

# Warm-Up

## Speed and Velocity

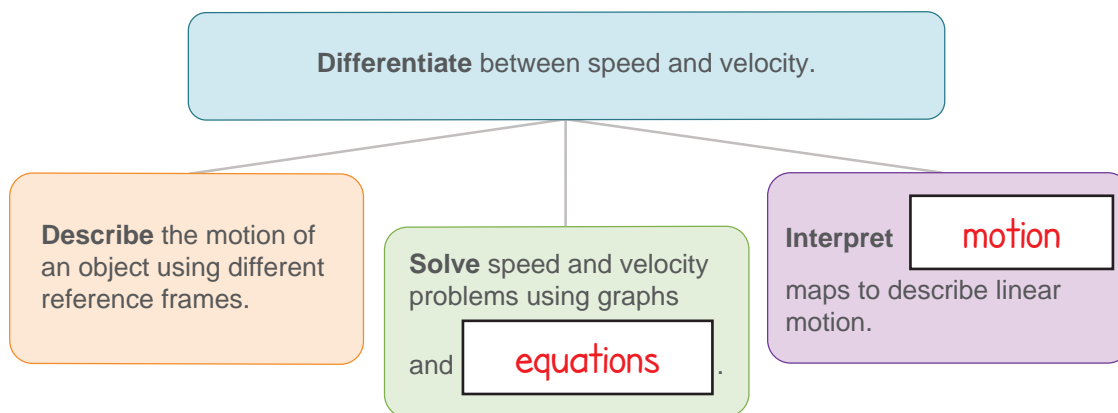


### Lesson Question

How can speed and velocity be used to describe motion?



### Lesson Goals



### Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

speed	the distance traveled per unit of time
velocity	the displacement of an object per unit of time
vector	a quantity that has both magnitude and direction
reference frame	the position from which an event is observed
motion map	an image that represents the position, velocity, and acceleration of an object at one-second intervals
scalar	a quantity that is described by magnitude alone

# Warm-Up | Speed and Velocity

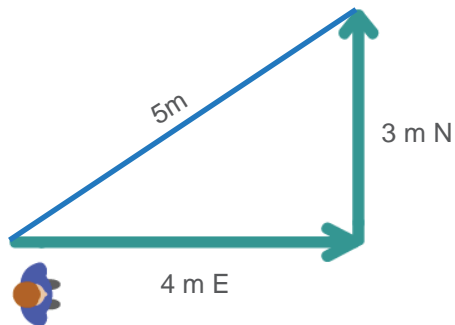


## Review of Motion

- A reference point is a **distinct** location that is compared to another location.
- Distance is a measurement of **length**.
- Displacement is the change in **position** from the reference point.

$$\text{Distance} = 4 \text{ m} + 3 \text{ m} = 7 \text{ m}$$

$$\text{Displacement} = 5 \text{ m N}$$



# Instruction

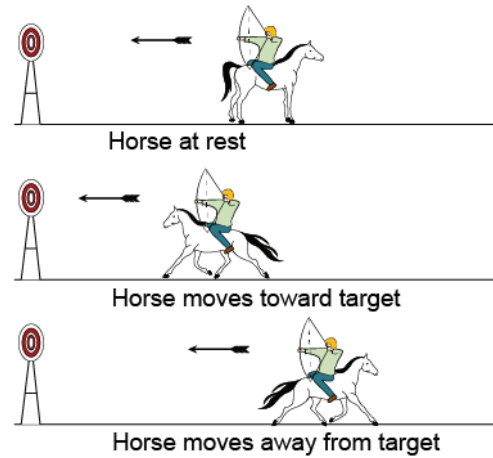
## Speed and Velocity

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### Motion and Reference Frames

- All motion is **relative**; it depends on a **reference frame**.
- A reference frame is the position from which an event is **observed**.
- An object may appear to move **faster** or slower depending on the reference frame.



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### Speed

- **Speed** is the **distance** traveled during a specific unit of time.
- Speed is a **scalar**, a quantity that is described by **magnitude** alone.
- **Constant** speed refers to a fixed distance per unit of time.
- Average speed includes the total distance and total time.

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

$$50 + 30 = 80 \text{ miles}$$

$$1 + 1 = 2 \text{ hrs}$$

$$\frac{80 \text{ miles}}{2 \text{ hrs}} = \boxed{40} \text{ mph}$$

## Instruction

## Speed and Velocity

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**Velocity**

- **Velocity** is the **displacement** of an object during a specific unit of time.
- Since displacement includes a direction, so does velocity.
  - Speed with **direction**
- Velocity is a **vector**, a quantity that has both magnitude and direction.

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

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**Average Velocity**

Average velocity is the **overall** displacement over time.

100 m in 10.61 s

$$x_f = \mathbf{100} \text{ m}$$

$$x_i = 0 \text{ m}$$

$$t_f = \mathbf{10.61} \text{ s}$$

$$t_i = 0 \text{ s}$$

$$v_{avg} = \frac{100 \text{ m} - 0 \text{ m}}{10.61 \text{ s} - 0 \text{ s}} = \frac{100}{10.61} = \mathbf{9.43} \text{ m/s}$$

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

## Instruction

## Speed and Velocity

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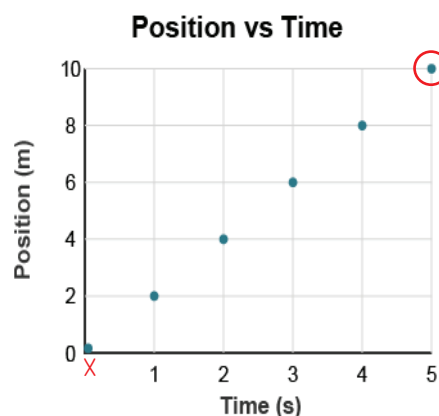
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## Position vs. Time Graphs

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

Circle the final position of the toy car.

Mark an X on the initial position of the toy car.



$$v = \frac{\Delta x}{t} = \frac{10\text{m}}{5\text{s}} = \boxed{2} \text{ m/s}$$

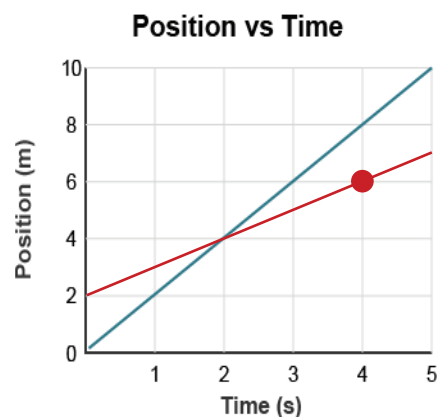
The slope of a position-time graph represents an object's

**velocity**.

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

$$\frac{\Delta X}{\Delta t}$$

$$m = \frac{6\text{m} - \boxed{4\text{m}}}{4\text{s} - 2\text{s}} = \frac{2\text{m}}{2\text{s}} = \boxed{1\text{m/s}}$$



## Instruction

## Speed and Velocity

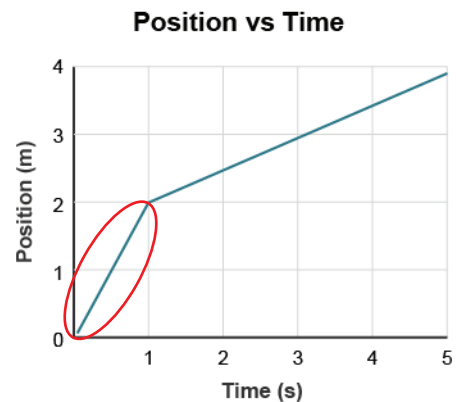
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## Average Velocity vs. Instantaneous Velocity

- The **slope** of a line changes when the velocity of an object changes.
  - The steeper the slope, the greater the velocity.
- The average velocity will be **different** than any of the slopes of the lines on the graph.
  - Any point on the line will give only an instantaneous **velocity**.

Circle the line section that represents the greater velocity of the object.

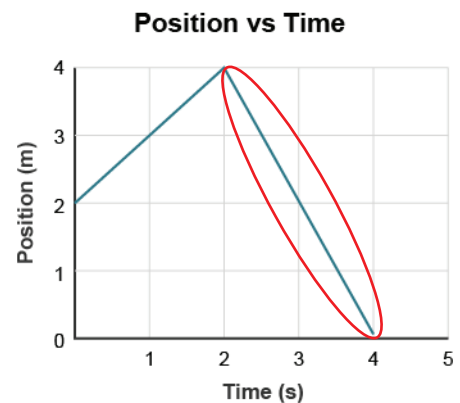


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## Change in Direction

- A change in direction is represented when the line on a position-time graph 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 **toward** the origin.
  - A positive slope indicates an object moving **away** from the origin.

Circle the negative slope of the object.



## Instruction

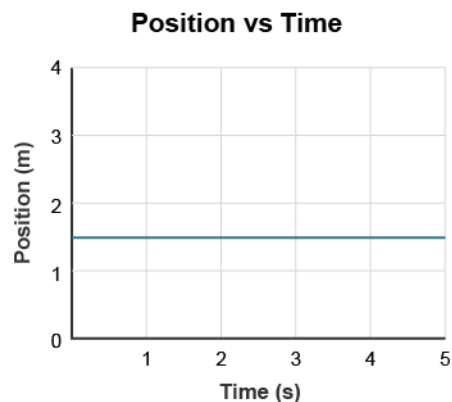
## Speed and Velocity

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**No Motion**

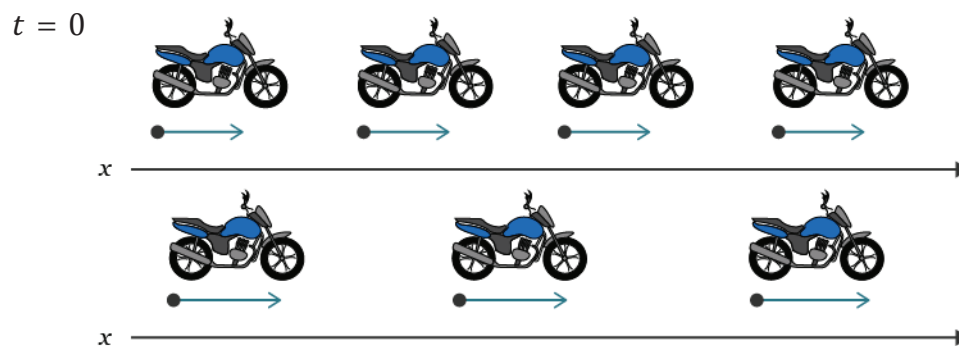
- A **horizontal** line means an object is not moving.
  - The object's position does not change.



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**Motion Maps**

A **motion map** is an image that represents the position, **velocity**, and acceleration of an object at one-second intervals.



- Each image represents the position of the motorcycle at one-second intervals, starting at  $t = 0$ .
- At each position, the motorcycle's velocity is represented by a **vector**.
- Now, this means that the motorcycle is moving faster and has a **greater** velocity.

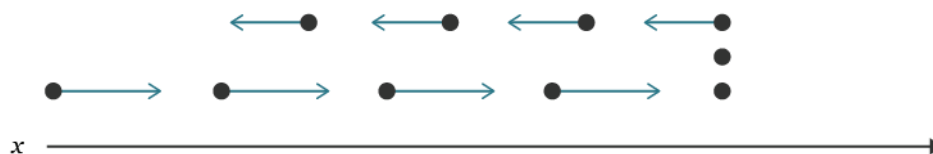
# Instruction

## Speed and Velocity

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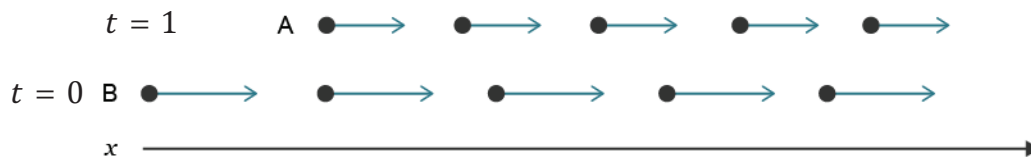
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- Start with the dots closest to the position line.
  - An object moves away from the **origin** at a constant velocity.
  - Next, it stops for two seconds.
  - Then, it moves toward the origin at a **slower** constant velocity.



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### Motion Maps



- Car A starts moving at a position away from the origin and moves away from the origin at a **constant** velocity.
- Car B starts at the origin and moves away from the origin at a **greater** constant velocity.
- After **two** seconds, car B passes car A.

# Summary | Speed and Velocity

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## Lesson Question

How can speed and velocity be used to describe motion?

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## Answer

(Sample answer) Speed describes the distance an object travels in a given time. Velocity is speed with a direction. Both speed and velocity can be calculated with formulas, depicted with graphs of position versus time, and depicted with motion maps.

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## Review: Key concepts

- All motion is **relative**; it depends on a reference frame.
- **Speed** is the distance traveled during a specific unit of time.

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

- Velocity is the displacement of an object during a specific unit of time.

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

# Summary | Speed and Velocity

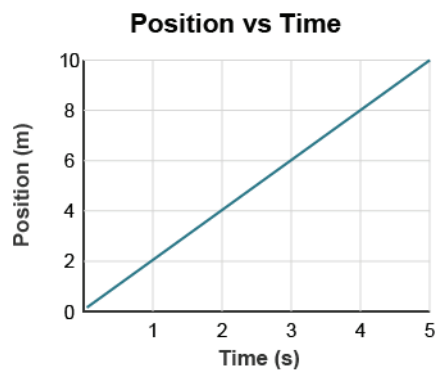
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- A position-time graph shows the relationship of position over time for a

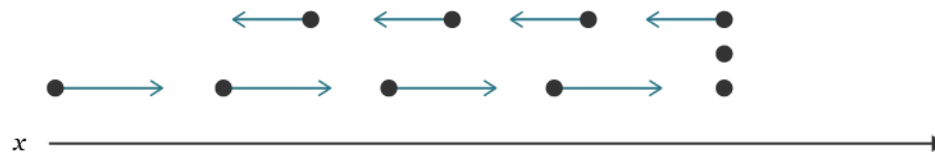
**moving** object.

- The slope represents the object's velocity.
- The slope changes when velocity changes.



A motion map is an image that represents the position, velocity, and

**acceleration** of an object at one-second intervals.





# Summary

## Speed and Velocity

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