Position and Displacement

James H Dann, Ph.D.

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AUTHORS
James H Dann, Ph.D.

CONTRIBUTORS
Antonio De Jesus López
Chris Addiego

CONCEPT 1 Position and Displacement

Students will learn the meaning of an object's position, the difference between distance and displacement, and some basic graphing of position vs. time.

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Key Equations

$$\text{Symbols} \begin{cases} \Delta(\text{anything}) & \text{Final value - initial value} \\ \text{anything}_0 & \text{Value at time 0} \end{cases}$$

$$\text{Scalors} \begin{cases} t & \text{Time in seconds, s} \\ d = |\Delta x_1| + |\Delta x_2| & \text{Distance (in meters, m)} \\ v = |v| & \text{Speed (in meters per second, m/s)} \end{cases}$$

$$\text{Vectors} \begin{cases} x = x(t) & \text{Position} \\ \Delta x = x_f - x_i & \text{Displacement} \end{cases}$$

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.

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.

Example 1 Problem: An indecisive car goes 120 m North, then 30 m south then 60m North. What is the car's distance and displacement?

Solution:

Distance is the total amount traveled. Thus distance = 120 + 30 + 60 m = 210 m

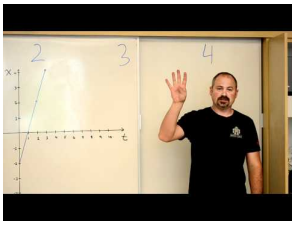
Displacement is the amount displaced from the starting position. Thus displacement = 120 - 30 + 60 m = 150 m.

Example 2 Problem: An 8th grader is timed to run 24 feet in 12 seconds, what is her speed in meters per second?

Solution:

$$D = vt$$
$$24\ ft = v(12\ s)$$
$$v = 24\ ft/12\ s = 2\ ft/s$$
$$v = 2\ ft/s * (1m/3.28\ ft) = 0.61\ m/s$$

Watch this Explanation



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Time for Practice

1. What is the difference between distance d and displacement $\triangle x$ Write a few sentences explaining this.
2. Does the odometer reading in a car measure distance or displacement?
3. Imagine a fox darting around in the woods for several hours. Can the displacement $\triangle x$ of the fox from his initial position ever be larger than the total distance d he traveled? Explain.
4. Your brother borrowed the scissors from your room and now you want to use them. Do you care about the distance the scissors have traveled or their displacement? Explain your answer.
5. You're trying to predict how long it's going to take to get to Los Angeles for the long weekend. Do you care about the distance you'll travel or your displacement? Explain your answer.

Answers

1. discuss in class

2. distance

3. No, displacement is 'as the crow flies' so to speak, while distance takes into account the curves and turns that the fox takes.

4. displacement

5. distance