

Lesson 1 Determining Position

Grade Eight Science Content Standard. 1.a. Students know position is defined in relation to some choice of a standard reference point and a set of reference directions.

Before You Read

When you move from place to place, how do you know you have moved? Write your answer on the lines below. Then read the lesson to learn more about determining position.

Read to Learn

Position and Reference Points

A new student tells you that her house is three blocks east of the grocery store. Did she give you enough information to find her house? If you know where the grocery store is, then you can walk three blocks east from there. The store is the starting place for you to find the location, or position, of her house. A **reference point** is a starting point used to describe the position of an object.

How can you describe an object's position?

The new student told you where to start, which direction to walk, and how far to walk to reach her house. You had to start at the grocery store, which was the reference point. The direction you had to walk was east. Finally, you had to walk a distance of three blocks. To describe an object's position you must include three things in your description:

- a reference point,
- a direction from the reference point, and
- a distance from the reference point.

You describe the position of an object using units of length, such as meters. For longer distances, kilometers might be used. For shorter distances, centimeters might be used.

MAIN Idea

The position of an object depends on the choice of a reference point.

What You'll Learn

- how to describe an object's position in two dimensions
- why displacement is a vector

Mark the Text

Underline As you read, underline material you do not understand. Reread the information until you understand it. If the text is still unclear, ask your teacher for help.

FOLDABLES

A Record Information

Make four note cards. Label the quarter sheets as illustrated and use them to record what you learn about the position of objects, and terms and definitions introduced in the lesson.

Terms	Definitions
Speed Formulas	Main Ideas

Academic Vocabulary
indicate (IN duh kayt) (verb)
to point out or point to

✓ Reading Check

- 1. Identify** What sign is used to indicate a reference direction?
-

✓ Reading Check

- 2. Determine** On a map, which best describes the term “west”? (Circle your choice.)
- part of the map scale
 - a reference direction

How can you describe a reference direction?

You can use a plus (+) or minus (−) sign to describe direction. The plus sign indicates the reference direction, and the minus sign indicates the opposite direction. For example, (+) could mean toward the new student’s house and (−) could mean away from the student’s house. So, the position of an object can be described as its distance from the reference point, together with a plus (+) or minus (−) sign. ✓

What is a vector?

To describe the position of an object, you must specify two things. One is the distance from the reference point. The other is the direction from the reference point.

The position of an object is an example of a vector. A **vector** (VEK tur) is a quantity that has both a size and a direction. For example, the size of a position vector is the distance of an object from the reference point. The direction of a position vector is the direction from the reference point to the object. A vector can be represented by an arrow. The length of the arrow represents the size of the vector.

Position in Two Dimensions

A runner moves in one direction only—toward the finish line. To describe the runner’s position, you could use the starting line as the reference point. The reference direction could be the direction from the starting line to the finish line. Because the runner moves in a straight line, you only need to use one reference direction.

But a car traveling from San Diego to Sacramento doesn’t move in a straight line. And it doesn’t move only north. It moves west as well. To describe how it moves, you need to know how to show position with two directions. North and east are often chosen as the positive reference directions.

How does a map show position with two directions?

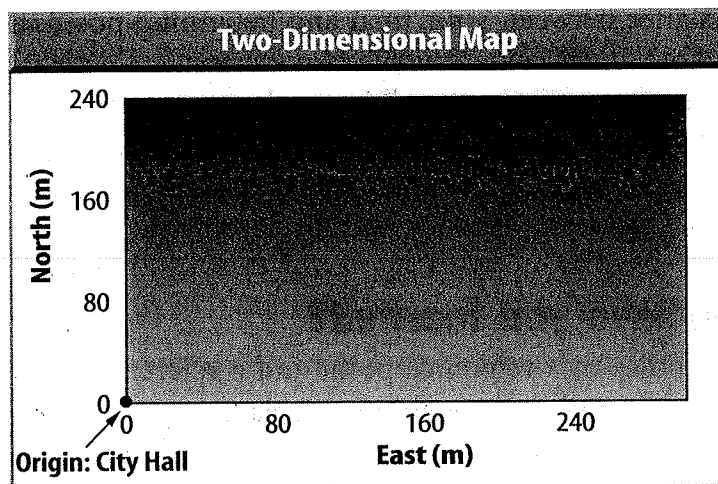
A map has two reference directions—north/south and east/west. A map also has a scale to show the distances in meters. ✓

Suppose someone walks from the bus station four blocks west and one block south. If each city block is 90 m long, then the person would walk 360 m west and 90 m south. The bus station is the reference point, and 360 m west and 90 m south are distances and directions in two dimensions.

How can you locate a position in two dimensions?

A two-dimensional map is a graph used to show the location of an object with two reference directions. Two-dimensional maps are similar to the graphs you've used in math class. In a two-dimensional map, east is the positive x direction. North is the positive y direction. To create a two-dimensional map, you must choose a location that will be the origin of the graph.

Suppose a visitor to your city uses a two-dimensional map where City Hall is the origin of the map, as shown below. City Hall's position is $x = 0$ m and $y = 0$ m. The x -axis line goes east through City Hall. The y -axis line goes north through City Hall. Distance units are marked on the axes of the graph. The locations of buildings are points plotted on the graph. On the graph below, the bus station is 180 m east and 270 m north of City Hall. So the bus station's location is $x = 180$ m and $y = 270$ m.



Changing Position

Suppose you walk to a friend's home from your home, and then you walk back. How has your position changed? You might have walked a distance of many meters, but your final position is the same as your beginning position. So your distance traveled and your change in position are different.

What is displacement?

The change in your position is called the displacement. **Displacement** is the difference between the beginning position and final position of an object.



Think it Over

3. **Describe** Using a two-dimensional map, how would you refer to a direction that is west?

Picture This

4. **Locate** Circle the origin on the map. Draw a line from the origin to the reference point on the map.



Think it Over

5. Determine If you know in which direction you moved on a trip, what do you need to know to determine your displacement on that trip?

Picture This

6. Explain Why is the displacement in the third figure zero?

How is displacement a vector?

Displacement includes a size and a direction, just as the position does. As a result, displacement is also a vector. The direction of a displacement vector is the direction from the beginning position to the final position. The size of a displacement vector is the distance from the beginning position to the final position.

What's the difference between distance and displacement?

Distance depends on the length of the path traveled. Displacement depends only on the beginning position and the final position. For example, suppose you first walk a distance of 40 m to the east. The difference between your beginning position and final position is 40 m. This means your displacement is 40 m east. If you then walk 30 m north, the total distance you've traveled from the starting point is 40 m + 30 m, or 70 m. However, your final position is not 70 m from your beginning position. Instead the distance between your final and beginning position is 50 m. Your displacement is 50 m northeast.

Suppose you continue walking and return to your beginning position. The total distance you travel is 140 m, but your displacement is 0 m. The figure below shows the difference between distance and displacement.

What have you learned?

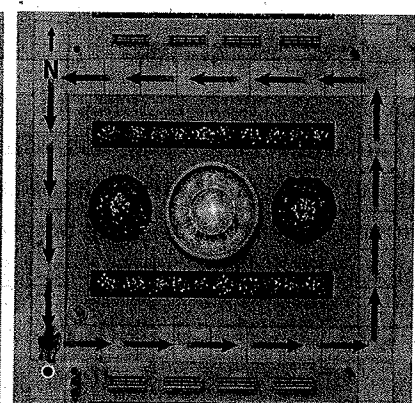
The choice of a reference point and a reference direction determines an object's position. Displacement is a vector—a quantity with both size and direction.



Distance: 40 m
Displacement: 40 m east



Distance: 70 m
Displacement: 50 m northeast



Distance: 140 m
Displacement: 0 m