A Sample Is Prepared By Completely Dissolving 10.0 Grams Of Nacl In 1.0 Liter Of H2o. Which Classification

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Understanding the classification of a solution prepared by dissolving a specific amount of solute in a solvent is fundamental in chemistry. In this article, we will explore the nature of the solution formed when 10.0 grams of sodium chloride (NaCl) is completely dissolved in 1.0 liter of water (H_2O), and determine its classification based on various parameters such as concentration, physical state, and solution properties.

Introduction to Solutions and Their Classifications

Solutions are homogeneous mixtures composed of a solute dissolved uniformly in a solvent. The classification of solutions depends on multiple factors, including the amount of solute relative to the solvent, the physical state of the components, and the properties of the resulting mixture.

Types of solutions based on concentration:
- Dilute solutions: Contain a small amount of solute relative to solvent.
- Concentrated solutions: Contain a large amount of solute relative to solvent.
- Saturated solutions: Cannot dissolve any more solute at a given temperature.
- Unsaturated solutions: Can dissolve more solute at a given temperature.
- Supersaturated solutions: Contain more solute than the equilibrium solubility; unstable and can precipitate.

Types based on physical state:
- Gaseous solutions (e.g., air)
- Liquid solutions (e.g., saltwater)
- Solid solutions (e.g., alloys)

In this case, because we are dissolving NaCl in water, the solution is a liquid solution.

Calculating the Concentration of the NaCl

Solution

To classify the solution accurately, it is essential to determine its concentration, typically expressed in molarity (M), which is moles of solute per liter of solution.

Step 1: Calculate the molar mass of NaCl

- Sodium (Na): 22.99 g/mol
- Chlorine (Cl): 35.45 g/mol

Molar mass of NaCl = 22.99 + 35.45 = 58.44 g/mol

Step 2: Determine moles of NaCl dissolved

$$
\text{Moles of NaCl} = \frac{\text{Mass of NaCl}}{\text{Molar mass of NaCl}} = \frac{10.0\, \text{g}}{58.44\, \text{g/mol}} \approx 0.171\, \text{mol}
$$

Step 3: Calculate molarity of the solution

Since the solution volume is 1.0 liter:

$$
\text{Molarity} = \frac{\text{Moles of NaCl}}{\text{Volume of solution in liters}} = \frac{0.171\, \text{mol}}{1.0\, \text{L}} = 0.171\, \text{M}
$$

Conclusion: The solution is approximately 0.171 molar.

Classification of the NaCl Solution

Based on the concentration, physical state, and properties, the solution can be classified as follows:

1. Based on Concentration

The molarity of approximately 0.171 M indicates a dilute solution in comparison to saturated saltwater, which has a molarity of about 6.14 M at room temperature. Therefore, the solution is clearly dilute.

2. Physical State and Nature

Since NaCl is dissolved uniformly in water, the mixture is:
- Homogeneous
- A liquid solution

Specifically, it is an aqueous solution, meaning water is the solvent.

3. Based on Solubility and Saturation

Given the amount of NaCl dissolved (10 grams) in 1 liter of water:
- The amount is well below the solubility limit of NaCl in water at room temperature (~36 g per 100 mL).
- Therefore, the solution is unsaturated.

Implications of Solution Classification

Understanding the classification of this solution has practical significance in various fields such as chemistry, environmental science, and industrial processes.

Applications include:
- Preparation of laboratory solutions
- Understanding saltwater behavior in marine environments
- Industrial processes involving saline solutions
- Educational demonstrations of solution properties

Safety and Handling:
- NaCl solutions are generally safe, but high concentrations can cause irritation.
- Proper labeling and handling protocols should be followed in laboratory settings.

Factors Affecting Solution Classification

While the current classification is based on the specified parameters, several factors can influence the nature of solutions:

- **Temperature:** Higher temperatures increase solubility of NaCl, potentially making the solution more concentrated.
- **Pressure:** For gases, pressure significantly affects solubility, but for liquids like NaCl in water, temperature plays a more prominent role.
- **Nature of solute and solvent:** The polarity and intermolecular forces

determine solubility and solution behavior.

Conclusion

In summary, a sample prepared by completely dissolving 10.0 grams of NaCl in 1.0 liter of water results in a dilute, aqueous, homogeneous solution. Its molarity of approximately 0.171 M classifies it as a dilute solution that is unsaturated under standard conditions. Such a solution exemplifies typical saltwater solutions used in both educational and industrial contexts.

Key Takeaways:
- The solution is homogeneous and aqueous.
- It is classified as a dilute, unsaturated solution.
- Understanding the concentration helps in predicting properties like conductivity, reactivity, and potential uses.
- Factors like temperature can influence the solution’s classification, especially regarding saturation.

By grasping these fundamental concepts, students and professionals can better understand solution chemistry and its applications across various scientific disciplines.

Frequently Asked Questions

What classification does a sample fall under when 10.0 grams of NaCl is completely dissolved in 1.0 liter of water?

The sample is classified as a saturated aqueous solution of sodium chloride.

Is the NaCl solution prepared by dissolving 10.0 grams in 1.0 liter of water considered a dilute or concentrated solution?

Since 10.0 grams of NaCl in 1.0 liter of water results in a relatively low concentration, it is considered a dilute solution.

How does the solubility of NaCl at room temperature relate to the classification of this solution?

NaCl's solubility at room temperature (~36 g per 100 mL) indicates that dissolving 10.0 grams in 1 liter (1000 mL) is well within its solubility

limit, classifying it as an unsaturated solution.

Can we determine if the solution is saturated, unsaturated, or supersaturated based solely on the given data?

Yes, since 10.0 grams of NaCl dissolves completely in 1 liter of water, which is below its solubility limit, the solution is classified as unsaturated.

What factors influence the classification of the NaCl solution prepared in this manner?

The key factors are the amount of NaCl dissolved, the volume of water, and the solubility of NaCl at the given temperature, which together determine whether the solution is saturated, unsaturated, or supersaturated.

Additional Resources

Classification of a Sample Prepared by Completely Dissolving 10.0 Grams of NaCl in 1.0 Liter of H_2O

Introduction: Deciphering the Nature of the Solution

When examining a solution created by dissolving 10.0 grams of sodium chloride (NaCl) into 1.0 liter of water (H_2O), the fundamental question that arises is: What classification does this solution fall under? This inquiry is not merely academic; understanding the classification provides insights into the solution’s properties, behavior, and applications across various fields such as chemistry, biology, environmental science, and industrial processes.

In this article, we delve deeply into the classification of such a solution, exploring the scientific principles behind it, its characteristics, and its relevance. We will analyze the type of solution, the nature of solutes and solvents involved, and how concentration impacts its classification.

Understanding the Components: NaCl and Water

What is Sodium Chloride (NaCl)?

Sodium chloride, commonly known as table salt, is an ionic compound composed of sodium (Na^+) and chloride (Cl^-) ions. It is highly soluble in water and dissociates into its constituent ions when dissolved:

$$ \text{NaCl} \rightarrow \text{Na}^+ + \text{Cl}^- $$

NaCl’s solubility in water at room temperature is approximately 36 g per 100 mL of water, meaning that 10 grams of NaCl readily dissolves in 1 liter of water, resulting in a saturated or near-saturated solution depending on the temperature.

What is Water (H_2O)?

Water is a polar solvent, characterized by its high dielectric constant and ability to dissolve a wide range of substances, especially ionic compounds like NaCl. Its polarity allows it to stabilize ions through ion-dipole interactions, facilitating dissolution.

Classification of Solutions: Core Concepts

Before analyzing the specific sample, it’s essential to understand the fundamental classifications of solutions:

- Homogeneous vs. Heterogeneous:
- Homogeneous solutions have uniform composition throughout.
- Heterogeneous mixtures have visibly different components or phases.

- Based on the state of solute and solvent:
- Gaseous solutions: e.g., air (a mixture of gases).
- Liquid solutions: e.g., saltwater, sugar syrup.
- Solid solutions: e.g., alloys like brass.

- On the basis of concentration:
- Dilute solutions: low solute concentration.
- Concentrated solutions: high solute concentration.
- Saturated solutions: maximum solute dissolved at given conditions.
- Unsaturated solutions: less than maximum solute dissolved.
- Supersaturated solutions: more solute than normally possible, unstable under certain conditions.

Analyzing the Sample: NaCl in Water

Type of Solution – Homogeneity

Given that the NaCl is completely dissolved in water, the resulting mixture is homogeneous. The ions are evenly distributed throughout the solvent, with no visible phase separation or particles, which makes it a classic example of a liquid homogeneous solution.

Key features:

- Uniform composition at the molecular level.
- Transparent appearance, typical of saltwater solutions.
- No distinguishable layers or particles when observed visually.

Conclusion: The solution is a homogeneous liquid solution.

Nature of the Solute and Solvent

- Solute: Sodium chloride (NaCl), an ionic compound.
- Solvent: Water (H_2O), a polar solvent.

This combination exemplifies ionic solution formation driven by polarity differences and ion-dipole interactions.

Implication: The solution is an ionic aqueous solution.

Classification Based on Concentration and Saturation

Calculating the Concentration

To classify the solution further, it's essential to determine its concentration:

- Mass of NaCl: 10.0 grams
- Volume of water: 1.0 liter (1000 mL)

The molar mass of NaCl:

$$ \text{Na} = 23.00\, \text{g/mol} $$
$$ \text{Cl} = 35.45\, \text{g/mol} $$
$$ \text{NaCl} = 23.00 + 35.45 = 58.45\, \text{g/mol} $$

Number of moles of NaCl:

$$ \text{Moles} = \frac{10.0\, \text{g}}{58.45\, \text{g/mol}} \approx 0.171\, \text{mol} $$

Concentration in molarity (M):

$$ \text{Molarity} = \frac{\text{moles of solute}}{\text{liters of solution}} = \frac{0.171\, \text{mol}}{1.0\, \text{L}} = 0.171\, \text{M} $$

Interpreting the Concentration

- Dilute Solution:
Typically, solutions with molarity less than 1 M are considered dilute. Here, the concentration (~0.171 M) is well within the dilute range.

- Saturation Status:
Since the solubility of NaCl at room temperature (~36 g/100 mL) exceeds 10 g/L, the solution is unsaturated, meaning more NaCl could dissolve if added.

Classification:
The solution is a dilute, unsaturated aqueous solution of sodium chloride.

Implications of the Classification

Understanding that the solution is a dilute, unsaturated, homogeneous ionic aqueous solution is critical for various reasons:

- Chemical Behavior:
Such solutions are excellent conductors of electricity due to free ions, making them useful in electrochemical applications.

- Biological Relevance:
Similar solutions mimic bodily fluids, playing a vital role in physiological processes.

- Industrial Uses:
Used in food preservation, water treatment, and chemical manufacturing.

Additional Classifications and Related Concepts

Electrolyte Solutions

Since NaCl dissociates into ions, the solution is classified as an electrolyte solution, capable of conducting electricity. This is fundamental in electrochemistry and explains why saltwater is conductive.

Nature of the Solution – Ionic vs. Covalent

- Ionic Solution:
Due to the dissociation of NaCl into Na^+ and Cl^- ions, the solution is ionic in nature.

- Comparison with Covalent Solutions:
Solutions of covalent compounds like sugar (sucrose) involve molecules remaining intact, whereas NaCl dissociates into ions.

Physical State

- The solution remains in the liquid phase at room temperature.
- No phase change occurs unless temperature or pressure varies significantly.

Summary and Final Classification

Taking into account all the scientific considerations:

- The sample is a homogeneous, liquid, aqueous solution.
- It contains dissolved ionic solute (NaCl).
- The concentration (~0.171 M) classifies it as a dilute solution.
- It is unsaturated, capable of dissolving more NaCl.
- It exhibits ionic behavior, making it an electrolyte solution.

Therefore, the solution prepared by completely dissolving 10.0 grams of NaCl in 1.0 liter of water is best classified as a dilute, unsaturated, ionic aqueous solution—a classic example of an electrolyte solution.

Final Thoughts: Why Classification Matters

Understanding the classification of this NaCl solution is not just an academic exercise but a practical tool that influences how we utilize and manipulate such solutions. Whether in laboratory settings, industrial manufacturing, or biological systems, knowing the solution's nature helps predict its behavior, reactivity, and application potential.

In summary, this simple yet scientifically rich mixture exemplifies core principles of solution chemistry and offers a window into the complex interplay of solutes and solvents that underpin countless scientific and industrial processes.

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