

A Cube Of Metal Has A Mass Of 0.347 Kg And Measures 3.21 Cm On A Side. Calculate The Density And Identify

A Cube Of Metal Has A Mass Of 0.347 Kg And Measures 3.21 Cm On A Side. Calculate The Density And Identify

Understanding the properties of materials is fundamental in physics and engineering. When analyzing a metal cube, one of the crucial parameters is its density, which helps identify the material and assess its applications. In this comprehensive guide, we will explore how to calculate the density of a metal cube with given measurements and mass, and how to use this information to identify the type of metal. This article is designed to provide a detailed step-by-step process, insights into the significance of density, and practical tips for students, educators, and professionals alike.

What Is Density and Why Is It Important?

Definition of Density

Density is a physical property of matter defined as the mass of an object per unit volume. Mathematically, it is expressed as:

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

where:

- ρ is the density, typically measured in grams per cubic centimeter (g/cm³) or kilograms per cubic meter (kg/m³).
- m is the mass of the object.
- V is the volume of the object.

Significance of Density in Material Identification

Density serves as a fingerprint for materials. Different metals have characteristic density ranges, making it a valuable property for:

- Material identification
- Quality control
- Engineering design
- Scientific research

By calculating the density of a cube, we can compare it with standard values of known metals to help identify the material.

Given Data and Objective

Before we proceed with calculations, let's clearly state the known data:

- Mass of the metal cube, $(m = 0.347, \text{kg})$
- Side length of the cube, $(s = 3.21, \text{cm})$

Our objectives are:

1. Convert all measurements to consistent units.
2. Calculate the volume of the cube.
3. Determine the density.
4. Use the density to identify the metal.

Step-by-Step Calculation of Density

Step 1: Convert Units to Consistent Measurements

Since the mass is given in kilograms and the length in centimeters, it is practical to convert all measurements to SI units:

- Mass: $(0.347, \text{kg})$ (already in SI units)
- Length: $(3.21, \text{cm})$

Convert length from centimeters to meters:

$$1, \text{cm} = 0.01, \text{m}$$

$$s = 3.21, \text{cm} \times 0.01 = 0.0321, \text{m}$$

Step 2: Calculate the Volume of the Cube

The volume of a cube is given by:

$$V = s^3$$

Substitute the value:

$$V = (0.0321, \text{m})^3$$

$$V = 0.0321^3, \text{m}^3$$

Calculating:

$$V = 0.0321 \times 0.0321 \times 0.0321$$

$$V \approx 3.30 \times 10^{-5}, \text{m}^3$$

Step 3: Calculate the Density

Using the formula:

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

Substitute the known values:

$$\rho = \frac{0.347 \text{ kg}}{3.30 \times 10^{-5} \text{ m}^3}$$
$$\rho \approx 10,515.15 \text{ kg/m}^3$$

To express this in g/cm³ (which is common for metals):

- Recall that:

$$1 \text{ kg/m}^3 = 0.001 \text{ g/cm}^3$$

Thus:

$$\rho \approx 10,515.15 \text{ kg/m}^3 \times 0.001 = 10.52 \text{ g/cm}^3$$

Interpreting the Density: Identifying the Metal

With the calculated density of approximately 10.52 g/cm³, we can compare this value with standard densities of common metals:

Metal	Typical Density (g/cm ³)
Aluminum	2.70
Copper	8.96
Iron	7.87
Nickel	8.90
Zinc	7.13
Silver	10.49
Gold	19.32
Lead	11.34

From this comparison, the density of approximately 10.52 g/cm³ closely matches that of silver.

Conclusion:

Based on the density calculation, the metal cube is most likely silver or a silver alloy. This identification is made considering the typical density range and the proximity of the calculated value to the known density of silver.

Additional Considerations and Practical Tips

Factors Affecting Density Calculations

- Measurement accuracy: Precise measurements of mass and dimensions are crucial.
- Material purity: Alloys or impure metals can alter the density.
- Temperature effects: Density can vary with temperature, so measurements should be taken under controlled conditions.

Applications of Density Calculation

- Material verification: Confirm if a metal is genuine silver.
- Quality assessment: Detect counterfeit or impure metals.
- Design specifications: Ensure materials meet required density standards for engineering applications.

Summary of Key Points

- Convert all measurements to SI units for consistency.
- Calculate volume using the cube's side length.
- Use the formula $\rho = \frac{m}{V}$ to find density.
- Compare the computed density with standard values to identify the material.
- Recognize the significance of density in material science and engineering.

Final Thoughts

Calculating the density of a metal cube provides valuable insights into the material's identity and properties. This process combines fundamental physics principles with practical measurement skills. Whether you're a student learning about material properties, an engineer verifying material authenticity, or a hobbyist exploring metals, understanding how to determine density is a vital tool in your toolkit. Remember that precision and attention to detail are key to accurate identification and analysis.

If you wish to explore further, consider investigating how to measure density using other methods, such as water displacement for irregular objects, or how density varies with temperature and alloy composition. Mastery of these concepts enhances your understanding of the material world and supports various scientific and industrial endeavors.

Frequently Asked Questions

How do you calculate the density of a metal cube given its mass and side length?

Density is calculated by dividing the mass of the cube by its volume. First, find the volume by cubing the side length ($V = \text{side}^3$). Then, divide the mass by this volume to get the density ($\text{Density} = \text{mass} / \text{volume}$).

What is the volume of a cube with a side length of 3.21 cm?

The volume is calculated as $3.21 \text{ cm} \times 3.21 \text{ cm} \times 3.21 \text{ cm}$, which equals approximately 32.97 cubic centimeters.

Given a mass of 0.347 kg and a volume of approximately 32.97 cm³, what is the density of the metal cube?

Convert mass to grams (0.347 kg = 347 g). Then, density = 347 g / 32.97 cm³ ≈ 10.52 g/cm³.

Based on the calculated density of approximately 10.52 g/cm³, which metal could the cube be made of?

A density of around 10.52 g/cm³ suggests the cube could be made of aluminum, which has a density of about 2.7 g/cm³, or steel (~7.85 g/cm³), but since the value is higher, it may be a denser alloy or metal like copper (~8.96 g/cm³). Further identification requires comparison with known densities.

Why is it important to convert the mass to grams when calculating density in g/cm³?

Because the volume is in cubic centimeters (cm³), and density in g/cm³ requires mass in grams to maintain consistent units, ensuring accurate calculation.

What are the steps to identify the metal of the cube based on its calculated density?

First, calculate the density using the given mass and volume. Then, compare the calculated density with standard densities of known metals to identify the material. Additional tests may be needed for confirmation.

Additional Resources

A Cube Of Metal Has A Mass Of 0.347 Kg And Measures 3.21 Cm On A Side. Calculate The Density And Identify is a classic physics and materials science problem that combines fundamental concepts such as volume, mass, and density. This type of problem is common in introductory science courses and serves as a practical application of the formula for density, allowing students and professionals alike to understand material properties and identify unknown substances based on their physical characteristics.

In this comprehensive guide, we will walk through the step-by-step process of calculating the density of the metal cube and then explore how to identify the material based on that calculated density. Whether you're a student preparing for exams or an educator guiding learners, this detailed analysis aims to clarify each step and provide insights into the reasoning behind the calculations.

Understanding the Problem

The problem provides three key pieces of information:

- Mass of the cube: 0.347 kg
- Side length of the cube: 3.21 cm

- Objective: Calculate the density of the cube and identify the material based on known density values.

Before diving into calculations, it's essential to understand what density is and why it matters.

What Is Density?

Density is a physical property that measures how much mass is contained within a given volume. It is expressed mathematically as:

$$\rho = \frac{\text{Mass (m)}}{\text{Volume (V)}}$$

The units of density depend on the units used for mass and volume. Common units include:

- Kilograms per cubic meter (kg/m^3)
- Grams per cubic centimeter (g/cm^3)
- Grams per milliliter (g/mL)

In this problem, the given measurements are in kilograms and centimeters, so we'll initially calculate density in kg/cm^3 and then convert to more standard units like g/cm^3 .

Step 1: Calculating the Volume of the Cube

Since the object is a cube, its volume can be found using:

$$V = \text{side length}^3$$

Given:

- Side length, $s = 3.21 \text{ cm}$

Calculate:

$$V = (3.21 \text{ cm})^3$$

$$V = 3.21 \text{ cm} \times 3.21 \text{ cm} \times 3.21 \text{ cm}$$

Let's perform this calculation explicitly:

- $3.21 \times 3.21 = 10.3041$
- $10.3041 \times 3.21 \approx 33.055$

Thus,

$$V \approx 33.055 \text{ cm}^3$$

Step 2: Convert Mass to Appropriate Units

The mass is given as 0.347 kg. Since 1 kg = 1000 g, converting to grams makes sense for easier comparison with typical density values:

$$m = 0.347 \text{ kg} \times 1000 \frac{\text{g}}{\text{kg}} = 347 \text{ g}$$

Step 3: Calculate Density in g/cm³

Using the formula:

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

Substitute known values:

$$\rho = \frac{347 \text{ g}}{33.055 \text{ cm}^3}$$

Perform the division:

$$\rho \approx 10.49 \text{ g/cm}^3$$

Therefore, the density of the metal cube is approximately 10.49 g/cm³.

Step 4: Interpreting the Result — Identifying the Material

With the calculated density in hand, the next step is to compare this value to known densities of common metals and materials. Here are some typical densities:

Material	Density (g/cm ³)
Aluminum	2.70
Copper	8.96
Iron	7.87
Steel (varies)	7.85 - 8.05
Lead	11.34
Gold	19.32
Silver	10.49
Brass	8.4 - 8.7
Titanium	4.50

Comparing the calculated density (~10.49 g/cm³) to this table, it closely matches the density of silver.

Additional Considerations

While the calculated density suggests the cube is made of silver, a few factors are worth considering:

- Purity: Real-world metals may have impurities affecting density.
- Measurement Accuracy: Slight errors in measurement can influence the calculated density.
- Material Variability: Some alloys or composite materials could have similar densities.

In the context of a typical physics problem, the close match to silver's density strongly indicates that the cube is likely made of silver or a silver alloy.

Summary of the Calculation Process

Here's a quick recap of the steps involved:

1. Identify known quantities: Mass and side length.
2. Calculate volume: Cube of side length.
3. Convert units: Mass from kg to g for easier comparison.
4. Calculate density: Divide mass by volume.
5. Compare to known densities: Use reference data to identify the material.

Final Thoughts

Understanding how to calculate density and utilize it for material identification is a fundamental skill in physics and materials science. This problem demonstrates the importance of precise measurements and unit conversions, as well as the practical application of theoretical formulas.

By mastering these steps, you can analyze various objects, determine their properties, and even identify unknown materials based solely on their physical characteristics. Whether in a laboratory setting or an academic exam, the ability to perform these calculations accurately and interpret the results is invaluable.

Additional Practice Tips

- Always double-check your measurements and conversions.
- Keep a reference table of common material densities handy.
- Practice with different shapes—cylinders, spheres—and their volume formulas.
- Explore how density varies with temperature and pressure for advanced understanding.

In conclusion, this comprehensive guide has shown how to efficiently calculate the density of a metal cube and how to interpret that data to identify the material. Armed with these skills, you can confidently approach similar problems and deepen your understanding of material properties.

A Cube Of Metal Has A Mass Of 0.347 Kg And Measures 3.21 Cm On A Side Calculate The Density And Identify

A Cube Of Metal Has A Mass Of 0.347 Kg And Measures 3.21 Cm On A Side Calculate The Density And Identify

Related Articles

- [For 6 Consecutive Days, Alejandro Studied For 5 Minutes More Each Day Than He Did The Previous Day. Which](#)
- [Choose One \(or Possibly Two\) Pivotal Scenes That Focus On Our Protagonist, Beowulf. If Beowulf Represents](#)
- [Calculate The PH Change That Results When 13 ML Of 2.4 M HCl Is Added To 600. ML Of Each Of The Following](#)

[Back to Home](#)