Quick Lab

Comparing Distance and Displacement

Procedure

1. Draw a dot at the intersection of two lines near the bottom edge of a sheet of graph paper. Label the dot "Start."
2. Draw a second, similar dot near the top of the paper. Label this dot "End."
3. Draw a path from the Start dot to the End dot. Choose any path that stays on the grid lines.
4. Use a ruler to determine the distance of your path.
5. Use a ruler to determine the displacement from start to end.

Analyze and Conclude

1. **Observing** Which is shorter, the distance or the displacement?
2. **Evaluating and Revising** How could you have made the distance shorter?
3. **Inferring** If you keep the Start and End points the same, is it possible to make the displacement shorter? Explain your answer.

Measuring Displacements

To describe an object's position relative to a given point, you n[...] know how far away and in what direction the object is from that [...] Displacement provides this information. **Distance is the len[...] the path between two points. Displacement is the direction fr[...] starting point and the length of a straight line from the starti[...] to the ending point.**

Displacements are sometimes used when giving directions. [...] someone to "Walk 5 blocks" does not ensure they'll end up in th[...] place. However, saying "Walk 5 blocks north from the bus st[...] get the person to the right place. Accurate directions give the di[...] from a starting point as well as the distance.

Think about the motion of a roller coaster car. If you meas[...] path along which the car has traveled, you are describing dista[...] direction from the starting point to the car and the length [...] straight line from the starting point to the car describe displa[...] After completing one trip around the track, the roller coaster ca[...] placement is zero.

Combining Displacements

Displacement is an example of a vector. A **vector** is a quantity [...] magnitude and direction. The magnitude can be size, length, or a[...] Arrows on a graph or map are used to represent vectors. The le[...] the arrow shows the magnitude of the vector. Vector addition is th[...] bining of vector magnitudes and directions. **Add displa[...] using vector addition.**

Displacement Along a Straight Line When two di[...] ments, represented by two vectors, have the same direction, you [...] their magnitudes. In Figure 3A, the magnitudes of the car's displa[...] are 4 kilometers and 2 kilometers. The total magnitude of the di[...] ment is 6 kilometers. If two displacements are in opposite direc[...] magnitudes subtract from each other, as shown in Figure 3B. Beca[...] car's displacements (4 kilometers and 2 kilometers) are in oppos[...] tions, the magnitude of the total displacement is 2 kilometers.

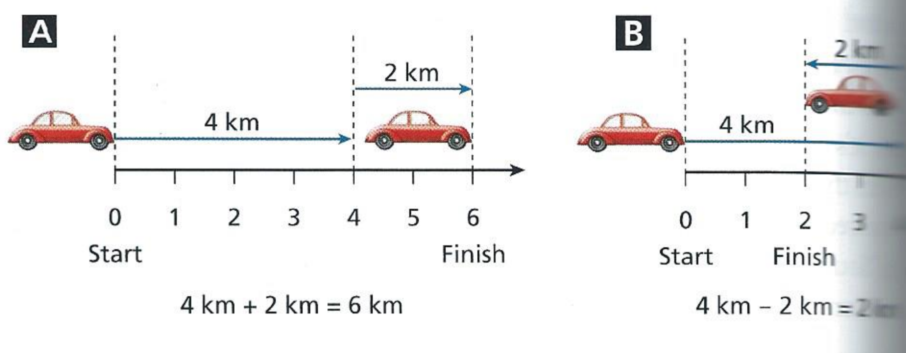

Figure 3 When motion is in a straight line, vectors add and subtract easily. **A** Add the magnitudes of two displacement vectors that have the same direction. **B** Two displacement vectors with opposite directions are subtracted from each other.

Displacement That Isn't Along a Straight Path

When two or more displacement vectors have different directions, they may be combined by graphing. Figure 4 shows vectors representing the movement of a boy walking from his home to school. He starts by walking 1 block east. Then he turns a corner and walks 1 block north. He turns once again and walks 2 blocks east. For the last part of his trip to school, he walks 3 blocks north. The lengths of the vectors representing this path are 1 block, 1 block, 2 blocks, and 3 blocks.

The boy walked a total distance of 7 blocks. You can determine this distance by adding the magnitudes of each vector along his path.

The vector in red is called the **resultant vector,** which is the vector sum of two or more vectors. In this case, it shows the displacement. The resultant vector points directly from the starting point to the ending point. If you place a sheet of paper on the figure and mark the length of the resultant vector, you see that it equals the length of 5 blocks. Vector addition, then, shows that the boy's displacement is 5 blocks approximately northeast, while the distance he walked is 7 blocks.

Figure 4 Measuring the resultant vector (the diagonal red line) shows that the displacement from the boy's home to his school is two blocks less than the distance he actually traveled.

Section 11.1 Assessment

Reviewing Concepts

1. What is a frame of reference? How is it used to measure motion?
2. How are distance and displacement similar and different?
3. How are displacements combined?
4. A girl who is watching a plane fly tells her friend that the plane isn't moving at all. Describe a frame of reference in which the girl's description would be true.

Critical Thinking

5. **Using Analogies** Is displacement more like the length of a rope that is pulled tight or the length of a coiled rope? Explain.
6. **Making Judgments** Would you measure the height of a building in meters? Give reasons for your answer.
7. **Problem Solving** Should your directions to a friend for traveling from one city to another include displacements or distances? Explain.
8. **Inferring** The resultant vector of two particular displacement vectors does not equal the sum of the magnitudes of the individual vectors. Describe the directions of the two vectors.

Writing in Science

Compare-Contrast Paragraph Write a paragraph describing how the distance you travel from home to school is different from your displacement from home to school. (*Hint:* Make a simple sketch similar to Figure 4 and refer to it as you write.)