

Lesson 1 Graphing Motion

Grade Eight Science Content Standard. 1.f. Students know how to interpret graphs of position versus time and graphs of speed versus time for motion in a single direction. **Also covers:** 9.d, 9.e.

MAIN Idea

Graphs can show changes in an object's position and speed.

What You'll Learn

- to construct a position-time graph
- how motion with constant speed and changing speed appears on a position-time graph

Mark the Text

Identify the Main Idea

When you read each paragraph, highlight the main idea. When you finish reading, make sure you understand each main point.

Picture This

1. **Identify** What was the approximate position of the turtle at 50 s?

Before You Read

If someone asked you to show position and speed, how would you do it? Write your answer on the lines below. Then, read the lesson to learn about interpreting graphs.

Read to Learn

Position-Time Graphs

Graphs are useful tools for summarizing many kinds of information. One type of graph—a position-time graph—is used to show how position changes with time.

How do you graph positions from data?

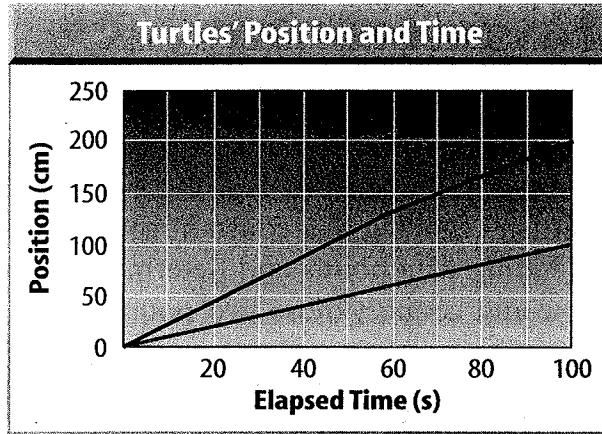
Imagine a turtle crawling across a sidewalk. You can measure the position of the turtle with a meterstick and its travel time with a watch. You can write down the position and time in a table, such as the one below.

With the data in the table, you can graph the turtle's motion. The position of the turtle is plotted on the y -axis and the time is plotted on the x -axis. The data points are connected with a line. The line is a useful tool for estimating the position of the turtle for times you did not measure.

Turtle's Position and Time	
Elapsed Time (in s)	Position (in cm)
0	0
20	40
40	81
60	123
80	158

What are the units on position-time graphs?

The values plotted on a position-time graph have units. Each plotted point is the position at a certain instant of time. Position always has units of length, such as centimeters, meters, or kilometers. Time has units such as seconds, minutes, or years.



What is the purpose of a position-time graph?

A graph compares the motions and the speeds of objects. The graph above shows the positions of two turtles in a 200-cm race. The turtles' owners measured the positions of the turtles every 20 seconds. Then, they plotted the data on the same graph. The turtle that reached 200 cm first won the race.

What does the slope of a line show?

Recall that average speed equals the distance traveled divided by the time needed to travel the distance. The winning turtle travels 200 cm in 100 s. So its average speed is 200 cm/100 s, which equals 2 cm/s. The losing turtle travels 100 cm in 100 s, so its average speed is 1 cm/s.

Notice in the graph above that the line for the winning turtle is steeper than the line for the losing turtle. The steepness of the line is called the line's slope. The steeper line means a greater average speed.

How do you calculate slope?

Two points must be used to calculate the slope of a line plotted on a position-time graph. One point can be the origin of the graph. The other point can be any other point on the plotted line. First, determine the change in units in the vertical direction, the rise, from the origin to the chosen point. Next determine the change in units in the horizontal direction, the run. To calculate slope, divide the rise by the run.

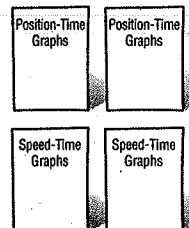
Picture This

2. Identify What type of data is shown on the y-axis?

Academic Vocabulary
data (DAY tuh) (noun)
individual pieces of information

FOLDABLES™

C Record Information
Make four note cards. Label the quarter sheets as illustrated. Use two note cards to record what you learn about position-time graphs and speed-time graphs. Use the other note cards to draw an example of each type of graph.



Applying Math

- 4. Calculate** A horse runs a 2-km race in 15 minutes. On the graph of the horse's race, which is the rise and which is the run? (Circle your answer.)
- rise=2 km; run=15 min
 - rise=15 min; run=2 km



Think it Over

5. Draw Conclusions

If the line is not horizontal, what can you conclude about an object's movement?

How can you calculate average speed from a position-time graph?

On a position-time graph, the slope equals the rise divided by the run. The rise is the same as the distance traveled. The run equals the time needed to travel that distance. Therefore, the slope of a line on a position-time graph equals the average speed. If the rise of a slope is equal to 20 m and the run is equal to 5 s, the average speed is 4 m/s.

How can you graph changing speed?

Only objects that move at a constant speed have graphs with straight lines. How can you find the average speed of an object that isn't moving at a constant speed? You use the starting and ending data points and determine the slope of the line that would connect those two points.

Speed-Time Graphs

A speed-time graph compares the instantaneous speed of an object to time. Instantaneous speed is plotted on the y -axis and time is plotted on the x -axis. When the speed of an object is constant, the graph will show a horizontal line.

How are speed changes shown on a speed-time graph?

Sometimes, a car travels at a constant speed. Other times, its speed changes. The line on a speed-time graph for the car is horizontal until the driver brakes. If you plot the slowing speeds on a speed-time graph, the slope of the line decreases. As the driver gives the car more gas, the car gains speed. Plotted on a speed-time graph, the slope of the line increases as the car gains speed. The line becomes horizontal again when the car returns to a constant speed.

What have you learned?

Graphs are often used to summarize information. The slope of a line on a position-time graph is the speed of the object. The steeper the slope, the more distance the object travels in a certain amount of time. So a steeper slope on a position-time graph means a greater speed.

On speed-time graphs, a horizontal line means the object's speed is constant. A line that slopes upward means the object is speeding up, while a line that slopes downward means the object is slowing down.