Solutions And Mixtures

1. Mind Map on Mixtures and Solutions

Mixtures

- Definition
- Types
    - Homogeneous Mixture
        - Single phase
        - Examples: salt and water, sugar and water
    - Heterogeneous Mixture
        - Multiple phases
        - Examples: sand and water, salt and sand

Solutions

- Definition
- Components
    - Solute
    - Solvent
- Types
    - Based on physical state (Gas-Gas, Gas-Liquid, Liquid-Liquid, etc.)
- Concentration Expressions
    - Molarity (M)
    - Molality (m)
    - Normality (N)
    - Mole fraction
    - Percent by weight or volume

Factors Affecting Solubility

- Nature of Components
- Temperature
- Pressure
- Henry's Law

Here are additional descriptive and multiple-choice questions for each major topic from the document.

1. Mixtures and Solutions

Descriptive Questions

1. **What are the main differences between a solution and a mixture? Provide examples.**
2. **Describe the process of forming a homogeneous solution using salt and water.**
3. **Explain how the physical state of a solute and solvent affects the type of solution formed, with examples.**
4. **Define and explain the concept of concentration in a solution. Why is it important to understand concentration?**
5. **Discuss the concept of solute and solvent with examples. How does the amount of solute and solvent affect the classification of a solution?**

Multiple Choice Questions (MCQs)

1. **Which one of the following is not a component of a solution?**
    - A) Solute
    - B) Solvent
    - C) Solid
    - D) None of the above
    - **Answer:** C
2. **Which of the following is a heterogeneous mixture?**
    - A) Sugar in water
    - B) Oil and water
    - C) Alcohol in water
    - D) Vinegar
    - **Answer:** B
3. **In a solution of carbon dioxide in water (carbonated drink), which is the solute?**
    - A) Carbon dioxide
    - B) Water
    - C) Oxygen
    - D) Sugar
    - **Answer:** A

4. **Which of the following represents a liquid-solid solution?**
    - A) Alcohol in water
    - B) Mercury in silver
    - C) Air
    - D) Salt in water
    - **Answer:** B

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2. Types of Concentrations

Descriptive Questions

1. **Explain molarity and derive the formula used to calculate it. Include an example calculation.**
2. **What is the difference between molarity and molality? When is each one used?**
3. **How is normality different from molarity? Give an example where normality is more useful.**
4. **Describe how the mole fraction is calculated and why it is a unitless quantity.**
5. **Calculate the percent by weight of NaCl in a solution if 10g of NaCl is dissolved in 90g of water.**

Multiple Choice Questions (MCQs)

1. **What is the unit of molarity?**
    - A) mol/kg
    - B) mol/L
    - C) g/L
    - D) % (w/w)
    - **Answer:** B
2. **Which concentration term does not depend on temperature?**
    - A) Molarity
    - B) Normality
    - C) Molality
    - D) Percent by volume
    - **Answer:** C
3. **The molality of a solution is defined as the number of moles of solute per...**
    - A) Gram of solvent
    - B) Kilogram of solvent
    - C) Litre of solution
    - D) Mole of solvent
    - **Answer:** B
4. **If 36g of HCl is dissolved in 100g of solution, the percent concentration by weight (w/w) is...**
    - A) 25%

   - B) 36%
   - C) 36g
   - D) 64%
   - **Answer:** B
5. **For a solution prepared by dissolving 75g of KOH in 500 ml of water, what is the molarity if the molecular weight of KOH is 56 g/mol?**
   - A) 2.68 M
   - B) 1.34 M
   - C) 5.36 M
   - D) 3.78 M
   - **Answer:** A

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3. Factors Affecting Solubility

Descriptive Questions

1. **Explain how the nature of solute and solvent affects solubility. Use NaCl and benzene as examples.**
2. **Describe the effect of temperature on the solubility of gases in liquids, using Henry's Law as a reference.**
3. **What role does pressure play in the solubility of gases in liquids? Illustrate your answer with an example from daily life.**
4. **Describe how polar and nonpolar solvents interact differently with solutes.**
5. **Provide a brief explanation of why increasing temperature generally increases solubility for solid solutes in liquids.**

Multiple Choice Questions (MCQs)

1. **The solubility of NaCl in water is primarily due to...**
   - A) The nonpolar nature of NaCl
   - B) The polar nature of water
   - C) The nonpolar nature of water
   - D) The effect of temperature only
   - **Answer:** B
2. **According to Henry's Law, which of the following is true about gas solubility?**
   - A) It decreases with an increase in pressure.
   - B) It increases with an increase in pressure.
   - C) It decreases with an increase in molarity.
   - D) It remains unchanged with pressure changes.
   - **Answer:** B
3. **If the temperature increases, the solubility of a gas in water generally...**
   - A) Increases
   - B) Decreases

   - C) Remains unchanged
   - D) Depends on pressure only
   - **Answer:** B
4. **Why does NaCl dissolve well in water but not in benzene?**
   - A) Benzene is too volatile
   - B) NaCl is polar and water is polar
   - C) NaCl is nonpolar
   - D) NaCl is not soluble in any solvent
   - **Answer:** B
5. **Which of the following statements is true about solid-liquid systems?**
   - A) Solubility always decreases with temperature.
   - B) Solubility usually increases with temperature.
   - C) Solubility is unaffected by temperature.
   - D) Solubility depends only on pressure.
   - **Answer:** B

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4. Distribution Law

Descriptive Questions

1. **Explain Nernst's Distribution Law and provide a mathematical expression for it.**
2. **How can the distribution law be applied in solvent extraction techniques? Give an example.**
3. **Describe the significance of the distribution coefficient.**
4. **What are the limitations of Nernst's Distribution Law?**
5. **Using the distribution law, explain how the equilibrium constant of a reaction can be determined.**

Multiple Choice Questions (MCQs)

1. **Nernst's Distribution Law applies to...**
   - A) Solutes that react chemically in one of the solvents
   - B) Non-miscible solvents
   - C) Solutions with high concentrations
   - D) Solutes that change molecular state in solvents
   - **Answer:** B
2. **Which of the following is true according to the distribution law?**
   - A) The solute concentration is the same in both solvents.
   - B) The ratio of solute concentration in two solvents is constant.
   - C) The solute dissolves equally in both solvents.
   - D) The solute remains in the solvent where it was initially added.
   - **Answer:** B
3. **The distribution coefficient is defined as the ratio of the solute concentration in...**

- A) A gas-liquid system
- B) Two immiscible solvents
- C) A single-phase solution
- D) A solid-liquid system
- **Answer:** B

4. **Which solvent pair is commonly used to study the distribution of iodine?**
   - A) Water and carbon disulfide
   - B) Water and benzene
   - C) Water and ammonia
   - D) Water and alcohol
   - **Answer:** A
5. **According to the distribution law, which condition is essential?**
   - A) Constant pressure
   - B) Non-dilute solutions
   - C) Constant temperature
   - D) Variable solute concentration
   - **Answer:** C

1. What is the difference between a mixture and a solution? Provide examples.

Answer:
A **mixture** is a combination of two or more substances where they retain their individual chemical properties and are not chemically bonded.

- Example: Salt and sand, oil and water.

A **solution** is a homogeneous mixture where the solute is uniformly dispersed at the molecular level in the solvent.

- Example: Salt dissolved in water, sugar dissolved in water.

The key difference lies in the uniformity and phase composition:

- Mixtures can be homogeneous (single phase) or heterogeneous (multiple phases).
- Solutions are always homogeneous.

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2. Explain the factors that affect the solubility of a solute in a solvent.

Answer:
The solubility of a solute depends on:

1. **Nature of Components:**
    - Polar solutes dissolve in polar solvents (e.g., NaCl in water).
    - Nonpolar solutes dissolve in nonpolar solvents (e.g., benzene dissolves CCl4).
2. **Temperature:**
    - For solids in liquids: Solubility generally increases with temperature (e.g., NaCl in water).
    - For gases in liquids: Solubility decreases with increasing temperature due to higher gas molecule mobility.
3. **Pressure (Henry's Law):**
    - For gases in liquids: Solubility increases with pressure (e.g., CO2 in carbonated drinks).

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3. Define molarity and derive its formula. Provide an example.

Answer:
Molarity (M) is the number of moles of solute per liter of solution.

Formula:

$$s = number\ of\ moles\ /volum\ of\ solution\ in\ liter$$

s=(w x 1000)/(v x M)

Where:

- w = Weight of solute (g)
- M = Molecular weight of solute
- V = Volume of solution in ml

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4. Why does the solubility of gases in liquids decrease with increasing temperature? Explain with an example.

Answer:
The dissolution of gases in liquids is an **exothermic process**:

Gas + Liquid↔Gas in solution+Heat.\text{Gas + Liquid} \leftrightarrow \text{Gas in solution} + \text{Heat}.Gas + Liquid↔Gas in solution+Heat.

As temperature increases, the equilibrium shifts to favor gas escaping from the solution (Le Chatelier's principle).

Example:
In carbonated drinks, CO2 escapes faster when the drink is warm because the solubility of CO2 decreases with temperature.

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5. What is Henry’s Law? State its applications.

Answer:
Henry’s Law states that the concentration of a gas dissolved in a liquid is directly proportional to the gas's pressure on the liquid's surface at a constant temperature.

Mathematical Expression:

$$C=k\times P$$

Where:

- C = Concentration of gas in solution
- P = Pressure of the gas
- k = Henry’s law constant

Applications:

1. Used in carbonated drinks to maintain CO_2 concentration.
2. Predicting oxygen levels in water bodies under different pressures.
3. In designing underwater breathing apparatus for divers.

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6. Explain molality and how it differs from molarity.

Answer:
Molality (m) is the number of moles of solute per kilogram of solvent.

Formula:

$$\mathbf{m=}number\ of\ moles\ of\ solute\ /mass\ of\ solvent\ in\ kg$$

$$\mathbf{m=}w \times 100 \div M \times W$$

Where:

- w = Weight of solute (g)
- M = Molecular weight of solute
- W = Weight of solvent (g)

Difference:

1. **Molarity** depends on the **volume** of the solution and varies with temperature.
2. **Molality** depends on the **mass** of the solvent and does not vary with temperature.

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7. What is the distribution law? Write its formula and significance.

Answer:
The **Distribution Law** states that if a solute is distributed between two immiscible solvents, at equilibrium, the ratio of the solute concentrations in the two solvents is constant.

Mathematical Expression:

$$c1 \div c2 = k$$

Where:

- C1 = Concentration of solute in solvent A
- C2 = Concentration of solute in solvent B
- K= Distribution coefficient

Significance:

1. Helps in solvent extraction techniques.
2. Used in liquid-liquid chromatography.
3. Determines solubility and reaction constants.

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8. How does the nature of solute and solvent affect solubility? Provide examples.

Answer:
The nature of solubility follows the principle: **“Like dissolves like.”**

1. **Polar Solutes:** Dissolve well in polar solvents due to dipole interactions.
    - Example: NaCl dissolves in water but not in benzene.
2. **Nonpolar Solutes:** Dissolve in nonpolar solvents due to van der Waals forces.
    - Example: Iodine dissolves in carbon tetrachloride but not in water.

This behavior is attributed to the strength of interaction between solute and solvent molecules.

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9. Discuss the limitations of Henry's Law.

Answer:
Henry’s Law is applicable under specific conditions:

1. **Low solubility:** Applicable when the gas solubility in the liquid is low.
2. **No reaction with solvent:** The gas must not react chemically with the solvent (e.g., HCl and NH3 do not obey Henry’s law in water).
3. **Moderate temperature and pressure:** The law fails at very high or very low temperatures and pressures.
4. **Ideal behavior:** The gas should exhibit nearly ideal behavior.
5. **No dissociation or association:** The gas must retain its molecular form in the solution.

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10. Why is the solubility of NaCl in water higher than in benzene?

Answer:
NaCl is an ionic compound that dissociates into Na+ and Cl− ions in water. Water, being polar, stabilizes these ions via strong ion-dipole interactions.

Benzene is nonpolar and cannot interact with the ions effectively, leading to negligible solubility of NaCl.
