General Physics I
Classnotes

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1 Position

Let

$$\begin{aligned} x &= \text{position} \\ x_i &= \text{initial position} \\ x_f &= \text{final position} \\ \Delta x &= \text{Displacement} \\ &= x_f - x_i \end{aligned}$$

Example:

$$\begin{aligned} x_i &= +3\ ft \\ x_f &= +5\ ft \\ \Delta x &= x_f - x_i \\ &= 5\ ft - 3\ ft \\ &= +2\ ft \end{aligned}$$

Example:

$$\begin{aligned} x_i &= +5\ ft \\ x_f &= -1\ ft \\ \Delta x &= x_f - x_i \\ &= -1\ ft - 5\ ft \\ &= -6\ ft \end{aligned}$$

Example:

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

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:

$$\begin{aligned} \text{Start at } x &= +3\ ft \\ \text{Move to } x &= +5\ ft \\ \text{End at } x &= -1\ ft \\ \text{Trip takes } 4\ s & \\ \text{Find } a)&average velocity \\ b)&average speed \end{aligned}$$

$$\begin{aligned} \bar{v} &\equiv \frac{\Delta x}{\Delta t} \\ &= \frac{-1\ ft - 3\ ft}{4\ s} = \frac{-4\ ft}{4\ s} = -1\ ft/s \\ \text{average speed} &= \frac{\text{distance}}{\text{time}} = \frac{8\ ft}{4\ s} = 2\ ft/s \end{aligned}$$

$$
\begin{aligned}
v &= \text{instantaneous velocity} \\
&= \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} \\
v &\equiv \frac{dx}{dt}
\end{aligned}
$$

Example:

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

Find

a)position at $t = 2\ s$

b)position at $t = 4\ s$

c)average velocity from$2\ s \to 4\ s$

a)

$$
\begin{aligned}
x &= 3\ m + (17\ m/s)(2\ s) + (7\ m/s^3)(2\ s)^3 \\
&= 3\ m + 34\ m + 56\ m \\
&= 93\ m
\end{aligned}
\tag{1}
$$

b)

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

c)

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

d)

$$\begin{aligned} v &= \frac{dx}{dt} \\ &= \frac{d}{dt}\left[3\ m + (17\ m/s)t + (7\ m/s^3)t^3\right] \\ &= 0 + 17\ m/s + (21\ m/s^3)t^2 \\ v(3\ s) &= 17\ m/s + (21\ m/s^3)(3\ s)^2 \\ &= 17\ m/s + 189\ m/s = 208\ m/s \end{aligned}$$