3.2.1: Position and Displacement

Figure 2.1.1

In stockcar races, drivers often travel 500 miles or more, but their final displacement is only a few feet. Why?

Position, Distance, and Displacement

In order to study how something moves, we must know where it is. This location is an object's **position.** To visualize position for objects moving in a straight line, you can imagine the object is on a number line. It may be placed at any point on the number line in the positive numbers or the negative numbers. It is common to choose the original position of the object to be on the zero mark. In making the zero mark the reference point, you have chosen a frame of reference. The exact position of an object is the separation between the object and the reference point.

When an object moves, we often refer to the amount it moves as the **distance**. Distance does not need a reference point and does not need a direction. If an automobile moves 50 kilometers, the distance traveled is 50 kilometers regardless of the starting point or the direction of movement. If we wish to find the final position of the automobile, however, just having the distance traveled will not allow us to determine the final position. We need to know the starting point and the direction of the motion. The change in the position of the object is called its **displacement**. The displacement must include a direction because the final position may be either in the positive or negative direction along the number line from the initial position. The displacement is a vector quantity and vectors are discussed in the section "Vectors". This tells us that the displacement of an object is a **vector** (a quantity that has both magnitude and direction), rather than a **scalar** (a quantity that has only magnitude).

To return to the first image, these cars travel a distance of 500 miles over the course of the race. However, they are traveling in a circle, and the start and finish line are the same. Therefore, when the car finishes the race, it is in essentially the same position it was when it started. The car's total displacement is only a few feet.

Use the following simulation to further explore the concepts of position, distance and displacement:

Summary

- The length traveled by an object moving in any direction or even changing direction is called distance.
- The location of an object in a frame of reference is called position.
- For straight line motion, positions can be shown using a number line.
- The separation between original and final position is called displacement.

Review

1. Explain the difference between distance and displacement in your own words.
2. Suppose that John lives on a square block that is 180 yards per side, and in the evenings, he walks with his dog around the block for a little exercise.
    1. If John walks once around the block, what distance does he travel?
    2. If John walks once around the block, what is his final displacement?

3. Joanna's house is 8000 feet due west of her school. If her house is assigned the position of zero and her school is assigned the position of +8000, what would be Joanna's position if she walked 100 feet west of her house?

Explore More

Watch the video below to explore more on scalar and vector quantities and answer the questions below:

1. What is the difference between a scalar and a vector?
2. Provide an example of a scalar and an example of a vector.

Watch these two short videos to understand position, distance, and displacement, and answer the questions below:

1. What is position?
2. Can two objects be the same distance from a single point but be in different positions? Why or why not?
3. What is the difference between distance and displacement?
4. Does distance have direction? Does displacement have direction?

Additional Resources

Study Guide: Motion Study Guide

Real World Application: Driving Safely at Night

Video:

PLIX: Play, Learn, Interact, eXplore: Driverless Car

Other Sources: OpenStax College Physics Textbook https://openstax.org/books/college-p...1-displacement

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