

Find The Mass Of Body Which Is Accelerated By Applying A Force Of 200n,that Speed Up It To 36 Ms⁻²

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Understanding the relationship between force, mass, and acceleration is fundamental in physics. When a force is applied to an object, it causes the object to accelerate, and this acceleration depends directly on the magnitude of the force and inversely on the object's mass. This principle is encapsulated in Newton's Second Law of Motion, which states that $F = m \times a$. In this article, we will explore how to determine the mass of a body when a specific force causes it to accelerate to a given velocity, with step-by-step explanations, practical examples, and related concepts to enhance your understanding.

Introduction to Newton's Second Law of Motion

Newton's Second Law is a cornerstone in classical mechanics. It provides a quantitative description of how forces influence the motion of objects. The law is expressed mathematically as:

$$F = m \times a$$

where:

- F is the net force applied to the object (in Newtons, N),
- m is the mass of the object (in kilograms, kg),
- a is the acceleration produced (in meters per second squared, $\mathrm{m\,s^{-2}}$).

Key Points:

- The force and acceleration are directly proportional.
- The mass acts as a measure of an object's inertia, or resistance to change in motion.
- To find the mass, knowing the force and acceleration is essential.

Understanding the Problem Statement

Given data:

- Force applied: $F = 200\,\mathrm{N}$
- Acceleration: $a = 36\,\mathrm{m\,s^{-2}}$

The problem asks:

- To find the mass (m) of the body that accelerates under the given force to the specified acceleration.

This is a straightforward application of Newton's Second Law, rearranged as:

$$m = \frac{F}{a}$$

Step-by-Step Calculation of the Body's Mass

Step 1: Write down the known quantities

- Force, ($F = 200\text{ N}$)

- Acceleration, ($a = 36\text{ m/s}^2$)

Step 2: Apply the formula

Using the rearranged form of Newton's Second Law:

$$m = \frac{F}{a}$$

Step 3: Substitute the known values

$$m = \frac{200\text{ N}}{36\text{ m/s}^2}$$

Step 4: Perform the division

$$m \approx 5.56\text{ kg}$$

Final Answer:

The mass of the body is approximately 5.56 kilograms.

Additional Insights and Practical Applications

Understanding how to determine the mass of an object based on applied force and resulting acceleration is crucial in various engineering and physics contexts. Here are some key insights:

Why is this important?

- Vehicle Dynamics: Engineers calculate the mass of vehicles or components to optimize performance.
- Robotics: Determining motor force requirements based on robot mass and desired acceleration.
- Space Missions: Calculating spacecraft mass based on thruster force and acceleration.

Real-world examples:

- Elevator systems: Ensuring the motor can provide enough force to accelerate the elevator with passengers.
- Sports science: Analyzing athlete performance by measuring the force exerted and resulting acceleration.
- Manufacturing: Designing conveyor belts and robotic arms with accurate mass and force parameters.

Related Concepts in Physics

Understanding the basic problem leads to exploring related principles:

1. Newton's First Law of Motion

- An object remains at rest or in uniform motion unless acted upon by an external force.
- Highlights the importance of net force in changing an object's motion.

2. Newton's Third Law of Motion

- For every action, there is an equal and opposite reaction.
- Important when considering forces between interacting objects.

3. Friction and Other Resistive Forces

- In real-world scenarios, forces like friction oppose motion.
- Adjustments are necessary when calculating net force and acceleration.

Limitations and Assumptions in the Calculation

While the calculation above is straightforward, it is based on ideal conditions:

- Assumes that the entire force of 200 N is effectively used to accelerate the body (no losses).
- Assumes no other forces like friction, air resistance, or other external influences.
- Assumes the applied force remains constant during acceleration.

In practical situations, these factors can influence the actual mass or acceleration.

Summary of Key Points

- The mass of a body can be accurately calculated using Newton's Second Law when the applied force and acceleration are known.
- The formula used: $m = \frac{F}{a}$.
- For a force of 200 N causing an acceleration of 36 m/s^2 , the mass is approximately 5.56 kg.
- Understanding these principles is vital in engineering, physics, and everyday problem-solving.

Conclusion

Determining the mass of a body based on applied force and resulting acceleration is a fundamental skill in physics. By applying Newton's Second Law, we can solve for the unknown mass with simple arithmetic, provided the force and acceleration are known. This principle not only helps in academic problem-solving but also plays a significant role in designing mechanical systems, analyzing motion, and understanding the physical world around us. Remember, always consider real-world factors like friction and external forces for more accurate calculations in practical applications.

Further Reading and Resources

- Newton's Laws of Motion — [Khan Academy](<https://www.khanacademy.org/science/physics/forces-newtons-laws>)
- Classical Mechanics Textbooks — for in-depth understanding
- Physics Simulation Tools — to model forces and motion interactively

By mastering these concepts, you'll be better equipped to tackle a wide range of physics problems involving force, mass, and acceleration.

Frequently Asked Questions

What is the formula to find the mass of a body when a force and acceleration are known?

The formula is $m = F / a$, where m is mass, F is the applied force, and a is the acceleration.

How do you calculate the mass of a body accelerated by a

force of 200 N with an acceleration of 36 m/s²?

Use the formula $m = F / a$, so $m = 200 \text{ N} / 36 \text{ m/s}^2 = \text{approximately } 5.56 \text{ kg}$.

Why is it important to know the mass of a body in physics?

Knowing the mass helps determine how a body responds to applied forces, specifically its acceleration according to Newton's second law.

What units are used for force, mass, and acceleration in this calculation?

Force is in newtons (N), mass in kilograms (kg), and acceleration in meters per second squared (m/s²).

Can this method be applied if the force or acceleration values change?

Yes, the same formula $m = F / a$ can be used with different values to find the mass or analyze the body's response to various forces and accelerations.

What assumptions are made when calculating mass using $F = m a$?

It assumes there are no other external forces acting on the body and that the force and acceleration are in the same direction.

If a different force of 150 N causes the same acceleration, what would be the mass?

Using $m = F / a$, $m = 150 \text{ N} / 36 \text{ m/s}^2 \approx 4.17 \text{ kg}$.

What real-world applications involve calculating mass using force and acceleration?

Applications include automotive crash analysis, spacecraft acceleration calculations, and designing moving machinery.

How does increasing the applied force affect the acceleration if the mass remains constant?

Increasing the force increases the acceleration proportionally, according to Newton's second law.

What is the significance of understanding the relationship

between force, mass, and acceleration?

It helps predict how objects will move under different forces, essential for engineering, physics experiments, and safety assessments.

Additional Resources

Mass Calculation of a Body Accelerated by a 200 N Force to Reach 36 m/s²

In the realm of classical mechanics, understanding the relationship between force, mass, and acceleration is fundamental. Whether you're a student mastering physics principles or an engineer designing mechanical systems, accurately determining the mass of a body based on applied forces and resulting accelerations is crucial. Today, we explore a specific scenario: finding the mass of a body that is accelerated by a force of 200 N to achieve an acceleration of 36 m/s². This analysis will not only clarify the calculation process but also delve into the underlying physics concepts, ensuring comprehensive understanding.

Understanding the Fundamental Principles

Before diving into the calculation, it's important to revisit the core physics law governing this scenario: Newton's Second Law of Motion.

Newton's Second Law of Motion

Formulated by Sir Isaac Newton, this law states:

> The acceleration of an object is directly proportional to the net force acting upon it and inversely proportional to its mass.

Mathematically, it is expressed as:

$$F = m \times a$$

where:

- F is the net force applied to the body (in Newtons, N),
- m is the mass of the body (in kilograms, kg),
- a is the acceleration produced (in meters per second squared, m/s²).

This simple yet powerful relation allows us to solve for any one of the three variables if the other two are known:

$$m = \frac{F}{a}$$

In our case, the problem reduces to identifying the mass using the provided force and acceleration.

Detailed Step-by-Step Calculation

Let's approach this problem systematically.

Given Data

- Force applied, $(F = 200\text{ N})$
- Acceleration achieved, $(a = 36\text{ m/s}^2)$

Objective

Find the mass (m) of the body.

Applying Newton's Second Law

Using the formula:

$$m = \frac{F}{a}$$

Substituting the given values:

$$m = \frac{200\text{ N}}{36\text{ m/s}^2}$$

Calculating:

$$m \approx 5.555\text{ kg}$$

or, rounded to three decimal places,

$$m \approx 5.556\text{ kg}$$

Result: The mass of the body is approximately 5.556 kg.

Understanding the Significance of the Result

The calculated mass provides insight into the physical characteristics of the object under consideration. A mass of approximately 5.556 kg indicates a moderately heavy object, comparable to

a large bag of rice or a small domestic appliance.

Why is this calculation important?

- Design Applications: Engineers can use this relation to determine the mass of unknown objects based on force and acceleration measurements, crucial in robotics, vehicle dynamics, and material testing.
- Educational Purposes: Students learn to apply fundamental physics equations to real-world problems, reinforcing their understanding of Newtonian mechanics.
- Safety and Efficiency: In industrial settings, knowing the mass of objects under force helps in designing safe lifting and transportation systems.

Additional Considerations and Real-World Factors

While the calculation appears straightforward, real-world applications often involve complexities beyond the ideal scenario.

Friction and Resistance

- In practical situations, forces such as friction, air resistance, or other resistive forces oppose the motion.
- The net force used in calculations should account for these resistances if present. Otherwise, the calculated mass might not reflect the true mass if external forces are unaccounted for.

Force Application and Direction

- The force must be applied in the direction of motion to achieve the specified acceleration.
- Any lateral or unaligned forces could affect the actual acceleration, leading to discrepancies.

Measurement Accuracy

- Precise measurement of force and acceleration is essential.
- Instruments like force sensors and accelerometers should be calibrated for accuracy.

Practical Example: Applying the Concept

Suppose a robotics engineer wants to design a system where a motor exerts a force of 200 N on a robotic arm segment, aiming to accelerate it at 36 m/s^2 . Using our calculation, they determine the segment's mass to be approximately 5.556 kg.

This information allows the engineer to:

- Select appropriate motors capable of delivering the necessary force.
- Ensure the structural integrity of the robotic arm by understanding the load it will bear.
- Optimize power consumption by accurately estimating the required force.

Summary of Key Points

- Newton's Second Law is the foundation for calculating mass from force and acceleration.
- The formula used: $m = F/a$ where:
 - F = applied force (200 N),
 - a = acceleration (36 m/s^2),
- leads to a mass of approximately 5.556 kg.
- Real-world factors such as friction and measurement errors can influence the actual force needed or the perceived acceleration.
- Accurate knowledge of mass is critical in engineering, physics education, and safety considerations.

Final Remarks

The ability to determine the mass of a body based on applied force and resulting acceleration is a cornerstone of classical mechanics. This straightforward calculation exemplifies how fundamental physics principles translate directly into practical applications, from designing machinery to understanding everyday objects. Whether you're a student, researcher, or engineer, mastering this calculation reinforces your grasp of Newtonian physics and enhances your problem-solving toolkit.

In essence, by applying Newton's second law, we seamlessly convert force and acceleration data into meaningful physical characteristics like mass, enabling precise control, safety, and efficiency in various technological and scientific endeavors.

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