A Piece Of Iron Has A Density Of 7.86 G/cm3 And A Mass Of 1.09 X 10^-1 Kg. Calculate The Volume Of The

A Piece Of Iron Has A Density Of 7.86 G/cm3 And A Mass Of 1.09 X 10-1 Kg. Calculate The Volume Of The

Understanding the Problem

In this article, we will explore how to determine the volume of a piece of iron given its density and mass. This is a common problem in physics and materials science, where understanding the relationship between mass, volume, and density is essential.

The key data provided:
- Density of iron: 7.86 g/cm3
- Mass of the iron piece: 1.09 × 10-1 Kg

Our goal is to calculate the volume of this iron piece, expressed in cubic centimeters (cm3).

Fundamental Concepts

Before proceeding with the calculation, let's review some fundamental concepts:

Density

Density is defined as the mass of a substance per unit volume:
$$ \text{Density} (\rho) = \frac{\text{Mass} (m)}{\text{Volume} (V)} $$

- The SI unit of density is kilograms per cubic meter (kg/m3).
- In the context of this problem, the density is given in grams per cubic centimeter (g/cm3).

Mass

Mass is the amount of matter in an object, typically measured in grams (g) or kilograms (kg).

Converting Units

When performing calculations, it’s important to ensure that units are compatible:
- Convert mass from kilograms to grams.
- Use the density units in g/cm3.

Step-by-Step Calculation

Step 1: Convert Mass to Grams

Given:
$$ m = 1.09 \times 10^{-1} \text{ Kg} $$

Since 1 kg = 1000 g:
$$ m = 1.09 \times 10^{-1} \text{ kg} \times 1000 \frac{\text{g}}{\text{kg}} = 109 \text{ g} $$

Step 2: Recall the Density

Given:
$$ \rho = 7.86 \text{ g/cm}^3 $$

Step 3: Use the Density Formula to Find Volume

Rearranged formula:
$$ V = \frac{m}{\rho} $$

Plug in the known values:
$$ V = \frac{109 \text{ g}}{7.86 \text{ g/cm}^3} $$

Calculate:
$$ V \approx \frac{109}{7.86} \text{ cm}^3 $$

Using a calculator:
$$ V \approx 13.86 \text{ cm}^3 $$

Thus, the volume of the iron piece is approximately 13.86 cubic centimeters.

Additional Insights and Applications

Why Is Calculating Volume Important?

Understanding the volume of an object based on its mass and density is crucial across various fields:

- **Material Science:** Determining the amount of material needed for manufacturing.
- **Engineering:** Calculating load-bearing capacities and material properties.
- **Geology:** Estimating the volume of mineral deposits.
- **Physics:** Understanding buoyancy and displacement in fluids.

Practical Applications

- Design and Manufacturing: Precise volume calculations help in designing components to fit specific spaces.
- Quality Control: Verifying whether a material meets the required density specifications.
- Recycling: Estimating the volume of scrap metal for transportation and processing.

Additional Considerations

Density Variations

While standard density values are used, actual density can vary based on:
- Purity of the material.
- Structural imperfections.
- Temperature and pressure conditions.

Unit Consistency

Always ensure unit consistency for accurate calculations:
- Convert all measurements to compatible units.
- Be cautious with scientific notation to avoid errors.

Examples of Similar Problems

To further understand the application, here are some example problems:

1. Calculate the volume of a copper piece with a mass of 250 g and density of 8.96 g/cm^3.
2. If a piece of aluminum weighs 500 g and has a density of 2.70 g/cm^3, what is its volume?
3. A block of lead has a volume of 100 cm^3. If its density is 11.34 g/cm^3, what is its mass?

Summary

In conclusion, calculating the volume of an object when given its mass and density is straightforward using the fundamental relation:
$$ V = \frac{m}{\rho} $$
Ensure proper unit conversions to maintain accuracy. In our specific problem, a piece of iron with a mass of 109 g and a density of 7.86 g/cm3 has an approximate volume of 13.86 cm3.

This knowledge is essential in various scientific and engineering disciplines, enabling professionals to design, analyze, and utilize materials effectively.

References

- Physics textbooks on density and material properties.
- Engineering materials handbooks.
- Scientific calculators for precise computations.

If you want more detailed explanations, additional examples, or related topics, feel free to ask!

Frequently Asked Questions

How do you calculate the volume of a piece of iron given its density and mass?

You can calculate the volume by dividing the mass by the density, ensuring units are consistent. Use the formula V = mass / density.

What is the formula to find the volume of an object when density and mass are known?

The formula is Volume (V) = Mass / Density.

Given the density of iron as 7.86 g/cm³ and its mass as 1.09 x 10^-1 kg, how do you convert mass to grams?

Since 1 kg = 1000 g, multiply the mass in kg by 1000: 0.109 kg x 1000 = 109 g.

After converting the mass to grams, how is the volume of the iron piece calculated?

Divide the mass in grams by the density in g/cm³: V = 109 g / 7.86 g/cm³.

What is the calculated volume of the iron piece in cubic centimeters?

V = 109 g / 7.86 g/cm³ ≈ 13.86 cm³.

Why is it important to convert units before calculating volume in such problems?

Converting units ensures consistency, which is essential for accurate calculations, especially when different units are used for mass and density.

What are common pitfalls to avoid when calculating volume from density and mass?

Common pitfalls include not converting units properly, using inconsistent units, or misapplying the formula. Always verify units before calculation.

How can this calculation be useful in practical applications?

Calculating volume from density and mass helps in material measurement, quality control, and designing objects with specific volume or weight requirements.

Additional Resources

Understanding the Calculation of Volume for Iron Based on Density and Mass

When dealing with physical objects, especially in the fields of physics and engineering, understanding the relationship between an object's mass, volume, and density is fundamental. The problem at hand involves calculating the volume of a piece of iron, given its density and mass. To approach this comprehensively, we need to understand the concepts of density, mass, and volume, their units, the formula that links them, and the step-by-step calculation process.

Fundamental Concepts: Density, Mass, and Volume

What is Density?

Density is a physical property that measures how much mass is contained within a unit volume of a substance. It is a scalar quantity expressed as:

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

- Units of Density: Common units include grams per cubic centimeter (g/cm^3), kilograms per cubic meter (kg/m^3), and grams per liter (g/L).

- Physical Significance: Higher density indicates that the substance is more tightly packed with mass, whereas lower density suggests more space between particles.

What is Mass?

Mass is a measure of the amount of matter in an object, typically expressed in kilograms (kg) or grams (g). In the SI system, the base unit is the kilogram.

- Note: Mass remains constant regardless of an object's location, unlike weight, which varies with gravity.

What is Volume?

Volume is the amount of three-dimensional space occupied by an object, measured in cubic centimeters (cm^3), liters (L), or cubic meters (m^3).

Given Data and Their Units

Parameter	Value	Units	Notes
Density (ρ)	7.86	g/cm^3	Density of iron
Mass (m)	1.09×10^{-1}	kg	Mass of the iron piece

Unit Conversion: Ensuring Consistent Units for Calculation

Before applying the formula, it’s crucial to ensure all quantities are expressed in compatible units because the density is given in g/cm^3, while the mass is in kg.

Step 1: Convert Mass from kilograms to grams

Since 1 kg = 1000 g,

$$
m = 1.09 \times 10^{-1} \text{ kg} = 0.109 \text{ kg}
$$

$$
m = 0.109 \text{ kg} \times 1000 \text{ g/kg} = 109 \text{ g}
$$

Result: The mass of the iron piece is 109 grams.

Applying the Density Formula to Find Volume

The core formula connecting mass, volume, and density:

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

where:

- V is the volume in cubic centimeters (cm^3),
- m is the mass in grams (g),
- ρ is the density in g/cm^3.

Step-by-step Calculation:

$$
V = \frac{109 \text{ g}}{7.86 \text{ g/cm}^3}
$$

$$
V \approx 13.86 \text{ cm}^3
$$

Final answer:

The volume of the iron piece is approximately 13.86 cubic centimeters.

Deeper Insights into the Calculation

Significance of the Calculation

Understanding how to derive volume from mass and density is vital in numerous practical applications:

- Material Science: Determining how much space a certain mass of material occupies.
- Manufacturing: Ensuring components fit within specified volume constraints.
- Density-based Identification: Confirming material identity by comparing calculated density with known values.
- Design and Engineering: Calculating weight-to-volume ratios for structural integrity.

Implications of Density Value (7.86 g/cm³)

The density of 7.86 g/cm³ closely matches the known density of iron, which is approximately 7.87 g/cm³ at room temperature. This consistency confirms the material's identity and quality.

Impact of Measurement Precision

The calculation's accuracy relies on precise measurements:

- Mass measurement: Any error in weighing affects volume calculation.
- Density value: Variations due to temperature, impurities, or alloying elements can alter density.
- Significant figures: Maintaining consistent significant figures ensures the precision of the result.

Additional Considerations and Related Calculations

Calculating Other Properties

Once volume is known, other properties can be derived:

- Weight (Force due to gravity): $W = m \times g$, where $g \approx 9.81 \text{ m/s}^2$.
- Surface Area: If shape is known, surface area calculations can be performed.
- Material Composition Checks: Comparing calculated density with standard values.

Handling Different Units

In some cases, measurements might be in different units, requiring conversions:

- Density in kg/m³: $7.86 \text{ g/cm}^3 = 7860 \text{ kg/m}^3$.
- Mass in kg: Already known.
- Volume in m³: $V = \frac{m}{\rho}$ with compatible units.

For example,

$$
V = \frac{0.109 \text{ kg}}{7860 \text{ kg/m}^3} \approx 1.386 \times 10^{-5} \text{ m}^3
$$

which confirms the earlier calculation when converted appropriately.

Practical Applications and Real-World Contexts

Material Testing and Quality Control

Manufacturers often verify material authenticity by measuring density. Deviations from standard values can indicate impurities or alloying.

Designing with Iron Components

Engineers use density and volume calculations to estimate:

- Weight: Critical for load calculations.
- Material requirements: Ensuring sufficient material is available.
- Cost estimation: Based on the mass and volume of materials.

Environmental and Safety Considerations

Accurate volume and density data help assess:

- Displacement and buoyancy: For objects submerged in fluids.
- Recycling: Identifying and sorting materials based on density.

Summary and Final Remarks

Calculating the volume of a piece of iron from its mass and density involves straightforward application of the density formula, but it emphasizes the importance of unit consistency and precise measurements. In this specific case:

- The given density of iron: 7.86 g/cm³
- The given mass: 1.09 × 10\(^{-1}\) kg (which converts to 109 g)
- The calculated volume: approximately 13.86 cm³

This calculation exemplifies foundational physics principles and illustrates their real-world significance across multiple industries. Whether in material science, engineering, or manufacturing, understanding and accurately performing such calculations are essential skills.

In conclusion, the process of finding the volume of an iron piece given its density and mass is a fundamental exercise that encapsulates core concepts in physics and practical measurement

techniques. Mastery of these calculations enables professionals and students alike to analyze and manipulate material properties effectively, paving the way for innovation and quality assurance in various technological fields.

A Piece Of Iron Has A Density Of 7 86 G Cm3 And A Mass Of 1 09 X 10 1 Kg Calculate The Volume Of The

A Piece Of Iron Has A Density Of 7 86 G Cm3 And A Mass Of 1 09 X 10 1 Kg Calculate The Volume Of The

Related Articles

- A Plastic Dowel Has A Young's Modulus Of 1.50 1010 N/m2. Assume The Dowel Will Break If More Than 1.50
- A Class Researching The Worlds Population Would Like To Include A Graph That Shows Historical Changes.
- A Car Is Moving On A Straight Road At 5m/s. It Is Accelerated At 3m/s. What Will Be Its Velocity After

Back to Home