

A Graduated Cylinder Contains 17.5mL Of Water. When A Metal Cube Is Placed Into The Cylinder, Its Water

A Graduated Cylinder Contains 17.5mL Of Water. When A Metal Cube Is Placed Into The Cylinder, Its Water level changes, providing valuable insights into the principles of volume measurement and density. This fundamental experiment is often used in chemistry and physics to understand how objects displace water and how measurements can be used to determine the properties of materials. In this article, we will explore the process step-by-step, explain key concepts such as water displacement, and discuss how this experiment aids in understanding the characteristics of metals and other solids.

Understanding Water Displacement and Volume Measurement

What Is Water Displacement?

Water displacement is a method used to determine the volume of an irregularly shaped object, like a metal cube, by observing how much water it displaces when submerged. When you place an object into a container of water, the water level rises proportionally to the volume of the object submerged.

The Role of a Graduated Cylinder

A graduated cylinder is a precise measuring instrument designed to measure the volume of liquids accurately. Its narrow shape and marked graduations allow for precise readings. In our scenario, the cylinder initially contains 17.5 mL of water, serving as the baseline measurement.

Measuring Volume Changes

When the metal cube is submerged, the water level increases. The difference between the initial water level and the new level indicates the volume of the cube. For example, if the water level rises from 17.5 mL to 25.0 mL, then the volume of the metal cube is $25.0 \text{ mL} - 17.5 \text{ mL} = 7.5 \text{ mL}$.

The Step-by-Step Process of the Water

Displacement Method

Preparing the Equipment

To perform this measurement accurately, ensure you have:

- A clean graduated cylinder
- Distilled water
- A metal cube with a known or unknown volume
- Forceps or gloves to handle the metal cube

Initial Water Measurement

- Fill the graduated cylinder with enough water to cover the metal cube when submerged.
- Record the initial water level, which in this case is 17.5 mL.

Placing the Metal Cube

- Carefully lower the metal cube into the water using forceps or gloves, avoiding splashing that could affect measurements.
- Ensure the cube is fully submerged, but does not touch the sides or bottom of the cylinder excessively, to avoid measurement errors.

Recording the Final Water Level

- Observe and record the new water level after the cube is submerged. Suppose it reads 23.0 mL.
- Calculate the difference: $23.0 \text{ mL} - 17.5 \text{ mL} = 5.5 \text{ mL}$.
- This difference represents the volume of the metal cube.

Calculating the Density of the Metal

If the mass of the metal cube is known, you can determine its density:

- $\text{Density} = \text{Mass} / \text{Volume}$

For example, if the cube weighs 45 grams:

$\text{Density} = 45 \text{ g} / 5.5 \text{ mL} \approx 8.18 \text{ g/mL}$

This value can help identify the metal or assess its purity.

Understanding the Significance of Water Displacement in Science

Applications in Material Identification

By measuring the volume and mass of a metal, scientists can calculate its density, which is characteristic of specific materials. For example:

- Aluminum has a density of approximately 2.70 g/mL
- Copper has a density of about 8.96 g/mL
- Iron's density is roughly 7.87 g/mL

Comparing calculated density to known values helps identify unknown metals.

Determining Object Density for Quality Control

Manufacturers use water displacement to verify the density of metal products, ensuring they meet specifications. Deviations may indicate impurities or material flaws.

Understanding Archimedes' Principle

The water displacement method is a practical application of Archimedes' principle, which states that an object submerged in a fluid experiences an upward buoyant force equal to the weight of the displaced fluid.

Factors Affecting Accuracy in Water Displacement Measurements

Proper Technique

- Always read the water level at eye level to avoid parallax errors.
- Use distilled water to prevent impurities that could affect readings.
- Ensure the metal cube is fully submerged without touching the sides or bottom of the cylinder.

Instrument Calibration

- Verify that the graduated cylinder is clean and free from residue.

- Use a cylinder with fine graduation marks for more precise measurements.

Environmental Conditions

- Conduct measurements in a stable environment to avoid water splashing or evaporation.
- Avoid air bubbles sticking to the cube, which can affect volume readings.

Real-World Examples of Water Displacement Applications

Archaeology and Artifact Analysis

Scientists use water displacement to determine the volume of ancient artifacts, helping estimate their size and weight.

Environmental Monitoring

Researchers measure the volume of water displaced by debris or organisms to study ecological impacts.

Education and Demonstration

Water displacement experiments are common in classrooms to teach students about density, volume, and the scientific method.

Conclusion: The Importance of Water Displacement in Scientific Measurement

The simple act of placing a metal cube into a graduated cylinder containing 17.5 mL of water exemplifies foundational scientific principles. By observing how water levels rise, scientists and students alike can determine the volume of irregular objects accurately. This method not only facilitates understanding of material properties such as density but also plays an essential role in various scientific fields, including chemistry, physics, archaeology, and environmental science. Mastering water displacement techniques enhances precision in measurement and fosters a deeper appreciation for the fundamental laws governing matter and volume.

Whether identifying unknown metals, verifying manufacturing standards, or conducting educational demonstrations, the principle that a submerged object displaces an amount of water equal to its volume remains a cornerstone of scientific inquiry.

Frequently Asked Questions

What happens to the water level in the graduated cylinder when a metal cube is submerged?

The water level rises because the metal cube displaces an amount of water equal to its volume.

How can you determine the volume of the metal cube using the graduated cylinder?

Subtract the initial water level (17.5 mL) from the new water level after submerging the cube; the difference is the volume of the cube.

If the water level increases to 22.0 mL after placing the metal cube, what is the volume of the cube?

The volume of the cube is $22.0 \text{ mL} - 17.5 \text{ mL} = 4.5 \text{ mL}$.

Why does the water level in the graduated cylinder rise when the metal cube is added?

Because the metal cube displaces a volume of water equal to its own volume, causing the water level to increase.

Can the density of the metal be calculated from this experiment? If so, how?

Yes, by measuring the mass of the metal cube and its volume (determined from water displacement), the density can be calculated using $\text{density} = \text{mass}/\text{volume}$.

What precautions should be taken when measuring water displacement with a graduated cylinder?

Ensure the cylinder is on a level surface, read the water level at eye level to avoid parallax error, and avoid splashing to get an accurate measurement.

Additional Resources

A Graduated Cylinder Contains 17.5mL Of Water. When A Metal Cube Is Placed Into The Cylinder, Its Water

Introduction

In the realm of experimental science, understanding the principles of displacement and volume measurement is fundamental. One of the simplest yet most revealing experiments involves observing how the water level in a graduated cylinder changes when an object—particularly a metal cube—is submerged. This process not only demonstrates the concept of displacement but also provides insights into the density and physical properties of the material involved.

This article delves into the investigative process of measuring the volume of a metal cube via water displacement, focusing on the scenario where a graduated cylinder contains 17.5mL of water, and when a metal cube is placed into the cylinder, its water level shifts. Through detailed analysis, experimental procedures, and interpretation of results, we aim to clarify the significance of this phenomenon and its applications in scientific measurement and material characterization.

Background and Theoretical Foundations

The Principle of Water Displacement

The core principle underlying this experiment is Archimedes' principle, which states that an object submerged in a fluid experiences an upward buoyant force equal to the weight of the displaced fluid. When a solid object is immersed in water, it displaces a volume of water equivalent to its own volume.

Mathematically:

Volume of the object (V_{object}) = Volume of displaced water

In the context of a graduated cylinder:

- Initial water level: (V_{initial})
- Final water level after submersion: (V_{final})
- Volume of the object: $(V_{\text{object}} = V_{\text{final}} - V_{\text{initial}})$

This straightforward measurement allows for precise determination of the volume of irregularly shaped objects, provided the water displacement is accurately recorded.

Significance in Scientific Measurement

Understanding the displacement method is crucial in fields such as materials science, chemistry, and physics, especially for objects with irregular shapes where direct measurement of volume is challenging. Furthermore, combined with

mass measurements, this technique enables the calculation of density—a key property that helps identify materials and assess their purity.

Experimental Setup and Methodology

Materials Required

- Graduated cylinder (preferably with fine graduation marks)
- Metal cube (known or unknown material)
- Water (distilled preferred for accuracy)
- Analytical balance (for mass measurement)
- Tongs or gloves (to handle the metal cube safely)
- Ruler or caliper (optional, for measuring cube dimensions)

Step-by-Step Procedure

1. Preparation:

- Ensure the graduated cylinder is clean and dry.
- Fill the cylinder with water until the level reaches exactly 17.5mL.
- Record the initial water level precisely.

2. Measurement of the Metal Cube:

- Weigh the metal cube using the analytical balance, recording its mass.
- Optionally, measure the cube's dimensions with a ruler or caliper to determine its theoretical volume (if shape and dimensions are known).

3. Submersion:

- Using tongs or gloves, carefully immerse the metal cube into the water in the graduated cylinder.
- Ensure the cube is fully submerged without touching the sides or bottom of the cylinder to avoid measurement errors.
- Observe the new water level and record it accurately.

4. Data Collection:

- Note the change in water level: $\Delta V = V_{\text{final}} - V_{\text{initial}}$.
- Calculate the volume of the cube based on this displacement.

5. Analysis:

- Calculate the density of the metal:

$$\text{Density} = \frac{\text{Mass of the cube}}{\text{Volume of displaced water}}$$

- Compare the calculated density with known values to identify the material.

Observations and Results

Suppose the initial water level was 17.5mL, and upon placing the metal cube, the water level rose to 19.2mL. The change in water level:

$$V_{\text{displaced}} = 19.2\text{ mL} - 17.5\text{ mL} = 1.7\text{ mL}$$

If the mass of the cube measured on the balance was 4.25 grams, then:

$$\text{Density} = \frac{4.25\text{ g}}{1.7\text{ mL}} \approx 2.5\text{ g/mL}$$

This density suggests that the metal is likely aluminum, which has a known density of approximately 2.7 g/mL, indicating a close match considering experimental uncertainties.

Deep Dive: Factors Affecting Accuracy

Precise water displacement measurements hinge on several factors:

- Water Temperature: Changes in temperature affect water density and volume. Using distilled water at room temperature (~20°C) minimizes errors.
- Meniscus Reading: Reading the water level at eye level and noting the bottom of the meniscus ensures accurate readings.
- Cube Handling: Ensuring the cube is fully submerged without trapping air bubbles is vital, as bubbles can lead to underestimation of volume.
- Cylinder Calibration: Confirm that the graduated cylinder's markings are accurate; calibration errors can skew results.
- Object Shape and Surface: Irregular surfaces or rough textures may trap air or cause incomplete immersion.

Applications and Implications

Material Identification and Quality Control

By determining the density of unknown metal samples through water displacement, scientists can identify materials or verify purity standards. For instance, in manufacturing, verifying the density can confirm if a metal cube meets specifications.

Educational Demonstrations

This experiment offers a tangible demonstration of fundamental physics principles, making it a staple in educational laboratories to teach students about displacement, measurement, and density.

Scientific Research

In research settings, displacement techniques facilitate the study of novel materials, composites, or irregularly shaped objects where traditional volume measurement methods are impractical.

Limitations and Considerations

While water displacement is a powerful technique, it is not without limitations:

- Air Bubbles: Trapped air can cause underestimation of displaced volume.
- Water Absorption or Surface Tension Effects: These can slightly alter measurements.
- Material Compatibility: Some materials may react with water or swell, affecting results.

Researchers should account for these factors by conducting multiple trials, calibrating equipment, and following rigorous protocols.

Conclusion

The simple act of placing a metal cube into a graduated cylinder containing 17.5mL of water exemplifies fundamental scientific principles with broad applications. Through careful measurement of the water level change, researchers can determine the volume of the cube, and when combined with mass data, calculate its density. This process underscores the importance of displacement methods in physical science, providing insights into material properties and experimental accuracy.

In practical terms, such experiments not only reinforce theoretical concepts but also serve as foundational techniques in materials analysis, quality control, and educational instruction. As science continues to evolve, the principles demonstrated in this straightforward experiment remain as relevant as ever, illustrating the enduring value of precision, observation, and critical analysis in scientific inquiry.

A Graduated Cylinder Contains 17 5ml Of Water When A Metal Cube Is Placed Into The Cylinder Its Water

A Graduated Cylinder Contains 17 5ml Of Water When A Metal Cube Is Placed Into The Cylinder Its Water

Related Articles

- [At A Certain Frequency Range Sea Water Has The Following Parameters \$\epsilon_r=72\$, \$\sigma=4S/m\$. A Uniform Plane](#)
- [According To Research On Group Polarization, People Who Make Decisions In Groups Tend To Make Decisions](#)
- [A\) Find The First And Third Quartiles, And The Median For Length. Remember To Consider The Frequencies.](#)

[Back to Home](#)