Chapter 2 - Describing Motion

$\boxed{\text{position}}$ - where an object is relative to some other place.

$\boxed{\text{change in position}}$

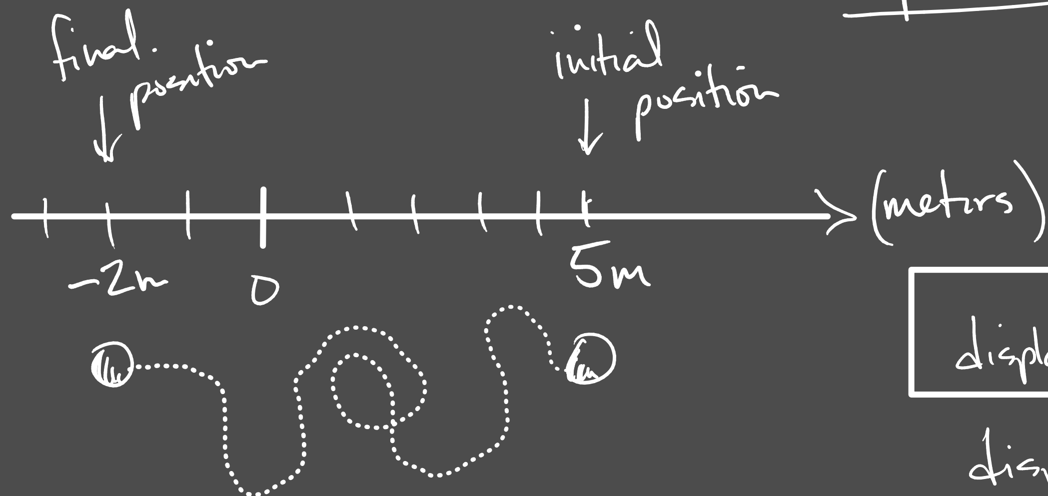
→ distance travelled

→ displacement → distance + direction

east / west

30° north of west

+ / −



$\boxed{\text{displacement} = \text{final position} - \text{initial position}}$

displacement = −2m − (+5m) = −7m

$\boxed{\text{time interval}}$ - t → time to get from initial position to final position

$\boxed{\text{rate of change of position}}$

ratio of distance/displacement and time

→ speed = $\dfrac{\text{distance}}{\text{time}}$

units → $\left[\dfrac{\text{miles}}{\text{hour}}\right]$ → $\left[\dfrac{\text{meters}}{\text{second}}\right]$

→ Velocity → speed and direction

$\hookrightarrow \dfrac{\text{displacement}}{\text{time}}$

$\boxed{\text{Average speed}}$

$\dfrac{85 \text{ miles}}{2 \text{ hours}} = 42.5 \text{ miles/hour}$ } trip to Montgomery

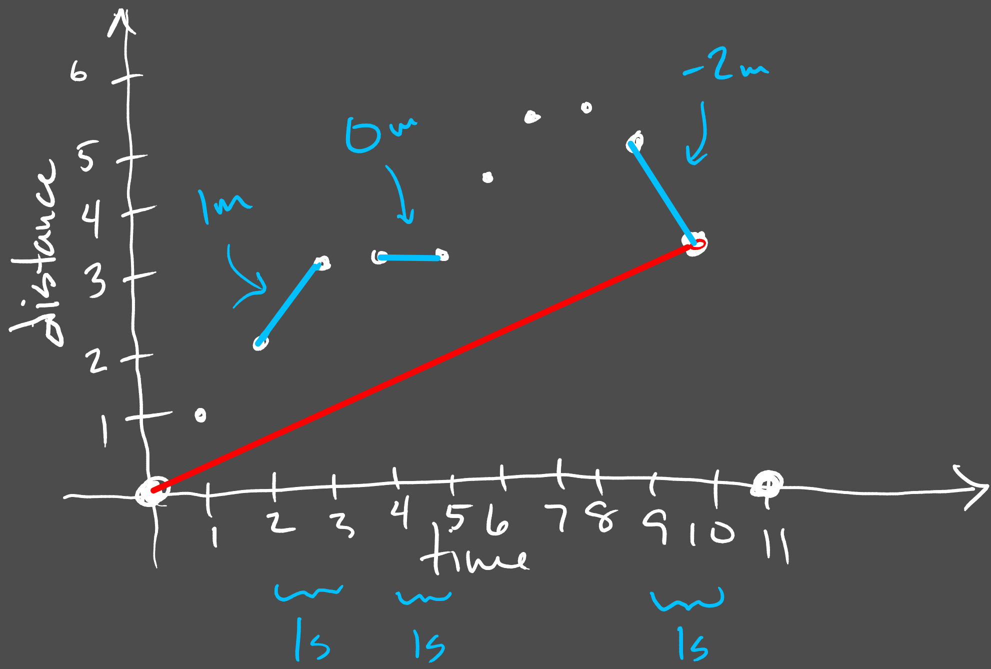
$\dfrac{150 \text{ miles}}{2.25 \text{ hours}} = 67 \text{ miles/hour}$ } trip to Atlanta

↳ ratio between long distances long times

having ratios makes comparing the trips easy

$\boxed{\text{Instantaneous speed}}$ → speedometer speed

↳ ratio of the distance and the smallest time interval possible



final position = 3m
initial position = 0m
time interval = 10s

$$\text{velocity} = \frac{\text{displacement}}{\text{time}}$$

$$\text{''} = \frac{\text{final position} - \text{initial position}}{\text{time}}$$

$$\text{''} = \frac{3m - 0m}{10s} = \frac{3m}{10s}$$

$$\text{''} = 0.3\ m/s$$

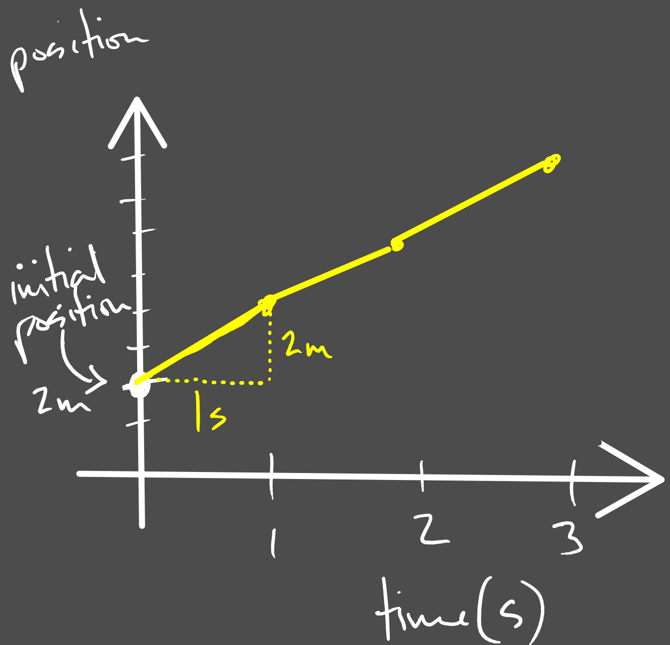
$$\boxed{\text{velocity} = \frac{\text{displacement}}{\text{time}}}$$

$$V_1 = \frac{1m}{1s} = 1\ m/s$$

$$V_2 = \frac{0m}{1s} = 0\ m/s$$

$$V_3 = \frac{-2m}{1s} = -2\ m/s$$

negative sign means going backwards



time	velocity	position	displacement
0-1s	2 m/s	4m	2m
1-2s	2 m/s	6m	2m
2-3s	2 m/s	8m	2m

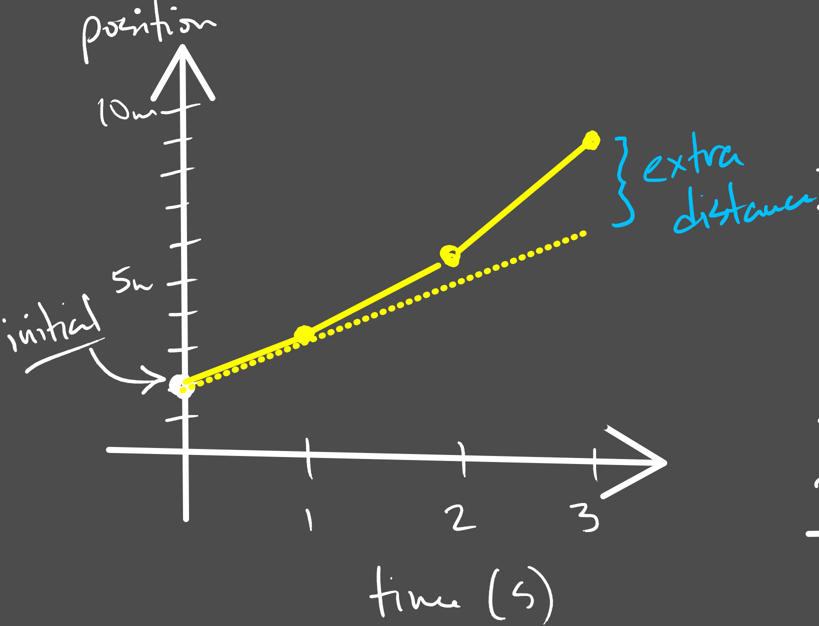
How long does it take to go 120 meters?

$$60s = \frac{120\,m}{2\,\frac{m}{s}} \quad \Big| \quad \frac{120\,\cancel{m}}{2} \cdot \frac{s}{\cancel{m}}$$

$$\text{velocity} = \frac{\text{displacement}}{\text{time}}$$

$$\text{displacement} = \text{velocity} \times \text{time}$$

$$\text{time} = \frac{\text{displacement}}{\text{velocity}}$$



time	velocity	position	displacement	change in velocity
0-1 s	1 m/s	3m	1m	
				1 m/s
1-2 s	2 m/s	5 m	2m	
				1 m/s
2-3 s	3 m/s	8m	3m	

Notice how the speed in the above problem was changing over time.

How much? How quickly?

Acceleration - rate of change of velocity

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time interval}}$$

What is the acceleration?

change →

$$a = \frac{\Delta\text{velocity}}{\Delta\text{time}} = \frac{1\text{ m/s}}{1\text{ s}}$$

$$a = 1\ \frac{\text{m/s}}{\text{s}} = 1\ \text{m/s}^2$$

what if acc changes over time?

$$\text{jerk} = \frac{\text{change in acc}}{\text{time}} \xrightarrow[\text{of change}]{\text{rate}} \text{snap} \xrightarrow[\text{of change}]{\text{rate}} \text{crackle} \xrightarrow[\text{of change}]{\text{rate}} \text{pop.}$$

So the rate of change of position is the speed (or velocity), and the rate of change of velocity is acceleration.

$$\boxed{v = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{\Delta t}}$$

$$\boxed{a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t}}$$

$$x_f = x_i + \underbrace{v \cdot \Delta t}_{\text{displacement}}$$

$$v_f = v_i + \underbrace{a \cdot \Delta t}_{\text{change in velocity}}$$

LIMITS

- constant velocity

  or

- short time interval

- constant acceleration

  or

- short time interval