Distance vs Displacement

Name: _____

Date: _____

Information: Reference Frames

Everywhere you look, objects are in motion. Each object's motion requires a **reference frame**. When we say that a car is going fast we usually mean compared to the ground. Of course, the ground is also technically moving when we consider the motion of the planet Earth!

Critical Thinking Questions

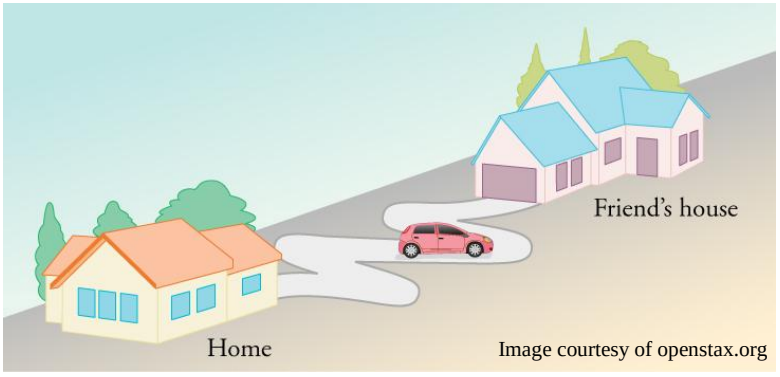
1. When we speak of the revolution of the Earth, what is a reference frame we could use?
   Earth is revolving around the sun, so the sun could be our reference frame.

2. Consider an airplane in midflight traveling from New York to London.
   a) A passenger stands up and walks to the back of the plane where the restroom is. Her speed is 1.8 miles per hour. What is the reference frame?
      The floor of the plane is the reference frame.

   b) The plane is traveling 420 miles per hour. What is the reference frame?
      Earth's surface is the reference frame.

3. Imagine that you are traveling in a windowless ship on a calm sea. Is it possible for you to determine if the ship is moving? Explain.
   No. Assuming constant speed and no waves, you would need to look out of a window to see if the ship was moving.

Information: Distance and Displacement



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Imagine that your friend's house is 10 kilometers (km) away, but the road to your friend's house is really curvy. If you travel from your home to your friend's house, your displacement will be 10 km, but the distance you traveled will be greater than 10 km because of the curvy road.

Critical Thinking Questions

4. Explain as best you can the difference between displacement and distance.

   Displacement is the difference between an object's last and first position as measured by a straight line. Distance is the actual length of the path traveled by an object regardless of whether that path was a straight line or not.

5. A man jogged 3.5 km east and then turned around and jogged 1 km west. Explain why the man's **distance** was 4.5 km, but his **displacement** was 2.5 km east.

   The difference between the jogger's last and first position = 3.5 – 1 = 2.5 m. This difference is the displacement. The actual length of the path traveled regardless of direction (distance) is 3.5 + 1 = 4.5 km

6. When calculating _____displacement_____ the direction (like east or west) affects the final answer.
   displacement OR distance?

7. A child threw a ball directly up and it reached a height of 5 meters (m) above the child's hand. Then the ball fell back into the child's hand.

   a) Explain why the ball's displacement was zero.

      The difference between the final and beginning position of the ball equals zero.

   b) Calculate the distance that the ball traveled.

      The ball traveled 5 m up and then 5m back down for a total of 10 m.

8. A car drove west for 30 km. Then the car drove east for 40 km. Find the displacement.

   a) Calculate the displacement.

      10 km east

   b) What distance did the car drive?

      70 km

9. A woman jogged 4 km south and then 2 km north.

   a) What is the woman's displacement?

      2 km south

   b) What distance did the woman jog?

      6 km

Information: Positive and Negative Displacement

Sometimes it is helpful to assign one direction a positive value and the opposite direction a negative value. For example, if a car drives 30 km and then turns around to drive 50 km in the opposite direction we know the displacement will be 20 km in a direction opposite of the first direction. To clarify directions we could assign a positive sign to the first direction and a negative sign to the second. Our calculation would then be:

Displacement = 30 km – 50 km = -20 km

The positive and negative signs are especially helpful for problems that do not mention directions like north, south, west, or east.

Critical Thinking Questions

14. A truck drives 120 km and then turns around to drive 250 km more. Calculate the displacement of the truck.

    -130 km

15. A motorcycle travels 85,449 m in one direction and then 32,877 m in the opposite direction. Calculate the displacement in units of km. Hint: you'll need to convert one of the units!

    52,572 m