Velocity

Jean Brainard, Ph.D.

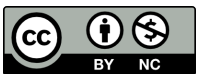
AUTHOR
Jean Brainard, Ph.D.

To access a customizable version of this book, as well as other interactive content, visit www.ck12.org

CK-12 Foundation is a non-profit organization with a mission to reduce the cost of textbook materials for the K-12 market both in the U.S. and worldwide. Using an open-source, collaborative, and web-based compilation model, CK-12 pioneers and promotes the creation and distribution of high-quality, adaptive online textbooks that can be mixed, modified and printed (i.e., the FlexBook® textbooks).

Printed: August 16, 2016

flexbook
next generation textbooks



CHAPTER 1 Velocity

- Distinguish between velocity and speed.
- Represent velocity with vector arrows.
- Describe objects that have different velocities.
- Show how to calculate average velocity when direction is constant.

Ramey and her mom were driving down this highway at 45 miles per hour, which is the speed limit on this road. As they approached this sign, Ramey's mom put on the brakes and started to slow down so she could safely maneuver the upcoming curves in the road. This speed limit sign actually represents two components of motion: speed and direction.

Speed and Direction

Speed tells you only how fast or slow an object is moving. It doesn't tell you the direction the object is moving. The measure of both speed and direction is called **velocity**. Velocity is a vector. A **vector** is measurement that includes both size and direction. Vectors are often represented by arrows. When using an arrow to represent velocity, the length of the arrow stands for speed, and the way the arrow points indicates the direction.

MEDIA

Click image to the left or use the URL below.

URL: https://www.ck12.org/flx/render/embeddedobject/5022

Using Vector Arrows to Represent Velocity

The arrows in the **Figure** 1.1 represent the velocity of three different objects. Arrows A and B are the same length but point in different directions. They represent objects moving at the same speed but in different directions. Arrow C is shorter than arrow A or B but points in the same direction as arrow A. It represents an object moving at a slower speed than A or B but in the same direction as A.

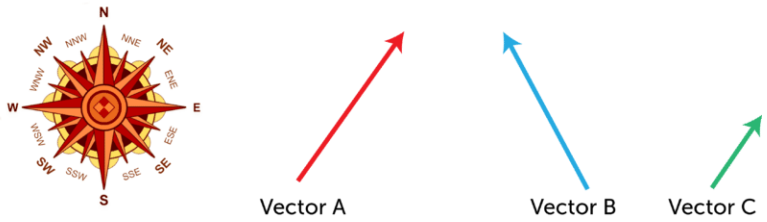


FIGURE 1.1

Differences in Velocity

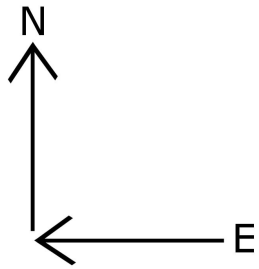
Objects have the same velocity only if they are moving at the same speed and in the same direction. Objects moving at different speeds, in different directions, or both have different velocities. Look again at arrows A and B from the **Figure** 1.1. They represent objects that have different velocities only because they are moving in different directions. A and C represent objects that have different velocities only because they are moving at different speeds. Objects represented by B and C have different velocities because they are moving in different directions and at different speeds.

Q: Jerod is riding his bike at a constant speed. As he rides down his street he is moving from east to west. At the end of the block, he turns right and starts moving from south to north, but he's still traveling at the same speed. Has his velocity changed?

A: Although Jerod's speed hasn't changed, his velocity has changed because he is moving in a different direction.

Q: How could you use vector arrows to represent Jerod's velocity and how it changes?

A: The arrows might look like this:



Calculating Average Velocity

You can calculate the average velocity of a moving object that is not changing direction by dividing the distance the object travels by the time it takes to travel that distance. You would use this formula:

$$\text{velocity} = \frac{\text{distance}}{\text{time}}$$

This is the same formula that is used for calculating average speed. It represents velocity only if the answer also includes the direction that the object is traveling.

Let's work through a sample problem. Toni's dog is racing down the sidewalk toward the east. The dog travels 36 meters in 18 seconds before it stops running. The velocity of the dog is:

$$\begin{aligned}\text{velocity} &= \frac{\text{distance}}{\text{time}} \\ &= \frac{36 \text{ m}}{18 \text{ s}} \\ &= 2 \text{ m/s east}\end{aligned}$$

Note that the answer is given in the SI unit for velocity, which is m/s, and it includes the direction that the dog is traveling.

Q: What would the dog's velocity be if it ran the same distance in the opposite direction but covered the distance in 24 seconds?

A: In this case, the velocity would be:

$$\begin{aligned}\text{velocity} &= \frac{\text{distance}}{\text{time}} \\ &= \frac{36 \text{ m}}{24 \text{ s}} \\ &= 1.5 \text{ m/s west}\end{aligned}$$

Summary

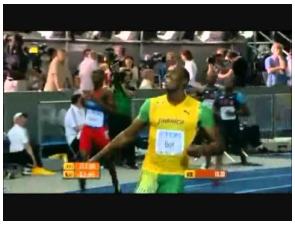
- Velocity is a measure of both speed and direction of motion. Velocity is a vector, which is a measurement that includes both size and direction.
- Velocity can be represented by an arrow, with the length of the arrow representing speed and the way the arrow points representing direction.
- Objects have the same velocity only if they are moving at the same speed and in the same direction. Objects moving at different speeds, in different directions, or both have different velocities.
- The average velocity of an object moving in a constant direction is calculated with the formula: velocity $= \frac{\text{distance}}{\text{time}}$. The SI unit for velocity is m/s, plus the direction the object is traveling.

Review

1. What is velocity?
2. How does velocity differ from speed? Why is velocity a vector?

3. Explain how an arrow can be used to represent velocity.
4. Use vector arrows to represent the velocity of a car that travels north at 50 mi/h and then travels east at 25 mi/h.
5. Another car travels northwest for 2 hours and covers a distance of 90 miles. What is the average velocity of the car?

Resources



MEDIA

Click image to the left or use the URL below.

URL: https://www.ck12.org/flx/render/embeddedobject/186661

MEDIA

Click image to the left or use the URL below.

URL: https://www.ck12.org/flx/render/embeddedobject/186662

References

1. Christopher Auyeung (CK-12 Foundation); Compass: Seamus McGill. These objects are moving at different speed and in different directions . CC BY-NC 3.0; Compass: Public Domain