Roger Needs 80mL Of A 83% Acid Solution For A Science Experiment. He Has Available A 80% Solution And

Roger Needs 80mL Of A 83% Acid Solution For A Science Experiment. He Has Available A 80% Solution And
In the realm of scientific experiments, precision in preparing chemical solutions is crucial to ensure accurate results. When a scientist like Roger requires exactly 80 mL of an 83% acid solution but only has access to an 80% acid solution, he must carefully calculate how to dilute or mix available solutions to achieve the desired concentration. This task involves understanding concepts such as concentration, volume, and the principles of dilution and mixing. In this article, we will explore the step-by-step process for solving such problems, the mathematical formulas involved, and practical tips to ensure accuracy during preparation.

Understanding Concentration and Solutions

What Is Concentration?

Concentration refers to the amount of solute—here, acid—dissolved in a given volume of solution. It is commonly expressed as a percentage, molarity, molality, or other units. In this context, the percentage indicates the mass of acid per 100 mL of solution.

- 83% Acid Solution: Contains 83 grams of acid per 100 mL of solution.
- 80% Acid Solution: Contains 80 grams of acid per 100 mL of solution.

Why Is Accurate Concentration Important?

Accurate concentration is essential because:
- It affects the chemical reactions' rates and yields.
- It ensures safety measures, especially with corrosive acids.
- It maintains the reproducibility and validity of experimental results.

Problem Breakdown

The primary challenge is: How to prepare 80 mL of an 83% acid solution using only an 80% acid solution?
Since the available solution is less concentrated than the target, it’s impossible to simply dilute the 80% solution to get 83%. Instead, the process involves mixing solutions of different concentrations or considering alternative strategies such as adding pure acid or concentrated solutions if available.

Key points:
- The target volume: 80 mL
- The target concentration: 83%
- Available solution concentration: 80%

Given the available solution is less concentrated than the desired, direct dilution will not suffice. Therefore, we need to determine if adding pure acid, or other solutions, is feasible.

Approach 1: Mixing the 80% Solution with Pure Acid

Assumption:
Pure acid (100%) is available. If not, this approach may not be practical.

Objective:
Find the volume of 80% solution (V1) and pure acid (V2) to mix to get 80 mL of 83% acid solution.

Set Up the Equation:

Let
- V1 = volume of 80% solution (mL)
- V2 = volume of pure acid (mL)

Total volume:
V1 + V2 = 80 mL

Total amount of acid:
(0.80 × V1) + (1.00 × V2) = 0.83 × 80 mL

Solve for V1 and V2:

1. Write the equations:

$$ V1 + V2 = 80 $$

$$ 0.80 V1 + V2 = 66.4 $$

2. Substitute V2 from the first into the second:

$$ V2 = 80 - V1 $$

$$ 0.80 V1 + (80 - V1) = 66.4 $$

$$ 0.80 V1 + 80 - V1 = 66.4 $$

$$ -0.20 V1 = -13.6 $$

$$ V1 = \frac{-13.6}{-0.20} = 68 \text{ mL} $$

3. Find V2:

$$ V2 = 80 - 68 = 12 \text{ mL} $$

Interpretation:
- Mix 68 mL of 80% acid solution with 12 mL of pure acid to obtain 80 mL of 83% acid solution.

Note:
This approach assumes access to pure acid, which may not always be practical due to safety and handling concerns.

Approach 2: Adjusting for Available Solutions Only

If pure acid is unavailable, and only an 80% solution is accessible, then achieving an 83% concentration through mixing alone is impossible because the maximum concentration available (80%) is less than the target (83%).

Implication:
In such cases, the experiment would require obtaining a more concentrated acid solution or purchasing a solution with a higher concentration.

Practical Tips for Preparing Precise Acid Solutions

Preparing solutions with high accuracy involves several best practices:

- **Use calibrated equipment:** Graduated cylinders, pipettes, and burettes ensure precise volume measurement.

- **Handle acids with care:** Always wear protective gear and work in a well-ventilated area.

- **Understand dilution principles:** Use formulas and calculations to determine the exact amounts needed.

- **Double-check calculations:** Confirm formulas and calculations before mixing.

- **Document the process:** Record measurements and steps for reproducibility and safety.

Mathematical Formulas for Solution Preparation

The core formula used in solution preparation is the dilution equation:

$$ C_1 V_1 = C_2 V_2 $$

Where:
- C_1 = initial concentration
- V_1 = volume of the initial solution used
- C_2 = final concentration
- V_2 = final volume of solution

Applying this to the current problem:

- To dilute a solution from concentration C_1 to C_2:

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

Using the earlier example of mixing 80% acid with pure acid:

- To find how much 80% solution to use:

$$ V_1 = \frac{0.83 \times 80}{0.80} = 83 \text{ mL} $$

which exceeds the total volume needed, indicating that pure acid addition is necessary.

Summary of Key Steps for Solution Preparation

1. Identify available solutions and their concentrations.
2. Determine if desired concentration can be achieved through mixing.
3. Set up relevant equations based on solution volumes and concentrations.
4. Solve the equations to find precise measurement amounts.
5. Use calibrated equipment for measurement.
6. Mix solutions carefully and safely.
7. Verify the final concentration if possible, using appropriate analytical methods.

Conclusion

Preparing an 83% acid solution when only an 80% solution is available presents challenges due to concentration limitations. If pure acid is accessible, mixing 68 mL of 80% solution with 12 mL of pure acid yields the desired 80 mL of 83% acid solution. Otherwise, obtaining a more concentrated acid solution or adjusting experimental requirements may be necessary.

Understanding the principles of solution concentration, dilution formulas, and careful measurement techniques are essential skills for any scientist handling chemical solutions. Proper planning, precise calculations, and safety are paramount to successful and accurate solution preparation for scientific experiments.

Keywords for SEO:
acid solution preparation, how to dilute acid solutions, mixing acid solutions, solution concentration calculations, acid solution formulas, preparing 83% acid solution, laboratory solution preparation, accurate chemical measurement, solution dilution formulas, scientific experiment safety

Frequently Asked Questions

How much of the 80% acid solution does Roger need to prepare 80 mL of an 83% acid solution?

It's not possible to prepare an 83% solution by mixing 80% solutions because 80% is less than 83%. You need a higher concentration solution or pure acid to reach 83%.

Can Roger use the 80% acid solution to make an 83% solution?

No, because the available solution is less concentrated than the desired concentration. To get 83%, he would need a more concentrated acid or pure acid.

What is the maximum concentration Roger can achieve by diluting the 80% solution?

The maximum concentration achievable by diluting the 80% solution is 80%, so he cannot reach 83% by dilution.

Is it possible to prepare 80 mL of an 83% acid solution using the 80% solution available?

No, since the available solution is only 80%, which is less concentrated than the desired 83%, it cannot be used to make an 83% solution.

What additional materials does Roger need to prepare an 83% acid solution?

Roger would need a more concentrated acid solution, pure acid, or a different method to achieve an 83% concentration, since his current 80% solution is insufficient.

How can Roger determine the amount of pure acid in his available 80% solution?

He can multiply the volume of the solution (e.g., 80 mL) by 0.80 to find the amount of pure acid: 80 mL × 0.80 = 64 mL of pure acid.

What is the implication of using an 80% solution to make an 83% solution?

It's impossible because the solution's concentration is lower than the target; mixing lower concentration solutions cannot produce a higher concentration than the original.

Can Roger achieve a higher concentration than 80% with his available solutions?

No, unless he has access to pure acid or more concentrated solutions, he cannot increase the concentration above 80%.

What is the importance of solution concentration in preparing specific acid solutions?

Concentration determines the strength of the solution; to achieve a specific concentration like 83%, the starting materials must have at least that concentration or higher.

What should Roger do if he needs exactly 80 mL of an 83% acid solution?

He should acquire a more concentrated acid solution or pure acid to mix with his 80% solution, or purchase the required concentration directly, since his current solution cannot reach 83%.

Additional Resources

Roger needs 80mL of an 83% acid solution for his science experiment, but he only has access to an 80% solution. This common scenario in laboratories and classrooms highlights the importance of understanding concentration, dilution, and precise measurement to achieve the desired solution strength. Whether you're a student, educator, or professional chemist, mastering the process of preparing solutions with specific concentrations is essential for accurate experimental outcomes.

In this guide, we will walk through the step-by-step process Roger can follow to determine how much of the 80% acid solution he needs to mix with water (or other diluents) to produce exactly 80mL of an 83% acid solution. We will explore the concepts of solution concentration, the mathematical formulas involved, and practical considerations to ensure safety and accuracy.

Understanding Solution Concentrations

Before diving into calculations, it's vital to understand what solution concentrations represent. When we say an acid solution is 80% or 83%, we are referring to the percentage by volume or weight of the pure acid in the total solution.

- Percent concentration = (Volume or weight of pure acid / Total volume or weight of solution) × 100%

For practical purposes, especially in liquid solutions, volume-based percentages are often used, assuming the density of the solutions is close to that of water (which is a reasonable approximation for dilute solutions).

The Goal: Dilution Calculation

Roger wants 80mL of an 83% acid solution. He has an 80% acid solution available. The problem boils down to:

- How much of the 80% solution should he use?
- How much water (or diluent) should he add to reach the target volume and concentration?

This is a classic dilution problem, which can be solved using the conservation of pure acid:

Amount of pure acid in the initial solution = Amount of pure acid in the final solution

Mathematically:

(Volume of initial solution) × (Concentration of initial solution) = (Final volume) × (Desired concentration)

Let’s define:

- V_i = volume of the 80% solution to be used (unknown)
- V_f = total final volume = 80mL
- C_i = initial concentration = 80% = 0.80
- C_f = final concentration = 83% = 0.83

Since the initial solution is less concentrated than the target, this indicates that we cannot simply dilute the 80% solution to reach 83%. In fact, to achieve a higher concentration than the available solution, we need to add pure acid directly or concentrate the solution, which is typically not feasible in a simple dilution scenario.

Recognizing the Impossibility: Can an 80% Solution Be Diluted to 83%?

It's critical to recognize that dilution always decreases concentration, never increases it. Since Roger’s target concentration (83%) exceeds his available solution (80%), simply mixing the 80% solution with water cannot produce an 83% solution.

Therefore, the only way to achieve an 83% concentration is by adding pure acid directly. This is a key insight — under normal dilution principles, increasing concentration requires adding pure acid, not water.

Correct Approach: Adding Pure Acid to the 80% Solution

Given the above, Roger needs to add pure acid to his 80% solution to reach

83%.

Step 1: Define the variables

- V_{acid} = volume of pure acid to add (unknown)
- $V_{initial}$ = volume of the initial 80% solution = $V_{initial}$
- V_{final} = total final volume = $V_{initial} + V_{acid}$

Step 2: Write the equation for pure acid content

The total amount of pure acid after adding pure acid:

$$\text{Pure acid from initial solution} + \text{Pure acid added} = \text{Pure acid in final solution}$$

Expressed as:

$$(V_{initial} \times 0.80) + V_{acid} = (V_{initial} + V_{acid}) \times 0.83$$

Step 3: Solve for V_{acid}

Rearranged:

$$0.80 V_{initial} + V_{acid} = 0.83 V_{initial} + 0.83 V_{acid}$$

Bring all V_{acid} terms to one side:

$$V_{acid} - 0.83 V_{acid} = 0.83 V_{initial} - 0.80 V_{initial}$$

Simplify:

$$(1 - 0.83) V_{acid} = (0.83 - 0.80) V_{initial}$$

$$0.17 V_{acid} = 0.03 V_{initial}$$

$$V_{acid} = \frac{0.03}{0.17} V_{initial} \approx 0.1765 V_{initial}$$

Step 4: Determine $V_{initial}$

Recall:

$$V_{final} = 80\, \text{mL}$$

$$V_{final} = V_{initial} + V_{acid}$$

Substitute V_{acid}:

$$80 = V_{initial} + 0.1765 V_{initial}$$

$$80 = V_{initial} \times (1 + 0.1765)$$

$$ 80 = 1.1765 V_{initial} $$

$$ V_{initial} = \frac{80}{1.1765} \approx 68\, \text{mL} $$

Step 5: Find V_{acid}

$$ V_{acid} = 0.1765 \times 68 \approx 12\, \text{mL} $$

Practical Steps for Roger

Based on the calculations:

- Use approximately 68mL of the 80% acid solution.
- Add approximately 12mL of pure acid.

This will give:

- Total volume: $68\, \text{mL} + 12\, \text{mL} = 80\, \text{mL}$
- Final concentration: approximately 83%

Important Considerations and Safety Tips

1. Pure Acid Handling: Pure acids are highly corrosive and hazardous. Always handle with appropriate personal protective equipment (PPE), including gloves, goggles, and lab coat.

2. Accurate Measurement: Use precise pipettes, burettes, or graduated cylinders for measuring small volumes to ensure solution accuracy.

3. Adding Acid to Water: When diluting or preparing solutions, always add acid to water—not water to acid—to prevent exothermic reactions and splashing.

4. Labeling and Storage: Clearly label the final solution with concentration and date of preparation. Store in appropriate containers.

5. Verification: If possible, verify the concentration with appropriate testing methods, such as titration, before proceeding with the experiment.

Summarized Recipe for Roger

Step	Action	Volume	Concentration/Notes
1	Measure 68mL of 80% acid solution	68mL	From available stock
2	Carefully add 12mL of pure acid	12mL	Use a syringe or pipette

3	Mix thoroughly to ensure homogeneity	-	Use a glass rod or gentle swirling
4	Verify total volume is 80mL	-	Confirm measurement
5	Use immediately or store properly	-	For the experiment

Final Thoughts

Preparing solutions with specific concentrations requires understanding the relationship between volume, concentration, and pure substance content. In Roger’s case, since the target concentration exceeds his available solution’s concentration, he must add pure acid rather than dilute. This scenario underscores the importance of verifying whether a target concentration is achievable with available materials before starting.

By following these calculated steps and safety precautions, Roger can confidently prepare his 83% acid solution, ensuring the accuracy and safety of his science experiment. Whether you're tackling similar problems or designing your own solutions, mastering the principles of solution chemistry is an invaluable skill in scientific practice.

Roger Needs 80ml Of A 83 Acid Solution For A Science Experiment He Has Available A 80 Solution And

Roger Needs 80ml Of A 83 Acid Solution For A Science Experiment He Has Available A 80 Solution And

Related Articles

- Question 12 You Have A Microsoft SQL Server Database That Contains Tables Named Customers And Orders.
- Let Y 1 ,Y 2 ,Y 3 ,Y 4 Be The Order Tatitic Of A U(0,) Random Ample X 1 ,X 2 ,X 3 ,X 4 . (a) Find The
- Please Write A Short Story Of 5-7 Or More Sentences About A Green Dancing Octopus With PhD In English

Back to Home