

2F Velocity

Read:

Speed and velocity do not have the same meaning to scientists. Speed is a *scalar quantity*, which means it can be completely described by its magnitude (or size). The magnitude is given by a number and a unit. For example, an object's speed may be measured as 15 meters per second.

Velocity is a *vector quantity*. In order to measure a vector quantity, you must know the both its magnitude and direction.

The velocity of an object tells you both its speed and its direction of motion. Velocity is an object's change in position over time. In the velocity formula, Δx means "a change in position" or displacement. Like the position variable, a velocity can be positive or negative.

VELOCITY

$$\text{Velocity (m/s)} \quad \mathbf{v} = \frac{\Delta \mathbf{x}}{t} \quad \begin{array}{l} \text{Displacement (m)} \\ \text{Time taken (s)} \end{array}$$

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 rearrange $v = \Delta x/t$ to solve velocity problems.

Examples:

Example 1: What is the velocity of a car that travels 100.0 meters, northeast in 4.65 seconds?

<p>Looking for</p> <p>Velocity of the car</p>	<p>Solution</p> $v = \frac{\Delta x}{t} = \frac{100.0 \text{ m}}{4.65 \text{ s}} = \frac{21.5 \text{ m}}{\text{s}}$ <p>The velocity of the car is 21.5 meters per second, northeast.</p>
<p>Given</p> <p>Displacement = 100.0 meters</p> <p>Time = 4.65 seconds</p>	
<p>Relationship</p> $v = \frac{\Delta x}{t}$	

Example 2: A boat travels with a velocity equal to 14.0 meters per second, east in 5.15 seconds. What distance in meters does the boat travel?

Looking for Distance the boat travels	Solution $\Delta x = v \times t = \frac{14.0 \text{ m}}{\text{s}} \times 5.15 \text{ s} = 72.1 \text{ m}$ The boat travels 72.1 meters.
Given Velocity = 14.0 meters per second, east Time = 5.15 seconds	
Relationship distance or $\Delta x = v \times t$	

Practice:

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

Looking for	Solution
Given	
Relationship	

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?
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3. A cruise ship travels east across a river at 19.0 meters per minute. If the river is 4,250 meters wide, how long does it take for the ship to reach the other side?
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4. Joaquin mows the lawn at his grandmother's home during the summer months. Joaquin measured the distance across his grandmother's lawn as 11.5 meters.
- If Joaquin mows one length across the lawn from east to west in 7.10 seconds, then what is the velocity of the lawnmower?
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- Once he reaches the edge of the lawn, Joaquin turns the lawnmower around. He mows in the opposite direction but maintains the same speed. What is the velocity of the lawnmower?
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5. 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?
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6. 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?
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7. Katie and her best friend Liam play tennis every Saturday morning. When Katie serves the ball to Liam, it travels 9.5 meters south in 2.1 seconds.
- a. What is the velocity of the tennis ball?
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- b. If the tennis ball travels at constant speed, what is its velocity when Liam returns Katie's serve?
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8. A driver realizes that she is traveling in the wrong direction on a one-way street. She has already driven 350 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?
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9. Juan's mother drives 7.25 miles southwest to her favorite shopping mall.
- a. Average velocity is the total displacement divided by the total time taken. What is the average velocity of Juan's mother's automobile if it arrives at the mall in 20.0 minutes?
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- b. Does the average velocity reflect the how fast Juan's mother was driving at *every* point in her journey? Explain your answer by comparing the terms average velocity and instantaneous velocity.
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10. A bus is traveling at 79.7 kilometers per hour east. How far does the bus travel 1.45 hours?
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11. A girl scout troop hiked 5.8 kilometers southeast in 1.5 hours. What was the troop's velocity?
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12. A volcanologist noted that a lahar rushed down a mountain at 32.2 kilometers per hour, south. How far did the mud flow in 17.5 minutes?
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