A Car Increase Its Speed Steadily From 30km/hr To 60km/hr In 1 Min A What Is The Average Speed During

A Car Increase Its Speed Steadily From 30km/hr To 60km/hr In 1 Min A What Is The Average Speed During

Understanding the concept of average speed is fundamental in physics and everyday driving scenarios. In this article, we explore a specific case where a car accelerates steadily from 30 km/hr to 60 km/hr over the span of one minute. We will analyze how to calculate the average speed during this interval, discuss related concepts such as uniform acceleration, and provide detailed explanations to grasp the underlying principles. Whether you're a student, a driver, or simply curious, this comprehensive guide will clarify the calculations and theory behind the average speed during such a scenario.

Understanding the Scenario: Steady Acceleration Over One Minute

Details of the Problem

Suppose a car is traveling along a straight road and its speed increases uniformly from an initial speed of 30 km/hr to a final speed of 60 km/hr over a period of 1 minute. The key points are:
- Initial speed, $u = 30\, \text{km/hr}$
- Final speed, $v = 60\, \text{km/hr}$
- Time taken, $t = 1\, \text{minute} = 60\, \text{seconds}$

The question posed is: What is the average speed of the car during this period?

Fundamental Concepts of Speed and Acceleration

What Is Speed?

Speed is a scalar quantity that measures how fast an object moves, regardless of direction. It is calculated as the distance traveled divided by the time taken:

$$
\text{Speed} = \frac{\text{Distance}}{\text{Time}}
$$

What Is Average Speed?

Average speed over a time interval is the total distance traveled divided by the total time taken:

$$
\text{Average Speed} = \frac{\text{Total Distance}}{\text{Total Time}}
$$

Uniform (Constant) Acceleration

In many real-world cases, vehicles accelerate or decelerate. When acceleration is steady, it is called uniform acceleration, characterized by a constant rate of change of velocity:

$$
a = \frac{\Delta v}{\Delta t}
$$

where:

- a = acceleration
- Δv = change in velocity
- Δt = change in time

In our scenario, the car accelerates uniformly from 30 km/hr to 60 km/hr over 60 seconds.

Calculating the Average Speed During Steady Acceleration

Key Insight: Average Speed During Uniform Acceleration

When an object accelerates uniformly from an initial velocity u to a final velocity v, the average speed v_{avg} during that interval is simply:

$$
v_{avg} = \frac{u + v}{2}
$$

This is because, under uniform acceleration, the velocity changes linearly over time, and the average (mean) of the initial and final velocities gives the average velocity during the entire period.

Applying the Formula

Given:
- $u = 30\, \text{km/hr}$
- $v = 60\, \text{km/hr}$

Calculate:
$$
v_{avg} = \frac{30 + 60}{2} = \frac{90}{2} = 45\, \text{km/hr}
$$

Therefore, the average speed of the car during this 1-minute interval is 45 km/hr.

Verifying the Calculation: Distance Traveled

Calculating Distance Using Average Speed

Total distance traveled can be computed by:
$$
\text{Distance} = v_{avg} \times t
$$
where:
- $v_{avg} = 45\, \text{km/hr}$
- $t = 1\, \text{minute} = \frac{1}{60}\, \text{hour}$

Calculate:
$$
\text{Distance} = 45\, \text{km/hr} \times \frac{1}{60}\, \text{hr} = \frac{45}{60} = 0.75\, \text{km}
$$

The car travels 0.75 km in 1 minute during its acceleration from 30 km/hr to 60 km/hr.

Alternative Approach: Calculating Distance Using Kinematic Equations

Using the Equation for Distance Under Uniform Acceleration

When acceleration is uniform, the distance traveled is given by:

$$
s = ut + \frac{1}{2} a t^2
$$

where:

- u = initial velocity
- a = acceleration
- t = time

Converting Speeds to Meters per Second

Since SI units are standard in physics calculations, convert speeds from km/hr to m/sec:

$$
1\, \text{km/hr} = \frac{1000}{3600} \approx 0.27778\, \text{m/sec}
$$

Calculate:

- $u = 30\, \text{km/hr} = 30 \times 0.27778 \approx 8.33\, \text{m/sec}$
- $v = 60\, \text{km/hr} = 60 \times 0.27778 \approx 16.67\, \text{m/sec}$

Determine acceleration:

$$
a = \frac{v - u}{t} = \frac{16.67 - 8.33}{60} \approx \frac{8.34}{60} \approx 0.139\, \text{m/sec}^2
$$

Calculate distance:

$$
s = ut + \frac{1}{2} a t^2
$$

$$
s = 8.33 \times 60 + \frac{1}{2} \times 0.139 \times 60^2
$$

$$
s = 499.8 + 0.0695 \times 3600
$$

$$
s = 499.8 + 250.2 = 750\, \text{meters}
$$

This matches the earlier calculation of 0.75 km, confirming our result.

Real-World Applications and Significance

Driving and Traffic Safety

Understanding average speeds helps drivers maintain safe and legal speeds, plan travel times, and analyze traffic flow. For example:
- Estimating arrival time based on average speeds
- Assessing the impact of acceleration on fuel consumption

Vehicle Performance and Engineering

Engineers utilize average speed calculations to optimize vehicle acceleration profiles, design better transmission systems, and improve fuel efficiency.

Physics Education

Problems like this serve as excellent examples for students learning about kinematics, acceleration, and motion dynamics.

Common Misconceptions About Average Speed

- **Average speed is not always the same as the speed at the midpoint of the journey.** For example, if a car travels at 30 km/hr for half the time and 60 km/hr for the other half, the average speed is not simply the midpoint (45 km/hr), but calculated as total distance over total time.

- **Average speed during acceleration can be calculated simply as the mean of initial and final speeds**

only when acceleration is uniform.

Summary and Key Takeaways

- When a vehicle accelerates uniformly from 30 km/hr to 60 km/hr over a period of 1 minute, its average speed during that interval is 45 km/hr.
- The calculation relies on the principle that, under uniform acceleration, the average velocity is the mean of initial and final velocities.
- The total distance traveled during this period is approximately 0.75 km.
- Converting units to SI (meters per second) provides a more precise calculation and confirms the results.
- Understanding these concepts is vital for practical applications in driving, vehicle engineering, and physics education.

FAQs About Average Speed During Acceleration

Q1: Does the average speed depend on the acceleration rate?

A: No, if the acceleration is uniform, the average speed depends only on the initial and final velocities, not on how quickly the acceleration occurs.

Q2: How would the average speed change if the acceleration was non-uniform?

A: In non-uniform acceleration, the average speed is not simply the mean of initial and final speeds. You would need to integrate the velocity over time or use specific data points to calculate the average.

Q3: Can the average speed be higher than the final speed?

A: No. The average speed during a uniform acceleration from a lower to a higher speed will always be between the initial and final speeds.

In conclusion, understanding how to compute the average speed during steady acceleration provides valuable insights into motion dynamics. In the specific case of a car accelerating from 30 km/hr to 60 km/hr over one minute

Frequently Asked Questions

What is the average speed of a car that accelerates steadily from 30 km/hr to 60 km/hr in 1 minute?

The average speed is 45 km/hr, which is the midpoint between the initial and final speeds.

How do you calculate the average speed of a car accelerating uniformly over a period?

For uniform acceleration, the average speed is the mean of the initial and final speeds: (initial speed + final speed) / 2.

If a car increases its speed from 30 km/hr to 60 km/hr in 1 minute, what is its total distance covered during this time?

The total distance covered is 0.75 km or 750 meters, calculated as average speed (45 km/hr) multiplied by time (1 hour).

Why is the average speed of a car increasing uniformly from 30 km/hr to 60 km/hr calculated as 45 km/hr?

Because when speed increases uniformly, the average speed is simply the mean of the initial and final speeds, which is (30 + 60)/2 = 45 km/hr.

What is the significance of calculating average speed in uniformly accelerated motion?

It helps determine the overall rate of travel over the time interval, simplifying calculations for distance covered during acceleration.

Additional Resources

A Car Increase Its Speed Steadily From 30km/hr To 60km/hr In 1 Min A What Is The Average Speed During

Imagine a scenario where a car starts its journey at a modest speed of 30 km/hr and accelerates uniformly over a period of one minute until reaching a speed of 60 km/hr. Such a situation is common in everyday driving, whether it's a vehicle leaving a stoplight or gradually speeding up on a highway entrance ramp. But how do we determine the average speed during this acceleration? Is it simply the mean of the initial and final speeds, or is there more to consider? This article explores the concept of average speed during uniform acceleration, provides detailed calculations, and discusses how understanding these principles can be useful for drivers, engineers, and students alike.

Understanding Average Speed and Uniform Acceleration

What Is Average Speed?

Average speed is a fundamental concept in kinematics, representing the total distance traveled divided by the total time taken. Mathematically, it is expressed as:

Average Speed (V_{avg}) = Total Distance (S) / Total Time (T)

In scenarios where an object moves at a constant speed, calculating the average speed is straightforward because the instantaneous speed remains the same throughout. However, when the object accelerates or decelerates, the situation becomes more nuanced.

Uniform Acceleration Defined

Uniform acceleration occurs when an object's velocity changes at a constant rate over time. In the context of our scenario, the car accelerates steadily from 30 km/hr to 60 km/hr over one minute. The key properties of uniform acceleration include:

- Constant rate of change of velocity
- Linear variation of speed with time
- Predictable relationships between initial velocity, final velocity, acceleration, and displacement

Understanding these properties allows us to derive formulas that can help us compute average speed accurately during the acceleration phase.

Deconstructing the Scenario: From 30 km/hr to 60 km/hr in 1 Minute

Given Data and Assumptions

Let's list the known parameters:

- Initial velocity, $u = 30\, \text{km/hr}$
- Final velocity, $v = 60\, \text{km/hr}$
- Time taken, $t = 1\, \text{minute} = 60\, \text{seconds}$

Note: To perform calculations consistently, it is best to convert velocities into meters per second.

Conversion:

- $1\, \text{km/hr} = \frac{1000}{3600} = \frac{1}{3.6}\, \text{m/sec}$

Therefore:

- $u = 30\, \text{km/hr} = 30 \times \frac{1}{3.6} \approx 8.33\, \text{m/sec}$
- $v = 60\, \text{km/hr} = 60 \times \frac{1}{3.6} \approx 16.67\, \text{m/sec}$

Calculating the Average Speed During Acceleration

The Common Misconception: Taking the Mean of Initial and Final Speeds

A common approach when dealing with uniform acceleration is to calculate the average speed as the arithmetic mean:

$V_{avg} = (u + v) / 2$

Applying this:

$$
V_{avg} = \frac{8.33 + 16.67}{2} = \frac{25}{2} = 12.5\, \text{m/sec}
$$

Converting back to km/hr:

$$
12.5 \times 3.6 = 45\, \text{km/hr}
$$

This suggests that, during the acceleration from 30 km/hr to 60 km/hr over a minute, the average speed is approximately 45 km/hr.

Why Is the Mean of Speeds Valid Here?

In cases of uniform acceleration, the average speed over the period is exactly the mean of the initial and final speeds. This is because the velocity changes linearly over time, and the average value of a linear function over an interval is simply the average of its endpoints.

Mathematically:

$$
V_{avg} = \frac{u + v}{2}
$$

This holds true only when acceleration is uniform, making the velocity-time graph a straight line.

Alternative Approach: Using Displacement and Time

To double-check this, we can calculate the total distance traveled during the acceleration:

$$
\text{Displacement } S = \frac{(u + v)}{2} \times t
$$

Plugging in the values:

$$
S = \frac{8.33 + 16.67}{2} \times 60 = 12.5 \times 60 = 750\, \text{meters}
$$

Then, the average speed:

$$
V_{avg} = \frac{S}{t} = \frac{750}{60} = 12.5\, \text{m/sec}
$$

which confirms our previous calculation.

Understanding the Physics: How Does This Work?

Velocity-Time Graph for Uniform Acceleration

Imagine plotting velocity (vertical axis) against time (horizontal axis). For uniform acceleration:

- The graph is a straight line
- The line starts at u and ends at v

The area under this line represents displacement, which is a trapezoid:

$$
S = \text{Area} = \frac{(u + v)}{2} \times t
$$

This geometric interpretation reinforces that the average speed during uniform acceleration is the mean of initial and final velocities.

Implication for Real-World Driving

In real driving conditions, acceleration may not be perfectly uniform. But in controlled scenarios or theoretical models, assuming uniform acceleration simplifies calculations and provides useful estimates.

Practical Significance and Applications

Driving and Vehicle Dynamics

Understanding average speed during acceleration helps drivers estimate travel times more accurately, especially in situations involving gradual speed increases, such as merging onto highways or city driving with frequent stops.

Engineering and Design

Automobile engineers use these principles to design acceleration profiles, optimize fuel efficiency, and enhance safety features. For instance, knowing how long a vehicle takes to reach certain speeds assists in designing better acceleration controls.

Transportation Planning

Transit authorities and urban planners analyze average speeds and acceleration patterns to improve traffic flow, reduce congestion, and design better road infrastructure.

Limitations and Considerations

- Non-uniform acceleration: Real-world acceleration often involves variable rates, making the simple average less accurate.
- External factors: Friction, road incline, and driver behavior influence actual speeds and distances.
- Measurement accuracy: Precise measurement of initial and final speeds, as well as timing, is essential for accurate calculations.

Summary and Final Thoughts

In the scenario where a car accelerates uniformly from 30 km/hr to 60 km/hr over one minute, the average speed during this period is 45 km/hr. This conclusion is supported by the principles of kinematics, particularly the properties of uniform acceleration and the geometric interpretation of velocity-time graphs.

Understanding these concepts not only enriches our knowledge of physics but also has practical implications in transportation, vehicle design, and everyday driving. Whether you're a student learning about motion or a driver trying to estimate your travel time, recognizing that the average speed during steady acceleration is the mean of the initial and final speeds can be a useful and straightforward tool.

In conclusion, during uniform acceleration, the average speed is simply the midpoint between the starting and ending velocities, providing a clear and elegant answer to what might seem like a complex problem at first glance.

A Car Increase Its Speed Steadily From 30km Hr To 60km Hr In 1 Min A What Is The Average Speed During

A Car Increase Its Speed Steadily From 30km Hr To 60km Hr In 1 Min A What Is The Average Speed During

Related Articles

- A Closed Rectangular Faced Box With A Square Base Is To Be Constructure Using Only 16m^2 Of Material.
- Which Day-to-day Responsibility Of A Project Manager Includes Maintaining Timelines And Schedules To
- What Would Be The Price Of A Perpetuity Bond That Has A 5100 Interest Payment And 5% Yield A. $5.000

Back to Home