

A Car Traveling Initially At 8.79m/s Accelerates At The Rate Of 0.767m/s² For 3.78s. What Is Its Velocity

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Understanding the dynamics of motion is essential in physics, especially when analyzing real-world scenarios like a car accelerating on a road. In this article, we will explore how to determine the final velocity of a car given its initial velocity, acceleration, and the duration of acceleration. Using the problem statement: a car initially traveling at 8.79 meters per second (m/s), accelerating at 0.767 meters per second squared (m/s²) over a period of 3.78 seconds, we will perform detailed calculations and discuss the underlying physics principles.

Fundamentals of Motion and Key Concepts

Before delving into calculations, it's important to understand some basic concepts related to motion:

Initial Velocity (u)

- The velocity of an object at the beginning of a time interval.
- Denoted as u .
- In our scenario, $u = 8.79 \text{ m/s}$.

Acceleration (a)

- The rate at which an object's velocity changes over time.
- Can be positive (speeding up), negative (slowing down), or zero (constant velocity).
- In our case, $a = 0.767 \text{ m/s}^2$.

Time (t)

- The duration over which acceleration occurs.
- Given as $t = 3.78 \text{ seconds}$.

Final Velocity (v)

- The velocity of the object after a certain period.
- The primary quantity we want to find.

Calculating Final Velocity: The Kinematic Equation

The problem involves uniformly accelerated motion—meaning the acceleration remains constant. The fundamental kinematic equation relating initial velocity, acceleration, time, and final velocity is:

$$v = u + at$$

Where:

- v is the final velocity,
- u is the initial velocity,
- a is acceleration,
- t is time.

This equation is straightforward and applicable because of the constant acceleration assumption.

Step-by-Step Calculation

Given:

- $u = 8.79 \text{ m/s}$
- $a = 0.767 \text{ m/s}^2$
- $t = 3.78 \text{ s}$

Plugging into the equation:

$$v = 8.79 + (0.767 \times 3.78)$$

First, calculate the product of acceleration and time:

$$0.767 \times 3.78 \approx ?$$

Let's perform this multiplication:

- $0.767 \times 3.78 = (0.767 \times 3) + (0.767 \times 0.78)$
- $0.767 \times 3 = 2.301$
- $0.767 \times 0.78 \approx 0.598$

Adding these:

$$2.301 + 0.598 \approx 2.899$$

Now, sum with the initial velocity:

$$v \approx 8.79 + 2.899 \approx 11.689 \text{ m/s}$$

Thus, the car's velocity after 3.78 seconds is approximately 11.69 meters per second.

Interpreting the Result

The calculation indicates that the car accelerates from 8.79 m/s to approximately 11.69 m/s over the given period. Several important points emerge from this:

- The increase in velocity (Δv) is about 2.9 m/s.
- The acceleration remains constant throughout the period.
- The final velocity is higher than the initial, confirming the car's speed increased during the interval.

Additional Considerations in Motion Analysis

While the calculation above assumes ideal conditions, real-world scenarios may involve additional factors:

Factors Affecting Vehicle Acceleration

- Road conditions (wet, dry, inclined surfaces)
- Vehicle mass and engine power
- External forces like air resistance and friction

Implications for Vehicle Performance

- Understanding acceleration helps in designing safe and efficient vehicles.
- It assists drivers in estimating travel times and vehicle behavior.

Practical Applications of Velocity Calculations

Knowing how to compute the velocity of a vehicle after a certain acceleration period has several practical uses:

- **Traffic Safety:** Ensuring vehicles accelerate within safe limits.
- **Transportation Planning:** Estimating travel times based on acceleration profiles.
- **Engineering Design:** Developing vehicle systems that optimize acceleration and deceleration.
- **Driving Techniques:** Improving driving strategies for fuel efficiency and safety.

Summary of Key Points

- The initial velocity of the car is 8.79 m/s.
- It accelerates at a rate of 0.767 m/s².
- The acceleration occurs over a duration of 3.78 seconds.
- The final velocity of the car after this period is approximately 11.69 m/s.
- The calculation uses the fundamental kinematic equation for uniformly accelerated motion.

Conclusion

Understanding the relationship between initial velocity, acceleration, and time is crucial in physics and engineering. In this scenario, a straightforward application of the basic kinematic equation allows us to determine the car's final velocity accurately. Such calculations are vital for designing safe vehicles, optimizing travel plans, and enhancing our comprehension of motion dynamics.

Whether you're a student learning physics, an engineer designing vehicle systems, or a driver interested in understanding vehicle behavior, mastering these concepts empowers you to analyze and predict motion effectively. Remember, the core principles of motion are universal, and applying them correctly can provide valuable insights into everyday phenomena involving movement.

Frequently Asked Questions

A car initially travels at 8.79 m/s and accelerates at 0.767 m/s² for 3.78 seconds. What is its final velocity?

To find the final velocity, use the formula $v = u + at$, where $u = 8.79$ m/s, $a = 0.767$ m/s², and $t = 3.78$ s. Calculating: $v = 8.79 + (0.767 \times 3.78) \approx 8.79 + 2.898 \approx 11.688$ m/s. The final velocity is approximately 11.69 m/s.

How does the acceleration affect the final speed of the car in this scenario?

The acceleration increases the car's speed over time. In this case, with an acceleration of 0.767 m/s² over 3.78 seconds, the car's velocity increases by approximately 2.9 m/s, resulting in a final speed of about 11.69 m/s.

If the car's initial velocity was higher, say 10 m/s, and it had the same acceleration and time, what would be its final velocity?

Using $v = u + at$, with $u = 10$ m/s, $a = 0.767$ m/s², and $t = 3.78$ s: $v = 10 + (0.767 \times 3.78) \approx 10 + 2.898 \approx 12.898$ m/s. The final velocity would be approximately 12.90 m/s.

What is the significance of the acceleration value in determining the car's final velocity?

The acceleration value directly influences how much the car's velocity increases over time. A higher acceleration results in a greater increase in speed, while a lower acceleration results in a smaller increase, given the same time interval.

How can we verify the calculation of the final velocity using the given data?

By applying the kinematic equation $v = u + at$ with the initial speed, acceleration, and time provided, we can accurately determine the final velocity. Plugging in the numbers confirms the velocity increases from 8.79 m/s to approximately 11.69 m/s after 3.78 seconds.

Additional Resources

A Car Traveling Initially At 8.79 m/s Accelerates At The Rate Of 0.767 m/s² For 3.78 s. What Is Its Velocity?

Introduction

In the realm of physics and automotive dynamics, understanding how velocity changes under acceleration is fundamental. Whether analyzing vehicle performance, designing safety features, or simply understanding everyday motion, grasping the principles behind velocity calculations is essential. This detailed investigation delves into a specific scenario: a car initially traveling at 8.79 meters per second (m/s) undergoes a constant acceleration of 0.767 meters per second squared (m/s²) over a period of 3.78 seconds. The core question posed is: What is its velocity after this interval?

This inquiry not only exemplifies core kinematic principles but also offers insights applicable across automotive engineering, safety assessments, and physics education. By dissecting this problem thoroughly, we aim to elucidate the underlying mechanics and highlight the broader implications of such calculations.

Contextualizing the Scenario

Imagine a vehicle on a straight road, perhaps during a controlled acceleration test or everyday driving conditions. The initial velocity is given as 8.79 m/s, which is roughly equivalent to 31.6 kilometers per hour (km/h) or approximately 19.7 miles per hour (mph). This speed might be typical for city driving or a gentle acceleration phase.

The acceleration rate of 0.767 m/s² indicates a moderate increase in speed. To put this into perspective, typical acceleration rates for different vehicles can vary:

- Urban driving acceleration: Usually around 1-2 m/s².
- High-performance cars: Can accelerate at 3-6 m/s² or more.
- Gentle acceleration: Often below 1 m/s².

Thus, 0.767 m/s² reflects a moderate, controlled acceleration—common in scenarios like cruise control adjustments, gradual hill climbs, or driver-initiated acceleration in everyday traffic.

Mathematical Foundations

The core physics principle applicable here is the equation of motion for uniformly accelerated linear motion:

$$v = v_0 + a \times t$$

Where:

- v is the final velocity after time t ,
- v_0 is the initial velocity,
- a is the acceleration,
- t is the elapsed time.

Given the parameters:

- $v_0 = 8.79 \text{ m/s}$,
- $a = 0.767 \text{ m/s}^2$,
- $t = 3.78 \text{ s}$,

the calculation proceeds straightforwardly.

Step-by-Step Calculation

1. Applying the Kinematic Equation

$$v = v_0 + a \times t$$

Substituting the values:

$$v = 8.79 \text{ m/s} + (0.767 \text{ m/s}^2 \times 3.78 \text{ s})$$

2. Calculating the Acceleration Term

$$0.767 \times 3.78 = 2.898 \text{ m/s}$$

3. Final Velocity Computation

$$v = 8.79 + 2.898 = 11.688 \text{ m/s}$$

Thus, the vehicle's velocity after 3.78 seconds is approximately 11.69 m/s.

Interpreting the Result

Converting to more familiar units:

- Kilometers per hour (km/h):

$$[11.69, \text{m/s}] \times 3.6 = 42.1, \text{km/h}]$$

- Miles per hour (mph):

$$[11.69, \text{m/s}] \times 2.237 = 26.2, \text{mph}]$$

This indicates that the vehicle, initially traveling at about 31.6 km/h (19.7 mph), accelerates to approximately 42.1 km/h (26.2 mph) within the 3.78-second interval.

Broader Implications and Applications

Safety and Performance Analysis

Understanding how quickly a vehicle can accelerate is critical for safety assessments and performance benchmarking. For instance, in collision avoidance systems, knowing the acceleration capabilities helps model potential escape maneuvers, especially in urban environments where speeds are relatively low.

Automotive Engineering

Engineers leverage these calculations to design engines, transmission systems, and control algorithms to optimize acceleration profiles. The moderate acceleration rate modeled here reflects typical engine torque and driver input scenarios, ensuring comfort while maintaining safety.

Driver Behavior and Traffic Flow

From a traffic management perspective, the acceleration profile influences congestion patterns and driver experience. Recognizing how vehicles accelerate over specific timeframes helps in designing better traffic signals, speed regulations, and autonomous vehicle algorithms.

Factors Affecting Real-World Application

While the idealized calculation provides a clear answer, real-world scenarios involve additional complexities:

- Friction and Drag: Air resistance and rolling friction reduce actual acceleration.
- Driver Input Variability: Human drivers may not accelerate uniformly.

- Road Conditions: Inclines, surface quality, and weather conditions influence acceleration.

Limitations of the Model

The calculations assume constant acceleration, which may not hold true in real driving conditions. Transient accelerations, deceleration, or variable inputs can significantly alter final velocities.

Advanced Considerations

1. Incorporating Initial and Final Kinetic Energies

The change in the vehicle's kinetic energy can be expressed as:

$$\Delta KE = \frac{1}{2} m (v^2 - v_0^2)$$

Where m is the vehicle's mass. This helps in understanding energy consumption and efficiency during acceleration.

2. Impact of Mass and Powertrain Efficiency

Different vehicle masses or engine efficiencies affect how acceleration translates into actual velocity gains, especially under real-world conditions.

Conclusion

The detailed analysis reveals that a car initially traveling at 8.79 m/s, under a steady acceleration of 0.767 m/s² for 3.78 seconds, reaches a velocity of approximately 11.69 m/s, or about 42.1 km/h. This scenario exemplifies fundamental kinematic principles, illustrating how initial conditions and acceleration influence vehicle speed over time.

From an automotive engineering standpoint, such calculations underpin design decisions, safety assessments, and performance evaluations. Recognizing the nuances beyond simple equations—such as environmental factors and driver behavior—further enriches our understanding of vehicle dynamics.

In conclusion, the straightforward application of physics principles provides powerful insights into everyday motion, enabling engineers, safety specialists, and enthusiasts to better comprehend and predict vehicle behavior under various conditions. As automotive technology advances, integrating precise models of acceleration and velocity will continue to enhance vehicle safety, efficiency, and driver experience.

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