Objectives: Students will understand the basic concepts of one-dimensional motion

Students will be able to describe the differences between displacement, velocity, and acceleration

Students will be able to solve physics problems involving displacement, velocity, and acceleration

What is 1-D motion?

Motion in a straight line:

things go one way or the other

+ / - values:

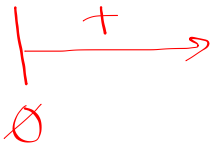
\+ : one direction

\- : the other one

Frame of reference:

Where is position 0?

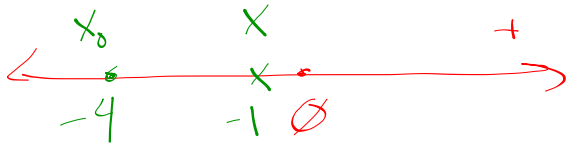
Which direction is +?



Displacement:

$\Delta x = x - x_0$

$-1 + -4 = +3$



- Measures how far something goes and in what direction (vector quantity)

x = an object's position (current)

x_0 = an object's position at $t = 0$

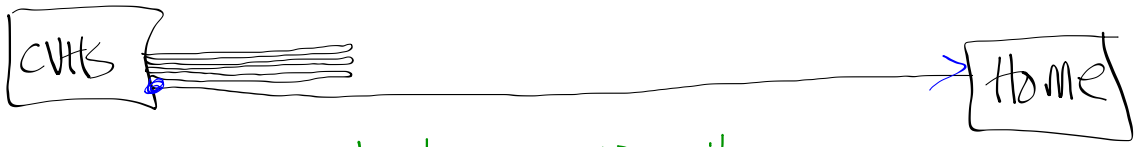
$\Delta x = x - x_0$ } displacement

- Difference between displacement and distance:

Distance has no direction. (Displacement does.)

Distance tells us the total length of an object's path.

Displacement only tells us how far an object is from where it started...



distance: 10 miles

disp. (Δx): 3 miles (East)

Velocity:

- Measures how fast something goes and its direction (vector quantity)

speed + direction

$$v = \frac{\Delta x}{\Delta t} = \frac{\text{displacement}}{\text{change in time}}$$

- Difference between speed and velocity:

speed has no direction (velocity does)

$$\text{speed} = \frac{\text{distance}}{\text{time}} \qquad \text{velocity} = \frac{\text{displacement}}{\text{time}}$$

- Difference between average and instantaneous velocity:

$$\bar{v} = \frac{\Delta x}{\Delta t}$$

real, measured number

$$v = \frac{\Delta x}{\Delta t}$$

as $\Delta t \Rightarrow 0$

Acceleration:

- Measures how fast something's velocity changes (no change = uniform velocity); includes direction (vector quantity)

$$a = \frac{\Delta v}{\Delta t}$$

- Anytime velocity changes, acceleration is occurring (3 ways)
  - speeds up
  - slows down
  - CHANGING DIRECTION (even if speed stays the same...)
- Difference between average acceleration and instantaneous acceleration

$$\bar{a} = \frac{\Delta v}{\Delta t}$$

actual #

$$a = \frac{\Delta v}{\Delta t}$$

as $\Delta t \Rightarrow 0$

Unit Conversions:

All the units for a given type of quantity in a problem have to match!

Use dimensional analysis -

1. Find a conversion factor (look up if necessary)
2. Write original number as a fraction
3. Multiply by conversion factor so that old units cancel and new units remain

27 mph $\Rightarrow$ m/s

$$\frac{27 \text{ miles}}{1 \text{ hr}} \cdot \frac{1609.34 \text{ meters}}{1 \text{ miles}} \cdot \frac{1 \text{ hr}}{3600 \text{ s}}$$

12.07 m/s

conv. fact #1:

$$\frac{1609.34 \text{ meters}}{1 \text{ mile}}$$

conv. fact. #2:

$$\frac{3600 \text{ s}}{1 \text{ hr}}$$

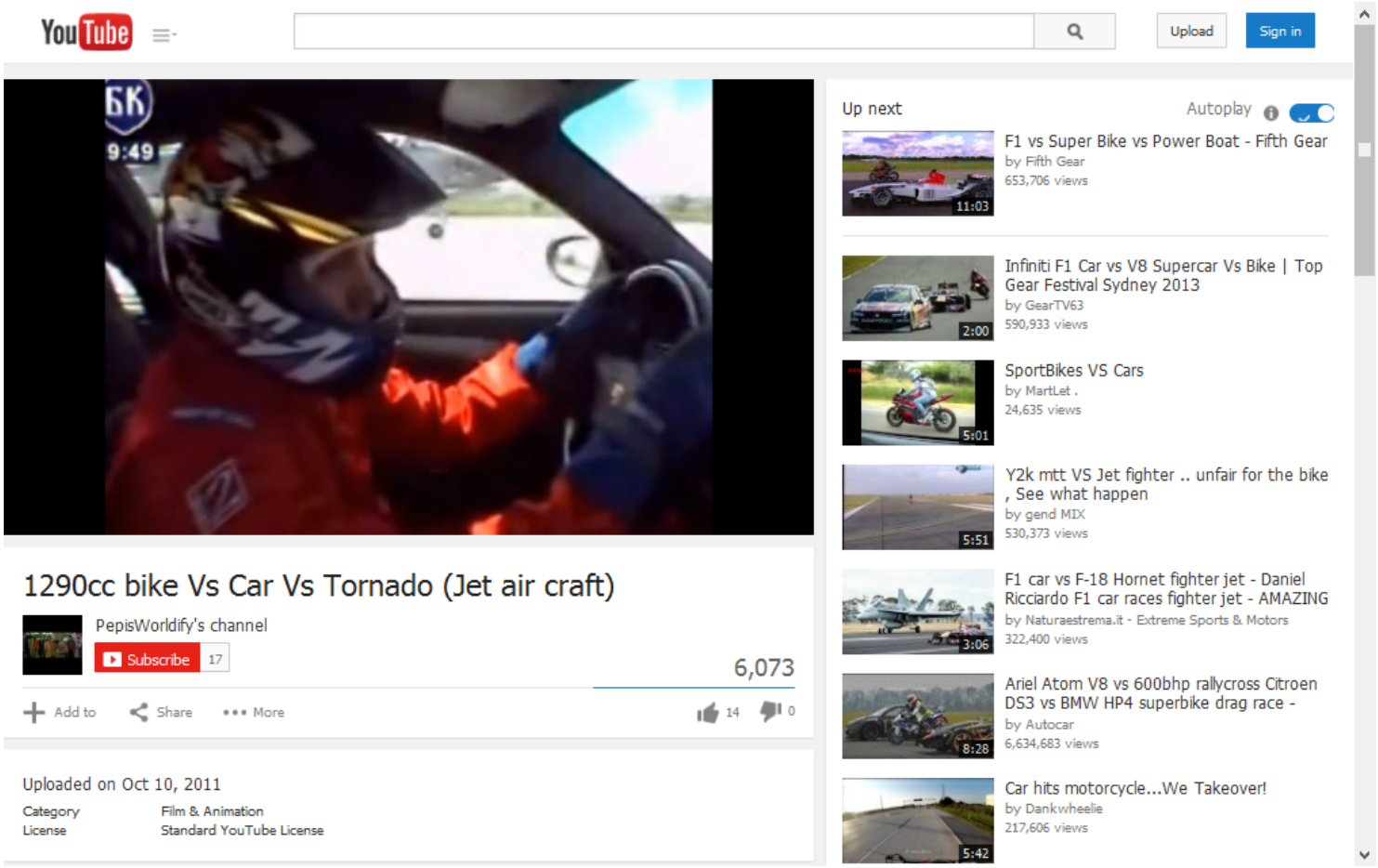
At an average speed of 11.8 km/h, how far will a bicyclist travel in 175 minutes?

$$\frac{175\ \text{min}}{1} \cdot \frac{1\ \text{hr}}{60\ \text{min}} = 2.92\ \text{hr} \qquad \frac{60\ \text{min}}{1\ \text{hr}}$$

$$\text{Speed} = \frac{d}{t}$$

$$2.92 \cdot \frac{11.8\ \text{km}}{\text{hr}} = \frac{d}{2.92\ \text{hr}} \cdot 2.92$$

$$\boxed{d = 34.46\ \text{km}}$$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