real-world-physics-problems.com
Jan. 12, 2020

This is a 1-D problem involving average velocity and average speed.

The position of an object moving along the x-axis is given by $x = -2t^3 + 2t^2 + 3t - 5$, where x is in meters, and t is in seconds.

(a) Find the position of the object at $t = 2.0\,s$, and $t = 3.5\,s$.

(b) What is the displacement of the object between 2.0 s and 3.5 s?

(c) What is the average velocity of the object between 2.0 s and 3.5 s?

(d) What is the average speed of the object between 2.0 s and 3.5 s?

Solution:

(a) At 2.0 s, $x = -2(2.0)^3 + 2(2.0)^2 + 3(2.0) - 5 = -7$ m (answer)

At 3.5 s, $x = -2(3.5)^3 + 2(3.5)^2 + 3(3.5) - 5 = -55.75$ m (answer)

(b) The displacement of the object is $x(3.5) - x(2.0)$

$= -55.75\,m - (-7\,m)$

$= -48.75$ m (answer)

(c) The average velocity of the object is:

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{-48.75m}{3.5s - 2.0s} = -32.5\,m/s \quad \text{(answer)}$$

(d) The average speed of the object is:

$$\bar{s} = \frac{\text{total distance}}{\Delta t}$$

The position of the object continuously decreases from $t = 2.0s$ to $t = 3.5s$, so the total travel distance is equal to the absolute value of the displacement.

Then, total distance = 48.75m

and $\bar{s} = \frac{48.75m}{3.5s - 2.0s} = 32.5\,m/s$ (answer)