7. Chemical Equilibrium – Multiple Choice Questions

1. Reversible and Irreversible Reaction

1. Which of the following is a characteristic of a reversible reaction

(a) Number of moles of reactants and products are equal

(b) It can be influenced by a catalyst

(c) It can never proceed to completion

(d) None of the above

2. Which of the following reactions is reversible

(a) $H_2 + I_2 \longrightarrow 2HI$

(b) $H_2SO_4 + Ba(OH)_2 \longrightarrow BaSO_4 + 2H_2O$

(c) $NaCl + AgNO_3 \longrightarrow NaNO_3 + AgCl$

(d) $Fe + S \longrightarrow FeS$

3. Which of the following is reversible process

(a) Melting of ice at $10^\circ C$

(b) Mixing of two gases by diffusion

(c) Evaporation of water at $100^\circ C$ and 1 atm pressure

(d) None of the above

4. Amongst the following chemical reactions the irreversible reaction is

(a) $H_2 + I_2 \rightleftharpoons HI$

(b) $AgNO_3 + NaCl \rightleftharpoons AgCl + NaNO_3$

(c) $CaCO_3 \rightleftharpoons CaO + CO_2$

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

5. Which of the following is irreversible reaction

(a) $2NH_3 \rightarrow N_2 + 3H_2$ (b) $PCl_5 \rightarrow PCl_3 + Cl_2$

(c) $KClO_3 \rightarrow KCl + O_2$ (d) $SO_3 \rightarrow SO_2 + O_2$

2. Equilibrium State

1. In the given reaction $N_2 + O_2 \rightleftharpoons 2NO$, equilibrium means that

(a) Concentration of reactants is changing whereas concentration of products is constant

(b) Concentration of all substances is constant

(c) Concentration of reactants is constant whereas concentration of products is changing

(d) Concentration of all substances is changing

2. In any chemical reaction, equilibrium is supposed to be established when

(a) Mutual opposite reactions undergo

(b) Concentration of reactants and resulting products are equal

(c) Velocity of mutual reactions become equal

(d) The temperature of mutual opposite reactions become equal

3. For the synthesis of ammonia by the reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$ in the Haber process, the attainment of equilibrium is correctly predicted by the curve

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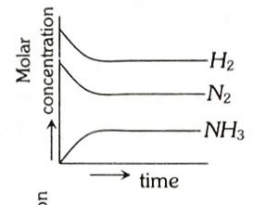

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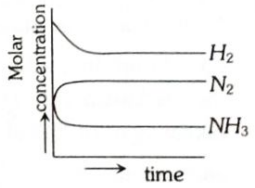

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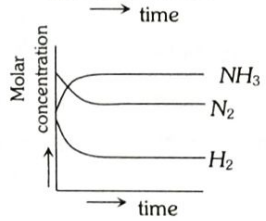

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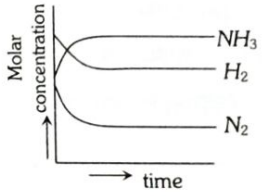


4. Which of the following is not a general characteristic of equilibria involving physical processes

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

(b) All measurable properties of the system remain constant

(c) All the physical processes stop at equilibrium

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

3. Law of Mass Action

1. According to law of mass action, rate of a chemical reaction is proportional to

(a) Concentration of reactants

(b) Molar concentration of reactants

(c) Concentration of products

(d) Molar concentration of products

2. The law of mass action was enunciated by

(a) Guldberg and Waage (b) Bodenstein

(c) Birthelot (d) Graham

3. Chemical equations convey quantitative information on the

(a) Type of atoms/molecules taking part in the reaction

(b) Number of atoms/molecules of the reactants and products involved in the reaction

(c) Relative number of moles of reactants and products involved in the reaction

(d) Quantity of reactant consumed and quantity of product formed

4. In the thermal decomposition of potassium chlorate given as $2KClO_3 \longrightarrow 2KCl + 3O_2$, law of mass action

(a) Cannot be applied

(b) Can be applied

(c) Can be applied at low temperature

(d) Can be applied at high temp. and pressure

5. Equimolar concentrations of H_2 and I_2 are heated to equilibrium in a 2 litre flask. At equilibrium, the forward and the backward rate constants are found to be equal. What percentage of initial concentration of H_2 has reacted at equilibrium

(a) 33% (b) 66%

(c) 50% (d) 40%

(e) 20%

4. Law of Equilibrium and Equilibrium Constant

1. 2 moles of PCl_5 were heated in a closed vessel of 2 litre capacity. At equilibrium, 40% of PCl_5 is dissociated into PCl_3 and Cl_2. The value of equilibrium constant is

(a) 0.266 (b) 0.53

(c) 2.66 (d) 5.3

2. 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) 1.0

(c) 3.0 (d) 0.50

3. 15 moles of H_2 and 5.2 moles of I_2 are mixed and allowed to attain equilibrium at $500°C$. At equilibrium, the concentration of HI is found to be 10 moles. The equilibrium constant for the formation of HI is

(a) 50 (b) 15

(c) 100 (d) 25

4. The equilibrium constant of a reaction is 300. If the volume of the reaction flask is tripled, the equilibrium constant will be

(a) 100 (b) 900

(c) 600 (d) 300

5. On doubling P and V with constant temperature the equilibrium constant will

(a) Remain constant (b) Become double

(c) Become one-fourth (d) None of these

6. Consider the reaction where $K_p = 0.497$ at 500 K.

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

If the three gases are mixed in a rigid container so that the partial pressure of each gas is initially 1 atm. Which is true

(a) More PCl_5 will be produced

(b) More PCl_3 will be produced

(c) Equilibrium will be established when 50% reaction is complete

(d) None of the above

7. K for the synthesis of HI is 50. K for dissociation of HI is

(a) 50 (b) 5

(c) 0.2 (d) 0.02

8. 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

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

10. In the thermal dissociation of PCl_5, the partial pressure in the gaseous equilibrium mixture is 1.0 atmosphere when half of PCl_5 is found to dissociate. The equilibrium constant of the reaction (K_p) in atmosphere is

(a) 0.25 (b) 0.50

(c) 1.00 (d) 0.3

11. PCl_5, PCl_3, and Cl_2 are at equilibrium at 500 K in a closed container and their concentrations are $0.8\times10^{-3} mol\,L^{-1}$, $1.2\times10^{-3} mol\,L^{-1}$ and $1.2\times10^{-3}\ mol\ L^{-1}$, respectively. The value of K_c for the reaction

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

(a) $1.8\times10^{3} mol\,L^{-1}$ (b) 1.8×10^{-3}

(c) $1.8\times10^{-3} mol^{1}L$ (d) 0.55×10^{4}

12. A reversible chemical reaction having two reactants in equilibrium. If the concentrations of the reactants are doubled, then the equilibrium constant will

(a) Also be doubled (b) Be halved

(c) Become one-fourth (d) Remain the same

13. A reaction is $A+B \rightleftharpoons C+D$. Initially we start with equal concentration of A and B. At equilibrium we find the moles of C is two times of A. What is the equilibrium constant of the reaction

(a) 4 (b) 2

(c) 1/4 (d) 1/2

14. A 1 M solution of glucose reaches dissociation equilibrium according to equation given below $6HCHO \rightleftharpoons C_6H_{12}O_6$. What is the concentration of $HCHO$ at equilibrium if equilibrium constant is 6×10^{22}

(a) $1.6\times10^{-8} M$ (b) $3.2\times10^{-6} M$

(c) $3.2\times10^{-4} M$ (d) $1.6\times10^{-4} M$

15. The reaction, $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ is carried out in a 1 dm^3 vessel and 2 dm^3 vessel separately. The ratio of the reaction velocities will be

(a) 1 : 8 (b) 1 : 4

(c) 4 : 1 (d) 8 : 1

16. Calculate the partial pressure of carbon monoxide from the following

$CaCO_{3(s)} \xrightarrow{\Delta} CaO_{(s)} + CO_2\uparrow;\ K_p = 8\times10^{-2}$

$CO_{2(g)} + C_{(s)} \rightarrow 2CO_{(g)}\ ;\ K_p = 2$

(a) 0.2 (b) 0.4

(c) 1.6 (d) 4

17. For a reaction $H_2 + I_2 \rightleftharpoons 2HI$ at 721K, the value of equilibrium constant is 50. If 0.5 moles each of H_2 and I_2 is added to the system the value of equilibrium constant will be

(a) 40 (b) 60

(c) 50 (d) 30

18. One mole of N_2O_4 gas at 300 K is kept in a closed container at 1 atm. It is heated to 600 K when 20% by mass of N_2O_4 decomposes to $NO_{2(g)}$. The resultant pressure in the container would be

(a) 1.2 atm (b) 2.4 atm

(c) 2.0 atm (d) 1.0 atm

19. 4 moles each of SO_2 and O_2 gases are allowed to react to form SO_3 in a closed vessel. At equilibrium 25% of O_2 is used up. The total number of moles of all the gases at equilibrium is

(a) 6.5 (b) 7.0

(c) 8.0 (d) 2.0

20. 3 moles of A and 4 moles of B are mixed together and allowed to come into equilibrium according to the following reaction

$3A_{(g)} + 4B_{(g)} \rightleftharpoons 2C_{(g)} + 3D_{(g)}$

When equilibrium is reached, there is 1 mole of C. The equilibrium extent of the reaction is

(a) $\frac{1}{4}$ (b) $\frac{1}{3}$

(c) $\frac{1}{2}$ (d) 1

21. For the reaction $AB_{(g)} \rightleftharpoons A_{(g)} + B_{(g)}$, AB is 33% dissociated at a total pressure of P. Therefore, P is related to K_p by one of the following options

(a) $P = K_p$ (b) $P = 3K_p$

(c) $P = 4K_p$ (d) $P = 8K_p$

22. At temperature T, a compound $AB_{2(g)}$ dissociates according to the reaction $2AB_{2(g)} \rightleftharpoons 2AB_{(g)} + B_{2(g)}$ with a degree of dissociation x, which is small compared with unity. The expression for K_P, in terms of x and the total pressure, P is

(a) $\frac{Px^3}{2}$ (b) $\frac{Px^2}{3}$

(c) $\frac{Px^3}{3}$ (d) $\frac{Px^2}{2}$

23. 1 mol of A and 0.5 mole of B were enclosed in a three litres vessel. The following equilibrium was established under suitable conditions.

$A + 2B \rightleftharpoons C$

At equilibrium, the amount of B was found to be 0.3 mol. The equilibrium constant K_C at the experimental temperature will be

(a) 11.1 (b) 1.11

(c) 0.01 (d) 2.50

24. $A_{(g)} + 3B_{(g)} \rightleftharpoons 4C_{(g)}$. Starting concentration of A is equal to B, equilibrium concentration of A and C are same. K_c =

(a) 0.08 (b) 0.8

(c) 8 (d) 80

(e) 1/8

25. For the reaction in aqueous solution $Zn^{2+} + X^- \rightleftharpoons ZnX^+$, the K_{eq} is greatest when X is

(a) F^- (b) NO_3^-

(c) ClO_4^- (d) I^-

26. The correct order of equilibrium constants for the reactions is

$H_2CO + H_2O \overset{K_1}{\rightleftharpoons} H_2C(OH)_2$

$CH_3CH_2CHO + H_2O \overset{K_2}{\rightleftharpoons} CH_3CH_2CH(OH)_2$

$CH_3COCH_3 + H_2O \overset{K_3}{\rightleftharpoons} CH_3C(OH)_2CH_3$

(a) $K_1 > K_2 > K_3$ (b) $K_1 < K_2 < K_3$

(c) $K_1 > K_3 > K_2$ (d) $K_1 < K_3 < K_2$

5. K_p & K_c Relationship and Characteristics of K

1. We know that the relationship between K_c and K_p is

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

What would be the value of Δn for the reaction

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

(a) 1 (b) 0.5

(c) 1.5 (d) 2

2. At $500\,K$, equilibrium constant, K_c, for the following reaction is 5.

$$\frac{1}{2}H_2(g) + \frac{1}{2}I_2(g) \rightleftharpoons HI(g)$$

What would be the equilibrium constant K_c for the reaction

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

(a) 0.04 (b) 0.4

(c) 25 (d) 2.5

3. 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) $\frac{x^2}{1-x^2}$

6. Activation Energy, Standard Free Energy and Degree of Dissociation and Vapour Density

1. The equilibrium constant (K) of a reaction may be written as

(a) $K = e^{-\Delta G/RT}$ (b) $K = e^{-\Delta G^\circ/RT}$

(c) $K = e^{-\Delta H/RT}$ (d) $K = e^{-\Delta H^\circ/RT}$

2. For a system in equilibrium $\Delta G = 0$ under conditions of constant

(a) Temperature and pressure

(b) Temperature and volume

(c) Energy and volume

(d) Pressure and volume

3. In a reversible reaction, the catalyst

(a) Increases the activation energy of the backward reaction

(b) Increases the activation energy of the forward reaction

(c) Decreases the activation energy of both, forward and backward reaction

(d) Decreases the activation energy of forward reaction

4. Reactions that have standard free energy changes less than zero always have equilibrium constant equal to

(a) Unity (b) Greater than unity

(c) Less than unity (d) Zero

5. For the reaction, $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$, the standard free energy is $\Delta G^0 > 0$. The equilibrium constant (K) would be

(a) $K = 0$ (b) $K > 1$

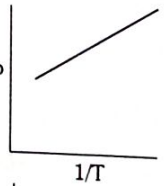
(c) $K = 1$ (d) $K < 1$

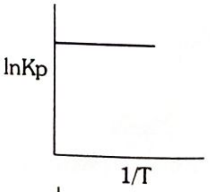
6. Which of the following options will be correct for the state of half completion of the reaction $A \rightleftharpoons B$

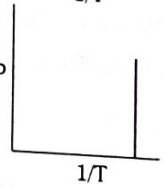
(a) $\Delta G^\ominus = 0$ (b) $\Delta G^\ominus > 0$

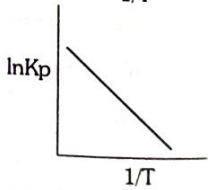
(c) $\Delta G^\ominus < 0$ (d) $\Delta G^\ominus = -RT \ln K$

7. Which of the following plots represent an exothermic reaction

(a) 

(b) 

(c) 

(d) 

8. If in the reaction $N_2O_4 \rightleftharpoons 2NO_2, \alpha$ 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) $(1+\alpha)$

9. $2SO_3 \rightleftharpoons 2SO_2 + O_2$. 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) $0.001M$ (b) $\frac{1}{2}SO_2$

(c) 2 times of SO_2 (d) Data incomplete

7. Le-Chatelier Principle and its Application

1. In the formation of SO_3 by contact process, the conditions used are

(a) Catalyst, optimum temperature and higher concentration of reactants

(b) Catalyst, optimum temperature and lower concentration of reactants

(c) Catalyst, high temperature and higher concentration of reactants

(d) Catalyst, low temperature and lower concentration of reactants

2. What is the effect of increasing pressure on the dissociation of PCl_5 according to the equation

$$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)} - x\ cal$$

(a) Dissociation decreases

(b) Dissociation increases

(c) Dissociation does not change

(d) None of these

3. If pressure increases then its effect on given equilibrium $C_{(s)} + H_2O_{(g)} \rightleftharpoons CO_{(g)} + H_{2(g)}$ it is satisfied in

(a) Forward direction (b) Backward direction

(c) No effect (d) None of these

4. Le-Chatelier's principle is applicable only to a

(a) System in equilibrium (b) Irreversible reaction

(c) Homogeneous reaction (d) Heterogeneous reaction

5. In which of the following equilibrium systems is the rate of the backward reaction favoured by increase of pressure

(a) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ (b) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

(c) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (d) $N_2 + O_2 \rightleftharpoons 2NO$

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

7. The rate of reaction of which of the following is not affected by pressure

(a) $PCl_3 + Cl_2 \rightleftharpoons PCl_5$ (b) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

(c) $N_2 + O_2 \rightleftharpoons 2NO$ (d) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

8. The equilibrium reaction that is not influenced by volume change at constant temperature is

(a) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI$

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

(c) $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$

(d) $2NO_{(g)} + O_2 \rightleftharpoons 2NO_{2(g)}$

9. Which reaction is not effected by change in pressure

(a) $H_2 + I_2 \rightleftharpoons 2HI$ (b) $2C + O_2 \rightleftharpoons 2CO$

(c) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (d) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

10. In the manufacture of ammonia by Haber's process,

$N_{2(g)} + 3H_2 \rightleftharpoons 2NH_{3(g)} + 92.3kJ$,

which of the following conditions is unfavourable

(a) Increasing the temperature

(b) Increasing the pressure

(c) Reducing the temperature

(d) Removing ammonia as it is formed

11. The following reaction is known to occur in the body $CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$. If CO_2 escapes from the system

(a) pH will decrease

(b) Hydrogen ion concentration will decrease

(c) H_2CO_3 concentration will be unaltered

(d) The forward reaction will be promoted

12. Among the following, the equilibrium which is not affected by an increase in pressure is

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

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

(c) $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$

(d) $3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$

13. When the pressure is applied over system *ice* $\rightleftharpoons$ *water* what will happen

(a) More water will form

(b) More ice will form

(c) There will be no effect over equilibrium

(d) Water will decompose in H_2 and O_2

14. On the velocity in a reversible reaction, the correct explanation of the effect of catalyst is

(a) It provides a new reaction path of low activation energy

(b) It increases the kinetic energy of reacting molecules

(c) It displaces the equilibrium state on right side

(d) It decreases the velocity of backward reaction

15. According to Le-chatelier principle, if heat is given to solid-liquid system, then

(a) Quantity of solid will reduce

(b) Quantity of liquid will reduce

(c) Increase in temperature

(d) Decrease in temperature

16. Sodium sulphate dissolves in water with evolution of heat. Consider a saturated solution of sodium sulphate. If the temperature is raised, then according to Le-Chatelier principle

(a) More solid will dissolve

(b) Some solid will precipitate out from the solution

(c) The solution will become supersaturated

(d) Solution concentration will remain unchanged

17. Under what conditions of temperature and pressure the formation of atomic hydrogen from molecular hydrogen will be favoured most

(a) High temperature and high pressure

(b) Low temperature and low pressure

(c) High temperature and low pressure

(d) Low temperature and high pressure

18. For a reaction if $K_p > K_c$, the forward reaction is favoured by

(a) Low pressure (b) High pressure

(c) High temperature (d) Low temperature

19. Consider the following reversible reaction at equilibrium, $2H_2O_{(g)} \rightleftharpoons 2H_{2(g)} + O_{2(g)}$; $\Delta H = 241.7\,kJ$

Which one of the following changes in conditions will lead to maximum decomposition of $H_2O_{(g)}$

(a) Increasing both temperature and pressure

(b) Decreasing temperature and increasing pressure

(c) Increasing temperature and decreasing pressure

(d) Increasing temperature at constant pressure

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

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

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

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

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

(d) The sign of ΔH cannot be predicted on the basis of this information

21. On increasing the pressure, in which direction will the gas phase reaction proceed to re-establish equilibrium, is predicted by applying the Le-Chatelier's principle. Consider the reaction,

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

Which of the following is correct, if the total pressure at which the equilibrium is established, is increased without changing the temperature

(a) K will remain same

(b) K will decrease

(c) K will increase

(d) K will increase initially and decrease when pressure is very high

22. In which of the following reactions, the equilibrium remains unaffected on addition of small amount of argon at constant volume

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

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

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

(d) The equilibrium will remain unaffected in all the three cases

23. Which of the following statement is incorrect

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

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

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

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

8. IIT-JEE/ AIEEE

1. Change in volume of the system does not alter the number of moles in which of the following equilibrium **[2002]**

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

2. What is the equilibrium expression for the reaction $P_{4(s)} + 5O_{2(g)} \rightleftharpoons P_4O_{10(s)}$ **[2004]**

(a) $K_c = [O_2]^5$

(b) $K_c = [P_4O_{10}]/5[P_4][O_2]$

(c) $K_c = [P_4O_{10}]/[P_4][O_2]^5$

(d) $K_c = 1/[O_2]^5$

3. The equilibrium constants 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 **[2016]**

(a) 0.818 (b) 1.818

(c) 1.182 (d) 0.182

4. For the following three reactions (i), (ii) and (iii), equilibrium constants are given :

(i) $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}; K_1$

(ii) $CH_{4(g)} + H_2O_{(g)} \rightleftharpoons CO_{(g)} + 3H_{2(g)}; K_2$

(iii) $CH_{4(g)} + 2H_2O_{(g)} \rightleftharpoons CO_{2(g)} + 4H_{2(g)}; K_3$

Which of the following relations is correct **[2008]**

(a) $K_2K_3 = K_1$ (b) $K_3 = K_1K_2$

(c) $K_3.K_2^3 = K_1^2$ (d) $K_1\sqrt{K_2} = K_3$

5. In which of the following reactions, increase in the volume at constant temperature don't affect the number of moles at equilibrium **[2002]**

(a) $2NH_3 \rightarrow N_2 + 3H_2$

(b) $C_{(g)} + \frac{1}{2} O_{2(g)} \rightarrow CO_{(g)}$

(c) $H_{2(g)} + O_{2(g)} \rightarrow H_2O_{2(g)}$

(d) None of these

6. Pure ammonia is placed in a vessel at temperature where its dissociation constant (α) is appreciable. At equilibrium **[1984]**

(a) K_p does not change significantly with pressure

(b) α does not change with pressure

(c) Concentration of NH_3 does not change with pressure

(d) Concentration of H_2 is less than that of N_2

7. An amount of solid NH_4HS is placed in a flask already containing ammonia gas at a certain temperature and 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 **[2005]**

(a) 0.30 (b) 0.18

(c) 0.17 (d) 0.11

8. The equilibrium constant for the reaction $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$ at temperature T is 4×10^{-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 **[2004, 2012]**

(a) 4×10^{-4} (b) 50

(c) 2.5×10^2 (d) 0.02

9. A vessel at 1000K 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 **[2011]**

(a) 1.8 *atm* (b) 3 *atm*

(c) 0.3 *atm* (d) 0.18 *atm*

10. For the reaction $SO_2 + \frac{1}{2}O_2 \rightleftharpoons SO_3$, if we write $K_p = K_c(RT)^x$, then x becomes **[2009; 2014]**

(a) –1 (b) $-\frac{1}{2}$

(c) $\frac{1}{2}$ (d) 1

11. The relation between equilibrium constant K_p and K_c is **[1994]**

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

(c) $K_p = \left(\frac{K_c}{RT}\right)^{\Delta n}$ (d) $K_p - K_c = (RT)^{\Delta n}$

12. For the reaction

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

$(K_c = 1.8 \times 10^{-6}$ at 184°C)

$(R = 0.0831 kJ/(mol.K))$

When K_p and K_c are compared at 184°C it is found that

[2005]

(a) K_p is greater than K_c

(b) K_p is less than K_c

(c) $K_p = K_c$

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

13. For the reversible reaction,

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

at 500°C, the value of K_P is 1.44×10^{-5} when partial pressure is measured in atmospheres. The corresponding value of K_c with concentration in mole $litre^{-1}$, is **[2000]**

(a) $1.44 \times 10^{-5}/(0.082 \times 500)^{-2}$

(b) $1.44 \times 10^{-5}/(8.314 \times 773)^{-2}$

(c) $1.44 \times 10^{-5}/(0.082 \times 773)^{2}$

(d) $1.44 \times 10^{-5}/(0.082 \times 773)^{-2}$

14. For the reaction, $CO_{(g)} + Cl_{2(g)} \rightleftharpoons COCl_{2(g)}$ the K_p/K_c is equal to **[2004]**

(a) $\sqrt{RT}$ (b) RT

(c) $1/RT$ (d) 1.0

15. 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 **[2006]**

(a) $\left(\frac{x}{x+1}\right)P$ (b) $\left(\frac{2x}{1-x}\right)P$

(c) $\left(\frac{x}{x-1}\right)P$ (d) $\left(\frac{x}{1-x}\right)P$

16. Ammonia under a pressure of 15 *atm* at 27°C is heated to 347°C in a closed vessel in the presence of a catalyst. Under the conditions, NH_3 is partially decomposed according to the equation,

$2NH_3 \rightleftharpoons N_2 + 3H_2$. The vessel is such that the volume remains effectively constant where as pressure increases to 50 *atm*. Calculate the percentage of NH_3 actually decomposed **[1981]**

(a) 65% (b) 61.3%

(c) 62.5% (d) 64%

17. For the reaction $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$, the equilibrium constant changes with **[1981]**

(a) Total pressure

(b) Catalyst

(c) The amounts of H_2 and I_2 taken

(d) Temperature

18. The reaction $A + B \rightleftharpoons C + D$ + *heat* has reached equilibrium. The reaction may be made to proceed forward by **[1978]**

(a) Adding more C

(b) Adding more D

(c) Decreasing the temperature

(d) Increasing the temperature

19. The exothermic formation of ClF_3 is represented by the equation

$Cl_{2(g)} + 3F_{2(g)} \rightleftharpoons 2ClF_{3(g)}$; $\Delta H = -329\,kJ$

Which of the following will increase the quantity of ClF_3 in an equilibrium mixture of Cl_2, F_2 and ClF_3 **[2005]**

(a) Increasing the temperature

(b) Removing Cl_2

(c) Increasing the volume of the container

(d) Adding F_2

20. For the chemical reaction $3X_{(g)} + Y_{(g)} \rightleftharpoons X_3Y_{(g)}$, the amount of X_3Y at equilibrium is affected by **[1999]**

(a) Temperature and pressure

(b) Temperature only

(c) Pressure only

(d) Temperature, pressure and catalyst

21. 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 **[1998]**

(a) Adding a suitable catalyst

(b) Adding an inert gas

(c) Decreasing the volume of the container

(d) Increasing the amount $CO(g)$

22. In the following reversible reaction

$2SO_2 + O_2 \rightleftharpoons 2SO_3 + Q\ Cal$

Most suitable condition for the higher production of SO_3 is **[1981]**

(a) High temperature and high pressure

(b) High temperature and low pressure

(c) Low temperature and high pressure

(d) Low temperature and low pressure

23. In Haber process for synthesis of ammonia $N_2 + 3H_2 \rightleftharpoons 2NH_3$; $\Delta H < 0$. Pick the correct statement **[2006]**

(a) Addition of catalyst does not change K_p but changes ΔH

(b) At equilibrium, $2G_{NH_3} = G_{N_2} + 3G_{H_2}$ (where G is Gibb's free energy)

(c) At higher temperature in increases the rate of forward and backward reaction by a factor of 2

(d) At 400K addition of catalyst will increase forward reaction by 2 times while reverse reaction rate will be changed by 1.7 times

24. 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 is correct **[1989]**

(a) More chlorine is formed

(b) Concentration of SO_2 is reduced

(c) More SO_2Cl_2 is formed

(d) Concentration of SO_2Cl_2, SO_2 and Cl_2 does not change

25. At constant temperature, the equilibrium constant (K_p) for the decomposition reaction $N_2O_4 \rightleftharpoons 2NO_2$ is expressed by

$$K_P = \frac{(4x^2P)}{(1-x^2)},$$

where P = pressure, x = extent of decomposition. Which one of the following statements is true **[2001]**

(a) K_p increases with increase of P

(b) K_p increases with increase of x

(c) K_p increases with decrease of x

(d) K_p remains constant with change in P and x

9. NEET/ AIPMT/ CBSE-PMT

1. In a chemical equilibrium $A + B \rightleftharpoons C + D$, when one mole each of the two reactants are mixed, 0.6 mole each of the products are formed. The equilibrium constant calculated is **[1989]**

(a) 1 (b) 0.36

(c) 2.25 (d) 4/9

2. In the gas phase reaction, $C_2H_4 + H_2 \rightleftharpoons C_2H_6$, the equilibrium constant can be expressed in units of **[1992]**

(a) $litre^{-1}\ mole^{-1}$ (b) $litre\ mole^{-1}$

(c) $mole^2\ litre^{-2}$ (d) $mole\ litre^{-1}$

3. In a 500 mL capacity vessel CO and Cl_2 are mixed to form $COCl_2$. At equilibrium, it contains 0.2 moles of $COCl_2$ and 0.1 mole of each of CO and Cl_2. The equilibrium constant K_c for the reaction $CO + Cl_2 \rightleftharpoons COCl_2$ is **[1998]**

(a) 5 (b) 10

(c) 15 (d) 20

4. For the reaction $H_2 + I_2 \rightleftharpoons 2HI$, the equilibrium concentration of H_2, I_2 and HI are 8.0, 3.0 and 28.0 *mol per litre* respectively, the equilibrium constant of the reaction is **[2001]**

(a) 30.66 (b) 32.66

(c) 34.66 (d) 36.66

5. The equilibrium constant (K_c) for the reaction $HA + B \rightleftharpoons BH^+ + A^-$ is 100. If the rate constant for the forward reaction is 10^5, then rate constant for the backward reaction is **[2002]**

(a) 10^7 (b) 10^3

(c) 10^{-3} (d) 10^{-5}

6. The reaction $2A_{(g)} + B_{(g)} \rightleftharpoons 3C_{(g)} + D_{(g)}$ is begun with the concentrations of A and B both at an initial value of 1.00 M. When equilibrium is reached, the concentration of D is measured and found to be 0.25 M. The value for the equilibrium constant for this reaction is given by the expression **[2010]**

(a) $[(0.75)^3(0.25)] \div [(1.00)^2(1.00)]$

(b) $[(0.75)^3(0.25)] \div [(0.50)^2(0.75)]$

(c) $[(0.75)^3(0.25)] \div [(0.50)^2(0.25)]$

(d) $[(0.75)^3(0.25)] \div [(0.75)^2(0.25)]$

7. Given that the equilibrium constant for the reaction $2SO_2(g)+O_2(g) \rightleftharpoons 2SO_3(g)$ has a value of 278 at a particular temperature. What is the value of the equilibrium constant for the following reaction at the same temperature

$SO_3(g) \rightleftharpoons SO_2(g)+\frac{1}{2}O_2(g)$ **[2012]**

(a) 1.8×10^{-3} (b) 3.6×10^{-3}

(c) 6.0×10^{-2} (d) 1.3×10^{-5}

8. Given the reaction between 2 gases represented by A_2 and B_2 to give the compound $AB(g)$.

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

At equilibrium, the concentration

of $A_2 = 3.0\times10^{-3}M$

of $B_2 = 4.2\times10^{-3}M$

of $AB = 2.8\times10^{-3}M$

If the reaction takes place in a sealed vessel at $527°C$, then the value of K_C will be **[2012]**

(a) 2.0 (b) 1.9

(c) 0.62 (d) 4.5

9. Two gaseous equilibria $SO_{2(g)}+\frac{1}{2}O_{2(g)} \rightleftharpoons SO_{3(g)}$ and $2SO_{3(g)} \rightleftharpoons 2SO_{2(g)}+O_{2(g)}$ have equilibrium constants K_1 and K_2 respectively at $298K$. Which of the following relationships between K_1 and K_2 is correct **[1989, 2005]**

(a) $K_1 = K_2$ (b) $K_2 = K_1^2$

(c) $K_2 = \frac{1}{K_1^2}$ (d) $K_2 = \frac{1}{K_1}$

10. $H_2+I_2 \rightleftharpoons 2HI$

In the above equilibrium system if the concentration of the reactants at $25°C$ is increased, the value of K_c will **[1990; 1990]**

(a) Increase

(b) Decrease

(c) Remains the same

(d) Depends on the nature of the reactants

11. The equilibrium constant for the reaction $N_2+3H_2 \rightleftharpoons 2NH_3$ is K, then the equilibrium constant for the equilibrium $NH_3 \rightleftharpoons \frac{1}{2}N_2+\frac{3}{2}H_2$ is **[1996]**

(a) $1/K$ (b) $1/K^2$

(c) $\sqrt{K}$ (d) $\frac{1}{\sqrt{K}}$

12. The following equilibrium given by

$N_2+3H_2 \rightleftharpoons 2NH_3$; K_1

$N_2+O_2 \rightleftharpoons 2NO$; K_2

$H_2+\frac{1}{2}O_2 \rightleftharpoons H_2O$; K_3

the equilibrium constant of the reaction

$2NH_3+\frac{5}{2}O_2 \rightleftharpoons 2NO+3H_2O$ in terms of K_1, K_2 and K_3 is **[2003, 07; 2017]**

(a) $\frac{K_2K_3^3}{K_1}$ (b) $K_1K_2K_3$

(c) $\frac{K_1K_2}{K_3}$ (d) $\frac{K_1K_3^2}{K_2}$

13. Value of K_p in the reaction

$MgCO_{3(s)} \rightleftharpoons MgO_{(s)} + CO_{2(g)}$ is **[2000]**

(a) $K_P = P_{CO_2}$

(b) $K_P = Pco_2 \times \frac{Pco_2 \times P_{MgO}}{P_{MgCO_3}}$

(c) $K_P = \frac{Pco_2 \times P_{MgO}}{P_{MgCO_3}}$

(d) $K_P = \frac{P_{MgCO_3}}{P_{CO_2} \times P_{MgO}}$

14. 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 **[2015]**

(a) $K_1 = K_2$ (b) $K_2 = \sqrt{K_1}$

(c) $K_1 = 2K_2$ (d) $K_1 = \frac{1}{2}K_2$

15. If the concentration of OH^- ions in the reaction $Fe(OH)_3 \rightleftharpoons Fe^{3+}(aq)+3OH^-(aq)$ is decreased by $\frac{1}{4}$ times, then equilibrium concentration of Fe^{3+} will increase by **[2008]**

(a) 64 times (b) 4 times

(c) 8 times (d) 16 times

16. If the value of an equilibrium constant for a particular reaction is 1.6×10^{12}, then at equilibrium the system will contain **[2015]**

(a) Mostly reactions

(b) Mostly products

(c) Similar amounts of reactants and products

(d) All reactants

17. The reaction quotient (Q) for the reaction

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

is given by $Q = \frac{[NH_3]^2}{[N_2][H_2]^3}$. The reaction will proceed from right to left is **[2003]**

(a) $Q = 0$ (b) $Q = K_c$

(c) $Q < K_c$ (d) $Q > K_c$

Where K_c is the equilibrium constant

18. The dissociation constants for acetic acid and HCN at $25°C$ are 1.5×10^{-5} and 4.5×10^{-10}, respectively. The equilibrium constant for the equilibrium

$$CN^- + CH_3COOH \rightleftharpoons HCN + CH_3COO^-$$

would be **[2009]**

(a) 3.0×10^{5} (b) 3.0×10^{-5}

(c) 3.0×10^{-4} (d) 3.0×10^{4}

19. $28\,g$ of N_2 and $6\,g$ of H_2 were kept at $400°C$ in 1 *litre* vessel, the equilibrium mixture contained $27.54g$ of NH_3. The approximate value of K_c for the above reaction can be (in $mole^{-2}$ $litre^2$) **[1990]**

(a) 75 (b) 50

(c) 25 (d) 100

20. An amount of solid NH_4HS is placed in a flask already containing ammonia gas at a certain temperature and 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 **[2005]**

(a) 0.30 (b) 0.18

(c) 0.17 (d) 0.11

21. In Haber process 30 *litres* of dihydrogen and 30 *litres* of dinitrogen were taken for reaction which yielded only 50% of the expected product. What will be the composition of gaseous mixture under these condition in the end **[2003]**

(a) 20 *litres* ammonia, 25 *litres* nitrogen, 15 *litres* hydrogen

(b) 20 *litres* ammonia, 20 *litres* nitrogen, 20 *litres* hydrogen

(c) 10 *litres* ammonia, 25 *litres* nitrogen, 15 *litres* hydrogen

(d) 20 *litres* ammonia, 10 *litres* nitrogen, 30 *litres* hydrogen

22. For the reaction $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$, the equilibrium constant is K_1. The equilibrium constant is K_2 for the reaction $2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$. What is K for the reaction $NO_{2(g)} \rightleftharpoons \frac{1}{2}N_{2(g)} + O_{2(g)}$ **[2011]**

(a) $\frac{1}{(K_1K_2)}$ (b) $\frac{1}{(2K_1K_2)}$

(c) $\frac{1}{(4K_1K_2)}$ (d) $\left[\frac{1}{K_1K_2}\right]^{1/2}$

23. 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 these equilibria is **[2008]**

(a) 1 : 1 (b) 1 : 3

(c) 1 : 9 (d) 1 : 36

24. The dissociation equilibrium of a gas AB_2 can be represented as :

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

The degree of dissociation is 'x' and is small compared to 1. The expression relating the degree of dissociation (x) with equilibrium constant K_p and total pressure P is **[2008]**

(a) $(2K_P/P)^{1/2}$ (b) (K_P/P)

(c) $(2K_P/P)$ (d) $(2K_P/P)^{1/3}$

25. In which one of the following gaseous equilibria K_p is less than K_c **[2002]**

(a) $N_2O_4 \rightleftharpoons 2NO_2$ (b) $2HI \rightleftharpoons H_2 + I_2$

(c) $2SO_2 + O_2 \rightleftharpoons 2SO_3$ (d) $N_2 + O_2 \rightleftharpoons 2NO$

26. For the reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ at $721K$ the value of equilibrium constant (K_c) is 50. When the equilibrium concentration of both is $0.5\,M$, the value of K_p under the same conditions will be **[1990]**

(a) 0.002 (b) 0.2

(c) 50 (d) $50/RT$

27. In which of the following equilibrium K_c and K_p are not equal **[2010]**

(a) $2C_{(s)} + O_{2(g)} \rightleftharpoons 2CO_{2(g)}$

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

(c) $SO_{2(g)} + NO_{2(g)} \rightleftharpoons SO_{3(g)} + NO_{(g)}$

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

28. For a given exothermic reaction, Kp and $K'p$ are the equilibrium constants at temperatures T_1 and T_2, respectively. Assuming that heat of reaction is constant in temperature range between T_1 and T_2, it is readily observed that **[2014]**

(a) $K_p = K'_p$ (b) $K_p = \frac{1}{K'_p}$

(c) $K_p > K'_p$ (d) $K_p < K'_p$

29. For the reaction

$$CH_{4(g)} + 2O_{2(g)} \rightleftharpoons CO_{2(g)} + 2H_2O_{(l)},$$

$$\Delta H = -170.8\ kJ\ mol^{-1}$$

Which of the following statements is not true **[2006]**

(a) Addition of $CH_{4(g)}$ or $O_{2(g)}$ at equilibrium will cause a shift to the right

(b) The reaction is exothermic

(c) At equilibrium, the concentrations of $CO_{2(g)}$ and $H_2O_{(l)}$ are not equal

(d) The equilibrium constant for the reaction is given by $K_p = \frac{[CO_2]}{[CH_4][O_2]}$

30. In the manufacture of NH_3 by Haber's process, the condition which would give maximum yield is

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 + Q\,kcal$$

[1983, 84, 86, 94, 2010; 2014]

(a) High temperature, high pressure and high concentrations of the reactants

(b) High temperature, low pressure and low concentrations of the reactants

(c) Low temperature and high pressure

(d) Low temperature, low pressure and low concentration of H_2

31. The chemical reaction : $BaO_{2(S)} \rightleftharpoons BaO_{(s)} + \frac{1}{2}O_{2(g)}$, $\Delta H = +ve$. In equilibrium condition, pressure of O_2 depends upon **[2002]**

(a) Increase mass of BaO

(b) Increase mass of BaO_2

(c) Increase in temperature

(d) Increase mass of BaO_2 and BaO both

32. In the reaction, $A_{2(g)} + 4B_{2(g)} \rightleftharpoons 2AB_{4(g)}$

$\Delta H < 0$ the formation of AB_4 will be favoured at

[1990; 2011]

(a) Low temperature, high pressure

(b) High temperature, low pressure

(c) Low temperature, low pressure

(d) High temperature, high pressure

10. AIIMS

1. In which of the following reactions, the concentration of the product is higher than the concentration of reactant at equilibrium (K= equilibrium constant) **[2008]**

(a) $A \rightleftharpoons B; K = 0.001$ (b) $M \rightleftharpoons N; K = 10$

(c) $X \rightleftharpoons Y; K = 0.005$ (d) $R \rightleftharpoons P; K = 0.01$

2. The equilibrium constant in a reversible reaction at a given temperature **[1982]**

(a) Depends on the initial concentration of the reactants

(b) Depends on the concentration of the products at equilibrium

(c) Does not depend on the initial concentrations

(d) It is not characteristic of the reaction

3. For which of the following reactions does the equilibrium constant depend on the units of concentration **[1983]**

(a) $NO_{(g)} \rightleftharpoons \frac{1}{2}N_{2(g)} + \frac{1}{2}O_{2(g)}$

(b) $Zn_{(s)} + Cu^{2+}_{(aq)} \rightleftharpoons Cu_{(s)} + Zn^{2+}_{(aq)}$

(c) $C_2H_5OH_{(l)} + CH_3COOH_{(l)} \rightleftharpoons CH_3COOC_2H_{5(l)} + H_2O_{(l)}$

(Reaction carried in an inert solvent)

(d) $COCl_{2(g)} \rightleftharpoons CO_{(g)} + Cl_{2(g)}$

4. An equilibrium mixture of the reaction $2H_2S_{(g)} \rightleftharpoons 2H_{2(g)} + S_{2(g)}$ had 0.5 mole H_2S, 0.10 mole H_2 and 0.4 mole S_2 in one litre vessel. The value of equilibrium constant (K) in *mole litre*$^{-1}$ is **[1998]**

(a) 0.004 (b) 0.008

(c) 0.016 (d) 0.160

5. The rate constant for forward and backward reactions of hydrolysis of ester are 1.1×10^{-2} and 1.5×10^{-3} per minute respectively. Equilibrium constant for the reaction is

$$CH_3COOC_2H_5 + H_2O \rightleftharpoons CH_3COOH + C_2H_5OH$$

[1999]

(a) 4.33 (b) 5.33

(c) 6.33 (d) 7.33

6. A chemical reaction is catalyzed by a catalyst X. Hence X **[2000]**

(a) Reduces enthalpy of the reaction

(b) Decreases rate constant of the reaction

(c) Increases activation energy of the reaction

(d) Does not affect equilibrium constant of reaction

7. 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 **[2015]**

(a) $3.09 \times 10^{-7} mol/L$ (b) $5.07 \times 10^{-8} mol/L$

(c) $8.18 \times 10^{-9} mol/L$ (d) $9.24 \times 10^{-10} mol/L$

8. For which of the following reactions $K_p = K_c$ **[1996]**

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

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

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

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

9. For reaction $2NOCl_{(g)} \rightleftharpoons 2NO_{(g)} + Cl_{2(g)}$, K_C at 427°C is $3 \times 10^{-6} L\, mol^{-1}$. The value of K_P is nearly **[2005]**

(a) 7.50×10^{-5} (b) 2.50×10^{-5}

(c) 2.50×10^{-4} (d) 1.72×10^{-4}

10. The value of K_p for the following reaction $2H_2S_{(g)} \rightleftharpoons 2H_{2(g)} + S_{2(g)}$ is 1.2×10^{-2} at $106.5°C$. The value of K_c for this reaction is **[1999]**

(a) 1.2×10^{-2} (b) $< 1.2 \times 10^{-2}$

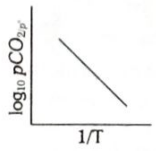
(c) 83 (d) $> 1.2 \times 10^{-2}$

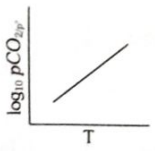
11. K_p for the following reaction at 700 K is 1.3×10^{-3} atm^{-1}. The K_c at same temperature for the reaction $2SO_2 + O_2 \rightleftharpoons 2SO_3$ will be **[2001]**

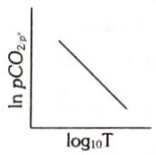
(a) 1.1×10^{-2} (b) 3.1×10^{-2}

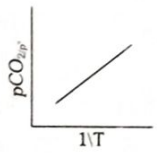
(c) 5.2×10^{-2} (d) 7.4×10^{-2}

12. For the chemical equilibrium, $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$, ΔH_r° can be determined from which one of the following plots **[2005]**

(a) 

(b) 

(c) 

(d) 

13. Of the following which change will shift the reaction towards the product $I_{2(g)} \rightleftharpoons 2I_{(g)}$, $\Delta H_r^0(298K) = +150\, kJ$ **[2004]**

(a) Increase in concentration of I

(b) Decrease in concentration of I_2

(c) Increase in temperature

(d) Increase in total pressure

14. In which of the following system, doubling the volume of the container cause a shift to the right **[1996]**

(a) $H_{2(g)} + Cl_{2(g)} = 2HCl_{(g)}$

(b) $2CO_{(g)} + O_{2(g)} = 2CO_{2(g)}$

(c) $N_{2(g)} + 3H_{2(g)} = 2NH_{3(g)}$

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

11. Assertion & Reason

Read the assertion and reason carefully to m-ark the correct option out of the options given below :

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.

(c) If assertion is true but reason is false.

(d) If the assertion and reason both are false.

(e) If assertion is false but reason is true.

1. Assertion : The equilibrium constant is fixed and is the characteristic of any given chemical reaction at a specified temperature.

Reason : The composition of the final equilibrium mixture at a particular temperature depends upon the starting amount of reactants. **[AIIMS 2000]**

2. Assertion : On cooling a freezing mixture, colour of the mixture turns to pink from deep blue for a reaction. $Co(H_2O)_{6\,(aq)}^{2+} + 4Cl^-_{(aq)} \rightleftharpoons CoCl_{4\,(aq)}^{2-} + 6H_2O_{(l)}$.

Reason : Reaction is endothermic so on cooling, the reaction moves to backward direction.

3. Assertion : *NaCl* solution can be purified by passage of hydrogen chloride through brine.

Reason : This type of purification is based on Le-Chatelier's principle.

4. Assertion : Equilibrium constant has meaning only when the corresponding balanced chemical equation is given.

Reason : Its value changes for the new equation obtained by multiplying or dividing the original equation by a number.

5. Assertion : Ice $\rightleftharpoons$ water, if pressure is applied water will evaporate.

Reason : Increase of pressure pushes the equilibrium towards the side in which number of gaseous mole decreases.

6. Assertion : For the reaction

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

Unit of $K_c = L^2\ mol^{-2}$

Reason : For the reaction

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

Equilibrium constant, $K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$

[AIIMS 2008]

7. Assertion : The dissociation of PCl_5 decreases on increasing pressure.

Reason : An increase in pressure favours the forward reaction. **[AIIMS 2015]**

7. Chemical Equilibrium – Answers Keys

1. Reversible and Irreversible Reaction

1	c	2	a	3	c	4	b	5	c

2. Equilibrium State

1	b	2	c	3	a	4	c

3. Law of Mass Action

1	b	2	a	3	c	4	a	5	a

4. Law of Equilibrium and Equilibrium Constant

1	a	2	a	3	a	4	d	5	a
6	a	7	d	8	c	9	d	10	d
11	b	12	d	13	a	14	d	15	d
16	b	17	c	18	b	19	b	20	c
21	d	22	a	23	a	24	c	25	a
26	a								

5. K_p & K_c Relationship and Characteristics of K

1	d	2	a	3	a				

6. Activation Energy, Standard Free Energy and Degree of Dissociation and Vapour Density

1	b	2	a	3	c	4	b	5	d
6	a	7	a	8	d	9	d		

7. Le-Chatelier Principle and its Application

1	a	2	a	3	b	4	a	5	a
6	b	7	c	8	a	9	a	10	a
11	b	12	d	13	a	14	a	15	a
16	b	17	c	18	a	19	c	20	a
21	a	22	d	23	b				

8. IIT-JEE/ AIEEE

1	a	2	d	3	b	4	b	5	d
6	a	7	d	8	b	9	a	10	b
11	b	12	a	13	d	14	c	15	a
16	b	17	d	18	c	19	d	20	a
21	d	22	c	23	b	24	d	25	d

9. NEET/ AIPMT/ CBSE-PMT

1	c	2	b	3	b	4	b	5	b
6	b	7	c	8	c	9	c	10	c
11	d	12	a	13	a	14	b	15	a
16	b	17	d	18	d	19	a	20	d
21	c	22	d	23	d	24	d	25	c
26	c	27	a	28	c	29	d	30	c
31	c	32	a						

10. AIIMS

1	b	2	c	3	d	4	c	5	d
6	d	7	a	8	c	9	d	10	b
11	d	12	a	13	c	14	d		

11. Assertion & Reason

1	c	2	a	3	c	4	a	5	e
6	a	7	c						