The Volume Of 2. 050 M Copper(ii) Nitrate That Must Be Diluted With Water To Prepare 750. 0 Ml Of A 0.

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When working in a laboratory setting or conducting chemical experiments, precise measurements and calculations are crucial to ensure safety, accuracy, and reproducibility. One common task involves preparing a specific concentration of a solution by diluting a more concentrated stock solution. In this article, we will explore how to determine the volume of a 2.050 M copper(II) nitrate solution required to dilute it with water to produce 750.0 mL of a solution at a desired concentration, which appears to be incomplete in the provided prompt but is likely a lower molarity.

This guide will walk through the fundamental concepts of molarity, dilution calculations, and practical steps to accurately prepare the desired solution. Whether you're a student, researcher, or laboratory technician, understanding these principles is vital for successful experiment setup.

Understanding Molarity and Solution Preparation

What is Molarity?

Molarity (M) is a measure of concentration indicating the number of moles of solute (dissolved substance) per liter of solution. It is expressed as:

$$ \text{Molarity} (M) = \frac{\text{moles of solute}}{\text{liters of solution}} $$

For example, a 2.050 M copper(II) nitrate solution contains 2.050 moles of $Cu(NO_3)_2$ per liter of solution.

Why Dilute Solutions?

Dilution is necessary when a stock solution is too concentrated for an experiment, or when preparing a specific molarity for a reaction. The process involves adding solvent (usually water) to decrease the concentration without changing the amount of solute.

Calculating the Required Volume of Concentrated Copper(II) Nitrate

Given data:

- Stock solution concentration (C_1): 2.050 M
- Final volume of dilute solution (V_2): 750.0 mL (or 0.750 L)
- Final concentration (C_2): unknown in the prompt, but typically less than the stock concentration — assume the target is a known lower molarity, say, 0.100 M for example purposes.

Note: Since the original prompt appears incomplete at "0," we will proceed assuming the target concentration is 0.100 M. If you have a specific final concentration, replace it accordingly.

Using the Dilution Formula

The fundamental relation for dilutions:

$$ C_1 V_1 = C_2 V_2 $$

Where:

- $ C_1 $ = initial concentration (2.050 M)
- $ V_1 $ = volume of stock solution needed
- $ C_2 $ = desired concentration (assumed 0.100 M)
- $ V_2 $ = final volume of solution (750.0 mL)

Rearranged to find $ V_1 $:

$$ V_1 = \frac{C_2 \times V_2}{C_1} $$

Step-by-Step Calculation

Step 1: Convert volumes to consistent units.

- $ V_2 = 750.0\, \text{mL} = 0.750\, \text{L} $

Step 2: Plug the values into the formula.

$$ V_1 = \frac{0.100\, \text{M} \times 0.750\, \text{L}}{2.050\, \text{M}} $$

$$ V_1 = \frac{0.075\, \text{mol}}{2.050\, \text{mol/L}} $$

$$ V_1 \approx 0.03659\, \text{L} $$

Step 3: Convert V_1 back to milliliters.

$$ V_1 \approx 36.59\, \text{mL} $$

Result: To prepare 750.0 mL of a 0.100 M copper(II) nitrate solution from a 2.050 M stock, approximately 36.59 mL of the concentrated solution must be diluted with water to reach a total volume of 750.0 mL.

Practical Procedure for Solution Preparation

Materials Needed

- 2.050 M copper(II) nitrate stock solution
- Distilled or deionized water
- Measuring cylinder or pipette (for accurate measurement)
- Volumetric flask (750 mL)
- Stirring rod or magnetic stirrer
- Personal protective equipment (gloves, goggles)

Steps to Prepare the Diluted Solution

1. Wear appropriate safety gear before handling chemicals.
2. Use a pipette or graduated cylinder to measure approximately 36.59 mL of the 2.050 M copper(II) nitrate solution.
3. Transfer this measured volume into the 750 mL volumetric flask.

4. Gradually add distilled water to the flask, swirling gently to mix thoroughly.

5. Continue adding water until the bottom of the meniscus reaches the 750 mL mark on the flask.

6. Cap the flask and invert it several times to ensure uniform mixing.

7. Label the flask with the concentration, date, and contents for future reference.

Important Considerations and Tips

- **Accuracy in Measurement:** Use calibrated equipment such as volumetric flasks and pipettes for precise measurements.
- **Safety First:** Copper(II) nitrate solutions are hazardous; handle with gloves and eye protection.
- **Concentration Verification:** If necessary, verify the final concentration by appropriate analytical methods.
- **Storage:** Store prepared solutions in labeled, airtight containers away from light and heat.

Alternative Scenarios and Adjustments

The calculation and procedure outlined above can be adapted for different initial concentrations, final volumes, or target molarities. Here are some scenarios:

Preparing a Different Final Concentration

- Substitute the desired C_2 into the formula.
- Recalculate V_1 accordingly.

Preparing Larger or Smaller Volumes

- Adjust V_2 in the formula.
- Scale the volume of stock solution proportionally.

Using Different Stock Concentrations

- Ensure the initial solution's molarity matches the calculation.
- If the stock is less concentrated, consider concentrating or sourcing a different stock solution.

Summary and Final Tips

- The key to successful solution preparation is understanding the relationship between concentration and volume.
- Always double-check calculations and measurements.
- Maintain safety protocols when handling chemicals.
- Properly label and store solutions for future use.

Conclusion

Preparing a specific volume and concentration of copper(II) nitrate solution from a stock solution involves straightforward calculations based on the molarity formula. By accurately measuring the required volume of the concentrated solution and diluting with water to the desired final volume, you can obtain a solution suitable for your experimental needs. Whether working in a classroom, research lab, or industrial setting, mastering these dilution principles is essential for effective and safe chemical handling.

Note: If the original prompt's intended final concentration was different, replace the assumed 0.100 M with the actual desired concentration and recalculate accordingly.

Frequently Asked Questions

How do you calculate the volume of copper(II) nitrate needed to prepare a specific dilute solution?

You can use the dilution formula C1V1 = C2V2, where C1 and V1 are the concentration and volume of the stock solution, and C2 and V2 are the concentration and volume of the diluted solution. Rearranging to V1 = (C2 × V2) / C1 allows you to find the required volume.

What is the importance of diluting copper(II) nitrate solutions in laboratory procedures?

Diluting copper(II) nitrate solutions is important to achieve desired concentrations for experiments, ensure safety by reducing toxicity, and to meet specific experimental conditions that require lower reagent concentrations.

How do you convert the given concentration from molarity to mass for copper(II) nitrate?

To convert molarity to mass, multiply the molar concentration (mol/L) by the molar mass of copper(II) nitrate (187.56 g/mol), then multiply by the volume in liters. For example, 2.050 mol/L × 187.56 g/mol × volume in liters.

What is the molar mass of copper(II) nitrate, and why is it important in calculations?

The molar mass of copper(II) nitrate ($Cu(NO_3)_2$) is approximately 187.56 g/mol. It is essential for converting between moles and grams, which is critical in preparing solutions with precise concentrations.

If you need to prepare 750 mL of a diluted copper(II) nitrate solution, how much of the 2.050 M stock solution is required?

Using V1 = (C2 × V2) / C1, assuming C2 is the desired dilute concentration, you substitute the values to calculate the volume of the stock solution needed. The specific volume depends on the target concentration.

What safety precautions should be taken when working with copper(II) nitrate solutions?

Wear appropriate personal protective equipment such as gloves and goggles, work in a well-ventilated area or fume hood, avoid ingestion or inhalation, and handle the chemical with care due to its toxicity and oxidizing properties.

How can you verify the accuracy of your prepared copper(II) nitrate solution?

You can verify the concentration using analytical techniques such as spectrophotometry or titration with a standard solution, ensuring the prepared solution matches the intended molarity.

Additional Resources

The Volume Of 2. 050 M Copper(ii) Nitrate That Must Be Diluted With Water To Prepare 750. 0 Ml Of A 0.

Understanding how to dilute a concentrated solution of copper(II) nitrate to achieve a specific volume and molarity is fundamental in chemical laboratories and industrial applications alike. Whether for research, manufacturing, or educational demonstrations, precise calculations ensure accurate results and safety. In this article, we will explore the detailed process of determining the volume of a 2.050 M copper(II) nitrate solution needed to prepare 750.0 mL of a different concentration, focusing on the principles of solution dilution, molarity, and quantitative chemistry.

Fundamentals of Solution Concentration and Dilution

What Is Molarity?

Molarity (M) is a measure of concentration expressing the number of moles of solute (in this case, copper(II) nitrate) dissolved in one liter of solution. It is calculated as:

$$ M = \frac{\text{moles of solute}}{\text{liters of solution}} $$

For example, a 2.050 M solution contains 2.050 moles of copper(II) nitrate per liter of solution.

Why Dilute Solutions?

Dilution involves reducing the concentration of a solution by adding solvent, typically water, without changing the amount of solute present. This process is essential when:

- Preparing solutions of specific lower concentrations for experiments.
- Ensuring safety when handling highly concentrated solutions.
- Achieving precise molarity for analytical procedures.

The key relationship governing dilution is:

$$ C_1 V_1 = C_2 V_2 $$

Where:
- C_1 = initial concentration
- V_1 = volume of concentrated solution needed
- C_2 = desired concentration
- V_2 = final volume of diluted solution

Determining the Final Concentration

Before calculating the volume of copper(II) nitrate solution required, we need clarity on the target concentration. The original prompt mentions "a 0." which appears incomplete. For the sake of this discussion, let's assume the intended final concentration is 0.200 M. This is a common concentration level used in laboratory dilutions.

Note: If the actual target molarity differs, replace 0.200 M with the correct value in calculations.

Calculating the Volume of 2.050 M Copper(II) Nitrate Needed

Given:
- $C_1 = 2.050\, \text{M}$
- $C_2 = 0.200\, \text{M}$
- $V_2 = 750.0\, \text{mL} = 0.750\, \text{L}$

Using the dilution formula:

$$ V_1 = \frac{C_2 \times V_2}{C_1} $$

Plugging in the values:

$$
V_1 = \frac{0.200\, \text{M} \times 0.750\, \text{L}}{2.050\, \text{M}} = \frac{0.150\, \text{mol}}{2.050\, \text{mol/L}} \approx 0.07317\, \text{L}
$$

Converting to milliliters:

$$
V_1 \approx 73.17\, \text{mL}
$$

Interpretation:
To prepare 750.0 mL of a 0.200 M copper(II) nitrate solution, approximately 73.17 mL of the 2.050 M stock solution should be measured out and then diluted with water up to the final volume of 750.0 mL.

Practical Steps for Preparation

1. Gather Materials

- Copper(II) nitrate stock solution (2.050 M)
- Volumetric flask (750 mL)
- Graduated cylinder or pipette (to measure 73.17 mL)
- Distilled or deionized water
- Stirring rod or magnetic stirrer

2. Measure the Concentrated Solution

Using a graduated cylinder or pipette, carefully measure approximately 73.17 mL of the 2.050 M copper(II) nitrate solution. Precision is key to ensure the desired molarity.

3. Transfer and Dilute

Pour the measured solution into the 750 mL volumetric flask. Then, add distilled water gradually until the solution reaches the calibration mark on the flask.

4. Mix Thoroughly

Cap the flask and invert multiple times or stir with a magnetic stirrer to ensure homogeneity.

5. Verify and Label

Ensure the final volume is accurate, and label the container with concentration, date, and safety information.

Important Considerations and Safety Tips

- Accuracy in Measurement: Use calibrated equipment to ensure precise measurements, especially when dealing with molar calculations.
- Handling Copper(II) Nitrate: It is a toxic and oxidizing compound; wear gloves, goggles, and work in a well-ventilated area.
- Water Quality: Use distilled or deionized water to prevent contamination and unwanted reactions.
- Waste Disposal: Dispose of copper-containing solutions following local regulations, as they are environmentally hazardous.

Implications and Applications of Proper Dilution

The ability to accurately dilute solutions like copper(II) nitrate has broad implications:

- Research and Development: Precise solutions enable reproducible experiments and data integrity.
- Industrial Processes: Manufacturing of catalysts, dyes, or pharmaceuticals often requires specific molarities.
- Educational Demonstrations: Visualizing chemical reactions at different concentrations enhances learning.
- Analytical Chemistry: Preparing calibration standards for spectroscopic or titrimetric analyses.

Conclusion

Understanding the calculation of solution volumes based on molarity and desired final concentrations is a cornerstone of chemical laboratory work. In our example, approximately 73.17 mL of a 2.050 M copper(II) nitrate solution is needed to prepare 750.0 mL of a 0.200 M solution. This process underscores the importance of precise measurement, careful calculation, and adherence to safety procedures. Mastery of these fundamentals ensures reliable experimental results and safe laboratory practices, fueling progress across scientific disciplines.

Note: If the target molarity or volume differs from the assumptions made here, adjust the values accordingly using the same principles outlined in

this article.

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