* Chemistry [400]

1. In which of the following equilibria, K_p and K_c are NOT equal?

   (A) $\mathrm{H}_{2(\mathrm{~g})}+\mathrm{I}_{2(\mathrm{~g})} \rightleftharpoons 2 \mathrm{HI}_{(\mathrm{g})}$

   (B) $\mathrm{CO}_{(\mathrm{g})}+\mathrm{H}_2 \mathrm{O}_{(\mathrm{g})} \rightleftharpoons \mathrm{CO}_{2(\mathrm{~g})}+\mathrm{H}_{2(\mathrm{~g})}$

   (C) $2 \mathrm{BrCl}_{(\mathrm{g})} \rightleftharpoons \mathrm{Br}_{2(\mathrm{~g})}+\mathrm{Cl}_{2(\mathrm{~g})}$

   (D) $\mathrm{PCl}_{5(\mathrm{~g})} \rightleftharpoons \mathrm{PCl}_{3(\mathrm{~g})}+\mathrm{Cl}_{2(\mathrm{~g})}$

   Ans. : d

   $\mathrm{K}_{\mathrm{p}}=\mathrm{K}_{\mathrm{c}}(\mathrm{RT})^{\Delta \mathrm{n}_g}$

   $\text{for } \mathrm{K}_{\mathrm{p}} \neq \mathrm{K}_{\mathrm{c}}$

   $\mathrm{n}_{\mathrm{g}} \neq 0$

   $\Delta \mathrm{n}_{\mathrm{g}}=\mathrm{n}_{\mathrm{p}}-\mathrm{n}_{\mathrm{f}}$

   (1) $\Delta \mathrm{n}_g=2-1=1$

   (2) $\Delta \mathrm{n}_{\mathrm{g}}=2-2=0$

   (3) $\Delta \mathrm{n}_9=2-2=0$

   (4) $\Delta \mathrm{n}_{\mathrm{g}}=2-2=0$

2. The equilibrium concentrations of the species in the reaction $A+B \rightleftharpoons C+D$ are $2,3,10$ and $6\, mol\, L-1$, respectively at $300\, K . \Delta G^{\circ}$ for the reaction is ($R=2\, cal / mol\, K)$

   (A) $-13.73\, cal$ (B) $1372.60\, cal$ (C) $-137.26\, cal$ (D) $-1381.80\, cal$

   Ans. : d

   $A+B \rightleftharpoons C+D$

   at equilibrium $2 \quad 3 \quad 10 \quad 6$

   $k_{eq}=[C][D] /[A][B]$

   $k_{eq}=\frac{10 \times 6}{2 \times 3}=10$

   $\Delta G^{\circ}=-R T \ln K$

   $=-2.303\, R T\, \log K$

   $=-2.303 \times 2 \times 300 \times \log 10$

   $=-1381.8\, cal$

3. For the reversible reaction,
   $N_{2(g)}+3 H_{2(g)} \rightleftharpoons 2 N H_{3(g)}+$ heat
   The equilibrium shifts in forward direction

   (A) by increasing the concentration of $N H_{3(g)}$

   (B) by decreasing the pressure

   (C) by decreasing the concentrations of $N_{2(g)}$ and $H_{2(g)}$

(D) by increasing pressure and decreasing temperature.

Ans. : d

Any change in the concentration, pressure and temperature of the reaction results in change in the direction of
equilibrium. This change in the direction of equilibrium is governed by Le-Chatelier's principle. According to Le-Chatellier's principle, equilibrium shifts in die opposite direction to undo the change. $\mathrm{N_2(g)+3H_2(g) \rightleftharpoons 2NH_3(g)+Heat}$

(a) Increasing the concentration of $NH_3(g)$: On increasing the concentration of $NH_3(g)$. the equilibrium shifts in the backward direction where concentration of $NH_3(g)$ decreases

(b) Decreasing the pressure: since, $p \propto n$ (number of moles), therefore, equilibrium shifts in the backward direction where number of moles are increasing.

(c) Decreasing the concentration of $N_2(g)$ and $H_2(g)$ Equilibrium shifts in the backward direction when concentration of $H_2(g)$ and $H_2(g)$ decreases.

(d) Increasing pressure and decreasing temperature: On increasing pressure, equilibrium shifts in the forward direction where number of moles decreases. It is an example of exothermic reaction therefore decreasing temperature favours the forward direction

4. $KMnO_4$ can be prepared from K_2MnO_4 as per the reaction,
$3MnO_4^{2-}+2H_2O \rightleftharpoons 2MnO_4^{-}+MnO_2+4OH^{-}$
The reaction can go to completion by removing OH^- ions by adding

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

Ans. : a

$\mathrm{MnO_4^-}$ oxidizes HCl and $\mathrm{SO_2}$ to $\mathrm{Cl_2}$ and $\mathrm{SO_3}$ respectively.

$\mathrm{MnO_4^-}$ does not oxidizes $\mathrm{H_2CO_3}$ (maximum oxidation state of C)

5. The rate of forward reaction is two times that of reverse reaction at a given temperature and identical concentration. $K_{equilibrium}$ is

(A) 2.5 (B) 2 (C) 0.5 (D) 1.5

Ans. : (b)The rate of forward reaction is two times that of reverse reaction at a given temperature and identical concentration $K_{\text{equilibrium}}$ is 2 because the reaction is reversible.

So $K=\frac{K_1}{K_2}=\frac{2}{1}=2$.

6. For the reaction : $H_{2(g)}+CO_{2(g)} \rightleftharpoons CO_{(g)}+H_2O_{(g)}$, if the initial concentration of $[H_2]=[CO_2]$ and x moles/litre of hydrogen is consumed at equilibrium, the correct expression of K_p is

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

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

Ans. : (a) $H_{2(g)} + CO_{2(g)} \rightleftharpoons CO_{(g)} + H_2O_{(l)}$

Intial Conc. $1 \quad 1 \quad 0 \quad 0$

At equili $(1-x) \quad (1-x) \quad x \quad x$

$K_p = \frac{p_{CO} \cdot p_{H_2O}}{p_{H_2} \cdot p_{CO_2}} = \frac{x.x}{(1-x)(1-x)} = \frac{x^2}{(1-x)^2}$

7. The equilibrium constant of the reaction $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$ is 64. If the volume of the container is reduced to one fourth of its original volume, the value of the equilibrium constant will be

(A) 16 (B) 32 (C) 64 (D) 128

Ans. : (c) For this reaction there is no change in equilibrium constant by change of volume.

8. $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$ which of the following expression is correct

(A) $K_P = (P_{CaO} + P_{CO_2}/P_{CaCO_3})$

(B) $K_P = P_{CO_2}$

(C) $K_P \times (P_{CaO} \times P_{CO_2}).P_{CaCO_3}$

(D) $\frac{K_p[CaO][CO_2]}{[CaCO_3]}$

Ans. : (b) $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$

$K_p = P_{CO_2}$

Solid molecule does not have partial pressure so in calculation of K_p only P_{CO_2} is applicable.

9. One mole of a compound AB reacts with one mole of a compound CD according to the equation $AB + CD \rightleftharpoons AD + CB$. When equilibrium had been established it was found that $\frac{3}{4}$mole each of reactant AB and CD had been converted to AD and CB. There is no change in volume. The equilibrium constant for the reaction is

(A) $\frac{9}{16}$ (B) $\frac{1}{9}$ (C) $\frac{16}{9}$ (D) 9

Ans. : (d) $AB + CD \rightleftharpoons AD + CD$

mole at $t=0$ $\quad 1 \quad 1 \quad 0 \quad 0$

Mole at equilibrium $\left(1-\frac{3}{4}\right) \quad \left(1-\frac{3}{4}\right) \rightleftharpoons \left(\frac{3}{4}\right) \quad \left(\frac{3}{4}\right)$

$0.25 \quad 0.25 \rightleftharpoons 0.75 \quad 0.75$

$K_c = \frac{0.75 \times 0.75}{0.25 \times 0.25} = \frac{0.5625}{0.0625} = 9$

10. One mole of SO_3 was placed in a litre reaction vessel at a certain temperature. The following equilibrium was established $2SO_3 \rightleftharpoons 2SO_2 + O_2$ At equilibrium 0.6 moles of SO_2 were formed. The equilibrium constant of the reaction will be

(A) 0.36 (B) 0.45 (C) 0.54 (D) 0.675

Ans. : (d) $\underset{(1-0.6)}{2SO_3} \rightleftharpoons \underset{(0.6)}{2SO_2} + \underset{(0.3)}{O_2}$

$K_c = \frac{[SO_2]^2[O_2]}{[SO_3]} = \frac{0.6\times0.6\times0.3}{0.4\times0.4} = 0.675$.

11. Consider the imaginary equilibrium $4A+5B \rightleftharpoons 4X+6Y$ The equilibrium constant K_c has the unit

(A) Mole^2 litre^{-2} (B) Litre mole^{-1} (C) Mole litre^{-1} (D) Litre^2 mole^{-2}

Ans. : (c) Unit of $K_c =$(unit of concentration)$^{\Delta n}$

= (mole/litre)$^{\Delta n}$

$\Delta n = 10-9 = 1$

$\therefore K_c =$ mol/Litre

12. For the system $2A(g)+B(g) \rightleftharpoons 3C(g)$, the expression for equilibrium constant K is

(A) $\frac{[2A]\times[B]}{[3C]}$ (B) $\frac{[A]^2\times[B]}{[C]^3}$ (C) $\frac{[3C]}{[2A]\times[B]}$ (D) $\frac{[C]^3}{[A]^2\times[B]}$

Ans. : (d) $K = \frac{[C]^3}{[A]^2[B]}$.

13. For the reaction

$2NO_2(g) \rightleftharpoons N_2O_4(g)$ at $300\ K$

The value of Kp is $2\,atm^{-1}$. The total pressure at equilibrium is $10\,atm$. If volume of container become two times of its original volume, what will be its equilibrium pressure at $300\ K$ ......atm

(A) 6.4 (B) 4.51 (C) 6 (D) 5.19

Ans. : d

$\underset{P_1}{2\mathrm{NO_2(g)}} \rightleftharpoons \underset{P_2}{\mathrm{N_2O_4}}\ at\ 300\,\mathrm{K}$

$\mathrm{kp} = \frac{\mathrm{P_2}}{\mathrm{P_1^2}} = 2......(i)$

$\mathrm{P_1 + P_2} = 10......(ii)$

$\mathrm{P_2} = 8\,\mathrm{atm} \quad \mathrm{P_1} = 2\,\mathrm{atm}$

$\underset{(1+2P)}{2\mathrm{NO_2}} \quad \rightleftharpoons \quad \underset{(4+P)}{\mathrm{N_2O_4}}$

$\mathrm{P_T} = (5+\mathrm{P})$

$K_p = \frac{(4-P)}{(1+2P)^2} = 2$

$\mathrm{P} = 0.19\,\mathrm{atm}$

$\mathrm{P_T} = 5.19\,\mathrm{atm}$

14. The equilibrium constants K_{p_1} and K_{p_2} for the reaction

$X \rightleftharpoons 2Y$ and $Z \rightleftharpoons P+Q$,

respectively are in the ratio of $1:4$. If the degree of dissociation of X is 2 times that of Z, then the ratio of total pressure $(P_1:P_2)$ at these equilibria is **:** (Assume degree of dissociation for both reactions are very very small)

(A) $1:36$ (B) $1:16$ (C) $1:64$ (D) None of these

Ans. : (C) $1:64$

15. In a reversible reaction $A \underset{k_2}{\overset{k_1}{\longleftrightarrow}} B$, the initial concentration of A and B are a and b and the equilibrium concentration are $(a-x)$ and $(b+x)$ respectively. Express " x " in terms of k_1, k_2, a and b

(A) $\frac{k_1 a - k_2 b}{k_1 + k_2}$ (B) $\frac{k_1 a - k_2 b}{k_1 - k_2}$ (C) $\frac{k_1 a - k_2 b}{k_1 k_2}$ (D) $\frac{k_1 a + k_2 b}{k_1 + k_2}$

Ans. : a

$\mathrm{K_{eq}} = \frac{\mathrm{K_1}}{\mathrm{K_2}} = \frac{[\mathrm{B}]}{[\mathrm{A}]} = \frac{(\mathrm{b+x})}{\mathrm{a-x}}$

$\mathrm{K_1 a - K_1 x = K_2 b + K_2 x}$

$\mathrm{K_1 a - K_2 b = (K_1 + K_2) x}$

$\mathrm{x} = \frac{\mathrm{K_1 a - K_2 b}}{\mathrm{K_1 + K_2}}$

16. In a system $A(s) \rightleftharpoons 2B(g) + 3C(g)$, if the concentration of C at equilibrium is increased by a factor of 2, it will cause the equilibrium concentration of B to change to

(A) two times the original value (B) one half of its original value

(C) $2\sqrt{2}$ times to the original value (D) $\frac{1}{2\sqrt{2}}$ times the original value

Ans. : d

$\mathrm{K_c = [B]^2 [C]^3 \ldots\ldots (1)}$

$\mathrm{K_c = [B']^2 [2C]^3 \ldots\ldots (2)}$

$\mathrm{eq(1) = eq(2)}$

$\mathrm{[B]^2 [C]^3 = [B']^2 \cdot [C]^3 \times 8}$

$\left[\mathrm{B^1}\right] = \frac{1}{\sqrt{8}} = \frac{1}{2\sqrt{2}}$

17. Find the value of $\frac{P}{k_p}$ for reaction at a certain temperature is :-

$2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$, where P is the total pressure of gases at equilibrium and $P_{Br_2} = \frac{P}{9}$

(A) 9 (B) 81 (C) 27 (D) 3

Ans. : (B) 81

18. 40% of a mixture of $0.2\,mol$ of N_2 and $0.6\,mol$ of H_2 reacts 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) $8:5$

Ans. : a

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

Moles	N_2	H_2	NH_3
Initial	0.2	0.6	0
At equilibrium	$0.2 - x$	$0.6 - 3x$	$2x$

Also, $0.4 = \frac{x}{0.2} \Rightarrow x = 0.08$

Ratio $= \frac{V_f}{V_i} = \frac{(n_{Toth})_f}{(n_{Toth})_i} = \frac{0.8-2x}{0.8}$

$= 1 - \frac{x}{0.4}$

$= 1 - \frac{0.08}{0.40} = \frac{4}{5}$

19. In reaction $A + 2B \rightleftharpoons 2C + D$, initial concentration of B was 1.5 times of $[A]$, but at equilibrium the concentrations of A and B became equal. The equilibrium constant for the reaction is

(A) 4 (B) 6 (C) 12 (D) 8

Ans. : a

$A + 2B \quad \rightleftharpoons \quad 2C$

$t = 0$

$t = t_{eqm} \quad a_o$

$a_0 - x \quad 1.5a_0$

$1.5a_0 - 2x$

$2x$

x

At equilibrium $[A] = [B]$

$a_0 - x = 1.5a_0 - 2x \Rightarrow x = 0.5a_0$

$[C] = 2 \times 0.5a_o = a_o, [D] = [A] = [B] = 0.5a_o$

$K_C = \frac{[C]^2[D]}{[A][B]^2} = \frac{(a_0)^2(0.5a_0)}{(0.5a_0)(0.5a_0)^2} = 4$

20. The reaction $A(g) + 2B(g) \longrightarrow C(g) + D(g)$ is an elementary process. In an experiment, the initial partial pressure of A and B are 0.6 and $0.8\,atm$, respectively. When partial pressure of C is $0.2\,atm$, the rate of reaction relative to the initial rate is

(A) $1/48$ (B) $1/24$ (C) $9/16$ (D) $1/6$

Ans. : d

The expression for the initial rate is $r_0 = K[A][B]^2 = K(0.60)(0.80)^2 \ldots\ldots$ (1)
After some time, the pressure of C is $0.20atm$. Hence, the pressures of A and B are $0.60 - 0.20 = 0.40$ atm and $0.80 - 2(0.20) = 0.40$ atm
respectively. The expression for the rate becomes $r = k[A][B]^2 = K(0.40)(0.40)^2 \ldots\ldots$ (2)

Divide equation (2) with equation (1) $\frac{r_o}{r_1} = \frac{k[A][B]^2 = K(0.60)(0.80)^2}{k[A][B]^2 = K(0.40)(0.40)^2} = \frac{1}{6}$

21. Eight moles of a gas AB_3 attained equilibrium in a closed container of volume $1\,dm^3$ is. $2AB_{3(g)} \rightleftharpoons A_{2(g)} + 3B_{2(g)}$ If at equilibrium $2\,moles$ of A_2 are present then equilibrium constant is......$mol^2\,L^{-2}$

(A) 72 (B) 36 (C) 3 (D) 27

Ans. : d

$$2AB_{3(g)} \rightleftharpoons A_{2(g)} + 3B_{2(g)}$$

ae $t=0$ $\quad 8 \quad 0 \quad 0$

at eq^m $\quad 8-a \quad a/2 \quad 3a/2$

thus $\mathrm{K_C} = \frac{[\mathrm{A_2}][\mathrm{B_2}]^3}{[\mathrm{AB_3}]^2}$

also $\frac{a}{2} = 2 \quad a = 4$

and $[\mathrm{AB_3}] = \frac{4}{1}; [\mathrm{A_2}] = \frac{2}{1}$ and $[\mathrm{B_2}] = \frac{6}{1}$

$\mathrm{K_c} = \frac{2\times6^3}{4^2} = 27\,\mathrm{mol^2L^{-2}}$

22. If equilibrium constant of a reaction is 20.0, at equilibrium, rate constant of forward reaction is 10.0, then rate constant for backward reaction is

(A) 0.5 (B) 2 (C) 10 (D) 200

Ans. : a

$K_{eq} = \frac{K_f}{K_b} \Rightarrow 20 = \frac{10}{K_b}$

$K_b = 0.5$

23. In a chemical equilibrium $A+B \rightleftharpoons C+D$ when $1\,mole$ each of two reactants are mixed, $0.5\,mol$ each of the products are formed. The equilibrium constant is

(A) 5 (B) 1 (C) 1.5 (D) None

Ans. : (B) 1

24. For the reaction $2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$, if $P_{Br_2} = \frac{P}{9}$ at equilibrium and P is total presssure, then find $\frac{K_P}{P}$?

(A) $\frac{1}{9}$ (B) $\frac{1}{81}$ (C) $\frac{1}{27}$ (D) $\frac{1}{3}$

Ans. : b

$$2NOBr(g) = 2NO(g) + Br_2(g)$$

at equilibrium $\quad \frac{2P}{9} \quad \frac{P}{9}$

$$\begin{cases} a + \dfrac{2P}{9} + \dfrac{P}{9} = P \\ a = \dfrac{2P}{3} \end{cases}$$

$$K_p = \frac{\left(\frac{2P}{9}\right)^2\left(\frac{P}{9}\right)}{\left(\frac{2P}{3}\right)^2} = \frac{P}{81}$$

$$\boxed{\frac{K_p}{P} = \frac{1}{81}}$$

25. For the reaction

$SnO_2(s) + 2H_2\,(g) \rightleftharpoons 2H_2O\,(g) + Sn\,(l)$

At equilibrium, the mixture of steam and hydrogen contains 40% H_2 by volume then find K_p for the reaction

(A) $\frac{9}{4}$ (B) $\frac{3}{2}$ (C) $\frac{6}{4}$ (D) None of these

Ans. : a

$$SnO_2(s) + 2H_2(g) \rightleftharpoons 2H_2O(g) + Sn(l)$$

Initial mole $(a-x)$ x

equi mole $a - x = 0.4\ a$

$x = 0.6\,a$

$$\mathrm{K_p} = \frac{[\mathrm{P_{H_2O}}]^2}{[\mathrm{P_{H_2}}]^2} = \frac{\left(\frac{\mathrm{x}}{\mathrm{a}} \times \mathrm{P_T}\right)^2}{\left(\frac{\mathrm{a-x}}{\mathrm{a}} \times \mathrm{P_T}\right)^2} = \frac{6 \times .6}{4 \times .4} = \frac{9}{4}$$

26. A mixture of SO_2 and O_2 at $5\,atm$ pressure reacts 30% till equilibrium. Determine the pressure of equilibrium mixture ......atm

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3$

(A) 5 (B) 2.5 (C) 4.5 (D) 9

Ans. : c

$\mathrm{Pe} := 5 - \frac{5 \times 30}{100}$

$= 5 - 1.5 \quad \frac{2 \times 1.5}{3}$

$= 3.5\,\mathrm{atm} \quad 1\ \mathrm{atm}\ \Sigma = 4.5\,\mathrm{atm}$

27. 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 of the reaction is

(A) 0.5 (B) 4 (C) 32 (D) 8

Ans. : d

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

particulation for given response is

$Kp =$ (Partial weight of CO) $^2/($ Partial weight of CO_2 $) = \left(4^2/2\right)$ atm $= 8$ atm

Kp of response is 8 atm.

28. Equivalent amounts of H_2 and I_2 are heated in a closed vessel till equilibrium is obtained. If 80% of the hydrogen is converted to HI, the K_c at this temperature is

(A) 64 (B) 16 (C) 0.25 (D) 14

Ans. : a

$\mathrm{H_2 + I_2 \rightleftharpoons 2HI}$

At initial $1 \quad 1 \quad 0$

At equal $(1-0.8)(1-0.8) \quad 2\times0.8$

$=0.2=0.2 \quad =1.6$

$\therefore \mathrm{K_c} = \frac{[\mathrm{HI}]^2}{[\mathrm{H_2}][\mathrm{I_2}]}$

$\therefore \mathrm{K_c} = \frac{1.6\times1.6}{0.2\times0.2}$

$\Rightarrow \mathrm{K_c} = 64$

29. If the equilibrium constant of the reaction $2HI \rightleftharpoons H_2 + I_2$ is 0.25, then the equilibrium constant of the reaction $H_2 + I_2 \rightleftharpoons 2HI$ would be

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

Ans. : (d) $K_1$for reaction $2HI \rightleftharpoons H_2 + I_2$ is 0.25 K_2 for reaction $H_2 + I_2 \rightleftharpoons 2HI$ will be

$K_2 = \frac{1}{K_1} = \frac{1}{0.25} = 4$

Because II^{nd} reaction is reverse of I^{st}.

30. In which of the following reaction $K_p > K_c$

(A) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (B) $H_2 + I_2 \rightleftharpoons 2HI$

(C) $PCl_3 + Cl_2 \rightleftharpoons PCl_5$ (D) $2SO_3 \rightleftharpoons O_2 + 2SO_2$

Ans. : (d) For reaction $2SO_3 \rightleftharpoons O_2 + 2SO_2$

Δn is $+ve$ so K_p is more than K_c.

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

31. For the reaction $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$

(A) $K_p = K_c$ (B) $K_p = K_c(RT)^{-1}$ (C) $K_p = K_c(RT)$ (D) $K_p = K_c(RT)^2$

Ans. : (c) $\Delta n = 2 - 1 = 1$

$K_p = K_c(RT)$

32. For the following gaseous reaction $H_2 + I_2 \rightleftharpoons 2HI$, the equilibrium constant

(A) $K_p > K_c$ (B) $K_p < K_c$ (C) $K_p = K_c$ (D) $K_p = 1/K_c$

Ans. : (c) If $\Delta n = 0$ then $K_p = K_c$

33. For which one of the following reactions $K_p = K_c$

(A) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (B) $N_2 + O_2 \rightleftharpoons 2NO$

(C) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ (D) $2SO_3 \rightleftharpoons 2SO_2 + O_2$

Ans. : b

It's Obvious

34. The equilibrium constant for the reversible reaction, $N_2 + 3H_2 \rightleftharpoons 2NH_3$ is K and for the reaction $\frac{1}{2}N_2 + \frac{3}{2}H_2 \rightleftharpoons NH_3$ the equilibrium constant is K'. K and K' will

be related as

(A) $K = K'$ (B) $K' = \sqrt{K}$ (C) $K = \sqrt{K'}$ (D) $K \times K' = 1$

Ans. : (b) $K' = K^n$; Hence $n = \frac{1}{2}$

$\therefore\ K' = K^{1/2} = \sqrt{K}$

35. The equilibrium constant for the reaction $PCl_{5(g)} \to PCl_{3(g)} + Cl_{2(g)}$ is 16. If the volume of the container is reduced to one half its original volume, the value of K_p for the reaction at the same temperature will be

(A) 32 (B) 64 (C) 16 (D) 4

Ans. : c

K_p depends only on temperature.

So K_p value wont change.

So the value of Kp is 16.

36. For $N_2 + 3H_2 \rightleftharpoons 2NH_3$ equilibrium constant is k then equilibrium constant for $2N_2 + 6H_2 \rightleftharpoons 4NH_3$ is

(A) $\sqrt{k}$ (B) k^2 (C) $k/2$ (D) $\sqrt{k + 1}$

Ans. : b

It’s Obvious

37. If equilibrium constant for reaction $2AB \rightleftharpoons A_2 + B_2$, is 49, then the equilibrium constant for reaction $AB \rightleftharpoons \frac{1}{2}A_2 + \frac{1}{2}B_2$, will be

(A) 7 (B) 20 (C) 49 (D) 21

Ans. : (a) $2AB \rightleftharpoons A_2 + B_2$

$K_c = \frac{[A_2]\ [B_2]}{[AB]^2}$

For reaction $AB \rightleftharpoons \frac{1}{2}A_2 + \frac{1}{2}B_2$

$K_c{}' = \frac{[A_2]^{1/2}\ [B_2]^{1/2}}{[AB]}$; $\quad K_c{}' = \sqrt{K_c} = \sqrt{49} = 7$

38. For reaction, $2A_{(g)} \rightleftharpoons 3C_{(g)} + D_{(g)}$, the value of K_c will be equal to

(A) $K_p(RT)$ (B) K_p/RT (C) $= K_p$ (D) None of these

Ans. : (b)$2A_{(g)} \rightleftharpoons 3C_{(g)} + D_{(g)}$

For this reaction, $\Delta n_g = 3 - 2 = 1$

$\therefore\ K_p = K_c[RT]^1$ or $\frac{K_p}{K_c} = RT$ or $K_c = \frac{K_p}{RT}$

39. If equilibrium constants of reaction, $N_2 + O_2 \rightleftharpoons 2NO$ is K_1 and $\frac{1}{2}N_2 + \frac{1}{2}O_2 \rightleftharpoons NO$ is K_2 then

(A) $K_1 = K_2$ (B) $K_2 = \sqrt{K_1}$ (C) $K_1 = 2K_2$ (D) $K_1 = \frac{1}{2}K_2$

Ans. : (b) $N_2 + O_2 \rightleftharpoons 2NO$.....$(i)$

$\frac{1}{2}N_2 + \frac{1}{2}O_2 \rightleftharpoons NO$......$(ii)$

For equation number (i)

$K_1 = \frac{[NO]^2}{[N_2]\,[O_2]}$ ..... (iii)

For equation number (ii)

$K_2 = \frac{[NO]}{[N_2]^{1/2}[O_2]^{1/2}}$ ...... (iv)

From equation (iii) & (iv) it is clear that

$K_2 = (K_1)^{1/2} = \sqrt{K_1}$; Hence, $K_2 = \sqrt{K_1}$

40. For the following reaction in gaseous phase $CO + \frac{1}{2}O_2 \rightarrow CO_2$; K_p/K_c is

(A) $(RT)^{1/2}$ (B) $(RT)^{-1/2}$ (C) (RT) (D) $(RT)^{-1}$

Ans. : (b) $K_p = K_c[RT]^{\Delta n_g}$

$\Delta n_g = 1 - 1.5 = -0.5$

$K_p = K_c[RT]^{-1/2}$ $\therefore$ $\frac{K_p}{K_c} = [RT]^{-1/2}$

41. At $700\,K$, the equilibrium constant K_p for the reaction $2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$ is 1.80×10^{-3} and kP_a is 14, ($R = 8.314\,Jk^{-1}\,mol^{-1}$). The numerical value in moles per litre of K_c for this reaction at the same temperature will be

(A) $3.09 \times 10^{-7}\ mol - litre$

(B) $5.07 \times 10^{-8}\ mol - litre$

(C) $8.18 \times 10^{-9}\ mol - litre$

(D) $9.24 \times 10^{-10}\ mol - litre$

Ans. : (a) $\underset{2}{2SO_3} \rightleftharpoons \underset{3}{2SO_2 + O_2}$

$\Delta n = 3 - 2 = +1$; $K_p = 1.80 \times 10^{-3}$

$[RT]^{\Delta n} = (8.314 \times 700)^1$

$K_c = \frac{K_p}{(RT)^{\Delta n}} = \frac{1.8 \times 10^{-3}}{(8.314 \times 700)^1}$

$= 3.09 \times 10^{-7}\ mole - litre.$

42. $xA_{(s)} \rightleftharpoons yB_{(g)} + zC_{(g)}$ If $\frac{k_c}{k_p} = (RT)^{-2}$, then which is correct

(A) $y + z - x = -2$ (B) $y + z - x = 2$ (C) $y + z = -2$ (D) $y + z = 2$

Ans. : d

$\mathrm{K_p = K_c \times (RT)^{\Delta n_g}}$

$\mathrm{\frac{K_g}{K_c} = (RT)^{\frac{dn_s}{K_s}}}$

Given : $-\mathrm{\frac{K_c}{K_p} = (RT)^{-2} \Rightarrow \frac{K_g}{K_c} = (RT)^2}$

$\therefore \quad \mathrm{\Delta n_g = 2}$

$\mathrm{y + z = 2}$

43. $xA_{(s)} \rightleftharpoons yB_{(g)} + zC_{(g)}$ If $\frac{k_c}{k_p} = (RT)^{-2}$, then which is correct

(A) $y + z - x = -2$ (B) $y + z - x = 2$ (C) $y + z = -2$ (D) $y + z = 2$

Ans. : d

$K_i = K_c \times (RT)^{\Delta n_g}$

$\frac{K_i}{K_c} - (RT)^{1/5}$

Gruen $= \frac{K_c}{K_i} - (RT)^{-2} \Rightarrow \frac{K_i}{K_c} - (RT)^2$

$\therefore \quad \Delta n_g = 2$

$y + z = 2$

44. What is the unit of K_p for the reaction ?

$CS_2(g) + 4H_2(g) \rightarrow CH_4(g) + 2H_2S(g)$

(A) atm (B) atm^{+2} (C) atm^{-2} (D) atm^{-1}

Ans. : c

$K_p = (atm)^{\Delta n_g}$

$\Delta n_g = -2$

$K_P = (atm)^{-2}$

45. For the complex ML_2, stepwise formation constants

$$M + L \rightleftharpoons ML$$
$$ML + L \rightleftharpoons ML_2$$

are 4 and 3. Hence, overall stability constant for

$$M + 2L \rightleftharpoons ML_2 \text{ is}$$

(A) 12 (B) 7 (C) 1.33 (D) 0.75

Ans. : a

$4 \times 3 = 12$

46. For the equilibrium

$SO_2Cl_2(g) \rightleftharpoons SO_2(g) + Cl_2(g)$, what is the temperature at which $\frac{K_p(atm)}{K_c(M)} = \frac{1}{3}$? ...... K

(A) 0.027 (B) 0.36 (C) 36.54 (D) 4.06

Ans. : d

$\Delta n = 1$

$\frac{K_p}{K_c} = (RT)^{\Delta n} = 0.0821 \times T$

$\frac{1}{3} = 0.0821 \times T$

$\frac{1}{3 \times 0.0821} = T$

$4.06\,K = T$

47. Two gaseous equilibrium $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_{3(g)}$ and $2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_2(g)$ have equilibrium constant K_1 and K_2 respectively at $298\,K$. Which of the following relationship between K_1 and K_2 is correct ?

(A) $K_1 = K_2$ (B) $K_2 = (K_1)^2$ (C) $K_2 = (\frac{1}{K_1})^2$ (D) $K_2 = \frac{1}{K_1}$

Ans. : c

$SO_2(g)+\frac{1}{2}O_2(g)\rightleftharpoons SO_{3(g)}, K_1$

$2SO_{3(g)}\rightleftharpoons 2SO_{2(g)}+O_2(g), K_2$

$K_2=\left(\frac{1}{K_1}\right)^2$

48. For a gaseous reaction $pA+qB\rightleftharpoons qC+pD$, Which of the following relationship is true

(A) $K_P=K_C(RT)^{p+q}$

(B) $K_P=K_C$

(C) $K_P=K_C(RT)^{p-q}$

(D) $K_P=K_C(RT)^{\left(\frac{1}{p+q}\right)}$

Ans. : b

$\Delta_{ng}=(p+q)-(p+q)=0$

$K_P=K_C\left(RT^{\Delta n_g}\right)=K_C$

49. The overall complex dissociation equilibrium constant for the complex $[Cu(NH_3)_4]^{2+}$ ion will be (β_4 for this complex is 2.1×10^{13}) $\beta_4=$ association constant

(A) 4.7×10^{-14} (B) 2.1×10^{13} (C) 11.9×10^{-2} (D) 2.1×10^{-13}

Ans. : a

$K=\frac{1}{\beta_4}$

$=\frac{1}{2.1\times10^{13}}$

$=4.7\times10^{-14}$

50. Which of the following expression is true regarding formation of $PCl_{5(g)}$.

$PCl_{3(g)}+Cl_2(g)\rightleftharpoons PCl_{5(g)}$

(A) $\frac{Kp}{Kc}<1$ (B) $\frac{Kp}{Kc}=1$ (C) $\frac{Kp}{Kc}>1$ (D) None

Ans.: (A) $\frac{Kp}{Kc}<1$

51. The equilibrium $PCl_{5(g)}\rightleftharpoons PCl_{3(g)}+Cl_{2(g)}$ shows that $K_P\,(atm)$ is double to the value of $K_C\,(mol/litre)$ at a particular temperature T, then T is ......K

(A) 300 (B) 48.72 (C) 12.18 (D) 24.36

Ans. : d

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

$2=(0.0821\times T)^1$

$T=24.36\,K$

52. For the reactions

$A\rightleftharpoons B$ $\quad K_C=2$

$B \rightleftharpoons C \qquad K_C = 3$

$C \rightleftharpoons D + E \qquad K_C = 5$

K_C for the reaction $A \rightleftharpoons D + E$ is

(A) $2+3+5$ (B) $\frac{2\times3}{5}$ (C) $\frac{5\times3}{2}$ (D) $2\times3\times5$

Ans. : d

By adding all the three reactions, we will get target reaction. On adding reaction, there equilibrium constant will be multiplled

53. For the reactions

$2NO + O_2 \rightleftharpoons 2NO_2\,;\, K_1$

$4NO + 2Cl_2 \rightleftharpoons 4NOCl\,;\, K_2$

$NO_2 + \frac{1}{2}Cl_2 \rightleftharpoons NOCl + \frac{1}{2}O_2\,;\, K_3$

where K_1, K_2, K_3 are equilibrium constants then K_3^2 equal to

(A) $\sqrt{K_2/K_1}$ (B) $\sqrt{K_1K_2}$ (C) $\sqrt{K_2}/K_1$ (D) $\frac{1}{K_1K_2}$

Ans. : c

$\mathrm{2NO + O_2 \rightleftharpoons 2NO_2}$

$\mathrm{K_1 = \frac{[NO_2]^2}{[NO]^2[O_2]}}\ldots$ (ii)

$\mathrm{4NO + 2Cl_2 \rightleftharpoons 4NOCl}$

$\mathrm{K_2 = \frac{[NOCl]^4}{[NO]^4[Cl_2]^2}}\ldots$ (ii)

$\mathrm{NO_2 + \frac{1}{2}Cl_2 \rightleftharpoons NOCl + \frac{1}{2}O_2}$

$\mathrm{K_3 = \frac{[NOCl][O_2]^{1/2}}{[NO_2][Cl_2]^{1/2}}}\ldots$ (iii)

divide $\mathrm{K_2}$ by square of $\mathrm{K_1^2}$ $\mathrm{\frac{[NOCl]^4}{[NO]^4[Cl_2]^2} \times \frac{[NO]^4[O_2]^2}{[NO_2]^4} = \frac{[NOCl]^4[O_2]^2}{[NO_2]^4[Cl_2]^2}}$

$\mathrm{K_2 \times \frac{1}{K_1^2} = K_3^4 \Rightarrow \frac{K_2}{K_1^2} = K_3^4}$

54. From the given data of equilibrium constant of following reactions

$CO_{2(s)} + H_{2(g)} \rightleftharpoons CO_{(s)} + H_2O(g)\,;\, K_1$

$CO_{2(s)} + CO(g) \rightleftharpoons CO_{(s)} + CO_2(g)\,;\, K_2$

Calculate the equilibrium for the reaction

$CO_{2(s)} + H_2(g) \rightleftharpoons CO(g) + H_2O(g)$

(A) $\frac{K_1}{K_2}$ (B) $K_1.K_2$ (C) $\frac{K_2}{K_1}$ (D) K_1+K_2

Ans.: (A) $\frac{K_1}{K_2}$

55. For the reaction

$N_2O_4(g) \rightleftharpoons 2NO_2(g),\ \frac{K_c}{K_p}$ is

(A) $(RT)^2$ (B) $(RT)^{-2}$ (C) $(RT)^1$ (D) $(RT)^{-1}$

Ans. : (D) $(RT)^{-1}$

56. Find out the value of K_C for the following reaction from the value of K_P

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

[Given : $K_P = 8 \times 10^{12}\, atm$ at $500\,K$ use $R = 0.08\, L\, atm\, mol^{-1}\, K^{-1}$]

(A) $32 \times 10^{13}\, mol\, L^{-1}$ (B) $8 \times 10^{12}\, mol\, L^{-1}$ (C) $2 \times 10^{11}\, mol\, L^{-1}$ (D) None of these

Ans. : (C) $2 \times 10^{11}\, mol\, L^{-1}$

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

$NH_3(g) \rightleftharpoons \frac{1}{2} N_2(g) + \frac{3}{2} H_2(g);\, K_2$

$\frac{1}{2} N_2(g) + \frac{3}{2} H_2(g) \rightleftharpoons NH_3(g); K_3$

$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g); K_4$

If $K_1 = K_2^x = K_3^y = K_4^z$ then correct values of x, y and z are respectively

(A) $2, 1, -2$ (B) $-1, 2, -2$ (C) $-2, 2, 1$ (D) $-2, 2, -1$

Ans. : d

eq. $(1) = 2\times$ opposite of eq. $(2) = 2\times$ eq. $(3) =$ opp. of eq. (4)

$\therefore \mathrm{K}_1 = \left(\frac{1}{\mathrm{K}_2}\right)^2 = (\mathrm{K}_3)^2 = \frac{1}{\mathrm{K}_4}$

$\Rightarrow \mathrm{K}_1 = \mathrm{K}_2^{-2} = \mathrm{K}_3^2 = \mathrm{K}_4^{-1}$

58. In which of the following K_p is less than K_c ?

(A) $N_2O_4 \rightleftharpoons 2NO_2$ (B) $2HI \rightleftharpoons H_2 + I_2$

(C) $2SO_2 + O_2 \rightleftharpoons 2SO_3$ (D) $N_2 + O_2 \rightleftharpoons 2NO$

Ans. : c

$K_p = K_c(RT)^{\Delta n}$ $\Delta n = -1$ $\therefore K_p = \frac{K_c}{RT}$

59. process $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3\,(g)} + heat$

(A) $K_p = K_c$ (B) $K_p = K_c\,(RT)^{-1}$ (C) $K_p = K_c\,(RT)^{-2}$ (D) $K_p = K_c\,(RT)$

Ans. : c

The correct option is C

$K_P = K_C(RT)^{-2}$

For the reaction, $\Delta n = 2 - (1+3) = -2$, hence the correct relation would be $K_p = K_C(RT)^{-2}$

60. At a certain temperature the equilibrium constant K_c is 0.25 for the reaction

$A_2(g) + B_2(g) \rightleftharpoons C_2(g) + D_2(g)$

If we take 1 mole of each of the four gases in a 10 litre container, what would be equilibrium concentration of $A_2(g)$?

(A) $0.331\,M$ (B) $0.033\,M$ (C) $0.133\,M$ (D) $1.33\,M$

Ans. : c

$Q_c = \frac{1 \times 1}{1 \times 1} = 1$

$\because \mathrm{Q_c} > \mathrm{K_c}$ so reaction will proceed in backward direction

$A_2(g) + B_2(g) \rightleftharpoons C_2(g) + D_2(g)$

conc. eqm $\frac{1+x}{10}\ \frac{1+x}{10}\ \frac{1-x}{10}\ \frac{1-x}{10}$

$0.25 = \frac{\left(\frac{1-x}{10}\right)^2}{\left(\frac{1+x}{10}\right)^2} \Rightarrow x = 0.333$

$[A_2(g)] = \frac{1+x}{10} = \frac{1.333}{10} = 0.133$

61. The equilibrium constant K and reaction quotient Q are in ratio $0.33:1$. It means that

(A) The reaction mixture will equilibrate to form more reactant species

(B) The reaction mixture will equilibrate to form more product species

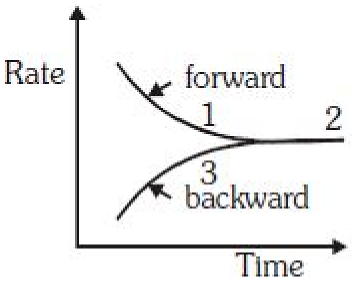
(C) The equilibrium ratio of reactant to product concentrations will be 3

(D) The equilibrium ratio of reactant to product concentrations will be 0.33

Ans. : a

If $Q > K$, equilibrium shifts backwards

62. In the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ a graph in plotted to show the variation of rate of forward and backward reactions against time. Which of the following is correct ?



(A) $Q > K_{eq} \rightarrow 3, Q = K_{eq} \rightarrow 2, Q < K_{eq} \rightarrow 1$

(B) $Q > K_{eq} \rightarrow 1, Q = K_{eq} \rightarrow 2, Q < K_{eq} \rightarrow 3$

(C) $Q > K_{eq} \rightarrow 2, Q = K_{eq} \rightarrow 3, Q < K_{eq} \rightarrow 1$

(D) $Q > K_{eq} \rightarrow 2, Q = K_{eq} \rightarrow 1, Q < K_{eq} \rightarrow 3$

Ans. : a

When $Q < K_{eq} \Rightarrow$ forward rn.

$Q = K_{eq} \Rightarrow$ equilibrium rn.

$Q > K_{eq} \Rightarrow$ backward rn.

63. If in the reaction $N_2O_4 = 2NO_2$, α is that part of N_2O_4 which dissociates, then the number of moles at equilibrium will be

(A) 3 (B) 1 (C) $(1-\alpha)^2$ (D) $(1+\alpha)$

Ans. : (d) $\underset{(1-\alpha)}{\underset{1}{N_2O_4}} \rightleftharpoons \underset{2\,\alpha}{\underset{0}{2NO_2}}$

total mole at equilibrium $= (1-\alpha) + 2\alpha = 1 + \alpha$

64. At a certain temp. $2HI \rightleftharpoons H_2 + I_2$ Only 50% HI is dissociated at equilibrium. The equilibrium constant is

(A) 0.25 (B) 1 (C) 3 (D) 0.5

Ans. : (a) $\underset{\substack{100\\50}}{2HI} \rightleftharpoons \underset{\substack{0\\25}}{H_2} + \underset{\substack{0\\25}}{I_2}$

$\frac{[H_2]\ [I_2]}{[HI]^2} = \frac{25\times25}{50\times50} = 0.25$.

65. In the reaction, $H_2 + I_2 \rightleftharpoons 2HI$. In a 2 litre flask 0.4 moles of each H_2 and I_2 are taken. At equilibrium 0.5 moles of HI are formed. What will be the value of equilibrium constant, K_c

(A) 20.2 (B) 25.4 (C) 0.284 (D) 11.1

Ans. : (d) $\underset{\substack{0.4\\0.4-0.25\,=\,0.15}}{H_2} + \underset{\substack{0.4\\0.4-0.25\,=\,0.15/2}}{I_2} \rightleftharpoons \underset{\substack{0.50\\0.50/2}}{2HI}$

$K_c = \frac{[HI]^2}{[H_2][I_2]} = \frac{\left[\frac{0.5}{2}\right]^2}{\left[\frac{0.15}{2}\right]\left[\frac{0.15}{2}\right]} = \frac{0.5\times0.5}{0.15\times0.15} = 11.11$

66. The vapour density of completely dissociated NH_4Cl would be

(A) Slight less than half that of NH_4Cl

(B) Half that of NH_4Cl

(C) Double that of NH_4Cl

(D) Determined by the amount of solid NH_4Cl in the experiment

Ans. : (b) $\frac{\text{Normal molecular weight}}{\text{experimental molecular wt.}} = 1 + \alpha$

$NH_4Cl \rightleftharpoons NH_3 + HCl$

$\therefore \alpha = 1$ $\therefore$ Experimental Molecular wt $= \frac{\text{nor.mol.wt.}}{2}$

67. If dissociation for reaction, $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ is 20% at 1 atm. pressure. Calculate K_c

(A) 0.04 (B) 0.05 (C) 0.07 (D) 0.06

Ans. : (b) $K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{\left[\frac{20}{100}\right]\times\left[\frac{20}{100}\right]}{\left[\frac{80}{100}\right]}$

$= \frac{0.2\times0.2}{0.8} = \frac{0.04}{0.8} = 0.05$

68. $2SO_3 \rightleftharpoons 2SO_2 + O_2$. If $K_c = 100$, $\alpha = 1$, half of the reaction is completed, the concentration of SO_3 and SO_2 are equal, the concentration of O_2 is

(A) $0.001\,M$ (B) $\frac{1}{2}\,SO_2$ (C) 2 times of SO_2 (D) Data incomplete

Ans. : (d) Conc. is not known so we can't calculate.

69. For the reaction ,$N_2 + O_2 \rightleftharpoons 2NO$ equilibrium constant $K_c = 2$. Degree of dissociation of N_2 and O_2 are (Both have same initial moles)

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

Ans. : c

$$\underset{\substack{1\\1-\alpha}}{N_2} + \underset{\substack{1\\1-\alpha}}{O_2} \leftrightarrow \underset{\substack{0\\2\alpha}}{2NO}$$

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

$\sqrt{\mathrm{K}} = \frac{2\alpha}{1-\alpha}$

$\alpha = \frac{\sqrt{\mathrm{K}}}{2+\sqrt{\mathrm{K}}} = \frac{\sqrt{2}}{2+\sqrt{2}} = \frac{1}{1+\sqrt{2}}$

70. $AB_3(g)$ is dissociates as ;

$AB_3(g) \rightleftharpoons AB_2(g) + \frac{1}{2}B_2(g)$, when the initial pressure of AB_3 is $800\,torr$ and the total pressure developed at equilibrium is $900\,torr$. What percentage of $AB_3(g)$ is dissociated?

(A) 10 (B) 20 (C) 25 (D) 30

Ans. : c

$\frac{1}{4}$ th in fraction or 25% of $\mathrm{AB3}$ is dissociated.
Explanation:
We have the reaction as
$AB_a(g) \leftrightarrow AB_2(g) + 1/2B_2(g)$
The initial pressure $= 800$ torr
Now, after the equilibrium, the pressures will be
$\mathrm{At AB_3} : 800 - \mathrm{a}$
At $\mathrm{AB_2} : a$
At $\left(\frac{1}{2}\mathrm{B_2}\right) : \frac{a}{2}$
Where a is the degree of dissociation
The total pressure at equilibrium is 900 torr
Therefore, we can write as
$(800 - a) + a + \frac{a}{2} = 900$
$\mathrm{Or}, \frac{a}{2} = 100$
$\mathrm{Or}, \mathrm{a} = 200$
Hence,
The fraction of $\mathrm{AB_2}$ dissociated will be
$= \frac{a}{initialpressure}$
$= \frac{200}{800}$
$= \frac{1}{4}$
Also, the percentage of dissociation is $\frac{1}{4} \times 100 = 25\%$

71. 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) $\alpha = \sqrt{\frac{K_p}{4P+K_p}}$ (C) $\alpha = \sqrt{\frac{K_p}{4P}}$ (D) $\alpha = \sqrt{\frac{K_p}{2P}}$

Ans. : b

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

$t = O$ $\quad 1\,mol \quad 0$

at eq. $\quad 1-\alpha \quad 2\alpha \quad n_f = 1+\alpha$

mole fraction $\quad \frac{1-\alpha}{1+\alpha} \quad \frac{2a}{1+\alpha}$

Partial pressure $\left(\frac{1-\alpha}{1+\alpha}\right)P \quad \left(\frac{2\alpha}{1+\alpha}\right)P$

$$K_P = \frac{(P_{NO_2})^2}{P_{N_2O_4}} = \frac{\left(\frac{2\alpha}{1+\alpha}\right)^2 P^2}{\left(\frac{1-\alpha}{1+\alpha}\right)P}$$

$$= \frac{4\alpha^2}{(1+\alpha)(1-\alpha)}P$$

on solving we will get,

$$a^2 = \frac{K_p}{4P+K_p}$$

$$\alpha = \sqrt{\frac{K_p}{4P+K_p}}$$

72. In a saturated solution of $Mg(OH)_2$, the degree of dissociation of $Mg(OH)_2$ is α, find concentration (C) of $Mg(OH)_2$ if concentration of $[OH^-]$, is 2

(A) α (B) 2α (C) $1/\alpha$ (D) $1/2\alpha$

Ans. : c

$[OH^-] = 2M$

$Mg(OH)_2 \Leftrightarrow \quad Mg^{2+} + \quad 2OH$

$C \quad 0 \quad 0$

$C(1-\alpha) \quad C\alpha \quad 2C\alpha$

$\therefore 2C\alpha = 2M$

$\therefore C = \frac{2}{2\alpha} = \quad \frac{1}{\alpha}$

73. $2NOBr_{(g)} \rightleftharpoons 2NO_{(g)} + Br_{2(g)}$ If $NOBr$ is 40% discociated at certain temp. and a total pressure of $0.30\,atm$. K_p for the reaction $2NO_{(g)} + Br_{2(g)} \rightleftharpoons 2NOBr_{(g)}$ is

(A) 45 (B) 25 (C) 0.022 (D) 0.25

Ans. : a

$$2\mathrm{NOBr(g)} \rightleftharpoons 2\mathrm{NO(g)} + \mathrm{Br_2(g)}$$

At $\mathrm{t} = 0$ $\quad$ a $\quad 0 \quad 0$

$At\ \mathrm{t} = \mathrm{t_{eq}}$ $\quad \mathrm{a}(1-\alpha) \quad 2\mathrm{a}\alpha/2 \quad \mathrm{a}\alpha/2$

$\alpha = 0.4$ (since 40% dissociated)

total pressure $= 0.30$ atm $\mathrm{K_P} = \frac{(\mathrm{PNO})^2 \times (\mathrm{PBr_2})}{(\mathrm{PNOBr})^2}$

Partial pressure of $\mathrm{NO} = \frac{\mathrm{a}\alpha}{\mathrm{a}(1+\alpha/2)} \times \mathrm{P} = \frac{0.4}{1.2} \times 0.3 = 0.1$

Partial pressure of $\mathrm{BR_2} = \frac{\mathrm{a}\alpha/2}{\mathrm{a}(1+\alpha/2)} \times \mathrm{P} = 0.05$

Partial pressure of $\mathrm{NOBr} = \frac{\mathrm{a}(1-\alpha)}{\mathrm{a}(1+\alpha/2)} \times \mathrm{P} = 0.15$

$\mathrm{K_{P_1}} = \frac{(0.1)^2 \times 0.05}{(0.15)^2} = \frac{1}{45}$

$\mathrm{K_{P_2}}$ for $\mathrm{2NO + Br_2 \rightleftharpoons 2NOBr}$

$\mathrm{K_{P_2}} = \mathrm{KP_1^{-1}} = 45$

74. The vapour density of a mixture containing NO_2 and N_2O_4 is 27.6 . The mole fraction of N_2O_4 in the mixture is

(A) 0.1 (B) 0.2 (C) 0.5 (D) 0.8

Ans. : b

Let $1\,mole$ of mixture has $x\,mole\ N_2O_4$

$2 \times 27.6 = x(92) + (1-x)46;\ x = 0.2$

75. For the following equilibrium $N_2O_4 \rightleftharpoons 2NO_2$ in gaseous phase, NO_2 is 50% of the total volume when equilibrium is set up. Hence percentage of dissociation of N_2O_4 is.......$\%$

(A) 50 (B) 25 (C) 66.66 (D) 33.33

Ans. : d

$$\underbrace{\underset{\substack{1\\1-\alpha}}{N_2O_4} \rightleftharpoons \underset{\substack{0\\2\alpha}}{2NO_2}}_{1+\alpha} \qquad \therefore V \propto mole$$

$2\alpha = \frac{1+\alpha}{2}$

$4\alpha = 1 + \alpha$

$3\alpha = 1$

$\therefore \alpha = \frac{1}{3}$

$\%$ disso $= 33.33\%$

76. For the reaction $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$; $K_C = 2$ then degree of dissociation of O_2 is

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

Ans. : c

$$\begin{array}{llll} & N_2(g) + & O_2(g) \rightleftharpoons & 2NO(g), \quad K_C = 2 \\ t=0 & 1\,M & 1\,M & 0 \\ & 1-\alpha & 1-\alpha & 2\alpha \end{array}$$

$K_C = \frac{(2\alpha)^2}{(1-\alpha)^2}$

$\sqrt{2} = \frac{2\alpha}{1-\alpha}$

$\sqrt{2} = 2\alpha + \sqrt{2}\alpha$

$\sqrt{2} = \alpha(2+\sqrt{2})$

$\alpha = \frac{\sqrt{2}}{2+\sqrt{2}} = \frac{1}{\sqrt{2}+1}$

77. In a saturated solution of $Mg(OH)_2$, the degree of dissociation of $Mg(OH)_2$ is α, find concentration (C) of $Mg(OH)_2$ if concentration of $[OH^-]$, is 2

(A) α (B) 2α (C) $1/\alpha$ (D) $1/2\alpha$

Ans. : (C) $1/\alpha$

78. Which of the following reactions proceed at low pressure

(A) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (B) $H_2 + I_2 \rightleftharpoons 2HI$

(C) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ (D) $N_2 + O_2 \rightleftharpoons 2NO$

Ans. : (c) At low pressure, reaction proceeds where volume is increasing. This is the favourable condition for the reaction.

$PCl_5 \rightleftharpoons PCl_3 + Cl_2$.

79. In the reaction $A_{(g)} + 2B_{(g)} \rightleftharpoons C_{(g)} + Q\,kJ$, greater product will be obtained or the forward reaction is favoured by

(A) At high temperature and high pressure

(B) At high temperature and low pressure

(C) At low temperature and high pressure

(D) At low temperature and low pressure

Ans. : (c) Both Δn and ΔH are negative. Hence, high pressure and low temperature will forward reaction.

80. Reaction in which yield of product will increase with increase in pressure is

(A) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

(B) $H_2O_{(g)} + CO_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$

(C) $H_2O_{(g)} + C_{(s)} \rightleftharpoons CO_{(g)} + H_{2(g)}$

(D) $CO_{(g)} + 3H_{2(g)} \rightleftharpoons CH_{4(g)} + H_2O_{(g)}$

Ans. : (d) In reaction $CO + 3H_2 \rightleftharpoons CH_4 + H_2O$

Volume is decreasing in forward direction so on increasing pressure the yield of product will increase.

81. The equilibrium which remains uneffected by change in pressure of the reactants is

(A) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$ (B) $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$

(C) $2O_{3(g)} \rightleftharpoons 3O_{2(g)}$ (D) $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$

Ans. : a

It's Obvious

82. In which of the following equilibrium reactions, the equilibrium would shift to the right, if total pressure is increased

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

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

(C) $H_2 + Cl_2 \rightleftharpoons 2HCl$

(D) $N_2O_4 \rightleftharpoons 2NO$

Ans. : (a) According to Le chatelier’s principle.

83. In which of the following gaseous equilibrium an increase in pressure will increase the yield of the products

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

(B) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

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

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

Ans. : (b) Increase in pressure causes the equilibrium to shift in that direction in which no. of moles (volume) is less.

84. Which of the following conditions is favourable for the production of ammonia by Haber's process

(A) High concentration of reactants

(B) Low temperature and high pressure

(C) Continuous removal of ammonia

(D) All of these

Ans. : d

1. High concentration of reactants
2. Low concentration and high pressure
3. Continuous removal of ammonia

so all of are correct

85. What would happen to a reversible reaction at equilibrium when an inert gas is added while the pressure remains unchanged

(A) More of the product will be formed

(B) Less of the product will be formed

(C) More of the reactants will be formed

(D) It remains unaffected

Ans. : d

When an inert gas is added to the system in equilibrium at constant pressure, then the total volume will increase. Hence, the number of moles per unit volume of various reactants and products will decrease. Hence, the equilibrium will shift towards the direction in which there is increase in number of moles of gases.

86. On addition of an inert gas at constant volume to the reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$ at equilibrium

(A) The reaction remains unaffected

(B) Forward reaction is favoured

(C) The reaction halts

(D) Backward reaction is favoured

Ans. : (a)Addition of an inert gas of constant volume condition to an equilibrium has no effect.

87. Le-Chatelier principle is not applicable to

(A) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

(B) $Fe_{(S)} + S_{(S)} \rightleftharpoons FeS_{(S)}$

(C) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

(D) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$

Ans. : (b)Le chatelier principle is not applicable to solid-solid equilibrium.

88. The dissociation of phosgene, which occurs according to the reaction
$COCl_2\,(g) \rightleftharpoons CO\,(g) + Cl_2$
is an endothermic process. Which of the following will increase the degree of dissociation of $COCl_2$

(A) Adding Cl_2 to the system

(B) Adding He to the system at constant pressure

(C) Decreasing the temperature of the sytem

(D) Increasing the total pressure of the system

Ans. : (B) Adding He to the system at constant pressure

89. Consider given endothermic reaction at equilibrium, $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
A graph is plotted between concentration and time as shown. Effect-1 & Effect-2 are due to respectively

(A) P increase, T increase

(B) P increase, T decrease

(C) Inert gas added at constant pressure, T increase

(D) P decrease, T decrease

Ans.: (A) P increase, T increase

90. Which of the following statement is incorrect regarding catalyst ?

(A) Does not alter, gibbs energy (ΔG) of a reaction

(B) The equilibrium position does not change in presence of a catalyst

(C) It increases speed of both forward and backward reaction

(D) Activation energy of reaction remain unaltered.

Ans. : (D) Activation energy of reaction remain unaltered.

91. 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

Ans. : (D) Amount of SO_2Cl_2 and CO will increase

92. For which of the following reaction, product formation is favoured at low pressure and low temperature ?

(A) $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$; $\Delta H^o = 172.5 \text{ kJ}$

(B) $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$; $\Delta H^o = -21.7\ kJ$

(C) $2O_3(g) \rightleftharpoons 3O_2(g)$; $\Delta H^o = -285\ kJ$

(D) $H_2(g) + F_2(g) \rightleftharpoons 2HF(g)$; $\Delta H^o = -541\ kJ$

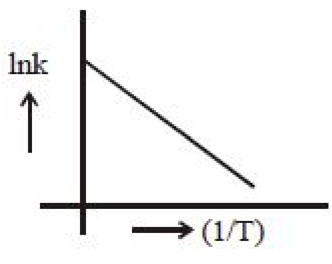
Ans. : c

Low P favoured ;$\Delta n = +ve$

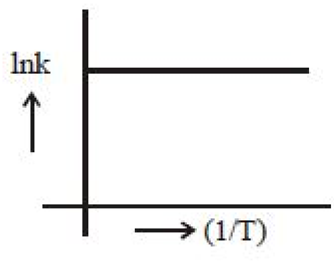
Low T favoured ; Exothermic $(\Delta H = -ve)$

93. An equilibrium shift towards reactants at higher temperatures. Find the correct graph

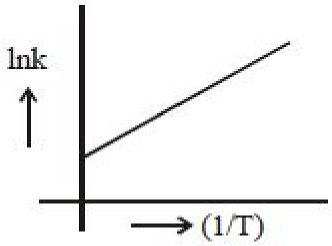
(A)



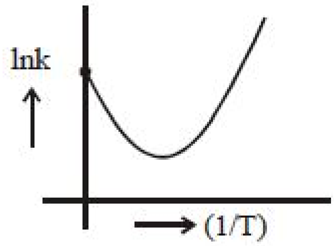
(B)



(C)



(D)



Ans. : c

The reaction is exothermic $(\Delta \mathrm{H}<0)$

slope $=-\frac{\Delta \mathrm{H}}{\mathrm{R}}$

94. The equation for the reaction in the figure below is: $H_2(g)+I_2(g)-heat \rightleftharpoons 2HI(g)$
At the instant 3 min, what change was imposed into the equilibrium ?

(A) Pressure was increased
(B) Temperature was decreased
(C) Temperature was increased
(D) Hydrogen was added

Ans. : d

On addition of H_2 , reaction goes in forward direction. Therefore first H_2 cuncentration increases than equilibrium reestablished

95. Which of the following equilibrium is not affected by pressure ?

(A) $CaCO_{3(s)} \rightleftharpoons CaO_{(s)}+CO_{2(g)}$
(B) $N_{2(g)}+3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$
(C) $N_{2(g)}+O_{2(g)} \rightleftharpoons 2NO_{(g)}$
(D) $2SO_{2(g)}+O_{2(g)} \rightleftharpoons 2SO_{3(g)}$

Ans. : c

$\Delta n_g=0$

96. Which among the following reactions is favoured in forward direction by increase of temperature?

(A) $N_2(g)+3H_2(g) \rightleftharpoons 2NH_3(g)+22.9\,kcal$
(B) $N_2(g)+O_2(g) \rightleftharpoons 2NO(g)-42.8\,kcal$
(C) $2SO_2(g)+O_2(g) \rightleftharpoons 2SO_3(g)+45.3\,kcal$
(D) $H_2(g)+Cl_2(g)-44\,kcal \rightleftharpoons 2HCl(g)$

Ans. : b

It is an endothermic reaction, hence the rise in temperature will favour forward direction.

97. In which of the following equilibrium, change in volume of the system does not alter the number of moles ?

(A) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$

(B) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$

(C) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

(D) $SO_2Cl_{2(g)} \rightleftharpoons SO_{2(g)} + Cl_{2(g)}$

Ans. : a

In the equilibrium $\mathrm{N_2(g) + O_2(g) \leftrightharpoons 2NO(g)}$, change in the volume of the system does not alter the number of moles.

Volume change is accompanied with pressure change. A reaction in which the total number of moles of gaseous reactants is equal to the total number of moles of gaseous products, the change in pressure will not affect the position of the equilibrium.

98. For the reaction; $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$ the forward reaction at constant temperature is not favoured by

(A) Introducing chlorine gas at constant volume

(B) Introducing an inert gas at constant pressure

(C) Introducing PCl_5 at constant volume

(D) Increasing the volume of the container

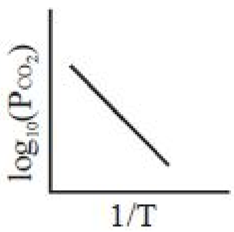
Ans. : a

This will favour backward reaction to consume added Cl_2

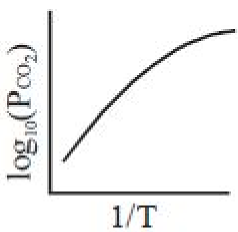
99. For the chemical reaction

$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ ΔH^o of reaction can be determined from which one of the following plots ?

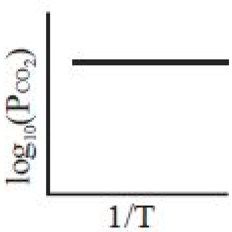
(A)



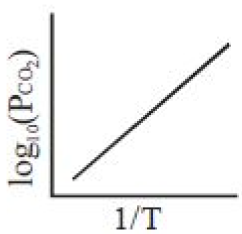
(B)



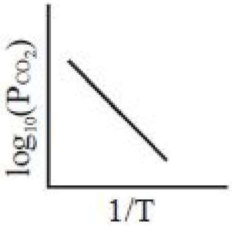
(C)



(D)



Ans.: (A)



100. 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

Ans. : (D) Amount of SO_2Cl_2 and CO will increase

----- उद्यमेन हि सिध्यन्ति कार्याणि न मनोरथैः। न हि सुप्तस्य सिंहस्य प्रविशन्ति मुखे मृगाः।।-जीवन में सफलता पाने के लिए मेहनत और प्रयास जरूरी हैं। केवल इच्छा करने या कल्पना करने से काम नहीं बनते -----