Average Velocity

Speed (v) is the distance an object travels during a given time interval divided by the time interval.

- ✓Speed is a scalar quantity.
- ✓The SI unit for speed is metres per second (m/s).

These two ski gondolas have the same speed (because they are attached to the same tow-line!)

Speed

Remember... This is what is measured on your car's "speedometer"!

Velocity

Velocity ($\vec{v}$) is the <u>displacement</u> of an object during a time interval divided by the time interval.

- ✓Velocity describes how fast an object's position is changing.

Velocity is a vector quantity and must include direction.

- ✓The direction of the velocity is the same as the direction of the displacement.

The SI unit for velocity is metres per second (m/s).

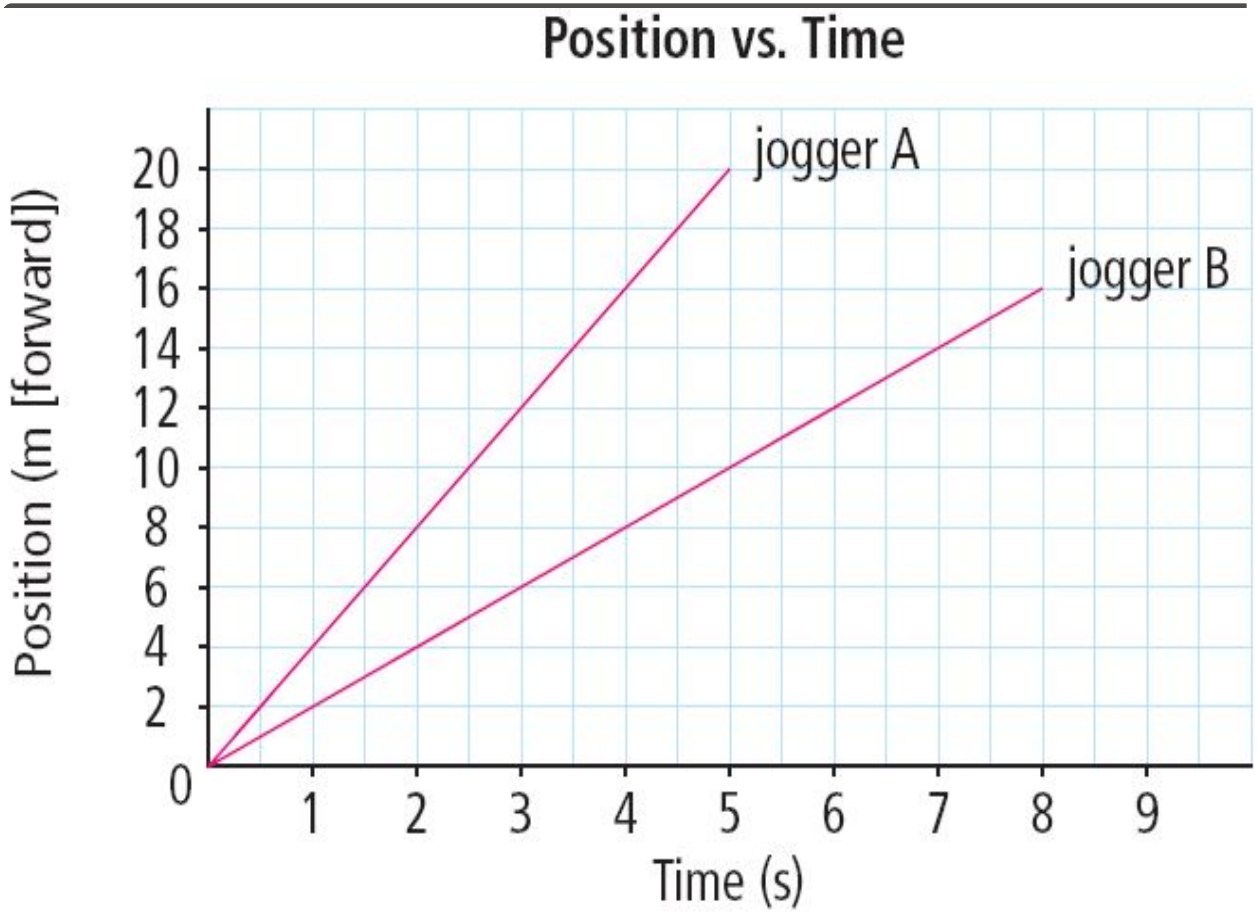
These two ski gondolas have different velocities because they are travelling in opposite directions!

Slope of a Position vs. Time Graph

- The slope of a graph is represented by rise/run.
- This slope represents the change in the *y*-axis divided by the change in the *x*-axis.
- On a position-time graph the slope is the change in position ( ) divided by the change in time ( ): Δd Δt

$$\text{slope} = \frac{\Delta d}{\Delta t}$$

- The steeper the slope the greater the change in displacement during the same time interval.



Which jogger's motion has a greater slope?
Which jogger is moving faster?

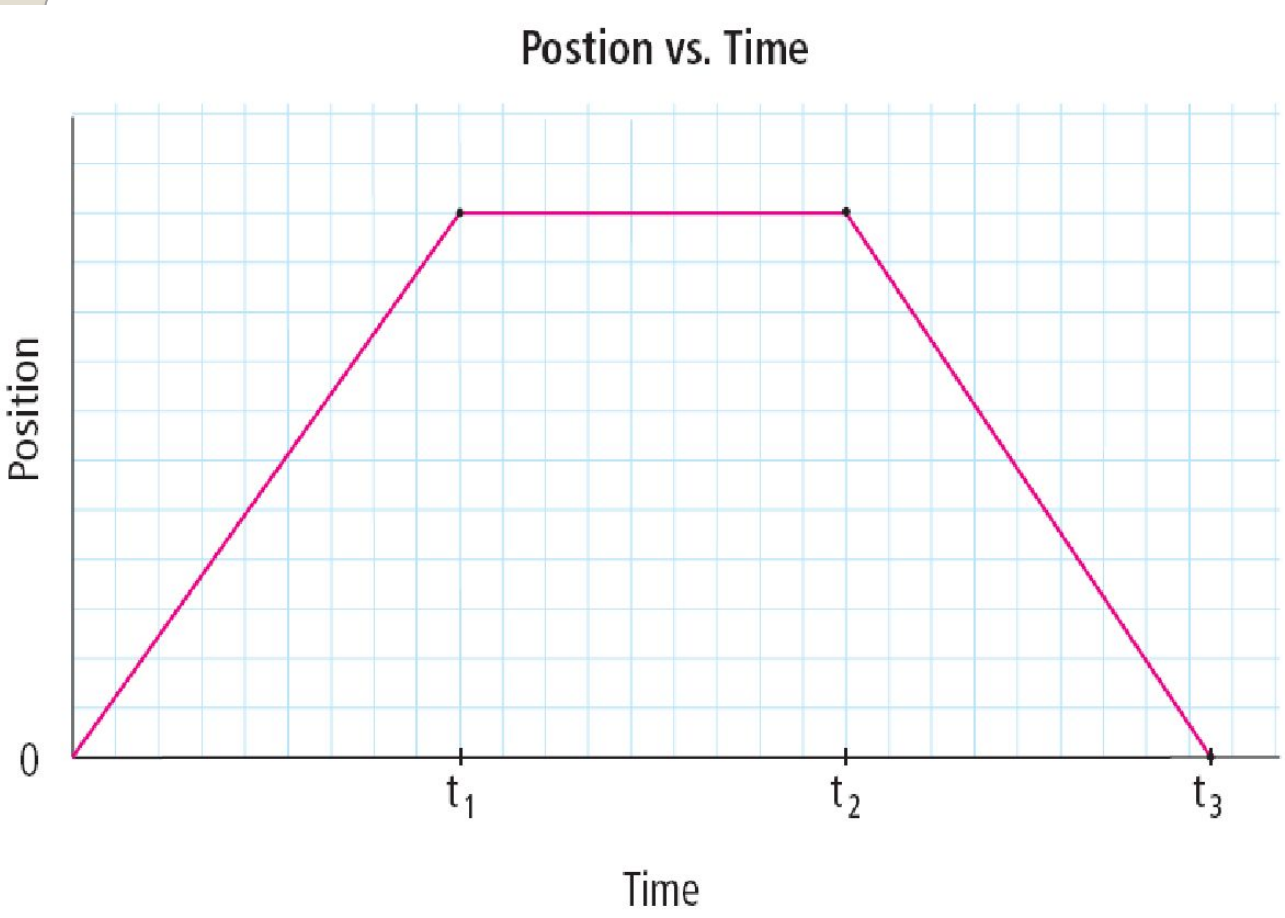
Graphing Position vs. Time...

Average Velocity

- The slope of a position-time graph is the object's average velocity.
- Average velocity is the rate of change in position for a time interval.
- The symbol of average velocity is: v_{av}

On a position-time graph, if forward is given a positive direction:

- A positive slope means that the object's average velocity is forward.
- A negative slope means that the object's average velocity is backward.
- Zero slope means the object's average velocity is zero (i.e. the object isn't moving!)



What is happening to the object between 0 and t_1?

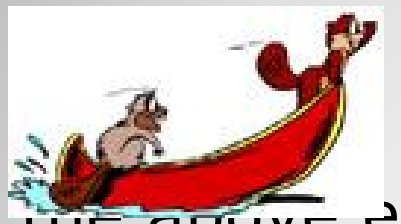
What is happening to the object between t_1 and t_2?

What is happening to the object between t_2 and t_3?

Average Velocity on a Graph...

Calculating Average Velocity

The relationship between average velocity, displacement, and time is given by:



$$\vec{v}_{av} = \frac{\Delta \vec{d}}{\Delta t}$$

Use the above equation to answer the following questions.

1. What is the average velocity of a dog that takes 4.0 s to run forward 14 m?

2. A boat travels 280 m east in a time of 120 s. What is the boat's average velocity?

Calculating Displacement

The relationship between displacement, average velocity, and time is given by:

$$\Delta \vec{d} = (\vec{v}_{av})(\Delta t)$$

Use the above equation to answer the following questions.

1. What is the displacement of a bicycle that travels 8.0 m/s [N] for 15 s?

2. A person, originally at the starting line, runs west at 6.5 m/s. What is the runner's displacement after 12 s?

Calculating Displacement

The relationship between displacement, average velocity, and time is given by:

$$\Delta \vec{d} = (\vec{v}_{av})(\Delta t)$$

Use the above equation to answer the following questions.

1. What is the displacement of a bicycle that travels 8.0 m/s [N] for 15 s? (120 m [N])

2. A person, originally at the starting line, runs west at 6.5 m/s. What is the runner's displacement after 12 s? (78 m west)

Calculating Time

The relationship between time, average velocity, and displacement is given by:

$$\Delta t = \frac{\Delta d}{v_{av}}$$

Use the above equation to answer the following questions.

1. How long would it take a cat walking north at 0.80 m/s to travel 12 m north?

2. A car is driving forward at [illegible] w
would it take this car to pa a
intersection that is 11 m long?

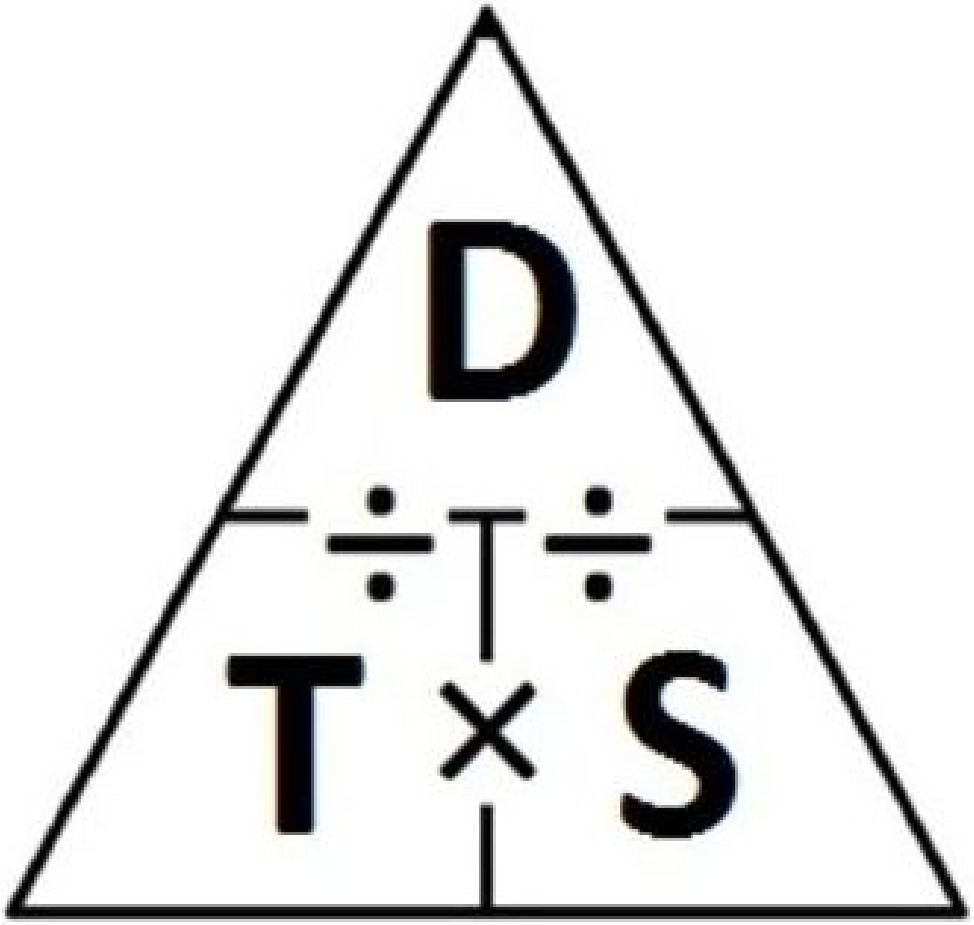
Calculating Time

The relationship between time, average velocity, and displacement is given by:

$$\Delta t = \frac{\Delta d}{v_{av}}$$

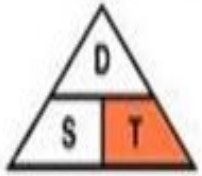
Use the above equation to answer the following questions.

1. How long would it take a cat walking north at 0.80 m/s to travel 12 m north? (15 s)
2. A car is driving forward at 15 m/s. How long would it take this car to pass through an intersection that is 11 m long? (0.73 s)

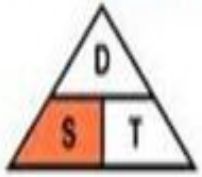


Calculating **Velocity**:
Distance/Speed/Time Triangle

Distance = Speed x Time



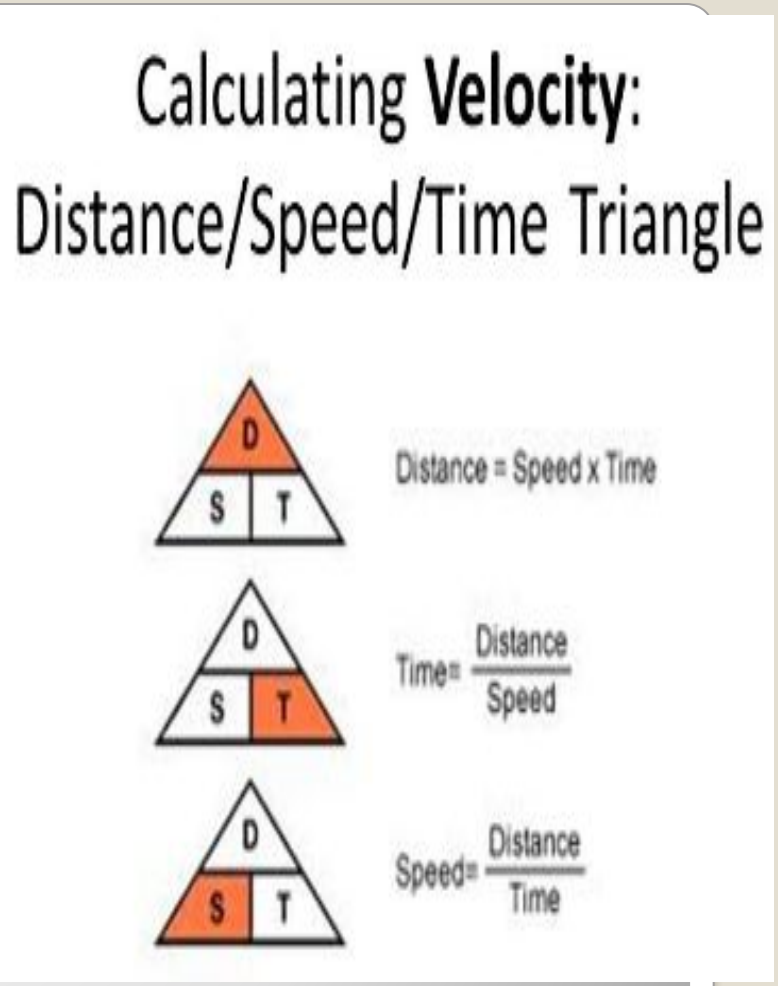
Time = $\frac{\text{Distance}}{\text{Speed}}$



Speed = $\frac{\text{Distance}}{\text{Time}}$

Relationship between Displacement, Time, & Velocity

- Distance (m) divided by time (s)
  - Gives VELOCITY (m/s)
- Distance (m) divided by velocity (m/s)
  - Gives TIME (s)
- Velocity(m/s) multiplied by time (s)
  - Gives DISTANCE (m)



Relationship between Displacement, Time, & Velocity

Converting between m/s and km/h

- To convert from km/h to m/s:
  - Change km to m: 1 km = 1000 m
  - Change h to s: 1 h = 3600 s
- Multiply by 1000 and divide by 3600

or

- Divide the speed in km/h by 3.6 to obtain the speed in m/s.

Speed zone limits are stated in kilometres per hour (km/h).

For example, convert 75 km/h to m/s.

$$\frac{75\ \text{km}}{1\ \text{h}} \times \left(\frac{1000\ \text{m}}{1\ \text{km}}\right) \times \left(\frac{1\ \text{h}}{3600\ \text{s}}\right) = 21\ \text{m/s}$$

Complete the two practice problems

Physics Unit Timeline

- Quick Quiz – average velocity, distance, time interval (Feb.16)
- Non-uniform Motion & Acceleration (Feb. 16)
- Review of the physics of motion (Feb. 20) (?Quiz on acceleration?)
- Big Bang Presentations (Feb. 22)
- Big Bang & Motion Unit Test (Feb. 27)