

Unit 2: Kinematics in 1D

2 - Speed and Velocity

Speed (v): distance travelled per time.

- Speed is a scalar

Average speed $V = \frac{d}{t}$

Velocity (v): change in position per time

- Velocity is a vector

Average velocity $\vec{v} = \frac{\vec{d}}{t}$ $\vec{v} = \frac{\Delta d}{t}$

Where Δ means "change in"
 $\Delta = \text{final} - \text{initial}$

Ex: A student travels 11 m north and then turns around and travels 25 m south. If the total time of travel is 12 s, find:

a) The student's average speed.

$$V = \frac{d}{t} = \frac{(11\text{m} + 25\text{m})}{12\text{s}} = \frac{36\text{m}}{12\text{s}} = 3.0 \text{ m/s}$$

b) The student's average velocity.

Diagram: 11m up, 25m down, Δd down.

$$\vec{V} = \frac{\vec{d}}{t} = \frac{11 + (-25)}{12\text{s}}$$

$$= \frac{-14\text{m}}{12\text{s}}$$

$$= -1.2 \text{ m/s} = 1.2 \text{ m/s S}$$

1) How long does it take a car traveling at 45 km/h to travel 100.0 m?

$45 \text{ km/h} \div 3.6 = 12.5 \text{ m/s}$

$$t \cdot v = \frac{d}{t} \cdot t \quad \frac{v \cdot t}{v} = \frac{d}{v} \quad t = \frac{d}{v} = \frac{100.0\text{m}}{12.5\text{m/s}} = 8.0 \text{ s}$$

2) How far does a skateboarder travel in 22 s if his average velocity is 12.0 m/s?

$$t \cdot v = \frac{d}{t} \cdot t \quad v \cdot t = d \quad d = v \cdot t = (12.0\text{m/s})(22\text{s}) = 264\text{m}$$

$$= 260\text{m}$$

3) A shopping cart moves from a point 3.0 m West of a flagpole to a point 18.0 m East of the flagpole in 2.5 s.

Find its average velocity

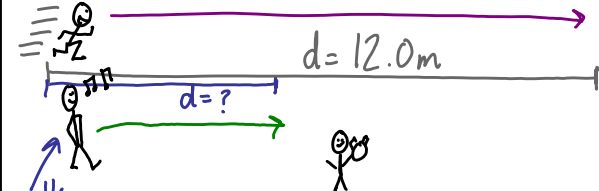
Diagram: 3.0 m W, 18.0 m E

$$\vec{v} = \frac{\Delta d}{t} = \frac{d_f - d_i}{t} = \frac{18.0 - (-3.0)}{2.5\text{s}}$$

$$= \frac{21.0\text{m}}{2.5\text{s}} = 8.4 \text{ m/s} = 8.4 \text{ m/s E}$$

Average Velocity vs. Average Speed

Procedure:



Calculations:

Student 1 - Runner

Speed

Velocity

Data:

Student 1

Time:

distance:

displacement:

Student 2

Time:

distance:

displacement:

Student 2 - Walker

Speed

Velocity

Worksheet 1.2 - Average Velocity and Speed

1. A high school bus travels 240 km in 6.0 h. What is its average speed for the trip? (in km/h)
2. A spider travels across a driveway 3.6 m wide with a speed of 14 cm/s. How long will it take to cross the driveway?
3. Jay Umpshot, one of the many stars of the local basketball team, steals the ball and runs the length of the court in 8.5 sec at a speed of 5.0 m/s. How long is the court?
4. If a car is traveling at 25 m/s, how far does it travel in 1.0 hour?
5. A caterpillar travels across the length of a 2.00 m porch in 6.5 minutes. What is the average velocity of the caterpillar in m/s?
6. A motorist traveling on a straight stretch of open highway sets his cruise control at 90.0 km/h. How far will he travel in 15 minutes?
7. A motorcycle travels 90.0 km/h. How many seconds will it take the motorcycle to cover 2.10×10^3 m?
8. A hiker is at the bottom of a canyon facing the canyon wall closest to her. She is 280.5 m from the wall and the sound of her voice travels at 340.0 m/s at that location. How long after she shouts will she hear her echo.
9. A woman from Pasadena makes a trip to a nearby shopping mall that is located 40.0 km from her home. On the trip to the mall she averages 80.0 km/h but gets a speeding ticket upon her arrival. On the return trip she averages just 40.0 km/h. What was her average speed for the entire trip?
10. A cross-country rally car driver sets out on a 100.0 km race. At the halfway marker (50.0 km), her pit crew radios that she has averaged only 80.0 km/h. How fast must she drive over the remaining distance in order to average 100.0 km/h for the entire race?
11. A supersonic jet travels once around the earth at an average speed of 1.6×10^3 km/h. Its orbital **radius** is 6.5×10^3 km. How many hours does the trip take?

1) 40. km/h 2) 26 s 3) 43 m 4) 9.0×10^4 m 5) 5.1×10^{-3} m/s 6) 23 000 m 7) 84.0 s 8) 1.650 s 9) 53.3 km/h 10) 133 km/h 11) 26 h