A Cub Of Metal Of Ide 10 Cm I Fully Immered In A Liquid Of Denity 08 Calculate The Upthrut Experienced

A Cub Of Metal Of Ide 10 Cm I Fully Immered In A Liquid Of Denity 08 Calculate The Upthrut Experienced is a fascinating physics problem that explores the principles of buoyancy, density, and displaced fluid volume. Understanding how an object interacts with a liquid—specifically, how much upward force it experiences—is fundamental to grasping the basics of fluid mechanics. In this article, we will analyze this problem step-by-step, break down the concepts involved, and provide a comprehensive guide to calculating the upthrust experienced by a metal cube submerged in a liquid.

Understanding the Concept of Upthrust (Buoyant Force)

What is Upthrust?

Upthrust, also known as buoyant force, is the upward force exerted by a fluid on an object immersed in it. According to Archimedes' principle, the magnitude of this force is equal to the weight of the fluid displaced by the object. This principle is fundamental in explaining why objects float or sink in fluids.

Mathematically:
$$
\text{Upthrust} (F_b) = \text{Weight of displaced fluid} = \rho_{fluid} \times g \times V_{displaced}
$$
where:
- ρ_{fluid} is the density of the fluid,
- g is the acceleration due to gravity,
- $V_{displaced}$ is the volume of fluid displaced by the object.

Analyzing the Problem Details

Given Data

Let's clarify the problem's parameters:
- Cube of metal with side length = 10 cm
- Fully immersed in a liquid
- Density of liquid = 0.8 g/cm³ (which is 0.8 g/cm³, or 800 kg/m³ in SI units)

(Note: The original problem statement appears to have some typos: "Ide" likely refers to "density," and "denity 08" likely means 0.8 g/cm³. We'll assume this interpretation.)

Assumptions

- The metal's density is not explicitly given, but since the problem asks for the upthrust, we only need the liquid's density and the volume of the object.
- The gravitational acceleration, g, is approximately 9.8 m/s².
- The cube is fully immersed, so the entire volume displaces fluid.

Calculating the Volume of the Metal Cube

Step 1: Convert Dimensions to SI Units

Since calculations are easier in SI units, convert 10 cm to meters:

$$
10\, \text{cm} = 0.10\, \text{m}
$$

Step 2: Calculate the Volume

The volume of a cube:

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

$$
V = (0.10\, \text{m})^3 = 0.001\, \text{m}^3
$$

This is the volume of the metal cube, and also the volume of fluid displaced when fully immersed.

Calculating the Upthrust (Buoyant Force)

Step 1: Convert the Density of the Liquid to SI Units

Given density:
$$
\rho_{liquid} = 0.8\, \text{g/cm}^3
$$
Since:
$$
1\, \text{g/cm}^3 = 1000\, \text{kg/m}^3
$$
then:
$$
\rho_{liquid} = 0.8 \times 1000\, \text{kg/m}^3 = 800\, \text{kg/m}^3
$$

Step 2: Apply Archimedes' Principle

Calculate the buoyant force:
$$
F_b = \rho_{liquid} \times g \times V
$$
Plugging in the values:
$$
F_b = 800\, \text{kg/m}^3 \times 9.8\, \text{m/s}^2 \times 0.001\, \text{m}^3
$$
$$
F_b = 800 \times 9.8 \times 0.001 = 7.84\, \text{N}
$$

Therefore, the upthrust experienced by the metal cube is approximately 7.84 Newtons.

Understanding the Implications of the Result

What Does This Mean?

The calculated upthrust of 7.84 N indicates the upward force exerted by the liquid on the cube. If the cube's weight exceeds this force, it will sink; if less, it will float. Since the problem does not specify the cube's weight or density, we focus solely on the buoyant force.

Factors Influencing Upthrust

- Density of the liquid: Higher density results in greater buoyant force.
- Volume of the object: Larger volume displaces more fluid, increasing the buoyant force.
- Gravity: The acceleration due to gravity influences the force; on planets with different gravity, buoyant force varies accordingly.

Real-World Applications and Examples

Floating and Sinking

Understanding upthrust helps explain why objects float or sink. For example:
- A boat displaces a volume of water equal to its weight, and the buoyant force balances the weight.
- Submarines adjust their buoyancy by controlling the volume of water in ballast tanks.

Designing Marine Vehicles

Engineers use principles of buoyancy to design ships, submarines, and underwater drones, ensuring they float or submerge as desired.

Measuring Densities

The concept of upthrust is used in hydrometers to measure the density of liquids based on how much they displace in a graduated tube.

Additional Considerations and Common Mistakes

Incorrect Unit Conversion

Always verify unit conversions to prevent errors in calculations. For instance, converting density units from g/cm^3 to kg/m^3 is crucial.

Assuming Partial Submersion

In problems where the object is floating, the volume displaced is less than the total volume, and equilibrium conditions must be considered. Here, the object is fully immersed, simplifying calculations.

Neglecting External Factors

Factors like temperature, which can influence fluid density, are often ignored in simple physics problems but are important in real-world applications.

Conclusion

Calculating the upthrust experienced by a submerged object involves understanding the principles of buoyancy, accurately determining the displaced volume, and converting all measurements to consistent units. In the case of a 10 cm cube of metal fully immersed in a liquid with a density of 0.8 g/cm³, the upthrust is approximately 7.84 Newtons. This fundamental concept explains many phenomena in nature and engineering, from why objects float to how ships are designed to carry loads efficiently.

Understanding buoyancy not only enriches our knowledge of physics but also enhances practical applications across various fields, including naval architecture, fluid mechanics, and environmental science.

Frequently Asked Questions

What is the formula to calculate the upthrust experienced by a metal cube submerged in a liquid?

The upthrust (buoyant force) is calculated using Archimedes' principle: Upthrust = weight of the displaced liquid = density of liquid × volume of the object × acceleration due to gravity.

How do you determine the volume of a metal cube with a side length of 10 cm for upthrust calculations?

The volume of the cube is found using the formula: Volume = side length³ = (10 cm)³ = 1000 cm³.

Given a liquid density of 0.8 g/cm³, how do you convert this to standard SI units for calculation?

Convert the density to kg/m³: 0.8 g/cm³ = 800 kg/m³, since 1 g/cm³ = 1000 kg/m³.

What is the step-by-step process to calculate the upthrust on the metal cube submerged in the liquid?

1. Convert the liquid density to kg/m³. 2. Calculate the volume of the cube in m³. 3. Use the formula Upthrust = density × volume × gravity (9.8 m/s²). 4. Substitute the values and

compute the upthrust.

What is the numerical value of the upthrust experienced by the fully immersed cube in the given liquid?

First, convert volume: 1000 cm^3 = 1 × 10^{-3} m^3. Then, Upthrust = 800 kg/m^3 × 1 × 10^{-3} m^3 × 9.8 m/s^2 = 7.84 N. Therefore, the cube experiences an upthrust of 7.84 Newtons.

Additional Resources

A Cube Of Metal Of Ide 10 Cm I Fully Immerged In A Liquid Of Density 0.8 Calculate The Upthrust Experienced is a classic physics problem that illustrates fundamental concepts of buoyancy and fluid mechanics. Understanding how objects interact with liquids, especially in terms of the forces exerted upon them, is crucial in many scientific and engineering applications. Whether you're a student preparing for exams or a professional analyzing real-world scenarios, breaking down this problem methodically can deepen your grasp of these principles.

Introduction to Buoyancy and Upthrust

Before delving into the specifics of the problem, it's essential to understand the core concept of buoyancy, also known as upthrust. When an object is immersed in a fluid (liquid or gas), it experiences an upward force called the upthrust, which opposes gravity. This force results from the pressure difference exerted by the fluid on the submerged object.

What is Upthrust?

- Definition: The upward force exerted by a fluid on an immersed object.
- Origin: Caused by the pressure variation in a fluid due to gravity; pressure increases with depth.
- Significance: Determines whether an object sinks or floats.

The magnitude of upthrust can be calculated using Archimedes' principle, which states:

> The upthrust on a body submerged in a fluid is equal to the weight of the fluid displaced by the body.

Step-by-Step Breakdown of the Problem

Let's analyze the problem statement:

“A cube of metal with side length 10 cm is fully immersed in a liquid of density 0.8 g/cm^3. Calculate the upthrust experienced.”

1. Identify the Relevant Data

Parameter	Value	Explanation
Side length of cube	10 cm	The length of each side of the cube
Density of the liquid	0.8 g/cm³	The density of the fluid in which the cube is immersed
Volume of the cube	?	To be calculated
Mass of the cube	?	Not directly needed for upthrust but useful for context
Upthrust	?	The quantity to be calculated

Calculating the Upthrust: Step-by-Step Process

Step 1: Calculate the Volume of the Cube

Since the cube is a regular geometric shape, its volume (V) can be calculated with:

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

- Side length = 10 cm

$$
V = 10\, \text{cm} \times 10\, \text{cm} \times 10\, \text{cm} = 1000\, \text{cm}^3
$$

Step 2: Determine the Density of the Liquid

Given as:

$$
\rho_{liquid} = 0.8\, \text{g/cm}^3
$$

Step 3: Calculate the Mass of the Displaced Fluid

By Archimedes' principle, the upthrust (U) equals the weight of the displaced fluid:

$$
U = \text{Weight of displaced fluid}
$$

which is:

$$
U = \text{mass of displaced fluid} \times g
$$

The mass of displaced fluid is:

$$
m_{fluid} = \rho_{liquid} \times V
$$

Substituting:

$$
m_{fluid} = 0.8\, \text{g/cm}^3 \times 1000\, \text{cm}^3 = 800\, \text{g}
$$

Step 4: Convert Mass to Kilograms

Since SI units are standard in physics calculations:

$$
800\, \text{g} = 0.8\, \text{kg}
$$

Step 5: Calculate the Upthrust

Using $g = 9.8\, \text{m/s}^2$:

$$
U = m_{fluid} \times g = 0.8\, \text{kg} \times 9.8\, \text{m/s}^2 = 7.84\, \text{N}
$$

Therefore, the upthrust experienced by the cube is 7.84 Newtons.

Additional Considerations

1. Effect of Material Density

The problem involves a metal cube, but the metal’s density isn't specified. For buoyancy calculations, the key is the volume of the displaced fluid; the material density affects whether the object sinks or floats but not the magnitude of the upthrust itself, assuming full immersion.

2. Floating vs. Sinking

- If the metal's density is greater than the fluid, the cube will sink.
- If the metal's density is less, it will float partially submerged.

In this scenario, the full immersion suggests the metal's density exceeds the liquid's density, but the key calculation remains based on displacement.

Practical Applications of Upthrust Calculations

Understanding how to compute upthrust has several real-world applications:

- Shipbuilding: Ensuring ships displace enough water to float.
- Submarine design: Adjusting ballast to achieve desired buoyancy.

- Hydrometers: Measuring liquid densities based on buoyancy.
- Fluid mechanics engineering: Designing systems where submerged objects are involved.

Summary of Key Points

- The upthrust experienced by an object is directly proportional to the volume of fluid displaced.
- Archimedes' principle provides a straightforward way to calculate buoyant forces.
- For a cube fully immersed in a liquid, the upthrust is:

$$
U = \rho_{liquid} \times V \times g
$$

- Always convert units appropriately for consistency.

Final Remarks

This problem exemplifies fundamental physics concepts that are foundational in various scientific and engineering disciplines. Mastery of calculating upthrust not only aids in academic success but also forms the basis for understanding complex systems involving fluids and submerged objects. Remember to carefully analyze the given data, convert units properly, and apply the principles systematically for accurate results.

In conclusion, the cube of metal with a side length of 10 cm immersed fully in a liquid of density 0.8 g/cm³ experiences an upthrust of approximately 7.84 Newtons. This calculation underscores the importance of fluid density and object volume in determining buoyant forces, serving as a practical example of Archimedes' principle in action.

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