CBSE TEST PAPER 01

CLASS XI CHEMISTRY (Equilibrium)

General Instruction:

- All questions are compulsory.
- Marks are given alongwith their questions.

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1. Define dynamic equilibrium. [1]

2. Name the three group into which chemical equilibrium can be classified. [3]

3. What is physical equilibrium? Give an example. [1]

4. What is meant by the statement 'Equilibrium is dynamic in nature'? [1]

5. On what factor does the boiling point of the liquid depends? [1]

6. State Henry's law. [1]

7. What happens to the boiling point of water at high altitude? [1]

8. On which factor does the concentration of solute in a saturated solution depends? [1]

9. Mention the general characteristics of equilibria involving physical processes. [2]

10. What conclusion is drawn from the following –

Solid $\rightleftharpoons$ Liquid

$H_2O(s) \rightleftharpoons H_2O(l)$ [1]

CBSE TEST PAPER 01
CLASS XI CHEMISTRY (Equilibrium)
[ANSWERS]

Ans 1. When the reactants in a closed vessel at a particular temperature react to give products, the concentrations of the reactants keep on decreasing, while those of products keep on increasing for sometime after which there is no change in the concentrations of either the reactants or products. This stage of the system is the dynamic equilibrium.

Ans 2. Chemical equilibrium can be classified into three groups –

(i) The reaction that proceeds nearly to completion and only negligible concentrations of the reactants are left.

(ii) The reactions in which only small amounts of products are formed and most of the reactants remain unchanged at equilibrium stage.

(iii) The reactions in which the concentrations of the reactants and products are comparable, when the system is in equilibrium.

Ans 3. Physical equilibrium is an equilibrium between two different physical states of same substance e.g. $H_2O(s) \rightleftharpoons H_2O(l)$

Ans 4. At equilibrium, reaction does not stop rather it still continues, the equilibrium is dynamic in nature. It appears to stop because rate of forward reaction is equal to the rate of backward reaction.

Ans 5. Boiling point depends on the atmospheric pressure.

Ans 6. The mass of a gas dissolved in a given mass of a solvent at any temperature is proportional to the gas above the solvent.

Ans 7. Boiling point of water depends on the altitude of the place. At high altitude atmosp here pressure thetore is less boiling point decreases.

Ans 8. The concentration of solute in a saturated solution depends upon the temperature. Sugar (soln.) $\rightleftharpoons$sugar (solid).

Ans 9. (a) For solid $\rightleftharpoons$ liquid equilibrium, there is only one temperature at 1 atm at which two phases can co-exist. If there is no exchange of heat with the surroundings, the mass of the two phases remain constant.

(b) For liquid $\rightleftharpoons$ vapors equilibrium, the vapors pressure is constant at a given temperature.

(c) For dissolution of solids in liquids, the solubility is constant at a given temperature.

(d) For dissolution of gases in liquids, the concentration of a gas in liquid is proportional to pressure of the gas over the liquid.

Ans 10. Melting point is fixed at constant pressure.

CBSE TEST PAPER 02

CLASS XI CHEMISTRY (Equilibrium)

1. State the law of chemical equilibrium. [1]

2. Write the equilibrium constant for the following equation :

aA +bB $\rightleftharpoons$ cC + dD [1]

3. Write the expression for the equilibrium constant for the reaction :

$4NH_3$ (g) + 50_2 (g) $\rightleftharpoons$ 4NO (g) + $6H_2O$ (g) [2]

4. Write the chemical equation for the following chemical constant.

$$Kc = \frac{[HI]^2}{[H_2][I_2]}$$ [1]

5. When the total number of moles of product and reactants are equal, K has no unit. Give reason. [2]

6. What is the unit of equilibrium for the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3$ (g). [2]

7. Give the relation Kp = Kc $(RT)^{\Delta n}$. [2]

8. Write the relationship between Kp and Kc for the following reactions:

(a) $PCl_5 \rightleftharpoons PCl_3$ (q)+ Cl_2(q)

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

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

(d) $2H_2O$(g) $\rightleftharpoons$ $2H_2O$ (g) +O_2(g) [2]

9. Write the expression for equilibrium constant Kp for the reaction

3Fe (s) + $4H_2O$ (g) $\rightleftharpoons$ Fe_3O_4 (s) + $4H_2$(g) [1]

10. The equilibrium constant for the reaction H_2O + CO $\rightleftharpoons$ H_2 + CO_2

Is 0.44 at 1260k. What will be the value of the equilibrium constant for the reaction : $2H_2$ (g) + 2CO (g) $\rightleftharpoons$ 2CO(g) + $2H_2O$ (g) at 1260 K [1]

CBSE TEST PAPER 02

CLASS XI CHEMISTRY (Equilibrium)

[ANSWERS]

Ans 1. At a given temperature, the product of concentrations of the reaction products raised to the respective stoichiometric coefficient in the balanced chemical equation divided by the product of concentrations of the reactants raised to their individual stoichiometric coefficients has a constant value. This is known as the equilibrium law or law of chemical equilibrium.

Ans 2. The equilibrium constant for a general reaction

aA + bB $\rightleftharpoons$ cC +dD is expressed as $Kc = \frac{[C]^c[D]^d}{[A]^a[B]^b}$

Where [A], [B], [C] and [D] are the equilibrium concentrations of the reactants and products.

Ans 3. The equilibrium constant is given by $Kc = \frac{[NO]^4[H_2O]^6}{[NH_3]^4[O_2]^5}$

Ans 4. The chemical equation is given by H_2 (g) +I_2(g) $\rightleftharpoons$ 2HI(g)

Ans 5. When the total number of moles of products is equal to the total number of moles of reactants the equilibrium constant k has no unit for eg.

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

$$K = \frac{[HI(g)]^2}{[H_2(g)][I_2(g)]}$$

Units of $K = \frac{mol/L \text{ x mol/L}}{mol/L \text{ x mol/L}} = No \text{ units}$.

Ans 6. $K = \frac{[NH_3(g)]^2}{[N_2(g)][H_2(g)]^3}$

$$units \text{ of K} = \frac{(mol/L)^2}{(mol/L)(mol/L)^3} = \frac{1}{(mol/L)^2}$$

= $(mol/L)^{-2}$ $= \underline{\underline{L^2 mol^{-2}}}$

Ans 7. Let us consider a reaction

aA +bB $\rightleftharpoons$ cC + dD

$$Kc = \frac{[C]^c[D]^d}{[A]^a[B]^b} \quad \text{..... (i)} < \text{Kp} = \frac{p_C{}^c \; \text{p}_\text{D}{}^d}{p_A{}^a \; \text{p}_\text{B}{}^b}$$

Assuming the gaseous components to behave ideally,

Pi Vi = ni RT ...

Or, $pi = \frac{ni}{vi} RT = CiRT = [c]RT \ldots.(iv).$

Where [i] is the molar concentration of the species i

Then,

$$Kp = \frac{p_C{}^c \, p_D{}^d}{p_A{}^a p_B{}^b} = \frac{([c]RT)^C \, x([D]RT)^d}{([A]RT)^a \, x([B]RT)^b}$$

$$= \frac{[C]^c [D]^d}{[A]^a [B]^b} x(RT)\left(\overline{c+d} \quad - \quad \overline{a+b}\right) \ldots.(v)$$

$$\Delta n = \left(\overline{c+d} \quad - \quad \overline{a+b}\right)$$

$$\therefore \text{Kp} = \text{Kc} \; (RT)^{\Delta n}$$

Ans 8. (a) $\Delta n = 1+1-1 = 1$

$\therefore$ Kp = Kc (RT)' = KcRT

(b) $\Delta n = 2-(3+1) = -2$

$\therefore$ Kp = Kc $(\text{RT})^{-2}$

(c) $\Delta n = 2-(1+1) = 0$

$\therefore$ Kp =Kc$(RT)^0 = Kc$

(d) $\Delta n = (2+1)-2 = 3-2 = 1$

$\therefore$ Kp=Kc$(RT)' = KcRT.$

Ans 9. $Kp = \frac{(PH_2)^4}{(PH_2O)^4} = \frac{PH_2}{PH_2O}.$

Ans 10. The reaction is reversed and also doubled,

$$\therefore \text{Kc} = \left(\frac{1}{0.44}\right)^2 = \underline{\underline{5.16}}.$$

CBSE TEST PAPER 03

CLASS XI CHEMISTRY (Equilibrium)

General Instruction:

- All questions are compulsory.
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1. Give the generalizations concerning the composition of equilibrium mixtures. [3]
2. Define reaction quotient. [1]
3. If Qc > Kc, what would be the type of reaction? [1]
4. What inference you get when Qc = Kc? [1]
5. The value of Kc for the reaction

$2A \rightleftharpoons B+C$ is $2x10^{-3}$. At a given time, the composition of the reaction mixture is [A] = [B] =[C] = $3x10^{-4}$ M. In which direction the reaction will proceed? [2]

6. Write the equilibrium constant expression for each of the following reactions. In each case, indicate which of the reaction is homogeneous or heterogeneous.

(a) $2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$

(b) $N_2O_5(g) \rightleftharpoons NO_2(g) + NO_3(g)$

(c) $Zn(s) + 2HCl(g) \rightleftharpoons ZnCl_2(s) + H_2(g)$

(d) $2H_2O(l) \rightleftharpoons 2H_2O(l) + O_2(g)$ [2]

7. The dissociation of HI is independent of pressure, while dissociation of PCl_5 depends upon the pressure applied. Why? [2]
8. On what factors does the value of the equilibrium constant of a reaction depend? [2]

CBSE TEST PAPER 03

CLASS XI CHEMISTRY (Equilibrium)

[ANSWERS]

Ans 1. (i) If Kc > 10^3, products predominates over reactants i.e; if Kc is very large, the reaction proceeds nearly to completion.

(ii) If Kc < 10^{-3}, reactants predominates over products i.e; if Kc is very small, the reaction proceeds rarely.

(iii) If Kc is in the range of 10^{-3} to 10^3, appreciable concentration of both reactants and products are present.

Ans 2. The reaction quotient, Q is same as equilibrium constant Kc, except that the concentrations in Qc are not necessarily equilibrium values.

Ans 3. If Qc > Kc, the reaction will proceed in the direction of the reactants (reverse reactions)

Ans 4. If Qc = Kc, the reaction mixture is already at equilibrium.

Ans 5. For the reaction the reaction Qc is given by

$$Qc = \frac{[B][C]}{[A]^2}$$

As [A] = [B] = [C] = $3x10^{-4M}$

$$Qc = \frac{\left(3x10^{-4}\right)\left(3x10^{-4}\right)}{\left(3x10^{-4}\right)^2} = 1$$

As Qc > Kc so the reaction will proceed in the reverse direction.

Ans 6. (a) $Kc = \frac{[CO_2]^2}{[CO]^2[O_2]}$ (b) $Kc = \frac{[NO_2][NO_3]}{[N_2O_5]}$

(c) $Kc = \frac{[H_2]}{[HCl]^2}$ (d) $Kc = [O_2]$

Homogeneous : a, b

Heterogeneous : c, d

Ans 7. For $2HI \rightleftharpoons H_2 + I_2$

$$Kc = \frac{x^2}{4(1-x)^2}$$

Where x is degree of dissociation

For $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

$$Kc = \frac{x^2}{v(1-x)}$$

Where x is degree of dissociation

Since Kc for HI does not have volume terms and thus dissociation of HI is independent of pressure. On the other hard Kc for PCl_5 has volume in denominator and thus an increase in pressure reduces volume. And to have kc constant, x decrease.

Ans 8. The equilibrium constant of a reaction depends upon

(i) Temperature

(ii) Pressure, &

(iii) Stoichiometry of the reaction