Types of Measurement Quantities: Scalar and Vector

You are already familiar with them from your everyday lives, you are just missing the terminology. In pairs, which of the following would you say in a conversation:

1. It will take you 3 hours to drive to Fredericton. ✓
2. My speed is 65 km/h. ✓
3. The mass of the car is 125 kg north. X
4. The movie starts at 2:30 pm west. X
5. The velocity of the plane is 200 m/s east. ✓
6. Gravity pulls me down with 195 lbs of force. ✓
7. The flight lasts 7 hours [E25°S]. X
8. Today I drove 50 km. ✓
9. Today I drove 50 km south. ✓

- **Scalars** are measurements that are independent of direction. * always positive measurements
  - Time
  - Mass
  - Distance
  - Speed
- **Vectors** are measurements that require a direction (it is relative to a coordinate system within a frame of reference)
  - Position
  - Displacement (change in position)
  - Velocity
  - Acceleration
  - Force

Important Examples of the Differences Between Scalars and Vectors (measurements or calculations).

Scalar

1. Walked 25 m. distance
2. Drove 62 km. distance
3. Flew 150 m/s. speed
4. Ran 15 km/h. speed

Vectors

1. Walked 25 m [E]. displacement
2. Drove 62 km [N]. displacement
3. Flew 150 m/s [W]. velocity
4. Ran 15 km/h [S]. velocity

4.2 Distance

Information taken from the Physical Science Concepts electronic document.

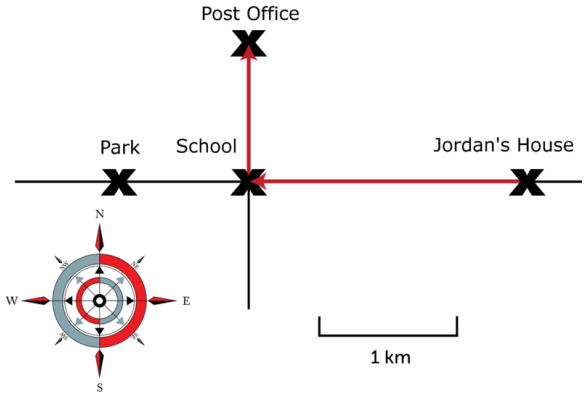
What Is Distance?

Distance is the length of the route between two points. The distance of a race, for example, is the length of the track between the starting and finishing lines. In a 100-meter sprint, that distance is 100 meters.

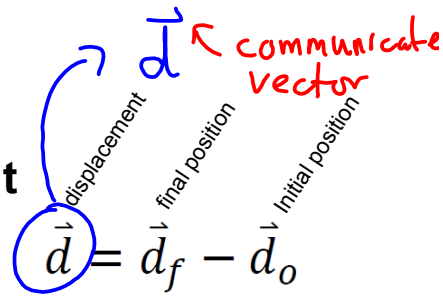
4.3 Direction

Introducing Direction

Direction can be described in relative terms, such as up, down, in, out, left, right, forward, backward, or sideways. Direction can also be described with the cardinal directions: north, south, east, or west. On maps, cardinal directions are indicated with a compass rose. You can see one in the bottom left corner of the map in the **Figure** 4.4. You can use the compass rose to find directions on the map. For example, to go to the school from Jordan's house, you would travel from east to west. If you wanted to go on to the post office, you would change direction at the school and then travel from south to north.



Position and Displacement



The Big Idea

Speed represents how quickly an object is moving through space. Velocity is speed with a direction, making it a *vector* quantity. If an object's velocity changes with time, the object is said to be accelerating. As we'll see in the next chapters, understanding the acceleration of an object is the key to understanding its motion. We will assume constant acceleration throughout this chapter.

When beginning a one dimensional problem, define a positive direction. The other direction is then taken to be negative. Traditionally, "positive" is taken to mean "to the right"; however, any definition of direction used consistently throughout the problem will yield the right answer.

Key Concepts

***Very important* We cannot do the math unless each variable is measured relative to the same direction.**

- When you begin a problem, define a coordinate system. For positions, this is like a number line; for example, positive $(+x)$ positions can be to the right of the origin and negative $(-x)$ positions to the left of the origin.
- For velocity v you might define positive as *moving to the right* and negative as *moving to the left*. What would it mean to have a **positive position** and a **negative velocity?**

Guidance

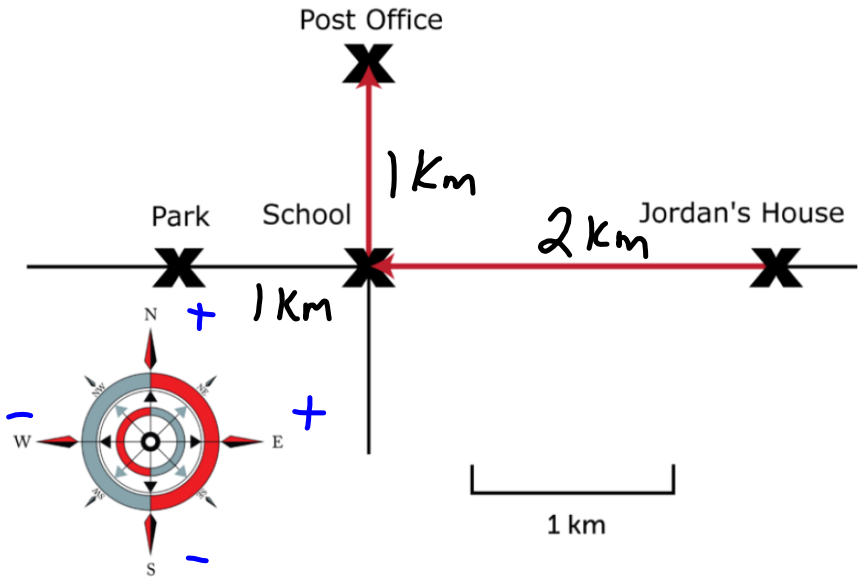
Position is the location of the object (whether it's a person, a ball or a particle) at a given moment in time. Displacement is the difference in the object's position from one time to another. Distance is the total amount the object has traveled in a certain period of time. Displacement is a vector quantity (direction matters), where as distance is a scalor (only the amount matters). Distance and displacement are the same in the case where the object travels in a straight line and always moving in the same direction.

Motion and Vectors

When both distance and direction are considered, motion can be represented by a vector. A **vector** is a measurement that has both size and direction. It may be represented by an arrow. If you are representing motion with an arrow, the length of the arrow represents distance, and the way the arrow points represents direction. The red arrows on the map above are vectors for Jordan's route from his house to the school and from the school to the post office. If you want to learn more about vectors, watch the video at this URL:

http://www.youtube.com/watch?v=B-iBbcFwFOk

Concept Practice:



In, pairs, carefully answer the questions below:

1. Calculate the distance from Jordan's house to the post office. 3 Km
2. T or F, the park is North-East from the post office. F
3. Calculate the position of the school from Jordan's house. 2 Km [W] or 2 [E]
4. Calculate Jordan's final position from school if he walks to the park and then home. 2 Km [E]
5. How would you calculate the displacement from Jordan's house to the post office? Pythag. Thrm
6. T or F, the school is -1 km North from the post office. T
7. T or F, the park is -3 km from the Jordan's house F -> -3 Km [E] or 3 [W]
8. T or F, Jordan's house is -3 km East from the park. F -> 3 Km [E]
9. Calculate the distance traveled if Jordan walked from home, to the park, to the post office, and finally to school. 6 Km
10. Calculate Jordan's displacement from home for question 9. 2 Km [W]
11. T or F, Jordan lives South-East of the post office. T
12. T or F, the post office is located North-West of Jordan's house. T
13. How does the choice of frame of reference effect the calculations for displacement?
14. Describe the importance of a coordinate system in physics.

Distance and Displacement Practice

A person walked the following path:

- 20 m [W] = -20 [E]
- 10 m [E]
- 50 m [E]
- 25 m [W] = -25 [E]
- 60 m [W] = -60 [E]

$\vec{d} = -45\ m\ [E]$ ← displacement

Calculate this person's distance and displacement. Do the calculations relative to east (east is positive).

$d = 165\ m$ ← distance

Position & Displacement

Grade: 11

Subject: Physics 112

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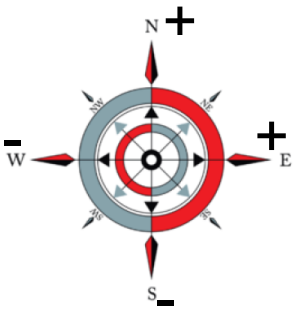
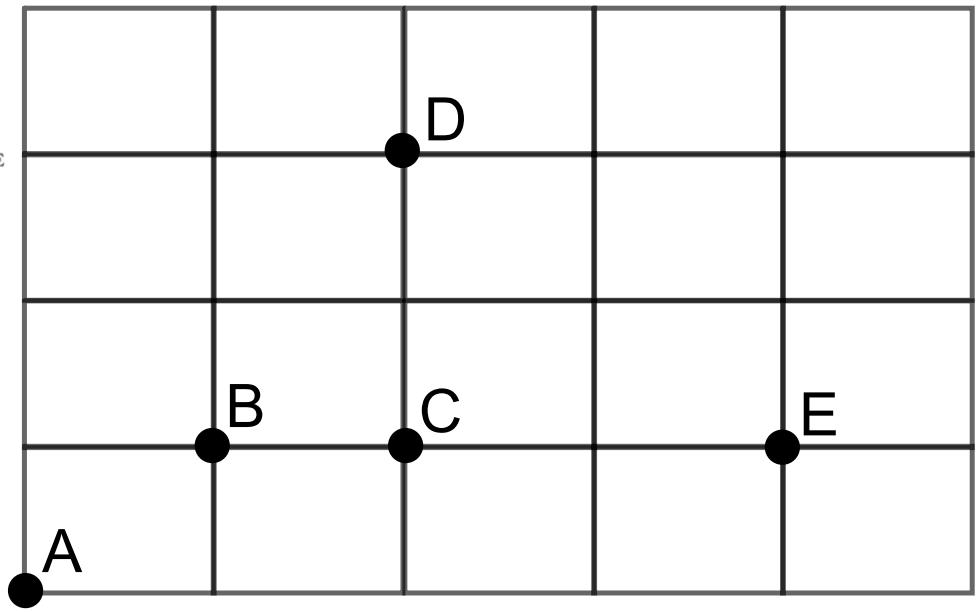


Each grid is 1km x 1km.

Cannot move digonally.



1 Calculate the shortest distance from A to E

A 5 km [E]

B 5 km

C 1 km [N] then 4 km [E]

2 Position C is -2 km North from D.

True

False