Motion on the Move

Trace a route, then compare how motion is measured.

PHY.1.5 "Differentiate and give examples of motion concepts such as distance-displacement, speed-velocity, and acceleration."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two statements that distinguish distance from displacement, circle two statements that distinguish speed from velocity, and number the three ways the robot's velocity changes. Use your marks to track how direction matters.

A Robot's Park Route

1. At a city park, Maya tests a delivery robot on a straight path. It travels 120 meters east from its charging spot, then moves 40 meters west toward a bench. The entire trip takes 40 seconds. A pedometer on the robot would record 160 meters of distance because it adds every part of the route. Displacement describes the change from starting position to ending position, including direction. The bench is 80 meters east of the charging spot, so the robot's displacement is 80 meters east. If the robot returned to its charging spot instead, its displacement would be zero even though it had traveled.

2. Speed tells how quickly distance accumulates; it does not specify a direction. For Maya's robot, average speed is total distance divided by total time, or 160 meters divided by 40 seconds: 4 meters per second. Velocity includes direction and is based on displacement rather than distance. The robot's average velocity is 80 meters east divided by 40 seconds: 2 meters per second east. These averages describe the whole trip, not every moment. On the westbound portion, its velocity points west, even though its average velocity for the full trip points east. A speedometer alone cannot report that difference.

3. Later, Maya tests how the robot changes its motion. On a straight eastbound stretch, its velocity rises from 2 meters per second east to 6 meters per second east in 2 seconds. Its average acceleration is the change in velocity divided by elapsed time, or 2 meters per second squared east. When it brakes while still moving east, its acceleration points west because its eastward velocity decreases. A turn can also cause acceleration: if the robot curves north at a steady speed, its velocity changes direction. Acceleration therefore does not always mean speeding up; it means velocity is changing.

2 ANSWER WITH EVIDENCE

Use the passage

1. Maya calls 160 meters east the robot's displacement. What did she mix up, and what is the correct displacement?

2. Give the robot's average speed and average velocity for the full trip. Why are they different?

3. The robot's eastward velocity rises from 2 to 6 meters per second in 2 seconds. What is its average acceleration, including direction?

4. Why is the robot accelerating both when it brakes while moving east and when it curves north at a steady speed?

3 YOUR TURN

Your own words

Invent a trip with two legs in opposite directions along one straight path and give its total time. In 4 to 6 sentences, calculate distance, displacement, average speed, and average velocity, then describe a later change in velocity and calculate the resulting average acceleration.

ANSWER KEY

Motion on the Move

PART 1 · READ AND MARK

Underline two statements that distinguish distance from displacement, circle two statements that distinguish speed from velocity, and number the three ways the robot's velocity changes. Use your marks to track how direction matters. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Maya calls 160 meters east the robot's displacement. What did she mix up, and what is the correct displacement?	**She mixed up distance and displacement. The distance is 160 meters, but the displacement is 80 meters east.**
2	Give the robot's average speed and average velocity for the full trip. Why are they different?	**Average speed is 4 meters per second; average velocity is 2 meters per second east. Speed uses the 160-meter distance, while velocity uses the 80-meter eastward displacement.**
3	The robot's eastward velocity rises from 2 to 6 meters per second in 2 seconds. What is its average acceleration, including direction?	**The velocity changes by 4 meters per second east in 2 seconds, so average acceleration is 2 meters per second squared east.**
4	Why is the robot accelerating both when it brakes while moving east and when it curves north at a steady speed?	**Braking decreases its eastward velocity, so its acceleration points west. Curving north changes the direction of its velocity, even at a steady speed.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

A jogger goes 90 meters north, then 30 meters south, in 30 seconds. The distance is 120 meters, but the displacement is 60 meters north. Average speed is 120 ÷ 30 = 4 meters per second, while average velocity is 60 ÷ 30 = 2 meters per second north. Later, the jogger moves north and increases velocity from 2 to 4 meters per second north in 2 seconds. The average acceleration is 1 meter per second squared north because the northward velocity increases.

Accept any consistent two-leg trip with correct totals and directions. The later velocity change must include enough information to calculate average acceleration.