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Given A Constant Acceleration Of 0.5 M/s², What Is The

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Understanding motion is fundamental in physics, especially when analyzing how objects move under various forces. When a body moves with an initial velocity and is subjected to constant acceleration, its future position, velocity, and other parameters can be calculated using basic kinematic equations. This article delves into the problem of determining the distance traveled by a body given its initial speed and constant acceleration, providing detailed explanations, relevant formulas, step-by-step calculations, and practical examples.

Fundamentals of Kinematic Equations

Before addressing the specific problem, it's essential to understand the core concepts and equations in kinematics—the branch of mechanics dealing with motion without considering forces.

Key Variables in Motion Analysis

- **Initial velocity (u):** The velocity of the body at the start (given as 2.4 m/s).
- **Final velocity (v):** The velocity of the body at a specific time or position.

- **Acceleration (a):** The rate of change of velocity (given as 0.5 m/s^2).
- **Displacement (s):** The distance traveled in a particular direction.
- **Time (t):** Duration over which motion occurs.

Basic Kinematic Equations for Constant Acceleration

These equations relate the above variables and are valid under constant acceleration:

1. $v = u + at$

2. $s = ut + 0.5at^2$

3. $v^2 = u^2 + 2as$

4. $s = \left(\frac{u + v}{2}\right) t$

Depending on the available data, these equations can be used to find unknown parameters such as displacement or final velocity.

Problem Breakdown: What Is the Displacement?

Given:

- Initial speed, $u = 2.4 \text{ m/s}$
- Constant acceleration, $a = 0.5 \text{ m/s}^2$

The problem asks: "What is the..." — likely "distance traveled in a certain time" or "final velocity after a certain time." Since the question is incomplete, we will explore various possible interpretations and calculations:

1. Displacement after a given time (t): If a specific time is provided.
2. Final velocity after a certain time: To understand how fast the body is moving after some period.
3. Displacement for a specific final velocity: Using the relation between displacement and velocities.

We will explore these scenarios step-by-step.

Scenario 1: Calculating Displacement After a Given Time

Suppose we want to find the distance traveled after a specific duration, say, t seconds.

Step 1: Define the known values

- $u = 2.4 \text{ m/s}$
- $a = 0.5 \text{ m/s}^2$
- $t =$ (assumed or given; let's choose $t = 10$ seconds as an example)

Step 2: Use the displacement formula

\[

$$s = ut + 0.5at^2$$

\]

Step 3: Plug in the values

$$s = (2.4 \times 10) + 0.5 \times 0.5 \times 10^2$$

]

$$s = 24 + 0.5 \times 0.5 \times 100$$

]

$$s = 24 + 0.25 \times 100$$

]

$$s = 24 + 25 = 49, \text{ \text{meters}}$$

]

Result: After 10 seconds, the body travels 49 meters.

Note: The specific time t greatly influences the displacement; shorter or longer times will yield different distances.

Scenario 2: Calculating Final Velocity After a Given Time

Assuming the same initial speed and acceleration, find the velocity after t seconds.

Step 1: Use the velocity formula

[

$$v = u + at$$

\]

Step 2: For $t = 10$ seconds

\[

$$v = 2.4 + 0.5 \times 10 = 2.4 + 5 = 7.4, \text{ m/s}$$

\]

Result: The body reaches a velocity of 7.4 m/s after 10 seconds.

This calculation is useful when analyzing how quickly an object accelerates over time.

Scenario 3: Finding Displacement for a Given Final Velocity

Suppose the final velocity (v) is known, and we want to find the displacement (s).

Given:

- $u = 2.4 \text{ m/s}$
- $v = 7.4 \text{ m/s}$ (from previous calculation)
- $a = 0.5 \text{ m/s}^2$

Step 1: Use the equation

\[

$$v^2 = u^2 + 2as$$

\]

Step 2: Rearrange to find s

$$s = \frac{v^2 - u^2}{2a}$$

Step 3: Plug in values

$$s = \frac{(7.4)^2 - (2.4)^2}{2 \times 0.5}$$

$$s = \frac{54.76 - 5.76}{1}$$

$$s = 49 \text{ meters}$$

Result: The displacement after reaching a velocity of 7.4 m/s is 49 meters, consistent with earlier calculations.

Understanding the Significance of These Calculations

These calculations demonstrate how initial velocity, constant acceleration, time, and displacement are interconnected. They form the basis for analyzing real-world motion scenarios, such as vehicle acceleration, sports dynamics, and mechanical systems.

Practical Applications of Kinematic Calculations

- Automotive Engineering: Designing acceleration and braking profiles.
- Sports Science: Analyzing sprint acceleration.
- Robotics: Planning trajectories under constant acceleration.
- Aerospace: Calculating spacecraft velocity and displacement during maneuvers.

Example Problem for Practice

Suppose a body starts moving with an initial velocity of 2.4 m/s and accelerates at 0.5 m/s². How far will it travel in 15 seconds? What will be its velocity at that time?

Solution:

1. Displacement:

$$s = ut + 0.5at^2 = (2.4 \times 15) + 0.5 \times 0.5 \times 15^2$$

$$s = 36 + 0.25 \times 225 = 36 + 56.25 = 92.25, \text{ \text{meters}}$$

2. Final velocity:

$$v = u + at = 2.4 + 0.5 \times 15 = 2.4 + 7.5 = 9.9, \text{ \text{m/s}}$$

Conclusion: In 15 seconds, the object travels approximately 92.25 meters and reaches a velocity of 9.9 m/s.

Conclusion

Analyzing motion with constant acceleration involves understanding and applying key kinematic equations. Whether calculating displacement, final velocity, or acceleration effects, these principles are fundamental in physics and engineering. The initial speed of 2.4 m/s and acceleration of 0.5 m/s² serve as a foundation for solving a variety of real-world motion problems. By mastering these calculations, students and professionals can accurately predict and analyze motion scenarios, which are crucial in designing systems, understanding natural phenomena, and solving engineering challenges.

Remember:

- Always clearly identify known variables.
- Choose the appropriate kinematic equation based on the data provided.
- Perform calculations carefully, ensuring units are consistent.
- Practice with different time frames and parameters to build a strong understanding of motion analysis.

Keywords for SEO Optimization:

motion analysis, kinematic equations, displacement calculation, constant acceleration, initial velocity, final velocity, physics problems, mechanics, displacement formula, velocity after acceleration, physics tutorial, motion under constant acceleration

Frequently Asked Questions

A body travels at an initial speed of 2.4 m/s with a constant

acceleration of 0.5 m/s^2 . What is its velocity after 10 seconds?

Using $v = u + at$, $v = 2.4 + (0.5)(10) = 2.4 + 5 = 7.4 \text{ m/s}$.

Given the initial speed and acceleration, how long will it take for the body to reach a velocity of 12 m/s ?

Using $v = u + at$, $t = (v - u) / a = (12 - 2.4) / 0.5 = 9.6 / 0.5 = 19.2 \text{ seconds}$.

What is the displacement of the body after 10 seconds with the given initial speed and acceleration?

Using $s = ut + 0.5at^2$, $s = (2.4)(10) + 0.5(0.5)(10)^2 = 24 + 0.5 \cdot 0.5 \cdot 100 = 24 + 25 = 49 \text{ meters}$.

What is the final velocity of the body after 15 seconds?

Using $v = u + at$, $v = 2.4 + (0.5)(15) = 2.4 + 7.5 = 9.9 \text{ m/s}$.

How far does the body travel in 20 seconds under the given conditions?

Using $s = ut + 0.5at^2$, $s = (2.4)(20) + 0.5(0.5)(20)^2 = 48 + 0.5 \cdot 0.5 \cdot 400 = 48 + 100 = 148 \text{ meters}$.

If the body accelerates at 0.5 m/s^2 , what is its velocity after 25 seconds?

Using $v = u + at$, $v = 2.4 + (0.5)(25) = 2.4 + 12.5 = 14.9 \text{ m/s}$.

What is the acceleration's effect on the body's motion over time?

The constant acceleration increases the body's velocity linearly over time, resulting in greater displacement as time progresses, as described by the equations $v = u + at$ and $s = ut + 0.5at^2$.

Additional Resources

A Body Travels At An Initial Speed Of 2.4 M/s. Given A Constant Acceleration Of 0.5 M/s², What Is The — this phrase encapsulates a fundamental problem in kinematics that is often encountered in physics education, engineering, and real-world motion analysis. Understanding how an object's velocity changes over time under uniform acceleration is essential for predicting its future position, velocity, and overall behavior. This article aims to provide a comprehensive review of solving such problems, exploring the underlying principles, step-by-step methodologies, and practical applications. Whether you are a student preparing for exams, an educator designing lesson plans, or a professional applying physics concepts in real-world scenarios, this detailed analysis will deepen your understanding of motion with constant acceleration.

Understanding the Fundamentals of Motion with Constant Acceleration

Before diving into the specific problem, it's crucial to understand the foundational concepts involved in motion under constant acceleration. These principles form the backbone of classical mechanics and are essential for accurately analyzing and solving related problems.

Basic Concepts and Definitions

- Initial Velocity (u): The velocity of the body at the starting point. In our case, $u = 2.4 \text{ m/s}$.
- Acceleration (a): The rate at which the velocity of the body changes with time. Given as $a = 0.5 \text{ m/s}^2$.
- Final Velocity (v): The velocity of the body after a certain time or distance.
- Time (t): The duration over which the motion occurs.
- Displacement (s): The total distance traveled by the body in a particular direction.

Understanding these variables and their relationships is essential for solving motion problems.

The Equations of Motion

In the context of constant acceleration, the following kinematic equations are fundamental:

1. $v = u + at$

Describes the final velocity after time t .

2. $s = ut + 0.5at^2$

Calculates the displacement over time t .

3. $v^2 = u^2 + 2as$

Relates initial and final velocities to displacement without involving time.

These equations are interconnected; knowing any two variables allows solving for the others.

Step-by-Step Approach to Solving the Problem

The core of understanding this problem lies in selecting what you want to find—most commonly, the final velocity after a certain time or displacement. Since the problem is incomplete in the prompt, let's assume the goal is to determine the final velocity after traveling a specific distance or time, or vice versa. Here, we will explore multiple scenarios.

Scenario 1: Calculating Final Velocity After Traveling a Certain

Distance

Suppose you are asked: What is the final velocity of a body starting at 2.4 m/s with an acceleration of 0.5 m/s² after traveling 10 meters?

Step 1: Identify known variables

- Initial velocity, $u = 2.4 \text{ m/s}$
- Acceleration, $a = 0.5 \text{ m/s}^2$
- Displacement, $s = 10 \text{ m}$

Step 2: Use the appropriate kinematic equation

Since time is not specified, the most suitable is:

$$v^2 = u^2 + 2as$$

Step 3: Plug in the values

$$v^2 = (2.4)^2 + 2 \cdot 0.5 \cdot 10$$

$$v^2 = 5.76 + 10$$

$$v^2 = 15.76$$

Step 4: Take the square root to find v

$$v = \sqrt{15.76} \approx 3.97 \text{ m/s}$$

Result: The final velocity after traveling 10 meters is approximately 3.97 m/s.

Scenario 2: Calculating Time to Reach a Certain Displacement

Suppose the question is: How long does it take for the body to reach this velocity?

Step 1: Known variables

- $u = 2.4 \text{ m/s}$

- $a = 0.5 \text{ m/s}^2$

- $v = 3.97 \text{ m/s}$ (from previous calculation)

Step 2: Use the first equation

$$v = u + at$$

$$t = (v - u) / a$$

Step 3: Plug in the values

$$t = (3.97 - 2.4) / 0.5$$

$$t \approx 1.57 / 0.5$$

$$t \approx 3.14 \text{ seconds}$$

Result: It takes approximately 3.14 seconds to reach the final velocity.

Scenario 3: Calculating Displacement Over a Given Time

If the goal is to find out how far the body travels in 4 seconds, for instance:

Step 1: Known variables

- $u = 2.4 \text{ m/s}$

- $a = 0.5 \text{ m/s}^2$

- $t = 4 \text{ s}$

Step 2: Use the second equation

$$s = ut + 0.5at^2$$

Step 3: Calculate

$$s = (2.4)(4) + 0.5 \cdot 0.5 (4)^2$$

$$s = 9.6 + 0.25 \cdot 16$$

$$s = 9.6 + 4$$

$$s = 13.6 \text{ meters}$$

Result: The body travels approximately 13.6 meters in 4 seconds.

Practical Applications and Real-World Significance

Understanding motion under constant acceleration has significant implications across various fields:

Engineering and Mechanical Design

- **Vehicle Dynamics:** Designing acceleration profiles for cars, trains, or aircraft involves calculating velocities and displacements under constant acceleration.

- Robotics: Programming motion paths with predictable acceleration ensures precision and safety.

Physics Education and Research

- Provides foundational understanding for students learning classical mechanics.
- Serves as a basis for more complex topics like non-uniform acceleration, rotational dynamics, and relativistic motion.

Sports Science and Biomechanics

- Analyzing athlete acceleration during sprints or jumps helps optimize training and technique.

Safety and Accident Analysis

- Calculating vehicle or object trajectories under acceleration can help reconstruct accidents or predict future positions in safety systems.

Features, Pros, and Cons of Analyzing Motion with Constant Acceleration

Features:

- Relies on straightforward equations with clear variables.

- Applicable when acceleration remains steady over time.
- Allows for predictive modeling of motion over specified distances or times.

Pros:

- Simplifies complex motion analysis into manageable calculations.
- Facilitates understanding of real-world scenarios like vehicle acceleration, free fall, and machinery movement.
- Supports both theoretical understanding and practical implementation.

Cons:

- Assumes acceleration remains constant, which may not be true in real-world situations involving variable forces.
- Does not account for external factors such as friction, air resistance, or other forces unless explicitly included.
- Limited to linear motion; rotational or non-linear motion require more advanced models.

Conclusion

The problem of a body traveling at an initial speed of 2.4 m/s with a constant acceleration of 0.5 m/s² encapsulates a fundamental aspect of kinematics—predicting how an object's velocity and position evolve over time under steady acceleration. By understanding and applying the core equations of motion, one can determine the final velocity after a given displacement, compute the time taken to reach certain speeds, or find the distance traveled over specific intervals. Such analyses are not only academically enriching but also practically vital across multiple industries, from engineering to sports science.

Mastering these concepts enables one to approach real-world problems with confidence, design systems that leverage predictable motion, and develop a deeper appreciation for the elegant laws that govern physical movement. Whether you are solving textbook exercises or designing complex machinery, the principles of constant acceleration provide a powerful toolset for understanding and predicting motion in our universe.

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