

General Physics I

Classnotes

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1 Position

Let

x = position

x_i = initial position

x_f = final position

Δx = Displacement

$$= x_f - x_i$$

Example:

$$x_i = +3 \text{ ft}$$

$$x_f = +5 \text{ ft}$$

$$\Delta x = x_f - x_i$$

$$= 5 \text{ ft} - 3 \text{ ft}$$

$$= +2 \text{ ft}$$

Example:

$$x_i = +5 \text{ ft}$$

$$x_f = -1 \text{ ft}$$

$$\Delta x = x_f - x_i$$

$$= -1 \text{ ft} - 5 \text{ ft}$$

$$= -6 \text{ ft}$$

Example:

$$\begin{aligned}
 x_i &= +3 \text{ ft} \\
 x_2 &= +5 \text{ ft} \\
 x_f &= -1 \text{ ft} \\
 \Delta x &= x_f - x_i \\
 &= -1 \text{ ft} - 3 \text{ ft} \\
 &= -4 \text{ ft} \\
 \text{Distance Traveled} &= 2 \text{ ft} + 6 \text{ ft} \\
 &= 8 \text{ ft}
 \end{aligned}$$

2 Velocity

$$\begin{aligned}
 \bar{v} &= \text{average velocity} \\
 \bar{v} &\equiv \frac{\Delta x}{\Delta t} = \frac{\text{displacement}}{\text{time elapsed}} \\
 \text{average speed} &= \frac{\text{distance travelled}}{\text{time elapsed}}
 \end{aligned}$$

Example:

$$\begin{aligned}
 &\text{Start at } x = +3 \text{ ft} \\
 &\text{Move to } x = +5 \text{ ft} \\
 &\text{End at } x = -1 \text{ ft} \\
 &\text{Trip takes } 4 \text{ s} \\
 &\text{Find } a) \text{average velocity} \\
 &\quad b) \text{average speed} \\
 \bar{v} &\equiv \frac{\Delta x}{\Delta t} \\
 &= \frac{-1 \text{ ft} - 3 \text{ ft}}{4 \text{ s}} = \frac{-4 \text{ ft}}{4 \text{ s}} = -1 \text{ ft/s} \\
 \text{average speed} &= \frac{\text{distance}}{\text{time}} = \frac{8 \text{ ft}}{4 \text{ s}} = 2 \text{ ft/s}
 \end{aligned}$$

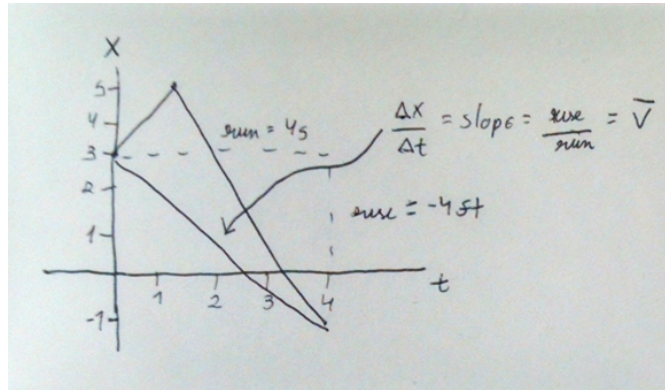


Figure 1: Graphic of the Average Speed

v = instantaneous velocity

$$= \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t}$$

$$v \equiv \frac{dx}{dt}$$

Example:

$$x = 3 \text{ m} + (17 \text{ m/s})t + (7 \text{ m/s}^3)t^3$$

Find

- a) position at $t = 2 \text{ s}$
- b) position at $t = 4 \text{ s}$
- c) average velocity from $2 \text{ s} \rightarrow 4 \text{ s}$

a)

$$\begin{aligned} x &= 3 \text{ m} + (17 \text{ m/s})(2 \text{ s}) + (7 \text{ m/s}^3)(2 \text{ s})^3 \\ &= 3 \text{ m} + 34 \text{ m} + 56 \text{ m} \\ &= 93 \text{ m} \end{aligned}$$

(1)

b)

$$\begin{aligned}x &= 3 \text{ m} + (17 \text{ m/s})(4 \text{ s}) + (7 \text{ m/s}^3)(4 \text{ s})^3 \\&= 3 \text{ m} + 68 \text{ m} + 448 \text{ m} \\&= 519 \text{ m}\end{aligned}$$

c)

$$\begin{aligned}\bar{v} &= \frac{\Delta x}{\Delta t} = \frac{519 \text{ m} - 93 \text{ m}}{4 \text{ s} - 2 \text{ s}} \\&= \frac{426 \text{ m}}{2 \text{ s}} \\&= 213 \text{ m/s}\end{aligned}$$

d)

$$\begin{aligned}v &= \frac{dx}{dt} \\&= \frac{d}{dt} [3 \text{ m} + (17 \text{ m/s})t + (7 \text{ m/s}^3)t^3] \\&= 0 + 17 \text{ m/s} + (21 \text{ m/s}^3)t^2 \\v(3 \text{ s}) &= 17 \text{ m/s} + (21 \text{ m/s}^3)(3 \text{ s})^2 \\&= 17 \text{ m/s} + 189 \text{ m/s} = 206 \text{ m/s}\end{aligned}$$

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v

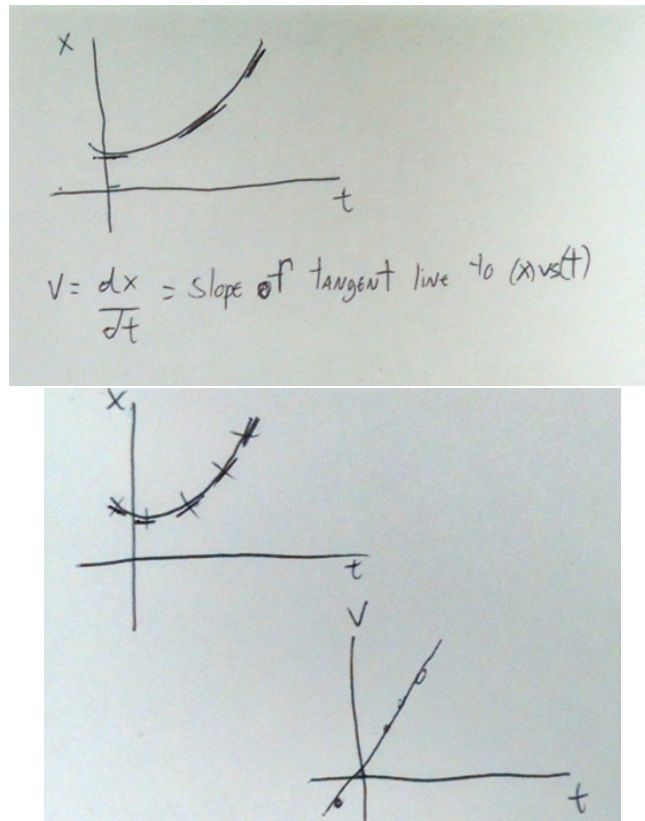


Figure 2: Graphics of Instantaneous Velocity