(c) A Solid Weights 64N In Air And 48N When Totally Immersed In A Liquid 0.8g/cm3.Calculate The() Upthrust

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Understanding the concept of upthrust, also known as buoyant force, is fundamental in physics, particularly in the study of fluids and objects submerged within them. In this article, we will thoroughly analyze the problem involving a solid object, which weighs 64N in air, and weighs 48N when fully immersed in a liquid with a density of 0.8 g/cm^3. Our goal is to calculate the upthrust acting on the object. We will explore the principles behind the calculation, provide step-by-step solutions, and discuss related concepts to deepen your understanding.

Understanding the Problem Statement

Before diving into calculations, it is essential to comprehend the key components of the problem:

- Weight in Air (W_{air}): 64N
- Weight in Liquid (W_{liquid}): 48N
- Density of Liquid (ρ_{liquid}): 0.8 g/cm^3

The question asks us to find the upthrust (also called buoyant force) acting on the solid object when fully immersed in the liquid.

Key Concepts and Principles

1. Weight and Apparent Weight

- Actual weight (W): The force due to gravity acting on the object; it is constant irrespective of the medium.
- Apparent weight in a fluid: The weight measured when the object is immersed in a fluid; it is less than the actual weight due to the upward buoyant force.

Mathematically:

$$ W_{apparent} = W_{actual} - \text{Upthrust} $$

2. Upthrust (Buoyant Force)

- The upthrust is the upward force exerted by the fluid on the submerged object.
- According to Archimedes’ principle:
$$ \text{Upthrust} = \text{Weight of displaced fluid} $$

Calculating the Upthrust

Given the data, the process involves several steps:

Step 1: Determine the actual weight of the object

- The actual weight of the object in air is directly given:
$$ W_{air} = 64\, \text{N} $$

Step 2: Find the apparent weight when immersed in the liquid

- The apparent weight when fully immersed:
$$ W_{liquid} = 48\, \text{N} $$

Step 3: Calculate the upthrust using the difference in weights

- From the principle of apparent weight:
$$ \text{Upthrust} = W_{air} - W_{liquid} $$

Substituting the known values:
$$ \text{Upthrust} = 64\, \text{N} - 48\, \text{N} = 16\, \text{N} $$

Therefore, the upthrust acting on the object is 16 N.

Verifying the Calculation with Archimedes’ Principle

To ensure our calculation is accurate, let's verify using Archimedes’ principle, which states:

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

Given the density of the liquid and the volume of the object, we can cross-check our work.

Step 4: Find the volume of the object

Using the actual weight:
$$ W_{air} = mg $$
where:
- m is the mass of the object,
- g is acceleration due to gravity ($\approx 9.8\, \text{m/s}^2$).

Thus:
$$ m = \frac{W_{air}}{g} = \frac{64\, \text{N}}{9.8\, \text{m/s}^2} \approx 6.53\, \text{kg} $$

Now, the volume (V) of the object:
$$ V = \frac{m}{\rho_{solid}} $$

But since the density of the solid is not directly provided, we can instead relate the upthrust to fluid parameters.

Calculating the Volume of Displaced Fluid

Using the relation:
$$ \text{Upthrust} = \rho_{liquid} \times V_{displaced} \times g $$

Rearranged to find $V_{displaced}$:
$$ V_{displaced} = \frac{\text{Upthrust}}{\rho_{liquid} \times g} $$

Convert the density of the liquid to SI units:

$$ \rho_{liquid} = 0.8\, \text{g/cm}^3 = 0.8 \times 10^3\, \text{kg/m}^3 = 800\, \text{kg/m}^3 $$

Now, substitute the values:
$$ V_{displaced} = \frac{16\, \text{N}}{800\, \text{kg/m}^3 \times 9.8\, \text{m/s}^2} $$

Calculating:
$$ V_{displaced} = \frac{16}{7840} \approx 0.00204\, \text{m}^3 $$

This volume corresponds to the volume of the object submerged, confirming that the upthrust equals the weight of the displaced fluid.

Related Concepts and Considerations

1. Factors Affecting Upthrust

- Density of the fluid: Higher density results in greater buoyant force.
- Volume of the object submerged: The larger the submerged volume, the greater the buoyant force.
- Object's shape and orientation: These influence the submerged volume and, consequently, the upthrust.

2. Real-World Applications of Upthrust

Understanding buoyant forces is crucial in various fields, including:

- Shipbuilding: Designing ships to ensure buoyancy and stability.
- Submarine engineering: Controlling buoyancy for submerged and surfaced states.
- Hydrometry: Measuring fluid densities using objects' buoyant properties.
- Fluid mechanics: Analyzing forces on submerged structures and objects.

3. Limitations and Assumptions

- The calculation assumes the object is fully immersed and the fluid is incompressible and at rest.
- Effects of fluid viscosity are neglected; only buoyant force and weight are considered.
- The density of the solid object is not specified; the focus is on buoyant force derived from weight differences.

Summary of Key Calculations

Parameter	Value	Explanation

Actual weight in air (W_{air})	64 N	Given
Apparent weight in liquid (W_{liquid})	48 N	Given
Upthrust	16 N	Calculated as $64\, \text{N} - 48\, \text{N}$
Density of liquid (ρ_{liquid})	800 kg/m³	Converted from 0.8 g/cm³
Volume of displaced fluid ($V_{displaced}$)	0.00204 m³	Calculated via upthrust relation

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Conclusion

The calculation of the upthrust acting on a solid object immersed in a liquid provides essential insights into fluid mechanics principles. In this scenario, the object experiences an upthrust of 16 N when fully submerged in a liquid with a density of 0.8 g/cm³. This force corresponds to the weight of the displaced fluid, as per Archimedes' principle. Understanding such principles has practical applications in engineering, design, and scientific research, emphasizing the importance of buoyancy in real-world contexts.

Additional Resources and Further Reading

- Archimedes' Principle and Its Applications
- Fluid Mechanics Fundamentals
- Density and Specific Gravity in Fluids
- Designing Buoyant Structures and Marine Vehicles
- Experiments Demonstrating Buoyancy and Upthrust

If you have further questions or need clarification on related topics, consider consulting physics textbooks or reputable online resources focused on fluid mechanics and buoyancy principles.

Frequently Asked Questions

What is the upthrust acting on the solid when immersed in the liquid?

The upthrust is 16 N.

How is upthrust calculated for a submerged object?

Upthrust is calculated as the difference between the weight in air and the weight when immersed, i.e., Upthrust = Weight in air - Weight in liquid.

Given the solid's weight in air is 64 N and in liquid is 48 N, what is the weight of the liquid displaced?

The weight of the displaced liquid is equal to the upthrust, which is 16 N.

What is the volume of the solid based on the given density of the liquid?

The volume of the solid is 60 cm^3, calculated using the upthrust and the density of the liquid.

How do you determine the volume of the solid from the upthrust and the liquid's density?

Use the formula Volume = Upthrust / (density of liquid × g). Given Upthrust = 16 N, density = 0.8 g/cm^3, $g \approx 9.8\ m/s^2$, convert units appropriately to find volume.

Why does the weight of the solid decrease when immersed in the liquid?

Because of the upthrust, which acts upward, effectively reducing the apparent weight of the object in the liquid.

What is the significance of the density value 0.8 g/cm^3 in this problem?

It represents the density of the liquid in which the solid is immersed, necessary for calculating the upthrust and volume of displaced liquid.

How does the principle of Archimedes apply to this problem?

It states that the upthrust on an immersed object equals the weight of the fluid displaced, which is used to find the upthrust value.

If the solid's weight in air is 64 N, what is its mass?

The mass is approximately 6.53 kg, calculated by dividing the weight in newtons by gravitational acceleration (64 N / 9.8 m/s^2).

Can the upthrust be used to determine the volume of an object? How?

Yes, by using the relation Upthrust = density of fluid × volume displaced × gravity, rearranged to find volume as Upthrust / (density × g).

Additional Resources

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Introduction

In the fascinating realm of physics, understanding the forces acting upon objects submerged in fluids is fundamental. The scenario of a solid object weighing 64 Newtons in air but appearing to weigh only 48 Newtons when completely immersed in a liquid with a density of $0.8 g/cm^3$ offers an excellent opportunity to explore Archimedes' principle and the concept of upthrust, also known as buoyant force. This article delves into the principles behind these observations, provides a step-by-step calculation of the upthrust acting on the object, and discusses the implications and applications of these concepts in real-world contexts.

Understanding the Scenario

Before diving into calculations, it is essential to clarify what the given data indicates:

- The weight of the solid in air is 64 N.
- The apparent weight of the solid when immersed in the liquid is 48 N.
- The density of the liquid is $0.8 g/cm^3$, which is equivalent to $800 kg/m^3$ when converted to SI units.

This change in apparent weight when immersed hints at the presence of an upward force exerted by the liquid—the upthrust—that counteracts some of the weight of the object.

Fundamental Concepts: Archimedes' Principle and Upthrust

Archimedes' Principle states that any object fully or partially submerged in a fluid experiences an upward buoyant force equal to the weight of the fluid displaced by the object. This principle underpins the phenomenon observed when objects are immersed in liquids and explains why objects seem lighter underwater.

Upthrust (Buoyant Force):
The force exerted by a fluid on a submerged object, acting vertically upward, is called the

upthrust. It is calculated as:

$$ \text{Upthrust} (F_b) = \text{Weight of displaced fluid} $$

Mathematically,

$$ F_b = \rho_{fluid} \times V_{object} \times g $$

where:

- ρ_{fluid} = density of the fluid (kg/m^3)
- V_{object} = volume of the object (m^3)
- g = acceleration due to gravity (~9.8 m/s^2)

Step-by-Step Calculation of Upthrust

To determine the upthrust acting on the object, we need to analyze the change in the object's apparent weight when submerged.

Step 1: Determine the true weight of the object

The true weight is the weight of the object in air, which is given as 64 N.

Step 2: Calculate the apparent weight in the liquid

The apparent weight when immersed is 48 N. This is the weight measured when the object is submerged, which is less than the true weight due to the upthrust.

Step 3: Find the upthrust

The difference between the true weight and the apparent weight gives the magnitude of the upthrust:

$$ F_b = \text{True weight} - \text{Apparent weight} $$
$$ F_b = 64\,N - 48\,N = 16\,N $$

Therefore, the upthrust acting on the object is 16 N.

Step 4: Confirm the volume of the object

Using the upthrust, we can determine the volume of the object, which is necessary for further analysis or practical applications.

The weight of the displaced fluid is:

$$ F_b = \rho_{fluid} \times V_{object} \times g $$

Rearranged to find volume:

$$ V_{object} = \frac{F_b}{\rho_{fluid} \times g} $$

Substituting the known values:

- $F_b = 16\,N$
- $\rho_{fluid} = 800\,kg/m^3$
- $g = 9.8\,m/s^2$

$$ V_{object} = \frac{16}{800 \times 9.8} $$
$$ V_{object} = \frac{16}{7840} $$
$$ V_{object} \approx 0.00204\,m^3 $$

Expressed in more convenient units:

$$ V_{object} \approx 2040\,cm^3 $$

This volume indicates how much space the object occupies, correlating with its displacement in the fluid.

Implications of the Calculations

The calculation of the upthrust not only confirms the principles of fluid mechanics but also sheds light on practical applications:

- Design of Submersible Equipment: Engineers need to account for buoyant forces when designing underwater vehicles or structures.
- Material Selection: The density of materials influences their buoyancy; lighter objects or those with lower densities displace enough fluid to float.
- Measurement Techniques: Apparent weight measurements in fluids serve as a basis for determining densities and volumes of irregular objects.

Real-World Applications of Upthrust

Understanding and calculating upthrust is vital across various industries and scientific fields:

1. Shipping and Nautical Engineering

Ships are constructed with hulls designed to displace large volumes of water, ensuring buoyancy exceeds weight for floating. Precise calculations of upthrust enable the design of vessels that can carry heavy loads safely.

2. Hydrometry and Density Measurement

Hydrometers utilize the principle of buoyancy to measure fluid densities. By observing how deeply the device sinks, scientists can determine the density of liquids like milk, oil, or wine.

3. Submarine Engineering

Submarines control their buoyancy by adjusting ballast tanks, exploiting the upthrust to submerge or surface. Accurate calculations are essential for operational safety and efficiency.

4. Medical and Biological Sciences

The technique of water displacement is used to measure body volume and density, aiding in assessments of body composition and health.

Advanced Considerations

While the simplified calculation provides the core understanding, real-world scenarios often involve additional factors:

- Temperature Effects: Fluid density varies with temperature, affecting buoyant force.
- Partial Submersion: When objects are only partially submerged, the calculations become more complex, requiring integration over the submerged surface.
- Object Density: Knowing the object's material density can help determine whether it will float or sink.

Conclusion

The scenario of a solid object weighing 64 N in air and 48 N when immersed in a liquid with a density of 0.8 g/cm^3 encapsulates the fundamental principles of buoyancy and fluid mechanics. The key takeaway is that the upthrust acting on the object equals 16 N, derived from the difference in the object's apparent weight in air and in the liquid. This force corresponds to the weight of the displaced fluid, which, in turn, reflects the volume of the object and the fluid's density.

Understanding these principles is not only academically enriching but also practically indispensable across diverse fields—from designing ships and submarines to developing measurement instruments and understanding natural phenomena. The elegance of Archimedes’ principle continues to underpin modern engineering and scientific endeavors, illustrating the timeless relevance of classical physics in solving contemporary challenges.

References

- Serway, R. A., & Jewett, J. W. (2014). Physics for Scientists and Engineers. Cengage Learning.
- Tipler, P. A., & Mosca, G. (2008). Physics for Scientists and Engineers. W. H. Freeman.

- Halliday, D., Resnick, R., & Walker, J. (2014). Fundamentals of Physics. Wiley.

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