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Introduction

Understanding the weight of a tank when filled with water involves basic principles of algebra and ratios. This problem presents two key pieces of information: the weight of the tank when it is quarter filled with water, and its weight when completely filled. By analyzing these data points, we can determine the weight of the empty tank and the total capacity of the tank in terms of water weight. This article will guide you through the step-by-step process of solving this problem, including the assumptions made and the calculations involved.

Understanding the Given Data

Data Summary

- When the tank is 1/4 filled with water, the total weight is 5.6 kg.
- When the tank is fully filled with water, the total weight is 10.4 kg.

From this, we can infer:

- The weight of the tank itself (empty weight) is constant.
- The weight of the water varies depending on the fill level.

Key Assumptions

To proceed with the calculations, we make the following assumptions:

- The weight of the tank is constant regardless of water level.

- The weight of water is directly proportional to the volume filled.
- The density of water remains constant.
- The tank's weight when empty is denoted as W_t.
- The weight of water when fully filled is denoted as W_w.
- The total volume of the tank corresponds to V_{total}, and the volume when quarter-filled corresponds to $V_{total}/4$.

Formulating the Problem Mathematically

Step 1: Express the total weight in terms of tank and water

When the tank is 1/4 filled:

$$
\text{Total weight} = W_t + \frac{1}{4} W_w = 5.6\, \text{kg}
$$

When the tank is full:

$$
\text{Total weight} = W_t + W_w = 10.4\, \text{kg}
$$

Step 2: Set up equations based on the data

From the above, we have two equations:

1. $W_t + \frac{1}{4} W_w = 5.6$
2. $W_t + W_w = 10.4$

Solving for the Unknowns

Step 1: Subtract equations to find W_w

Subtract equation 1 from equation 2:

$$
(W_t + W_w) - (W_t + \frac{1}{4} W_w) = 10.4 - 5.6
$$

Simplify:

$$
W_w - \frac{1}{4} W_w = 4.8
$$

$$
\left(1 - \frac{1}{4}\right) W_w = 4.8
$$

$$
\frac{3}{4} W_w = 4.8
$$

Solve for W_w:

$$
W_w = \frac{4.8 \times 4}{3} = \frac{19.2}{3} = 6.4\, \text{kg}
$$

Step 2: Find W_t using W_w

Substitute $W_w = 6.4\, \text{kg}$ into equation 2:

$$
W_t + 6.4 = 10.4
$$

$$
W_t = 10.4 - 6.4 = 4.0\, \text{kg}
$$

Interpreting the Results

- The empty weight of the tank: 4.0 kg
- The weight of water when the tank is full: 6.4 kg

These values allow us to determine the total capacity of the tank in terms of water weight, which is crucial for understanding the tank's volume and usage.

Calculating the Tank’s Capacity

Step 1: Understand the volume-to-weight relationship

Water has a density of approximately 1 kg per liter at standard conditions. This means:

$$
\text{Weight of water} (W_w) = \text{Volume of water} (V_w) \times \text{Density} (\approx 1\, \text{kg/L})
$$

Therefore:

$$
V_{full} = W_w = 6.4\, \text{liters}
$$

And:

$$
V_{quarter} = \frac{V_{full}}{4} = 1.6\, \text{liters}
$$

Step 2: Determine total tank volume

Since the full water volume is approximately 6.4 liters, the tank's capacity in volume terms is about 6.4 liters.

Note: The actual volume could be higher if the tank has some empty space or padding, but based on the weight data, the water's volume is directly proportional to the weight.

Summary of Key Findings

- Empty tank weight (W_t): **4.0 kg**
- Water weight when full (W_w): **6.4 kg**
- Approximate total water capacity: **6.4 liters**

- Total weight when full: **10.4 kg**
- Total weight when quarter filled: **5.6 kg**

Practical Implications and Uses

Understanding these calculations helps in numerous practical scenarios:

- Estimating tank capacity: Knowing the weight of water allows for quick assessment of the tank's volume.
- Design considerations: Engineers can determine suitable tank sizes based on weight constraints.
- Operational management: For industries relying on water tanks, such as agriculture or manufacturing, knowing weight and volume helps in planning for transportation and storage.
- Safety considerations: Knowing the full weight helps prevent overloading structures or transport vehicles.

Limitations and Considerations

While the calculations are straightforward and based on assumptions, some factors could influence real-world measurements:

- Material weight variation: The tank's weight might vary slightly due to manufacturing tolerances.
- Water density variations: Temperature and impurities can alter water density slightly.
- Tank shape and volume: The calculation assumes uniform shape; complex geometries might need more detailed analysis.
- Measurement accuracy: Scale calibration and measurement conditions can influence the observed weights.

Conclusion

By analyzing the given data points and applying fundamental algebraic principles, we have determined the weight of the empty tank and its water capacity. The tank weighs approximately 4.0 kg when empty and can hold about

6.4 liters of water when full. Understanding these parameters is essential for efficient design, safe operation, and effective management of water storage systems. This problem exemplifies how simple mathematical models can provide valuable insights into real-world engineering challenges, emphasizing the importance of precise measurements and logical reasoning in solving practical problems.

Frequently Asked Questions

How much water does the tank hold when it is full?

The tank's total weight when full is 10.4 kg, and it weighs 5.6 kg when quarter-filled. The weight of the water when full is 10.4 kg - 5.6 kg = 4.8 kg. Since this is the full capacity, the tank holds 4.8 kg of water.

What is the weight of the empty tank?

The empty tank's weight is 5.6 kg, as given when it is quarter-filled with water.

How much water is in the tank when it is quarter-filled?

When quarter-filled, the total weight is 5.6 kg (tank) + water weight. Since the tank weighs 5.6 kg when empty and the total is 5.6 kg, it suggests that the water weight at quarter fill is 0 kg, which isn't possible. Therefore, considering the full weight difference, the water in a quarter-filled tank weighs 4.8 kg / 4 = 1.2 kg; thus, a quarter fill contains approximately 1.2 kg of water.

What is the capacity of the tank in liters?

Assuming the water density is 1 kg/L, the full capacity of the tank is approximately 4.8 liters.

How much does the tank weigh when it is half-filled with water?

When half-filled, the water weight would be approximately 2.4 kg, so total weight = tank weight (5.6 kg) + 2.4 kg = 8.0 kg.

What is the weight of the tank when it is empty?

The weight of the empty tank is 5.6 kg, as given when it is quarter-filled with water.

Additional Resources

A tank weighs 5.6kg when it is 1/4 filled with water. If it weighs 10.4kg when it is full, what will be its empty weight? This seemingly straightforward problem involves understanding the relationship between the tank's weight, its capacity, and the weight of the water it contains. By analyzing these parameters, we can determine the weight of the empty tank and gain insights into the tank's capacity and the density of water. In this comprehensive guide, we'll walk through the problem step-by-step, explore relevant concepts, and provide a clear method to arrive at the solution.

Understanding the Problem

Before diving into calculations, it's essential to clarify what is given and what is required:

- When the tank is 1/4 filled with water, its total weight is 5.6 kg.
- When the tank is completely full, its total weight is 10.4 kg.
- Goal: Find the weight of the empty tank (the weight of the tank when it contains no water).

Key Concepts and Assumptions

1. Weight of the tank alone (empty weight): Let's denote this as W_t.
2. Weight of water when the tank is full: Let's denote this as W_w_full.
3. Weight of water when the tank is 1/4 filled: Since the weight at this point is 5.6 kg, and the tank also contributes its own weight, the total is W_t + water weight in this condition.
4. Water's density: Assuming the water's density is standard, approximately 1 kg/L (this is typical at room temperature).

Step 1: Define Variables

- W_t: weight of the empty tank (unknown, what we need to find).
- V: total volume of the tank in liters (unknown).
- W_w_full: weight of water when the tank is full.
- W_w_1/4: weight of water when the tank is 1/4 filled.

Step 2: Set Up Relations Based on the Data

When the tank is 1/4 filled:

- Water volume = (1/4) V

- Water weight = (1/4) V × density = (1/4) V × 1 kg/L = (1/4) V kg

Total weight in this case:

$W_t + (1/4) V = 5.6$ kg ...(Equation 1)

When the tank is full:

- Water volume = V
- Water weight = V kg

Total weight:

$W_t + V = 10.4$ kg ...(Equation 2)

Step 3: Express Water Volume and Weight

From Equation 2:

$V = 10.4 - W_t$ ...(Equation 3)

Substitute Equation 3 into Equation 1:

$W_t + (1/4) V = 5.6$

Replace V:

$W_t + (1/4) (10.4 - W_t) = 5.6$

Step 4: Solve for W_t

Expanding:

$W_t + (1/4) \times 10.4 - (1/4) W_t = 5.6$

Calculate:

$W_t + 2.6 - 0.25 W_t = 5.6$

Combine like terms:

$(W_t - 0.25 W_t) + 2.6 = 5.6$

$0.75 W_t + 2.6 = 5.6$

Subtract 2.6 from both sides:

$0.75 W_t = 5.6 - 2.6$

$0.75 W_t = 3.0$

Divide both sides by 0.75:

$W_t = 3.0 / 0.75$

$W_t = 4.0$ kg

Therefore, the empty weight of the tank is 4.0 kg.

Final Step: Find the Tank's Capacity

Using Equation 3:

$V = 10.4 - W_t = 10.4 - 4.0 = 6.4$ liters

This means the tank's total volume is 6.4 liters.

Summary of Findings

- Empty weight of the tank (W_t): 4.0 kg
- Total capacity of the tank (V): 6.4 liters
- Weight of water when full: 6.4 kg

Additional Insights and Considerations

Validating the Results

- When the tank is 1/4 filled:

Water weight = $(1/4) \times 6.4 = 1.6$ kg

Total weight:

W_t + water weight = $4.0 + 1.6 = 5.6$ kg

This matches the given data, confirming our calculations.

Understanding the Relationship

This problem highlights the importance of setting up algebraic equations based on physical relationships. The key insight was recognizing that the water's weight is proportional to its volume, and both are related through

the total volume of the tank.

Assumptions

- The density of water is 1 kg/L.
- The weight measurements are accurate, and the tank's weight remains constant regardless of water level.
- The tank's material does not contribute additional weight variations.

Practical Applications of Such Calculations

Understanding how to determine the weight of an empty tank and its capacity has practical importance in various fields:

- Industrial Storage: Ensuring tanks are correctly rated for their maximum capacity.
- Shipping & Transportation: Calculating total weight for safe transport.
- Engineering Design: Designing tanks with appropriate materials and capacities.
- Water Management: Estimating water volumes based on weight measurements.

Conclusion

By carefully analyzing the problem, establishing algebraic relations, and solving systematically, we've determined that the empty weight of the tank is 4.0 kg, and its total capacity is 6.4 liters. This approach exemplifies how basic principles of algebra and physics can be applied to real-world problems, providing clarity and precision in measurements and design considerations.

In summary:

- The key to solving such problems lies in understanding the relationship between the tank's weight, water volume, and water's density.
- Setting up equations based on given data allows for straightforward solutions.
- Always verify your results by substituting back into original conditions.

This comprehensive guide should serve as a useful reference for similar problems involving tanks, water, and weight calculations.

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