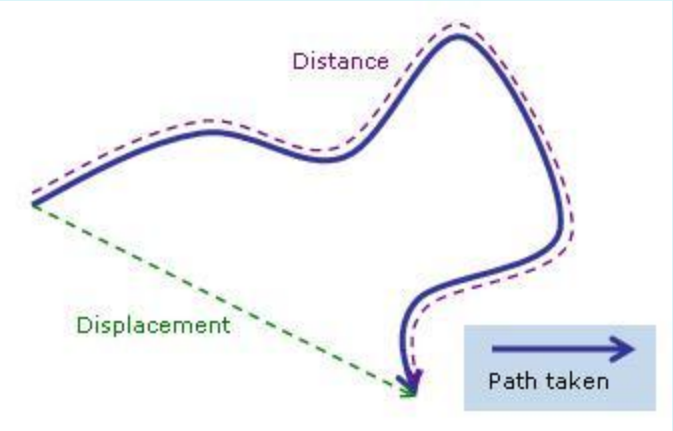
CHAPTER 2

DISTANCE AND DISPLACEMENT

- Distance and displacement are two quantities which may seem to mean the same thing, yet have distinctly different definitions and meanings.



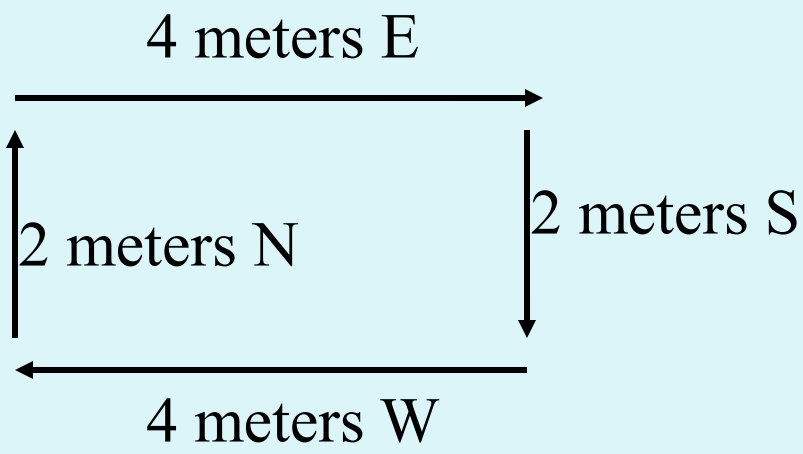
DISTANCE

- Distance is a scalar quantity.
- Distance refers to how much *ground* an object covers during it's motion.
- The metric unit to measure distance is a meter.

DISPLACEMENT

- Displacement is a vector quantity.
- Displacement refers to how far out of place an object is from it's starting position.
- The unit for displacement is a meter AND **direction**.

EXAMPLE



- A physics teacher walks 4 meters East, 2 meters South, 4 meters West, and finally 2 meters North.
- Draw a diagram.

1. CALCULATE DISTANCE

- Because distance refers to “how much ground an object covers, you do not need to be concerned about direction.
- Simply add the lengths together.

4 meters
2 metes
4 meters
2 meters

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12 meters

2. CALCULATE DISPLACEMENT

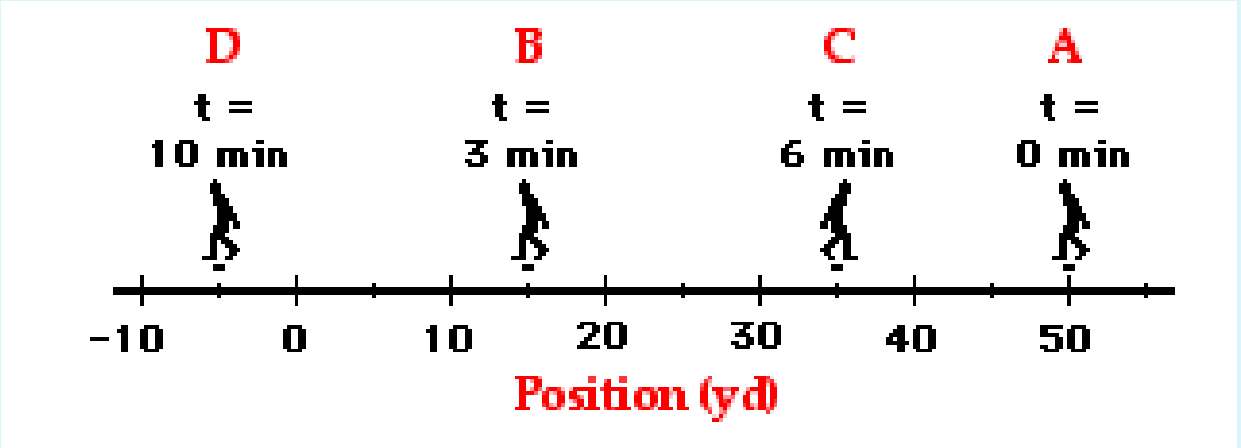
- Because displacement is the distance and direction of an object's change in position form the starting point, the displacement of the teacher is zero meters.

Even though the physics teacher has walked a total distance of 12 meters her displacement is 0 meters. During the course of her motion, she has covered 12 meters of ground. (Distance = 12 meters). Yet when she is finished walking, she is not out of place. There is no displacement for her motion. (Displacement = 0 meters)

Displacement, being a vector quantity, must give attention and regard to direction. The 4 meters East is cancelled by the 4 meters W and the 2 meters South is cancelled by the 2 meters North.

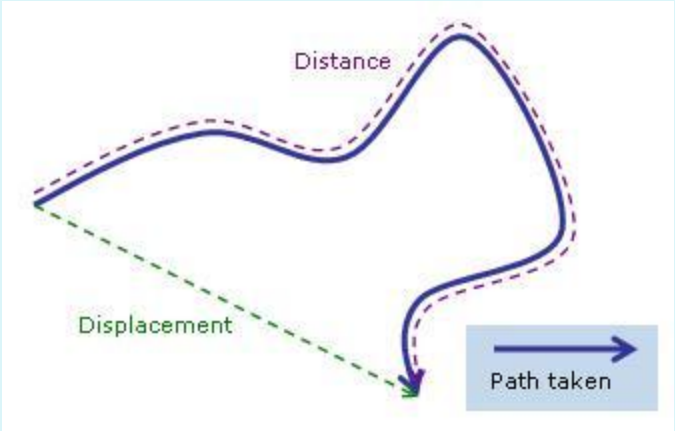
PRACTICE

- A football coach paces back and forth along the sidelines.



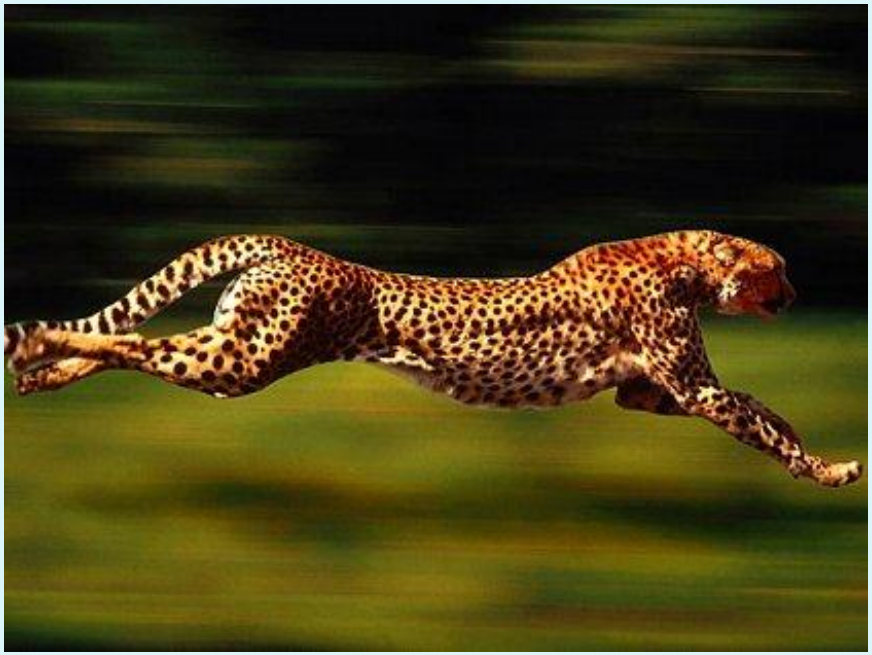
SPEED AND VELOCITY

- Just as distance and displacement have distinctly different meanings, so do speed and velocity.



SPEED

- Speed is a scalar quantity.
- Speed refers to how fast an object is moving.
- An object with no movement as all has zero speed.



VELOCITY

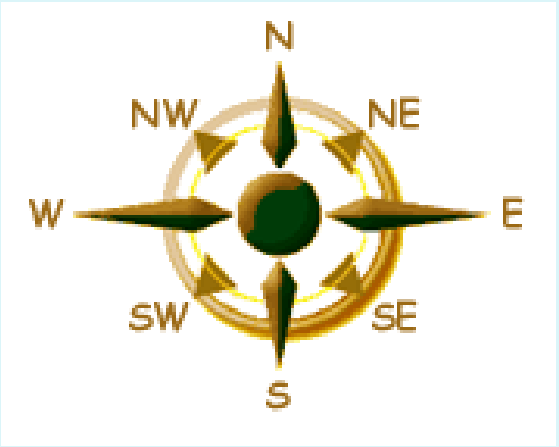
- Velocity is a vector quantity.
- Velocity refers to the rate at which an object changes position.

VELOCITY

- Imagine a person moving returning to the original starting position. While this might result in a frenzy of activity, it would result in a zero velocity. Because the person always returns to the original position, the motion would never result in a change of position.
- Since velocity is defined as the rate at which the position changes, this motion results in zero activity.

VELOCITY

- Velocity is direction aware.
- When evaluating the velocity of an object, you must keep track of direction.



WRONG
- An object has a velocity of 55 m/hr.

CORRECT
- An object's velocity is 55 m/hr east
- A direction must be included in order to fully describe the velocity of the object.

CALCULATIONS

- Average speed = $\frac{\text{distance traveled}}{\text{time of travel}}$

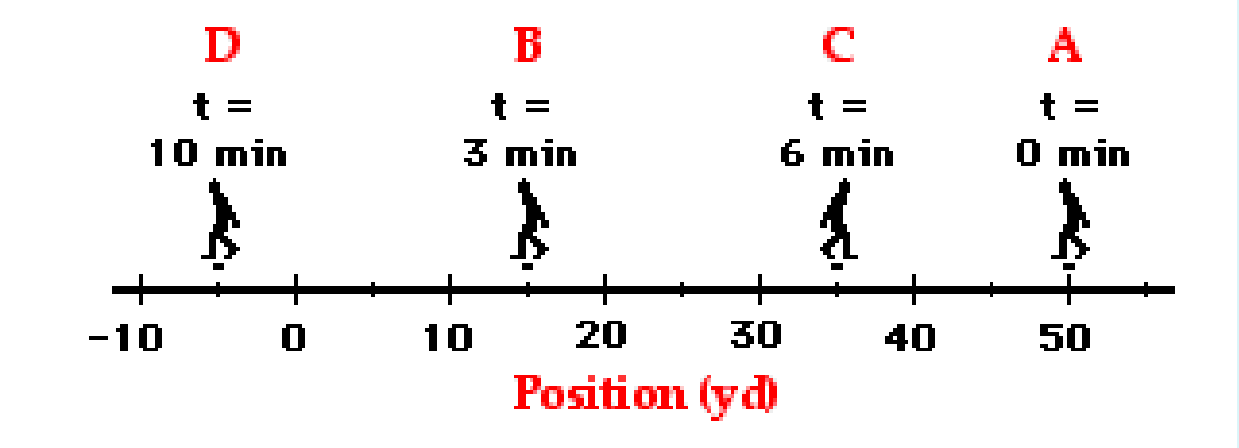
  S=

Example: While on vacation, my parents traveled a distance of 440 km. Their trip took 8 hours. What was their average speed?

Practice: A cyclist races 100 meters in 50 seconds. What is his speed?

AVERAGE VELOCITY

- Average velocity = $\frac{\text{displacement}}{\text{time}}$



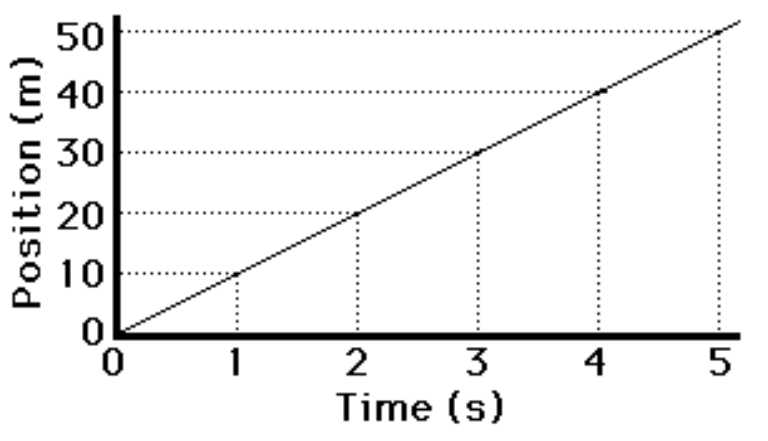
What is the coach's average speed?

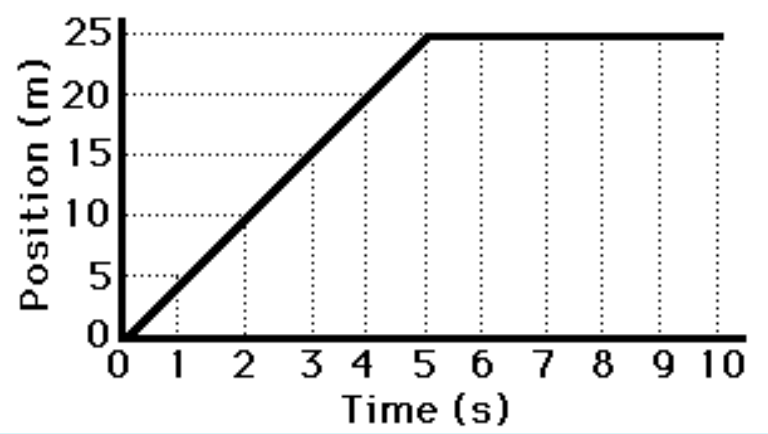
What was his average velocity?

INSTANTANEOUS SPEED/ CONSTANT SPEED

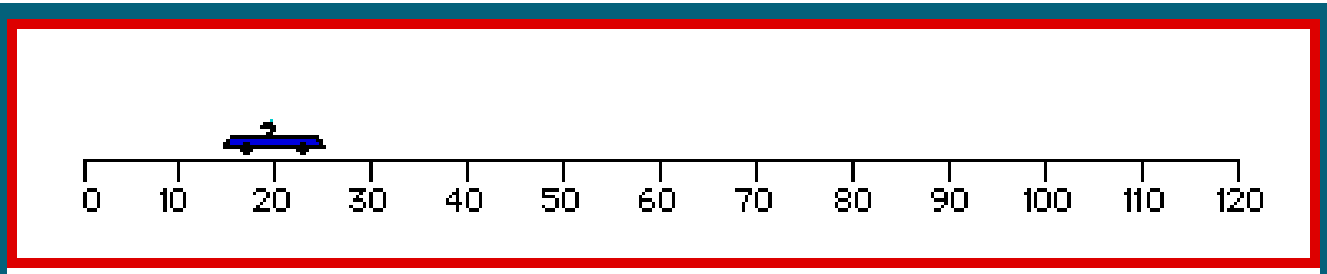
- Instantaneous: Speed at any given time (check a speedometer)
- Constant: Moving objects don't always travel with erratic and changing speeds. Occasionally, an object will move at a steady rate with a constant speed.
- Constant: nThe object will cover the same distance every regular interval of time.

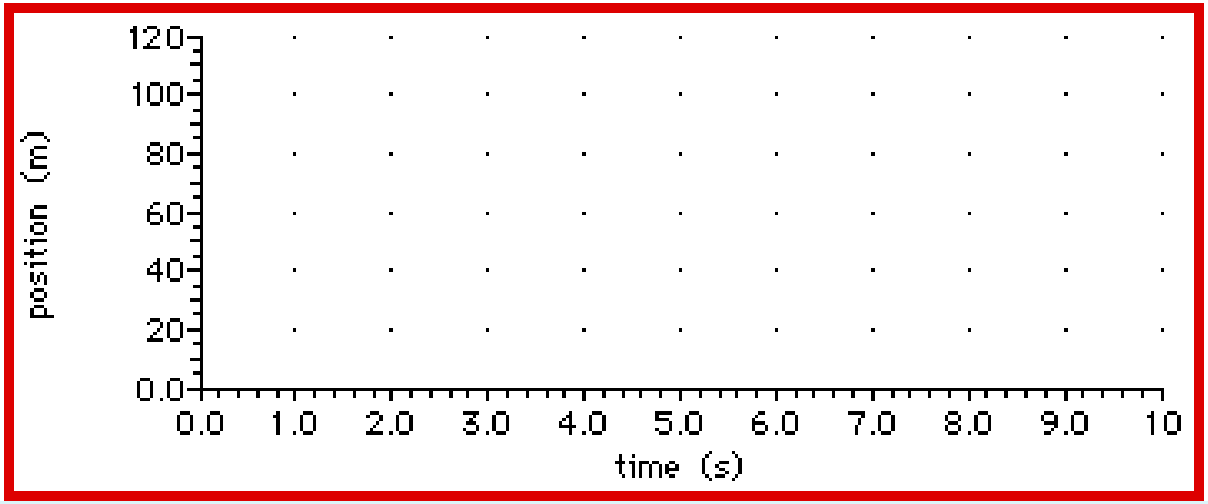
SPEED GRAPHS





- The steepness of the line indicates how fast an object is moving.
- Steeper Line= greater speed
- Horizontal Line=not moving (no change in distance or position)





Since the red car is moving faster, it eventually catches up with and passes the blue car. Observe the position-time graphs for these two cars. The position-time plot of each car's motion is depicted by a diagonal line with a constant slope. This diagonal line is an indicator of a constant velocity. At the time that the cars are side by side, the lines intersect. That is, the two cars share the same position at that instant in time.

CHECK YOUR UNDERSTANDING

- What is the displacement of the BHS cross-country team if they begin at the school, run 10 miles and finish back at the school?

- A marathon runner completes a 40 km race as follows: first 10 km in 1 hour, second 10 km in 1.6 hour, third 10 km in 1.2 hour, and fourth 10 km in 2.4 hour. Calculate the average speed of the marathon runner.