ChemTalk

Unit 4: Properties of Solutions

Colligative Properties

This worksheet will explore colligative properties, unique physical traits of solutions determined solely by the number of solute particles. It will cover Henry's Law, which links gas concentration to partial pressure, providing insights into gas solubility. Boiling Point Elevation and Freezing Point Depression will be examined as colligative properties, showcasing how adding a solute affects boiling and freezing points. Osmotic Pressure, crucial in biological and industrial processes, will also be discussed, emphasizing the fascinating influence of solutes on solution behavior.

1. Define colligative properties and explain how they are uniquely determined by the number of solute particles. Provide examples of colligative properties discussed in the paragraph.

2. Discuss the impact of adding a solute on boiling point and freezing point. Provide real-world examples illustrating Boiling Point Elevation and Freezing Point Depression as colligative properties.

3. Explore the concept of Henry's Law and its significance in understanding gas solubility. How does the concentration of a gas in a liquid relate to its partial pressure?

4. Define osmotic pressure and explain its significance in biological systems.

5. What factors would increase the osmotic pressure of a solution?

6. Explain the concept of freezing point depression, including the underlying principles and how it is used to determine the molecular weight of a solute. Provide an example calculation to illustrate the process.

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ANSWER KEY:

1. Define colligative properties and explain how they are uniquely determined by the number of solute particles. Provide examples of colligative properties discussed in the paragraph.

Colligative properties are physical properties of a solution that depend on the number of solute particles, regardless of their identity. Examples include Boiling Point Elevation, Freezing Point Depression, and Osmotic Pressure. These properties are influenced solely by the concentration of solute particles in the solution.

2. Discuss the impact of adding a solute on boiling point and freezing point. Provide real-world examples illustrating Boiling Point Elevation and Freezing Point Depression as colligative properties.

Adding a solute increases the boiling point and decreases the freezing point of a solvent. For example, adding salt to water raises its boiling point (Boiling Point Elevation) and lowers its freezing point (Freezing Point Depression). This is employed in winter road maintenance, where salt is used to prevent the freezing of ice on road surfaces.

3. Explore the concept of Henry's Law and its significance in understanding gas solubility. How does the concentration of a gas in a liquid relate to its partial pressure?

Henry's Law describes the relationship between the concentration of a gas in a liquid and its partial pressure. It states that the concentration of a gas in a solution is directly proportional to its partial pressure. This law is crucial for understanding gas solubility in liquids.

4. Define osmotic pressure and explain its significance in biological systems.

Osmotic pressure is the pressure exerted by solvent molecules as they move through a semipermeable membrane to equalize solute concentrations on both sides. In biological systems, osmotic pressure is crucial for processes like maintaining cell shape and controlling the movement of water and nutrients across cell membranes.

5. What factors would increase the osmotic pressure of a solution?

The osmotic pressure of a solution increases with higher solute concentration and temperature. Additionally, using solutes with greater molar mass or stronger ionization can increase osmotic pressure.

6. Explain the concept of freezing point depression, including the underlying principles and how it is used to determine the molecular weight of a solute. Provide an example calculation to illustrate the process.

Freezing point depression occurs when a non-volatile solute is added to a solvent, lowering the solvent's freezing point. This is due to a decrease in the solvent's vapor pressure caused by the solute. The phenomenon follows Raoult's Law, stating that a solution's vapor pressure is proportional to the mole fraction of the solvent. To determine a solute's molecular weight using freezing point depression, the formula $\Delta T_f = K_f * m$ is used, where ΔT_f is the change in freezing point, K_f is the cryoscopic constant (unique to the solvent), and m is the molality of the solution. Rearranging the formula allows the calculation of the solute's molar mass. For instance, in a solution of 0.5 moles of glucose ($C_6H_{12}O_6$) dissolved in 500 grams of water with a freezing point depression of 0.372°C, the molar mass of glucose is approximately 2.50 kg/mol when K_f for water is 1.86°C·kg/mol.