

## Equilibrium state

- In any chemical reaction, equilibrium is supposed to be establish when  
[CPMT 1974, 80, 89; EAMCET 1975, 77, 79; MP PMT 1990; NCERT 1980; MP PET 1995]
  - Mutual opposite reactions undergo
  - Concentration of reactants and resulting products are equal
  - Velocity of mutual reactions become equal
  - The temperature of mutual opposite reactions become equal
- Which of the following conditions represents an equilibrium
  - Freezing of ice in a open vessel, temperature of ice is constant
  - Few drops of water is present along with air in a balloon, temperature of balloon is constant
  - Water is boiling in an open vessel over stove, temperature of water is constant
  - All the statements (a), (b) and (c) are correct for the equilibrium
- When rate of forward reaction becomes equal to backward reaction, this state is termed as  
[NCERT 1975, 80; CPMT 1973, 74, 77]
  - Chemical equilibrium
  - Reversible state
  - Equilibrium
  - All of these
- In chemical reaction  $A \rightleftharpoons B$ , the system will be known in equilibrium when  
[MP PMT 1990; NCERT 1977]
  - A completely changes to B
  - 50% of A changes to B
  - The rate of change of A to B and B to A on both the sides are same
  - Only 10% of A changes to B
- A chemical reaction is at equilibrium when  
[NCERT 1975; CPMT 1974; MP PMT 1996; KCET 1993; IIT 1978; Manipal MEE 1995; Pb. PMT 2002]
  - Reactants are completely transformed into products
  - The rates of forward and backward reactions are equal
  - Formation of products is minimised
  - Equal amounts of reactants and products are present
- In the chemical reaction  $N_2 + 3H_2 \rightleftharpoons 2NH_3$  at equilibrium point, state whether  
[NCERT 1977]
  - Equal volumes of  $N_2$  and  $H_2$  are reacting
  - Equal masses of  $N_2$  and  $H_2$  are reacting
  - The reaction has stopped
  - The same amount of ammonia is formed as is decomposed into  $N_2$  and  $H_2$
- For the reaction  $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$  the position of equilibrium can be shifted to the right by  
[MP PMT 2004]
  - Increasing the temperature
  - Doubling the volume
  - Addition of  $Cl_2$  at constant volume
  - Addition of equimolar quantities of  $PCl_3$  and  $PCl_5$
- If a system is at equilibrium the rate of forward to the reverse reaction is  
[UPSEAT 2004]
  - Less
  - Equal
  - High
  - At equilibrium
- Chemical equilibrium is dynamic in nature because  
[IIT 1977]
  - Equilibrium is maintained rapidly
  - The concentration of reactants and products become same at equilibrium

- The concentration of reactants and products are constant but different
  - Both forward and backward reactions occur at all times with same speed
- The number of gram molecules of a substance present in unit volume is termed as  
[MP PMT 1993]
    - Activity
    - Normal solution
    - Molar concentration
    - Active mass

## Law of mass action

- According to law of mass action rate of a chemical reaction is proportional to  
[AFMC 2005]
  - Concentration of reactants
  - Molar concentration of reactants
  - Concentration of products
  - Molar concentration of products
- In a reaction the rate of reaction is proportional to its active mass, this statement is known as  
[IIT 1979]
  - Law of mass action
  - Le-chatelier principle
  - Faraday law of electrolysis
  - Law of constant proportion
- The active mass of 64 gm of HI in a two litre flask would be  
[CPMT 1979]
  - 2
  - 1
  - 5
  - 0.25
- Under a given set of experimental conditions, with increase in the concentration of the reactants, the rate of a chemical reaction
  - Decreases
  - Increases
  - Remains unaltered
  - First decreases and then increases
- The law of mass action was enunciated by  
[MP PMT 1995]
  - Guldberg and Waage
  - Bodenstein
  - Birthelet
  - Graham
- Theory of 'active mass' indicates that the rate of chemical reaction is directly proportional to the  
[MP PET 1990]
  - Equilibrium constant
  - Properties of reactants
  - Volume of apparatus
  - Concentration of reactants
- The rate at which substances react depends on their  
[MP PMT 1997]
  - Atomic weight
  - Molecular weight
  - Equivalent weight
  - Active mass
- Which is false  
[AMU 1999]
  - The greater the concentration of the substances involved in a reaction, the lower the speed of the reaction
  - The point of dynamic equilibrium is reached when the reaction rate in one direction just balances the reaction rate in the opposite direction
  - The dissociation of weak electrolyte is a reversible reaction
  - The presence of free ions facilitates chemical changes
- Chemical equations convey quantitative information on the  
[Orissa JEE 2002]
  - Type of atoms/molecules taking part in the reaction
  - Number of atoms/molecules of the reactants and products involved in the reaction
  - Relative number of moles of reactants and products involved in the reaction
  - Quantity of reactant consumed and quantity of product formed

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

[MADT Bihar 1983]

- (a) Cannot be applied  
 (b) Can be applied  
 (c) Can be applied at low temperature  
 (d) Can be applied at high temp. and pressure

### Law of equilibrium and Equilibrium constant

1. For the system  $3A + 2B \rightleftharpoons C$ , the expression for equilibrium constant is

[NCERT 1981; CPMT 1989; MP PMT 1990; RPMT 1999; Pb. PMT 2002; Pb. CET 2002]

- (a)  $\frac{[3A][2B]}{C}$  (b)  $\frac{[C]}{[3A][2B]}$   
 (c)  $\frac{[A]^3[B]^2}{[C]}$  (d)  $\frac{[C]}{[A]^3[B]^2}$

2. In the reversible reaction  $A + B \rightleftharpoons C + D$ , the concentration of each  $C$  and  $D$  at equilibrium was 0.8 mole/litre, then the equilibrium constant  $K_c$  will be

[MP PET 1986]

- (a) 6.4 (b) 0.64  
 (c) 1.6 (d) 16.0

3. 4 moles of  $A$  are mixed with 4 moles of  $B$ . At equilibrium for the reaction  $A + B \rightleftharpoons C + D$ , 2 moles of  $C$  and  $D$  are formed. The equilibrium constant for the reaction will be

[CPMT 1992]

- (a)  $\frac{1}{4}$  (b)  $\frac{1}{2}$   
 (c) 1 (d) 4

4. On a given condition, the equilibrium concentration of  $HI$ ,  $H_2$  and  $I_2$  are 0.80, 0.10 and 0.10 mole/litre. The equilibrium constant for the reaction  $H_2 + I_2 \rightleftharpoons 2HI$  will be

[MP PET 1986]

- (a) 64 (b) 12  
 (c) 8 (d) 0.8

5. In which of the following, the reaction proceeds towards completion

- (a)  $K = 10^3$  (b)  $K = 10^{-2}$   
 (c)  $K = 10$  (d)  $K = 1$

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

[CPMT 1982, 90; MP PMT 1990, 2004; MNR 1992; UPSEAT 2002; KCET 1999; Pb. CET 2004]

- (a) Also be doubled (b) Be halved  
 (c) Become one-fourth (d) Remain the same

7. The equilibrium constant in a reversible reaction at a given temperature

[AIIMS 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

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

[IIT 1984; Kurukshetra CEE 1998]

- (a)  $K_p$  does not change significantly with pressure  
 (b)  $\alpha$  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  $N_2$

9. For the system  $A(g) + 2B(g) \rightleftharpoons C(g)$ , the equilibrium concentrations are (A) 0.06 mole/litre (B) 0.12 mole/litre (C) 0.216 mole/litre. The  $K_{eq}$  for the reaction is

[CPMT 1983]

- (a) 250 (b) 416  
 (c)  $4 \times 10^{-3}$  (d) 125

10. The equilibrium constant for the given reaction  $H_2 + I_2 \rightleftharpoons 2HI$  is correctly given by expression

[CPMT 1984]

- (a)  $K_c = \frac{[H_2][I_2]}{[HI]}$  (b)  $K_c = \frac{[H_2][I_2]}{[2HI]}$   
 (c)  $K_c = \frac{[H_2][I_2]}{[HI]^2}$  (d)  $K_c = \frac{[HI]^2}{[H_2][I_2]}$

11. Partial pressures of  $A$ ,  $B$ ,  $C$  and  $D$  on the basis of gaseous system  $A + 2B \rightleftharpoons C + 3D$  are  $A = 0.20$ ;  $B = 0.10$ ;  $C = 0.30$  and  $D = 0.50$  atm. The numerical value of equilibrium constant is

- (a) 11.25 (b) 18.75  
 (c) 5 (d) 3.75

12. For the reaction  $A + 2B \rightleftharpoons C$ , the expression for equilibrium constant is

[MNR 1987; MP PMT 1999; UPSEAT 2002]

- (a)  $\frac{[A][B]^2}{[C]}$  (b)  $\frac{[A][B]}{[C]}$   
 (c)  $\frac{[C]}{[A][B]^2}$  (d)  $\frac{[C]}{2[B][A]}$

13. 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

[MP PMT 1989; RPMT 2000; UPSEAT 2004; Kerala CET 2005]

- (a) 0.266 (b) 0.53  
 (c) 2.66 (d) 5.3

14. For which of the following reactions does the equilibrium constant depend on the units of concentration

[AIIMS 1983]

- (a)  $NO_{(g)} \rightleftharpoons \frac{1}{2}N_{2(g)} + \frac{1}{2}O_{2(g)}$   
 (b)  $Zn_{(s)} + Cu_{(aq)}^{2+} \rightleftharpoons Cu_{(s)} + Zn_{(aq)}^{2+}$   
 (c)  $C_2H_5OH_{(l)} + CH_3COOH_{(l)} \rightleftharpoons CH_3COOC_2H_5_{(l)} + H_2O_{(l)}$   
 (Reaction carried in an inert solvent)  
 (d)  $COCl_{2(g)} \rightleftharpoons CO_{(g)} + Cl_{2(g)}$

15. Unit of equilibrium constant for the reversible reaction  $H_2 + I_2 \rightleftharpoons 2HI$  is

[DPMT 1984]

- (a)  $mol^{-1} litre$  (b)  $mol^{-2} litre$   
 (c)  $mol litre^{-1}$  (d) None of these

16. The decomposition of  $N_2O_4$  to  $NO_2$  is carried out at 280K in chloroform. When equilibrium has been established, 0.2 mol of

- $N_2O_4$  and  $2 \times 10^{-3}$  mol of  $NO_2$  are present in 2 litre solution. The equilibrium constant for reaction  $N_2O_4 \rightleftharpoons 2NO_2$  is
- (a)  $1 \times 10^{-2}$  (b)  $2 \times 10^{-3}$   
(c)  $1 \times 10^{-5}$  (d)  $2 \times 10^{-5}$
17. Concentration of a gas is expressed in the following terms in the calculation of equilibrium constant [EAMCET 1982]
- (a) No. of molecules per litre  
(b) No. of grams per litre  
(c) No. of gram equivalent per litre  
(d) No. of molecules equivalent per litre
18. The unit of equilibrium constant  $K$  for the reaction  $A + B \rightleftharpoons C$  would be [CPMT 1987]
- (a)  $mol\ litre^{-1}$  (b)  $litremol^{-1}$   
(c)  $mol\ litre$  (d) Dimensionless
19. In a reaction  $A + B \rightleftharpoons C + D$ , the concentrations of  $A, B, C$  and  $D$  (in moles/litre) are 0.5, 0.8, 0.4 and 1.0 respectively. The equilibrium constant is [BHU 1981]
- (a) 0.1 (b) 1.0  
(c) 10 (d)  $\infty$
20. 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 [CBSE PMT 1989]
- (a) 1 (b) 0.36  
(c) 2.25 (d) 4/9
21. For the reaction  $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ , the correct expression of equilibrium constant  $K$  is [CPMT 1984, 2000]
- (a)  $K = \frac{[NH_3]^2}{[N_2][H_2]^3}$  (b)  $K = \frac{[N_2][H_2]^3}{[NH_3]^2}$   
(c)  $K = \frac{2[NH_3]}{[N_2] \times 3[H_2]}$  (d)  $K = \frac{[N_2] \times 3[H_2]}{2[NH_3]}$
22. The suitable expression for the equilibrium constant of the reaction  $2NO_{(g)} + Cl_{2(g)} \rightleftharpoons 2NOCl_{(g)}$  is [CPMT 1983, 87]
- (a)  $K_c = \frac{[2NOCl]}{[2NO][Cl_2]}$  (b)  $K_c = \frac{[NOCl]^2}{[NO]^2[Cl_2]}$   
(c)  $K_c = \frac{[NOCl]^2}{[NO][Cl_2]^2}$  (d)  $K_c = \frac{[NOCl]^2}{[NO]^2[Cl_2]^2}$
23.  $A + B \rightleftharpoons C + D$ . If finally the concentration of  $A$  and  $B$  are both equal but at equilibrium concentration of  $D$  will be twice of that of  $A$  then what will be the equilibrium constant of reaction. [BHU 2005]
- (a) 4 / 9 (b) 9 / 4  
(c) 1 / 9 (d) 4
24. If in the reaction  $N_2O_4 = 2NO_2$ ,  $\alpha$  is that part of  $N_2O_4$  which dissociates, then the number of moles at equilibrium will be [MP PET 1990; MH CET 2001; KCET 2005]
- (a) 3 (b) 1  
(c)  $(1 - \alpha)^2$  (d)  $(1 + \alpha)$
25. In the gas phase reaction,  $C_2H_4 + H_2 \rightleftharpoons C_2H_6$ , the equilibrium constant can be expressed in units of [CBSE PMT 1992; Pb. PMT 1999]
- (a)  $litre^{-1} mole^{-1}$  (b)  $litremole^{-1}$   
(c)  $\frac{mole}{litre}$  (d)  $mole\ litre^{-1}$
26. For the reaction  $2SO_2 + O_2 \rightleftharpoons 2SO_3$ , the units of  $K_c$  are [CPMT 1990]
- (a)  $litremole^{-1}$  (b)  $mol\ litre^{-1}$   
(c)  $(mol\ litre^{-1})^2$  (d)  $(litremole^{-1})^2$
27. A quantity of  $PCl_5$  was heated in a 10 litre vessel at  $250^\circ C$ ;  $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ . At equilibrium the vessel contains 0.1 mole of  $PCl_5$ , 0.20 mole of  $PCl_3$  and 0.2 mole of  $Cl_2$ . The equilibrium constant of the reaction is [KCET 1993, 2001; MP PMT 2003]
- (a) 0.02 (b) 0.05  
(c) 0.04 (d) 0.025
28. A mixture of 0.3 mole of  $H_2$  and 0.3 mole of  $I_2$  is allowed to react in a 10 litre evacuated flask at  $500^\circ C$ . The reaction is  $H_2 + I_2 \rightleftharpoons 2HI$ , the  $K$  is found to be 64. The amount of unreacted  $I_2$  at equilibrium is [KCET 1990]
- (a) 0.15 mole (b) 0.06 mole  
(c) 0.03 mole (d) 0.2 mole
29. In a chemical equilibrium, the rate constant of the backward reaction is  $7.5 \times 10^{-4}$  and the equilibrium constant is 1.5. So the rate constant of the forward reaction is [KCET 1989]
- (a)  $5 \times 10^{-4}$  (b)  $2 \times 10^{-3}$   
(c)  $1.125 \times 10^{-3}$  (d)  $9.0 \times 10^{-4}$
30. 28 g of  $N_2$  and 6 g of  $H_2$  were kept at  $400^\circ C$  in 1 litre vessel, the equilibrium mixture contained 27.54 g of  $NH_3$ . The approximate value of  $K_c$  for the above reaction can be (in  $mole^{-2} litre^2$ ) [CBSE PMT 1990]
- (a) 75 (b) 50  
(c) 25 (d) 100
31. The equilibrium concentration of  $X, Y$  and  $YX_2$  are 4, 2 and 2 moles respectively for the equilibrium  $2X + Y \rightleftharpoons YX_2$ . The value of  $K_c$  is [EAMCET 1990]
- (a) 0.625 (b) 0.0625  
(c) 6.25 (d) 0.00625
32. 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 [AIEEE 2005]
- (a) 0.30 (b) 0.18  
(c) 0.09 (d) 0.11
33. In the reaction  $A + 2B \rightleftharpoons 2C$ , if 2 moles of  $A$ , 3.0 moles of  $B$  and 2.0 moles of  $C$  are placed in a 2.0 l flask and the equilibrium concentration of  $C$  is 0.5 mole/l. The equilibrium constant ( $K_c$ ) for the reaction is [KCET 1996]
- (a) 0.073 (b) 0.147

- (c) 0.05 (d) 0.026
34. 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  $CO_2$ . The equilibrium constant  $K_c$  for the reaction  $CO + Cl_2 \rightleftharpoons COCl_2$  is [CBSE PMT 1998]
- (a) 5 (b) 10  
(c) 15 (d) 20
35. A reaction is  $A + B \rightarrow C + D$ . 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 [BHU 1998; KCET 2000]
- (a) 4 (b) 2  
(c) 1/4 (d) 1/2
36. 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 [EAMCET 1998]
- (a) 1 (b) 10  
(c) 5 (d) 0.33
37. 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 is [AIIMS 1998; IIT 1992; AFMC 1999; UPSEAT 2001]
- (a) 0.004 (b) 0.008  
(c) 0.016 (d) 0.160
38. At 3000 K the equilibrium pressures of  $CO$ ,  $CO$  and  $O$  are 0.6, 0.4 and 0.2 atmospheres respectively.  $K_p$  for the reaction,  $2CO_2 \rightleftharpoons 2CO + O_2$  is [JIPMER 1999]
- (a) 0.089 (b) 0.0533  
(c) 0.133 (d) 0.177
39. The rate constant for forward and backward reactions of hydrolysis of ester are  $1.1 \times 10^{-2}$  and  $1.5 \times 10^{-3}$  per minute respectively. Equilibrium constant for the reaction is  $CH_3COOC_2H_5 + H_2O \rightleftharpoons CH_3COOH + C_2H_5OH$  [AIIMS 1999]
- (a) 4.33 (b) 5.33  
(c) 6.33 (d) 7.33
40. At a certain temp.  $2HI \rightleftharpoons H_2 + I_2$ . Only 50%  $HI$  is dissociated at equilibrium. The equilibrium constant is [DCE 1999]
- (a) 0.25 (b) 1.0  
(c) 3.0 (d) 0.50
41. When 3 mole of  $A$  and 1 mole of  $B$  are mixed in 1 litre vessel the following reaction takes place  $A_{(g)} + B_{(g)} \rightleftharpoons 2C_{(g)}$ . 1.5 moles of  $C$  are formed. The equilibrium constant for the reaction is [MP PMT 2000]
- (a) 0.12 (b) 0.25  
(c) 0.50 (d) 4.0
42. 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  $6 \times 10^{22}$  [MP PMT 2000]
- (a)  $1.6 \times 10^{-8} M$  (b)  $3.2 \times 10^{-6} M$   
(c)  $3.2 \times 10^{-4} M$  (d)  $1.6 \times 10^{-4} M$
43. Equilibrium concentration of  $HI$ ,  $I_2$  and  $H_2$  is 0.7, 0.1 and 0.1 M respectively. The equilibrium constant for the reaction  $I_2 + H_2 \rightleftharpoons 2HI$  is [JIPMER 2000]
- (a) 36 (b) 49  
(c) 0.49 (d) 0.36
44. For the equilibrium  $N_2 + 3H_2 \rightleftharpoons 2NH_3$ ,  $K_c$  at 1000 K is  $2.37 \times 10^{-3}$ . If at equilibrium  $[N_2] = 2M$ ,  $[H_2] = 3M$ , the concentration of  $NH_3$  is [JIPMER 2000]
- (a) 0.00358 M (b) 0.0358 M  
(c) 0.358 M (d) 3.58 M
45. In the reaction,  $A + B \rightleftharpoons 2C$ , at equilibrium, the concentration of  $A$  and  $B$  is 0.20 mol  $l^{-1}$  each and that of  $C$  was found to be 0.60 mol  $l^{-1}$ . The equilibrium constant of the reaction is
- (a) 2.4 (b) 18  
(c) 4.8 (d) 9
46. 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 [KCET 2005]
- (a) 50 (b) 15  
(c) 100 (d) 25
47. In a chemical reaction equilibrium is established when [MP PET 2001]
- (a) Opposing reaction ceases  
(b) Concentration of reactants and products are equal  
(c) Velocity of opposing reaction is the same as that of forward reaction  
(d) Reaction ceases to generate heat
48. 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 [BHU 2000; CBSE PMT 2001]
- (a) 30.66 (b) 32.66  
(c) 34.66 (d) 36.66
49. Change in volume of the system does not alter the number of moles in which of the following equilibrium [AIEEE 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)  $SO_2Cl_{2(g)} \rightleftharpoons SO_{2(g)} + Cl_{2(g)}$
50. The rate of forward reaction is two times that of reverse reaction at a given temperature and identical concentration.  $K_{eq}$  is [KCET 2002]
- (a) 2.5 (b) 2.0  
(c) 0.5 (d) 1.5
51. Write the equilibrium constant  $K$  for  $CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$  [Kerala (Med.) 2002]
- (a)  $K = \frac{[H_3O^+][H_2O]}{[CH_3COO^-][CH_3COOH]}$

$$(b) K = \frac{[H_3O^+][CH_3COO^-]}{[H_2O][CH_3COOH]}$$

$$(c) K = \frac{[H_3O^+][H_2O]}{[CH_3COOH][CH_3COO^-]}$$

$$(d) K = \frac{[H_2O][CH_3COO^-]}{[H_2O][CH_3COOH]}$$

52. The equilibrium constant ( $K$ ) for the reaction

$HA + B \rightleftharpoons BH^+ + A^-$  is 100. If the rate constant for the forward reaction is 10 then rate constant for the backward reaction is [CBSE PMT 2002]

$$(a) 10^7 \quad (b) 10^3$$

$$(c) 10^{-3} \quad (d) 10^{-5}$$

53. 9.2 grams of  $N_2O_{4(g)}$  is taken in a closed one litre vessel and heated till the following equilibrium is reached  $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$ .

At equilibrium, 50%  $N_2O_{4(g)}$  is dissociated. What is the equilibrium constant (in  $mol\ litre$ ) (Molecular weight of  $N_2O_4 = 92$ ) [MP PET 2003]

$$(a) 0.1 \quad (b) 0.4$$

$$(c) 0.2 \quad (d) 2$$

54. Two moles of  $NH_3$  when put into a previously evacuated vessel (one litre), partially dissociate into  $N_2$  and  $H_2$ . If at equilibrium one mole of  $NH_3$  is present, the equilibrium constant is

$$(a) 3/4 \text{ mol}^2 \text{ litre}^{-2} \quad (b) 27/64 \text{ mol}^2 \text{ litre}^{-2}$$

$$(c) 27/32 \text{ mol}^2 \text{ litre}^{-2} \quad (d) 27/1 \text{ mol}^2 \text{ litre}^{-2}$$

55. In a reaction, reactant 'A' decomposes 10% in 1 hour, 20% on 2 hour and 30% in 3 hour. The unit of rate constant of this reaction is

$$(a) \text{sec}^{-1} \quad (b) \text{mol litre}^{-1} \text{sec}^{-1}$$

$$(c) \text{litremol}^{-1} \text{sec}^{-1} \quad (d) \text{litre}^2 \text{mol}^{-2} \text{sec}^{-1}$$

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

The equilibrium concentrations of  $PCl_5$  and  $PCl_3$  are 0.4 and 0.2 mole/litre respectively. If the value of  $K_c$  is 0.5 what is the concentration of  $Cl_2$  in moles/litre [EAMCET 2003]

$$(a) 2.0 \quad (b) 1.5$$

$$(c) 1.0 \quad (d) 0.5$$

57. 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 the aforesaid condition in the end [CBSE PMT 2003]

$$(a) 20 \text{ litres ammonia, } 25 \text{ litres nitrogen, } 15 \text{ litres hydrogen}$$

$$(b) 20 \text{ litres ammonia, } 20 \text{ litres nitrogen, } 20 \text{ litres hydrogen}$$

$$(c) 10 \text{ litres ammonia, } 25 \text{ litres nitrogen, } 15 \text{ litres hydrogen}$$

$$(d) 20 \text{ litres ammonia, } 10 \text{ litres nitrogen, } 30 \text{ litres hydrogen}$$

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

$$(a) 3.3 \times 10^2 \text{ mol litre}^{-1} \quad (b) 3 \times 10^{-1} \text{ mol litre}^{-1}$$

$$(c) 3 \times 10^{-3} \text{ mol litre}^{-1} \quad (d) 3 \times 10^3 \text{ mol litre}^{-1}$$

59. 3.2 moles of hydrogen iodide were heated in a sealed bulb at  $444^\circ C$  till the equilibrium state was reached. Its degree of

dissociation at this temperature was found to be 22%. The number of moles of hydrogen iodide present at equilibrium are [BHU 1982]

$$(a) 2.496$$

$$(b) 1.87$$

$$(c) 2$$

$$(d) 4$$

60. 56 g of nitrogen and 8 g 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 [KCET 2004]

$$(a) 1,2,2$$

$$(b) 2,2,1$$

$$(c) 1,1,2$$

$$(d) 2,1,2$$

61. The reaction,  $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$  is carried out in a  $1 \text{ dm}^3$  vessel and  $2 \text{ dm}^3$  vessel separately. The ratio of the reaction velocities will be [KCET 2004]

$$(a) 1 : 8$$

$$(b) 1 : 4$$

$$(c) 4 : 1$$

$$(d) 8 : 1$$

62. The compound A and B are mixed in equimolar proportion to form the products,  $A + B \rightleftharpoons C + D$ . At equilibrium, one third of A and B are consumed. The equilibrium constant for the reaction is [KCET 2004]

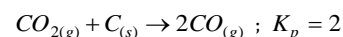
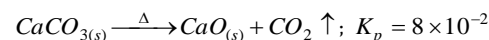
$$(a) 0.5$$

$$(b) 4.0$$

$$(c) 2.5$$

$$(d) 0.25$$

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



[Orissa JEE 2004]

$$(a) 0.4 \text{ MP PET 2003}$$

$$(b) 0.4$$

$$(c) 1.6$$

$$(d) 4$$

64. 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 [MP PET 2003]

$$(a) 4 \times 10^{-4}$$

$$(b) 50$$

$$(c) 2.5 \times 10^2$$

$$(d) 0.02$$

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

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

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

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

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

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

$$(a) 20.2$$

$$(b) 25.4$$

$$(c) 0.284$$

$$(d) 11.1$$

67. Ammonia carbonate when heated to  $200^\circ C$  gives a mixture of  $NH_3$  and  $CO_2$  vapour with a density of 13.0. What is the degree of dissociation of ammonium carbonate [Kerala PMT 2004]

$$(a) 3/2$$

$$(b) 1/2$$

$$(c) 2$$

$$(d) 1$$

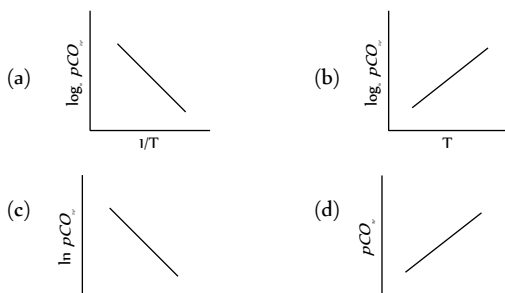
$$(e) 5/2$$

68. 2 mol of  $N_2$  is mixed with 6 mol of  $H_2$  in a closed vessel of one litre capacity. If 50% of  $N_2$  is converted into  $NH_3$  at equilibrium, the value of  $K_c$  for the reaction  $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$  is

- (a) 4/27 (b) 27/4  
(c) 1/27 (d) 24  
(e) 9
69. For a reaction  $H_2 + I_2 \rightleftharpoons 2HI$  at 721K, the value of equilibrium constant is 50. If 0.5 mols each of  $H_2$  and  $I_2$  is added to the system the value of equilibrium constant will be [DCE 2004]  
(a) 40 (b) 60  
(c) 50 (d) 30
70. What is the effect of halving the pressure by doubling the volume on the following system at 500°C  
 $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$  [UPSEAT 2004]  
(a) Shift to product side  
(b) Shift to product formation  
(c) Liquefaction of HI  
(d) No effect
71. When  $NaNO_3$  is heated in a closed vessel,  $O_2$  is liberated and  $NaNO_2$  is left behind. At equilibrium [IIT 1986; Roorkee 1995]  
(a) Addition of  $NaNO_3$  favours forward reaction  
(b) Addition of  $NaNO_2$  favours reverse reaction  
(c) Increasing pressure favours reverse reaction  
(d) Increasing temperature favours forward reaction
72. 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 [Orissa JEE 2005]  
(a)  $\frac{x^2}{(1-x)^2}$  (b)  $\frac{(1+x)^2}{(1-x)^2}$   
(c)  $\frac{x^2}{(2+x)^2}$  (d)  $\frac{x^2}{1-x^2}$
73. 0.6 mole of  $NH_3$  in a reaction vessel of 2 dm capacity was brought to equilibrium. The vessel was then found to contain 0.15 mole of  $H_2$  formed by the reaction  
 $2NH_{3(g)} = N_{2(g)} + 3H_{2(g)}$   
Which of the following statements is true [KCET 1999]  
(a) 0.15 mole of the original  $NH_3$  had dissociated at equilibrium  
(b) 0.55 mole of ammonia is left in the vessel  
(c) At equilibrium the vessel contained 0.45 mole of  $N_2$   
(d) The concentration of  $NH_3$  at equilibrium is 0.25 mole per dm
74. 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% of  $SO_2$  is used up. The total number of moles of  $SO_2$ ,  $O_2$  and  $SO_3$  in the vessel now is [KCET 2001]  
(a) 10.0 (b) 8.5  
(c) 10.5 (d) 3.9
1. In which of the following reaction, the value of  $K_p$  will be equal to  $K_c$  [MP PMT 1995]  
(a)  $H_2 + I_2 \rightleftharpoons 2HI$  (b)  $PCl_5 \rightleftharpoons PCl_3 + Cl_2$   
(c)  $2NH_3 \rightleftharpoons N_2 + 3H_2$  (d)  $2SO_2 + O_2 \rightleftharpoons 2SO_3$
2. Equilibrium constants  $K_1$  and  $K_2$  for the following equilibria  
 $NO(g) + \frac{1}{2}O_2 \rightleftharpoons NO_2(g)$   
and  $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$  are related as [CBSE PMT 2005]  
(a)  $K_2 = \frac{1}{K_1}$  (b)  $K_2 = K_1^2$   
(c)  $K_2 = \frac{K_1}{2}$  (d)  $K_2 = \frac{1}{K_1^2}$
3. For the reaction  $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$  at 250°C, the value of  $K_c$  is 26, then the value of  $K_p$  on the same temperature will be [MNR 1990; MP PET 2001]  
(a) 0.61 (b) 0.57  
(c) 0.83 (d) 0.46
4. The relation between equilibrium constant  $K_p$  and  $K_c$  is [IIT 1994; MP PMT 1994; CPMT 1997; AMU 2000; RPMT 2000, 02; MP PET 2002; Kerala PMT 2002]  
(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)  $K_p - K_c = (RT)^{\Delta n}$
5.  $CH_3COOH_{(l)} + C_2H_5OH_{(l)} \rightleftharpoons CH_3COOC_2H_5_{(l)} + H_2O_{(l)}$   
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]  
(a) 1 mole of ethyl acetate is formed  
(b) 2 mole of ethyl acetate are formed  
(c) 1/2 moles of ethyl acetate is formed  
(d) 2/3 moles of ethyl acetate is formed
6. If the equilibrium constant of the reaction  $2HI \rightleftharpoons H_2 + I_2$  is 0.25, then the equilibrium constant of the reaction  $H_2 + I_2 \rightleftharpoons 2HI$  would be [MP PMT 1989, 95]  
(a) 1.0 (b) 2.0  
(c) 3.0 (d) 4.0
7. For  $N_2 + 3H_2 \rightleftharpoons 2NH_3 + \text{heat}$  [CPMT 1990; MP PMT 1997; RPMT 1999; MP PET 2000; KCET 2001]  
(a)  $K_p = K_c(RT)$  (b)  $K_p = K_c(RT)$   
(c)  $K_p = K_c(RT)^{-2}$  (d)  $K_p = K_c(RT)^{-1}$
8. In the reaction  $N_2(g) + 3H_2 \rightleftharpoons 2NH_3(g)$ , the value of the equilibrium constant depends on [CPMT 1990; AIIMS 1991; MP PET 1996]  
(a) Volume of the reaction vessel

- (b) Total pressure of the system  
 (c) The initial concentration of nitrogen and hydrogen  
 (d) The temperature

9. For the chemical equilibrium,  $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ ,  $\Delta H_r^\circ$  can be determined from which one of the following plots [AIIMS 2005]



10. In which of the following equilibria, the value of  $K_p$  is less than  $K_c$  [MP PMT 1993]

- (a)  $H_2 + I_2 \rightleftharpoons 2HI$   
 (b)  $N_2 + 3H_2 \rightleftharpoons 2NH_3$   
 (c)  $N_2 + O_2 \rightleftharpoons 2NO$   
 (d)  $CO + H_2O \rightleftharpoons CO_2 + H_2$

11. 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 298 K. Which of the following relationships between  $K_1$  and  $K_2$  is correct

[CPMT 1988; CBSE PMT 1989; MP PET 1993, 95; RPMT 1999; MP PMT 2001]

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

12.  $H_2 + I_2 \rightleftharpoons 2HI$

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

[BHU 1979; CPMT 1990; CBSE PMT 1990]

- (a) Increase  
 (b) Decrease  
 (c) Remains the same  
 (d) Depends on the nature of the reactants

13. At a given temperature, the equilibrium constant for reaction  $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$  is  $2.4 \times 10^{-3}$ . At the same temperature, the equilibrium constant for reaction  $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$  is [KCET 1992]

- (a)  $2.4 \times 10^{-3}$  (b)  $-2.4 \times 10^{-3}$   
 (c)  $4.2 \times 10^2$  (d)  $4.8 \times 10^{-2}$

14. For the reaction  $C(s) + CO_2(g) \rightleftharpoons 2CO(g)$ , the partial pressure of  $CO_2$  and  $CO$  are 2.0 and 4.0 atm respectively at equilibrium.

The  $K_p$  for the reaction is [Roorkee 1990]

- (a) 0.5 (b) 4.0  
 (c) 8.0 (d) 32.0

15.  $K$  for the synthesis of  $HI$  is 50.  $K$  for dissociation of  $HI$  is [Roorkee 1990]

- (a) 50 (b) 5  
 (c) 0.2 (d) 0.02

16. In which one of the following gaseous equilibria  $K_p$  is less than  $K_c$  [EAMCET 1989; MP PET 1994; Pb. PMT 2000; KCET 2001; CBSE PMT 2002]

- (a)  $N_2O_4 \rightleftharpoons 2NO_2$  (b)  $2HI \rightleftharpoons H_2 + I_2$   
 (c)  $2SO_2 + O_2 \rightleftharpoons 2SO_3$  (d)  $N_2 + O_2 \rightleftharpoons 2NO$

17. For which of the following reactions  $K_p = K_c$

[KCET 1991; IIT 1991; EAMCET 1992; AIIMS 1996; KCET 2000; AMU 2000]

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

18. 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 [CBSE PMT 1990]

- (a) 0.002 (b) 0.2  
 (c) 50.0 (d) 50/RT

19. In which of the following reaction  $K_p > K_c$  [AFMC 1995]

- (a)  $N_2 + 3H_2 \rightleftharpoons 2NH_3$  (b)  $H_2 + I_2 \rightleftharpoons 2HI$   
 (c)  $PCl_3 + Cl_2 \rightleftharpoons PCl_5$  (d)  $2SO_3 \rightleftharpoons O_2 + 2SO_2$

20. For the reaction  $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

[MP PET 1996]

- (a)  $K_p = K_c$  (b)  $K_p = K_c(RT)^{-1}$   
 (c)  $K_p = K_c(RT)$  (d)  $K_p = K_c(RT)^2$

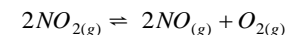
21. The equilibrium constant of the reaction  $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$  is 64. If the volume of the container is reduced to one fourth of its original volume, the value of the equilibrium constant will be [MP PET 1996]

- (a) 16 (b) 32  
 (c) 64 (d) 128

22. For the following gaseous reaction  $H_2 + I_2 \rightleftharpoons 2HI$ , the equilibrium constant [MP PMT 1996; MP PET/PMT 1998]

- (a)  $K_p > K_c$  (b)  $K_p < K_c$   
 (c)  $K_p = K_c$  (d)  $K_p = 1/K_c$

23. For the reaction



$$(K_c = 1.8 \times 10^{-6} \text{ at } 184^\circ C)$$

$$(R = 0.0831 \text{ kJ/(mol.K)})$$

When  $K_p$  and  $K_c$  are compared at  $184^\circ\text{C}$  it is found that

[AIEEE 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

24. In equilibrium  $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}_3\text{O}^+$

The equilibrium constant may change when

- (a)  $\text{CH}_3\text{COO}^-$  are added (b)  $\text{CH}_3\text{COOH}$  is added  
 (c) Catalyst is added (d) Mixture is heated

25. For reaction  $2\text{NOCl}(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) + \text{Cl}_2(\text{g})$ ,  $K_c$  at  $427^\circ\text{C}$  is

$3 \times 10^{-6} \text{ L mol}^{-1}$ . The value of  $K_p$  is nearly [AIIMS 2005]

- (a)  $7.50 \times 10^{-5}$  (b)  $2.50 \times 10^{-5}$   
 (c)  $2.50 \times 10^{-4}$  (d)  $1.75 \times 10^{-4}$

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

[MP PET 1997]

- (a)  $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$  (b)  $\text{N}_2 + \text{O}_2 \rightleftharpoons 2\text{NO}$   
 (c)  $\text{PCl}_5 \rightleftharpoons \text{PCl}_3 + \text{Cl}_2$  (d)  $2\text{SO}_3 \rightleftharpoons 2\text{SO}_2 + \text{O}_2$

27. The equilibrium constant for the reversible reaction,  $\text{N}_2 + 3\text{H}_2 \rightleftharpoons$

$2\text{NH}_3$  is  $K$  and for the reaction  $\frac{1}{2}\text{N}_2 + \frac{3}{2}\text{H}_2 \rightleftharpoons \text{NH}_3$  the equilibrium constant is  $K'$ .  $K$  and  $K'$  will be related as

- (a)  $K = K'$  (b)  $K' = \sqrt{K}$   
 (c)  $K = \sqrt{K'}$  (d)  $K \times K' = 1$

28. The equilibrium constant ( $K_p$ ) for the reaction  $\text{PCl}_5(\text{g}) \rightarrow \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$  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

[KCET 1996]

- (a) 32 (b) 64  
 (c) 16 (d) 4

29.  $2\text{NO}_2 \rightleftharpoons 2\text{NO} + \text{O}_2$ ;  $K = 1.6 \times 10^{-12}$

$\text{NO} + \frac{1}{2}\text{O}_2 \rightleftharpoons \text{NO}_2$   $K' = ?$

[CPMT 1996]

- (a)  $K' = \frac{1}{K^2}$  (b)  $K' = \frac{1}{K}$   
 (c)  $K' = \frac{1}{\sqrt{K}}$  (d) None of these

30. The value of  $K_p$  for the following reaction  $2\text{H}_2\text{S}(\text{g}) \rightleftharpoons 2\text{H}_2(\text{g}) + \text{S}_2(\text{g})$  is  $1.2 \times 10^{-2}$  at  $106.5^\circ\text{C}$ . The value of  $K_c$  for this reaction is

[EAMCET 1997; AIIMS 1999; AFMC 2000; KCET 2001]

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

31. Which statement for equilibrium constant is true for the reaction  $\text{A} + \text{B} \rightleftharpoons \text{C}$

[CPMT 1997]

- (a) Not changes with temperature  
 (b) Changes when catalyst is added  
 (c) Increases with temperature

(d) Changes with temperature

32. The equilibrium constant for the reaction  $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$  is  $K$ , then the equilibrium constant for the equilibrium  $\text{NH}_3 \rightleftharpoons \frac{1}{2}\text{N}_2 + \frac{3}{2}\text{H}_2$  is

[CBSE PMT 1996; UPSEAT 2001]

- (a)  $1/K$  (b)  $1/K^2$   
 (c)  $\sqrt{K}$  (d)  $\frac{1}{\sqrt{K}}$

33. Which of the following statements regarding a chemical equilibrium is wrong [JIPMER 1999]

- (a) An equilibrium can be shifted by altering the temperature or pressure  
 (b) An equilibrium is dynamic  
 (c) The same state of equilibrium is reached whether one starts with the reactants or the products  
 (d) The forward reaction is favoured by the addition of a catalyst

34. The reaction between  $\text{N}_2$  and  $\text{H}_2$  to form ammonia has

$K_c = 6 \times 10^{-2}$  at the temperature  $500^\circ\text{C}$ . The numerical value of  $K_p$  for this reaction is [UPSEAT 1999]

- (a)  $1.5 \times 10^{-5}$  (b)  $1.5 \times 10^5$   
 (c)  $1.5 \times 10^{-6}$  (d)  $1.5 \times 10^6$

35. For the gaseous phase reaction



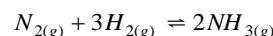
Which statement is correct

[MP PET 1997]

- (a)  $K$  varies with addition of  $\text{NO}$   
 (b)  $K$  decrease as temperature decreases  
 (c)  $K$  increases as temperature decreases  
 (d)  $K$  is independent of temperature

[MH CET 1999]

36. For the reversible reaction,



at  $500^\circ\text{C}$ , 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, is

[IIT Screening 2000; Pb. CET 2004]

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

37. A chemical reaction is catalyzed by a catalyst  $X$ . Hence  $X$

[AIIMS 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

38. At  $490^\circ\text{C}$ , the equilibrium constant for the synthesis of  $\text{HI}$  is 50, the value of  $K$  for the dissociation of  $\text{HI}$  will be

[KCET 2000]

- (a) 20.0 (b) 2.0  
 (c) 0.2 (d) 0.02

39. In which of the following case  $K$  is less than  $K'$

[AFMC 1997; Pb. PMT 2000]

- (a)  $\text{H}_2 + \text{Cl}_2 \rightleftharpoons 2\text{HCl}$  (b)  $2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3$   
 (c)  $\text{N}_2 + \text{O}_2 \rightleftharpoons 2\text{NO}$  (d)  $\text{PCl}_5 \rightleftharpoons \text{PCl}_3 + \text{Cl}_2$



40.  $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$  which of the following expression is correct [MH CET 2000]
- (a)  $K_p = (P_{CaO} + P_{CO_2} / P_{CaCO_3})$   
 (b)  $K_p = P_{CO_2}$   
 (c)  $K_p \times (P_{CaO} \times P_{CO_2}) \cdot P_{CaCO_3}$   
 (d)  $\frac{K_p [CaO][CO_2]}{[CaCO_3]}$
41. If  $K_c$  is the equilibrium constant for the formation of  $NH_3$ , the dissociation constant of ammonia under the same temperature will be [DPMT 2001]
- (a)  $K_c$  (b)  $\sqrt{K_c}$   
 (c)  $K_c^2$  (d)  $1/K_c$
42. 3.2 moles of hydrogen iodide were heated in a sealed bulb at  $444^\circ C$  till the equilibrium was reached. The degree of dissociation of  $HI$  at this temperature was found to be 22%. The number of moles of hydrogen iodide present at equilibrium are [MH CET 2001]
- (a) 1.87 (b) 2.496  
 (c) 4.00 (d) 2.00
43. The  $K_c$  for  $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$  is 64. If the volume of the container is reduced to one-half of its original volume, the value of the equilibrium constant will be [JIPMER 2001]
- (a) +28 (b) 64  
 (c) 32 (d) 16
44. A reversible reaction  $H_2 + Cl_2 \rightleftharpoons 2HCl$  is carried out in one litre flask. If the same reaction is carried out in two litre flask, the equilibrium constant will be [JIPMER 2001]
- (a) Decreased (b) Doubled  
 (c) Halved (d) Same
45. For the reaction  $2NO_{2(g)} \rightleftharpoons 2NO_{(g)} + O_{2(g)}$ ,  $K_c = 1.8 \times 10^{-6}$  at  $185^\circ C$ . At  $185^\circ C$  the  $K$  for  $NO_{(g)} + \frac{1}{2} O_{2(g)} \rightleftharpoons NO_{2(g)}$  is [JIPMER 2001]
- (a)  $1.95 \times 10^{-3}$  (b)  $1.95 \times 10^3$   
 (c)  $7.5 \times 10^2$  (d)  $0.9 \times 10^6$
46. If for  $H_{2(g)} + \frac{1}{2} S_{2(g)} \rightleftharpoons H_2S_{(g)}$  and  $H_{2(g)} + Br_{2(g)} \rightleftharpoons 2HBr_{(g)}$  The equilibrium constants are  $K_1$  and  $K_2$  respectively, the reaction  $Br_{2(g)} + H_2S_{(g)} \rightleftharpoons 2HBr_{(g)} + \frac{1}{2} S_{2(g)}$  would have equilibrium constant [MP PMT 2001]
- (a)  $K_1 \times K_2$  (b)  $K_1 / K_2$   
 (c)  $K_2 / K_1$  (d)  $K_2^2 / K_1$
47. Some solid  $NH_4HS$  is placed in a flask containing 0.5 atm of  $NH_3$ , what would be pressures of  $NH_3$  and  $H_2S$  when equilibrium is reached  $NH_4HS_{(s)} \rightleftharpoons NH_{3(g)} + H_2S_{(g)}$ ,  $K_p = 0.11$  [UPSEAT 2001]
- (a) 6.65 atm (b) 0.665 atm  
 (c) 0.0665 atm (d) 66.5 atm
48. In which of the following reactions, increase in the volume at constant temperature don't affect the number of moles at equilibrium. [AIEEE 2002]
- (a)  $2NH_3 \rightleftharpoons N_2 + 3H_2$  (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
49. A chemical reaction was carried out at 300 K and 280 K. The rate constants were found to be  $K$  and  $K'$  respectively. The energy of activation is  $1.157 \times 10^4 \text{ cal mole}^{-1}$  and  $R = 1.987 \text{ cal}$ . Then
- (a)  $K_2 \approx 0.25K_1$  (b)  $K_2 \approx 0.5K_1$   
 (c)  $K_2 \approx 4K_1$  (d)  $K_2 \approx 2K_1$
50.  $\Delta n$ , the change in the number of moles for the reaction,  $C_{12}H_{22}O_{11(s)} + 12O_{2(g)} \rightleftharpoons 12CO_{2(g)} + 11H_2O_{(l)}$  at  $25^\circ C$  is [Pb. PMT 2002]
- (a) 0 (b) 2  
 (c) 4 (d) -1
51. Value of  $K_p$  in the reaction  $MgCO_{3(s)} \rightleftharpoons MgO_{(s)} + CO_{2(g)}$  is [CBSE PMT 2000; RPMT 2002]
- (a)  $K_p = P_{CO_2}$   
 (b)  $K_p = P_{CO_2} \times \frac{P_{CO_2} \times P_{MgO}}{P_{MgCO_3}}$   
 (c)  $K_p = \frac{P_{CO_2} \times P_{MgO}}{P_{MgCO_3}}$   
 (d)  $K_p = \frac{P_{MgCO_3}}{P_{CO_2} \times P_{MgO}}$
52. For  $N_2 + 3H_2 \rightleftharpoons 2NH_3$  equilibrium constant is  $k$  then equilibrium constant for  $2N_2 + 6H_2 \rightleftharpoons 4NH_3$  is [RPMT 2002]
- (a)  $\sqrt{k}$  (b)  $k^2$   
 (c)  $k/2$  (d)  $\sqrt{k+1}$
53. For the reaction,  $PCl_{3(g)} + Cl_{2(g)} \rightleftharpoons PCl_{5(g)}$ , the value of  $K_c$  at  $250^\circ C$  is 26. The value of  $K_p$  at this temperature will be [UPSEAT 1999, 2000, 02]
- (a) 0.61 (b) 0.57  
 (c) 0.83 (d) 0.46
54. A tenfold increase in pressure on the reaction  $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$  at equilibrium, makes  $K_p$  [MP PET 2003]
- (a) Unchanged (b) Two times  
 (c) Four times (d) Ten times
55. If equilibrium constant for reaction  $2AB \rightleftharpoons A_2 + B_2$ , is 49, then the equilibrium constant for reaction  $AB \rightleftharpoons \frac{1}{2} A_2 + \frac{1}{2} B_2$ , will be [EAMCET 1998; MP PMT 2003]
- (a) 7 (b) 20  
 (c) 49 (d) 21
56. In the manufacture of ammonia by Haber's process,  $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} + 92.3 \text{ kJ}$ , which of the following conditions is unfavourable [KCET 2004]
- (a) Increasing the temperature

- (b) Increasing the pressure  
(c) Reducing the temperature  
(d) Removing ammonia as it is formed
57. The chemical equilibrium of a reversible reaction is not influenced by [KCET 2004]  
(a) Pressure  
(b) Catalyst  
(c) Concentration of the reactants  
(d) Temperature
58. Of the following which change will shift the reaction towards the product  
 $I_2(g) \rightleftharpoons 2I(g)$ ,  $\Delta H_r^0(298K) = +150 \text{ kJ}$  [AIIMS 2004]  
(a) Increase in concentration of I  
(b) Decrease in concentration of  $I_2$   
(c) Increase in temperature  
(d) Increase in total pressure
59. For the reaction,  $CO(g) + Cl_{2(g)} \rightleftharpoons COCl_{2(g)}$  the  $K_p / K_c$  is equal to [AIEEE 2004]  
(a)  $\sqrt{RT}$  (b)  $RT$   
(c)  $1/RT$  (d) 1.0
60. Consider the following reversible reaction at equilibrium,  $2H_2O(g) \rightleftharpoons 2H_{2(g)} + O_{2(g)}$ ;  $\Delta H = 241.7 \text{ kJ}$   
Which one of the following changes in conditions will lead to maximum decomposition of  $H_2O(g)$  [Kerala PMT 2004]  
(a) Increasing both temperature and pressure  
(b) Decreasing temperature and increasing pressure  
(c) Increasing temperature and decreasing pressure  
(d) Increasing temperature at constant pressure
61. For reaction,  $2A(g) \rightleftharpoons 3C(g) + D(g)$ , the value of  $K_c$  will be equal to [Pb. CET 2003]  
(a)  $K_p(RT)$  (b)  $K_p / RT$   
(c)  $= K_p$  (d) None of these
62. In the reaction,  $A_2(g) + 4B_2(g) \rightleftharpoons 2AB_4(g)$   
 $\Delta H < 0$  the formation of  $AB_4$  is will be favoured at [IIT Screening 1990; MP PET 2004]  
(a) Low temperature, high pressure  
(b) High temperature, low pressure  
(c) Low temperature, low pressure  
(d) High temperature, high pressure
63. The formation of  $SO_3$  takes place according to the following reaction,  $2SO_2 + O_2 \rightleftharpoons 2SO_3$ ;  $\Delta H = -45.2 \text{ kcal}$   
The formation of  $SO_3$  is favoured by [UPSEAT 2004]  
(a) Increasing in temperature  
(b) Removal of oxygen  
(c) Increase of volume  
(d) Increasing of pressure
64. What is the effect of increasing pressure on the dissociation of  $PCl_5$  according to the equation  
 $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)} - x \text{ cal}$  [UPSEAT 2004]  
(a) Dissociation decreases  
(b) Dissociation increases  
(c) Dissociation does not change  
(d) None of these
65. 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 [BHU 2004]  
(a)  $K_1 = K_2$  (b)  $K_2 = \sqrt{K_1}$   
(c)  $K_1 = 2K_2$  (d)  $K_1 = \frac{1}{2}K_2$
66. For the following reaction in gaseous phase  $CO + \frac{1}{2}O_2 \rightarrow CO_2$ ;  $K_p / K_c$  is [DCE 2002]  
(a)  $(RT)^{1/2}$  (b)  $(RT)^{-1/2}$   
(c)  $(RT)$  (d)  $(RT)^{-1}$
67. For the reaction  $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$ , the value of  $K_c$  at  $800^\circ C$  is 0.1. When the equilibrium concentrations of both the reactants is 0.5 mol, what is the value of  $K_p$  at the same temperature [KCET 2005]  
(a) 0.5 (b) 0.1  
(c) 0.01 (d) 0.025
68.  $A_{(g)} + 3B_{(g)} \rightleftharpoons 4C_{(g)}$ . Starting concentration of A is equal to B, equilibrium concentration of A and C are same.  $K_c =$  [Kerala CET 2005]  
(a) 0.08 (b) 0.8  
(c) 8 (d) 80  
(e) 1/8
69.  $NH_4COONH_{2(s)} \rightleftharpoons 2NH_{3(g)} + CO_{2(g)}$  if equilibrium pressure is 3 atm for the above reaction  $K_p$  for the reaction is  
(a) 4 (b) 27  
(c) 4/27 (d) 1/27

### Activation energy, Standard free energy and Degree of dissociation and Vapour density

1. The vapour density of completely dissociated  $NH_4Cl$  would be  
(a) Slight less than half that of  $NH_4Cl$   
(b) Half that of  $NH_4Cl$   
(c) Double that of  $NH_4Cl$   
(d) Determined by the amount of solid  $NH_4Cl$  in the experiment
2. In an equilibrium reaction for which  $\Delta G^0 = 0$ , the equilibrium constant  $K =$  [BHU 1987]  
(a) 0 (b) 1  
(c) 2 (d) 10
3. 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
4. A reaction attains equilibrium when the free energy change accompanying it is [KCET 1989]  
(a) Positive and large (b) Zero

- (c) Negative and large (d) Negative and small
5.  $\Delta G^{\circ}(HI, g) \cong +1.7 \text{ kJ}$ . What is the equilibrium constant at  $25^{\circ} \text{C}$  for  $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$  [KCET 1992]
- (a) 24.0 (b) 3.9  
(c) 2.0 (d) 0.5
6. The standard state gibbs free energy change for the given isomerization reaction *cis*-2-pentene  $\rightleftharpoons$  *trans*-2-pentene is  $-3.67 \text{ kJ/mol}$  at  $400 \text{ K}$ . If more *trans*-2-pentene is added to the reaction vessel, then [CBSE PMT 1995; BHU 1999; AFMC 2000]
- (a) More *cis*-2-pentene is formed  
(b) Equilibrium is shifted in the forward direction  
(c) Equilibrium remains unaffected  
(d) Additional *trans*-2-pentene is formed
7. In a reversible reaction, the catalyst [KCET 2003]
- (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
8. For the reaction  $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ , the equilibrium constant changes with [IIT 1981; MNR 1983, 85; NCERT 1984; MP PMT 1987, 97; MP PET/PMT 1988; CPMT 1976, 90; UPSEAT 2000]
- (a) Total pressure  
(b) Catalyst  
(c) The amounts of  $H_2$  and  $I_2$  taken  
(d) Temperature
9. Calculate  $\Delta G^{\circ}$  for conversion of oxygen to ozone  $3/2 O_2(g) \rightarrow O_3(g)$  at  $298 \text{ K}$ , if  $K_p$  for this conversion is  $2.47 \times 10^{-29}$  [DPMT 2004]
- (a)  $163 \text{ kJ mol}^{-1}$  (b)  $2.4 \times 10^2 \text{ kJ mol}^{-1}$   
(c)  $1.63 \text{ kJ mol}^{-1}$  (d)  $2.38 \times 10^6 \text{ kJ mol}^{-1}$
- (a) The speed of forward and backward reaction increases  
(b) The speed of forward and backward reaction decreases  
(c) Only the speed of that reaction increases which nullifies the factor causing increase of speed  
(d) No difference
4. Which of the following reactions proceed at low pressure [MP PET 1985; CPMT 1984; MP PMT 1995; RPMT 1997]
- (a)  $N_2 + 3H_2 \rightleftharpoons 2NH_3$  (b)  $H_2 + I_2 \rightleftharpoons 2HI$   
(c)  $PCl_5 \rightleftharpoons PCl_3 + Cl_2$  (d)  $N_2 + O_2 \rightleftharpoons 2NO$
5. Le-chatelier principle is applicable
- (a) Both for physical and chemical equilibrium  
(b) Only for chemical equilibrium  
(c) Only for physical equilibrium  
(d) Neither for (b) nor for (c)
6. In the following reversible reaction  $2SO_2 + O_2 \rightleftharpoons 2SO_3 + Q \text{ Cal}$
- Most suitable condition for the higher production of  $SO_3$  is [NCERT 1974; DPMT 1983, 89; IIT 1981; MP PET 1992; MP PMT 1990, 91, 94, 99; CPMT 1973, 77, 84, 89, 94, 99]
- (a) High temperature and high pressure  
(b) High temperature and low pressure  
(c) Low temperature and high pressure  
(d) Low temperature and low pressure
7. When the pressure is applied over system  $ice \rightleftharpoons water$  what will happen? [MP PMT 1990; CPMT 1983; NCERT 1978; DPMT 2002]
- (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  $O_2$
8. The reaction  $A + B \rightleftharpoons C + D + heat$  has reached equilibrium. The reaction may be made to proceed forward by [IIT 1978]
- (a) Adding more C  
(b) Adding more D  
(c) Decreasing the temperature  
(d) Increasing the temperature
9. On the velocity in a reversible reaction, the correct explanation of the effect of catalyst is [MP PMT 1987]
- (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
10. Select the correct statement from the following [MP PMT 1985]
- (a) Equilibrium constant changes with addition of catalyst  
(b) Catalyst increases the rate of forward reaction  
(c) The ratio of mixture at equilibrium is not changed by catalyst  
(d) Catalyst are active only in solution
11. According to Le-chatelier principle, if heat is given to solid-liquid system, then [MNR 1990]
- (a) Quantity of solid will reduce

### Le-Chatelier principle and It's application

1. When in any system at equilibrium state pressure, temperature and concentration is changed then the equilibria shifted to such a direction which neutralize the effect of change. This is known as [MP PMT/PET 1988; DPMT 1985]
- (a) First law of thermodynamics  
(b) Le-chatelier's principle  
(c) Ostwald's rule  
(d) Hess's law of constant heat summation
2.  $N_2 + O_2 \rightleftharpoons 2NO - Q \text{ cal}$
- In the above reaction which is the essential condition for the higher production of  $NO$  [CPMT 1971, 89; MP PMT 1985]
- (a) High temperature (b) High pressure  
(c) Low temperature (d) Low pressure
3. A reversible reaction is in equilibrium. If a factor is changed which affect it, then

- (b) Quantity of liquid will reduce  
(c) Increase in temperature  
(d) Decrease in temperature
12. In the reaction  $A(g) + 2B(g) \rightleftharpoons C(g) + Q$ , greater product will be obtained **or** the forward reaction is favoured by  
[MNR 1988; MP PMT 1989, 97]  
(a) At high temperature and high pressure  
(b) At high temperature and low pressure  
(c) At low temperature and high pressure  
(d) At low temperature and low pressure
13. Following gaseous reaction is undergoing in a vessel  
 $C_2H_4 + H_2 \rightleftharpoons C_2H_6$ ;  $\Delta H = -32.7 \text{ Kcal}$   
Which will increase the equilibrium concentration of  $C_2H_6$   
[IIT 1984; MP PET/PMT 1988; MADT Bihar 1995]  
(a) Increase of temperature  
(b) By reducing temperature  
(c) By removing some hydrogen  
(d) By adding some  $C_2H_6$
14. The effect of increasing the pressure on the equilibrium  
 $2A + 3B \rightleftharpoons 3A + 2B$  is  
[EAMCET 1980; MP PMT 1991]  
(a) Forward reaction is favoured  
(b) Backward reaction is favoured  
(c) No effect  
(d) None of the above
15. For the equilibrium  $2NO_2(g) \rightleftharpoons N_2O_4(g) + 14.6 \text{ kcal}$  the increase in temperature would  
[CPMT 1974, 78]  
(a) Favour the formation of  $N_2O_4$   
(b) Favour the decomposition of  $N_2O_4$   
(c) Not alter the equilibrium  
(d) Stop the reaction
16. Which of the following factors will favour the reverse reaction in a chemical equilibrium  
[AIIMS 1982]  
(a) Increase in the concentration of one of the reactants  
(b) Removal of at least one of the product at regular time intervals  
(c) Increase in the concentration of one or more products  
(d) None of these
17. In the formation of  $SO_3$  by contact process, the conditions used are  
[CPMT 1984]  
(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
18. Given reaction is  $2X_{(gas)} + Y_{(gas)} \rightleftharpoons 2Z_{(gas)} + 80 \text{ kcal}$   
Which combination of pressure and temperature gives the highest yield of Z at equilibrium  
[NCERT 1979]  
(a) 1000 atm and  $500^\circ C$   
(b) 500 atm and  $500^\circ C$   
(c) 1000 atm and  $100^\circ C$   
(d) 500 atm and  $100^\circ C$
19. Consider the reaction  $HCN_{(aq)} \rightleftharpoons H^+_{(aq)} + CN^-_{(aq)}$ . At equilibrium, the addition of  $CN^-_{(aq)}$  would  
[NCERT 1979]  
(a) Reduce  $HCN_{(aq)}$  concentration  
(b) Decrease the  $H^+_{(aq)}$  ion concentration  
(c) Increase the equilibrium constant  
(d) Decrease the equilibrium constant
20. In the gaseous equilibrium  $H_2X_2 + \text{heat} \rightleftharpoons 2HX$ , the formation of  $HX$  will be favoured by [CPMT 1977]  
(a) High pressure and low temperature  
(b) High temperature and low pressure  
(c) Low temperature and low pressure  
(d) High temperature and high pressure
21. Raising the temperature of an equilibrium system  
[MP PMT 1987]  
(a) Favours the exothermic reaction only  
(b) Favours the endothermic reaction only  
(c) Favours both the exothermic and endothermic reactions  
(d) Favours neither the exothermic nor endothermic reactions
22. Reaction in which yield of product will increase with increase in pressure is  
[NCERT 1984]  
(a)  $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$   
(b)  $H_2O_{(g)} + CO_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$   
(c)  $H_2O_{(g)} + C_{(s)} \rightleftharpoons CO_{(g)} + H_{2(g)}$   
(d)  $CO_{(g)} + 3H_{2(g)} \rightleftharpoons CH_{4(g)} + H_2O_{(g)}$
23. In reaction  $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ ;  $\Delta H = -93.6 \text{ kJ}$ , the yield of ammonia does not increase when  
[CPMT 1988]  
(a) Pressure is increased  
(b) Temperature is lowered  
(c) Pressure is lowered  
(d) Volume of the reaction vessel is decreased
24. The equilibrium which remains unaffected by change in pressure of the reactants is  
[CPMT 1987; KCET 1991; EAMCET 1992; MP PET 1992, 95; MP PMT 1999]  
(a)  $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$   
(b)  $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$   
(c)  $2O_{3(g)} \rightleftharpoons 3O_{2(g)}$   
(d)  $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$
25. The endothermic reaction ( $M + N \rightleftharpoons P$ ) is allowed to attain an equilibrium at  $25^\circ$ . Formation of  $P$  can be increased by [BHU 1981]  
(a) Raising temperature  
(b) Lowering temperature  
(c) Keeping temperature constant  
(d) Decreasing the concentration of  $M$  and  $N$
26. According to Le-chatelier's principle, an increase in the temperature of the following reaction will  
 $N_2 + O_2 \rightleftharpoons 2NO - 43,200 \text{ kcal}$   
[MP PMT 1985, 93]  
(a) Increase the yield of  $NO$   
(b) Decrease the yield of  $NO$

- (c) Not effect the yield of  $NO$   
(d) Not help the reaction to proceed in forward direction
27. In the manufacture of  $NH_3$  by Haber's process, the condition which would give maximum yield is  

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 + Q \text{ kcal}$$
 [NCERT 1978; EAMCET 1980; MNR 1987; AFMC 1999; CPMT 1983, 84, 86, 94; MP PMT 1999]  
 (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  $H_2$
28. Suppose the reaction  $PCl_5(s) \rightleftharpoons PCl_3(s) + Cl_2(g)$  is in a closed vessel at equilibrium stage. What is the effect on equilibrium concentration of  $Cl_2(g)$  by adding  $PCl_5$  at constant temperature [MP PMT 1992]  
 (a) Decreases  
 (b) Increases  
 (c) Unaffected  
 (d) Cannot be described without the value of  $K_p$
29. In which of the following equilibrium reactions, the equilibrium would shift to the right, if total pressure is increased [KCET 1993]  
 (a)  $N_2 + 3H_2 \rightleftharpoons 2NH_3$       (b)  $H_2 + I_2 \rightleftharpoons 2HI$   
 (c)  $H_2 + Cl_2 \rightleftharpoons 2HCl$       (d)  $N_2O_4 \rightleftharpoons 2NO$
30. In which of the following gaseous equilibrium an increase in pressure will increase the yield of the products [EAMCET 1988]  
 (a)  $2HI \rightleftharpoons H_2 + I_2$       (b)  $2SO_2 + O_2 \rightleftharpoons 2SO_3$   
 (c)  $H_2 + Br_2 \rightleftharpoons 2HBr$       (d)  $H_2O + CO \rightleftharpoons H_2 + CO_2$
31. In the reaction  $A(g) + B(g) \rightleftharpoons C(g)$ , the backward reaction is favoured by [EAMCET 1986]  
 (a) Decrease of pressure      (b) Increase of pressure  
 (c) Either of the two      (d) None of the two
32. The formation of  $NO_2$  in the reaction  $2NO + O_2 \rightleftharpoons 2NO_2 + \text{heat}$  is favoured by [Rookee Qualifying 1998]  
 (a) Low pressure      (b) High pressure  
 (c) Low temperature      (d) Reduction in the mass of
33. For the reaction  $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ , the forward reaction at constant temperature is favoured by [IIT 1991; AMU 2001]  
 (a) Introducing an inert gas at constant volume  
 (b) Introducing chlorine gas at constant volume  
 (c) Introducing an inert gas at constant pressure  
 (d) Decreasing the volume of the container
34. Which of the following conditions is favourable for the production of ammonia by Haber's process [MP PET 1994]  
 (a) High concentration of reactants  
 (b) Low temperature and high pressure  
 (c) Continuous removal of ammonia  
 (d) All of these
35. According to Le-chatelier's principle, which of the following factors influence a chemical system [MP PMT 1996]  
 (a) Concentration only  
 (b) Pressure only  
 (c) Temperature only  
 (d) Concentration, pressure and temperature
36. If pressure increases then its effect on given equilibrium  $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$  it is satisfied in [BCECE 2005]  
 (a) Forward direction      (b) Backward direction  
 (c) No effect      (d) None of these
37. The exothermic formation of  $ClF_3$  is represented by the equation  

$$Cl_2(g) + 3F_2(g) \rightleftharpoons 2ClF_3(g); \Delta H = -329 \text{ kJ}$$
 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]  
 (a) Increasing the temperature  
 (b) Removing  $Cl_2$   
 (c) Increasing the volume of the container  
 (d) Adding  $F_2$
38. What would happen to a reversible reaction at equilibrium when an inert gas is added while the pressure remains unchanged  
 (a) More of the product will be formed  
 (b) Less of the product will be formed  
 (c) More of the reactants will be formed  
 (d) It remains unaffected
39. Formation of  $SO_3$  takes place according to the reaction  $2SO_2 + O_2 \rightleftharpoons 2SO_3; \Delta H = -45.2 \text{ kcal}$   
 Which of the following factors favours the formation of  $SO_3$  [MP PET/PMT 1998]  
 (a) Increase in temperature  
 (b) Increase in pressure  
 (c) Removal of oxygen  
 (d) Increase in volume
40. For the chemical reaction  $3X(g) + Y(g) \rightleftharpoons X_3Y(g)$ , the amount of  $X_3Y$  at equilibrium is affected by [IIT 1999]  
 (a) Temperature and pressure  
 (b) Temperature only  
 (c) Pressure only  
 (d) Temperature, pressure and catalyst
41. In  $N_2 + 3H_2 \rightleftharpoons 2NH_3$  reversible reaction, increase in pressure will favour [DPMT 1996]  
 (a) Reaction in forward direction  
 (b) Reaction in reverse direction  
 (c) Will not exert any effect  
 (d) In backward and forward direction equally
42. In the reaction  $N_2 + 3H_2 \rightarrow 2NH_3$ , the product increases on  
 (a) Increasing temperature  
 (b) Increasing pressure  
 (c) Increasing temperature and pressure both  
 (d) Decreasing temperature and pressure both  
 (e) None of these
43. In which of the following system, doubling the volume of the container cause a shift to the right [AIIMS 1996]  
 (a)  $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$   
 (b)  $2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$

- (c)  $N_2(g) + 3H_2(g) = 2NH_3(g)$   
 (d)  $PCl_5(g) = PCl_3(g) + Cl_2(g)$
44. Which of the following information can be obtained on the basis of Le-Chatelier's principle  
 [AIIMS 1998; Pb. PMT 1999; BHU 2000; DPMT 2004]
- (a) Entropy change in a reaction  
 (b) Dissociation constant of a weak acid  
 (c) Equilibrium constant of a chemical reaction  
 (d) Shift in equilibrium position on changing value of a constant
45. The equilibrium  $2SO_{2(g)} + O_{2(g)} = 2SO_{3(g)}$  shifts forward, if  
 [CPMT 1988]
- (a) A catalyst is used  
 (b) An adsorbent is used to remove  $SO_3$  as soon as it is formed  
 (c) Low pressure  
 (d) Small amounts of reactants are used
46. The equilibrium  $SO_2Cl_{2(g)} = SO_{2(g)} + Cl_{2(g)}$  is attained at  $25^\circ C$  in a closed container and an inert gas helium is introduced which of the following statement is correct  
 [MP PMT 2000]
- (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
47. Which of the following equilibria will shift to right side on increasing the temperature  
 [MP PMT 2000]
- (a)  $CO_{(g)} + H_2O_{(g)} = CO_{2(g)} + H_2_{(g)}$   
 (b)  $2SO_{2(g)} + O_{2(g)} = 2SO_{3(g)}$   
 (c)  $H_2O_{(g)} = H_{2(g)} + \frac{1}{2}(O_{2(g)})$   
 (d)  $4HCl_{(g)} + O_{2(g)} = 2H_2O_{(g)} + 2Cl_{2(g)}$
48. 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
49. Consider the equilibrium  
 $N_2(g) + 3H_2(g) = 2NH_3(g)$ ;  $\Delta H = -93.6 \text{ kJ}$ . The maximum yield of ammonia is obtained by  
 [UPSEAT 1999; AMU 2000]
- (a) Decrease of temp. and increase of pressure  
 (b) Increase of temp. and decrease of pressure  
 (c) Decrease of both the temp. and pressure  
 (d) Increase of both the temp. and pressure
50. In the equilibrium  $AB = A + B$ ; if the equilibrium concentration of A is doubled, the equilibrium concentration of B would become: [AMU 2000]
- (a) Twice (b) Half  
 (c)  $1/4$  (d)  $1/8$
51. Le-Chatelier's principle is applicable only to a  
 [MP PET/PMT 1988; KCET 1999; AFMC 2000; Pb. CET 2002]
- (a) System in equilibrium (b) Irreversible reaction  
 (c) Homogeneous reaction (d) Heterogeneous reaction
52. 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  $SO_3$   
 [UPSEAT 2000]
- (a) Increases (b) Decreases  
 (c) Remains unaltered (d) Changes unpredictably
53.  $H_{2(g)} + I_{2(g)} = 2HI_{(g)}$   $\Delta H = +q \text{ cal}$ , then formation of HI  
 [AMU 2000]
- (a) Is favoured by lowering the temperature  
 (b) Is favoured by increasing the pressure  
 (c) Is unaffected by change in pressure  
 (d) Is unaffected by change in temperature
54. In which of the following equilibrium systems is the rate of the backward reaction favoured by increase of pressure  
 [KCET 2001]
- (a)  $PCl_5 = PCl_3 + Cl_2$  (b)  $2SO_2 + O_2 = 2SO_3$   
 (c)  $N_2 + 3H_2 = 2NH_3$  (d)  $N_2 + O_2 = 2NO$
55. Which of the following equilibrium is not shifted by increase in the pressure  
 [MP PMT 2001]
- (a)  $H_{2(g)} + I_{2(g)} = 2HI_{(g)}$   
 (b)  $N_{2(g)} + 3H_{2(g)} = 2NH_{3(g)}$   
 (c)  $2CO_{(g)} + O_{2(g)} = 2CO_{2(g)}$   
 (d)  $2C_{(s)} + O_{2(g)} = 2CO_{(g)}$
56. According to Le-Chatelier's principal adding heat to a solid and liquid in equilibrium with endothermic nature will cause the [JIPMER 2000; MP PMT 2001]
- (a) Temperature to rise  
 (b) Temperature to fall  
 (c) Amount of solid to decrease  
 (d) Amount of liquid to decrease
57. On addition of an inert gas at constant volume to the reaction  
 $N_2 + 3H_2 = 2NH_3$  at equilibrium  
 [MP PET 2000]
- (a) The reaction remains unaffected  
 (b) Forward reaction is favoured  
 (c) The reaction halts  
 (d) Backward reaction is favoured
58. Le-Chatelier principle is not applicable to  
 [MH CET 2001]
- (a)  $H_{2(g)} + I_{2(g)} = 2HI_{(g)}$   
 (b)  $Fe_{(s)} + S_{(s)} = FeS_{(s)}$   
 (c)  $N_{2(g)} + 3H_{2(g)} = 2NH_{3(g)}$   
 (d)  $N_{2(g)} + O_{2(g)} = 2NO_{(g)}$
59. For the reaction:  $A + B + Q = C + D$ , if the temperature is increased, then concentration of the products will  
 [AFMC 2001]
- (a) Increase (b) Decrease  
 (c) Remain same (d) Become Zero
60.  $H_{2(g)} + I_{2(g)} = 2HI_{(g)}$   
 In this reaction when pressure increases, the reaction direction [RPMT 2002]

- (a) Does not change (b) Forward  
(c) Backward (d) Decrease
61. The rate of reaction of which of the following is not affected by pressure [MP PMT 2002]  
(a)  $PCl_3 + Cl_2 \rightleftharpoons PCl_5$  (b)  $N_2 + 3H_2 \rightleftharpoons 2NH_3$   
(c)  $N_2 + O_2 \rightleftharpoons 2NO$  (d)  $2SO_2 + O_2 \rightleftharpoons 2SO_3$
62. In the equilibrium  $N_2 + 3H_2 \rightleftharpoons 2NH_3 + 22 \text{ kcal}$ , the formation of ammonia is favoured by [MP PET 2000, 02]  
(a) Increasing the pressure  
(b) Increasing the temperature  
(c) Decreasing the pressure  
(d) Adding ammonia
63. The reaction  $2SO_2 + O_2 \rightleftharpoons 2SO_3$ ;  $\Delta H = -ve$  is favoured by [CPMT 2002; Pb. PMT 2001]  
(a) Low temperature, low pressure  
(b) Low temperature, high pressure  
(c) High temperature, high pressure  
(d) High temperature, low pressure
64. Which of the following will favour the reverse reaction in a chemical equilibrium [Kerala (Med.) 2002]  
(a) Increasing the concentration of the reactants  
(b) Removal of at least one of the products at regular intervals  
(c) Increasing the concentration of one or more of the products  
(d) Increasing the pressure  
(e) None of these
65. Under what conditions of temperature and pressure the formation of atomic hydrogen from molecular hydrogen will be favoured most [UPSEAT 2000, 01, 02]  
(a) High temperature and high pressure  
(b) Low temperature and low pressure  
(c) High temperature and low pressure  
(d) Low temperature and high pressure
66. The formation of nitric oxide by contact process  $N_2 + O_2 \rightleftharpoons 2NO$ .  $\Delta H = 43.200 \text{ kcal}$  is favoured by [AMU 2002]  
(a) Low temperature and low pressure  
(b) Low temperature and high pressure  
(c) High temperature and high pressure  
(d) High temperature and excess reactants concentration
67. The chemical reaction:  $BaO_{2(s)} \rightleftharpoons BaO_{(s)} + O_{2(g)}$ .  $\Delta H = +ve$ . In equilibrium condition, pressure of  $O_2$  depends upon [CBSE PMT 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
68. The yield of product in the reaction  $A_{2(g)} + 2B_{(g)} \rightleftharpoons C_{(g)} + Q_{(g)}$  would be high at [UPSEAT 2002]  
(a) High temperature and high pressure  
(b) High temperature and low pressure  
(c) Low temperature and high pressure  
(d) Low temperature and low pressure
69. Which reaction is not effected by change in pressure [UPSEAT 2003]  
(a)  $H_2 + I_2 \rightleftharpoons 2HI$  (b)  $2C + O_2 \rightleftharpoons 2CO$   
(c)  $N_2 + 3H_2 \rightleftharpoons 2NH_3$  (d)  $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
70. The gaseous reaction  $A + B \rightleftharpoons 2C + D + Q$  is most favoured at [Karnataka CET 2003]  
(a) Low temperature and high pressure  
(b) High temperature and high pressure  
(c) High temperature and low pressure  
(d) Low temperature and low pressure
71. For a reaction if  $K_p > K_c$ , the forward reaction is favoured by [RPET 2003]  
(a) Low pressure (b) High pressure  
(c) High temperature (d) Low temperature
72.  $A_{2(g)} + B_{2(g)} \rightleftharpoons 2AB_{(g)}$ ;  $\Delta H = +ve$  [BHU 2003]  
(a) Unaffected by pressure  
(b) It occurs at 1000 pressure  
(c) It occurs at high temperature  
(d) It occurs at high pressure and high temperature
73. Consider the reaction equilibrium,  $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ ;  $\Delta H^\circ = -198 \text{ kJ}$ . On the basis of Le-Chatelier's principle, the condition favourable for the forward reaction is  
(a) Lowering of temperature as well as pressure  
(b) Increasing temperature as well as pressure  
(c) Lowering the temperature and increasing the pressure  
(d) Any value of temperature and pressure



## Critical Thinking

### Objective Questions

1. If dissociation for reaction,  $PCl_5 \rightleftharpoons PCl_3 + Cl_2$  is 20% at 1 atm pressure. Calculate  $K_c$  [Kerala (Med.) 2003]  
(a) 0.04 (b) 0.05  
(c) 0.07 (d) 0.06
2. Ammonia under a pressure of 15 atm at  $27^\circ C$  is heated to  $347^\circ C$  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. [IIT 1981; MNR 1991; UPSEAT 2001]  
(a) 65% (b) 61.3%  
(c) 62.5% (d) 64%
3.  $K_f$  for the following reaction at 700 K is  $1.3 \times 10^{-3}$  atm. The  $K$  at same temperature for the reaction  $2SO_2 + O_2 \rightleftharpoons 2SO_3$  will be [AIIMS 2001]  
(a)  $1.1 \times 10^{-2}$  (b)  $3.1 \times 10^{-2}$   
(c)  $5.2 \times 10^{-2}$  (d)  $7.4 \times 10^{-2}$
4. For the reaction  $2NO_{2(g)} \rightleftharpoons 2NO_{(g)} + O_{2(g)}$   $K_c = 1.8 \times 10^{-6}$  at  $185^\circ C$ . At  $185^\circ C$ , the value of  $K_c$  for the reaction  $NO_{(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons NO_{2(g)}$  is [UPSEAT 2000]  
(a)  $0.9 \times 10^6$  (b)  $7.5 \times 10^2$   
(c)  $1.95 \times 10^{-3}$  (d)  $1.95 \times 10^3$

5.  $2SO_3 \rightleftharpoons 2SO_2 + O_2$ . 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 [CPMT 1996]

- (a)  $0.001 M$  (b)  $\frac{1}{2}SO_2$   
(c) 2 times of  $SO_2$  (d) Data incomplete

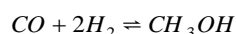
6. At 700 K, the equilibrium constant  $K_p$  for the reaction  $2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$  is  $1.80 \times 10^{-3}$  and  $kP$  is 14, ( $R = 8.314 Jk mol$ ). The numerical value in moles per litre of  $K_c$  for this reaction at the same temperature will be [AFMC 2001]

- (a)  $3.09 \times 10^{-7} mol\text{-litre}$  (b)  $5.07 \times 10^{-8} mol\text{-litre}$   
(c)  $8.18 \times 10^{-9} mol\text{-litre}$  (d)  $9.24 \times 10^{-10} mol\text{-litre}$

7. 0.1 mole of  $N_2O_{4(g)}$  was sealed in a tube under one atmospheric conditions at  $25^\circ C$ . Calculate the number of moles of  $NO_{2(g)}$  present, if the equilibrium  $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$  ( $K_p = 0.14$ ) is reached after some time [UPSEAT 2001]

- (a)  $1.8 \times 10^2$  (b)  $2.8 \times 10^2$   
(c) 0.034 (d)  $2.8 \times 10^{-2}$

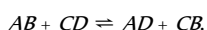
8. The partial pressures of  $CH_3OH$ ,  $CO$  and  $H_2$  in the equilibrium mixture for the reaction



at  $427^\circ C$  are 2.0, 1.0 and 0.1 atm respectively. The value of  $K_p$  for the decomposition of  $CH_3OH$  to  $CO$  and  $H_2$  is [Roorkee 1999]

- (a)  $1 \times 10^2 atm$  (b)  $2 \times 10^2 atm^{-1}$   
(c)  $50 atm^2$  (d)  $5 \times 10^{-3} atm^2$

9. One mole of a compound  $AB$  reacts with one mole of a compound  $CD$  according to the equation



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 [Kerala (Med.) 2003]

- (a)  $\frac{9}{16}$  (b)  $\frac{1}{9}$   
(c)  $\frac{16}{9}$  (d) 9

10. For the reaction  $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$  at a given temperature, the equilibrium amount of  $CO_2(g)$  can be increased by [IIT 1998]

- (a) Adding a suitable catalyst  
(b) Adding an inert gas  
(c) Decreasing the volume of the container

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

11. At constant temperature, the equilibrium constant ( $K$ ) 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 [IIT Screening 2001]

- (a)  $K$  increases with increase of  $P$   
(b)  $K$  increases with increase of  $x$   
(c)  $K$  increases with decrease of  $x$   
(d)  $K$  remains constant with change in  $P$  and  $x$

## Assertion & Reason

For AIIMS Aspirants

Read the assertion and reason carefully to mark 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 :  $K_p = K_c$  for all reaction.

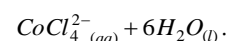
Reason : At constant temperature, the pressure of the gas is proportional to its concentration.

3. Assertion : The equilibrium constant for the reaction  $CaSO_4 \cdot 5H_2O(s) \rightleftharpoons CaSO_4 \cdot 3H_2O(s) + 2H_2O(g)$

$$\text{is } K_C = \frac{[CaSO_4 \cdot 3H_2O][H_2O]^2}{[CaSO_4 \cdot 5H_2O]}$$

Reason : Equilibrium constant is the ratio of the product of molar concentration of the substances produced to the product of the molar concentrations of reactants with each concentrations term raised to the power equal to the respective stoichiometric constant.

4. Assertion : On cooling a freezing mixture, colour of the mixture turns to pink from deep blue for a reaction.  $Co(H_2O)_6^{2+}_{(aq)} + 4Cl^-_{(aq)} \rightleftharpoons$



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

5. Assertion : If  $Q_c$  (reaction quotient)  $< K_C$  (equilibrium constant) reaction moves in direction of reactants.

Reason : Reaction quotient is defined in the same way as equilibrium constant at any stage of the reaction.

6. 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.
7. Assertion : According to Le-Chatelier's principle addition of heat to an equilibrium solid  $\rightleftharpoons$  liquid results in decrease in the amount of solid.
- Reason : Reaction is endothermic, so on heating forward reaction is favoured.
8. 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.
9. Assertion : Equilibrium constant for the reverse reaction is the inverse of the equilibrium constant for the reaction in the forward direction.
- Reason : Equilibrium constant depends upon the way in which the reaction is written.
10. Assertion : The value of  $K$  gives us a relative idea about the extent to which a reaction proceeds.
- Reason : The value of  $K$  is independent of the stoichiometry of reactants and products at the point of equilibrium.
11. Assertion : Catalyst affects the final state of the equilibrium.
- Reason : It enables the system to attain a new equilibrium state by complexing with the reagents.
12. Assertion : For the reaction,  

$$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$$
, the unit of  $K_p$  will be atm.
- Reason : Unit of  $K_p$  is  $(atm)^{\Delta n}$ .
13. Assertion : Effect of temperature of  $K_c$  or  $K_p$  depends on enthalpy change.
- Reason : Increase in temperature shifts the equilibrium in exothermic direction and decrease in temperature shifts the equilibrium position in endothermic direction.
14. Assertion : For a gaseous reaction,  

$$xA + yB \rightleftharpoons lC + mD, K_p = K_c.$$
- Reason : Concentration of gaseous reactant is taken to be unity.
15. 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.
16. Assertion :  $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g) + \text{heat}$ .
- Reason : Forward reaction is favoured at high temperature and low pressure.
- Reason : Reaction is exothermic.
17. Assertion : For a reaction  $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$  if the volume of vessel is reduced to half of its original volume, equilibrium constant will be doubled.
- Reason : According to Le-Chatelier principle, reaction shifts in a direction that tends to undo the effect of the stress.

## Reversible and Irreversible reaction

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

## Equilibrium state

1	c	2	b	3	a	4	c	5	b
6	d	7	c	8	b	9	cd	10	cd

## Law of mass action

1	b	2	a	3	d	4	b	5	a
6	d	7	d	8	a	9	c	10	a

## Law of equilibrium and Equilibrium constant

1	d	2	d	3	c	4	a	5	a
6	d	7	c	8	a	9	a	10	d
11	b	12	c	13	a	14	d	15	d
16	c	17	a	18	b	19	b	20	c
21	a	22	b	23	d	24	d	25	b
26	a	27	c	28	b	29	c	30	a
31	b	32	d	33	c	34	b	35	a
36	a	37	c	38	a	39	d	40	a
41	d	42	d	43	b	44	c	45	d
46	a	47	c	48	b	49	a	50	b
51	b	52	b	53	c	54	d	55	b
56	c	57	c	58	c	59	a	60	c
61	d	62	d	63	b	64	b	65	d
66	d	67	d	68	a	69	c	70	d
71	abcd	72	a	73	d	74	b		

 $K_p$  &  $K_c$  Relationship and Characteristics of  $K$ 

1	a	2	d	3	a	4	b	5	d
6	d	7	c	8	d	9	a	10	b
11	c	12	c	13	c	14	c	15	d
16	c	17	c	18	c	19	d	20	c
21	c	22	c	23	a	24	d	25	d
26	b	27	b	28	c	29	c	30	b
31	d	32	d	33	d	34	a	35	b
36	d	37	d	38	d	39	b	40	b
41	d	42	b	43	b	44	d	45	c

46	c	47	b	48	d	49	a	50	a
51	a	52	b	53	a	54	a	55	a
56	a	57	b	58	c	59	c	60	c
61	b	62	a	63	d	64	a	65	b
66	b	67	b	68	c	69	b		

### Activation energy, Standard free energy and Degree of dissociation and Vapour density

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

### Le-Chatelier principle and It's application

1	b	2	a	3	c	4	c	5	a
6	c	7	a	8	c	9	a	10	c
11	a	12	c	13	b	14	c	15	b
16	c	17	a	18	c	19	b	20	b
21	b	22	d	23	c	24	a	25	a
26	a	27	c	28	b	29	a	30	b
31	a	32	b,c	33	c	34	d	35	d
36	b	37	d	38	d	39	b	40	a
41	a	42	b	43	d	44	d	45	b
46	d	47	c	48	b	49	a	50	b
51	a	52	b	53	c	54	a	55	a
56	c	57	a	58	b	59	a	60	a
61	c	62	a	63	b	64	c	65	c
66	d	67	a	68	c	69	a	70	d
71	a	72	a	73	c				

### Critical Thinking Questions

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

### Assertion & Reason

1	c	2	e	3	e	4	a	5	e
6	c	7	b	8	a	9	a	10	c
11	d	12	e	13	c	14	d	15	e
16	e	17	e						