A Solution Is Made By Mixing 114.g Of Benzene C6H6 And 83.g Of Acetyl Bromide CH3COBr. Calculate The

A Solution Is Made By Mixing 114.g Of Benzene C6H6 And 83.g Of Acetyl Bromide CH3COBr. Calculate The in the first paragraph. When preparing chemical solutions, it is essential to understand the quantities involved and the resulting concentration, reactivity, and potential applications. In this article, we will explore how to calculate various parameters based on the mixing of benzene (C_6H_6) and acetyl bromide (CH_3COBr), focusing on molar mass, moles, and concentration. This comprehensive guide will help students, chemists, and enthusiasts understand the process of calculating the properties of such a solution.

Understanding the Components: Benzene and Acetyl Bromide

Benzene (C_6H_6)

Benzene is an aromatic hydrocarbon with the molecular formula C_6H_6. It is a colorless, flammable liquid with a sweet odor and is widely used as a solvent and in chemical synthesis.

Acetyl Bromide (CH_3COBr)

Acetyl bromide is an acyl halide with the molecular formula CH_3COBr. It is used as an acetylating agent in organic synthesis, especially in the preparation of acetyl derivatives.

Calculating Moles of Benzene and Acetyl Bromide

Step 1: Find the Molar Mass of Each Compound

The molar mass (molecular weight) is calculated by summing the atomic masses of each element, based on the periodic table.

- Benzene (C_6H_6):
- C (Carbon): 12.01 g/mol
- H (Hydrogen): 1.008 g/mol

Calculating molar mass of benzene:

$$
\text{Molar mass of C}_6\text{H}_6 = (6 \times 12.01) + (6 \times 1.008) = 72.06 + 6.048 = 78.108 \text{ g/mol}
$$

- Acetyl Bromide (CH_3COBr):

Calculating molar mass:

$$
\text{Molar mass of CH}_3\text{COBr} = (1 \times 12.01) + (3 \times 1.008) + (1 \times 12.01) + (1 \times 16.00) + (1 \times 79.90) = 12.01 + 3.024 + 12.01 + 16.00 + 79.90 = 122.944 \text{ g/mol}
$$

Note: The molar mass of acetyl bromide is approximately 122.94 g/mol.

Step 2: Calculate the Number of Moles in the Given Masses

Using the formula:

$$
\text{Moles} = \frac{\text{Mass (g)}}{\text{Molar mass (g/mol)}}
$$

Calculations:

- Moles of benzene:

$$
\frac{114\, \text{g}}{78.108\, \text{g/mol}} \approx 1.459\, \text{mol}
$$

- Moles of acetyl bromide:

$$
\frac{83\, \text{g}}{122.94\, \text{g/mol}} \approx 0.676\, \text{mol}
$$

Determining the Limiting Reagent and Reaction Stoichiometry

Understanding the Reaction

The typical reaction involving benzene and acetyl bromide is an electrophilic substitution, often under Friedel-Crafts acylation conditions, where benzene reacts with acyl halides to produce ketones.

The general reaction:

$$
\text{C}_6\text{H}_6 + \text{CH}_3\text{COBr} \rightarrow \text{C}_6\text{H}_5\text{COCH}_3 + \text{HBr}
$$

This indicates a 1:1 molar ratio between benzene and acetyl bromide.

Identify the Limiting Reagent

Based on molar calculations:
- Benzene: 1.459 mol
- Acetyl bromide: 0.676 mol

Since acetyl bromide is present in fewer moles, it is the limiting reagent.

Calculating the Concentration of the Solution

Total Volume of the Solution

To determine concentration, the total volume of the mixture is required. If the volumes of individual components are known, they can be summed. In the absence of specific volume data, assume the solution is prepared by mixing the masses directly, and approximate the total volume based on densities or standard solution preparation methods.

Assumption: Let's assume the total volume after mixing is approximately 100 mL (0.1 L).

(Note: In real scenarios, the actual volume should be measured or provided.)

Calculate Molar Concentration (Molarity)

Molarity (M) is defined as moles of solute per liter of solution:

$$
\text{Molarity} = \frac{\text{Moles of solute}}{\text{Volume in liters}}
$$

\]

Since acetyl bromide is the limiting reagent:

$$
\text{Concentration of acetyl bromide} = \frac{0.676\, \text{mol}}{0.1\, \text{L}} = 6.76\, \text{M}
$$

Similarly, for benzene:

$$
\text{Concentration of benzene} = \frac{1.459\, \text{mol}}{0.1\, \text{L}} = 14.59\, \text{M}
$$

Applications and Safety Considerations

Applications of the Solution

The mixture of benzene and acetyl bromide is often used in organic synthesis, particularly in Friedel-Crafts acylation to produce aromatic ketones such as acetophenone. These compounds are valuable intermediates in pharmaceuticals, fragrances, and polymers.

Safety Precautions

Both benzene and acetyl bromide are hazardous substances:
- Benzene is carcinogenic and should be handled in a fume hood with appropriate personal protective equipment.
- Acetyl bromide is corrosive and reacts violently with water, releasing hydrogen bromide (HBr) fumes.

Proper safety protocols, including wearing gloves, goggles, and working in a well-ventilated area, are essential.

Conclusion

Calculating the properties of a solution made by mixing benzene and acetyl bromide involves understanding their molar masses, calculating moles from given weights, identifying limiting reagents based on molar ratios, and estimating concentrations based on the total volume. By following these steps, chemists can determine the key parameters necessary for safe handling, reaction planning, and further chemical analysis. Whether used in research or industrial applications, these calculations are vital for ensuring accuracy and safety in chemical processes.

Summary of key calculations:
- Moles of benzene: approximately 1.459 mol
- Moles of acetyl bromide: approximately 0.676 mol

- Limiting reagent: acetyl bromide
- Estimated concentrations (assuming 100 mL total volume): benzene at 14.59 M, acetyl bromide at 6.76 M

Understanding these calculations enhances your ability to prepare, analyze, and utilize chemical solutions effectively in various laboratory and industrial settings.

Frequently Asked Questions

What is the total mass of the solution formed by mixing 114 g of benzene and 83 g of acetyl bromide?

The total mass of the solution is 114 g + 83 g = 197 g.

How do you calculate the molar mass of benzene (C_6H_6)?

The molar mass of benzene is (6 × 12.01) + (6 × 1.008) = 78.11 g/mol.

What is the molar mass of acetyl bromide (CH_3COBr)?

The molar mass of acetyl bromide is (12.01 + 3 × 1.008) + 12.01 + 79.90 = 137.01 g/mol.

How many moles of benzene are present in 114 g of benzene?

Number of moles = 114 g / 78.11 g/mol ≈ 1.46 mol.

How many moles of acetyl bromide are present in 83 g of acetyl bromide?

Number of moles = 83 g / 137.01 g/mol ≈ 0.61 mol.

What is the molarity of the solution if it is prepared in 1 liter of total volume?

Assuming the total volume is 1 liter, the molarity of benzene is approximately 1.46 M, and acetyl bromide is approximately 0.61 M.

What is the significance of mixing benzene and acetyl bromide in chemical reactions?

Mixing benzene and acetyl bromide is significant in organic synthesis, especially for acetylation reactions like forming acetyl derivatives or producing acetophenone.

How do you determine the limiting reagent in this mixture if a specific reaction is conducted?

To determine the limiting reagent, compare the mole ratios of benzene and acetyl bromide based on the balanced reaction equation, and identify which reactant is exhausted first during the reaction.

Additional Resources

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Introduction: Understanding the Context of the Chemical Reaction

In the realm of organic chemistry, the preparation and analysis of chemical solutions are fundamental processes that underpin numerous applications—from pharmaceutical development to industrial manufacturing. Today, we explore a classic example involving benzene (C_6H_6) and acetyl bromide (CH_3COBr). Specifically, a solution is prepared by mixing 114 grams of benzene with 83 grams of acetyl bromide, and the task is to determine the outcome of this mixture—be it the amount of product formed, the limiting reagent, or other relevant parameters.

This article aims to dissect the problem comprehensively, guiding readers through the underlying principles, calculations, and implications with clarity and precision. Whether you are a student, a researcher, or an enthusiast, understanding this process sheds light on the core concepts of stoichiometry, molecular weights, and chemical reactivity.

Understanding the Components: Benzene and Acetyl Bromide

Before delving into calculations, it is essential to familiarize ourselves with the chemical nature of the reactants involved.

Benzene (C_6H_6)

- Structure and Properties: Benzene is a planar aromatic hydrocarbon characterized by a ring of six carbon atoms with alternating double bonds. It is known for its stability due to resonance and is widely used as a solvent and precursor in chemical synthesis.

- Molecular Weight: Calculated based on atomic weights:
- Carbon (C): approximately 12.01 g/mol
- Hydrogen (H): approximately 1.008 g/mol

Therefore:

Molecular weight of benzene = (6 × 12.01) + (6 × 1.008) = 72.06 + 6.048 = 78.11 g/mol

Acetyl Bromide (CH_3COBr)

- Structure and Properties: Acetyl bromide is an acyl halide, commonly used as an acylating agent in organic synthesis. It features a bromine atom attached to the carbonyl carbon, making it reactive and useful in preparing acetylated compounds.

- Molecular Weight:
- Carbon (C): 12.01 g/mol
- Hydrogen (H): 1.008 g/mol
- Bromine (Br): approximately 79.90 g/mol
- Oxygen (O): approximately 16.00 g/mol

Calculations:

Molecular weight of acetyl bromide = (2 × 12.01) + (3 × 1.008) + 79.90 + 16.00 = 24.02 + 3.024 + 79.90 + 16.00 = 122.94 g/mol

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Identifying the Reaction: Acetylation of Benzene

The mixture of benzene and acetyl bromide typically indicates an acetylation process, often facilitated by a Lewis acid catalyst such as aluminum chloride ($AlCl_3$). The reaction yields acetophenone (phenyl methyl ketone), a valuable compound in pharmaceuticals and fragrances.

The general reaction:

$C_6H_6 + CH_3COBr \rightarrow C_6H_5COCH_3 + HBr$

Here:

- Benzene reacts with acetyl bromide to produce acetophenone.
- Hydrogen bromide (HBr) is a byproduct.

Note: This reaction is a form of Friedel–Crafts acylation, where benzene is acylated using a suitable acyl halide in the presence of a catalyst.

Calculating Moles: Transition from Mass to Mole Concept

The first step in quantitative analysis involves converting the provided masses into moles, facilitating stoichiometric calculations.

Moles of Benzene (C_6H_6)

Given:
- Mass of benzene = 114 g
- Molecular weight = 78.11 g/mol

Calculation:

Number of moles = Mass / Molecular weight = 114 g / 78.11 g/mol ≈ 1.459 mol

Moles of Acetyl Bromide (CH_3COBr)

Given:
- Mass of acetyl bromide = 83 g
- Molecular weight = 122.94 g/mol

Calculation:

Number of moles = 83 g / 122.94 g/mol ≈ 0.675 mol

Determining the Limiting Reagent

In any chemical reaction, the limiting reagent is the reactant that is entirely consumed first, thus limiting the amount of product formed. To identify this, compare the molar ratios of reactants based on the balanced chemical equation.

Balanced Reaction Equation

From the reaction:

$C_6H_6 + CH_3COBr \rightarrow C_6H_5COCH_3 + HBr$

The molar ratio:

- 1 mol benzene reacts with 1 mol acetyl bromide.

Comparison of Available Moles

- Benzene: ~1.459 mol
- Acetyl bromide: ~0.675 mol

Since the reaction requires equal molar amounts, acetyl bromide, with fewer moles relative to benzene, will be consumed first. Therefore, acetyl bromide is the limiting reagent.

Calculating the Theoretical Yield of Acetophenone

Knowing the limiting reagent allows us to determine the maximum amount of product (acetophenone) that can be formed.

Using the Limiting Reagent (Acetyl Bromide)

- Moles of acetyl bromide = 0.675 mol
- The reaction ratio: 1 mol acetyl bromide yields 1 mol acetophenone

Thus, maximum moles of acetophenone = 0.675 mol

Mass of Acetophenone Formed

- Molecular weight of acetophenone ($C_6H_5COCH_3$):

- Carbon: 8 × 12.01 = 96.08 g
- Hydrogen: 8 × 1.008 = 8.064 g
- Oxygen: 1 × 16.00 = 16.00 g

Total: 96.08 + 8.064 + 16.00 = 120.14 g/mol

- Mass of acetophenone = moles × molecular weight = 0.675 mol × 120.14 g/mol ≈ 81.10 g

Therefore, the theoretical maximum yield of acetophenone is approximately 81.10 grams.

Additional Considerations: Actual Yield and Reaction Conditions

While the above calculation provides the theoretical yield, real-world reactions often yield less due to factors such as incomplete reactions, side reactions, and purification losses. Factors influencing the reaction include:

- Presence of a Catalyst: Typically, a Lewis acid catalyst like $AlCl_3$ enhances the reaction rate and yield.
- Reaction Temperature and Time: Proper control ensures maximum conversion.
- Purification Processes: Washing, filtration, and recrystallization can lead to product loss.

Hence, actual yields are often lower than the theoretical calculations, but the theoretical yield serves as a benchmark for assessing reaction efficiency.

Implications and Applications of the Reaction

Understanding the stoichiometry and yield calculations has practical significance:

- Pharmaceuticals: Acetophenone is a key intermediate in synthesizing various drugs.
- Fragrance Industry: It is used in perfumes and flavorings.
- Academic Research: The reaction exemplifies Friedel–Crafts acylation, fundamental in organic synthesis.

Moreover, precise calculations enable chemists to optimize reaction conditions, scale up processes, and minimize waste—integral aspects of sustainable chemical manufacturing.

Conclusion: From Raw Data to Chemical Insight

In summary, the process of mixing 114 grams of benzene with 83 grams of acetyl bromide involves detailed stoichiometric calculations to determine the limiting reagent and the maximum possible yield of acetophenone. By converting mass to moles, comparing molar ratios, and applying molecular weights, chemists can accurately predict reaction outcomes. This analytical approach not only deepens understanding of the specific reaction but also exemplifies the broader principles of quantitative organic chemistry—a vital skill for scientific progress and industrial innovation.

Recap of Key Calculations:

- Moles of benzene: ~1.459 mol
- Moles of acetyl bromide: ~0.675 mol
- Limiting reagent: Acetyl bromide

- Theoretical yield of acetophenone: ~81.10 g

Through such meticulous calculations, chemists can ensure efficient reaction planning, quality control, and the development of new derivatives, further advancing the field of organic synthesis.

References

- Clayden, Greeves, Warren, and Wothers. Organic Chemistry, 2nd Edition.
- Atkins, Peter, and Julio de Paula. Physical Chemistry, 10th Edition.
- Organic Chemistry Portal. Friedel–Crafts Acylation Reactions.
- NIST Chemistry WebBook. Molecular Weights and Data.

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