

What Is The Density Of The Object That Has A Mass 13.87g And A Volume Of 31.75cm³?

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Understanding the concept of density is fundamental in physics and chemistry, especially when analyzing materials and their properties. In this article, we will explore how to determine the density of an object with a given mass and volume, specifically an object with a mass of 13.87 grams and a volume of 31.75 cubic centimeters. We will discuss the formula involved, the steps to calculate density, and the significance of density in various scientific and practical contexts.

What Is Density?

Density is a physical property that describes how much mass is contained within a specific volume of a substance. It is a measure of compactness or concentration of matter in an object. The higher the density, the more mass is packed into a given volume; conversely, lower density indicates a less compact object.

Definition and Importance of Density

- Definition: Density (symbol: ρ or D) is mathematically expressed as:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

- Units of Density: Common units include grams per cubic centimeter (g/cm³), kilograms per cubic meter (kg/m³), and grams per liter (g/L).

- Why Is Density Important?
- Identifies materials based on their density values.
- Helps in identifying unknown substances.
- Essential in designing objects and understanding buoyancy.
- Used in engineering, construction, and material science.

Calculating Density: The Formula and Steps

To find the density of an object, you need two key pieces of information: the mass and volume. The basic formula is straightforward:

$$\boxed{\text{Density} = \frac{\text{Mass}}{\text{Volume}}}$$

Where:

- Mass is the amount of matter in the object.
- Volume is the amount of space the object occupies.

Step-by-Step Calculation

Given data:

- Mass = 13.87 grams
- Volume = 31.75 cm³

Step 1: Insert the values into the formula:

$$\text{Density} = \frac{13.87 \text{ g}}{31.75 \text{ cm}^3}$$

Step 2: Perform the division:

$$\text{Density} = 0.4366 \text{ g/cm}^3$$

Step 3: Round the result to an appropriate number of significant figures. Since the given data has four significant figures, the density should also be expressed with four:

$$\boxed{\text{Density} \approx 0.4366 \text{ g/cm}^3}$$

Final Result:

The density of the object is approximately 0.4366 g/cm³.

Understanding the Result

The calculated density provides valuable information:

- The object has a density of about 0.4366 g/cm^3 .
- This value suggests the material's compactness; for comparison, water has a density of 1 g/cm^3 .
- Therefore, this object is less dense than water and would likely float if placed in water.

Implications of the Density Value

- Material Identification:

If you know the density of common materials, you can compare and potentially identify the substance of the object. For example, if a material's density is close to 0.44 g/cm^3 , it could be a type of plastic or foam.

- Buoyancy and Floatation:

Since the density is less than water, the object would float, which is useful in designing ships, boats, or floating devices.

- Quality Control:

In manufacturing, density measurements help ensure materials meet specifications for strength, durability, or weight.

Factors Affecting Density Measurements

While calculating density appears straightforward, several factors can influence the accuracy of measurements:

Measurement Accuracy

- Precise measurement of mass using a calibrated scale.
- Accurate volume determination, especially for irregular shapes, using methods like water displacement.

Material Homogeneity

- Uniformly composed materials yield consistent density values.
- Heterogeneous objects may have variable density throughout.

Environmental Conditions

- Temperature and pressure can affect material density slightly.
- For precise scientific work, measurements should be taken under controlled conditions.

Additional Considerations in Density Calculations

Converting Units

Sometimes, measurements are provided in different units, requiring conversions before calculation. For example:

- Mass in kilograms (kg) and volume in liters (L), where:

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\[
1\, \text{kg} = 1000\, \text{g}
\]
```

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\[
1\, \text{L} = 1000\, \text{cm}^3
\]
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Calculating Density of Irregularly Shaped Objects

- Use water displacement method: submerge the object in water and measure the volume of water displaced.
- Ensure no air bubbles cling to the object, as they can affect the volume reading.

Practical Applications of Density Calculation

Understanding how to calculate density has numerous practical applications across various fields:

Material Science and Engineering

- Selecting appropriate materials based on their density for specific applications.
- Designing lightweight yet strong components.

Geology and Earth Sciences

- Determining mineral compositions.
- Assessing rock and soil densities to understand geological formations.

Medicine

- Calculating body mass index (BMI) and body composition.
- Using density in imaging techniques like MRI.

Environmental Science

- Monitoring pollution by analyzing the density of pollutants in water or air samples.
- Assessing the buoyancy of pollutants or particles.

Summary

In conclusion, the density of an object with a mass of 13.87 grams and a volume of 31.75 cm³ is approximately 0.4366 g/cm³. This simple yet crucial calculation involves dividing the mass by the volume, providing insights into the material's properties and behavior. Whether you're a student, scientist, engineer, or hobbyist, understanding how to compute and interpret density is essential in analyzing materials and their applications effectively.

Key Takeaways

- Density is a measure of how much mass is packed into a given volume.
- The formula for density is straightforward: $\text{Density} = \frac{\text{Mass}}{\text{Volume}}$.
- For the given data, the density is approximately 0.4366 g/cm³.
- Density informs about material identification, buoyancy, and quality control.
- Accurate measurements and consideration of environmental factors are vital for precise density calculations.

By mastering the concept and calculation of density, you can better understand the physical properties of objects and materials in various scientific and practical contexts.

Frequently Asked Questions

How do you calculate the density of an object with a given mass and volume?

Density is calculated by dividing the mass of the object by its volume:
 $\text{Density} = \text{Mass} / \text{Volume}$.

What is the formula used to find the density of an object?

The formula is $\text{Density} = \text{Mass (g)} / \text{Volume (cm}^3\text{)}$.

Given a mass of 13.87g and a volume of 31.75cm³, what is the object's density?

The density is approximately 0.436 g/cm³, calculated as 13.87 g divided by 31.75 cm³.

Why is knowing the density of an object important in science?

Density helps identify materials, determine buoyancy, and understand an object's properties in scientific studies.

What units are typically used to express density?

Density is commonly expressed in grams per cubic centimeter (g/cm³) or kilograms per cubic meter (kg/m³).

Can the density of an object tell us if it will float or sink in water?

Yes, if the object's density is less than water's density (about 1 g/cm³), it will float; otherwise, it will sink.

Is density affected by temperature or pressure?

Yes, changes in temperature and pressure can affect an object's density by causing expansion or compression.

How precise is the calculation of density when using measured values?

The precision depends on the accuracy of the mass and volume measurements; errors can affect the calculated density.

What practical applications rely on knowing an object's density?

Applications include material identification, quality control, designing ships and aircraft, and environmental studies.

If the mass of an object increases but volume stays the same, what happens to its density?

The density increases because the numerator (mass) increases while the volume remains constant.

Additional Resources

Density: The Key to Understanding Material Composition and Properties

When delving into the physical characteristics of materials, one of the most fundamental and insightful properties to examine is density. It provides critical information about how tightly matter is packed within an object, influencing everything from buoyancy to strength, and even material identification. Today, we will explore the concept of density through a practical example involving an object with a known mass and volume. Specifically, we'll determine the density of an object that has a mass of 13.87 grams and a volume of 31.75 cubic centimeters. This in-depth analysis aims not just to compute a value but to shed light on what it signifies and how it can be applied across various fields.

Understanding Density: Definition and Significance

Density is defined as the mass of an object divided by its volume. It is expressed mathematically as:

$$\rho = \frac{m}{V}$$

Where:

- ρ represents the density,
- m is the mass,
- V is the volume.

Units of Density: The SI unit of density is kilograms per cubic meter (kg/m^3), but in practical applications, especially in laboratory settings and materials science, grams per cubic centimeter (g/cm^3) or grams per milliliter (g/mL) are more common.

Why is density important?

- **Material Identification:** Different materials have characteristic densities (e.g., gold $\sim 19.3 \text{ g/cm}^3$, aluminum $\sim 2.7 \text{ g/cm}^3$), making density a useful property for identifying unknown substances.
- **Buoyancy and Archimedes' Principle:** Density determines whether an object floats or sinks in a fluid.
- **Mechanical and Structural Properties:** Density influences strength, durability, and weight of materials.

- Quality Control: Consistency in density indicates manufacturing precision and purity.

Calculating the Density of the Object

Now, let's execute the calculation based on the provided data:

- Mass (m): 13.87 grams
- Volume (V): 31.75 cubic centimeters

Applying the formula:

$$\rho = \frac{m}{V}$$

$$\rho = \frac{13.87 \text{ g}}{31.75 \text{ cm}^3}$$

Carrying out the division:

$$\rho \approx 0.4368 \text{ g/cm}^3$$

Rounding to a reasonable degree of precision:

$$\boxed{\rho \approx 0.437 \text{ g/cm}^3}$$

Interpretation of the Result

This density value indicates that the object's material is relatively lightweight compared to many metals—consider, for example, that water has a density of 1 g/cm³, and many metals are significantly denser.

Implications and Context of the Density Measurement

Understanding this density's implications involves examining several factors:

1. Material Identification

The computed density (~0.437 g/cm³) suggests the object is composed of a material less dense than water, which is 1 g/cm³. Materials with such low densities are often:

- Polymers or plastics: Many plastics have densities in the range of 0.9 to 1.4 g/cm³, but some lightweight plastics and foams fall below this.
- Foams or porous materials: These often have densities well below 1 g/cm³ due to air pockets.
- Certain organic materials or composites: Some organic substances or composites can have densities around this range.

Example: Styrofoam has a density approximately 0.05–0.2 g/cm³, but some lightweight plastics can reach closer to 0.5 g/cm³.

2. Comparative Analysis

By comparing the calculated density to known materials, one might narrow down the possibilities:

Material Type	Typical Density (g/cm³)	Notes
Water	1.00	N/A
Light plastics (e.g., Polyethylene)	0.91–0.94	Slightly higher than our object
Polystyrene (Styrofoam)	0.05–0.1	Much lower than our object
Lightweight foams	0.03–0.2	Usually lower density
Organic or biological materials	1.0–1.5	Higher than our object

Given that the density is approximately 0.437 g/cm³, the object could be made of a lightweight plastic, certain foams, or a composite material designed for low weight.

3. Practical Applications

Understanding such a low density has practical significance:

- Design and Engineering: For lightweight structures, materials with low density are preferred.
- Packaging and Insulation: Materials with low density often serve as insulators or protective packaging.
- Environmental Considerations: Low-density materials may be biodegradable or eco-friendly, depending on composition.

Additional Factors to Consider

While the calculation appears straightforward, real-world applications demand attention to several nuances:

1. Measurement Accuracy

- Mass Measurement: Using a precise scale is essential. Small errors can significantly impact density calculations.
- Volume Measurement: Accurate volume determination is critical. Methods include water displacement for irregular objects or geometric calculations for regular shapes.

2. Material Homogeneity

- Variations within the object, such as internal porosity or density gradients, can influence the overall density measurement.
- For porous or composite materials, the measured density might reflect an average, not the true density of the solid material itself.

3. Temperature and Environmental Conditions

- Density can vary with temperature, especially for polymers and liquids.
- Ensuring measurements are taken under controlled conditions improves reliability.

Conclusion: The Significance of the Density Value

The calculated density of approximately 0.437 g/cm^3 provides a window into the nature of the object's material composition. It indicates a lightweight, possibly polymeric or foam-like substance, offering insights into its potential uses and properties.

Understanding density isn't just an academic exercise; it's a practical tool that empowers engineers, scientists, and manufacturers to:

- Identify unknown materials
- Optimize designs for weight and strength

- Ensure quality and consistency
- Make environmentally conscious choices

In this case, the object's low density suggests applications where lightness is prized, such as packaging, insulation, or lightweight structural components. It exemplifies how a simple calculation can open pathways to deeper understanding and informed decision-making across diverse industries.

Final Thoughts: Whether you're a student, a scientist, or an industry professional, mastering the concept of density and its calculations offers a foundational skill that enhances your analytical capabilities. Remember, behind every numerical value lies a story about the material's structure, purpose, and potential.

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