

Speed and Velocity

• Speed

- Rate of change of _____
- $v_{ave} = \frac{distance}{time}$
- $v_{ave} = \frac{dist}{\Delta t}$
- _____ (no direction)

• Instantaneous velocity is the exact velocity at a given moment

• Velocity

- Rate of change of _____
- $v_{ave} = \frac{displacement}{time}$
- $v_{ave} = \frac{\Delta d}{\Delta t} = \frac{d_f - d_0}{t_f - t_0}$
- _____

A coyote walks east 2 km, then turns around and walks back west 3 km. If this trip takes 1.5 hours, what is the coyote's average speed?

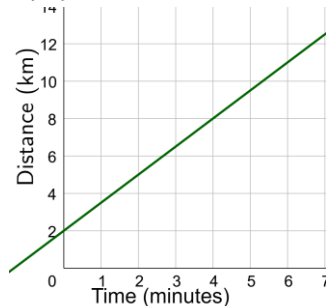
A coyote walks east 2 km, then turns around and walks back west 3 km. If this trip takes 1.5 hours, what is the coyote's average velocity?

A black bear at top speed can run about 13.5 m/s. If its friend is 50.0 m away, how much time does it have to prepare for a bear hug before the it gets there?

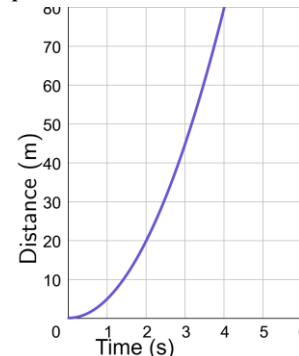
Position vs. Time graph

- $slope = \frac{rise}{run} = \frac{\Delta d}{\Delta t} = v$
- _____ of d vs. t is _____
- If the graph is _____, use the _____ of the _____ line at the given time

The graph shows the distance a car is from its house. What is the velocity of the car at 5 minutes? (Give the answer in m/s.)



The graph shows the distance a car is from the starting point of a race. What is the velocity of the car at 3 seconds?



Practice Work

- What is the difference between speed and velocity?
- (a) Does a car's odometer measure distance or displacement? (b) Does its speedometer measure speed or velocity?
- If you divide the total distance traveled on a car trip (as determined by the odometer) by the time for the trip, (a) are you calculating the average speed or the magnitude of the average velocity? (b) Under what circumstances are these two quantities the same?
- What does a negative velocity mean?
- (a) Draw a quick sketch of position–time graph of a ball being thrown up so that it goes up, then comes back down. (b) Describe the graph using mathematical terms.
- What is the slope of a position vs. time graph?
- When the average velocity is zero, there are two options for the object's motion. What are they? (RW)
- What is the average velocity of running completely around an oval 400 m track in 160 s? (RW)
- The spine-tailed swift is the fastest bird in powered flight. On one flight, a particular bird flies 306 m east, then turns around and flies 406.5 m back west. This flight takes 15 s. (a) What is the bird's average velocity? (b) Average speed? (RW) **6.7 m/s west, 47.5 m/s**
- You are traveling down a highway in your car. When the clock is at 30 min, you are at the 124 km distance marker. When the clock says 50 min, you are at the 157 km marker. What is the magnitude of your average velocity? (RW) **99 km/h**
- Conversations with astronauts on the lunar surface were characterized by a kind of echo in which the earthbound person's voice was so loud in the astronaut's space helmet that it was picked up by the astronaut's microphone and transmitted back to Earth. It is reasonable to assume that the echo time equals the time necessary for the radio wave to travel from the Earth to the Moon and back (that is, neglecting any time delays in the electronic equipment). Calculate the distance from Earth to the Moon given that the echo time was 2.56 s and that radio waves travel at the speed of light (3.00×10^8 m/s). (OpenStax 2.13) **384,000 km**
- A football quarterback runs 15.0 m straight forward 2.50 s. He is then hit and pushed 3.00 m straight backward in 1.75 s. He breaks the tackle and runs straight forward another 21.0 m in 5.20 s. Calculate his average velocity (a) for each of the three intervals and (b) for the entire motion. (OpenStax 2.14) **6.00 m/s, -1.71 m/s, 4.04 m/s, 3.49 m/s**
- A bus makes a trip according to the position–time graph shown in the drawing. What is the average velocity (magnitude and direction) of the bus during each of the segments labeled A, B, and C? Express your answers in km/h. (Cutnell 2.48) **-20 km/h, 10 km/h, 40 km/h**
- A person who walks for exercise produces the position–time graph given with this problem. (a) Without doing any calculations, decide which segments of the graph (A, B, C, or D) indicate positive, negative, and zero average velocities. (b) Calculate the average velocity for each segment to verify your answers to part (a). (Cutnell 2.60) **6.3 km/h, -3.8 km/h, 0.63 km/h, 0 km/h**
- (a) Which labeled point has the highest velocity? (b) Lowest velocity? (RW)

