Chapter 10

Acids, Bases, and Salts

Short Questions (Exercise)

2. (i) Differentiate between forward and reverse reactions:

Aspect	Forward Reaction	Reverse Reaction
Definition	The reaction proceeds from reactants to products.	The reaction proceeds from products to reactants.
Direction	Left to right in the chemical equation.	Right to left in the chemical equation.
Energy Change	May release or absorb energy.	Opposite energy change of the forward reaction.

2. (ii) What is chemical equilibrium?

Chemical equilibrium occurs when the rate of the forward reaction equals the rate of the reverse reaction, resulting in constant concentrations of reactants and products in a closed system.

2. (iii) Write two chemical equations of reversible reactions:

1. $N_2 + 3H_2 \leftrightarrow 2NH_3$ (Haber process).
2. $CaCO_3 \leftrightarrow CaO + CO_2$ (Thermal decomposition of calcium carbonate).

2. (iv) Write down the conditions for equilibrium:

1. Closed System: No substances can enter or leave the reaction system.
2. Dynamic Process: Both forward and reverse reactions occur at equal rates.
3. Constant Temperature and Pressure: External conditions should remain steady.
4. Constant Concentrations: The concentrations of reactants and products remain unchanged at equilibrium.

3. Write forward and reverse reactions for the given equation:

Reaction: $CO(g) + 3H_2(g) \leftrightarrow CH_4(g) + H_2O(g)$

- Forward Reaction: $CO(g) + 3H_2(g) \rightarrow CH_4(g) + H_2O(g)$
- Reverse Reaction: $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$

4. How does temperature affect cobalt chloride equilibrium?

Reaction: $CoCl_2(aq) + 6H_2O \leftrightarrow [Co(H_2O)_6]^{2+}(aq) + 2Cl^-(aq)$

- At higher temperatures, the equilibrium shifts to the left, favoring the formation of $CoCl_2$ (blue color, endothermic direction).
- At lower temperatures, the equilibrium shifts to the right, forming the hydrated complex $[Co(H_2O)_6]^{2+}$ (pink color, exothermic direction).

Think Tank: Bromine chloride (BrCl) decomposes to form chlorine and bromine. Write reversible chemical reaction for this reaction:

The reversible reaction is:

$2BrCl \leftrightarrow Br_2 + Cl_2$

- Forward Reaction: Bromine chloride decomposes into bromine and chlorine.
- Reverse Reaction: Bromine and chlorine combine to form bromine chloride.

Extera Short Questions (Topic Wise)

10.1: Concept of Acids and Bases

What are acids?

Acids are substances that release hydrogen ions (H^+) when dissolved in water, making the solution acidic. Examples include hydrochloric acid (HCl) and sulfuric acid (H_2SO_4).

What are bases?

Bases are substances that release hydroxide ions (OH^-) in water or accept hydrogen ions, making the solution basic. Examples include sodium hydroxide (NaOH) and potassium hydroxide (KOH).

What is the pH scale?

The pH scale measures the acidity or basicity of a solution. A pH less than 7 indicates an acid, exactly 7 indicates neutrality, and greater than 7 indicates a base.

How do acids and bases neutralize each other?

When an acid reacts with a base, they neutralize each other to form water and a salt. For example: $HCl + NaOH \rightarrow NaCl + H_2O$

10.2: Strength of Acids and Bases

What is the difference between strong and weak acids?

Strong acids completely ionize in water (e.g., HCl), while weak acids partially ionize (e.g., acetic acid, CH_3COOH).

What determines the strength of a base?

A base's strength is determined by its ability to dissociate and release OH^- ions in water. Strong bases, like NaOH, dissociate completely, whereas weak bases, like NH_3, do not.

How does concentration affect acid and base strength?

Strength refers to the degree of ionization, while concentration refers to the amount of acid or base in a solution. A dilute strong acid can still be more ionized than a concentrated weak acid.

What is a polyprotic acid?

A polyprotic acid can donate more than one proton (H^+) per molecule. For example, sulfuric acid (H_2SO_4) donates two protons.

10.3: Characteristic Properties of Acids

How do acids taste and feel?

Acids typically have a sour taste. They can cause a stinging sensation when they come into contact with the skin.

What is the effect of acids on litmus paper?

Acids turn blue litmus paper red.

How do acids react with metals?

Acids react with certain metals to produce hydrogen gas. For example:
$2HCl + Zn \rightarrow ZnCl_2 + H_2$

How do acids react with carbonates?

Acids react with carbonates to produce carbon dioxide, water, and a salt. For example:
$HCl + Na_2CO_3 \rightarrow NaCl + H_2O + CO_2$

Do acids conduct electricity?

Yes, acids conduct electricity in aqueous solutions because they produce ions.

10.4: Characteristic Properties of Bases

How do bases taste and feel?

Bases have a bitter taste and feel slippery to the touch due to their ability to react with skin oils.

What is the effect of bases on litmus paper?

Bases turn red litmus paper blue.

How do bases react with acids?

Bases react with acids to form water and salt, a process known as neutralization.

Can bases conduct electricity?

Yes, bases conduct electricity in aqueous solutions due to the presence of ions.

How do bases interact with organic matter?

Strong bases, like NaOH, can break down organic materials, making them useful in cleaning agents.

10.5: Oxides and Hydroxides

What are acidic oxides?

Acidic oxides are oxides of nonmetals that react with water to form acids or with bases to form salts. Example: CO_2 reacts with water to form H_2CO_3.

What are basic oxides?

Basic oxides are oxides of metals that react with water to form bases or with acids to form salts. Example: CaO reacts with water to form $Ca(OH)_2$.

What are amphoteric oxides?

Amphoteric oxides can act as both acids and bases. Example: Al_2O_3 reacts with both acids and bases to form salts.

What are hydroxides?

Hydroxides are compounds containing the hydroxide ion (OH^-). Examples include NaOH and KOH, which are strong bases.

How are oxides and hydroxides used in everyday life?

- Acidic oxides: CO_2 is used in carbonated beverages.
- Basic oxides: CaO (lime) is used in construction.
- Hydroxides: NaOH is used in soap manufacturing.

Extera Long Questions (Topic Wise)

Question 1: Explain the Concept of Acids and Bases with Examples and Their Role in Everyday Life

Acids and bases are two fundamental categories of chemical compounds that have distinct characteristics and play a crucial role in both chemical reactions and everyday life.

Concept of Acids:

- Acids are substances that increase the concentration of hydrogen ions (H^+) or protons in an aqueous solution.
- They typically have a sour taste, turn blue litmus paper red, and react with bases to form salts and water (neutralization reaction).
- Examples:
  - Hydrochloric acid (HCl): Found in the stomach, aids digestion.
  - Sulfuric acid (H_2SO_4): Used in car batteries.
  - Acetic acid (CH_3COOH): Found in vinegar.

Concept of Bases:

- Bases are substances that increase the concentration of hydroxide ions (OH^-) in an aqueous solution or accept hydrogen ions.
- They usually have a bitter taste, feel slippery to touch, turn red litmus paper blue, and react with acids to neutralize them.
- Examples:
  - Sodium hydroxide (NaOH): Used in soap production.
  - Calcium hydroxide ($Ca(OH)_2$): Known as lime, used in construction.

Role in Everyday Life:

- Acids:

- Citric acid in fruits adds flavor and preserves food.
- Ascorbic acid (Vitamin C) is essential for human health.
- Carbonic acid is used in carbonated beverages.

- Bases:

- Baking soda (sodium bicarbonate) is used in cooking.
- Bases like ammonia are used in cleaning products.
- Calcium hydroxide is used in agricultural soil treatment.

These compounds not only provide the basis for numerous chemical processes but are also integral to biological and industrial applications.

Question 2: Discuss the Strength of Acids and Bases and How It Is Determined with Examples

The strength of acids and bases refers to their ability to ionize or dissociate in water, which determines their chemical behavior in reactions.

Strength of Acids:

- A strong acid completely ionizes in water, producing a high concentration of H^+ ions. Examples include hydrochloric acid (HCl) and sulfuric acid (H_2SO_4).
- A weak acid partially ionizes in water, leading to a lower concentration of H^+ ions. Examples include acetic acid (CH_3COOH) and formic acid (HCOOH).
- The strength of an acid is often represented by its dissociation constant (Ka). Strong acids have a high Ka value, while weak acids have a lower one.

Strength of Bases:

- A strong base completely dissociates in water, releasing a high concentration of OH^- ions. Examples include sodium hydroxide (NaOH) and potassium hydroxide (KOH).
- A weak base partially dissociates in water. Examples include ammonia (NH_3) and methylamine (CH_3NH_2).
- The strength of a base is measured using its base dissociation constant (Kb). Strong bases have a high Kb value.

Factors Affecting Strength:

1. **Concentration:** While strength refers to the degree of ionization, the concentration affects the number of ions present in a solution.
2. **Molecular Structure:** The ability of a molecule to donate or accept ions depends on its bond strength and electronegativity.

Examples:

- Hydrochloric acid (HCl) is a strong acid that fully ionizes:
  $HCl \rightarrow H^+ + Cl^-$
- Acetic acid (CH_3COOH) is a weak acid that only partially ionizes:
  $CH_3COOH \leftrightarrow CH_3COO^- + H^+$

Understanding the strength of acids and bases is critical in fields like medicine, where pH control is essential, and in industry, where these compounds are used for manufacturing and processing.

Question 3: Compare and Contrast Acidic, Basic, and Amphoteric Oxides with Their Reactions and Applications

Oxides are compounds formed by the combination of oxygen with other elements. They are categorized into acidic, basic, and amphoteric oxides based on their chemical properties and reactions.

Acidic Oxides:

- Acidic oxides are typically formed by nonmetals and react with water to produce acids.
- Example: Carbon dioxide (CO_2) reacts with water to form carbonic acid:
  $CO_2 + H_2O \rightarrow H_2CO_3$
- Applications:
  - CO_2 is used in the beverage industry for carbonated drinks.
  - Sulfur dioxide (SO_2) is used in the production of sulfuric acid.

Basic Oxides:

- Basic oxides are formed by metals and react with water to produce bases.
- Example: Calcium oxide (CaO) reacts with water to form calcium hydroxide:
  $CaO + H_2O \rightarrow Ca(OH)_2$
- Applications:
  - Calcium oxide (quicklime) is used in construction and agriculture.
  - Magnesium oxide (MgO) is used as a refractory material in furnaces.

Amphoteric Oxides:

- Amphoteric oxides can react with both acids and bases to form salts and water.
- Example: Aluminum oxide (Al_2O_3) reacts with hydrochloric acid to form aluminum chloride:
  $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$
  It also reacts with sodium hydroxide to form sodium aluminate:
  $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$
- Applications:
  - Al_2O_3 is used in the manufacturing of ceramics and as an abrasive.

Understanding these oxides is essential for environmental chemistry, industrial processes, and developing sustainable technologies. Acidic and basic oxides are crucial for balancing environmental pH, while amphoteric oxides have versatile applications in advanced material science.

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10.1: Concept of Acids and Bases

1. What do acids release in water?

- A) Hydroxide ions
- ☑ **B) Hydrogen ions**
- C) Oxygen ions
- D) Carbon ions

2. Which of the following is a base?

- A) Hydrochloric acid
- B) Sulfuric acid
- C) Sodium hydroxide
- ☑ **D) Ammonia**

3. What is the pH of a neutral solution?

- A) 1
- ☑ **B) 7**
- C) 14
- D) 0

4. Which substance is an example of an acid?

- A) NaOH
- ☑ **B) HCl**
- C) CaO
- D) NH_3

5. What happens when an acid reacts with a base?

- ☑ **A) Salt and water are formed**
- B) Hydrogen gas is formed
- C) Carbon dioxide is released
- D) Oxygen is released

10.2: Strength of Acids and Bases

6. Which of the following is a strong acid?

- A) Acetic acid
- ☑ **B) Hydrochloric acid**
- C) Citric acid
- D) Formic acid

7. What does the strength of a base depend on?

- ☑ **A) Its ability to dissociate in water**
- B) Its molecular weight
- C) Its reaction time
- D) Its concentration

8. Which of the following is a weak acid?

- A) HCl
- B) H_2SO_4
- ☑ **C) CH_3COOH**
- D) HNO_3

9. What is the dissociation constant of a strong acid?

- A) Low
- B) Moderate
- ☑ **C) High**
- D) Zero

10. What is the pH of a strong base?

- A) Less than 7
- ☑ **B) Greater than 7**
- C) Exactly 7
- D) 0

10.3: Characteristic Properties of Acids

11. What is the taste of acids?

- A) Bitter
- ☑ **B) Sour**
- C) Salty

- D) Sweet

12. How do acids affect blue litmus paper?

- ☑ **A) Turn it red**
- B) Turn it green
- C) No effect
- D) Turn it yellow

13. Which gas is released when acids react with metals?

- A) Carbon dioxide
- ☑ **B) Hydrogen gas**
- C) Oxygen
- D) Nitrogen

14. What happens when acids react with carbonates?

- A) Only salt is formed
- B) Only water is formed
- C) Only hydrogen gas is formed
- ☑ **D) Salt, water, and carbon dioxide are formed**

15. Which of the following is an acid used in batteries?

- A) Nitric acid
- B) Hydrochloric acid
- C) Acetic acid
- ☑ **D) Sulfuric acid**

10.4: Characteristic Properties of Bases

16. What is the taste of bases?

- A) Sour
- ☑ **B) Bitter**
- C) Salty
- D) Sweet

17. How do bases affect red litmus paper?

- A) Turn it yellow
- B) Turn it green

- ☑ **C) Turn it blue**
- D) No effect

18. Which of the following is a weak base?

- A) NaOH
- B) KOH
- ☑ **C) NH_3**
- D) $Ca(OH)_2$

19. Which of the following is a common use of bases?

- A) Preservation of food
- B) In construction
- ☑ **C) Cleaning agents**
- D) Carbonation

20. Which base is used in agriculture to neutralize acidic soil?

- A) Sodium hydroxide
- B) Potassium hydroxide
- ☑ **C) Calcium hydroxide**
- D) Ammonium hydroxide

10.5: Oxides and Hydroxides

21. Which oxide reacts with water to form an acid?

- A) Magnesium oxide
- B) Calcium oxide
- ☑ **C) Carbon dioxide**
- D) Sodium oxide

22. Which oxide reacts with water to form a base?

- A) Sulfur dioxide
- ☑ **B) Calcium oxide**
- C) Carbon monoxide
- D) Aluminum oxide

23. What is an amphoteric oxide?

- A) Reacts only with acids

- B) Reacts only with bases
- ☑ **C) Reacts with both acids and bases**
- D) Does not react with anything

24. Which of the following is an example of a basic oxide?

- A) CO_2
- ☑ **B) CaO**
- C) SO_2
- D) Al_2O_3

25. Which oxide is used in carbonated beverages?

- A) Calcium oxide
- ☑ **B) Carbon dioxide**
- C) Magnesium oxide
- D) Sulfur dioxide

26. What happens when acidic oxides react with water?

- A) Bases are formed
- ☑ **B) Acids are formed**
- C) Salts are formed
- D) No reaction

27. What is the chemical formula for lime water?

- A) NaOH
- ☑ **B) $Ca(OH)_2$**
- C) KOH
- D) $Mg(OH)_2$

28. Which oxide reacts with acids to form salts?

- A) Sulfur dioxide
- ☑ **B) Calcium oxide**
- C) Carbon dioxide
- D) Water

29. Which hydroxide is commonly used in soap manufacturing?

- A) Potassium hydroxide
- B) Calcium hydroxide

- ☑ **C) Sodium hydroxide**
- D) Magnesium hydroxide

30. What is responsible for the basicity of a compound?

- A) H^+ ions
- ☑ **B) OH^- ions**
- C) Na^+ ions
- D) Cl^- ions