Note Information

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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

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

Review

1.

Links to Other Notes

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