# Day 6: Motion (3 ec pts)

**#1 Motion:** The **velocity** of an object is the rate of change of its position.

a. **Position** is defined in relation to some choice of a standard reference point and a set of reference directions.

b. **Average speed** is the total distance traveled divided by the total time elapsed and that the speed of an object along the path traveled can vary.

c. Solve problems involving distance, time, and average speed.

d. The **velocity** of an object must be described by specifying both the *direction* and the *speed* of the object.

e. Changes in velocity may be due to changes in speed, direction, or both.

f. Interpret graphs of position versus time and graphs of speed versus time for motion in a single direction.

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| | Speed | Average Speed | Velocity |
|---|---|---|---|
| Explanation in your own words. | | | |
| Equation | | | |

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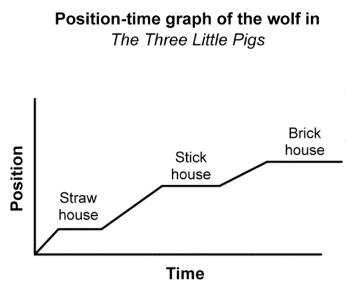
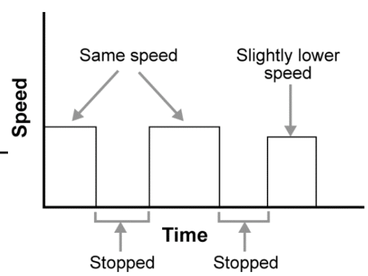
**2. Motion Graphs Without Numbers:** Remember the graphs that represent the story of "The Three Little Pigs"? The parts of the story are listed below:

- The wolf started from his house. The graph starts at the origin.
- Traveled to the straw house. The line moves upward.
- Stayed to blow it down and eat dinner. The line is flat because position is not changing.
- Traveled to the stick house. The line moves upward again.
- Again stayed, blew it down, and ate seconds. The line is flat.
- Traveled to the brick house. The line moves upward.
- Died in the stew pot at the brick house. The line is flat.




***It is your turn to make a notebook size (8x11) poster graphing the story of your choice! Here are the requirements:***

- Type or neatly write a story step by step.
- Create a position-time graph AND a speed-time graph that accurately represent the story.
- Here is how you will be graded:
  - 5 points for creativity of story of *at least 5 steps*
  - 5 points for accurate Position-Time graph
  - 5 points for accurate Speed-Time graph
  - 5 points for neatness
- The top 5 posters of each period will receive an additional 10 extra credit points.

# Solving Speed Problems

<table>
<tr><td colspan="2">Example: What is the speed of a cheetah that travels 112.0 meters in 4.0 seconds?</td></tr>
<tr><td>Looking for: Speed of cheetah</td><td rowspan="3">Solution<br>$$\text{speed} = \frac{d}{t} = \frac{112.0\text{ m}}{4.0\text{ s}} = \frac{28\text{ m}}{\text{s}}$$<br>The speed of the cheetah is 28 meters per second.</td></tr>
<tr><td>Given:<br>Distance = 112.0 meters<br>Time = 4.0 seconds</td></tr>
<tr><td>Relationship: $\text{speed} = \frac{d}{t}$</td></tr>
</table>

1. A bicyclist travels 60.0 kilometers in 3.5 hours. What is the cyclist's average speed?

2. What is the average speed of a car that traveled 300.0 miles in 5.5 hours?

3. How much time would it take for the sound of thunder to travel 1,500 meters if sound travels at a speed of 330 m/s?

4. A snail can move approximately 0.30 meters per minute. How many meters can the snail cover in 15 minutes?

5. A person in a kayak paddles down river at an average speed of 10 km/h. After 3.25 hours, how far has she traveled?

6. The speed of light is about $3.00 \times 10^5$ km/s. It takes approximately 1.28 seconds for light reflected from the moon to reach Earth. What is the average distance from Earth to the moon?

7. Suppose you are walking home after school. The distance from school to your home is five km. On foot, you can get home in 25 min. However, if you rode a bike, you could get home in 10 minutes.
   a. What is your average speed while walking?

   b. What is your average speed while bicycling?

   c. How much faster you travel on your bicycle?

# Solving *Velocity* Problems

**Remember:** The velocity of an object is determined by measuring both the *speed* and *direction* in which an object is traveling.

- If the speed of an object changes, then its velocity also changes.
- If the direction in which an object is traveling changes, then its velocity changes.
- A change in either **speed**, **direction**, or **both** causes a change in velocity.

You can use ***v = d/t*** to solve velocity problems. The velocity of an object in motion is equal to the distance it travels per unit of time in a given direction.

| **Example 1:** What is the velocity of a car that travels 100.0 meters, northeast in 4.65 seconds? | |
|---|---|
| **Looking for:** Velocity of the car. | **Solution** $\text{velocity} = \frac{d}{t} = \frac{100.0\text{ m}}{4.65\text{ s}} = \frac{21.5\text{ m}}{\text{s}}$ The velocity of the car is 21.5 meters per second northeast. |
| **Given:** Distance = 100.0 meters Time = 4.65 seconds | |
| **Relationship:** $\text{velocity} = \frac{d}{t}$ | |

1. An airplane flies 525 kilometers north in 1.25 hours. What is the airplane's velocity?

2. A soccer player kicks a ball 6.5 meters. How much time is needed for the ball to travel this distance if its velocity is 22 meters per second, south?

3. A bus is traveling at 79.7 kilometers per hour east, how far does the bus travel 1.45 hours?

4. A Girl Scout troop hiked 5.8 kilometers southeast in 1.5 hours. What was the troop's velocity?

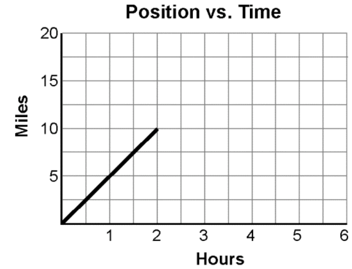
5. A driver realizes that she is traveling in the wrong direction on a one-way street. She has already driven 3.5 meters at a velocity of 16 meters per second, east before deciding to make a U-turn. How long did it take for the driver to realize her error?

6. A family drives 881 miles from Houston, Texas to Santa Fe, New Mexico for vacation. How long will it take the family to reach their destination if they travel at a velocity of 55.0 miles per hour, northwest?

7. A shopping cart is pushed 15.6 meters west across a parking lot in 5.2 seconds. What is the velocity of the shopping cart?

# Motion Graphs With Numbers

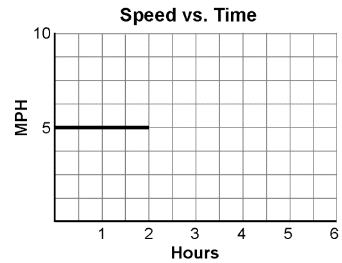
Speed can be calculated from position-time graphs and distance can be calculated from speed-time graphs. Both calculations rely on the familiar speed equation: $v = d/t$.




**Calculating speed from a position-time graph**

- The speed equation allows us to calculate that the boat's speed during this time was 5 miles per hour.

$$v = d/t$$
$$v = 10 \text{ miles} / 2 \text{ hours}$$
$$v = 5 \text{ miles/hour, read as 5 miles per hour}$$




- This result can now be transferred to a speed-time graph. Remember that this speed was measured during the first two hours.
- The line showing the boat's speed is horizontal because the speed was constant during the two-hour period.

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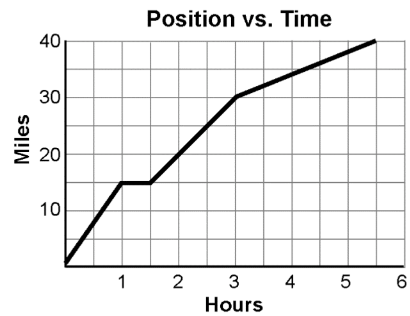
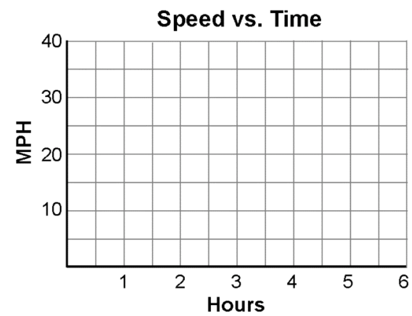
For each position-time graph, calculate and plot speed on the speed-time graph to the right.

a. The bicycle trip through hilly country

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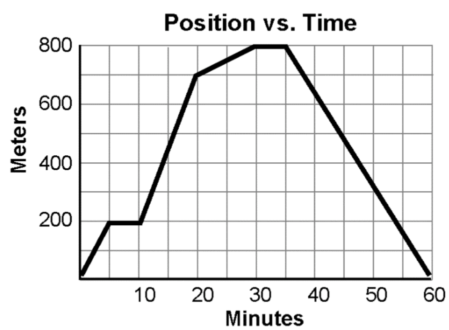
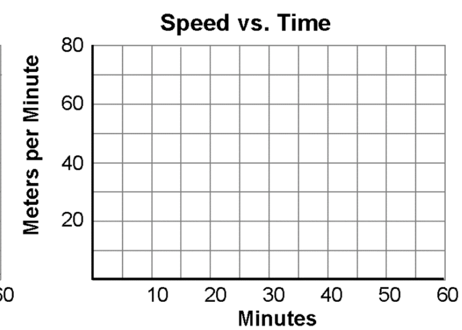
b. A walk in the park

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**Challenge:** Strolling up and down the supermarket aisles