# Exercise-1

**Marked Questions may have for Revision Questions.**

## OBJECTIVE QUESTIONS

### Section (A) : Equilibrium and its properties

**A-1.** In a reaction $A + B \rightleftharpoons C + D$ the rate constant of forward reaction & backward reaction is $k_1$ and $k_2$ then the equilibrium constant (k) for reaction is expressed as –

(1) $K_C = \frac{K_2}{K_1}$ (2*) $K_C = \frac{K_1}{K_2}$ (3) $K_C = K_1 \times K_2$ (4) $K_C = K_1 + K_2$

**A-2.** Molar concentration of 96 g of $O_2$ contained in a 2 litre vessel is -

(1) 16 mol/litre (2*) 1.5 mol/litre (3) 4 mol/litre (4) 24 mol/litre

**A-3.** $\log \frac{K_p}{K_c} + \log RT = 0$ is a relationship for the reaction :

(1) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ (2*) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

(3) $H_2 + I_2 \rightleftharpoons 2HI$ (4) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

**A-4.** The equilibrium concentration of $[B]_{eq}$ for the reversible reaction $A \rightleftharpoons B$ can be evaluated by the expression:

(1) $K_C[A]_e^{-1}$ (2) $\frac{k_f}{k_b}[A]_e^{-1}$ (3*) $k_f k_b^{-1}[A]_e$ (4) $k_f k_b[A]^{-1}$

**A-5.** In a chemical equilibrium, the rate constant for the backward reaction is $7.5 \times 10^{-4}$ and the equilibrium constant is 1.5 the rate constant for the forward reaction is :

(1) $2 \times 10^{-3}$ (2) $5 \times 10^{-4}$ (3*) $1.12 \times 10^{-3}$ (4) $9.0 \times 10^{-4}$

**A-6.** For the reaction, $CuSO_4.5H_2O(s) \rightleftharpoons CuSO_4.3H_2O(s) + 2H_2O(g)$. Which one is correct representation:

(1) $K_P = \left(P_{H_2O}\right)^2$ (2) $K_C = [H_2O]^2$ (3) $K_P = K_C(RT)^2$ (4*) All

**A-7.** For a reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$, the value of $K_C$ does not depends upon :

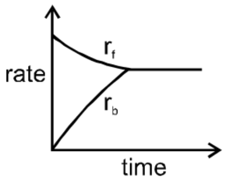
(a) Initial concentration of the reactants (b) Pressure

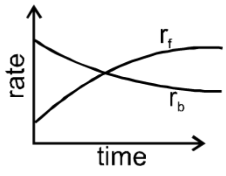
(c) Temperature (d) catalyst

**A-8.** At 1000 K, the value of $K_p$ for the reactionm, $A(g) + 2B(g) \rightleftharpoons 3C(g) + D(g)$ is 0.05 atmosphere. The value of $K_C$ in terms of R would be :

(1) 20000 R (2) 0.02 R (3) $5 \times 10^{-5}$ R (4*) $5 \times 10^{-5} \times R^{-1}$

**A-9.** Rate of reaction curve for equilibrium can be like : [$r_f$ = forward rate , $r_b$ = backward rate]

(1*)


(2)


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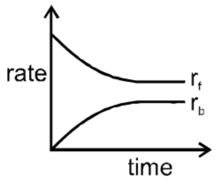
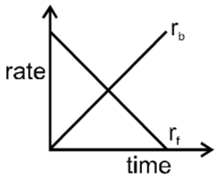


(4)


**A-10.** The equilibrium constant of the reaction $SO_2(g) + ½O_2(g) \rightleftharpoons SO_3(g)$ is $4 \times 10^{-3}$ atm$^{-1/2}$. The equilibrium constant of the reaction $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ would be :

(1) 250 atm (2) $4 \times 10^3$ atm (3) $0.25 \times 10^4$ atm (4*) $6.25 \times 10^4$ atm

## Section (B) : Calculation of $K_P$ & $K_C$ in homogenous equilibrium

**B-1.** For the reaction $3A(g) + B(g) \rightleftharpoons 2C(g)$ at a given temperature, $K_c = 9.0$. What must be the volume of the flask, if a mixture of 2.0 mol each of A, B and C exist in equilibrium?

(1*) 6 L (2) 9 L (3) 36 L (4) None of these

**B-2.** The equilibrium constant ($K_p$) for the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ 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 :

(1) 32 (2) 64 (3*) 16 (4) 4

**B-3.** The equilibrium constant for the reaction : $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ at 2000 K is $4 \times 10^4$ In presence of a catalyst the equilibrium is established ten times faster at the same temperature. What is the value of equilibrium constant in presence of catalyst : -

(1) $40 \times 10^4$ (2) $4 \times 10^{-4}$ (3*) $4 \times 10^4$ (4) None

**B-4.** The equilibrium constant for 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 :

(1) 16 (2) 32 (3*) 64 (4) 128

**B-5.** $A_3(g) \rightleftharpoons 3A(g)$

In the above reaction, the initial concentration of $A_3$ is "a" moles/lit. If x is degree of dissociation of $A_3$. The total number of moles at equilibrium will be :

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

**B-6.** The reaction $A(g) + B(g) \rightleftharpoons C(g) + D(g)$ is studied in a one litre vessel at 250°C. The initial concentration of A was 3n and that of B was n. When equilibrium was attained, equilibrium concentration of C was found to the equal to the equilibrium concentration of B. What is the concentration of D at equilibrium?

(1*) n/2 (2) (3n – 1/2) (3) (n – n/3) (4) n

**B-7.** When alcohol ($C_2H_5OH$) and acetic acid are mixed together in equimolar ratio at 27°C , 33% is converted into ester. Then the $K_C$ for the equilibrium

$$C_2H_5OH(\ell) + CH_3COOH(\ell) \rightleftharpoons CH_3COOC_2H_5(\ell) + H_2O(\ell).$$

(1) 4 (2*) 1/4 (3) 9 (4) 1/9

**B-8.** 'a' moles of $PCl_5$, undergoes, thermal dissociation as : $PCl_5 \rightleftharpoons PCl_3 + Cl_2$, the mole fraction of $PCl_3$ at equilibrium is 0.25 and the total pressure is 2.0 atmosphere. The partial pressure of $Cl_2$ at equilibrium is :

(1) 2.5 (2) 1.0 (3*) 0.5 (4) None

**B-9.** 4.5 moles each of hydrogen and iodine heated in a sealed ten litre vessel. At equilibrium 3 moles of HI were found. The equilibrium constant for $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ is :

(1*) 1 (2) 10 (3) 5 (4) 0.33

**B-10.** 1.50 moles each of hydrogen and iodine were placed in a sealed 10 litre container maintained at 717 K. At equilibrium 1.25 moles each of hydrogen and iodine were left behind. The equilibrium constant, $K_c$ for the reaction. $H_2(g) + I_2(g)$  $2HI(g)$ at 717 K is

(1) 0.4 (2*) 0.16 (3) 25 (4) 50

**B-11.** 500 ml vessel contains 1.5 M each of A,B, C and D at equilibrium. If 0.5 M each of C and D are taken out, the value of $K_C$ for $A + B \rightleftharpoons C + D$ will be **[DCE 2000]**

(1*) 1.0 (2) 1/9 (3) 4/9 (4) 8/9

**B-12.** The relation between $K_p$ and $K_c$ in equilibrium is : **[RPMT 2001]**

(1*) $K_p = K_c (RT)^{\Delta ng}$ (2) $K_p = K_c \times RT$ (3) $K_c = K_p (RT)^{\Delta n}$ (4) $K_c = K_p \times \Delta n$

**[Correction by AGA_25.9.17]**

## Section (C) : Reaction quotient

**C-1.** In a 20 litre vessel initially 1 – 1 mole CO, $H_2O$ $CO_2$ is present, then for the equilibrium of

$CO + H_2O \rightleftharpoons CO_2 + H_2$ following is true :

(1) $H_2$, more then 1 mole (2*) CO, $H_2O$, $H_2$ less then 1 mole

(3) $CO_2$ & $H_2O$ both more than 1 mole (4) All of these

**C-2.** Vapour density of $PCl_5$ is 104.16 but when heated to 230°C its vapour density is reduced to 62.. The degree of dissociation of $PCl_5$ at this temperature will be :

(1) 6.8 % (2*) 68% (3) 46% (4) 64%

**C-3.** A reaction mixture containing $H_2$, $N_2$ and $NH_3$ has partial pressure 2 atm, 1 atm and 3 atm respectively at 725 K. If the value of $K_P$ for the reaction, $N_2 + 3H_2 \rightleftharpoons 2NH_3$ is $4.28 \times 10^{-5}$ $atm^{-2}$ at 725 K, in which direction the net reaction will go :

(1) Forward (2*) Backward

(3) No net reaction (4) Direction of reaction cannot be predicted

**C-4.** 2 mole each of $SO_3$, CO, $SO_2$ and $CO_2$ is taken in a one lit. vessel. If $K_C$ for

$SO_3(g) + CO(g) \rightleftharpoons SO_2(g) + CO_2(g)$ is 1/9 then

(1) total no. of moles at equilibrium are less than 8 (2) $n(SO_3) + n(CO_2) = 4$

(3) $[n(SO_2)/n(CO)] < 1$ (4*) nksuksa (2) rFkk (3).

**C-5.** The reaction quotient Q for $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ is given by $Q = \frac{[NH_3]^2}{[N_2][H_2]^3}$. The reaction will proceed in backward direction, when **(SID Sir) (CEQ–RQ) (SCQ) (M)**

(1) $Q = K_C$ (2) $Q < K_C$ (3*) $Q > K_C$ (4) A = 0

**C-6.** For the reaction, **(SID Sir) (CEQ–RQ) (SCQ) (E)**

$2A + B \rightleftharpoons 3C$ at 298 K, $K_C = 49$

A 3L vessel contains 2, 1 and 3 moles of A, B and C respectively. The reaction at the same temperature

(1*) must proceed in forward direction (2) must proceed in backward direction
(3) must be equilibrium (4) can not be predicted

## Section (D) : Degree of dissociation

**D-1.** In a container equilibrium $N_2O_4\,(g) \rightleftharpoons 2NO_2\,(g)$
is attained at 25°C. The total equilibrium pressure in container is 380 torr. If equilibrium constant of above equilibrium is 0.667 atm, then degree of dissociation of $N_2O_4$ at this temperature will be

(1) $\frac{1}{3}$ (2*) $\frac{1}{2}$ (3) $\frac{2}{3}$ (4) $\frac{1}{4}$

**D-2.** The extent of dissociation of $PCl_5$ at a certain temperature is 20 % at one atm pressure . Calculate the pressure at which this substance is half dissociated at the same temperature.

(1*) 0.123 (2) 0.246 (3) 0.826 (4) 0.111

**D-3.** Consider the reactions

(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

(1) will increase the dissociation of $PCl_5$ as well as $N_2O_4$
(2) will reduce the dissociation of $PCl_5$ as well as $N_2O_4$
(3) will increase the dissociation of $PCl_5$ and step up the formation of $NO_2$
(4*) will not disturb the equilibrium of the reactions

**D-4.** At 248° C , the $k_P$ for the reaction , $SbCl_5\,(g) \rightleftharpoons SbCl_3\,(g) + Cl_2\,(g)$ is 1.07 atm at a total pressure of 1 atm . Calculate the degree of dissociation of $SbCl_5$ .

(1) 0.516 (2*) 0.718 (3) 0.321 (4) None of these

**D-5.** 4 moles of A are mixed with 4 moles of B, when 2 moles of C are formed at equilibrium, according to the reaction, $A + B \rightleftharpoons C + D$. The equilibrium constant is :

(1) 4 (2*) 1 (3) $\sqrt{2}$ (4) $\sqrt{4}$

**D-6.** 4 moles of $PCl_5$ are heated at constant temperature in closed container. If degree of dissociation for $PCl_5$ is 0.5 calculate total number of moles at equilibrium :

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

**D-7.** The dissociation of $CO_2$ can be expressed as $2CO_2 \rightleftharpoons 2CO + O_2$. If the 2 moles of $CO_2$ is taken initially and 40% of the $CO_2$ is dissociated equilibrium then total number of moles at equilirbrium :

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

**D-8.** In the reaction $2P(g) + Q(g) \rightleftharpoons 3R(g) + S(g)$. If 2 moles each of P and Q taken initially in a 1 litre flask. At equilibrium which is true :

(1*) [P] < [Q] (2) [P] = [Q] (3) [Q] = [R] (4) None of these

**D-9.** In a 0.25 litre tube dissociation of 4 moles of NO is take place. If its degree of dissociation is 10%. The value of $K_p$ for reaction $2NO \rightleftharpoons N_2 + O_2$ is :

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

**D-10.** The vapour density of $N_2O_4$ at a certain temperature is 30. What is the percentage dissociation of $N_2O_4$ at this temperature ?

(1*) 53.3 % (2) 106.6% (3) 26.7% (4) none

**D-11.** A sample of mixture of A(g), B(g) and C(g) under equilibrium has a mean molecular weight (observed) is 80.

The equilibrium is $\underset{\text{(mol. wt. = 100)}}{A(g)} \rightleftharpoons \underset{\text{(mol. wt. = 60)}}{B(g)} + \underset{\text{(mo. wt. = 40)}}{C(g)}$

Find the degree of dissociation α for A(g).

(1*) 0.25 (2) 0.5 (3) 0.75 (4) 0.8

**D-12.** The degree of dissociation of $PCl_5$ (g) obeying the equilibrium, $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ , is approximately related to the presure at equilibrium by -

(1) $\alpha \propto P$ (2*) $\alpha \propto \frac{1}{\sqrt{P}}$ (3) $\alpha \propto \frac{1}{P^2}$ (4) $\alpha \propto \frac{1}{P^4}$

**D-13.** $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

In above reaction, at equilibrium condition mole fraction of $PCl_5$ is 0.4 and mole fraction of $Cl_2$ is 0.3. Then find out mole fraction of $PCl_3$

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

(1*) 0.3 (2) 0.7 (3) 0.4 (4) 0.6

**D-14.** $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ In this reaction the dissociation of $N_2O_4$ is X then the how much mole will of $N_2O_4$ and $NO_2$ at equilibrium : **[RPMT 2001]**

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

(1) $(1 - x)^2$ (2) 1 (3*) (1 + x) (4) 2

**D-15.** 5 moles of $SO_2$ and 5 moles of $O_2$ are allowed to react to form $SO_3$ in a closed vessel. At the equilibrium stage, 60% $SO_2$ is used up. The total number of moles of $SO_2$, $O_2$ and $SO_3$ in the vessel now is :

(1) 3.9 (2) 10.5 (3*) 8.5 (4) 10.0

**D-16.** A mixture of $NO_2$ and $N_2O_4$ has a vapour density of 38.3 at 300 K. What is the number of moles of $NO_2$ in 100 g of the mixture ? **[Kerla PMT 2004]**

(1) 0.043 (2) 4.4 (3) 3.4 (4*) 0.437

## Section (E) : Heterogenous Equilibrium

**E-1.** In the reaction $C(s) + CO_2(g) \rightleftharpoons 2CO(g)$, the equilibrium pressure is 12 atm. If 50% of $CO_2$ reacts then $K_p$ will be :

(1) 12 atm (2*) 16 atm (3) 20 atm (4) 24 atm

**E-2.** What is the minimum mass of $CaCO_3$ (s), below which it decomposes completely, required to establish equilibrium in a 6.50 litre container for the reaction : $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ $K_c$ = 0.05 mole/litre

(1*) 32.5 g (2) 24.6 g (3) 40.9 g (4) 8.0 gm

## Section (F) : Thermodynamics of Equilibrium

**F-1.** The correct relationship between free energy change in a reaction and the corresponding equilibrium constant K is : **[RPMT 2008]**

(1*) $-\Delta G^o = RT \ln K$ (2) $\Delta G = RT \ln K$ (3) $-\Delta G = RT \ln K$ (4) $\Delta G^o = RT \ln K$

**F-2.** Which of the following is not favourable for $SO_3$ formation

$$2SO_2\,(g) + O_2\,(g) \rightleftharpoons 2SO_3\,(g); \qquad \Delta H = -45.0 \text{ kcal}$$

(1) High pressure (2*) High temperature

(3) Decreasing $SO_3$ concentration (4) Increasing reactant concentration

**F-3.** In an equilibrium reaction for which $\Delta G° = 0$, the value of equilibrium constant K =

(1) 0 (2*) 1 (3) 2 (4) 10

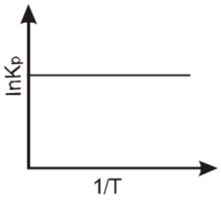
**F-4.** The effect of temperature on equilibrium constant is expressed as ($T_2 > T_1$)

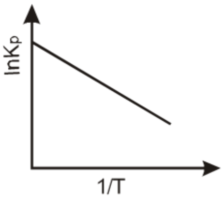
$\log (K_2/K_1) = \frac{-\Delta H}{2.303R}\left[\frac{1}{T_2}-\frac{1}{T_1}\right]$. For endothermic reaction false statement is

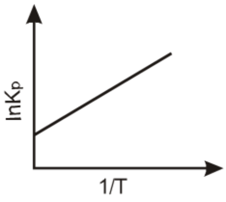
(1*) $\left[\frac{1}{T_2}-\frac{1}{T_1}\right]$ = positive (2) $\Delta H$ = positive **[Correction by AGA_25.9.17]**

(3) $\log K_2 > \log K_1$ (4) $K_2 > K_1$

**F-5.** An exothermic reaction is represented by the graph :

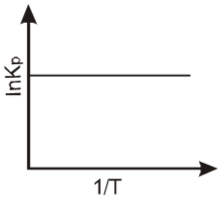
(1)


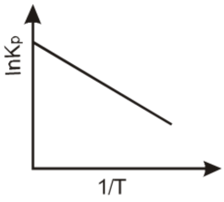
(2)


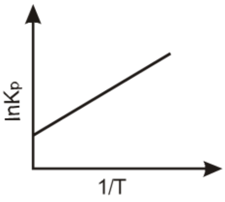
(3*)


(4) None of these

**F-6.** An endothermic reaction is represented by the graph :

(1)


(2*)


(3)


(4) None of these

**F-7.** The value of $\Delta G°$ for a reaction in aqueous phase having $K_c = 1$, would be:

(1) $-RT$ (2) $-1$ (3*) 0 (4) $+RT$

**F-10.** The equilibrium constant for the reaction $Br_2 \rightleftharpoons 2Br$ at 500 K and 700 K are $1 \times 10^{-10}$ and $1 \times 10^{-5}$ respectively. The reaction is :

(1*) Endothermic (2) Exothermic (3) Fast (4) Slow

## Section (G) : Le-chatelier's principle

**G-1.** A reaction in equilibrium is represented by the following equation –

$2A_{(s)} + 3B_{(g)} \rightleftharpoons 3C_{(g)} + D(g) + O_2$ if the pressure on the system is reduced to half of its original value

(1) The amounts of C and D decreases (2*) The amounts of C and D increases

(3) The amount of B and D decreases (4) All the amounts remain constant

**G-2.** In which of the following equilibrium reactions, the equilibrium would shift to right side, if total pressure is decreased :

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

(3*) $N_2O_4 \rightleftharpoons 2NO_2$ (4) $H_2 + Cl_2 \rightleftharpoons 2HCl$

**G-3.** In a vessel containing $SO_3$, $SO_2$ and $O_2$ at equilibrium, some helium gas is introduced so that the total pressure increases while temperature and volume remain constant. According to Le-Chatelier principle, the dissociation of $SO_3$,

(1) Increases (2) Decreases (3*) Remains unaltered (4) None of these

**G-4.** On cooling of following system at equilibrium $CO_2(s) \rightleftharpoons CO_2(g)$

(1) There is no effect on the equilibrium state (2) More gas is formed

(3*) More gas solidifies (4) None of above

**G-5.** For an equilibrium $H_2O(s) \rightleftharpoons H_2O(\ell)$ which of the following statements is true.

(1) The pressure changes do not affect the equilibrium

(2*) More of ice melts if pressure on the system is increased

(3) More of liquid freezes if pressure on the system is increased

(4) The degree of advancement of the reaction do not depend on pressure.

**G-6.** In the Haber process for the industrial manufacture of ammonia involving the reaction,

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at 200 atm pressure in the presence of a catalyst, a temperature of about 500ºC is used. This is considered as optimum temperature for the process because

(1) yield is maximum at this temperature

(2) catalyst is active only at this temperature

(3) energy needed for the reaction is easily obtained at this temperature

(4*) rate of the catalytic reaction is fast enough while the yield is also appreciable for this exothermic reaction at this temperature.

**G-7.** The effect of increasing the pressure on the following equilibrium $2A + 3B \rightleftharpoons 3A + 2B$ is -

(1) Forward reaction is favoured (2) Backward reaction is favoured

(3*) No effect (4) None of these

**G-8.** When $NaNO_3(s)$ is heated in a closed vessel, $O_2$ is liberated and $NaNO_2(s)$ is left behind. At equilibrium–

(1) Addition of $NaNO_3(s)$ favours forward reaction (2) Addition of $NaNO_2(s)$ favours reverse reaction

(3*) Increasing pressure favours reverse reaction (4) Decreasing temperature favours forward reaction

**G-9.** $aA + bB \rightleftharpoons cC + dD$

In above reaction low pressure and high temperature, conditions are shift equilibrium in back direction so correct set :

$aA + bB \rightleftharpoons cC + dD$

## Exercise-2

**Marked Questions may have for Revision Questions.**

## OBJECTIVE QUESTIONS

**1.** The equilibrium constant, $K_p$ for the reaction

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

is 4.0 $atm^{-1}$ at 1000 K. What would be the partial pressure of $O_2$ if at equilibrium the amount of $SO_2$ and $SO_3$ is the same ?

(1) 16.0 atm (2*) 0.25 atm (3) 1 atm (4) 0.75 atm

**2.** If $K_1$, $K_2$, $K_3$ are equilibrium constant for formation of AD, $AD_2$, $AD_3$ respectively as follows $A + D \rightleftharpoons AD$, $AD + D \rightleftharpoons AD_2$, $AD_2 + D \rightleftharpoons AD_3$ . Then equilibrium constant 'K' for $A + 3D \rightleftharpoons AD_3$ is related as

(1) $K_1 + K_2 + K_3 = K$ (2*) $\log K_1 + \log K_2 + \log K_3 = \log K$

(3) $K_1 + K_2 = K_3 + K$ (4) $\log K_1 + \log K_2 = \log K_3 + \log K$

**3.** For the reaction

$$A_2(g) + 3B_2 \rightleftharpoons 2C_2(g)$$

the partial pressure of $A_2$, $B_2$ at equilibrium are 0.80 atm and 0.40 atm respectively. The pressure of the system is 2.80 atm. The equilibrium constant $K_p$ will be

(1*) 50 (2) 5.0 (3) 0.02 (4) 0.2

**4.** On decomposition of $NH_4HS$, the following equilibrium is established :

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

If the total pressure is P atm, then the equilibrium constant $K_P$ is equal to

(1) P atm (2) $P^2$ $atm^2$ (3*) $P^2 / 4$ $atm^2$ (4) 2P atm

**5.** Equilibrium constant for the following equilibrium is given at 0ºC.

$$Na_2HPO_4.12H_2O(s) \rightleftharpoons Na_2HPO_4.7H_2O(s) + 5H_2O(g) \qquad K_P = 31.25 \times 10^{-13}$$

Find out equilirbium pressure of water vapour.

(1) $\frac{1}{5} \times 10^{-3}$ atm (2) $0.5 \times 10^{-3}$ atm (3) $5 \times 10^{-2}$ atm (4*) $5 \times 10^{-3}$ atm.

**6.** In a reaction the rate of reaction is proportional to its active mass, this statement is known as :

(1*) Law of mass action (2) Le-chatelie principle

(3) Faraday law of electrolysis (4) Law of constant proportion

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

(1) 0.5 (2) 4.0 (3) 8.0 (4*) 1

**8.** Consider the two gaseous equilibrium involving $SO_2$ and the corresponding equilibrium constant at 299 K

$SO_2\,(g) + 1/2O_2(g) \rightleftharpoons SO_3(g)\ ;\ K_1$

$4SO_3\,(g) \rightleftharpoons 4SO_2\,(g) + 2O_2\,(g)\ ;\ K_2$

The value of the equilibrium constant are related by :

(1*) $K_2 = \frac{1}{(K_1)^4}$ (2) $K_2 = K_1^4$ (3) $K_2 = \left(\frac{1}{K_1}\right)^{1/4}$ (4) $K_2 = \frac{1}{K_1}$

**9.** Equilibrium constant for the reaction ,

$2\,NO + O_2 \rightleftharpoons 2\,NO_2$ is $K_{C1}$ ;

$NO_2 + SO_2 \rightleftharpoons SO_3 + NO$ is $K_{C2}$ and

$2\,SO_3 \rightleftharpoons 2\,SO_2 + O_2$ is $K_{C3}$ then correct reaction is :

(1) $K_{C3} = K_{C1} \times K_{C2}$ (2*) $K_{C3} \times K_{C1} \times K^2_{C2} = 1$ (3) $K_{C3} \times K_{C1} \times K_{C2} = 1$ (4) $K_{C3} \times K^2_{C1} \times K_{C2} = 1$

**10.** In a chemical equilibrium $A + B \rightleftharpoons C + D$ when one mole each of the two reactants are mixed 0.4 mole each of the products are formed. The equilibrium constant calculated is :

(1) 1 (2) 0.36 (3) 2.25 (4*) 4/9

**11.** The correct relationship between $K_p$ and $K_c$ in gaseous equilibrium is : **[RPMT 2000]**

(1) $K_p = K_p\,(RT)^{\Delta n}$ (2) $K_C = RT\,(K_p)^{\Delta n}$ (3*) $K_p = K_C\,(RT)^{\Delta n}$ (4) $K_p = RT\,(K_C)^{\Delta n}$

**12.** At constant temperature, the equilibrium constant ($K_p$) for the decomposition reaction $N_2O_4 \rightleftharpoons 2NO_2$ is expressed by $K_p = (4x^2\,P) / (1 - x^2)$ where P = pressure, x = extent of decomposition. Which one of the following statements is true ? **[KCET 2001]**

(1) $K_p$ increases with increase of P (2) $K_p$ increase with increase of x

(3) $K_p$ increase with decrease of x (4*) $K_p$ remains constant with change in P and x.

**13.** For the reaction, $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ ; $K_p$ is : **[RPMT 2002]**

(1) $K_p = P_{(CaCO_3)}$ (2*) $K_p = P_{(CO_2)}$ (3) $K_p = \frac{1}{P_{(CaCO_3)}}$ (4) $K_p = \frac{1}{P_{(CO_2)}}$

**14.** For $N_2 + 3H_2 \rightleftharpoons 2NH_3$ equilibrium constant is K then equilibrium constant for $2N_2 + 6H_2 \rightleftharpoons 4NH_3$ : **[RPMT 2002]**

(1) $\sqrt{K}$ (2*) $K^2$ (3) $\frac{K}{2}$ (4) $\sqrt{\frac{1}{K}} + 1$

**15.** Relation between $K_p$ and $K_c$ is : **[RPMT 2002]**

(1) $K_c = K_p\,(RT)^{\Delta ng}$ (2) $K_p = K_c\,(RT)^{\Delta ng}$ (3) $K_c = K_p\,(RT)^{-\Delta ng}$ (4*) both (2) and (3)

**16.** 56 g of nitrogen and 8 g of hydrogen gas are heated in a closed vessel. At equilibrium, 34 g of ammonia are present. The equilibrium number of moles of nitrogen, hydrogen and ammonia are respectively. **[Karnatak 2004]**

(1) 1,2,2 (2) 2,2,1 (3*) 1,1,2 (4) 2,1,2

**17.** Which of the following is in favour of forward reaction

(1) $Q = K_c$ (2) $Q > K_c$ (3*) $Q < K_c$ (4) None

**18.** At room temperature, the equilibrium constant for the reaction $P + Q \rightleftharpoons R + S$ was calculated to be 4.32. At 425°C the equilibrium constant became $1.24 \times 10^{-2}$. This indicates that the reaction

(1*) is exothermic (2) is endothermic

(3) is difficult to predict (4) no relation between $\Delta H$ and K

**19.** For the reaction (1) and (2) : $A \rightleftharpoons B + C$ ....(1)

$D \rightleftharpoons 2E$ ....(2)

Given $K_{P_1} : K_{P_2} :: 9 : 1$

If the degree dissociation of A and D be same then the total pressure at equilibria (1) and (2) are in the ratio (Assume reaction are started with equal number of moles of A and D).

(1) 3 : 1 (2*) 36 : 1 (3) 1 : 1 (4) 0.5 : 1

**20.** Pure ammonia is placed in a vessel at a temperature where its dissociation constant ($\alpha$) is appreciable. At equilibrium :

(1*) $K_p$ does not change significantly with pressure.

(2) $\alpha$ does not change with pressure

(3) concentration of $NH_3$ does not change with pressure.

(4) concentration of hydrogen is less than that of nitrogen

**Sol.** $K_P$ is not dependent on pressure and depend only on the temperature.

**21.** Vapour density of $PCl_5$ at equilibrium is 52.125 at T°C. Then degree of dissociation of $PCl_5$ is. (Mw = 208.5)

(1) 20% (2*) 100% (3) 30% (4) 15%

**22.** The degree of dissociation of $SO_3$ is $\alpha$ at equilibrium pressure $P_0$ .

$K_p$ for $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ is

(1) $[(P_0\alpha^3)/2(1 - \alpha)^3]$ (2*) $[(P_0\alpha^3)/(2+\alpha)(1 - \alpha)^2]$

(3) $[(P_0\alpha^2)/2(1 - \alpha)^2]$ (4) None of these

**23.** For reaction $aA \rightleftharpoons \ell L + mM$. In condition of suddenly volume increase, degree of dissociation is decrease it represent that.

(1) $a < (\ell + m)$ (2) $a = (\ell + m)$ (3) $a = (\ell - m)$ (4*) $a > (\ell + m)$

**24.** 2 moles of $PCl_5$ when heated in a closed vessels of 2 litre capacity at equilibrium, 40% of $PCl_5$ dissociated in $PCl_3$ and $Cl_2$.

The value of the equilibrium constant is : **[RPMT 2000]**

(1) 2.67 (2) 5.3 (3) 5.33 (4*) 0.267

**25.** 1 mole of $N_2$ and 2 moles of $H_2$ are allowed to react in a 1 $dm^3$ vessel. At equilibrium, 0.8 mole of $NH_3$ is formed. The concentration of $H_2$ in the vessel is : **[Manipal PMT 2002]**

(1) 0.6 mole (2*) 0.8 mole (3) 0.2 mole (4) 0.4 mole

**26.** The equilibrium $P_4(s) + 6Cl_2(g) \rightleftharpoons 4PCl_3\,(g)$ is attained by mixing equal moles of $P_4$ and $Cl_2$ in an evacuated vessel. Then at equilibrium **[J&K CET 2004]**

(1) $[Cl_2] > [PCl_3]$ (2) $[Cl_2] > [P_4]$ (3*) $[P_4] > [Cl_2]$ (4) $[PCl_3] > [P_4]$

**27.** For the reaction $PCl_5 \rightleftharpoons PCl_3 + Cl_2$, the degree of dissociation varies inversely as the square root of pressure of the system. Supposing at constant temperature. If the volume is increased 16 times the initial volume, the degree of dissociation for this reaction will becomes :

(1*) 4 times (2) $\frac{1}{4}$ times (3) 2 times (4) $\frac{1}{2}$ times

**28.** A liquid is in equilibrium with its vapour at its boiling point . On the average the molecules in the two phases have equal :

(1) inter molecular forces (2) potential energy

(3*) kinetic energy (4) none of these .

**29.** The equilibrium constant for the reaction

$Br_2 \rightleftharpoons 2Br$ at 500 K and 700 K are $1 \times 10^{-10}$ and $1 \times 10^{-5}$ respectively. The reaction is :

(1*) Endothermic (2) Exothermic (3) Fast (4) Slow

**Sol.** $T\uparrow\ K_c\uparrow \Rightarrow$ Endothermic

**30.** In the given reaction $2\,X(g) + Y(g) \rightleftharpoons 2Z(g) + 80$ kcal, which combination of pressure and temperature will give the highest yield of Z at equilibrium ? **[Kerla CET 2004]**

(1*) 1000 atm and 100°C (2) 500 atm and 500°C

(3) 1000 atm and 200°C (4) 500 atm and 100°C

**31.** The reaction in which yield of production cannot be increased by the application of high pressure is :

(1) $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5\,(g)$ (2*) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

(3) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3\,(g)$ (4) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

**32.** Does Le chatelier's principle predict a change of equilibrium concentration for the following reaction if the gas mixture is compressed $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

(1*) Yes, backward reaction is favoured (2) Yes, forward reaction is favoured

(3) No change (4) No information

**33.** What would happen to a reversible dissociation reaction at equilibrium when an inert gas is added while the pressure remains unchanged (Assume $\Delta ng > 0$ of reaction)? **[DCE 1999]**

(1) Less of the product will be formed (2*) More of the product will be formed

(3) More of the reactants will be formed (4) It remains unaffected

**34.** Which reaction will proceed in forward direction on increasing pressure ? **[RPMT 2004]**

(1) $C(s) + O_2 \longrightarrow CO_2$ (2) $SO_2(s) + 0.5\,O_2 \longrightarrow SO_3$

(3*) $N_2 + 3H_2 \longrightarrow 2NH_3$ (4) None of the above buesa ls dksbZ ugha

**35.** In a given system, water and ice are in equilibrium. If pressure is applied to the above system then **:**

(1) More of ice is formed (2) Amount of ice and water will remain same

(3*) More of ice is melted (4) Either (1) or (3)

**36.** For the equilibrium reaction, $H_2O(l) \rightleftharpoons H_2O(g)$. What happens, if pressure is applied :

(1) More water evaporates (2*) The boiling point of water is increased

(3) No effect on boiling point (4) None of the above

**37.** 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 :

(1) adding a suitable catalyst (2) adding an inert gas

(3) decreasing the volume of container (4*) increasing the amount of CO(g)

**38.** 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.

(1) More $NH_3(g)$ is produced (2*) Less $NH_3(g)$ is produced

(3) No affect on the equilibrium (4) $K_p$ of the reaction is decreased

**39.** The equilibrium, $SO_2Cl_2(g) \rightleftharpoons SO_2(g) + Cl_2(g)$ is attained at 25°C in a closed container and an inert gas, helium, is introduced. Which of the following statement(s) is/are correct.

(1) Concentrations of $SO_2$, $Cl_2$ and $SO_2Cl_2$ are changed (2*) No effect on equilibrium

(3) Concentration of $SO_2$ is reduced (4) $K_p$ of reaction is increasing

**40.** Introduction of inert gas (at the same temperature) will affect the equilibrium if :

(1) volume is constant and $\Delta n_g \neq 0$ (2*) pressure is constant and $\Delta n_g \neq 0$

(3) volume is constant and $\Delta n_g = 0$ (4) pressure is constant and $\Delta n_g = 0$

**41.** The following reaction is favourable at – **(SIS Mam) (CEQ) (SCQ) (E)**

$H_2O(s) \rightleftharpoons H_2O(\ell)$ $\Delta H = +ve$ ; T = 0ºC

(1) Low pressure & low temperture (2*) High pressure & high temperture

(3) Low pressure & high temperture (4) None of these

**42.** **Match the following :**

| **Column I (Assume only reactant were present initially)** | **Column II** |
|---|---|
| (A) For the equilibrium $NH_4I(s) \rightleftharpoons NH_3(g) + HI(g)$, if pressure is increased at equilibrium | (p) Forward shift |
| (B) For the equilibrium $H_2O(g) + CO(g) \rightleftharpoons H_2(g) + CO_2$ (g) inert gas is added at constant pressure at equilibrium | (q) No shift in equilibrium |
| (C) For the equilibrium $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ $Cl_2$ is removed at equilibrium. | (r) Backward shift |

(1*) (A - r) ; (B - q) ; (C - p) (2) (A - q) ; (B - r) ; (C - p)

(3) (A - p) ; (B - q) ; (C - r) (4) (A - p) ; (B - r) ; (C - q)

**43.** For the reaction : $N_2\ (g) + 3H_2(g) \rightleftharpoons 2NH_3\ (g)$ ; equilibrium constant $K_c = \frac{[NH_3]^2}{[N_2]\ [H_2]^3}$

Some reactions are written bellow in column I and their equilibrium constants in terms of $K_c$ are written in column II. Match the following reactions with the corresponding equilibrium constant

| **Column I (Reaction)** | **Column II (Equilibrium constnat)** |
|---|---|
| (A) $2N_2\ (g) + 6H_2\ (g) \rightleftharpoons 4NH_3\ (g)$ | (p) $K_c^{\frac{1}{2}}$ |
| (B) $2NH_3\ (g) \rightleftharpoons N_2(g) + 3H_2(g)$ | (q) $\frac{1}{K_c}$ |
| (C) $\frac{1}{2} N_2(g) + \frac{3}{2} H_2(g) \rightleftharpoons NH_3\ (g)$ | (r) $K_c^2$ |

**44.** **Assertion :** A net reaction can occur only if a system is not at equilibrium.

**Reason :** All reversible reactions occur to reach a state of equilibrium.

(1*) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**45.** **Assertion :** For the reaction, $N_2 + O_2 \rightleftharpoons 2NO$, increase in pressure at equilibrium has no effect on the reaction.

**Reason :** $\Sigma$ moles of gaseous product – $\Sigma$ moles of gaseous reactant = 0.

(1*) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**46.** **Assertion :** The reaction quotient , Q has the same form as the equilibrium constant $K_{eq}$, and is evaluated using any given concentrations of the species involved in the reaction, and not necessarily equilibrium concentrations.

**Reason :** If the numerical value of Q is not the same as the value of equilibrium constant, a reaction will occur.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2*) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**47.** **Assertion :** A catalyst does not influences the values of equilibrium constant.

**Reason :** Catalysts influence the rate of both forward and backward reactions equally.

(1*) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

# Exercise-3

## PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

## OFFLINE JEE-MAIN

**1.** Change in volume of the system does not alter the number of moles in which of the following equilibriums : **[AIEEE 2002, 3/225]**

(1*) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ (2) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

(3) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ (4) $SO_2Cl_2(g) \rightleftharpoons SO_2(g) + Cl_2(g)$

**2.** In which of the following reactions, increase in the volume at constant temperature don't effect the number of moles of at equilibrium : **[AIEEE 2002, 3/225]**

(1) $2NH_3 \rightleftharpoons N_2 + 3H_2$ (2) $C(g) + (1/2)\ O_2(g) \rightleftharpoons CO\ (g)$

(3) $H_2\ (g) + O_2\ (g) \rightleftharpoons H_2O_2\ (g)$ (4*) none of these. buesa dksbZ ugha

**3.** For the reaction $CO\ (g) + (1/2)\ O_2\ (g) \rightleftharpoons CO_2\ (g)$, $K_c/K_p$ is : **[AIEEE 2002, 3/225]**

(1) RT (2) $(RT)^{-1}$ (3) $(RT)^{-1/2}$ (4*) $(RT)^{1/2}$

**4.** Consider the reaction equilibrium

$$2SO_2\ (g) + O_2\ (g) \rightleftharpoons 2SO_3\ (g)\ ;\ \Delta H^\circ = -\ 198\ kJ.$$

On the basis of Le Chatelier's principle, the condition favourable for the forward reaction is : **[AIEEE 2003, 3/225]**

(1) lowering of temperature as well as pressure

(2) increasing temperature as well as pressure

(3*) lowering the temperature and increasing the pressure

(4) any value of temperature and pressure.

**5.** For the reaction equilibrium, $N_2O_4\ (g) \rightleftharpoons 2NO_2\ (g)$ the concentrations of $N_2O_4$ and $NO_2$ at equilibrium are $4.8 \times 10^{-2}$ and $1.2 \times 10^{-2}$ mol $L^{-1}$ respectively. The value of $K_c$ for the reaction is **[AIEEE 2003, 3/225]**

(1) $3.3 \times 10^2$ mol $L^{-1}$ (2) $3 \times 10^{-1}$ mol $L^{-1}$ (3*) $3 \times 10^{-3}$ mol $L^{-1}$ (4) $3 \times 10^3$ mol $L^{-1}$

**6.** What is the equilibrium constant expression for the reaction : **[AIEEE 2004, 3/225]**

$$P_4\ (s) + 5O_2\ (g) \rightleftharpoons P_4O_{10}\ (s)\ ?$$

(1) $K_C = [P_4O_{10}]/[P_4]\ [O_2]^5$ (2*) $K_C = 1/[O_2]^5$

(3) $K_C = [O_2]^5$ (4) $K_C = [P_4O_{10}]\ /\ 5[P_4]\ [O_2]$

**7.** For the reaction, $CO(g) + Cl_2\ (g) \rightleftharpoons COCl_2\ (g)$ then $K_p\ /\ K_c$ is equal to : **[AIEEE 2004, 3/225]**

(1*) 1/RT (2) 1.0 (3) $\sqrt{RT}$ (4) RT

**8.** The equilibrium constant for the reaction, $N_2\ (g) + O_2\ (g) \rightleftharpoons 2NO(g)$ at temperature T is $4 \times 10^{-4}$. The value of $K_c$ for the reaction, $NO(g) \rightleftharpoons \frac{1}{2}\ N_2\ (g) + \frac{1}{2}\ O_2\ (g)$ at the same temperature is: **[AIEEE 2004, 3/225]**

(1) $2.5 \times 10^2$ (2) 0.02 (3) $4 \times 10^{-4}$ (4*) 50

**9.** For the reaction, $2NO_2\ (g) \rightleftharpoons 2\ NO(g) + O_2\ (g)$,

($K_C = 1.8 \times 10^{-6}$ at 184°C)
($R = 0.0831$ kJ/(mol.K))
When $K_p$ and $K_c$ are compared at 184°C it is found that : **[AIEEE 2005, 3/225]**
(1) Whether $K_p$ is greater than, less than or equal to $K_c$ depends upon the total gas pressure
(2) $K_p = K_c$
(3) $K_p$ is less than $K_c$
(4*) $K_p$ is greater than $K_c$

**10.** The exothermic formation of $ClF_3$ is represented by the equation $Cl_2(g) + 3F_2(g) \rightleftharpoons 2ClF_3(g)$; $\Delta_rH = -329$ J. which of the following will increase the quantity of $ClF_3$ in an equilibrium mixture of $Cl_2$, $F_2$ and $ClF_3$. **[AIEEE 2005, 3/225]**
(1*) Adding $F_2$
(2) Increasing the volume of container
(3) Removing $Cl_2$
(4) Increasing the temperature

**11.** An amount of solid $NH_4HS$ is placed in a flask already containing ammonia gas at a certain temperature at 0.50 atm pressure. Ammonium hydrogen sulphide decomposes to yield $NH_3$ and $H_2S$ gases in the flask. When the decomposition reaction reaches equilibrium, the total pressure in the flask rises to 0.84 atm? The equilibrium constant for $NH_4HS$ decomposition at this temperature is : **[AIEEE 2005, 4½/225]**
(1*) 0.11
(2) 0.17
(3) 0.18
(4) 0.30

**12.** Phosphorus pentachloride dissociates as follows in a closed reaction vessel.

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

If total pressure at equilibrium of the reaction mixture is P and degree of dissociation of $PCl_5$ is x, the partial pressure of $PCl_3$ will be : **[AIEEE 2006, 3/165]**
(1*) $\left(\frac{x}{x+1}\right)P$
(2) $\left(\frac{2x}{1-x}\right)P$
(3) $\left(\frac{x}{x+1}\right)P$
(4) $\left(\frac{x}{1-x}\right)P$

**13.** The equilibrium constant for the reaction, $SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$ is $K_C = 4.9 \times 10^{-2}$. The value of $K_C$ for the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ will be : **[AIEEE 2006, 3/165]**
(1*) 416
(2) $2.40 \times 10^{-3}$
(3) $9.8 \times 10^{-2}$
(4) $4.9 \times 10^{-2}$

**14.** For the following three reactions a, b and c, equilibrium constants are given:
(a) $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$; $K_1$
(b) $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$; $K_2$
(c) $CH_4(g) + 2H_2O(g) \rightleftharpoons CO_2(g) + 4H_2(g)$; $K_3$
(1) $K_2 K_3 = K_1$
(2*) $K_3 = K_1K_2$
(3) $K_3 K_2^3 = K_1^2$
(4) $K_1\sqrt{K_2} = K_3$

**15.** The equilibrium constants $K_{p_1}$ and $K_{p_2}$ for the reactions $X \rightleftharpoons 2Y$ and $Z \rightleftharpoons P + Q$, respectively are in the ratio of 1 : 9. If the degree of dissociation of X and Z be equal then the ratio of total pressures at
(1) 1 : 1
(2) 1 : 3
(3) 1 : 9
(4*) 1 : 36

**16.** A vessel at 1000 K contains $CO_2$ with a pressure of 0.5 atm. Some of the $CO_2$ is converted into CO on the addition of graphite. If the total pressure at equilibrium is 0.8 atm, the value of K is : **[AIEEE 2011, 4/120]**

(1*) 1.8 atm (2) 3 atm (3) 0.3 atm (4) 0.18

**17.** The equilibrium constant ($K_c$) for the reaction $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ at temperature T is $4 \times 10^{-4}$. The value of $K_c$ for the reaction $NO(g) \rightleftharpoons \frac{1}{2} N_2(g) + \frac{1}{2} O_2(g)$ at the same temperature is :

(1) 0.02 (2) $2.5 \times 10^2$ (3) $4 \times 10^{-4}$ (4*) 50.0

**18.** For the reaction $SO_{2(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons SO_{3(g)}$, if $K_P = K_C(RT)^x$ where the symbols have usual meaning then the value of x is : (assuming ideality) **[JEE(Main) 2014, 4/120]**

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

**19.** The standard Gibbs energy change at 300 K for the reaction $2A \rightleftharpoons B + C$ is 2494.2 J. At a given time, the composition of the reaction mixture is $[A] = \frac{1}{2}$, $[B] = 2$ and $[C] = \frac{1}{2}$. The reaction proceeds in the : [R = 8.314 J/K/mol, e = 2.718] **[JEE(Main) 2015, 4/120]**

(1) forward direction because $Q > K_C$ (2*) reverse direction because $Q > K_C$

(3) forward direction because $Q < K_C$ (4) reverse direction because $Q < K_C$

**20.** The equilibrium constant at 298 K for a reaction $A + B \rightleftharpoons C + D$ is 100. If the initial concentration of all the four species were 1 M each, then equilibrium concentration of D (in mol $L^{-1}$) will be :

**[JEE(Main) 2016, 4/120]**

(1) 0.818 (2*) 1.818 (3) 1.182 (4) 0.182

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## ONLINE JEE-MAIN

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**1.** At a certain temperature, only 50% HI is dissociated into $H_2$ and $I_2$ at equilibrium. The equilibrium constant is: **[JEE(Main) 2014 Online (09-04-14), 4/120]**

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

**2.** Consider the following equilibrium $AgCl\downarrow + 2NH_3 \rightleftharpoons [Ag(NH_3)_2]^+ + Cl^-$. White precipitate of AgCl appears on adding which of the following ? **[JEE(Main) 2014 Online (11-04-14), 4/120]**

(1) $NH_3$ (2) aqueous NaCl (3*) aqueous $HNO_3$ (4) aqueous $NH_4Cl$

**3.** What happens when an inert gas is added to an equilibrium keeping volume unchanged ?

**[JEE(Main) 2014 Online (12-04-14), 4/120]**

(1) More product will form (2) Less product will form

(3) More reactant will form (4*) Equilibrium will remain unchanged

**4.** For the decomposition of the compound, represented as $NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$ the $K_p = 2.9 \times 10^{-5}$ atm$^3$. If the reaction is started with 1 mol of the compounds, the total pressure at equilibrium would be : **[JEE(Main) 2014 Online (19-04-14), 4/120]**

(1) $1.94 \times 10^{-2}$ atm (2*) $5.82 \times 10^{-2}$ atm (3) $7.66 \times 10^{-2}$ atm (4) $38.8 \times 10^{-2}$ atm

**5.** Gaseous $N_2O_4$ dissociates into gaseous $NO_2$ according to the reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ at 300 K and 1 atm pressure, the degree of dissociation of $N_2O_4$ is 0.2. If one mole of $N_2O_4$ gas is contained in a vessel, then the density of the equilibrium mixture is : **[JEE(Main) 2015 Online (10-04-15), 4/120]**

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

**6.** The increase of pressure on ice $\rightleftharpoons$ water system at constant temperature will lead to : **[JEE(Main) 2015 Online (11-04-15), 4/120]**

(1) a decrease in the entropy of the system (2) an increase in the Gibbs energy of the system

(3) no effect on the equilibrium (4*) a shift of the equilibrium in the forward direction

**7.** A solid XY kept in an evacuated sealed container undergoes decomposition to form a mixture of gases X and Y at temperature T. The equilibrium pressure is 10 bar in this vessel. $K_P$ for this reaction is : **[JEE(Main) 2016 Online (10-04-16), 4/120]**

(1*) 25 (2) 5 (3) 10 (4) 100

**8.** The following reaction occurs in the Blast Furnace where iron ore is reduced to iron metal :

$Fe_2O_3(s) + 3CO(g) \rightleftharpoons 2Fe(\ell) + 3CO_2(g)$

Using the Le Chatelier's principle, predict which one of the following will **not** disturb the equilibrium ? **[JEE(Main) 2017 Online (09-04-17), 4/120]**

(1*) Addition of $Fe_2O_3$ (2) Removal of $CO_2$ (3) Removal of CO (4) Addition of $CO_2$

## PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

*** Marked Questions may have more than one correct option.**

**1.** 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 **[JEE-1998]**

(A) Adding a suitable catalyst (B) Adding an inert gas

(C) Decreasing the volume of the container (D*) Increasing the amount CO(g)

**2.** For a chemical reaction $3X(g) + Y(g) \rightleftharpoons X_3Y(g)$, the amount of $X_3Y$ at equilibrium is affected by

(A*) temperature and pressure (B) temperature only

(C) pressure only (D) temperature, pressure and catalyst **[JEE-1999, 2/80]**

**3.** For the reversible reaction, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3$ at 500°C, the value of $K_P$ is $1.44 \times 10^{-5}$ when partial pressure is measured in atmospheres. The corresponding value of $K_C$, with concentration in mole litre$^{-1}$, is

**4.** When two reactants, A & B are mixed to give products C & D, the reaction quotient Q, at the initial stages of the reaction. **[JEE-2000, 1/35]**

(A) is zero (B) decrease with time

(C) is independent of time (D*) increases with time

**5.** At constant temperature, the equilibrium constant ($K_P$) for the decomposition reaction $N_2O_4 \rightleftharpoons 2NO_2$ is expressed by $K_P = \frac{(4x^2\ \ P)}{(1-x^2)}$, where P = pressure, x = extent of decomposition. Which one of the following statements is true? **[JEE 2001, 1/35]**

(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 and x

**6.** Consider the following equilibrium in a closed container **[JEE 2002, 3/90]**

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

At a fixed temperature, the volume of the reaction container is halved. For this change, which of the following statements holds true regarding the equilibrium constant ($K_P$) and degree of dissociation (α)?

(A) neither $K_P$ nor α changes
(B) both $K_P$ and α change
(C) $K_P$ changes, but α does not change
(D*) $K_P$ does not change but α changes

**7.** The value of $\log_{10}K$ for a reaction $A \rightleftharpoons B$ is :

(Given : $\Delta_r H^\circ_{298K} = -54.07$ kJ mol$^{-1}$, $\Delta_r S^\circ_{298K} = 10$ JK$^{-1}$ mol$^{-1}$ and R = 8.314 JK$^{-1}$ mol$^{-1}$; 2.303 x 8.314 x 298 = 5705) **[JEE 2007, 3/162]**

(A) 5 (B*) 10 (C) 95 (D) 100

## Sheet Repeat Question

**F-8.** The correct relationship between free energy change in a reaction and the corresponding equilibrium constant K is **(Repeated with F-1)** **[Correction by AGA_25.9.17]**

(1*) $-\Delta G^o = RT \ln K$ (2) $\Delta G = RT \ln K$ (3) $-\Delta G = RT \ln K$ (4) $\Delta G^o = RT \ln K$

**F-9.** The effect of temperature on equilibrium constant is expressed as ($T_2 > T_1$)

$\log K_2 / K_1 = \frac{-\Delta H}{2.303}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$. For endothermic reaction false statement is

(1*) $\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$ = positive
(2) ΔH = positive
(3) $\log K_2 > \log K_1$
(4) $K_2 > K_1$

## Additional Problems For Self Practice (APSP)

# PART - I : PRACTICE TEST PAPER

***This Section is not meant for classroom discussion. It is being given to promote self-study and self testing amongst the Resonance students.***

**Max. Marks : 120** **Max. Time : 1 Hr.**

### Important Instructions

**1.** The test is of **1 hour** duration.

**2.** The Test Booklet consists of **30** questions. The maximum marks are **120.**

**3.** Each question is allotted **4 (four)** marks for correct response.

**4.** Candidates will be awarded marks as stated above in Instructions No. 3 for correct response of each question.

**¼ (one fourth)** marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.

**5.** There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 4 above.

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**1.** 1 mole of $N_2$ and 2 moles of $H_2$ are allowed to react in a 1 $dm^3$ vessel. At equilibrium, 0.8 mole of $NH_3$ is formed. The concentration of $H_2$ in the vessel is :

(1) 0.6 mole (2*) 0.8 mole (3) 0.2 mole (4) 0.4 mole

**2.** For the following mechanism , $P + Q \underset{K_B}{\overset{K_A}{\rightleftharpoons}} PQ \underset{K_D}{\overset{K_C}{\rightleftharpoons}} R$ at equilibrium $\dfrac{[R]}{[P]\ [Q]}$ is :

[ k represents rate constant ]

(1) $\dfrac{K_A \cdot K_B}{K_C \cdot K_D}$ (2) $\dfrac{K_A \cdot K_D}{K_B \cdot K_C}$ (3) $\dfrac{K_B \cdot K_D}{K_A \cdot K_C}$ (4*) $\dfrac{K_A \cdot K_C}{K_B \cdot K_D}$

**3.** Select the reaction for which the equilibrium constant is written as $[MX_3]^2 = K_{eq.} [MX_2]^2 [X_2]$

(1) $MX_3 \rightleftharpoons MX_2 + \frac{1}{2} X_2$ (2) $2MX_3 \rightleftharpoons 2MX_2 + X_2$

(3*) $2MX_2 + X_2 \rightleftharpoons 2MX_3$ (4) $MX_2 + \frac{1}{2} X_2 \rightleftharpoons MX_3$.

**4.** What should be the value of $K_C$ for the reaction $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$. If the amount are $SO_3$ = 48g, $SO_2$ = 12.8 g and $O_2$ = 9.6 g at equilibrium and the volume of the container is one litre ?

(1) 64 (2*) 0.30 (3) 42 (4) 8.5

**5.** If 0.5 mole $H_2$ is reacted with 0.5 mole $I_2$ in a ten-litre container at 444°C and at same temperature value of equilibrium constant $K_C$ is 49, the ratio of [HI] and $[I_2]$ will be :

(1*) 7 (2) $\frac{1}{7}$ (3) $\sqrt{\frac{1}{7}}$ (4) 49

**6.** 4.5 moles each of hydrogen and iodine heated in a sealed ten litre vessel. At equilibrium 3 moles of HI were found. The equilibrium constant for $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ is :

(1*) 1 (2) 10 (3) 5 (4) 0.33

**7.** In a 20 litre vessel initially each have 1 mole CO, $H_2O$ $CO_2$ is present, then for the equilibrium of $CO + H_2O \rightleftharpoons CO_2 + H_2$ following is true :

(1) $H_2$, more then 1 mole (2*) CO, $H_2O$, $H_2$ less then 1 mole

(3) $CO_2$ & $H_2O$ both more than 1 mole (4) All of these

**8.** At 1000 K, the value of $K_p$ for the reaction $A(g) + 2B(g) \rightleftharpoons 3C(g) + D(g)$ is 0.05 atmosphere. The value of $K_C$ in terms of R would be :

(1) 20000 R (2) 0.02 R (3) $5 \times 10^{-5}$ R (4*) $5 \times 10^{-5} \times R^{-1}$

**9.^** In which of the following reactions is $K_p < K_c$ ?

(1*) $CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$ (2) $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$

(3) $2BrCl(g) \rightleftharpoons Cl_2(g) + Br_2(g)$ (4) $I_2(g) \rightleftharpoons 2I(g)$

**10.** K for the synthesis of HI is 50. K for dissociation of HI is : **[Roorkee 1990]**

(1) 50 (2) 5 (3) 0.2 (4*) 0.02

**11.** 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 **[MP PET 1996]**

(1) 16 (2) 32 (3*) 64 (4) 128

**12.** In equilibrium $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$. The equilibrium constant may change when

(1) $CH_3COO^-$ is added (2) $CH_3COOH$ is added

(3) Catalyst is added (4*) Mixture is heated

**13.** $CH_3COOH(l) + C_2H_5OH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$ In the above reaction, one mole of each of acetic acid and alcohol are heated in the presence of little conc. $H_2SO_4$. On equilibrium being attained **[CPMT 1985; MP PET 1992]**

(1) 1 mole of ethyl acetate is formed (2) 2 mole of ethyl acetate are formed

(3) 1/2 moles of ethyl acetate is formed (4*) 2/3 moles of ethyl acetate is formed

**14.** In the following reaction started only with $A_8$, $2A_8(g) \rightleftharpoons 2A_3(g) + 3A_2(g) + A_4(g)$ mole fraction of $A_2$ is found to 0.36 at a total pressure of 100 atm at equilibrium. The mole fraction of $A_8(g)$ at equilibrium is :

(1*) 0.28 (2) 0.72 (3) 0.18 (4) None of these

**15.** In a 0.25 litre tube dissociation of 4 moles of NO is take place. If its degree of dissociation is 10%. The value of $K_p$ for reaction $2NO \rightleftharpoons N_2 + O_2$ is :

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

**16.** For the given reaction at constant pressure ,

| | $nA(g)$ $\rightleftharpoons$ | $A_n(g)$ |
|---|---|---|
| **Initial moles** | 1 | 0 |
| **Moles at equilibrium** | $1-\alpha$ | $\alpha/n$ |

Then the correct relation between initial density ($d_i$) & final density ($d_f$) of the system is

(1) $\left[\frac{n-1}{n}\right]\left[\frac{d_f-d_i}{d_f}\right]=\alpha$ (2*) $\frac{n}{n-1}\frac{[d_f-d_i]}{d_f}=\alpha$

(3) $\left[\frac{n-1}{n}\right]\left[\frac{d_i-d_f}{d_i}\right]=\alpha$ (4) $\frac{1}{(n-1)}\left[\frac{d_i-d_f}{d_i}\right]=\alpha$

**17.** On decomposition of $NH_4HS$, the following equilibrium is established :

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

If the total pressure is P atm, then the equilibrium constant $K_P$ is equal to

(1) P atm (2) $P^2$ atm$^2$ (3*) $P^2 / 4$ atm$^2$ (4) 2P atm

**18.** At room temperature, the equilibrium constant for the reaction $P + Q \rightleftharpoons R + S$ was calculated to be 4.32. At 425°C the equilibrium constant became $1.24 \times 10^{-2}$. This indicates that the reaction

(1*) is exothermic (2) is endothermic

(3) is difficult to predict (4) no relation between $\Delta H$ and K

**19.** Calculate $\Delta G°$ for conversion of oxygen to ozone $3/2\ O_2(g) \longrightarrow O_3(g)$ at 298 *K,* if $K_p$ for this conversion is $2.47 \times 10^{-29}$ **[DPMT 2004]**

(1*) 163 kJ mol$^{-1}$ (2) $2.4 \times 10^2$ kJ mol$^{-1}$ (3) 1.63 kJ mol$^{-1}$ (4) $2.38 \times 10^6$ kJ mol$^{-1}$

**20.** For the reaction, $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(\ell)$ , $\Delta H$ = positive .

At equilibrium which factor will not effect the concentration of $NH_3$ is :

(1) change in pressure (2) change in volume (3*) catalyst (4) None of these

**21.** The effect of adding krypton (Kr) gas on position of equilibrium, keeping the volume of the system constant is

(1) If $\Delta n = 0$, backward reaction is favoured. (2) If, $\Delta n$ = +ve, forward reaction is favoured

(3) If $\Delta n$ = –ve, forward reaction is favoured (4*) No effect watever be the value of $\Delta n$

**22.** Le-Chatelier's principle is applicable only to a **[USS]**

(1*) System in equilibrium (2) Irreversible reaction

(3) Homogeneous reaction (4) Heterogeneous reaction

**23.** Two solid compounds X and Y dissociates at a certain temperature as follows

$X(s) \rightleftharpoons A(g) + 2B(g)$ ; $K_{p1} = 9 \times 10^{-3}$ atm$^3$

$Y(s) \rightleftharpoons 2B(g) + C(g)$ ; $K_{p2} = 4.5 \times 10^{-3}$ atm$^3$

The total pressure of gases over a mixture of X and Y is :

(1) 4.5 atm (2*) 0.45 atm (3) 0.6 atm (4) None of these

**24.** The value of $\Delta G^o$ for the phosphorylation of glucose in glycolysis is 15 kJ/mole. Find the value of $K_c$ at 300 K.

(1) $e^6$ (2*) $10^{-\frac{6}{2.303}}$ (3) $\frac{1}{e^{-6}}$ (4) $10^{\frac{2.303}{6}}$

**25.** Which of the following statements is correct for a reversible process in a state of equilibrium ?

(1) $\Delta G = 2.30\ RT \log K$ (2*) $\Delta G° = –2.30\ RT \log K$

(3) $\Delta G° = 2.30\ RT \log K$ (4) $\Delta G = –2.30\ RT \log K$

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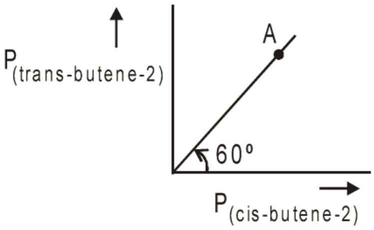
(1) $\Delta G = 2.30\ RT \log K$ (2*) $\Delta G° = –2.30\ RT \log K$

(3) $\Delta G° = 2.30\ RT \log K$ (4) $\Delta G = –2.30\ RT \log K$

**26.** For the following isomerisation reaction **(SID Sir) (CEQ–RQ) (MCQ) (M)**

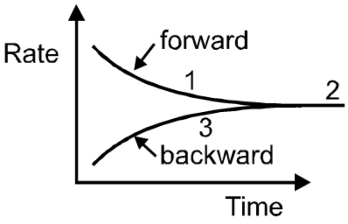
cis-butene-2 $\rightleftharpoons$ trans-butene-2 $K_P = 1.732$



Which of the following statement is true at point 'A' ?

(1) $Q > K_P$ (2) $Q < K_P$ (3) $Q = K = 1$ (4*) $Q = K = 1.732$

**27.** In the reaction $PCl_5(g)$ $PCl_3(g) + Cl_2(g)$ a graph in plotted to show the variation of rate of forward and backward reactions against time. Which of the following is correct ? **(SID Sir) (CEQ–RQ) (MCQ) (M)**



| | Q > K | Q = K | Q < K |
|---|---|---|---|
| (1*) | 3 | 2 | 1 |
| (2) | 1 | 2 | 3 |
| (3) | 2 | 3 | 1 |
| (4) | 2 | 1 | 3 |

**28.** For the reaction : $PCl_5\,(g) \rightleftharpoons PCl_3\,(g) + Cl_2\,(g)$.
The backward reaction at constant temperature is favoured by

(1*) introducing chlorine gas at constant volume (2) introducing an inert gas at constant pressure

(3) increasing the volume of the container (4) introducing $PCl_5$ at constant volume

**29.** Find out $\ln K_{eq}$ for the formation of $NO_2$ from NO and $O_2$ at 298 K :

$$NO_{(g)} + \frac{1}{2}O_2 \rightleftharpoons NO_2\ g$$

Given : $\Delta G_f^\circ$ ($NO_2$) = 52.0 KJ/mole

$\Delta G_f^\circ$ (NO) = 87.0 KJ/mole

$\Delta G_f^\circ$ ($O_2$) = 0 KJ/mole

(1*) $\frac{35\times10^3}{8.314\times298}$ (2) $-\frac{35\times10^3}{8.314\times298}$ (3) $\frac{35\times10^3}{2.303\times8.314\times298}$ (4) $\frac{35\times10^3}{2\times298}$

**30.** If a reaction vessel at 400ºC is charged with equimolar mixture of CO and steam such that $P_{CO}$ = $P_{H_2O}$ = 4 bar what will be that partial pressure of $H_2$ at equilibrium

$CO_{if} + H_2O \rightleftharpoons CO_2 + H_2$ $K_P = 9$

(1*) 0.3 bar (2) 0.4 bar (3) 0.2 bar (4) 0.1 bar

## Practice Test (JEE-Main Pattern)

### OBJECTIVE RESPONSE SHEET (ORS)

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

# PART - II : PRACTICE QUESTIONS

**1.** The value of $K_p$ for the reaction, $2H_2O(g) + 2Cl_2(g) \rightleftharpoons 4HCl(g) + O_2(g)$ is 0.03 atm at 427° C, when the partial pressure are expressed in atmosphere then the value of $K_C$ for the same reaction is

(1*) $5.23 \times 10^{-4}$ (2) $7.34 \times 10^{-4}$ (3) $3.2 \times 10^{-3}$ (4) $5.43 \times 10^{-5}$

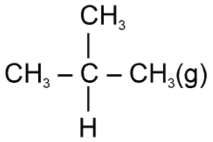
**2.** The equilibrium $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ estabilished in a reaction vessel of 2.5 L capacity. The amounts of $N_2$ and $O_2$ taken at the start were respectively 2 moles and 4 moles. Half a mole of nitrogen has been used up at equilibrium. The molar concentration of nitric oxide is

(1) 0.2 (2*) 0.4 (3) 0.6 (4) 0.1

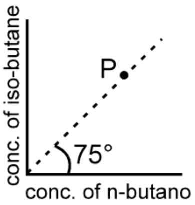
**3.** $N_2$ and $H_2$ are taken in 1 : 3 molar ratio in a closed vessel to attained the following equilibrium

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ . Find $K_p$ for reaction at total pressure of 2p if $P_{N_2}$ at equilibrium is $\frac{P}{3}$ .

(1) $\frac{1}{3\ P^2}$ (2*) $\frac{4}{3\ P^2}$ (3) $\frac{4\ P^2}{3}$ (4) none

**4.** For the equilibium $CH_3–CH_2–CH_2–CH_3(g) \rightleftharpoons$ 
$CH_3-\underset{\substack{|\\H}}{\overset{\substack{CH_3\\|}}{C}}-CH_3(g)$

equilibrium constant is found to be 1.732 at 298 K. Now if in a vessel at 298 K, a mixture of these two gases be taken as represented by the point P in the figure, predict what will happen.



(1) Immediately, above equilibrium will be setup

(2) Above reaction will go in the forward direction till it attains equilibrium

(3*) Above reaction will go in the backward direction till it attains equilibrium

(4) Nothing can be said

**6.** For the reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

$K_c$ = 66.9 at 350°C and $K_c$ = 50.0 at 448°C. The reaction has

(1) $\Delta H$ = + ve (2*) $\Delta H$ = – ve

(3) $\Delta H$ = zero (4) $\Delta H$ sign can not be determined

**7.** An equilibrium mixture in a vessel of capacity 100 litre contain 1 mol $N_2$, 2 mol $O_2$ and 3 mol NO. Number of moles of $O_2$ to be added so that at new equilibrium the conc. of NO is found to be 0.04 mol/lit.:

(1*) (101/18) (2) (101/9) (3) (202/9) (4) None of these

**8.** $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ in the reversible reaction the moles of $PCl_5$, $PCl_3$ and $Cl_2$ are a, b and c respectively and total pressure is P then value of $K_p$ is : **[RPMT 1999]**

(1) $\frac{bc}{a}.RT$ (2) $\frac{b}{(a+b+c)}.P$ (3*) $\frac{bc.P}{a\ (a+b+c)}$ (4) $\frac{c}{(a+b+c)}.P$

**9.** For the chemical reaction $3X(g) + Y(g) \rightleftharpoons X_3Y(g)$, the amount of $X_3Y$ at equilibrium is affected by :
(1*) temperature and pressure (2) temperature only
(3) pressure only (4) temperature, pressure and catalyst

**10.** For hypothetical equilibrium, $4A + 5B \rightleftharpoons 4X + 6Y$. The unit of $K_C$ will be : **[RPMT 2000]**
(1) litre $\text{mole}^{-1}$ (2*) mole $\text{litre}^{-1}$ (3) litre $\text{mole}^{-2}$ (4) $\text{mole}^{2}$ $\text{litre}^{-2}$

**11.** 9.2 gram of $N_2O_4$ (g) is taken in a closed one litre vessel and heated till the following equilibrium is reached

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

At equilibrium 50% $N_2O_4$ (g) is dissociated. What is the equilibrium constant (in mol $\text{lit}^{-1}$) molecular weight of $N_2O_4$ = 92) **[EAMCET 2001, RPMT 2008]**
(1) 0.1 (2*) 0.2 (3) 0.4 (4) 2

**12.** **$S_1$ :** When a liquid and its vapour are at equilibrium and the pressure is suddenly decreased, cooling occurs.

**$S_2$ :** If equilibrium constant for the reaction, $A_2 + B_2 \rightleftharpoons 2AB$, is K, then for the backward reaction $AB \rightleftharpoons \frac{1}{2}A_2 + \frac{1}{2}B_2$, the equilibrium constant is $\frac{1}{K}$.

**$S_3$ :** Catalyst makes a reaction more exothermic.
(1*) T F F (2) F T F (3) T T F (4) F T T

**13.** **$S_1$ :** The rate of an exothermic reaction increases with increasing temperature.

**$S_2$ :** For the reaction, $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$, $K_p = P_{CO2}$.

**$S_3$ :** A catalyst increases the value of the equilibrium constant for a reaction.
(1) T F F (2*) F T F (3) T T F (4) F T T

**14.** The role of catalyst in a chemical reaction is :
(1) To help attain equilibrium in a shorter time.
(2) To lower the activation energy.
(3) To shift the equilibrium in such a way as to increase the concentration of the product
(4*) Both 1 & 2

**15.** A quantity of $PCl_5$ was heated in a 10 $dm^3$ vessel at 250°C : $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$. At Equilibrium, the vessel contains 0.1 mole of $PCl_5$ and 0.2 mole of $Cl_2$. The equilibrium constant of the reaction is **[KCET 2001]**
(1*) 0.04 (2) 0.025 (3) 0.02 (4) 0.05

**16.** The rate of forward reaction is two times that of the reverse reaction at a given temperature and identical concentration. $K_{\text{equilibrium}}$ is **[KCET 2002]**
(1) 0.5 (2) 1.5 (3) 2.5 (4*) 2.0

**17.** $K_c$ = 9 for the reaction, $A + B \rightleftharpoons C + D$, If A and B are taken in equal amounts, then amount of C in equilibrium is : **[RPMT 2004]**

(1) 1 (2) 0.25 (3*) 0.75 (4) None of these

**18.** $N_2 + O_2 \rightleftharpoons 2NO$. For this reaction $K_p = 100$, then $K_p$ for reaction, $2NO \rightleftharpoons N_2 + O_2$ will be : **[RPMT 2004]**

(1*) 0.01 (2) ) 0.1 (3) 10 (4) 100

**19.** For which reaction at 298 K, the value of $\frac{K_p}{K_c}$ is maximum and minimum respectively :

(a) $N_2O_4 \rightleftharpoons 2NO_2$ (b) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

(c) $X + Y \rightleftharpoons 4Z$ (d) $A + 3B \rightleftharpoons 7C$

(1) d,c (2*) d,b (3) c,b (4) d,a

**20.** In a reversible reaction if the concentration of reactants and products are doubled, the value of $K_C$ will be :

(1) half of the initial value (2*) double of initial value

(3) one fourth of the initial value (4) same the initial value

**21.** $2A + 2B \rightleftharpoons 2C + 2D$

For the above equation, the correct relationship is : **[RPMT 1999]**

(1) $K_p = K_C\,(RT)^{-2}$ (2*) $K_p = K_C$ (3) $K_p = \frac{K_C}{2}$ (4) $K_p = K_C\,(RT)^{-1}$

**22.** For the reaction $H_2(g) + I_2\,(g) \rightleftharpoons 2HI(g)$, the equilibrium constant $K_p$ change with **[DCE 1999]**

(1*) temperature (2) total pressure (3) catalyst (4) amount of $H_2$ and $I_2$

**23.** The equilibrium constants for equilibria : **[RPMT 2000]**

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

are $K_1$ and $K_2$ are respectively, then : **[RPMT 2000]**

(1*) $K_2 = K_1^2$ (2) $K_2 = \frac{1}{K_1^2}$ (3) $K_2 = K_1$ (4) $K_2 = \frac{1}{K_1}$

**24.** Add 0.01 M HCl in some amount in aqueous solution of acetic acid : **[RPMT 2001]**

(1) Equlibrium conc. decreases of $CH_3COOH$. (2) Equlibrium conc. decreases of $CH_3COO^-$.

(3*) Equlibrium conc. increases of $CH_3COO^-$. (4) No any change.

**25.** $H_2\,(g) + I_2\,(g) \rightleftharpoons 2HI\,(g)$

In this reaction when increase pressure the reaction direction is : **[RPMT 2002]**

(1*) does not change (2) forward (3) backward (4) decrease

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

**26.** Calculate the partial pressure of carbon monoxide from the following data **[Orissa JEE 2004]**

$CaCO_3(s) \xrightarrow{\Delta} CaO\,(s) + CO_2 \uparrow$, $K_p = 8 \times 10^{-2}$

$CO_2(g) + C(s) \rightarrow 2CO(g)$, $K_p = 2$

**27.** **$S_1$ :** In case of endothermic reactions, the equilibrium shifts in backward direaction on increasing the temperature.

**$S_2$ :** The value of K increases with increases in pressure.

**$S_3$ :** For the reaction, $H_2 + I_2 \rightleftharpoons 2HI$, the equilibrium constant, K is dimensionless.

(1) T F F (2) F T F (3) T T F (4*) F F T

**28.** Densities of diamond and graphite are 3.5 and 2.3 g/mL.

$$\text{C (diamond)} \rightleftharpoons \text{C (graphite)} \qquad \Delta_rH = -1.9 \text{ kJ/mole}$$

favourable conditions for formation of diamond are

(1) high pressure and low temperature (2) low pressure and high temperature

(3*) high pressure and high temperature (4) low pressure and low temperature