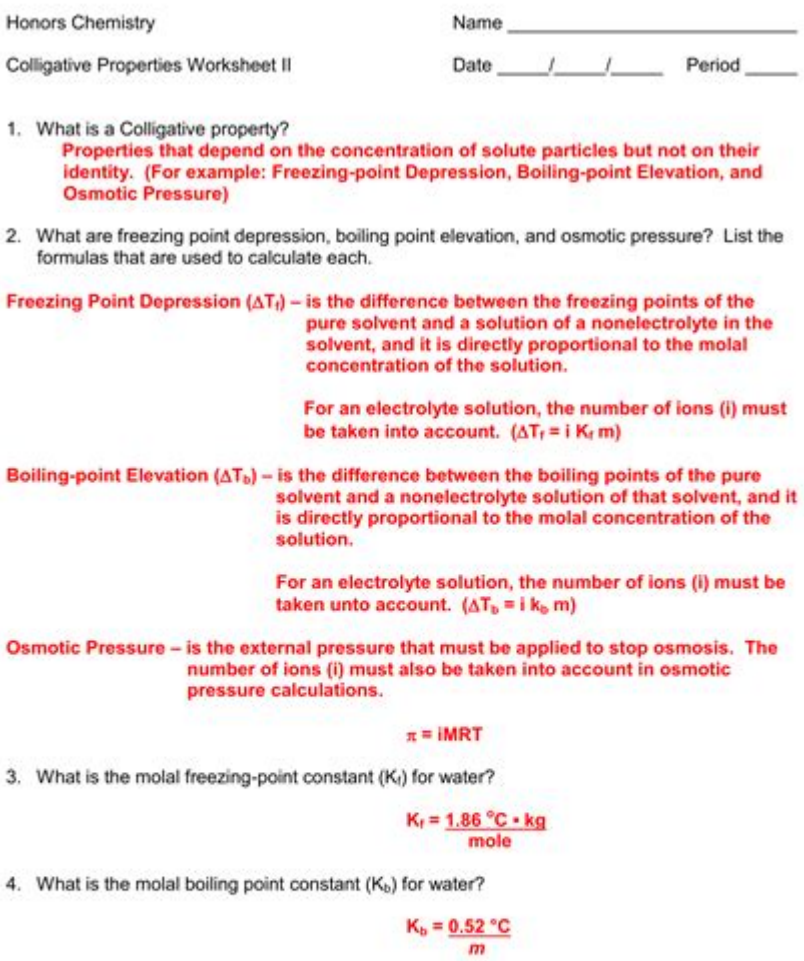
Colligative Properties Worksheet Answer Key



Honors Chemistry Name _____

Colligative Properties Worksheet II Date ____/____/____ Period ____

1. What is a Colligative property?
   Properties that depend on the concentration of solute particles but not on their identity. (For example: Freezing-point Depression, Boiling-point Elevation, and Osmotic Pressure)

2. What are freezing point depression, boiling point elevation, and osmotic pressure? List the formulas that are used to calculate each.

Freezing Point Depression (ΔT_f) – is the difference between the freezing points of the pure solvent and a solution of a nonelectrolyte in the solvent, and it is directly proportional to the molal concentration of the solution.

For an electrolyte solution, the number of ions (i) must be taken into account. ($\Delta T_f = i\ K_f\ m$)

Boiling-point Elevation (ΔT_b) – is the difference between the boiling points of the pure solvent and a nonelectrolyte solution of that solvent, and it is directly proportional to the molal concentration of the solution.

For an electrolyte solution, the number of ions (i) must be taken unto account. ($\Delta T_b = i\ k_b\ m$)

Osmotic Pressure – is the external pressure that must be applied to stop osmosis. The number of ions (i) must also be taken into account in osmotic pressure calculations.

$$\pi = iMRT$$

3. What is the molal freezing-point constant (K_f) for water?

$$K_f = \frac{1.86\ ^\circ C \cdot kg}{mole}$$

4. What is the molal boiling point constant (K_b) for water?

$$K_b = \frac{0.52\ ^\circ C}{m}$$

Colligative properties worksheet answer key is a crucial resource for students studying solutions and their behaviors in chemistry. Colligative properties are properties that depend on the number of solute particles in a solution rather than the identity of the solute itself. Understanding these properties is essential for various applications in chemistry, biology, and engineering. This article will explore the fundamental concepts of colligative properties, provide a detailed overview of common types, and offer insights into how these properties can be calculated and interpreted, ultimately leading to an understanding of what a colligative properties worksheet answer key entails.

Understanding Colligative Properties

Colligative properties arise when a solute is added to a solvent, resulting in changes to the

physical properties of the solution. These properties are significant because they can predict how a solution will behave in various conditions. The four primary colligative properties include:

1. Vapor Pressure Lowering
2. Boiling Point Elevation
3. Freezing Point Depression
4. Osmotic Pressure

Each of these properties can be explained and calculated based on the concentration of solute particles in the solution and the nature of the solvent.

1. Vapor Pressure Lowering

When a non-volatile solute is added to a solvent, the vapor pressure of the solvent decreases. This occurs because the solute particles occupy space at the surface of the liquid, reducing the number of solvent molecules that can escape into the vapor phase. The relationship can be described by Raoult's Law:

- Raoult's Law: The vapor pressure of a solvent in a solution (P_solution) is equal to the mole fraction of the solvent (X_solvent) multiplied by the vapor pressure of the pure solvent (P^o_solvent).

Mathematically, it can be expressed as:
$$ P_{solution} = X_{solvent} \times P^{\circ}_{solvent} $$

2. Boiling Point Elevation

Boiling point elevation refers to the phenomenon where the boiling point of a solvent increases when a solute is added. The elevation can be calculated using the formula:

$$ \Delta T_b = i \cdot K_b \cdot m $$

Where:
- ΔT_b = boiling point elevation
- i = van 't Hoff factor (number of particles the solute breaks into)
- K_b = ebullioscopic constant of the solvent
- m = molality of the solution

This property is particularly important in applications such as antifreeze solutions, where the boiling point needs to be increased for efficiency.

3. Freezing Point Depression

Freezing point depression is the decrease in the freezing point of a solvent when a solute

is added. This property can be calculated using the equation:

$$\Delta T_f = i \cdot K_f \cdot m$$

Where:
- ΔT_f = freezing point depression
- i = van 't Hoff factor
- K_f = cryoscopic constant of the solvent
- m = molality of the solution

This principle is utilized in road treatments during winter, where salt is spread to lower the freezing point of water and prevent ice formation.

4. Osmotic Pressure

Osmotic pressure is the pressure required to stop the flow of solvent into a solution through a semipermeable membrane. It can be calculated using the formula:

$$\Pi = i \cdot C \cdot R \cdot T$$

Where:
- Π = osmotic pressure
- i = van 't Hoff factor
- C = molar concentration of the solution
- R = ideal gas constant
- T = temperature in Kelvin

Osmotic pressure is a critical concept in biological systems, particularly in the transport of nutrients and waste across cell membranes.

Calculating Colligative Properties

To effectively work with colligative properties, students often use worksheets that require them to perform calculations based on various scenarios. The answer key to these worksheets provides the correct calculations and explanations, allowing students to verify their work and understand any mistakes they may have made.

Example Problems and Solutions

Here are a few example problems that might appear on a colligative properties worksheet, along with their solutions.

Problem 1: Boiling Point Elevation

Given a solution containing 0.5 moles of a non-volatile solute with a van 't Hoff factor of 1,

and a solvent with a boiling point elevation constant (K_b) of 0.51 °C kg/mol, calculate the boiling point elevation.

Solution:

Using the formula:
$$\Delta T_b = i \cdot K_b \cdot m$$

First, calculate molality (m):
Assuming the mass of the solvent is 1 kg (for simplicity),
$$m = \frac{0.5 \text{ moles}}{1 \text{ kg}} = 0.5 \text{ mol/kg}$$

Now plug the values into the equation:
$$\Delta T_b = 1 \cdot 0.51 \cdot 0.5 = 0.255 \text{ °C}$$

The new boiling point will be:
$$100 + 0.255 = 100.255 \text{ °C}$$

Problem 2: Freezing Point Depression

Calculate the freezing point depression for a solution containing 2 moles of a non-volatile solute with a van 't Hoff factor of 1, using a solvent with a freezing point depression constant (K_f) of 1.86 °C kg/mol.

Solution:

Using the freezing point depression formula:
$$\Delta T_f = i \cdot K_f \cdot m$$

Assuming 1 kg of solvent:
$$m = 2 \text{ mol/kg}$$

Plugging in the values:
$$\Delta T_f = 1 \cdot 1.86 \cdot 2 = 3.72 \text{ °C}$$

The new freezing point will be:
$$0 - 3.72 = -3.72 \text{ °C}$$

Importance of the Answer Key

The colligative properties worksheet answer key serves multiple purposes:

- Verification: Students can check their computations against the answer key to confirm their understanding of the material.
- Learning Tool: By comparing their work to the answer key, students can identify errors and misconceptions, providing an opportunity for learning.
- Practice: Answer keys can highlight common problems and solutions, reinforcing the concepts learned in class.

Conclusion

Colligative properties are foundational concepts in chemistry that explain how solutes affect the physical properties of solvents. Understanding the calculations involved in determining these properties is essential for students pursuing studies in chemistry and related fields. The colligative properties worksheet answer key not only provides the correct answers but also enhances the learning experience by allowing students to engage with the material actively. As students practice and apply their knowledge, they become more adept at solving problems related to colligative properties, laying the groundwork for more complex topics in chemistry.

Frequently Asked Questions

What are colligative properties?

Colligative properties are properties of solutions that depend on the number of solute particles in a given amount of solvent, not the identity of the solute.

What are the main types of colligative properties?

The main types of colligative properties include vapor pressure lowering, boiling point elevation, freezing point depression, and osmotic pressure.

How do you calculate boiling point elevation?

Boiling point elevation can be calculated using the formula: $\Delta T_b = i K_b m$, where ΔT_b is the boiling point elevation, i is the van't Hoff factor, K_b is the ebullioscopic constant, and m is the molality of the solution.

What is the van't Hoff factor?

The van't Hoff factor (i) represents the number of particles the solute dissociates into when dissolved in a solution, affecting the calculations of colligative properties.

How do colligative properties relate to molecular weight determination?

Colligative properties can be used to determine the molecular weight of a solute by measuring changes in boiling point or freezing point when a known quantity of solute is dissolved in a solvent.

What is osmotic pressure?

Osmotic pressure is the pressure required to stop the flow of solvent into a solution through a semipermeable membrane, and it can be calculated using the formula: $\pi = i C R T$, where π is the osmotic pressure, C is the molarity of the solution, R is the gas constant, and T is the temperature in Kelvin.

How does the presence of a solute affect freezing point?

The presence of a solute lowers the freezing point of a solvent, a phenomenon known as freezing point depression, which can be calculated using the formula: $\Delta T_f = i K_f m$.

Why is it important to understand colligative properties in chemistry?

Understanding colligative properties is crucial in fields such as chemistry, biology, and engineering, as they influence processes like solution behavior, biological functions, and industrial applications.

Colligative Properties Worksheet Answer Key

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