

1. Session-1

1.1. Question 1

1.2. Question 2

1.3. Question-3

Note Information

- **ID:** 202501120904
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- **References:**

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Main Content

Main Idea

Suppose a particle is moving on the x -axis in a simple harmonic motion. Its velocity, in meters per second, at time t , for $0 \leq t \leq 100$ seconds, is given by $v(t) = -\frac{5}{3} \sin(\frac{t}{3})$. The total distance traveled by the particle in the time interval $0 \leq t \leq 21\pi$ seconds is 70 meters.

Explanation

The velocity of the particle is modeled by $v(t) = -\frac{5}{3} \sin(\frac{t}{3})$. The total distance the particle travels in the time interval $0 \leq t \leq 21\pi$ is equal to $\int_0^{21\pi} |v(t)| dt$, where $|v(t)| = \frac{5}{3} |\sin(\frac{t}{3})|$. Since $\sin(\frac{t}{3}) = 0$ when $t = 3n\pi$ for all integers n , the velocity function maintains its sign throughout the interval $[3n\pi, 3(n+1)\pi]$. The period for the velocity function is 6π , thus twice the aforementioned interval is equal to the full period. This relationship can be modeled through the following expressions:

$$\begin{aligned} \frac{5}{3} \int_0^{6\pi} |\sin(\frac{t}{3})| dt &= \frac{5}{3} \cdot 2 \int_0^{3\pi} \sin(\frac{t}{3}) dt \\ &= \frac{5}{3} \cdot 2 [-3 \cos(\frac{t}{3})]_0^{3\pi} \\ &= \frac{5}{3} \cdot 2 [6] \\ &= 20 \end{aligned}$$

The interval from 0 to 21π is equal to 3.5 periods. Therefore, the total distance traveled by the particle is equal to

$$3 \cdot 20 + \frac{5}{3} \cdot 6 = 70 \text{ meters}$$

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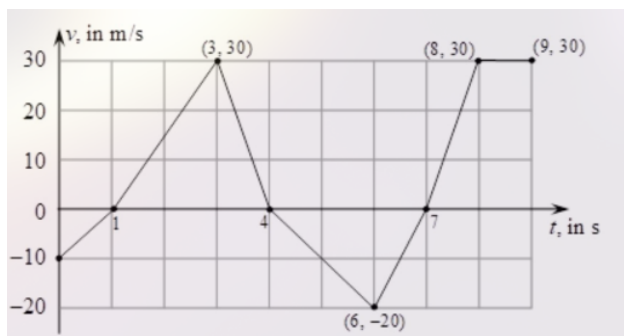
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Main Content

Main Idea

Suppose a particle is moving on the x -axis between the time $t = 0$ seconds and $t = 9$ seconds. Its initial position at $t = 0$ seconds is $x(0) = 2$ meters. The velocity-time graph of the motion is shown below.



On the x -axis, the abscissa of the farthest point to the right of the origin that the particle reaches over the time interval $0 \leq t \leq 9$ seconds is 42 meters. **Explanation**

By looking at the graph, we notice that the velocity is positive on the intervals $1 \leq t \leq 4$ and $7 \leq t \leq 9$. The velocity is negative on the intervals $0 \leq t \leq 1$ and $4 \leq t \leq 7$. The area under the curve between $t = 1$ and $t = 4$ is calculated by finding the area of the triangle with base 3 and height 30:

$$A_1 = \frac{1}{2} \cdot 3 \cdot 30 = 45$$

The area under the curve for the other three intervals are computed in a similar way below:

$$A_2 = \frac{1}{2} \cdot 1 \cdot 30 + 1 \cdot 30 = 30$$

$$A_3 = \frac{1}{2} \cdot 1 \cdot 10 = 5$$

$$A_4 = \frac{1}{2} \cdot 3 \cdot 20 = 30$$

Using the areas above, we can compute $x(t)$ at key times, using the fact that $x(t) = x(0) + \int_0^t v(t)dt$:

At $t = 1$:

$$x(1) = x(0) - A_3 = 2 - 5 = -3$$

At $t = 4$:

$$x(4) = x(1) + A_1 = -3 + 45 = 42$$

At $t = 7$:

$$x(7) = x(4) - A_4 = 42 - 30 = 12$$

At $t = 9$:

$$x(9) = x(7) - A_2 = 12 + 30 = 42$$

The particle is farthest to the right at $t = 4$ and $t = 9$, where:

$$x_{max} = 42 \text{ meters}$$

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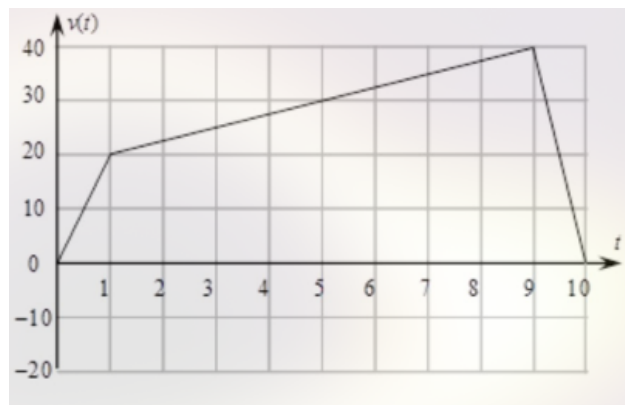
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Main Content

Main Idea

The velocity-time graph of a particle moving along a straight line is shown below. Time t is measured in minutes, and the velocity $v(t)$ is measured in meters per minute.



If the average acceleration of the particle in the time interval $1 \leq t \leq 9$ minutes is k m/min², the value of k is 2.5 m/min².

Explanation

The average acceleration can be calculated using the following formula:

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

According to the graph, $\Delta v = v(9) - v(1) = 40 - 20 = 20$. Thus,

$$k = \frac{20}{8} = \frac{5}{2} = 2.5 \text{ m/min}^2$$

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