

Holiday homework of Chemistry for winter vacation

Class XI

MCQs:

- Which of the following is true for a system in dynamic equilibrium?
 - The concentrations of reactants and products are equal.
 - The rate of the forward reaction equals the rate of the reverse reaction.
 - The reaction stops.
 - The system does not change over time.
- In a reaction the concentration of reactants decreases. What can be inferred?
 - The reaction is moving towards the formation of more products.
 - The reaction is moving towards the formation of more reactants.
 - The equilibrium constant is increasing.
 - The reaction is no longer at equilibrium.
- What is the equilibrium constant expression for the reaction $aA + bB \rightleftharpoons cC + dD$
 - $\frac{[A]^a [B]^b}{[C]^c [D]^d}$
 - $\frac{[C]^c [D]^d}{[A]^a [B]^b}$
 - $\frac{[C]^a [D]^b}{[A]^c [B]^d}$
 - $\frac{[A]^a [B]^b}{[C]^d [D]^c}$
- What effect does an increase in temperature have on an exothermic reaction at equilibrium?
 - It shifts the equilibrium towards the products.
 - It shifts the equilibrium towards the reactants.
 - It has no effect on the equilibrium.
 - It increases the equilibrium constant.
- Which of the following is a characteristic of an equilibrium state?
 - The rate of the forward reaction is greater than the rate of the reverse reaction.
 - The concentrations of reactants and products do not change with time.
 - The forward and reverse reactions occur at different rates.
 - The system is in a state of rest.
- According to Le Chatelier's principle, what happens when the concentration of a reactant is increased in an equilibrium system?
 - The equilibrium shifts towards the reactants.
 - The equilibrium shifts towards the products.
 - The equilibrium constant changes.
 - The reaction stops.
- If the pressure of a gaseous equilibrium system is increased, how does the system respond?
 - It shifts towards the side with more gas molecules.
 - It shifts towards the side with fewer gas molecules.
 - It shifts towards the side with an equal number of gas molecules.
 - It has no effect on the equilibrium.
- When a catalyst is added to a reaction at equilibrium, what happens?
 - It changes the position of equilibrium.
 - It increases the rate of the forward reaction.
 - It decreases the rate of the reverse reaction.
 - It does not affect the position of equilibrium but increases the rate at which equilibrium is reached.
- What is the effect of adding an inert gas to a system at equilibrium?
 - It shifts the equilibrium towards the reactants.

- B) It shifts the equilibrium towards the products.
 C) It has no effect on the position of equilibrium.
 D) It increases the concentration of reactants.
10. Which of the following factors does NOT affect the equilibrium constant of a reaction?
 A) Temperature
 B) Pressure
 C) Concentration of reactants
 D) Catalyst
11. For the reaction $2A + B \rightleftharpoons 3C$
 what is the equilibrium constant expression?
 A) $\frac{[C]^3}{[A]^2 [B]}$
 B) $\frac{[A]^2 [B]}{[C]^3}$
 C) $\frac{[A]^2 [B]^3}{[C]}$
 D) $\frac{[C]}{[A]^2 [B]}$
12. The equilibrium constant for a reaction at a given temperature is 0.5. What is the equilibrium constant for the reverse reaction at the same temperature?
 A) 0.5
 B) 1.0
 C) 2.0
 D) 1/0.3
13. For the reaction
 $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, if the equilibrium constant K_c is 2.0, which statement is true?
 A) At equilibrium, the concentration of NH_3 is twice that of N_2 .
 B) At equilibrium, the concentration of NH_3 is half that of N_2 .
 C) At equilibrium, the concentrations of N_2 and H_2 are equal.
 D) The concentration of NH_3 is greater than the concentration of N_2 at equilibrium.
14. If the equilibrium constant K_c of a reaction is very large, what can be inferred?
 A) The reaction favors the reactants.
 B) The reaction favors the products.
 C) The reaction is not at equilibrium.
 D) The equilibrium concentration of reactants and products is equal.
15. In a reaction where $K_c = 10^{-3}$, what can be said about the reaction at equilibrium?
 A) The concentration of products is much higher than that of reactants.
 B) The concentration of reactants is much higher than that of products.
 C) The concentrations of reactants and products are approximately equal.
 D) The reaction is not at equilibrium.
16. For the physical equilibrium
 $H_2O(l) \rightleftharpoons H_2O(g)$
 what happens when the temperature is increased?
 A) The equilibrium shifts towards the liquid phase.
 B) The equilibrium shifts towards the gas phase.
 C) The equilibrium constant decreases.
 D) The reaction rate decreases.
17. In a saturated solution, what happens to the rate of dissolution of a solid when the temperature is increased?
 A) It decreases.
 B) It remains the same.
 C) It increases.
 D) It becomes zero.
18. What is the principle of microscopic reversibility?
 A) The forward and reverse reactions occur at the same rate.
 B) The rates of the forward and reverse reactions are different.
 C) The rate of the forward reaction is always higher.
 D) The reverse reaction occurs spontaneously without an external force.
19. For the equilibrium of a solute in a solution, if the temperature is increased, what happens to the solubility of the solute?
 A) It decreases for all types of solutes.
 B) It increases for all types of solutes.

- C) It increases for endothermic dissolution processes and decreases for exothermic processes.
 D) It decreases for endothermic dissolution processes and increases for exothermic processes.
20. What is the reaction quotient (Q) for the reaction $2A + B \rightleftharpoons C$ at a point where $[A] = 2M$, $[B] = 3M$, and $[C] = 4M$?
 A) $1/3$ B) $2/3$
 C) 3 D) $4/3$
21. Which of the following statements is true for a system at equilibrium?
 A) The concentrations of reactants and products are equal.
 B) The rate of the forward reaction is equal to the rate of the reverse reaction.
 C) The temperature of the system remains constant.
 D) The system does not exchange energy with its surroundings.
22. In a reversible reaction at equilibrium, what happens to the value of the equilibrium constant if the temperature is increased?
 A) It remains unchanged. B) It decreases.
 C) It increases. D) It depends on the nature of the reaction.
23. For the reaction $B+C \rightleftharpoons A$ which expression correctly represents the equilibrium constant K?
 A) $K_c = [A]/[B][C]$ B) $K_c = [B]^2/[C][A]$
 C) $K_c = [B]/[A]^2[C]$ D) $K_c = [A]/[B][C]^2$
24. According to Le Chatelier's principle, how will the equilibrium position shift if the pressure is increased in a gaseous reaction involving a decrease in the number of moles of gas?
 A) The equilibrium will shift to the side with more moles of gas.
 B) The equilibrium will shift to the side with fewer moles of gas.
 C) The equilibrium position will remain unchanged.
 D) The equilibrium will shift towards the reactants.
25. What happens to the equilibrium constant if the concentration of reactants is increased in a system already at equilibrium?
 A) The equilibrium constant increases.
 B) The equilibrium constant decreases.
 C) The equilibrium constant remains unchanged.
 D) The equilibrium constant becomes zero.
26. In an exothermic reaction, what effect does an increase in temperature have on the equilibrium constant?
 A) It increases the equilibrium constant.
 B) It decreases the equilibrium constant.
 C) It has no effect on the equilibrium constant.
 D) It makes the equilibrium constant zero.
27. Consider a sealed container with a mixture of gases at equilibrium. If the container is suddenly expanded to double its volume, which of the following will most accurately describe the new equilibrium state assuming the reaction involves a change in the number of moles of gas?

- A) The equilibrium position will shift in the direction that produces more moles of gas to counteract the decrease in pressure.
- B) The equilibrium position will shift in the direction that produces fewer moles of gas to counteract the decrease in volume.
- C) The equilibrium constant will change due to the volume change.
- D) The equilibrium position will not change because the concentration of gases remains the same.
28. In a system at equilibrium, if a catalyst is added, what is the effect on the equilibrium position?
- A) The equilibrium position shifts to the right.
- B) The equilibrium position shifts to the left.
- C) The equilibrium constant changes.
- D) The equilibrium position remains unchanged.
29. If a reaction is at equilibrium and the concentration of one of the products is increased, what will be the immediate effect on the reaction?
- A) The reaction rate of the forward reaction decreases.
- B) The reaction rate of the reverse reaction increases.
- C) The equilibrium constant increases.
- D) The equilibrium position will shift towards the reactants.
30. In a system at equilibrium, if the temperature is increased and the system is exothermic, what would be the best approach to quantitatively analyse the effect on the equilibrium constant K_c ?
- A) Apply the Van't Hoff equation to determine how the equilibrium constant changes with temperature.
- B) Use Le Chatelier's principle to predict the direction of shift in equilibrium.
- C) Calculate the change in entropy to determine the effect on the equilibrium constant.
- D) Measure the concentration of reactants and products after temperature change to find K_c .

ASSERTION AND REASON TYPE QUESTIONS

1. **Assertion (A):** The equilibrium constant K_c for a reaction can be determined from the equilibrium concentrations of reactants and products.
Reason (R): The equilibrium constant expression is a ratio of the concentrations of products to reactants, each raised to the power of their coefficients in the balanced equation.
2. **Assertion (A):** Adding a catalyst to an equilibrium reaction affects the equilibrium constant.
Reason (R): A catalyst increases the rate of both the forward and reverse reactions equally, thereby reducing the time required to reach equilibrium but does not affect the position of equilibrium.
3. **Assertion (A):** A plot of the concentration of a reactant versus time for a reaction at equilibrium will show a hyperbolic curve.
Reason (R): At equilibrium, the concentrations of reactants and products remain constant over time, which is reflected by a horizontal line in a concentration vs. time plot.
4. **Assertion (A):** In an industrial process, increasing the pressure shifts the equilibrium towards the side with fewer gas molecules.
Reason (R): For an exothermic reaction, increasing the pressure shifts the equilibrium towards the products.

5: Assertion (A): If the equilibrium constant K_c for a reaction increases with temperature, the reaction is exothermic.

Reason (R): For an exothermic reaction, increasing temperature shifts the equilibrium towards the reactants, which decreases K_c .

2 MARK QUESTIONS

- What is meant by the statement 'Equilibrium is dynamic in nature'?
 - State the law of chemical equilibrium.
- What is the effect of reducing the volume on the system described below? $2C(s) + O_2(g) \rightleftharpoons 2CO(g)$
 - What happens when temperature increases for a reaction?
- If $Q_c < K_c$, when we continuously remove the product, what would be the direction of the reaction?
 - Select Lewis acid and Lewis base from the following : Cu^{2+} , H_2O , BF_3 , OH^-
- The equilibrium constant for the reaction $SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2} O_2(g)$ is 0.18 at 900 K. What will be the equilibrium constant for the reaction $SO_2(g) + \frac{1}{2} O_2(g) \rightleftharpoons SO_3(g)$?
 - What is the relation between K_c and K_p for the reaction:
 $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
- Define physical equilibrium.
 - If $Q_c > K_c$, what would be the type of reaction?
- Arrange the following in increasing acidic strength HCl , HBr , HF , HI
 - Arrange the basic strength of following F^- , Br^- , Cl^- , I^-
- Conjugate acid of a weak base is always stronger. What will be the decreasing order of basic strength of the following conjugate bases? OH^- , RO^- , CH_3COO^- , Cl^-
 - Arrange the following in increasing order of pH. $KNO_3(aq)$, $CH_3COONa(aq)$, $NH_4Cl(aq)$, $C_6H_5COONH_4(aq)$
- The values of K_{sp} of two sparingly soluble salts $Ni(OH)_2$ and $AgCN$ are 2.0×10^{-15} and 6×10^{-17} respectively. Which salt is more soluble? Explain.

b. If S and K_{sp} are solubility and solubility product respectively of a sparingly soluble binary electrolyte, find the relation between them?

9. a. Define Ostwald's dilution law.

b. Classify the equilibrium as homogeneous or heterogeneous :
 $\text{CH}_3\text{COOC}_2\text{H}_5(\text{aq.}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{CH}_3\text{COOH}(\text{aq.}) + \text{C}_2\text{H}_5\text{OH}(\text{aq.})$

10. a. The solubility of A_2X_3 is $y \text{ mol dm}^{-3}$. Calculate its solubility product.

b. Predict whether the solution is acidic, basic or natural when NH_4NO_3 undergo hydrolysis.

3 MARK QUESTIONS

1. What are the applications of equilibrium constant.

2. Explain Le Chatelier's principle with suitable example.

3. Explain the effect of concentration change on equilibrium.

4. Equilibrium constant K_c for the reaction, $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ at 500 K is 0.061. At a particular time, the analysis shows that the composition of the reaction mixture is: 3.0 mol L^{-1} of N_2 , 2.0 mol L^{-1} of H_2 and 0.50 mol L^{-1} of NH_3 . Is the reaction at equilibrium? If not, in which direction does the reaction tend to proceed to reach the equilibrium?

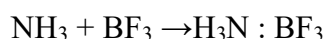
The value of the reaction quotient is smaller than the value of the equilibrium constant. Since the value of Q_c is less than that of K_c (0.061), the reaction is not in a state of equilibrium. It will proceed in the forward direction till Q_c becomes the same as K_c .

5. Explain the effect of temperature on equilibrium constant.

6. Explain the effect of inert gas on equilibrium.

7. Write difference between Arrhenius acid base and Bronsted acid base.

8. A reaction between ammonia and boron trifluoride is given below:



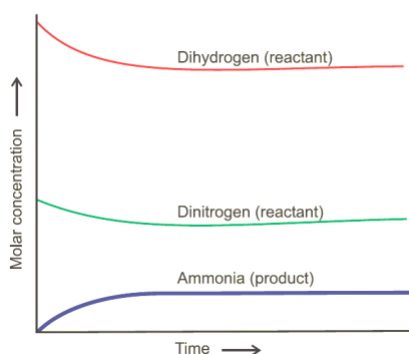
Identify the acid and base in this reaction. Which theory explains it? What is the hybridization of B and N in the reactants?

9. pH of a solution of a strong acid is 5.0. What will be the pH of the solution obtained after diluting the given solution a 100 times?

10. Explain common ion effect with suitable example.

5 MARKS QUESTIONS

1. Consider the following reversible reaction at equilibrium: $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}) + \text{heat}$



Based on Le Chatelier's principle, answer the following questions:

- If the concentration of N_2 is increased, in which direction will the equilibrium shift? Explain your answer. (1 mark)
 - How would an increase in temperature affect the equilibrium? Justify your response. (1.5 marks)
 - What would be the effect of increasing the pressure on the equilibrium? Provide reasoning for your answer. (1.5 marks)
 - Suggest one way to increase the yield of NH_3 without changing the temperature or pressure of the system. (1 mark)
3. A group of students is conducting an experiment to study the solubility of calcium carbonate ($CaCO_3$) in water. They observe that $CaCO_3$ is sparingly soluble in pure water. To their surprise, when they add a small amount of calcium chloride ($CaCl_2$) to the solution, they notice a decrease in the solubility of $CaCO_3$.

Based on this scenario, answer the following questions:

- Explain the phenomenon observed by the students when $CaCl_2$ is added to the $CaCO_3$ solution.
- Write the solubility product expression (K_{sp}) for $CaCO_3$.
- How does the addition of $CaCl_2$ affect the equilibrium of $CaCO_3$ in water? Use Le Chatelier's principle to support your answer.
- If the initial concentration of Ca^{2+} ions in the saturated $CaCO_3$ solution was 5.0×10^{-5} M, calculate the new concentration of Ca^{2+} ions after adding $CaCl_2$ to make its concentration 1.0×10^{-3} M. Assume the volume change is negligible.
- Suggest one practical application of this phenomenon in daily life or industry.

CASE BASED QUESTIONS

- Reactants and products coexist in equilibrium so that reactant conversion to product is always less than 100%. Equilibrium reactions may involve the decomposition of a covalent (non-polar) reactant or the ionization of ionic compounds into their ions in polar solvents. In this section, we will learn about the ionic equilibrium in ionic solutions. Substances in ionic equilibrium can be classified into two categories on the basis of their ability to conduct electricity.

Non-Electrolytes-These are substances that consist of molecules that bear no electric charge, do not dissociate into their constituent ions, and thus do not conduct electricity in their aqueous solution or molten state. For example, sugar solution.

Electrolytes-These are substances that dissociate into their constituent ions in their aqueous solution, and thus conduct electricity in their aqueous solutions or molten state. For

example, salt solution, acid solution, base solution, etc. Electrolytes in ionic equilibrium can be further classified into strong and weak electrolytes.:-

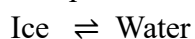
1.1 A base according to Bronsted concept is a substance which can:

1.2 Arrange the following in the decreasing order of base? NaOH, Ca(OH)₂, NH₄OH, KOH

1.3 The conjugate base of HCl is OR The conjugate acid of NH₃ is

2. When a solid – liquid system at melting point is taken in a well – insulated container, then this system constitutes a system in which solid is in dynamic equilibrium with liquid.

For Example: If ice and water at 273K (melting point of ice) taken in a perfectly insulated thermos flask. It may be noted that temperature as well as masses of ice and water remain constant. This represents a dynamic equilibrium between ice and water.



Since there is no change in mass of ice and water, the number of molecules going from ice into water is equal to number of molecules going from water into ice. Thus, at equilibrium, Rate of melting = Rate of freezing

2.1 Explain dynamic equilibrium.

2.2 A liquid is in equilibrium with its vapours in a sealed container at a fixed temperature. The volume of the container is suddenly increased, What is the initial effect of the change on the vapour pressure?

2.3 At high temperature ice water equilibrium will shift in which direction.