

Enter Your Answer In The Provided Box. A Sample Of 7.73 G Of Naphthalene ($C_{10}H_8$) Is Dissolved In 85.9

Enter Your Answer In The Provided Box. A Sample Of 7.73 G Of Naphthalene ($C_{10}H_8$) Is Dissolved In 85.9 grams of solvent to analyze its properties, solubility, and related chemical concepts. This scenario is commonly encountered in chemistry laboratories and educational settings, where understanding how to calculate molarity, molality, and the solubility of compounds like naphthalene is essential. Whether you're a student preparing for exams or a professional working on chemical solutions, grasping the fundamentals of dissolving substances like naphthalene in a solvent is vital for accurate measurements and chemical analysis.

Understanding Naphthalene and Its Properties

What Is Naphthalene?

Naphthalene, with the chemical formula $C_{10}H_8$, is a polycyclic aromatic hydrocarbon composed of two fused benzene rings. It is most commonly recognized for its use in mothballs and as an intermediate in the production of dyes, plastics, and other chemicals. Its solid form is crystalline, with a distinctive smell, and it is relatively insoluble in water but soluble in organic solvents like benzene, toluene, and ethanol.

Physical and Chemical Characteristics

- **Appearance:** White crystalline solid
 - **Odor:** Aromatic, mothball-like
 - **Molecular Weight:** 128.17 g/mol
 - **Solubility:** Slightly soluble in water (~0.009 g/100 mL at 25°C), soluble in organic solvents
 - **Boiling Point:** 218°C
 - **Melting Point:** 80°C
-

Calculating Moles of Naphthalene in the Sample

Given Data

- Mass of naphthalene (C₁₀H₈): 7.73 g
- Mass of solvent: 85.9 g (assumed to be a common organic solvent like ethanol or benzene)

Calculating Moles of Naphthalene

To determine the number of moles present in the sample, use the molar mass of naphthalene:

$$\text{Molar mass of C}_{10}\text{H}_8 = (10 \times 12.01) + (8 \times 1.008) = 128.17 \text{ g/mol}$$

Now, calculate the moles:

$$\text{Moles of naphthalene} = \text{Mass} / \text{Molar mass} = 7.73 \text{ g} / 128.17 \text{ g/mol} \approx 0.0603 \text{ mol}$$

Understanding Solubility and Concentration

What Is Solubility?

Solubility refers to the maximum amount of a substance that can dissolve in a solvent at a specific temperature to form a saturated solution. For naphthalene, solubility varies depending on the solvent and temperature.

Calculating Concentrations

Knowing the amount of naphthalene and solvent allows for the calculation of concentration metrics like molarity and molality.

Calculating Molarity of the Naphthalene Solution

What Is Molarity?

Molarity (M) is defined as the number of moles of solute per liter of solution. It's a key measure in solution chemistry for understanding concentration.

Estimating Volume of the Solution

Since the mass of the solvent is given (85.9 g), and its density is necessary to find the volume, assume the solvent is ethanol (density approximately 0.789 g/mL at room temperature).

$$\text{Volume of solvent} = \text{Mass} / \text{Density} = 85.9 \text{ g} / 0.789 \text{ g/mL} \approx 108.8 \text{ mL} \approx 0.1088 \text{ L}$$

Note: The total volume of the solution includes the volume contributed by the dissolved naphthalene, but given its small amount relative to the solvent, this approximation is acceptable.

Molarity Calculation

$$\begin{aligned} \text{Molarity (M)} &= \text{Moles of naphthalene} / \text{Volume of solution in liters} \\ &= 0.0603 \text{ mol} / 0.1088 \text{ L} \approx 0.554 \text{ mol/L} \end{aligned}$$

Therefore, the solution has a molarity of approximately 0.554 M.

Calculating Molality and Other Concentration Measures

What Is Molality?

Molality (m) is defined as the number of moles of solute per kilogram of solvent. It's useful because it remains constant regardless of temperature changes.

Calculation of Molality

Convert the mass of the solvent to kilograms:

$$\text{Mass of solvent} = 85.9 \text{ g} = 0.0859 \text{ kg}$$

Now, calculate molality:

$$\text{Molality (m)} = \text{Moles of naphthalene} / \text{Mass of solvent in kg} = 0.0603 \text{ mol} / 0.0859 \text{ kg} \approx 0.702 \text{ mol/kg}$$

The molality of the solution is approximately 0.702 mol/kg.

Understanding Solubility Limits and Saturation

What Is a Saturated Solution?

A saturated solution contains the maximum amount of solute that can dissolve at a given temperature. Any additional solute will remain undissolved.

Relevance to the Sample

Given the small amount of naphthalene dissolved in the solvent, the solution is likely unsaturated if the solubility limit exceeds 7.73 g in 85.9 g of solvent at room temperature.

Factors Affecting Solubility

- Temperature: Higher temperatures usually increase solubility for solids in liquids.
- Solvent Nature: Naphthalene dissolves more readily in organic solvents like benzene and ethanol.
- Pressure: Less significant for solids but critical for gases.

Practical Applications of Naphthalene Solution Calculations

Laboratory Preparations

Understanding how to calculate the concentration of naphthalene solutions allows chemists to prepare solutions with precise molarity or molality for experiments.

Industrial Uses

Accurate calculations ensure proper formulation in manufacturing processes involving naphthalene, such as dye production or chemical synthesis.

Environmental and Safety Considerations

Knowing the exact amount of naphthalene in solutions helps assess exposure risks and environmental impact, as naphthalene is toxic and volatile.

Conclusion: Mastering Chemical Calculations with Naphthalene

The process of analyzing a sample of naphthalene dissolved in a solvent involves multiple steps—calculating moles, molarity, molality, and understanding solubility. By starting with a known mass, applying molar mass calculations, and considering solvent properties, chemists can accurately describe solution concentrations. These skills are fundamental in laboratory settings, research, and industrial applications, ensuring safe and effective use of chemicals like naphthalene.

Remember: Always consider temperature effects, solvent properties, and safety guidelines when working with chemical solutions. Proper measurement and calculation are key to successful and safe chemical handling.

Frequently Asked Questions

What is the purpose of entering your answer in the provided box in this chemistry problem?

Entering your answer in the provided box ensures that your response is correctly recorded and can be evaluated or graded, especially in online assessments or digital homework platforms.

How do you calculate the molar mass of naphthalene (C₁₀H₈)?

The molar mass of naphthalene is calculated by summing the atomic masses: (10 × 12.01 g/mol for carbon) + (8 × 1.008 g/mol for hydrogen) = 128.17 g/mol.

Given 7.73 g of naphthalene, how do you determine the number of moles dissolved in the solution?

Divide the mass of naphthalene by its molar mass: 7.73 g ÷ 128.17 g/mol = 0.0603 moles.

What additional information is needed to calculate the molarity of the naphthalene solution?

The volume of the solution in liters is needed to calculate molarity, which is moles of solute divided by liters of solution.

Why is it important to enter your answer precisely in the provided box in chemistry exercises?

Precise entry ensures accuracy in grading and prevents discrepancies caused by formatting errors, rounding, or units, leading to fair assessment of your understanding.

Additional Resources

In-Depth Analysis of Dissolving 7.73 g of Naphthalene (C₁₀H₈) in 85.9 mL of Solvent

Introduction

The process of dissolving a solid compound such as naphthalene in a liquid solvent is fundamental in

chemistry, especially in organic synthesis, analytical chemistry, and industrial applications.

Naphthalene ($C_{10}H_8$), a polycyclic aromatic hydrocarbon, is commonly used in mothballs, as a precursor in chemical syntheses, and in various other applications. Understanding the details of this dissolution process—from solubility to solution behavior—is essential for scientists and students alike. This comprehensive review explores the dissolution of 7.73 grams of naphthalene in 85.9 mL of solvent, examining the chemical context, physical properties, solubility principles, calculations involved, and practical implications.

Chemical and Physical Properties of Naphthalene

Molecular Structure and Composition

- Chemical Formula: $C_{10}H_8$
- Molecular Weight: Approximately 128.17 g/mol
- Structural Features:
 - Composed of two fused benzene rings, forming a polycyclic aromatic hydrocarbon.
 - Planar, aromatic, and hydrophobic in nature.
- Physical State:
 - White, crystalline solid at room temperature.
 - Melting point around 80°C.
 - Boiling point approximately 218°C.

Solubility Characteristics

- Solubility in Water: Very low (~0.02 g/100 mL at 25°C), indicating high hydrophobicity.
- Solubility in Organic Solvents: High in organic solvents such as benzene, toluene, chloroform, and ethanol.
- Implication: Naphthalene exhibits typical aromatic hydrocarbon behavior, being largely insoluble in polar solvents like water but soluble in nonpolar or slightly polar organic solvents.

Theoretical Foundations of Dissolution

Solubility Principles

- Like Dissolves Like: Nonpolar compounds dissolve best in nonpolar solvents.
- Intermolecular Forces: Van der Waals interactions dominate for naphthalene; solvent molecules must be compatible to facilitate dissolution.
- Saturation and Solubility Limits: The maximum amount of naphthalene that can dissolve in a specific solvent at a given temperature.

Factors Affecting Dissolution

- Temperature: Increased temperature generally increases solubility for solids.
- Polarity of Solvent: More nonpolar solvents enhance dissolution.
- Particle Size: Smaller particles dissolve faster due to higher surface area.
- Stirring and Agitation: Promotes dissolution by reducing boundary layers.

Experimental Context and Calculations

Given Data

- Mass of Naphthalene (m): 7.73 g
- Volume of Solvent (V): 85.9 mL

Assuming the solvent is a typical organic solvent like benzene or toluene, which are commonly used with naphthalene, but since the solvent isn't specified, calculations can be generalized or adapted based on the solvent's properties.

Calculating Moles of Naphthalene

Using the molecular weight:

$$\begin{aligned} \text{Moles of naphthalene} &= \frac{\text{Mass}}{\text{Molecular weight}} = \frac{7.73 \text{ g}}{128.17 \text{ g/mol}} \\ &\approx 0.0603 \text{ mol} \end{aligned}$$

Concentration of the Solution

- If the solvent volume is converted to liters:

$$\begin{aligned} V &= 85.9 \text{ mL} = 0.0859 \text{ L} \end{aligned}$$

- Molarity (M):

$$\begin{aligned} \text{Concentration} &= \frac{0.0603 \text{ mol}}{0.0859 \text{ L}} \approx 0.702 \text{ M} \end{aligned}$$

This molarity indicates the amount of naphthalene per liter of solvent, which is useful for understanding solution behavior.

Solubility Considerations

Solubility Data for Naphthalene

- Typical Solubility in Benzene at 25°C: ~0.16 g/mL

- Implication for the Given Mass:

- Dissolving 7.73 g in 85.9 mL:

$$\text{Required solubility} = \frac{7.73 \text{ g}}{85.9 \text{ mL}} \approx 0.09 \text{ g/mL}$$

- The actual solubility of naphthalene in benzene is around 0.16 g/mL, so 85.9 mL of benzene can readily dissolve 7.73 g of naphthalene, with some excess capacity.

Saturation and Dissolution Limit

- Since the solubility in benzene exceeds the amount used, the solution is unsaturated.
- If the solvent were less capable, or the temperature lower, saturation might occur, leading to undissolved solids.

Practical Implications of Dissolving Naphthalene

Industrial and Laboratory Context

- Purification: Dissolving naphthalene in an organic solvent aids in purification via recrystallization.
- Analytical Chemistry: Preparing solutions of known concentration for titrations, spectroscopic analysis, or chromatography.
- Chemical Synthesis: Naphthalene solutions serve as intermediates in producing dyes, resins, or other aromatic compounds.

Handling and Safety Considerations

- Naphthalene is volatile, toxic, and carcinogenic; proper ventilation, gloves, and eye protection are essential.
- Organic solvents used should be handled with care, considering flammability and health hazards.
- Proper waste disposal protocols should be followed, especially when dealing with aromatic hydrocarbons.

Temperature Effects on Dissolution

- Increased Temperature:
 - Typically increases solubility by providing additional energy to overcome lattice energies.
 - For naphthalene, heating above its melting point ($\sim 80^{\circ}\text{C}$) can improve dissolution.
- Cooling:
 - Can result in crystallization, useful for recrystallization processes to purify naphthalene.

Analytical and Experimental Techniques

Determining Solubility

- Use gravimetric analysis: dissolve a known amount of naphthalene, filter undissolved solids, dry, and weigh to determine saturation point.
- Spectroscopic methods: UV-Vis or IR spectroscopy can quantify naphthalene concentration in solution.

Monitoring Dissolution

- Visual inspection for clarity.
- Turbidity or cloudiness indicates incomplete dissolution or saturation.

- Use of stirring or agitation to facilitate uniform dissolution.

Environmental and Safety Aspects

- Naphthalene's volatility makes it prone to inhalation hazards.
- It is toxic to aquatic life; spills should be cleaned promptly.
- Storage should be in airtight containers away from heat sources.

Summary and Conclusions

Dissolving 7.73 grams of naphthalene in 85.9 mL of solvent exemplifies typical laboratory procedures involving aromatic hydrocarbons. The calculations reveal that, given standard organic solvents like benzene or toluene, the amount of naphthalene is well within solubility limits, ensuring a saturated or unsaturated solution depending on temperature and solvent choice. Understanding the physical properties, solubility behavior, and safety considerations is crucial for effectively handling naphthalene in various applications.

This process underscores fundamental principles of solution chemistry, including molarity calculations, solubility limits, and the importance of environmental safety. Proper handling, temperature control, and solvent selection optimize dissolution, which is essential for subsequent analytical or synthetic procedures.

Final Remarks

The dissolution of naphthalene is a straightforward yet instructive example of organic solubility

principles. By comprehensively understanding the molecular structure, physical properties, and experimental parameters, chemists can manipulate conditions to achieve desired outcomes—be it purification, formulation, or analysis—while maintaining safety and environmental responsibility.

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