

What Is The Mass Of A Solid Iron Wrecking Ball Of Radius 18 Cm? Density Of Iron Is 7800 G/l. Answer In

What Is The Mass Of A Solid Iron Wrecking Ball Of Radius 18 Cm? Density Of Iron Is 7800 G/l. Answer In this article, we will explore the process of calculating the mass of a solid iron wrecking ball with a radius of 18 centimeters, considering the density of iron is 7800 grams per liter. Understanding how to determine the mass involves applying principles of geometry and physics, specifically the formulas for the volume of a sphere and the relationship between density, volume, and mass.

Understanding the Basics: Key Concepts and Formulas

Before jumping into the calculation, it's essential to understand the fundamental concepts involved.

1. Volume of a Sphere

The wrecking ball is spherical, so its volume (V) can be calculated using the formula:

$$V = \frac{4}{3} \pi r^3$$

Where:

- r is the radius of the sphere
- π is approximately 3.1416

2. Density of Iron

Density (ρ) is the mass per unit volume of a material. Given as:

$$\rho = 7800 \text{ g/l}$$

Note: 1 liter (l) equals 1000 cubic centimeters (cm^3), so converting density to grams per cubic centimeter is helpful for our calculations.

3. Relationship Between Mass, Volume, and Density

The fundamental relation:

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

Using the above, once we find the volume of the sphere, we can easily determine its mass.

Step-by-Step Calculation of the Wrecking Ball's Mass

Let's now apply these concepts step-by-step.

Step 1: Convert Density to Grams per Cubic Centimeter

Given density:

$$\rho = 7800 \text{ g/l}$$

Since $1 \text{ liter} = 1000 \text{ cm}^3$,

$$\rho = \frac{7800 \text{ g}}{1000 \text{ cm}^3} = 7.8 \text{ g/cm}^3$$

Step 2: Calculate the Volume of the Sphere

Radius:

$$r = 18 \text{ cm}$$

Plug into the volume formula:

$$V = \frac{4}{3} \pi r^3$$

$$V = \frac{4}{3} \times 3.1416 \times (18)^3$$

Calculate (18^3) :

$$18^3 = 18 \times 18 \times 18 = 5832$$

Now, compute the volume:

$$V = \frac{4}{3} \times 3.1416 \times 5832$$

$$V = 4.1888 \times 5832$$

$$V \approx 24404.8 \text{ cm}^3$$

Step 3: Calculate the Mass of the Wrecking Ball

Using the density:

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

$$\text{Mass} = 7.8 \text{ g/cm}^3 \times 24404.8 \text{ cm}^3$$

$$\text{Mass} \approx 190219.4 \text{ g}$$

To express in kilograms:

$$\text{Mass} = \frac{190219.4}{1000} \approx 190.22 \text{ kg}$$

Final Answer and Summary

The mass of a solid iron wrecking ball with a radius of 18 centimeters is approximately 190.22 kilograms.

Additional Considerations and Practical Implications

Understanding the mass of such a wrecking ball has practical significance in construction, demolition, and safety planning. The weight determines the force exerted during swinging or dropping, influencing the design of supporting structures and safety measures.

Factors Affecting Real-World Measurements

- Material Consistency: Variations in iron density due to impurities or alloying.
- Shape Deviations: Slight imperfections in the spherical shape.
- Measurement Accuracy: Precision in measuring the radius.

Summary of Calculation Process

To summarize, calculating the mass involved:

1. Converting density from grams per liter to grams per cubic centimeter.
2. Calculating the volume of the sphere using the radius.
3. Multiplying the volume by the density to find the mass.

This straightforward approach leverages fundamental physics and geometry principles, providing an accurate estimate for the mass of a solid iron wrecking ball.

Conclusion

Knowing how to determine the mass of spherical objects like a wrecking ball is valuable across various engineering and scientific contexts. With a radius of 18 cm and the given iron density, the wrecking ball's mass is approximately 190.22 kg. This calculation underscores the importance of

understanding physical properties and geometric formulas in practical applications.

Whether for safety assessments, equipment design, or academic purposes, mastering these calculations enhances technical understanding and supports informed decision-making in engineering projects.

Frequently Asked Questions

How do you calculate the mass of a solid iron wrecking ball with a radius of 18 cm?

First, find the volume of the sphere using $V = (4/3)\pi r^3$, then multiply by iron's density (7800 g/l) to get the mass.

What is the formula to determine the volume of a sphere in this context?

The volume $V = (4/3)\pi r^3$, where r is the radius in centimeters.

How do you convert the volume from cubic centimeters to liters for density calculation?

Since 1 liter equals 1000 cubic centimeters, divide the volume in cm^3 by 1000 to get liters.

What is the approximate mass of the wrecking ball in kilograms?

After calculating the mass in grams, divide by 1000 to convert to kilograms; the approximate mass is around 11.54 kg.

Why is the density of iron important in calculating the mass of the wrecking ball?

Density relates the mass to volume; knowing it allows us to find the mass based on the volume of the sphere.

What units should the final answer be in, given the density is in g/l and radius in cm?

The final mass is best expressed in grams or kilograms for clarity, depending on the context.

Can you provide the step-by-step calculation for the mass of

the wrecking ball?

Yes. First, calculate volume: $V = (4/3)\pi(18)^3 \approx 24432.74 \text{ cm}^3$. Convert to liters: 24.43274 l. Then, multiply by density: $24.43274 \text{ l} \times 7800 \text{ g/l} \approx 190,514 \text{ g}$. Convert to kg: approximately 190.51 kg.

Additional Resources

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In construction and demolition industries, wrecking balls have long been an iconic symbol of force and power. These massive objects, primarily made of dense materials like iron, are instrumental in bringing down large structures with precision and efficiency. But have you ever wondered how much a typical iron wrecking ball weighs? Specifically, how do its size and material properties influence its mass? This article explores the fascinating process of calculating the mass of a solid iron wrecking ball with a radius of 18 centimeters, given that the density of iron stands at 7800 grams per liter. By examining the principles of volume, density, and mass, we aim to provide a comprehensive, reader-friendly understanding of this intriguing calculation.

Understanding the Basics: Volume, Density, and Mass

Before delving into the calculation, it's essential to clarify the key concepts involved:

- Volume: The amount of space occupied by an object. For a sphere, such as a wrecking ball, volume depends on its radius.
- Density: The mass per unit volume of a material. For iron, this is given as 7800 grams per liter.
- Mass: The total amount of matter in the object, calculated as the product of volume and density.

Mathematically, the relationship is expressed as:

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

Understanding this relationship allows us to convert the physical dimensions of the wrecking ball into a measurable mass.

Calculating the Volume of a Solid Sphere

Since the wrecking ball is spherical, its volume can be calculated using the formula for the volume of a sphere:

$$V = \frac{4}{3} \pi r^3$$

Where:

- V is the volume,
- r is the radius,

- π is Pi, approximately 3.1416.

Given:

- Radius $r = 18 \text{ cm}$

Substituting the values:

$$V = \frac{4}{3} \times 3.1416 \times (18 \text{ cm})^3$$

Calculating step-by-step:

1. Cube of the radius:

$$18^3 = 18 \times 18 \times 18 = 5832 \text{ cm}^3$$

2. Multiply by Pi:

$$3.1416 \times 5832 \approx 3.1416 \times 5832 \approx 18321.6 \text{ cm}^3$$

3. Multiply by $\frac{4}{3}$:

$$\frac{4}{3} \times 18321.6 \approx 1.3333 \times 18321.6 \approx 24428.8 \text{ cm}^3$$

Thus, the volume of the wrecking ball is approximately 24,428.8 cubic centimeters.

Converting Volume to Liters

Since the density is given in grams per liter, it's convenient to convert the volume from cubic centimeters to liters. The conversion factor is:

$$1 \text{ liter} = 1000 \text{ cm}^3$$

Therefore:

$$\text{Volume in liters} = \frac{24428.8 \text{ cm}^3}{1000} = 24.4288 \text{ liters}$$

This means the wrecking ball occupies about 24.43 liters of space.

Calculating the Mass of the Wrecking Ball

Now, applying the fundamental formula:

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

Given:

- Volume $V = 24.43 \text{ liters}$

- Density ($\rho = 7800 \text{ g/l}$)

Calculating:

$$\text{Mass} = 24.43 \text{ liters} \times 7800 \text{ g/l}$$

$$\text{Mass} \approx 24.43 \times 7800 = 190,554 \text{ grams}$$

To express the mass in kilograms, divide by 1000:

$$190,554 \text{ grams} \div 1000 = 190.554 \text{ kg}$$

Therefore, the solid iron wrecking ball with an 18 cm radius weighs approximately 190.55 kilograms.

Implications and Practical Significance

Understanding the mass of such a wrecking ball isn't just an academic exercise; it has practical implications in engineering, safety, and operational planning.

- Design and Safety: The weight influences the equipment used to lift and swing the wrecking ball. Heavy objects require robust cranes and support structures.
- Operational Force: The mass affects the force exerted during impacts, which determines the wrecking ball's effectiveness in demolishing structures.
- Transport and Handling: Knowing the weight aids in logistics, ensuring proper handling equipment and safety protocols are in place.

Variations and Real-World Considerations

While the calculation above assumes a perfect sphere and uniform density, real-world wrecking balls may vary due to:

- Manufacturing imperfections: Slight deviations in shape or density.
- Material composition: Iron may contain impurities or alloying elements affecting density.
- Safety margins: Engineers often account for additional weight or safety factors.

Additionally, in some cases, wrecking balls are hollow or have different internal structures, which would influence their total mass.

Conclusion: A Quantitative Perspective on Power

Calculating the mass of a solid iron wrecking ball based on its size and material density offers a tangible appreciation of the sheer power involved in demolition work. With a radius of 18 centimeters and a density of 7800 grams per liter, the wrecking ball weighs approximately 190.55 kilograms—nearly 420 pounds—highlighting the immense force harnessed in construction and

deconstruction activities.

This exercise underscores the importance of fundamental physics principles in real-world engineering challenges. Whether designing safer demolition procedures or understanding the mechanics of heavy machinery, such calculations form the backbone of practical engineering solutions. As technology advances, precise measurements and calculations like these continue to underpin the safe and effective use of heavy equipment, ensuring that colossal forces are wielded with accuracy and confidence.

Note: The calculations presented are approximate, rounded to two decimal places, and based on idealized assumptions.

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