A Body Moves On A Coordinate Line Such That It Has A Position S = F(t)=1 - 5t + 4 On The Interval 05158,

A Body Moves On A Coordinate Line Such That It Has A Position S = F(t)=1 - 5t + 4 On The Interval 05158, exploring the motion of objects along a line is fundamental in understanding kinematics, calculus, and physics. The given function, S = F(t) = 1 - 5t + 4, describes the position of a moving body at any given time t within a specified interval. In this article, we will analyze this motion in detail, examining the concepts of position, velocity, acceleration, and overall movement patterns. Whether you are a student studying physics or a curious enthusiast, understanding this type of problem will enhance your grasp of how objects move along a one-dimensional line.

Understanding the Position Function S = F(t) = 1 - 5t + 4

Simplifying the Function

The given position function is:
$$S(t) = 1 - 5t + 4$$
which simplifies to:
$$S(t) = (1 + 4) - 5t = 5 - 5t$$
This linear function indicates that the position of the body depends linearly on time t. The coefficients tell us how the position changes with respect to time.

Interval of Interest

The interval specified is 0 to 5, with t ∈ [0, 5]. Within this interval, the position function will be evaluated to understand the movement patterns, direction of motion, and key points such as maximum, minimum, and points where the body may change direction.

Analyzing the Motion

Position at Key Time Points

Calculating the position at the start, middle, and end of the interval gives us a clear picture:

- At t = 0: S(0) = 5 - 50 = 5
- At t = 2: S(2) = 5 - 52 = 5 - 10 = -5
- At t = 5: S(5) = 5 - 55 = 5 - 25 = -20

This shows the position decreases linearly as time progresses, indicating the body moves in a specific direction along the line.

Velocity of the Body

The velocity function is the first derivative of the position function:
$$ v(t) = S'(t) = \frac{d}{dt}(5 - 5t) = -5 $$
Since the velocity is a constant -5, the body moves at a uniform rate in the negative direction along the coordinate line.

Implication of Constant Velocity

A constant velocity implies uniform motion, meaning the body covers equal distances in equal intervals of time. Specifically, it moves 5 units in magnitude per unit time, but in the negative direction because of the negative sign.

Key Concepts in Motion Analysis

Direction of Movement

- Since $v(t) = -5$ (a negative constant), the body moves consistently toward decreasing coordinate values.
- The body starts at position $S(0) = 5$ and moves toward more negative positions as time increases.

Time to Reach Specific Positions

- To find when the body reaches a particular position, solve for t:
$$ S(t) = 5 - 5t = \text{desired position} $$
- For example, to find when it reaches position 0:
$$ 0 = 5 - 5t \Rightarrow 5t = 5 \Rightarrow t = 1 $$
- Similarly, for position -10:
$$ -10 = 5 - 5t \Rightarrow 5t = 15 \Rightarrow t = 3 $$

Displacement and Total Distance Traveled

- Since velocity is constant, displacement over the interval [0, t] is:
$$ \text{Displacement} = S(t) - S(0) $$
- Total distance traveled is the absolute sum of all movement segments, which in this case is straightforward due to uniform motion.

Acceleration and Its Effect

Calculating Acceleration

The acceleration function is the derivative of velocity:
$$ a(t) = v'(t) = 0 $$
The zero acceleration indicates uniform motion with no change in velocity.

Physical Interpretation

- No acceleration means the body does not speed up or slow down; it maintains a constant velocity.
- This simplifies the analysis, as the motion is linear and predictable.

Visualizing the Movement

Graphing Position vs. Time

- The graph of $S(t) = 5 - 5t$ is a straight line with a slope of -5.
- The y-intercept is at 5 when $t=0$.
- The line decreases uniformly, crossing the t-axis at $t=1$ (position 0), then continuing downward to $t=5$ at position -20.

Graphing Velocity vs. Time

- A horizontal line at $v(t) = -5$ indicates constant velocity.

Overall Movement Pattern

- The body starts at position 5 at $t=0$.
- It moves steadily toward more negative positions.
- By $t=5$, it reaches position -20.

Applications and Real-World Examples

Physics and Engineering

- Understanding linear motion with constant velocity is fundamental in physics.
- Designing systems where uniform motion is desired, such as conveyor belts or vehicles moving at constant speeds.

Tracking and Navigation

- Position functions help in predicting where an object will be at a future time.
- Useful in GPS tracking, robotics, and automated systems.

Mathematical Modeling

- Linear functions like $S(t) = 5 - 5t$ serve as simple models for more complex motions.
- Extending to non-linear functions allows modeling acceleration and more intricate movement patterns.

Summary and Conclusions

The analysis of the motion described by the position function $S = 5 - 5t$ over the interval $[0, 5]$ reveals a uniform movement in the negative direction along a coordinate line. The constant velocity of -5 units per time unit simplifies the understanding of how the body moves from its initial position at $t=0$ to a final position at $t=5$. Key insights include the linear nature of the motion, the unchanging speed, and the predictable path.

Understanding such functions is crucial in physics, engineering, and mathematics, providing foundational knowledge for analyzing more complex scenarios involving acceleration, oscillations, or non-linear movement. Whether for academic purposes or practical applications, mastering the analysis of linear motion functions like this forms a core part of understanding the dynamics of objects in motion.

Additional Resources:
- Calculus tutorials on derivatives and motion
- Physics textbooks on kinematics
- Software tools for graphing functions and simulating motion

Frequently Asked Questions

What is the position function of the body on the coordinate line?

The position function is $S(t) = 1 - 5t + 4$.

What is the interval over which the position function is defined?

The position function is defined over the interval $[0, 5, 1, 5, 8]$, which appears to be a typo; likely meant as $[0, 5, 1, 5, 8]$, but should be clarified.

How do you interpret the function $S(t) = 1 - 5t + 4$?

It represents the position of the body at time t, with the position changing linearly as t varies.

What is the initial position of the body at $t = 0$?

At $t = 0$, $S(0) = 1 - 5(0) + 4 = 1 + 4 = 5$.

How does the position change as time increases?

Since the coefficient of t is -5, the position decreases by 5 units per unit increase in t, indicating the body moves in the negative direction along the line.

At what time does the body reach the position S(t) = 0?

Set S(t) = 0: 0 = 1 - 5t + 4, which simplifies to 5t = 5, so t = 1.

What is the velocity of the body?

The velocity is the derivative of S(t), which is dS/dt = -5, indicating constant velocity in the negative direction.

Is the motion uniform, and why?

Yes, because the velocity is constant (-5), indicating uniform motion along the line.

How can we determine the total displacement over the interval?

Calculate S at the endpoints of the interval and subtract: displacement = S(t_end) - S(t_start).

Additional Resources

A Body Moves On A Coordinate Line Such That It Has a Position S = F(t) = 1 - 5t + 4 on The Interval 0 ≤ t ≤ 5,

Understanding the motion of a body along a coordinate line is fundamental in physics and mathematics, providing insight into concepts such as velocity, acceleration, and the overall nature of movement. This article delves deeply into the analysis of a specific position function, $S = F(t) = 1 - 5t + 4$, over the interval $0 \leq t \leq 5$. Through detailed examination, we will explore the mathematical foundations, interpret physical meaning, and analyze the behavior of the moving body at various points within the given interval.

Introduction to the Motion and the Position Function

Understanding the Position Function

The position function $S = F(t) = 1 - 5t + 4$ describes how the location of a body on a one-dimensional coordinate line varies over time t. At any specific instant t, the value of S provides the body's position relative to a chosen origin.

Notably, the given function simplifies as:

$$
F(t) = (1 + 4) - 5t = 5 - 5t
$$

which is a linear function with a slope of -5 and a y-intercept at 5.

This form suggests that the body's position decreases linearly as time increases, indicating a uniform motion with a constant velocity component.

Interval of Interest

The interval $0 \leq t \leq 5$ specifies the period during which observations or measurements are considered. This interval is crucial for analyzing the body's behavior, as it encompasses the initial time ($t=0$) through to $t=5$.

Mathematical Analysis of the Position Function

Simplification and Basic Properties

Given:

$$
F(t) = 5 - 5t
$$

- Initial position ($t=0$):

$$
F(0) = 5 - 5 \times 0 = 5
$$
The body starts at position 5 units from the origin.

- Position at the end of the interval ($t=5$):

$$
F(5) = 5 - 5 \times 5 = 5 - 25 = -20
$$
The body reaches position -20 units, indicating it has moved past the origin into the negative side of the coordinate line.

- Range of positions:

Since $F(t)$ is decreasing linearly:

$$
\text{Maximum position} = F(0) = 5
$$
$$
\text{Minimum position} = F(5) = -20
$$

The body travels a total distance of:

$$
|5 - (-20)| = 25
$$

which is the magnitude of displacement over the interval.

Velocity and Acceleration

- Velocity $v(t)$:

Velocity is the derivative of the position function with respect to time:

$$
v(t) = \frac{dF(t)}{dt} = -5
$$

This constant negative value indicates the body moves at a uniform speed of 5 units per time interval in the negative direction along the coordinate line.

- Acceleration $a(t)$:

Since the velocity is constant:

$$
a(t) = \frac{dv(t)}{dt} = 0
$$

There is no acceleration; the motion is uniform.

Physical Interpretation of the Motion

Uniform Motion in One Dimension

The constant velocity signifies a body moving at a steady rate without speeding up or slowing down. Because the velocity is negative, the body moves from positive to negative positions over time.

- Initial position: 5 units at $t=0$.
- Final position: -20 units at $t=5$.

The body covers 25 units in 5 seconds, implying a speed of 5 units/sec in the negative direction.

Implications of the Motion

This scenario is typical in introductory physics problems, illustrating fundamental concepts such as:

- Displacement: The net change in position, here (-25) units.
- Average velocity: Total displacement divided by total time:

$$
v_{avg} = \frac{-25}{5} = -5 \text{ units/sec}
$$

which matches the constant velocity derived from the derivative.

- Graphical interpretation: The straight line with slope -5 on the position vs. time graph confirms uniform motion.

Graphical Representation of the Motion

Plotting the Position Function

A graph of $F(t) = 5 - 5t$ over $t \in [0, 5]$:

- Starts at point (0, 5).
- Ends at point (5, -20).

The line decreases uniformly, illustrating the constant velocity.

Additional Graphical Insights

- The slope of the line is -5, reaffirming the negative velocity.
- The graph crosses the origin line at $t=1$:

$$
F(1) = 5 - 5 \times 1 = 0
$$

indicating the body passes through the origin at $t=1$.

Deeper Analytical Insights and Applications

Understanding Motion Parameters

By analyzing $F(t)$, several important parameters emerge:

- Time to reach specific positions:

Suppose we wish to find when the body reaches position $S = 0$:

$$
0 = 5 - 5t
\Rightarrow 5t = 5
\Rightarrow t=1
$$

Similarly, to find when the body reaches position -10:

$$
-10 = 5 - 5t
\Rightarrow 5t= 15
\Rightarrow t=3
$$

\]

- Time intervals between positions:

Between positions 0 and -10, the body takes:

\[
t=3 - 1 = 2 \text{ seconds}
\]

which aligns with the uniform velocity of 5 units/sec.

Implications in Real-World Contexts

This type of linear motion model can be applied to various real-world phenomena:

- Conveyor belts: objects moving at constant speed.
- Vehicles: cruising at a steady pace.
- Physics laboratory experiments: measuring uniform linear motion.

Understanding the nature of such functions provides a foundation for more complex motion analysis involving acceleration, forces, and non-linear behaviors.

Extensions and Further Analysis

Inclusion of Acceleration and Non-Linear Motion

While the current function indicates uniform motion, real-world scenarios often involve acceleration. For example, if the position function were quadratic, such as:

\[
S(t) = at^2 + bt + c
\]

then the analysis would involve:

- Deriving velocity as \(v(t) = 2at + b \).
- Understanding acceleration as \(a(t) = 2a \).

This extension allows modeling accelerative motions, such as objects under gravity or propelled systems.

Impacts of Changing the Function Form

Suppose the position function changes to include a quadratic term; then:

- The velocity would vary over time.
- The body could accelerate or decelerate during its motion.

Analyzing such functions involves advanced calculus, including second derivatives, to understand the body's

changing speed and direction.

Limitations of the Linear Model

While linear models like $F(t) = 5 - 5t$ are straightforward and instructive, they are limited to idealized scenarios. Real physical systems often involve resistance, friction, and forces leading to non-linear behaviors. Nonetheless, linear models serve as essential building blocks for understanding more complex dynamics.

Conclusion

The position function $S = F(t) = 5 - 5t$ exemplifies uniform motion along a coordinate line, showcasing fundamental principles in physics and mathematics. The analysis reveals that the body moves steadily at 5 units per second in the negative direction, beginning at position 5 at $t=0$ and reaching -20 at $t=5$. The function's linearity simplifies the interpretation, making it an ideal case for studying basic kinematic concepts such as displacement, velocity, and the graphical representation of motion.

Understanding such models is vital for students and professionals alike, as they form the foundation for analyzing more complex, real-world systems. The ability to interpret, analyze, and extend these basic functions equips learners with the tools necessary for exploring the rich dynamics of motion in various physical and engineering contexts. Whether applied in designing transportation systems, analyzing mechanical components, or understanding natural phenomena, the principles exemplified in this position function remain central to scientific inquiry.

References

- Physics textbooks on kinematics and motion analysis.
- Calculus resources for derivatives and function analysis.
- Mathematical modeling literature for real-world applications of linear and non-linear functions.

This comprehensive exploration underscores the elegance and utility of mathematical functions in describing motion, illustrating how simple models can reveal profound insights into the nature

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