Q.5 The endothermic reaction $MCO_3(s) \rightleftharpoons MO(s) + CO_2(g)$ is taking place in such a way that the vapour pressure of CO_2 is equal to atmospheric pressure. Which of the following is not correct ?

(A) $\Delta G^{o} = 0$ (B) $K_p = 1$

(C) $\Delta G = 0$ (D) $\Delta H = 0$

Q.6 For $NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$, if $K_p = 64$ atm^2, equilibrium pressure of mixture is:

(A) 8 atm (B) 16 atm

(C) 64 atm (D) 4 atm

Q.7 At 35ºC, the equilibrium constant for the reaction below is

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

$K_c = 1.6 \times 10^{-5}$

An equilibrium mixture was found to have the following concentration of Cl_2 and NOCl. $[Cl_2] = 1.2 \times 10^{-2}$ M, $[NOCl] = 2.8 \times 10^{-1}$ M. Calculate the concentration of NO(g) at equilibrium :

(A) 1.0×10^{-4} M (B) 1.0×10^{-2} M

(C) 2.8×10^{-1} M (D) 2.4×10^{-2} M

Q.8 2.0 mol of PCl_5 were introduced in a vessel of 5.0 L capacity at a particular temperature. At equilibrium, PCl_5 was found to be 35% dissociated into PCl_3 and Cl_2. The value of K_c for the reaction is -

(A) 1.89 (B) 0.377

(C) 0.75 (D) 0.075

Q.9 The reaction $A + B \rightleftharpoons C + D$ is studied in a one litre vessel at 250ºC. The initial concentration of A was 3n and the initial concentration of B was n. After equilibrium was attained then equilibrium concentration of C was found to be equal to equilibrium concentration of B. What is the concentration of D at equilibrium ?

(A) n/2 (B) (3n – n/2)

(C) n (D) None of these

Q.10 Which of the following is not favourable for formation of SO_3 ?

$2SO_2(g) + O_2\ (g) \rightleftharpoons 2SO_3(g)$; $\Delta H = -188$ KJ

(A) High pressure (B) High temperature

(C) Decreasing $[SO_3]$ (D) Increasing $[SO_2]$

Q.11 On heating a mixture of SO_2Cl_2 and CO, two equilibria are simultaneously established :

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

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

On adding more SO_2 at equilibrium what will happen ?

(A) Amount of CO will decrease

(B) Amount of SO_2Cl_2 and $COCl_2$ will increase

(C) Amount of CO will remain unaffected

(D) Amount of SO_2Cl_2 and CO will increase

Q.12 For the reaction, $N_2O_4(g) \rightleftharpoons 2NO_2(g)$; if percentage dissociation of N_2O_4 are 25%, 50%, 75% and 100%, then the sequence of observed vapour densities will be -

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

Q.13 Consider the reaction,

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

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

The addition of an inert gas at constant volume -

(A) will increase the dissociation of PCl_5 as well as N_2O_4

(B) will reduce the dissociation of PCl_5 as well as N_2O_4

(C) will increase the dissociation of PCl_5 and step up the formation of NO_2

(D) will not disturb the equilibrium of the reactions

Q.14 At constant pressure, the presence of inert gases -

(A) reduces the dissociation of PCl_5

(B) increases the dissociation of PCl_5

(C) does not affect the degree of dissociation of PCl_5

(D) steps up the formation of PCl_5

Q.15 In the reaction :

$NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$

the equilibrium pressure was 3 atm at 1000 K. The K_p of the reaction -

(A) 27 (B) 4

(C) 4/27 (D) 27/4

Q.16 In the decomposition reaction of ammonia :

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

2 moles of NH_3 are introduced in the vessel of 1 litre. At equilibrium, 1 mole of NH_3 was left, the value of K_c will be :

(A) 0.75 (B) 0.70

(C) 1.75 (D) 1.70

Q.17 When ℓnK is plotted against $\frac{1}{T}$ using the van't Hoff equation, a straight line is expected will a slope equal to -

(A) $\Delta H°/RT$(B) – $\Delta H°/R$

(C) $\Delta H°/R$ (D) $R/\Delta H°$

Q.18 For the reaction, $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, the forward reaction at constant temperature is favoured by -

I. introducing inert gas at constant volume.

II. introducing inert gas at constant pressure.

III. decreasing pressure of the reaction mixture.

IV. by adding PCl_3 to the reaction mixture.

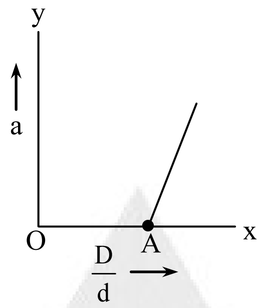
(A) I and II (B) II and III

(C) I and III (D) III and IV

Q.19 Decomposition of $N_2O_4(g)$ takes place as follows :

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

'D' is the vapour density at initial stage and 'd' is the vapour density at equilibrium. We get following graph when the degree of dissociation 'a' is plotted against $\left(\frac{D}{d}\right)$



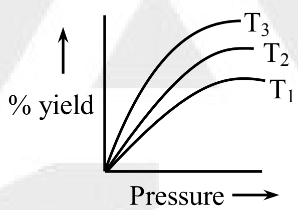
What is the value of $\frac{D}{d}$ at A ?

(A) 0 (B) 0.5 (C) 1 (D) 1.5

Q.20 Percentage yield of following reaction is plotted against pressure at a definite temperature :

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g); \Delta H = -ve$$

Which of the following relation is correct ?

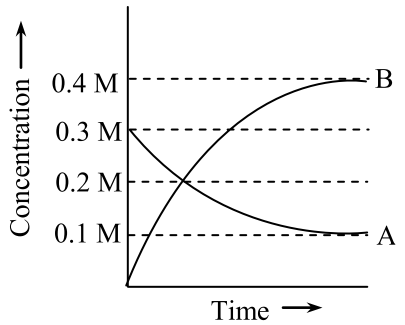


(A) $T_1 > T_2 > T_3$ (B) $T_3 > T_2 > T_1$

(C) $T_1 = T_2 = T_3$ (D) $T_1 > T_2 < T_3$

Q.21 The figure shows the change in concentration of species A and B as a function of time.

The equilibrium constant K_C for the reaction $A(g) \rightleftharpoons 2B(g)$ is -



(A) $K_C > 1$ (B) $K < 1$

(C) $K = 1$ (D) data insufficient

Q.22 Determine the value of equilibrium constant (K_C) for the reaction

$$A_2(g) + B_2(g) \rightleftharpoons 2AB(g).$$

If 10 moles of A_2; 15 moles of B_2 and 5 moles of AB are placed in a 2 litre vessel and allowed to come to equilibrium. The final concentration of AB is 7.5 M :

(A) 4.5 (B) 1.5

(C) 0.6 (D) None of these

Q.23 Given the following reaction at equilibrium, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. Some inert gas at constant pressure is added to the system. Predict which of the following facts will be affected ?

(A) More $NH_3(g)$ is produced

(B) Less $NH_3(g)$ is produced

(C) No affect on the equilibrium

(D) K_p of the reaction is decreased

Q.24 Some inert gas is added at constant volume to the following reaction at equilibrium

$NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$

Predict the effect of adding the inert gas -

(A) the equilibrium shifts in the forward direction

(B) the equilibrium shifts in the backward direction

(C) the equilibrium remains unaffected

(D) the value of K_p is increased

Q.25 Consider the following reactions at equilibrium and determine which of the indicated changes will cause the reaction to proceed to the right -

(1) $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$ (add CH_4)

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

(3) $H_2(g) + F_2(g) \rightleftharpoons 2HF(g)$ (add F_2)

(C) $BaO(s) + SO_3(g) \rightleftharpoons BaSO_4(s)$ (add BaO)

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

Q.26 If the pressure in a reaction vessel for the following reaction is increased by decreasing the volume, what will happen to the concentrations of CO and CO_2 ?

$H_2O(g) + CO(g) \rightleftharpoons H_2(g) + CO_2(g) + \text{Heat}$

(A) both the [CO] and [CO_2] will decrease

(B) neither the [CO] nor the [CO_2] will change

(C) both [CO] will decrease and the [CO_2] will increase

(D) both the [CO] and [CO_2] will increase

COMPREHENSION BASED QUESTION

Passage : (Q.27 & Q.28)

For general reaction,

$$aA + bB \rightleftharpoons cC + dD$$

equilibrium constant K_c is given by the following relation.

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

However, when all reactants and products are gases, the equilibrium constant is generally expressed in terms of partial pressures. The relationship between the partial pressure (p) of any one gas in the equilibrium mixture and the molar concentrations can be correlated provided the gas behaves as an ideal gas.

Q.27 The relation between partial pressure of the gas and its molar concentration at a given temperature T is -

(A) $p = \frac{\text{molar concentration}}{T}$

(B) $p = \frac{\text{molar concentration}}{RT}$

(C) p = molar concentration × RT

(D) p = molar concentration × T

Q.28 Equilibrium constant for the following reaction is

$$aA + bB \rightleftharpoons cC + dD$$

(A) $K_p = \frac{[C]^c[D]^d}{[A]^a[B]^b} \times P$

(B) $K_p = \frac{[C]^c[D]^d}{[A]^a[B]^b} \times \frac{(RT)^{c-d}}{(RT)^{a-b}}$

(C) $K_p = \frac{[C]^c[D]^d}{[A]^a[B]^b} \times \frac{(RT)^{c+d}}{(RT)^{a+b}}$

(D) $K_p = \frac{K_cRT}{P}$

STATEMENT BASED QUESTION

Each of the questions given below consist of Statement – I and Statement – II. Use the following Key to choose the appropriate answer.

(A) If both Statement- I and Statement- II are true, and Statement - II is the correct explanation of Statement– I.

(B) If both Statement - I and Statement - II are true but Statement - II is not the correct explanation of Statement – I.

(C) If Statement - I is true but Statement - II is false.

(D) If Statement - I is false but Statement - II is true.

Q.29 **Statement - I.** For the reaction

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$, $K_p = K_c$.

Statement - II. K_p of all gaseous reactions is equal to K_c.

Q.30 **Statement - I.** K_p is related to K_c by the relation,

$$K_p = K_c\,(RT)^{\Delta n}$$

Statement - II. K_p has same units as K_c.

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	A	A	B	D	B	B	D	A	B
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	D	A	D	B	B	D	B	B	C	A
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	A	A	B	C	A	D	C	C	C	C