QB365 Question Bank Software Study Materials

Physical and Chemical Equilibrium Important 2 Marks Questions With Answers (Book Back and Creative)

11th Standard

Chemistry

Total Marks : 60

2 Marks

30 x 2 = 60

1) Consider the following reaction

$Fe^{3+}(aq) + SCN^{-}(aq) \rightleftharpoons [Fe(SCN)]^{2+}(aq)$

A solution is made with initial Fe^{3+}, SCN^{-} concentration of 1×10^{-3} M and 8×10^{-4} M respectively. At equilibrium $[Fe(SCN)]^{2+}$ concentration is 2×10^{-4} M. Calculate the value of equilibrium constant.

Answer :

	Fe^{3+}	SCN^{-}	$[Fe(SCN)]^{2+}$
Initial concentration (M)	1×10^{-3} (10×10^{-4})	8×10^{-4}	-
Reacted	2×10^{-4}	2×10^{-4}	-
Equilibrium concentration	8×10^{-4}	6×10^{-4}	2×10^{-4}

$$K_{eq} = \frac{[Fe(SCN)]^{2+}}{[Fe^{3+}][SCN^{-}]}$$

$$= \frac{2\times10^{-4}M}{8\times10^{-4}M\times6\times10^{-4}M}$$

$= 0.0416 \times 10^{4}$

$K_{eq} = 41.6 \times 10^{2}\ M^{-1}$

2) The atmospheric oxidation of NO

$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

was studied with initial pressure of 1 atm of NO and 1 atm of O_2. At equilibrium, partial pressure of oxygen is 0.52 atm calculate K_p of the reaction.

Answer : $2\ NO(g) + O_2\ (g) \rightleftharpoons 2NO_2(g)$

	NO_2	O_2	NO_2
Initila Partial Pressure	1	1	-
Reacted	0.96	0.96	-
Equilibrium Partial Pressure	0.04	0.52	0.96

$$K_p = \frac{P^2_{NO_2}}{P^2_{NO_2}.Po_2}$$

$$= \frac{0.96\times0.96}{0.04\times0.04\times0.52}$$

$= 11.07 \times 10^{2}\ (atm)^{-1}$

$K_{eq} = 41.6 \times 10^{2}\ M^{-1}$.

3) If there is no change in concentration, why is the equilibrium state considered dynamic?

Answer : This condition is not static and is dynamic, because both the forward and reverse reactions are still occurring with the same rate. No macroscopic change is observed.

4) For a given reaction at a particular temperature, the equilibrium constant has constant value. Is the value of Q also constant? Explain.

Answer : The equilibrium constant is a constant and it is for equilibrium condition. But 'Q', the reaction quotient is not a constant as it is for non - equilibrium condition. 'Q' is the ratio of the product of active masses of a reaction products raised to the respective stoichiometric coefficients in the balanced chemical equation to that of the reactants, under non - equilibrium conditions.

i) If $Q = K_c$; it is equilibrium

ii) If $Q > K_c$.; the reaction will proceed in reverse direction

iii) If $Q < K_c$; the reaction will proceed in forward direction

5) Consider the following reactions,

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

In each of the above reaction find out whether you have to increase (or) decrease the volume to increase the yield of the product.

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

$K_c = \frac{4x^2}{(a-x)(b-x)}$

This expression doesn't involve, V. So, increase or decrease of volume will not affect the equilibrium and hence the yield of the product.

6) State law of mass action.

Answer : At any instant, the rate of a chemical reaction, at a given temperature is directly proportional to the product of the active masses of the reactants at that instant.

Rate of the reaction α [Reactant]^x

7) Write the K_p and K_c for the following reactions

(i) $2SO_2(g) + O_2g \rightleftharpoons 2SO_3(g)$

(ii) $2CO(g) \rightleftharpoons CO2(g) + C(s)$

Answer : (i) $K_C = \frac{[SO_3]^2}{[SO_2]^2[O_2]}, K_P = \frac{P^2SO_3}{P^2SO_2.po_2}$

(ii) $K_C = \frac{[CO_2]}{[CO]^{-2}}, K_P = \frac{p_{CO_2}}{P^2CO}$

8) Consider the following reaction

$CaCO_3 (s) \rightleftharpoons CaO (s) + CO_2(g)$

In the above reaction find out whether you have to increase (or) decrease the volume to increase the yield of the product.

Answer : $CaCO_3 \rightleftharpoons CaO_{(s)} + CO_{2(g)}$

(Lx) (x) (x)

$K_c = [CO_2]$

$K_c = \frac{x}{V}$

So, $K_c \propto \frac{1}{V}$. If V increases K_c wil decrease; As K_c is a constant x will increase and hence the yield of the product will increase. Similarly if V decreases the yield of the product will also decrease.

9) Consider the following reaction

$S(s) + 3F_2 (g) \rightleftharpoons SF_6 (g)$

In the above reaction find out whether you have to increase (or) decrease the volume to increase the yield of the product.

Answer : $S(s) + 3F_2(g) \rightleftharpoons SF_6(g)$
$(a - 3x) \quad x$

$K_c = \frac{[SF_6]}{[F_,]^3}$

$K_c = \frac{\frac{x}{V}}{\left(\frac{a-3x}{V}\right)^3} = \frac{x \cdot V^3}{V \cdot (a-3x)^3}$

$K_c = \frac{x \cdot V^2}{(a-3x)^3}$

So, $K_c \propto V^2$. IfV increases K_c will also increase. As K_c is a constant will decrease and hence the yield of the product will decrease. Similarly, if V decreases the yield of the product will increase.

10) Consider the following reactions,

$CaCO_3 (s) \rightleftharpoons CaO (s) + CO_2(g)$

In the above reaction find out whether you have to increase (or) decrease the volume to increase the yield of the product.

Answer : $\underset{(Lx)}{CaCO_3} \rightleftharpoons \underset{(x)}{\rightleftharpoons} CaO_{(s)} + \underset{(x)}{CO_{2(g)}}$

$K_c = [CO_2]$

$K_c = \frac{x}{V}$

So, $K_c \propto \frac{1}{V}$ If V increases K_c wil decrease; As K_c is a constant x will increase and hence the yield of the product will increase. Similarly if V decreases the yield of the product will also decrease.

11) Consider the following reactions,

$S(s) + 3F_2 (g) \rightleftharpoons SF_6 (g)$

In the above reaction find out whether you have to increase (or) decrease the volume to increase the yield of the product.

Answer : $\mathrm{S(s)} + 3\,\mathrm{F_2(\,g)} \rightleftharpoons \mathrm{SF_6(\,g)}$

$$(\mathrm{a}-3x)$$

$$K_c = \frac{[S_6]}{[F_7]^3}$$

$$\mathrm{K_c} = \frac{\frac{x}{\mathrm{V}}}{\left(\frac{\mathrm{a}-3x}{\mathrm{V}}\right)^3} = \frac{x\cdot \mathrm{V}^3}{\mathrm{V}\cdot(\mathrm{a}-3x)^3}$$

$$\mathrm{K_c} = \frac{x\cdot \mathrm{V}^2}{(\mathrm{a}-3x)^3}$$

So, $K_c \,\alpha\, V^2$. IfV increases K_c will also increase. As K_c is a constant rwill decrease and hence the yield of the product will decrease. Similarly if V decreases the yield of the product will increase.

12) For the reaction, $A_{(g)} + B_{(s)} \rightleftharpoons C_{(g)} + D_{(g)}$ K_c = 50 mol lit^{-1}at 127°C. Calculate K_p.

Answer : $\Delta n = 2-1 = 1$

$K_P = (RT)^{\Delta n}$

K_p . 50 x 0.082 x 400K

K_p = 1640 atms

13) "Rate of Melting = Rate of freezing"

When is the above condition achieved? Explain with an example

Answer : Let us consider the melting of ice in a closed container at 273 K. In the process the total number of water molecules leaving from and returning to the solid phase at any instant are equal.

If some ice-cubes and water are placed in a thermos flask (at 273K and 1 atm pressure), then there will be no change in the mass of ice and water. At equilibrium

Rate of melting of ice = Rate of freezing of water

$H_2O\,(S) \rightleftharpoons H_2O\,(1)$

The temperature at which the solid and liquid phases of a substance are at equilibrium is called the melting point or freezing point of that substance.

14) When does the rate of backward reaction increase? What is its consequence?

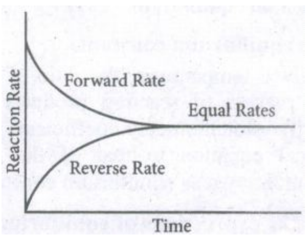
$A + B \rightleftharpoons C + D$

Answer : (i) Initially only A and B are present. Soon, a few molecules of the products C and D are formed by the forward reaction.

(ii) As the concentration of the products increases, more products collide and react in the backward direction.

(iii) This leads to an increase in the rate of backward reaction. As the rate of reverse reaction increases, the rate of the forward reaction decreases.

(iv) Eventually, the rate of both reactions becomes equal



15) "At constant volume addition of inert gas has no effect on equilibrium" - Justify

Answer : When an inert gas is added to an equilibrium system at constant volume, the total number of moles of gases present in the container increases, that is, the total pressure of gases increases the partial pressure of the reactants and the products are unchanged. Hence at constant volume addition of inert gas has no effect on equilibrium.

16) Following data is given for the reason,

$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(s)}$

$\Delta_f H^0[CaO_{(s)}]$ = -650.0 kJ mol-1

$\Delta_f H^0[CaO_{2(g)}]$ = -395.9 kJ mol-1

$\Delta_f H^0[CaCO_{3(s)}]$ = -1206.9 kJ mol-1

Predict the effect of temperature on the equilibrium constant of the abo e reaction

Answer : $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(s)}$

$\Delta_fH^0 = \Delta_fH^0[CaO_{(s)}] + \Delta_fH^0[CaO_{2(g)}] - \Delta_fH^0[CaCO_{3(s)}]$

$\Delta_fH^0 = -650 + (395.9) - (-1206.9)$

$= +161$ KJ mol^{-1}

Because AH value is positive, so the reaction is endothermic. Hence, according to Le-Chatelier's principle, reaction will proceed in forward direction on increasing temperature.

17) Explain about the equilibrium involving dissolution of solid in liquid with suitable example.

Answer : When sugar is added to water at a particular temperature, it dissolves to form sugar solution. When more sugar is added to that solution, a particular stage sugar remains as solid and results in the formation of saturated solution. Here a dynamic equilibrium is established between the solute molecules in the solid phase and in the solution phase.

$Sugar_{(solid)} \rightarrow Suga_{(solution)}$

18) What is meant by active mass? Give its unit.

Answer : The active mass represents the molar concentration of the reactants (or) products.

$$Active\ mass = \frac{n}{v} = \frac{number\ of\ moles}{volume\ in\ litre}$$

unit of active mass = mol dm^{-3} (or) mol L^{-1}

19) Show that $K_P = K_C$ with two examples

Answer : $K_{P,} = K_c\ (RT)^{'\Delta n}{}_g$.If $\Delta n_g = 0$, $K_p = K_c$.

Examples:

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

$\Delta n_g = 2 - 2 = 0$ g

(ii) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

$\Delta n_g = 2 - 2 = 0$

20) When will be $K_P < K_C$? Give two example

Answer : When Δn_g = - ve, $K_P < K_C$

$K_P = K_C\ .\ (RT)^{)\Delta n}{}_g$. If $K_P = K_C\ .\ (RT)^{-ve}$

$K_P < K_C$.

Examples:

$2H_2 + O_2(g) \rightleftharpoons 2H_20(g)$

$\Delta n_g = 2 - 3 = -1$

K_P x, = $K_c'.\ RT^{-1}$

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

$\Delta n_g = 2 - /3 = -1$ $K_P = K_C.(RT)^{-1}$

$\therefore$ K_PC

21) $2CO(g) + O_2(g) \rightleftharpoons 2CO_2$ at 1000 K. What is the Kc for this reaction? Predict the extent of this reaction.

Answer : $2CO(g) + O_2(g) \leftrightharpoons 2CO_2(g)2CO_2(g)$

$K_C = 2.2 \times 10^{22}$

$K_C > 10^3$ So [Products] > > [Reactants]

Reaction nearly goes to completion and forward reaction is favoured.

22) Explain about the effect of catalyst in an equilibrium reaction?

Answer : Addition of catalyst does not affect the state of equilibrium. The catalyst increases the rate of both the forward and reverse reactions to the same extent. Hence it does not change the equilibrium composition of the reaction mixture.

23) Predict which of the following will have appreciable concentration of reactions and products.

(a) $Cl_2(g) \rightleftharpoons 2Cl(g)$; $K_C = 5 \times 10^{-39}$

(b) $Cl_2(g) + 2NO(g) \rightleftharpoons 2NOCI(g)$; $K_C = 3.7 \times 108$

(c) $CI_2(g) + 2NO_2(g) \rightleftharpoons 2NO_2Cl(g)$; $K_C = 1.8$

Answer : Following conclusion can be drawn from the values of K_c-

(a) Since the value of K_C, is very small, this means that the molar concentration of the products is very small as compared to that of the reactants.

(b) Since the value of K_C is quite large, this means that the molar concentration of the products is very large as compared to that of the reactants.

(c) Since the value of K_C is 1.8, this means that both the products and reactants have appreciable concentrations.

24) What is the equilibrium constant K_4 in term of K_1 K_2 and K_3 for the following equilibria?

Answer : $A \overset{K_1}{\rightleftharpoons} B; \quad B \overset{K_2}{\rightleftharpoons} C; \quad C \overset{K_3}{\rightleftharpoons} D; \quad A \overset{K_4}{\rightleftharpoons} D$

$K_4 = K_1 \times K_2 \times K_3$

25) In an equilibrium, the concentration of a pure solid or liquid is always a constant. Why?

Answer : A pure solid always has the same concentration at a given temperature, as it does not expand to fill its container. i.e. it has same number of moles L^{-1} of its volume.

Therefore, the concentration of a pure solid is a constant.

This holds good for pure liquids also.

26) What do you mean by extent of a reaction?

Answer : The value of equilibrium constant, K_c tells us the extent of a reaction, i.e., it indicates how far the reaction has proceeded towards product formation at a given temperature.

27) How would you get the units of K_c and K_p for an equilibrium ?

Answer : (i) $K_c = [M]^{\Delta n_g} (\text{ or }) \left(\text{mol}L^{-1}\right)^{\Delta n_g}$

(ii) $K_n = [\text{ Pressure unit }]^{\Delta n_g}$ (or)

$(atm)^{\Delta n_g}$

$(bar)^{\Delta n_g}$

28) If: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g); K_1$

$N_2(g) + O_2(g) \rightleftharpoons 2NO(g); K_2$

$H_2(g) + 1/2O_2(g) \rightleftharpoons H_2O(g); K_3$

then what is the value for K_4 for the following equilibrium in terms of K_1, K_2 and K_3?

Answer : $2NH_3(g) + \frac{5}{2}O_2(g) \rightleftharpoons 2NO(g) + 3H_2O(g); K_4$

The final eqiation can be obtained as follows: 2 + 3 x 3 - 1

$\therefore K_4 = \frac{K_2 \times K_3^3}{K}$

29) The value of K_c for the reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ at 717 K is 4g. If at a particular instant $[H_2]$, $[I_2]$, & [HI] are 0.2 mol L^{-1},0.2 mol L^{-1} and 0.6 mol L^{-1} respectively, predict the direction of the reaction.

Answer : $Q = \frac{[HI]^2}{[H_2][I_2]} = \frac{0.6 \times 0.6}{0.2 \times 0.2} = 9$

Since Q < K_c; the reaction will proceed in the forward direction.

30) The value of K_c for the reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ is 0.21 at 373K,At a given time $[N_2O_4]$ and $[NO_2]$ are 0.125 mol dm^{-3} and 0.5 mol dm^{-3} respectively. Predict the direction of the reaction.

Answer : $Q = \frac{[NO_2]^2}{[N_2O_4]} = \frac{0.5 \times 0.5}{0.125} = 2$

As Q > K_c; the reaction will proceed in the reverse direction until it reaches 0.21.