For An Experiment, You Are Required To Prepare 150 Ml Of A 0.020 M Cobalt(ii) Chloride Solution From

For an experiment, you are required to prepare 150 ml of a 0.020 M cobalt(II) chloride solution from readily available chemical reagents. Preparing precise solutions is fundamental in chemistry laboratories, whether for analytical purposes, titrations, or research experiments. Accurate solution preparation ensures the reliability of experimental results and maintains safety standards. This comprehensive guide will walk you through the step-by-step process, including the calculations, safety precautions, and tips for preparing the cobalt(II) chloride solution accurately and efficiently.

Understanding the Basics of Solution Preparation

Before diving into the procedure, it's essential to comprehend the key concepts involved in preparing a chemical solution.

What is Molarity?

Molarity (M) indicates the concentration of a solution expressed in moles of solute per liter of solution. For this experiment:
- Desired molarity (M) = 0.020 mol/L
- Final volume = 150 mL = 0.150 L

What is Cobalt(II) Chloride?

Cobalt(II) chloride, with the chemical formula $CoCl_2$, is an inorganic compound used in various laboratory applications, including as a reagent in chemical reactions, in electrochemistry, and as a humidity indicator. It exists as a hydrate or anhydrous form, with the hydrate being more common for laboratory preparations.

Materials Required for Preparing 0.020 M Cobalt(II) Chloride Solution

To prepare the solution accurately, gather the following materials:

1. Pure cobalt(II) chloride ($CoCl_2$), preferably the anhydrous form or hydrate
2. Distilled or deionized water
3. Volumetric flask (150 mL capacity)
4. Analytical balance
5. Weighing boat or paper
6. Spatula or scoop
7. Glass stirring rod
8. Pipette or burette (optional, for transfer accuracy)
9. Safety equipment: gloves, lab coat, safety goggles

Calculating the Required Amount of Cobalt(II) Chloride

Accurate calculation is vital for preparing the correct concentration. Here's how to determine the amount of $CoCl_2$ needed:

Step 1: Calculate Moles of $CoCl_2$ Needed

$$
\text{Moles} = \text{Concentration} \times \text{Volume}
$$
$$
= 0.020\, \text{mol/L} \times 0.150\, \text{L} = 0.003\, \text{mol}
$$

Step 2: Find the Molar Mass of $CoCl_2$

Element	Atomic Mass (g/mol)	Quantity in $CoCl_2$
Cobalt (Co)	58.93	1 atom
Chlorine (Cl)	35.45	2 atoms

Molar mass of $CoCl_2$:
$$
58.93 + (2 \times 35.45) = 58.93 + 70.90 = 129.83\, \text{g/mol}
$$

Step 3: Calculate the Mass of $CoCl_2$ Required

$$
\text{Mass} = \text{Moles} \times \text{Molar mass}
$$
$$
= 0.003\, \text{mol} \times 129.83\, \text{g/mol} \approx 0.3895\, \text{g}
$$

Therefore, approximately 0.39 grams of $CoCl_2$ are needed to prepare 150 mL of a 0.020 M solution.

Step-by-Step Procedure for Solution Preparation

Follow these detailed steps to ensure precise and safe preparation:

1. Safety Precautions

- Wear appropriate personal protective equipment (gloves, goggles, lab coat).
- Handle cobalt(II) chloride in a well-ventilated area or under a fume hood.
- Be aware that cobalt compounds can be toxic; avoid inhalation and ingestion.

2. Weighing the Cobalt(II) Chloride

- Turn on the analytical balance and calibrate if necessary.
- Place a clean weighing boat or paper on the balance.
- Tare the balance to zero.
- Carefully weigh approximately 0.39 grams of $CoCl_2$.
- Transfer the weighed $CoCl_2$ into a clean, dry 150 mL volumetric flask.

3. Dissolving the Cobalt(II) Chloride

- Add a small volume of distilled water (around 50 mL) to the flask containing $CoCl_2$.
- Swirl or gently stir with a glass rod until the solid dissolves completely.
- Ensure the solution is homogeneous.

4. Diluting to Final Volume

- Carefully add distilled water to the flask until the bottom of the meniscus reaches the 150 mL mark.
- Use a pipette or dropper for fine adjustments near the mark.
- Mix thoroughly by gentle inversion or swirling to ensure uniform concentration.

5. Labeling and Storage

- Label the flask with the solution name, concentration, date of preparation, and safety information.
- Store in a cool, dry place or as per laboratory guidelines.

Quality Checks and Final Considerations

Ensuring the accuracy of your prepared solution is critical. Consider the following:

Verification

- Use spectrophotometry or titration methods to verify concentration if necessary.
- Check for any impurities or precipitates before use.

Storage

- Keep the solution away from direct sunlight.
- Use tightly sealed containers to prevent evaporation or contamination.
- Be aware that cobalt(II) chloride solutions can be hygroscopic and may require re-standardization over time.

Disposal

- Dispose of excess cobalt(II) chloride and waste solutions following your institution’s hazardous waste protocols.
- Never pour cobalt compounds down the drain without proper authorization.

Tips for Accurate Solution Preparation

- Always use high-quality distilled or deionized water.
- Calibrate your balance regularly.
- Use volumetric flasks for precise volume measurements.
- Handle chemicals with care to avoid contamination.
- Record all measurements and procedures meticulously.

Conclusion: Mastering Solution Preparation in the Laboratory

Preparing a 150 mL solution of 0.020 M cobalt(II) chloride is a fundamental skill for chemists and laboratory technicians. It combines precise calculations, careful weighing, and meticulous technique to ensure the desired concentration is achieved. By understanding the underlying principles such as molarity, molar mass, and proper laboratory procedures, you can confidently prepare solutions that are accurate, safe, and reliable for your experiments. Remember, attention to detail and adherence to safety protocols are paramount in all laboratory activities involving chemical reagents.

Additional Resources

- Safety Data Sheets (SDS) for cobalt(II) chloride
- Laboratory manuals on solution preparation
- Tutorials on using volumetric flasks and analytical balances
- Standard operating procedures for chemical handling and disposal

Ensuring proper preparation of solutions like cobalt(II) chloride not only enhances experimental accuracy but also promotes safety and efficiency in the laboratory environment.

Frequently Asked Questions

What are the initial steps to prepare 150 mL of a 0.020 M cobalt(II) chloride solution?

First, calculate the amount of cobalt(II) chloride needed using molarity and volume, then weigh out the required amount and dissolve it in a solvent, typically distilled water, to make up to 150 mL.

How do you calculate the mass of cobalt(II) chloride required for the solution?

Use the formula mass = molarity × volume (L) × molar mass. For 0.020 M in 0.150 L, multiply 0.020 mol/L by 0.150 L and then by the molar mass of $CoCl_2$.

What is the molar mass of cobalt(II) chloride ($CoCl_2$)?

The molar mass of $CoCl_2$ is approximately 129.84 g/mol (Co: 58.93 g/mol, Cl: 35.45 g/mol × 2).

How much cobalt(II) chloride should be weighed to prepare

the solution?

Calculate: 0.020 mol/L × 0.150 L = 0.003 mol. Then, 0.003 mol × 129.84 g/mol ≈ 0.389 g. So, weigh out approximately 0.389 grams of $CoCl_2$.

What precautions should be taken while preparing the cobalt(II) chloride solution?

Use clean, dry apparatus; handle chemicals with gloves and eye protection; accurately measure chemicals; and ensure the solution is well mixed.

Can distilled water be used to prepare the solution, and why?

Yes, distilled water is preferred because it is free from impurities that could affect the concentration or reactions during the experiment.

How do you ensure the solution has the correct concentration after preparation?

After dissolving the calculated amount of $CoCl_2$ in less than 150 mL of water, transfer to a volumetric flask and make up to the 150 mL mark with distilled water, ensuring proper mixing.

What are common applications of cobalt(II) chloride solutions in experiments?

Cobalt(II) chloride solutions are often used as humidity indicators, in chemical analysis, and in studies involving coordination chemistry.

What should be done if the solution is not fully dissolved after mixing?

Gently stir or swirl the solution until the cobalt(II) chloride is completely dissolved, ensuring the solution is homogeneous before use.

How should the prepared cobalt(II) chloride solution be stored?

Store the solution in a clean, labeled container, preferably glass, in a cool, dry place away from direct sunlight, and keep it tightly sealed to prevent contamination.

Additional Resources

For An Experiment, You Are Required To Prepare 150 mL Of A 0.020 M Cobalt(II) Chloride Solution From a solid cobalt(II) chloride, this task involves precise measurement, accurate calculation, and careful handling to ensure the solution's concentration and volume meet experimental requirements. Preparing such solutions is fundamental in chemical laboratories, whether for analytical chemistry,

spectroscopy, or other research applications. This article provides a comprehensive guide on how to prepare this specific solution, including the necessary calculations, step-by-step procedures, safety considerations, and tips for ensuring accuracy and reproducibility.

Understanding the Preparation of a Cobalt(II) Chloride Solution

Before diving into the step-by-step process, it's essential to understand the key concepts involved in preparing a solution of a specific molarity and volume.

What is Molarity?

Molarity (M) is a measure of concentration expressed as moles of solute per liter of solution. For example, a 0.020 M cobalt(II) chloride solution contains 0.020 moles of $CoCl_2$ per liter of solution.

Significance of Accurate Dilution

Accurate preparation ensures that the concentration of the solution is precise, which is crucial for the validity and reproducibility of experimental results. Errors in measurement or calculation can lead to incorrect conclusions.

Calculating the Required Mass of Cobalt(II) Chloride

The first step involves calculating how much solid $CoCl_2$ is needed to prepare 150 mL (0.150 L) of a 0.020 M solution.

Step 1: Write Down Known Values

- Desired volume of solution, V = 150 mL = 0.150 L
- Desired molarity, M = 0.020 mol/L
- Molar mass of $CoCl_2$:
- Co: approximately 58.93 g/mol
- Cl: approximately 35.45 g/mol
- Total molar mass of $CoCl_2$ = 58.93 + (2 × 35.45) = 58.93 + 70.90 = 129.83 g/mol

Step 2: Calculate Moles of $CoCl_2$ Needed

Number of moles = M × V = 0.020 mol/L × 0.150 L = 0.003 mol

Step 3: Convert Moles to Mass

Mass of $CoCl_2$ = moles × molar mass = 0.003 mol × 129.83 g/mol ≈ 0.3895 g

Therefore, approximately 0.39 grams of cobalt(II) chloride is required.

Preparing the Solution: Step-by-Step Procedure

Once the calculations are complete, the next phase is the actual preparation of the solution.

Materials Needed

- Solid cobalt(II) chloride (anhydrous or hydrated, depending on the experiment)
- Distilled or deionized water
- Analytical balance
- 150 mL volumetric flask
- Funnel
- Stirring rod or magnetic stirrer
- Pipette or graduated cylinder
- Gloves and safety goggles

Procedure

1. Safety Precautions: Wear gloves and safety goggles to prevent skin and eye contact. Cobalt salts can be toxic, so handle with care and work in a well-ventilated area or fume hood.

2. Weighing the Solid: Using an analytical balance, carefully weigh out approximately 0.39 g of cobalt(II) chloride. For higher accuracy, weigh slightly more and adjust or use the exact calculated mass.

3. Dissolving the Salt: Transfer the weighed salt into a clean beaker or directly into the volumetric flask. Add a small volume of distilled water—around 20-30 mL—to dissolve the salt completely. Stir with a glass rod or use a magnetic stirrer to facilitate dissolution.

4. Transferring to Volumetric Flask: Transfer the solution into a 150 mL volumetric flask using a funnel. Rinse the beaker and stirring rod with distilled water, adding the rinsings to the flask to ensure all salt is transferred.

5. Dilution to Final Volume: Add distilled water gradually until the solution reaches the 150 mL mark on the volumetric flask. Do this carefully to avoid overshooting the mark.

6. Mixing: Stopper the flask and invert several times to ensure thorough mixing of the solution, resulting in uniform concentration.

Safety and Handling Considerations

Handling cobalt salts requires attention to safety due to their toxicity and environmental impact.

Safety Precautions

- Always wear appropriate personal protective equipment, including gloves, lab coat, and goggles.
- Work in a fume hood to avoid inhaling dust or vapors.
- Dispose of cobalt-containing waste according to institutional hazardous waste protocols.
- Avoid ingestion, inhalation, and skin contact.

Storage

- Store cobalt(II) chloride in a tightly sealed container, labeled clearly.
- Keep away from incompatible substances, such as strong oxidizers.

Features and Pros/Cons of the Preparation Process

Features:
- Precise molarity control through accurate calculation and measurement.
- Use of standard laboratory equipment ensures reproducibility.
- Flexibility in scaling the preparation volume based on experimental needs.
- Use of volumetric flasks ensures high accuracy of final volume.

Pros:
- High accuracy in concentration delivery.
- Relatively straightforward and quick process.
- Safe handling procedures minimize risk to personnel.
- Well-established method suitable for various laboratory settings.

Cons:
- Requires precise weighing and measurement tools.
- Cobalt salts are toxic; mishandling can pose health risks.
- Hydrated forms of cobalt chloride may alter calculations slightly; proper identification is essential.
- Potential for contamination if equipment is not cleaned properly.

Additional Tips for Successful Preparation

- Always calibrate your balance regularly for accurate weighing.
- Use high-quality distilled or deionized water to prevent impurities.

- Double-check calculations before weighing to avoid errors.
- Add water gradually when diluting to avoid overshooting the final volume.
- Label the prepared solution clearly with concentration, date, and your initials.
- Store the solution in a properly labeled container away from light and heat if long-term storage is necessary.

Conclusion

Preparing 150 mL of a 0.020 M cobalt(II) chloride solution from solid cobalt(II) chloride involves careful calculation, precise measurement, and meticulous procedure. By understanding the fundamental concepts of molarity, molar mass, and solution preparation, a laboratory technician or student can accurately produce the desired solution for experimental use. Safety considerations are paramount due to the toxicity of cobalt salts, and proper handling and disposal procedures must be followed. The process, while straightforward, emphasizes accuracy and attention to detail, ensuring reproducibility and reliability of the experimental results. With proper technique and safety practices, preparing this solution can be accomplished efficiently and effectively, supporting a wide range of chemical investigations.

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