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Warm-Up | Speed and Velocity

Lesson Question

Lesson Goals

Differentiate between _____ and velocity.

Solve problems involving distance, _____, speed, and/or velocity.

Interpret _____ of distance versus time.

Words to Know

Write the letter of the definition next to the matching word as you work through the lesson. You may use the glossary to help you.

_____ average

_____ instantaneous

_____ position vs time graph

_____ slope

_____ speed

_____ velocity

A. a graph that shows the relationship between the position of an object over time; time is plotted on the x-axis, and the position of the object is plotted on the y-axis

B. occurring immediately

C. the sum of all items in a data set divided by the total number of items

D. a displacement per unit of time; or distance traveled per unit of time in a specific direction

E. the distance traveled per unit of time

F. the steepness of a line on a graph; abbreviated by m and calculated by $m = (y_2 - y_1)/(x_2 - x_1)$

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Distance or Displacement

- _____ point:
  - is needed to determine distance or displacement.
- Distance:
  - is how _____ an object traveled.
  - is measured along the _____ taken.
- Displacement:
  - is the difference between the _____ point and ending point.
  - is measured in a straight _____ from starting point to ending point.
  - includes _____.

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Speed

- _____ is the distance traveled during a specific unit of _____.
- Two measurements are needed to determine speed.
  - _____
  - Time
- _____ speed includes the total distance and total time.
- _____ speed includes the distance and time at a specific _____.

Velocity

- _____ is the displacement of an object during a specific unit of time.
- Two measurements are needed to determine velocity.
  - _____
  - _____
- Displacement includes a _____, so velocity also includes a direction.
  - _____ with direction
- Velocity can be an average velocity or an _____ velocity.

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Speed Formula

- Speed is a distance traveled per unit of time or distance [ ] by time.
  - Distance can be measured in [ ].
  - Time can be measured in [ ].
- Meters divided by seconds gives a unit of meters per second [ ] for speed.
- Other units for speed can be used.
  - [ ]
  - [ ]

$s =$ [ ]

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Speed of a Race Car

EXAMPLE

A race car takes 4.3 hours to travel 500 miles. What is the average speed of the race car?

- Time (t) = ☐ hours
- Distance (d) = ☐ miles
- Unknown: average speed (s) of the car.
- To find the answer, we need to use the equation speed equals distance divided by time.

$$s = \frac{d}{t} = \frac{500 \text{ miles}}{4.3 \text{ hours}} = \square \text{ miles/hour}$$

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Velocity Formula

- Velocity is displacement per unit of [ ] or displacement divided by time.
  - Units for velocity are the same as for [ ]: m/s, km/h, or mph.
- Delta *x* [ ] is the symbol used for displacement.
  - Delta (Δ) means “[ ].”
  - Δx means “change in [ ].”
  - Δx is calculated by final position minus [ ] position.

$$v = \frac{\Delta x}{t}$$

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Velocity of a Skateboarder

EXAMPLE

Trayvon is skateboarding home when he realizes he dropped his wallet. He is 500 meters north of his house when he realizes this and has to travel until he is 800 meters north of his home before he finds his wallet. If the entire trip took 200 seconds, what is Trayvon's [ ] velocity?

Given:

- $x_i =$ [ ]
- $x_f =$ [ ]
- $t =$ [ ]
- Unknown: v

Formula: $v = \frac{\Delta x}{t} = \frac{800\ \text{m} - 500\ \text{m}}{200\ \text{s}} = \frac{300\ \text{m}}{200\ \text{s}} =$ [ ] north

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Distance and Displacement

When speed (or velocity) and time are known, [ ] (or displacement) can be found.

$$s = \frac{d}{t}$$

Rearrange the equation:

$$d = st \quad \text{or} \quad \Delta x = vt$$

Example: A plane takes off from the airport and flies with a velocity of 850 km/h north for 2.5 hours. What is the plane's displacement?

Given:

- $v = 850 \text{ km/h}$ [ ]
- $t =$ [ ]
- Unknown: Δx

$$\Delta x = vt = (850 \text{ km/h})(2.5 \text{ h}) =$$ [ ] north

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Time

When speed (or velocity) and distance (or displacement) are known, [ ] can be found.

$$v = \frac{\Delta x}{t}$$

Rearrange the equation:

$$t = \frac{\Delta x}{v} \quad \text{or} \quad t = \frac{d}{s}$$

Example: A plane flies with a velocity of 800 km/h for a distance of 2,800 km. How long has the plane been flying?

Given:

- $v = 800\ \text{km/h}$
- $d = 2{,}800\ \text{km}$
- Unknown: t

$$t = \frac{d}{s} = \frac{2{,}800\ \text{km}}{800\ \text{km}} = \boxed{}$$

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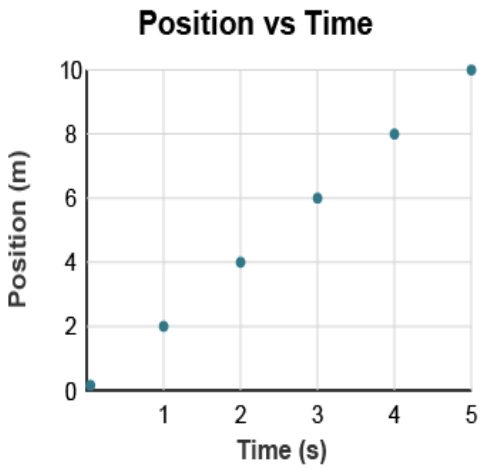
Position vs Time Graph

A [ ] vs [ ] graph shows the relationship of position over time for a moving object.

Time (s)	Position (m)
0	0
1	2
2	4
3	6
4	8
5	10



- The table shows the time and position of a toy car recorded every second for [ ] seconds.
- The first column in the table always represents the [ ]-axis values, and the second column always represents [ ]-axis values.
- These values are plotted on a graph to create a [ ] vs time graph.
- At 0 seconds the car is at the starting point, or [ ].

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- At 1 s the car is at 2 m, at 2 s the car is at [ ], and so on.
- The data create a [ ] line.
- The car has the same instantaneous [ ] at each point on the graph.
- The car traveled with a constant velocity of [ ], which is why this graph is a straight, diagonal line.

Draw the line representing the car's velocity on the graph above.

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Slope of a Position vs Time Graph

- The [ ] of a position vs time graph represents an object's [ ].
  - Slope is a measure of the [ ] of a line.

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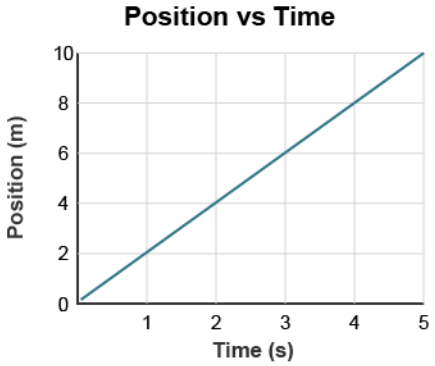
How to Calculate Slope

- Select [ ] points on the line that:
  - are close to each end of the line.
  - lie where gridlines cross.
- Label the [ ] closest to 0 as "1."
- Label the point [ ] from 0 as "2."

Mark the two points selected on the graph below.



- Determine the [ ] coordinates for point 1 (x_1, y_1).

  $x_1 = 1$ s; $y_1 = 2$ m
- Determine the (x, y) coordinates for [ ] (x_2, y_2).

  $x_2 = 4$ s; $y_2 = 8$ m

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Slope Formula

- The abbreviation for slope is [ ] .
- Plug x and y values of the points into the [ ] .
  - Keep units attached to the [ ] .
- Solve by subtracting first, then [ ] .
- Carry the [ ] through to the answer.

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$m = \frac{(8m - 2m)}{(4s - 1s)} = \frac{6m}{3s} = [\ ]$$

Notice that the slope formula matches our formula for velocity.

$$m = \frac{\text{change in } y}{\text{change in } x}$$

Since position is on the y-axis and time on the x-axis, it is the change in position over time or displacement over time.

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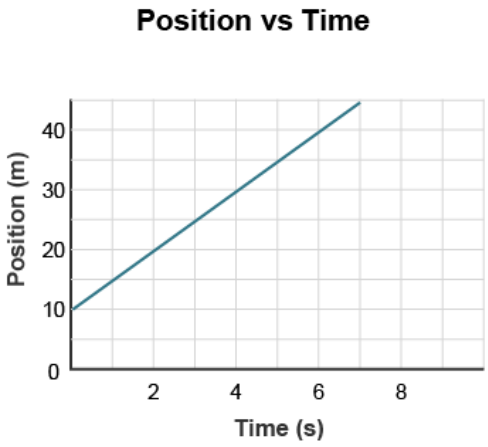
Initial Position

- The y-intercept of a position vs time graph indicates the [ ] position of an object.

Mark the initial position indicated by the graph.



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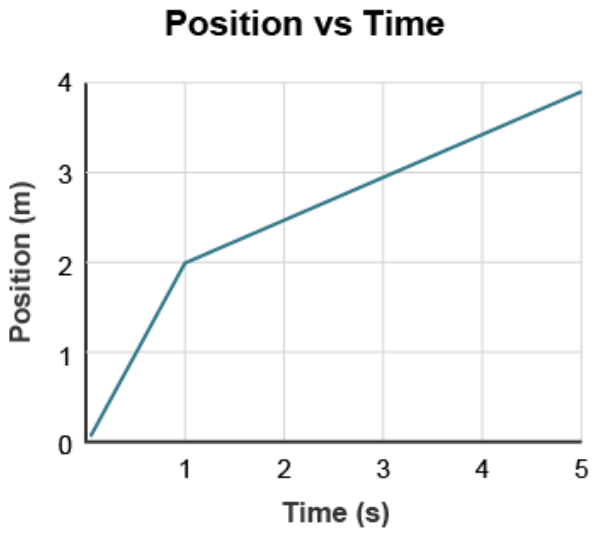
Instantaneous Velocity and Average Velocity

- The slope of a line changes when the [ ] or velocity of an object changes.
  - The [ ] the slope, the [ ] the speed or velocity.
- The average [ ] will be different than any of the slopes of the lines on the graph.
  - Any point on the line will give an [ ] velocity only.
  - The average velocity is $v = \Delta x/t = 4\ \text{m}/5\ \text{s} =$ [ ]

$$v = \frac{\Delta x}{t} = \frac{4m}{5s} = \boxed{}$$

Circle the part of the graph that shows the greatest velocity.



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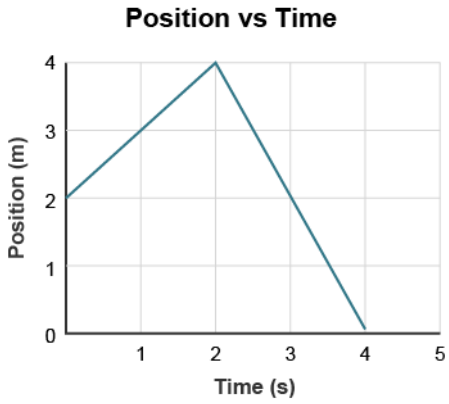
Direction Changes

What happens when an object changes direction?

- As you see here in this graph, we have an object that has changed direction.
  - First part of journey: ☐
  - Second part of journey: ☐
  - Total distance traveled:

$$2\text{ m} + 4\text{ m} = \square$$



- But the change in position is not 6 m. The object starts at 2 m and ends at 0 m. To find the displacement, calculate the final position minus initial position.

$$x_f - x_i = 0\text{ m} - 2\text{ m} = \square$$

The displacement is negative 2 meters.

Let's take a look at the slope for the second half of the journey.

$$m = \frac{(0m - 4m)}{(4s - 2s)} = \frac{-4m}{2s} = 2\text{m/s}$$

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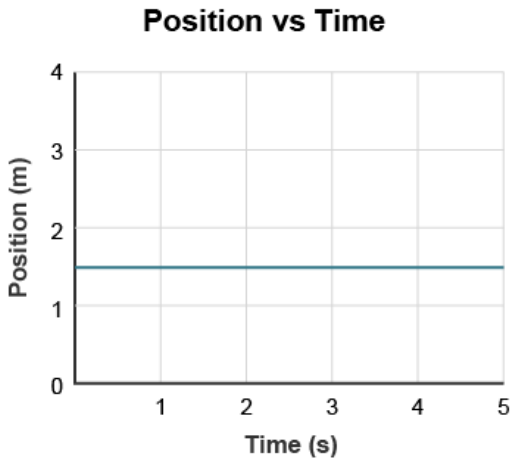
- A direction change is represented when the line on the [ ] changes from a positive slope to a negative slope or from a negative slope to a positive slope.
  - A negative slope indicates an object moving [ ] the origin.
  - A positive slope indicates an object moving [ ] from the origin.

No Motion

- A [ ] line means an object is [ ] moving.
  - The object's [ ] does not change.



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Summary | Speed and Velocity

Lesson Question

What are the similarities and differences between speed and velocity?

Answer

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Review: Key Concepts

Speed:

- is calculated using _____.
- is always _____.

Velocity:

- is calculated using _____.
- can be positive or _____.
- is represented by _____ of a position vs time graph.

Both:

- have units in m/s and _____.
- can be average or _____.

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Use this space to write any questions or thoughts about this lesson.

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