A. Write The Balanced NET IONIC Equation For The Reaction That Occurs When Hydrobromic Acid And Ammonia

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Understanding the interactions between acids and bases, especially in aqueous solutions, is fundamental in chemistry. When hydrobromic acid (HBr) reacts with ammonia (NH_3), a typical acid-base reaction occurs, resulting in the formation of ammonium bromide. To accurately describe this process, chemists use net ionic equations, which focus on the species that change during the reaction, ignoring the spectator ions that do not participate directly in the chemical change.

In this comprehensive article, we will explore the detailed steps involved in deriving the balanced net ionic equation for the reaction between hydrobromic acid and ammonia. We will cover the basic concepts of acid-base reactions, dissociation of ionic compounds, and the importance of net ionic equations in understanding chemical processes. Additionally, we will provide insights into the chemical properties of hydrobromic acid and ammonia, their behavior in aqueous solutions, and the practical applications of this reaction.

Understanding Hydrobromic Acid and Ammonia

Before diving into the reaction specifics, it is essential to understand the nature of the reactants involved: hydrobromic acid and ammonia.

Hydrobromic Acid (HBr)

- Chemical Nature: Hydrobromic acid is a strong acid, meaning it dissociates completely in aqueous solution.
- Dissociation in Water:
$$
\mathrm{HBr_{(aq)} \rightarrow H^+_{(aq)} + Br^-_{(aq)}}
$$
- Properties: It is used in organic synthesis, as a reagent in chemical reactions, and for cleaning purposes due to its strong acidity.

Ammonia (NH_3)

- Chemical Nature: Ammonia is a weak base; it does not dissociate completely but reacts with water to produce ammonium and hydroxide ions.
- Reaction with Water:
$$
\mathrm{NH_3_{(aq)} + H_2O_{(l)} \rightleftharpoons NH_4^+_{(aq)} + OH^-_{(aq)}}
$$
- Properties: Ammonia is a common nitrogenous compound used in fertilizers, cleaning agents, and industrial processes.

The Acid-Base Reaction Between Hydrobromic Acid and Ammonia

When hydrobromic acid interacts with ammonia in aqueous solution, an acid-base neutralization occurs. The hydrogen ion (H^+) from the acid reacts with the ammonia molecule (NH_3), which acts as a base, to form ammonium ions (NH_4^+). Simultaneously, bromide ions (Br^-) are present in solution, which typically do not participate directly in the acid-base reaction but are involved in forming the product compound.

Reaction overview:

$$
\mathrm{HBr_{(aq)} + NH_3_{(aq)} \rightarrow NH_4Br_{(s)}}
$$

This reaction results in the formation of ammonium bromide, which can be a precipitate or remain in solution depending on the conditions.

Step-by-Step Derivation of the Net Ionic Equation

To accurately write the net ionic equation, follow these steps:

1. Identify the strong and weak electrolytes:
- Hydrobromic acid (HBr) is a strong acid and dissociates completely.
- Ammonia (NH_3) is a weak base, reacting with water to produce NH_4^+ and OH^-.

2. Write the dissociation equations:
- For HBr:
$$
\mathrm{HBr_{(aq)} \rightarrow H^+_{(aq)} + Br^-_{(aq)}}
$$
- For NH_3 reacting with water:
$$
\mathrm{NH_3_{(aq)} + H_2O_{(l)} \rightleftharpoons NH_4^+_{(aq)} + OH^-_{(aq)}}
$$

3. Determine the primary reaction:
- The hydrogen ion (H^+) from HBr reacts with ammonia (NH_3) to produce ammonium (NH_4^+):

$$
\mathrm{H^+_{(aq)} + NH_3_{(aq)} \rightarrow NH_4^+_{(aq)}}
$$

4. Combine with the bromide ions to form the salt:
- Bromide ions (Br^-) from HBr combine with ammonium ions (NH_4^+) to form ammonium bromide (NH_4Br).

5. Write the overall net ionic equation:

$$
\mathrm{H^+_{(aq)} + NH_3_{(aq)} \rightarrow NH_4^+_{(aq)}}
$$

When considering the formation of the salt, the full balanced equation becomes:

$$
\mathrm{H^+_{(aq)} + NH_3_{(aq)} \rightarrow NH_4^+_{(aq)}}
$$

\]

And combining with bromide ions yields:

\[
\mathrm{H^+_{(aq)} + Br^-_{(aq)} + NH_3_{(aq)} \rightarrow NH_4^+_{(aq)} + Br^-_{(aq)}}
\]

Since bromide ions are spectator ions (they don't change during the reaction), the net ionic equation focuses on the main reacting species:

\[
\mathrm{H^+_{(aq)} + NH_3_{(aq)} \rightarrow NH_4^+_{(aq)}}
\]

Final Balanced Net Ionic Equation

The ultimate goal is to present the simplified, balanced net ionic equation that captures the essence of the reaction. Given that:

- Hydrobromic acid provides H^+ ions
- Ammonia accepts H^+ to form ammonium ions

The balanced net ionic equation is:

\[
\boxed{
\mathrm{H^+_{(aq)} + NH_3_{(aq)} \rightarrow NH_4^+_{(aq)}}
}
\]

This equation illustrates the acid-base neutralization process at the ionic level, emphasizing the transfer of a proton (H^+) from hydrobromic acid to ammonia, resulting in ammonium ions.

Additional Considerations and Practical Applications

Understanding the reaction between hydrobromic acid and ammonia extends beyond theoretical chemistry; it has practical applications in various industries and laboratory settings.

Applications include:

- Preparation of Ammonium Bromide: Used as a sedative and in certain chemical syntheses.
- Industrial Processes: Neutralization reactions like this are fundamental in wastewater treatment and chemical manufacturing.
- Analytical Chemistry: The reaction is used in titrations to determine concentrations of acids and bases.

Safety Precautions:
- Hydrobromic acid is highly corrosive; proper handling with protective equipment is essential.
- Ammonia vapors are toxic and can irritate the respiratory system; adequate ventilation is necessary during reactions.

Summary and Key Takeaways

- Hydrobromic acid (HBr) is a strong acid that dissociates completely in aqueous solutions, providing H^+ ions.
- Ammonia (NH_3) is a weak base that reacts with water to produce ammonium (NH_4^+) and hydroxide (OH^-) ions.
- When HBr reacts with ammonia, the primary ionic process involves the transfer of a proton (H^+) from HBr to NH_3, forming NH_4^+.
- The net ionic equation for this reaction is:

$$
\mathrm{H^+_{(aq)} + NH_3_{(aq)} \rightarrow NH_4^+_{(aq)}}
$$

- The formation of ammonium bromide (NH_4Br) is the overall outcome, with bromide ions acting as spectator ions.

In conclusion, understanding and deriving the balanced net ionic equation for the reaction between hydrobromic acid and ammonia provides vital insights into acid-base chemistry, ionic reactions, and practical applications in industry and laboratory analysis. This knowledge allows chemists to predict reaction outcomes accurately and design processes that leverage these fundamental chemical interactions.

Meta Description: Discover how to write the balanced net ionic equation for the reaction between hydrobromic acid and ammonia. Learn the step-by-step process, chemical concepts, and real-world applications in this detailed guide.

Frequently Asked Questions

What is the balanced net ionic equation for the reaction between hydrobromic acid and ammonia?

The balanced net ionic equation is: $^{-9}$ Br· (aq) + NH_3 (aq) ? NH_4^- (aq) + Br^- (aq).

Why does hydrobromic acid react with ammonia to produce ammonium bromide?

Because hydrobromic acid is a strong acid and ammonia is a weak base, they react to form ammonium bromide through proton transfer, resulting in the formation of NH_4^- and Br^- ions.

How do you identify the spectator ions in the reaction between hydrobromic acid and ammonia?

In this reaction, there are no spectator ions, as all ions participate in forming the products: ammonium ($^4{}_4^-$) and bromide ($^-$) ions.

What is the significance of balancing the net ionic equation in this reaction?

Balancing the net ionic equation ensures the conservation of mass and charge, accurately representing the chemical change that occurs between hydrobromic acid and ammonia.

Can you explain the process of deriving the net ionic equation from the full molecular equation for this reaction?

Yes, start with the molecular equation: $HBr + NH_3$ → $NH_4^- + Br^-$. Then, dissociate all strong electrolytes into ions and cancel out any spectator ions. The remaining ions form the net ionic equation.

Is the reaction between hydrobromic acid and ammonia a typical acid-base reaction? Why?

Yes, because hydrobromic acid donates a proton ($^{+-}$), and ammonia accepts it, forming ammonium, which is characteristic of acid-base reactions.

Additional Resources

Write The Balanced NET IONIC Equation For The Reaction That Occurs When Hydrobromic Acid And Ammonia

Understanding the chemical interactions between hydrobromic acid (HBr) and ammonia (NH_3) is fundamental in various fields of chemistry, especially in acid-base reactions and solution chemistry. The process of deriving the balanced net ionic equation provides insight into the underlying molecular exchanges and helps predict the behavior of these substances in aqueous environments. This article aims to explore in detail how to write the balanced net ionic equation for the reaction between hydrobromic acid and ammonia, including foundational concepts, step-by-step procedures, and relevance in practical applications.

Introduction to Hydrobromic Acid and Ammonia

Before diving into the reaction specifics, it is important to understand the nature of the reactants involved:

Hydrobromic Acid (HBr)

- Properties: Hydrobromic acid is a strong, monoprotic acid that dissociates completely in aqueous solutions.
- Chemical Behavior: It readily donates protons (H^+) to other species, making it highly reactive in acid-base chemistry.
- Uses: Employed in organic synthesis, as a reagent in chemical manufacturing, and as a cleaning agent.

Ammonia (NH_3)

- Properties: Ammonia is a weak base that can accept protons and participate in acid-base reactions.
- Chemical Behavior: It exists in aqueous solutions primarily as ammonia molecules and ammonium ions (NH_4^+) depending on the pH.
- Uses: Widely used in fertilizers, cleaning products, and as a refrigerant.

Understanding Acid-Base Reactions in Solution

The core concept underlying the reaction between HBr and NH_3 is acid-base chemistry, specifically the proton transfer mechanism. In aqueous solutions:

- Hydrobromic acid dissociates completely into H^+ and Br^- ions.
- Ammonia can accept a proton to form ammonium ions (NH_4^+).

The general reaction involves the transfer of a proton from HBr to NH_3, leading to the formation of ammonium bromide (NH_4Br), an ionic compound.

Step-by-Step Derivation of the Balanced Molecular Equation

The initial step involves writing the unbalanced molecular equation:

$HBr\,(aq) + NH_3\,(aq) \rightarrow NH_4Br\,(aq)$

This equation indicates that hydrobromic acid reacts with ammonia to produce ammonium bromide, which is a salt formed from the ammonium cation and bromide anion.

To balance this molecular equation:

- Both sides contain one HBr and one NH_3 molecule.
- The product is NH_4Br, which contains one ammonium ion and one bromide ion.

The molecular equation is already balanced as written:

$HBr\,(aq) + NH_3\,(aq) \rightarrow NH_4Br\,(aq)$

Writing the Complete Ionic Equation

Since all species are aqueous and dissociate into ions:

- $HBr \rightarrow H^+ + Br^-$
- NH_3 remains as a weak base, but in water, it exists predominantly as NH_3 molecules and some NH_4^+ and OH^- due to partial protonation.

However, in this reaction, the dominant process is the proton transfer:

$H^+ + NH_3 \rightarrow NH_4^+$

The bromide ion (Br^-) remains as a spectator ion because it does not participate directly in the proton transfer but is present in the solution.

Thus, the complete ionic equation is:

$H^+\,(aq) + NH_3\,(aq) + Br^-\,(aq) \rightarrow NH_4^+\,(aq) + Br^-\,(aq)$

Deriving the Net Ionic Equation

To obtain the net ionic equation, we eliminate spectator ions — ions that appear unchanged on both sides of

the ionic equation. Here, the bromide ion (Br^-) appears on both sides and does not participate directly in the proton transfer.

Therefore, removing the spectator ion yields:

$H^+ (aq) + NH_3 (aq) \rightarrow NH_4^+ (aq)$

This is the balanced net ionic equation for the reaction between hydrobromic acid and ammonia.

Features and Significance of the Net Ionic Equation

Features:
- Simplicity: Focuses solely on the species directly involved in the proton transfer.
- Clarity: Highlights the fundamental acid-base interaction.
- Applicability: Useful in predicting reaction outcomes and pH changes in solutions.

Significance:
- Demonstrates that hydrobromic acid acts as a proton donor.
- Shows ammonia as a proton acceptor forming ammonium ions.
- Helps in understanding salt formation and solution behavior.

Practical Applications of the Reaction and Equation

The reaction and its net ionic form have several practical implications:

1. Buffer Solution Formation

- Ammonia and ammonium salts can create buffers that resist pH changes, useful in biological and chemical laboratory settings.

2. Fertilizer Production

- Ammonium bromide, formed in similar reactions, is used in the manufacture of fertilizers.

3. Acid-Base Titrations

- The reaction provides a basis for titrations involving strong acids and weak bases.

4. Understanding Solution Chemistry

- The net ionic equation is essential for predicting the direction of the reaction and the extent of proton transfer.

Pros and Cons of the Reaction and Equation

Pros:
- Clarity in Proton Transfer: Clearly indicates the fundamental acid-base interaction.
- Educational Value: Helps students understand ionic reactions and the concept of spectator ions.
- Predictive Power: Useful in calculating pH, equilibrium positions, and salt formation.

Cons:
- Simplification: Assumes complete dissociation and ignores minor equilibria.
- Limited Scope: Does not account for complex equilibria involving ammonia's partial protonation.
- Context Dependence: In real solutions, side reactions and interactions may occur.

Conclusion

The reaction between hydrobromic acid and ammonia is a classic example of acid-base chemistry, illustrating proton transfer and salt formation. The balanced net ionic equation, $H^+(aq) + NH_3(aq) \rightarrow NH_4^+(aq)$, succinctly captures the essence of this interaction. Understanding how to derive and interpret this equation enhances one's grasp of solution chemistry, pH regulation, and ionic reactions. This knowledge is not only fundamental in academic settings but also vital in industrial applications, environmental chemistry, and laboratory analysis. Recognizing the features, applications, and limitations of this reaction equips chemists and students alike with a deeper insight into the dynamic world of aqueous chemical reactions.

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