Linear Kinematics

Describing Motion

(but not accounting for it)

Describing Motion

How far?

- Position

  Where something is relative to some defined origin.

- Path

  The total length of the trajectory an object takes.

- Displacement

  The straight-line distance from start to end.

Describing Motion

How fast (on average)?

- Average Speed

  Path per unit time = $\frac{Path}{Unit\ Time}$

- Average Velocity

  Displacement per unit time = $\frac{Displacement}{Unit\ time} = \frac{\Delta x}{\Delta t}$

Describing Motion

How fast?

- Instantaneous Speed

  How fast at a given instant = $\lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t} = \left| \frac{ds}{dt} \right|$

- Instantaneous Velocity

  How fast AND which direction at a given instant

  $= \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$

Describing Motion

How fast are you getting faster?

- Average Acceleration

$$a_{ave} = \frac{\Delta v}{\Delta t}$$

- Instantaneous Acceleration

$$a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

Example #5

The position of an object is described by

$$x(t) = 7.8 + 9.2t - 2.1t^2$$

where x is in meters and t is in seconds.

a) What are the units of the constant "–2.1"?

b) What is the displacement of the object during the time interval $0 < t < 3.5$ s?

Example #5 con’d

c) Determine the average velocity of the object over the time interval $0 < t < 3.5$ s.

d) Determine the velocity of the object 3.5 s into the motion.

e) Calculate the average the acceleration of the object over the time interval $0 < t < 3.5$ s.

f) Determine the acceleration of the object 3.5 s into the motion.

Example #6

You drive a car down a straight road due east for 5.2 miles at a speed of 65 mi/hr when you run out of gas. You walk 1.2 miles further down road to a gas station in 20 min. Determine your *average speed* from the time you got on the road to the time you arrived at the gas station.

You walk back to your car with the some gas in the gas can in 30 min. Determine your *average velocity* from the time you got on the road to the time you returned to your car.