Describing Motion Verbally with Speed and Velocity

Read from **Lesson 1** of the **1-D Kinematics** chapter at **The Physics Classroom**:

http://www.physicsclassroom.com/Class/1DKin/U1L1d.html

MOP Connection: Kinematic Concepts: sublevels 3 and 6

Review:

1. A _________ quantity is completely described by magnitude alone. A _________ quantity is completely described by a magnitude with a direction.
   a. scalar, vector b. vector, scalar
2. Speed is a __________ quantity and velocity is a __________ quantity.
   a. scalar, vector b. vector, scalar

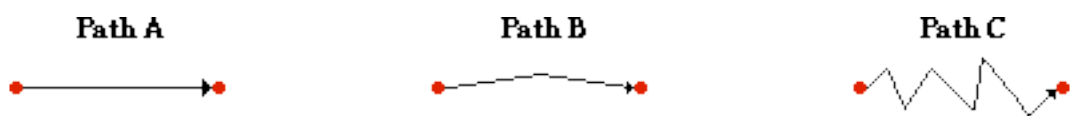
Speed vs. Velocity

Speed and velocity are two quantities in Physics that seem at first glance to have the same meaning. While related, they have distinctly different definitions. Knowing their definitions is critical to understanding the difference between them.

Speed is a quantity that describes how fast or how slow an object is moving.

Velocity is a quantity that is defined as the rate at which an object's position changes.

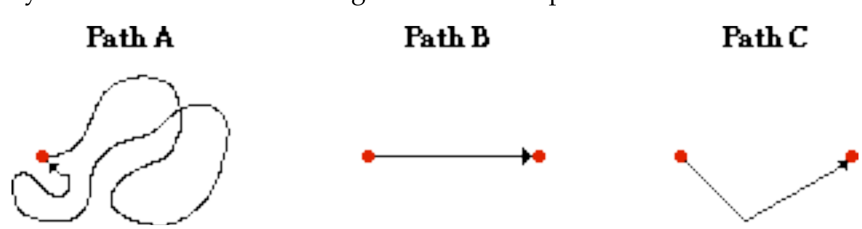
3. Suppose you are considering three different paths (A, B and C) between the same two locations.



Along which path would you have to move with the greatest speed to arrive at the destination in the same amount of time? ____________ Explain.

4. **True** or **False**: It is possible for an object to move for 10 seconds at a high speed and end up with an average velocity of zero.
   a. True b. False
5. If the above statement is true, then describe an example of such a motion. If the above statement is false, then explain why it is false.

6. Suppose that you run for 10 seconds along three different paths.



Rank the three paths from the lowest average speed to the greatest average speed. __________

Rank the three paths from the lowest average velocity to the greatest average velocity. __________

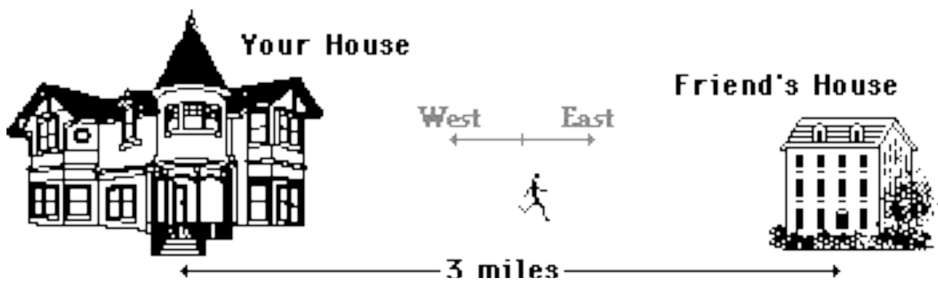
Calculating Average Speed and Average Velocity

The average speed of an object is the rate at which an object covers distance. The average velocity of an object is the rate at which an object changes its position. Thus,

$$\textbf{Ave. Speed} = \frac{\textbf{distance}}{\textbf{time}} \qquad \textbf{Ave. Velocity} = \frac{\textbf{displacement}}{\textbf{time}}$$

Speed, being a scalar, is dependent upon the scalar quantity distance. Velocity, being a vector, is dependent upon the vector quantity displacement.

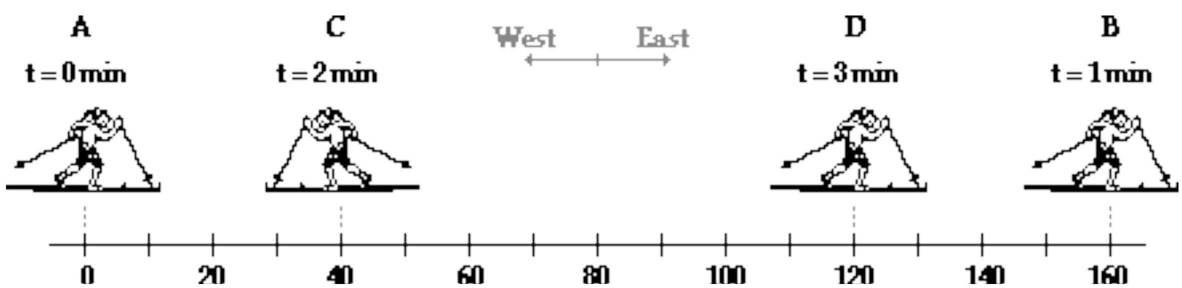
7. You run from your house to a friend's house that is 3 miles away in 30 minutes. You then immediately walk home, taking 1 hour on your return trip.



a. What was the average speed (in mi/hr) for the entire trip? _______________

b. What was the average velocity (in mi/hr) for the entire trip? _______________

8. A cross-country skier moves from location A to location B to location C to location D. Each *leg* of the back-and-forth motion takes 1 minute to complete; the total time is 3 minutes. The unit of length is meters.



Calculate the average speed (in m/min) and the average velocity (in m/min) of the skier during the three minutes of recreation. **PSYW**

Ave. Speed = **Ave. Velocity =**

Instantaneous Speed vs. Average Speed

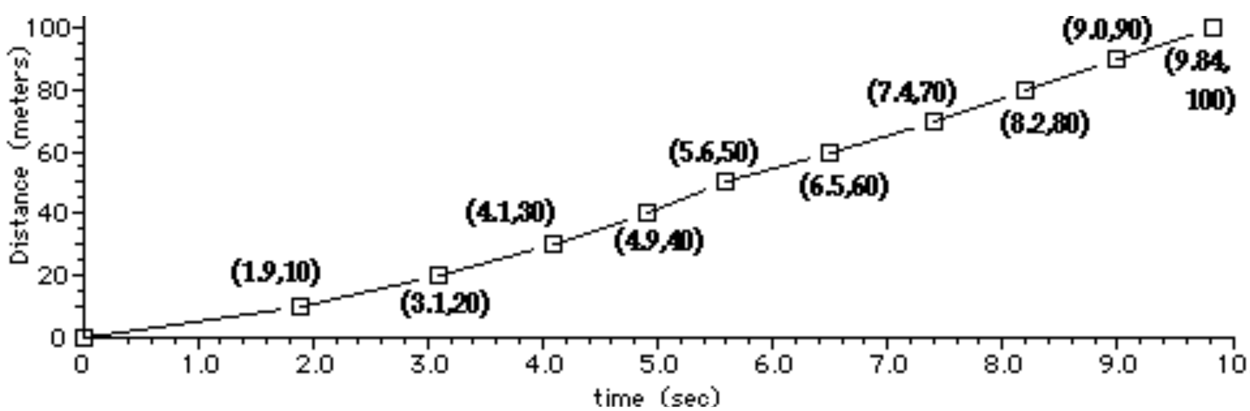
The instantaneous speed of an object is the speed that an object has at any given instant. When an object moves, it doesn't always move at a steady pace. As a result, the instantaneous speed is changing. For an automobile, the instantaneous speed is the speedometer reading. The average speed is simply the average of all the speedometer readings taken at regular intervals of time. Of course, the easier way to determine the average speed is to simply do a distance/time ratio.

9. Consider the data at the right for the first 10 minutes of a teacher's trip along the expressway to school. Determine ...
   a. ... the average speed (in mi/min) for the 10 minutes of motion.

   b. ... an estimate of the maximum speed (in mi/min) based on the given data.

Time (min)	Pos'n (mi)
0	0
1	0.4
2	0.8
3	1.3
4	2.1
5	2.5
6	2.7
7	3.8
8	5.0
9	6.4
10	7.6

10. The graph below shows Donovan Bailey's split times for his 100-meter record-breaking run in the Atlanta Olympics in 1996.



a. At what point did he experience his greatest average speed for a 10 meter interval? Calculate this speed in m/s. **PSYW**

b. What was his average speed (in m/s) for the overall race? **PSYW**

Problem-Solving:

11. Thirty years ago, police would check a highway for speeders by sending a helicopter up in the air and observing the time it would take for a car to travel between two wide lines placed 1/10th of a mile apart. On one occasion, a car was observed to take 7.2 seconds to travel this distance.
a. How much time did it take the car to travel the distance in hours?

b. What is the speed of the car in miles per hour?

12. The fastest trains are magnetically levitated above the rails to avoid friction (and are therefore called MagLev trains…cool, huh?). The fastest trains travel about 155 miles in a half an hour. What is their average speed in miles/hour?

13. In 1960, U.S. Air Force Captain Joseph Kittinger broke the records for the both the fastest and the longest sky dive…he fell an amazing 19.5 miles! (Cool facts: There is almost no air at that altitude, and he said that he almost didn't feel like he was falling because there was no whistling from the wind or movement of his clothing through the air. The temperature at that altitude was 36 degrees Fahrenheit *below* zero!) His average speed while falling was 254 miles/hour. How much time did the dive last?

14. A hummingbird averages a speed of about 28 miles/hour (Cool facts: They visit up to 1000 flowers per day, and reach maximum speed while diving … up to 100 miles/hour!). Ruby-throated hummingbirds take a 2000 mile journey when they migrate, including a non-stop trip across Gulf of Mexico in which they fly for 18 hours straight! How far is the trip across the Gulf of Mexico?