

Each Of The Following Compounds Are Dissolved In Pure Water. Which Will Result In The Formation Of A

Each Of The Following Compounds Are Dissolved In Pure Water. Which Will Result In The Formation Of A solution depends on the chemical nature of the compound, its ability to dissociate, and its interactions with water molecules. Understanding how different compounds behave when dissolved in water is fundamental in fields such as chemistry, environmental science, medicine, and industry. This article explores various types of compounds—ionic compounds, acids, bases, and molecular compounds—and explains which will produce solutions that are electrolytic, conductive, or non-conductive, as well as their specific properties in aqueous solutions.

Understanding Solubility and Dissociation in Water

What Happens When a Compound Dissolves?

When a compound dissolves in water, it interacts with water molecules, which can lead to:

- Dissociation: The separation of ionic compounds into their constituent ions.
- Ionization: The production of ions from molecules, especially acids and bases.
- Association: Formation of larger molecules or aggregates, often resulting in non-electrolyte solutions.

The nature of the compound determines whether it forms:

- An electrolyte solution (conducts electricity due to free ions),
- A nonelectrolyte solution (no significant ion formation, poor conductivity).

Classes of Compounds Dissolved in Water

Ionic Compounds

Ionic compounds consist of positively charged cations and negatively charged anions held together by ionic bonds. When dissolved:

- They dissociate into their ions.
- The extent of dissociation influences the solution's conductivity.
- Examples include sodium chloride (NaCl), potassium sulfate (K_2SO_4), and calcium chloride (CaCl_2).

Acids

Acids are compounds that release hydrogen ions (H^+) or protons in water:

- They are usually molecular compounds that ionize in water.
- Strong acids (e.g., hydrochloric acid, HCl) completely dissociate.
- Weak acids (e.g., acetic acid, CH_3COOH) partially dissociate.

Bases

Bases release hydroxide ions (OH^-) when dissolved:

- Strong bases (e.g., sodium hydroxide, NaOH) completely dissociate.
- Weak bases (e.g., ammonia, NH_3) partially ionize.

Molecular Compounds (Non-electrolytes)

Molecular compounds like glucose ($C_6H_{12}O_6$) or ethanol (C_2H_5OH):

- Typically do not dissociate into ions.
- Their solutions are poor conductors of electricity.
- They dissolve through intermolecular interactions rather than ionic dissociation.

Which Compounds Form Conductive Solutions?

Electrolyte Formation and Conductivity

The conductivity of an aqueous solution hinges on the presence of free ions:

- Strong electrolytes produce solutions that conduct electricity well.
- Weak electrolytes conduct poorly.
- Nonelectrolytes do not conduct electricity significantly.

Examples of Compounds Forming Conductive Solutions

1. Sodium chloride ($NaCl$)

- Dissolves completely into Na^+ and Cl^- ions.
- Produces a highly conductive solution.

2. Potassium sulfate (K_2SO_4)

- Dissociates into $2K^+$ and SO_4^{2-} ions.
- Good conductivity.

3. Calcium chloride ($CaCl_2$)

- Dissolves into Ca^{2+} and $2Cl^-$ ions.
- Strong electrolyte, high conductivity.

4. Hydrochloric acid (HCl)

- Fully ionizes into H^+ and Cl^- .

- Excellent conductivity.

5. Sodium hydroxide (NaOH)

- Fully dissociates into Na^+ and OH^- .

- Good electrical conduction.

Which Compounds Do Not Form Conductive Solutions?

Non-electrolytes and Weak Electrolytes

Compounds that do not dissociate significantly or at all produce solutions with minimal electrical conductivity:

- Molecular compounds like glucose ($\text{C}_6\text{H}_{12}\text{O}_6$)

- Dissolves as intact molecules.

- No free ions, poor conductance.

- Ethanol ($\text{C}_2\text{H}_5\text{OH}$)

- Dissolves via hydrogen bonding, no ionic dissociation.

- Non-conductive.

- Acetic acid (CH_3COOH) (weak acid)

- Partially ionizes, resulting in weak conductivity.

Predicting the Nature of the Solution: Formation of Aqueous

Solutions

Factors Influencing Solution Behavior

- Type of compound (ionic, molecular, acid, base)
- Degree of dissociation or ionization
- Concentration of the compound
- Temperature

Based on these factors, we can predict whether a compound will form:

- Electrolyte solutions that conduct electricity.
- Non-electrolyte solutions with minimal or no conduction.

Practical Examples and Applications

Electrolyte Solutions in Industry and Medicine

- Electrolyte solutions are vital in:
- Batteries and fuel cells (e.g., NaCl solutions).
- Medical IV fluids (e.g., saline solutions).
- Water treatment (e.g., calcium chloride for water hardness control).

Non-electrolyte Solutions in Daily Life

- Solutions of sugar or alcohol are common in beverages.
- They are used in:

- Cooking and food preservation.
- Pharmaceutical formulations where non-conductive solutions are necessary.

Summary Table: Compounds and Their Solution Types

Compound	Type	Dissociation/ Ionization	Conductivity	Notes
NaCl	Ionic	Complete	High	Produces strong electrolyte solution
HCl	Acid	Complete	High	Strong acid, strong electrolyte
K ₂ SO ₄	Ionic	Complete	High	Produces electrolyte solution
CaCl ₂	Ionic	Complete	High	Used in de-icing and water treatment
CH ₃ COOH	Weak Acid	Partial	Low to moderate	Weak electrolyte
C ₆ H ₁₂ O ₆	Molecular	None	None	Non-electrolyte
C ₂ H ₅ OH	Molecular	None	None	Non-electrolyte
NH ₃	Weak Base	Partial	Low to moderate	Weak electrolyte

Conclusion

Understanding which compounds produce solutions that are electrolytic or non-electrolytic when dissolved in pure water is essential for various scientific and industrial applications. Ionic compounds like NaCl, K₂SO₄, and CaCl₂ readily dissociate into ions, creating highly conductive solutions suitable for electrical applications. Conversely, molecular compounds such as glucose or ethanol dissolve without ionization, resulting in non-conductive solutions. Acids and bases display intermediate behaviors depending on whether they are strong or weak electrolytes.

In summary, the key to predicting whether a compound will result in a solution that conducts electricity or not hinges on its ability to dissociate into ions in water. This knowledge enables scientists and engineers to tailor solutions for specific uses, from medical treatments to industrial processes, ensuring efficiency and safety in their applications.

Keywords: solubility, electrolytes, non-electrolytes, ionic compounds, acids, bases, molecular compounds, water dissociation, conductivity, chemical solutions

Frequently Asked Questions

Which of the following compounds, when dissolved in pure water, will produce a conducting solution?

Electrolytes such as sodium chloride (NaCl) will dissociate into ions, resulting in a conductive solution.

Among the given compounds, which one will form a basic solution upon dissolving in pure water?

Ammonia (NH_3) will produce a basic solution because it reacts with water to form NH_4^+ and OH^- ions.

Which compound dissolved in pure water will result in a neutral solution?

A strong acid like hydrochloric acid (HCl) or a strong base like sodium hydroxide (NaOH) will produce solutions that are either strongly acidic or basic, so a neutral compound such as sodium chloride (NaCl) will result in a neutral solution.

If a compound is a covalent molecular substance, what type of solution does it typically form in water?

Many covalent molecular compounds are non-electrolytes and will form a non-conducting, neutral solution in water.

Which of the following compounds will form an acidic solution when dissolved in pure water?

A compound like sulfuric acid (H_2SO_4) will dissociate to produce H^+ ions, resulting in an acidic solution.

Additional Resources

Each Of The Following Compounds Are Dissolved In Pure Water. Which Will Result In The Formation Of An Acid?

Investigative Analysis: Which Compounds Dissolved in Pure Water Form Acids?

Introduction

The interaction between chemical compounds and water is foundational in understanding chemical reactivity, especially in aqueous solutions. When compounds dissolve in water, their behavior depends on their molecular structure and their ability to dissociate or react with water molecules. A particularly interesting question is: which compounds, upon dissolving in pure water, result in the formation of an acid?

This query is not only academically stimulating but also practically relevant in fields such as chemistry,

environmental science, industrial manufacturing, and medicine. Understanding the nature of acids formed in aqueous solutions can influence everything from pH regulation in biological systems to the design of industrial processes.

This review aims to provide a comprehensive examination of various compounds that, when dissolved in pure water, produce acidic solutions. We will explore the chemical principles behind acid formation, analyze specific compound classes, and elucidate the underlying mechanisms that lead to acidity in aqueous environments.

Fundamental Concepts in Acid Formation

What Is an Acid in Aqueous Solution?

An acid is a substance that increases the concentration of hydrogen ions (H^+) or protons in an aqueous solution. According to the Brønsted-Lowry definition, acids are proton donors, while Lewis acids are electron pair acceptors. In water, acids typically dissociate or react to produce H^+ ions, resulting in a solution with a pH less than 7.

Dissociation and Hydrolysis

The formation of acids upon dissolving compounds in water often involves:

- Dissociation of ionic compounds: e.g., acids like HCl dissociate completely into H^+ and Cl^- .
- Hydrolysis of covalent compounds: molecules that react with water to produce H^+ ions, such as certain oxides or salts derived from acids.

Types of Compounds That Form Acids in Water

- Strong acids: Completely dissociate in water (e.g., HCl, H_2SO_4).

- Weak acids: Partially dissociate, establishing an equilibrium (e.g., acetic acid).
- Acidic oxides: Non-metal oxides that react with water to form acids (e.g., SO₃ forms sulfuric acid).

Classes of Compounds and Their Behavior in Water

1. Acidic Oxides (Non-Metal Oxides)

Sulfur Trioxide (SO₃)

When SO₃ dissolves in water, it reacts vigorously to produce sulfuric acid:



This reaction is highly exothermic and results in a strong acid in solution. SO₃ is a classic example of an acidic oxide that forms an acid upon dissolution.

Nitrogen Dioxide (NO₂)

NO₂ reacts with water to form a mixture of nitric acid (HNO₃) and nitrous acid (HNO₂):



This reaction produces an acidic solution, with HNO₃ being a strong acid.

Carbon Dioxide (CO₂)

CO₂ dissolves in water to form carbonic acid:



Although carbonic acid is a weak acid, it still contributes to acidity, especially in natural waters like oceans and lakes.

2. Acidic Salts and Their Hydrolysis

Salts derived from acids can hydrolyze in water to release H^+ ions, thus forming acidic solutions.

Example: Ammonium Salts (e.g., NH_4Cl)

While ammonium chloride is a salt, it hydrolyzes in water to form ammonium ions (NH_4^+), which can donate protons:



This process results in an acidic solution.

3. Covalent Compounds That React with Water

Some covalent compounds, upon dissolving, react with water to produce H^+ ions directly.

Example: Hydrogen Halides (HCl , HBr , HI)

These gases or liquids, when dissolved, dissociate completely:



This makes their aqueous solutions strongly acidic.

Specific Compounds and Their Acid-Forming Behavior

1. Sulfur Trioxide (SO_3)

Behavior: Upon dissolving in water, SO_3 reacts to form sulfuric acid, a strong acid.

Mechanism: The reaction involves a highly exothermic addition of water, and the resulting H_2SO_4 dissociates completely in water, releasing H^+ ions.

Implication: SO_3 is a quintessential example of an acidic oxide that forms a strong acid in aqueous solution.

2. Nitrogen Dioxide (NO_2)

Behavior: Reacts with water to form nitric acid (HNO_3) and nitrous acid (HNO_2).

Mechanism: NO_2 undergoes hydrolysis, resulting in a mixture of acids that contribute to solution acidity.

Implication: NO_2 is an acidic oxide, and its dissolution produces a strongly acidic solution.

3. Carbon Dioxide (CO_2)

Behavior: Dissolves to form carbonic acid, which is a weak acid.

Mechanism: CO_2 reacts with water to produce H_2CO_3 , which partially dissociates to release H^+ ions.

Implication: CO_2 contributes to natural acidity in aquatic systems; however, it does not produce a strongly acidic solution.

4. Hydrogen Halides (HCl , HBr , HI)

Behavior: These gases or solutions dissociate completely in water, producing H^+ ions.

Mechanism: They are molecular compounds that ionize fully in aqueous solution, making them strong acids.

Implication: They are among the most potent acids formed upon dissolving in water.

5. Metal Hydrides (e.g., NaH , CaH_2)

Behavior: These compounds react with water to produce H_2 gas and hydroxide or hydronium ions.

Mechanism: For example, sodium hydride reacts with water:



The resulting solution is basic due to hydroxide ions, not acidic.

Implication: Metal hydrides tend to produce basic solutions rather than acids.

Summary of Compounds That Result in Acidic Solutions Upon Dissolution

Compound Type	Example	Reaction in Water	Acidic Nature
Acidic oxides	SO_2 , NO_2	React to form sulfuric acid, nitric acid	Strong acids
Covalent molecular acids	HCl , HBr , HI	Complete dissociation	Strong acids
Acidic salts (from acids)	NH_4Cl	Hydrolysis releases H^+	Weak to moderate acids
Carbon dioxide (CO_2)	CO_2	Forms carbonic acid	Weak acid

Note: Compounds such as metal hydroxides, metal oxides (like Na_2O), or basic salts tend to produce

basic solutions upon dissolution and are not considered acids.

Practical Implications and Applications

Understanding which compounds produce acids in water influences numerous fields:

- Environmental Science: Acid rain results from sulfur oxides and nitrogen oxides dissolving in rainwater, leading to environmental degradation.
- Industrial Chemistry: Manufacturing sulfuric acid involves SO_3 reacting with water.
- Biochemistry: Carbonic acid plays a vital role in blood pH regulation.
- Materials Science: Acidic solutions can corrode metals; thus, knowing which compounds form acids helps prevent material degradation.

Conclusion

The dissolution of certain compounds in pure water results in the formation of acids, primarily depending on their chemical nature and reactivity. Acidic oxides like sulfur trioxide and nitrogen dioxide readily produce strong acids such as sulfuric and nitric acid upon dissolution. Covalent molecules like hydrogen halides also dissociate completely, producing strong acids. Carbon dioxide, although a weak acid, still contributes to acidity in natural systems.

Conversely, compounds such as metal hydrides and basic oxides tend to generate basic solutions, not acids. Recognizing these behaviors is critical for scientific understanding, environmental considerations, and industrial applications.

In summary, the compounds most likely to result in acid formation upon dissolving in pure water are:

- Sulfur Trioxide (SO_3)
- Nitrogen Dioxide (NO_2)
- Hydrogen Halides (HCl , HBr , HI)
- Carbon Dioxide (CO_2)
- Acidic Salts (e.g., NH_4Cl)

This knowledge enhances our comprehension of aqueous chemistry and guides appropriate handling and application of chemical substances across diverse fields.

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