Math Skills

Units

What do the following units represent? Use D for distance, T for time, S for speed, or A for acceleration.

_____ 1. 14 km

_____ 2. 30 m/s

_____ 3. 34 min

_____ 4. 6 h

_____ 5. 12 cm/s^2

_____ 6. 150 mph

_____ 7. 14 mi

_____ 8. 3.2 s

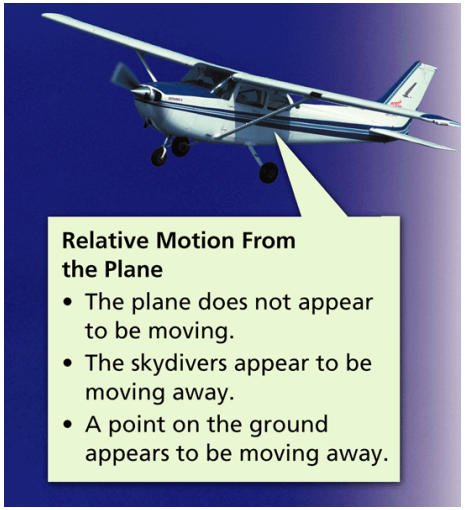
_____ 9. 25 m

_____ 10. 1.4 m/s^2

MOTION

Describing Motion

An object is in motion if it changes position relative to a reference point.



Calculating Speed

To calculate the speed of an object, divide the distance the object travels by the amount of time it took to travel the distance.

This object traveled 45 kilometers in 3 hours. What was the object's speed?

Speed = distance ÷ time

Speed = distance/time

Speed = 45 km ÷ 3 hr

Speed = 15 km/hr

Calculating Speed

- If the speed of an object does not change, the object is traveling at a constant speed. (The speed of most objects is not constant.)

- Average speed is the total distance an object travels divided by the total amount of time it took to travel the distance.

  - **Example**: *A car traveled 50 km in the first hour of a trip, 75 km in the second hour, and 25 km in the third hour. What is the car's average speed?*

    – Avg speed = total distance ÷ total time

    – Avg speed = 150 km ÷ 3 h

    – Avg speed = 50 km/h

Calculating Speed

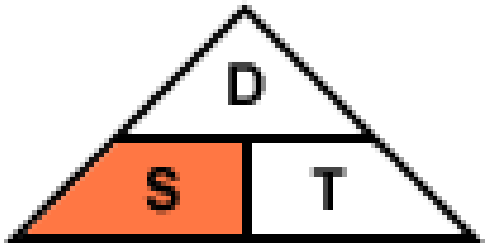
- Instantaneous speed is the speed an object is traveling at any given instant. (The speedometer of a car shows instantaneous speed.)

Velocity

- When you know both the speed AND direction of an object's motion, then you know the velocity of the object.
  - Why is it important for air traffic controllers to know the *velocity* of each aircraft in the area?
  - Why is it important for weather forecasters to predict the *velocity* of a hurricane?

Calculating Distance and Time

Using the speed triangle, you can solve for speed, distance, or time:



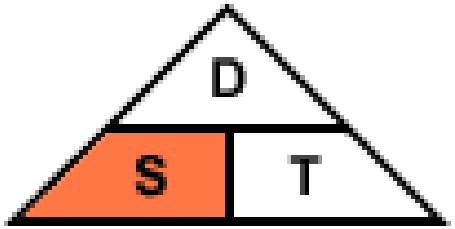
$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Cover any variable to find the formula for that variable:

- Cover S to find speed (distance ÷ time)
- Cover D to find distance (speed X time)
- Cover T to find time (distance ÷ speed)

Calculating Distance and Time

Using the speed triangle, you can solve for speed, distance, or time:



$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

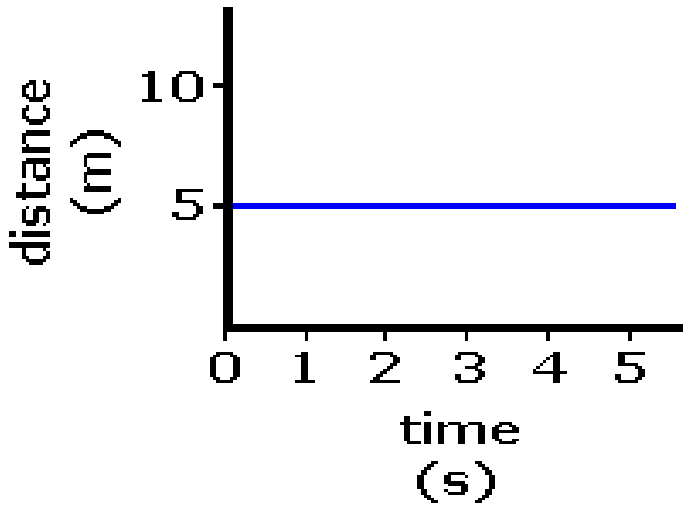
Practice

1.Meteorologists are tracking the path of Hurricane Bessie. The Trade Winds are blowing Bessie toward the west at 20 km/hr. If Miami is 140 km directly west of the hurricane, predict how long it will take Bessie to make landfall in Miami. **Answer: 7 hours**

2. According to the theory of Plate Tectonics, convection currents in Earth's mantle are causing the continents to change position over time. Using GPS, scientists have found that the continent of South America is moving toward the west at 10 cm per year. Predict how far the continent will have moved 500 years from today. **Answer: 5000 cm or 50 m**

Graphing Motion

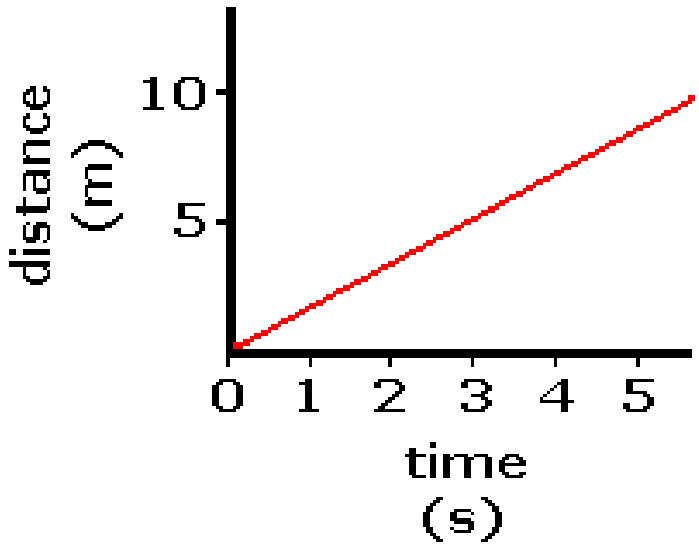
You can show the motion of an object on a line graph in which you plot distance versus time.



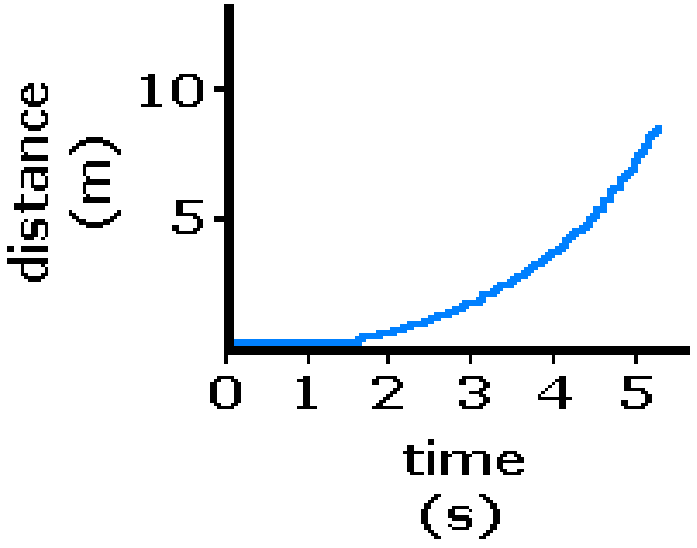
A horizontal line on a distance vs. time graph indicates that he object is ***at rest (not moving)***.

Graphing Motion

You can show the motion of an object on a line graph in which you plot distance versus time.



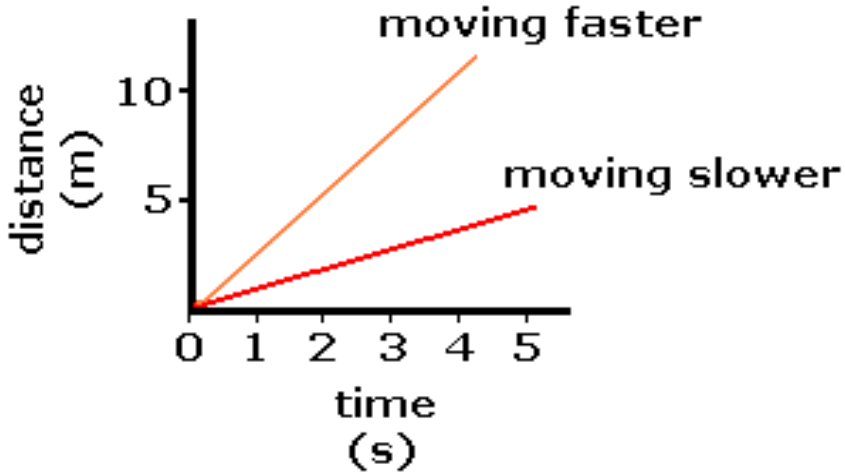
A straight, sloped line on a distance vs. time graph indicates that the object is moving with ***constant speed****.*



A curved line on a distance vs. time graph indicates that the object is ***accelerating (speeding up)****.*

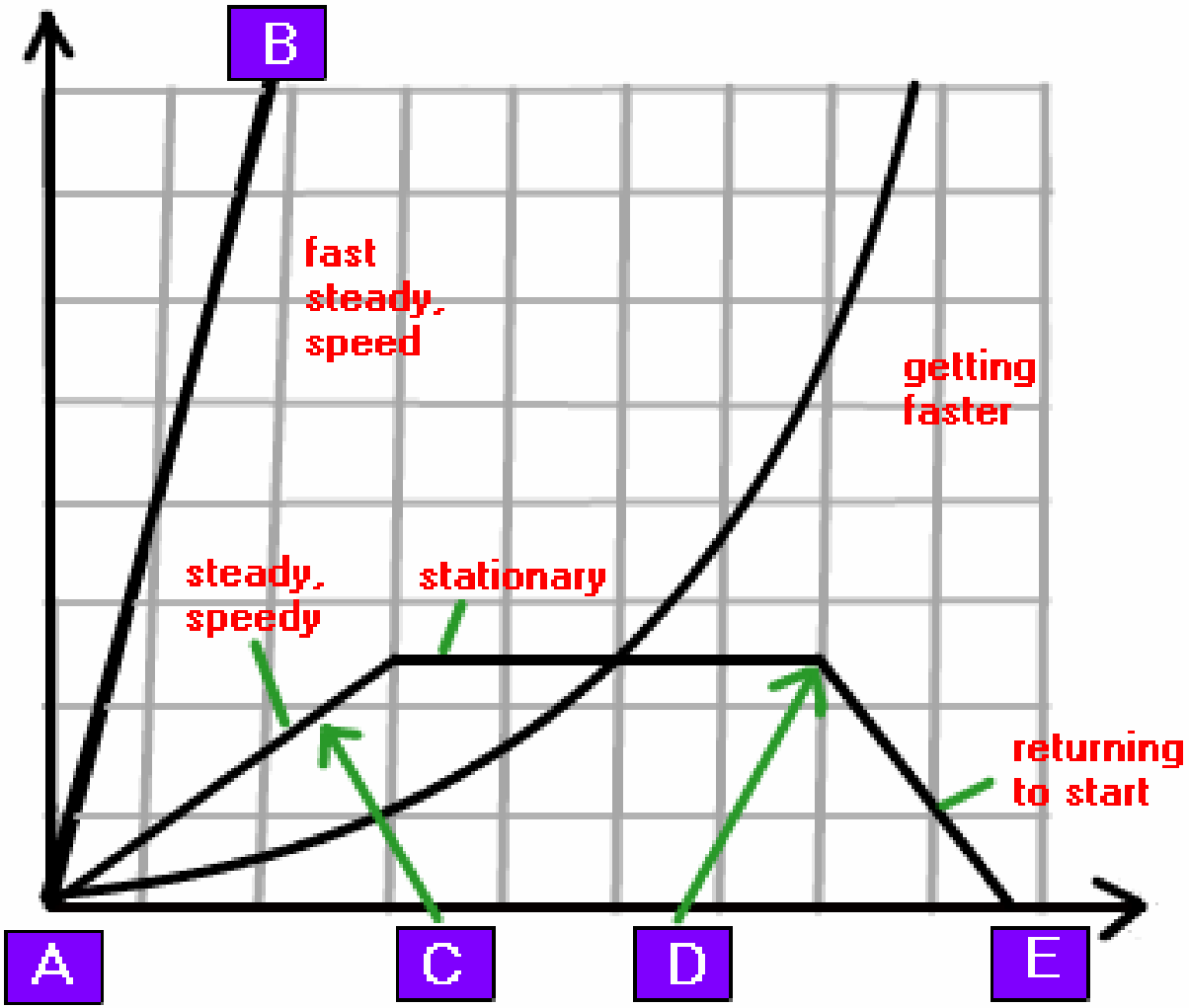
Graphing Motion

You can show the motion of an object on a line graph in which you plot distance versus time.



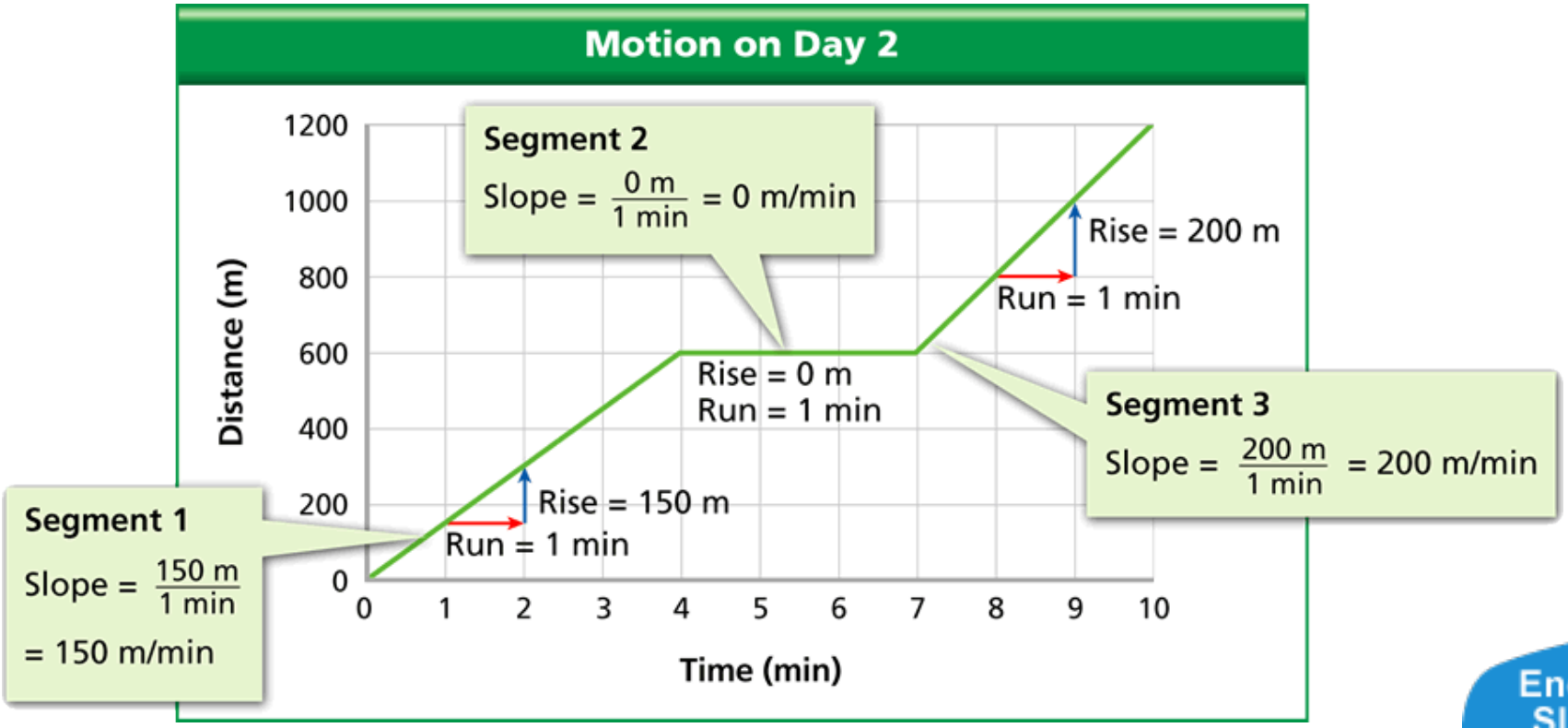
For an object with constant speed:
the steeper the slope, the faster the speed.

Motion


B
fast
steady,
speed
getting
faster
steady,
speedy
stationary
returning
to start
A
C
D
E

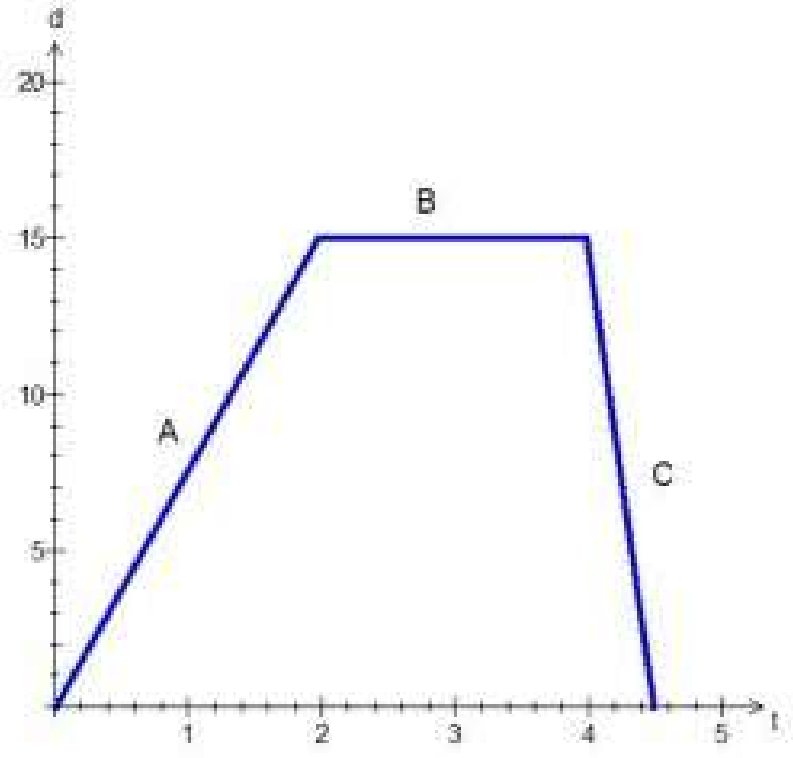
Graphing Motion

The slope of a distance-vs-time graph is the speed.



Graphing Motion

Andrew rode a motorcycle up a steep hill, stayed a while to take pictures of the view, and then rode back down the hill to where he started. The graph shows his motion. (Distance is in miles and time is in hours).



1. How would you describe Andrew's motion in each segment?
   - *A. Constant speed away from starting point*
   - *B. Stopped*
   - *C. Constant speed back toward start*
2. How fast did Andrew travel in each segment?
   - *A. 7.5 mph*
   - *B. 0 mph*
   - *C. 30 mph*
3. What is the difference between segment A and segment C?

   He is moving away from starting point in segment A and toward the starting point in segment C.

Graphing Motion

Robin was roller skating down a sidewalk. Graph Robin's motion using the time and distance data provided. Graph time on the x-axis and distance on the y-axis. Then answer the questions.

Time (s)	Distance (m)
0	0
2	1
4	2
6	3
8	4
10	4
12	4
14	8
16	12

At the end of Robin's trip, how far had she traveled?

What was her average speed (total distance ÷ total time)?

Describe her motion from 8 s to 12 s.

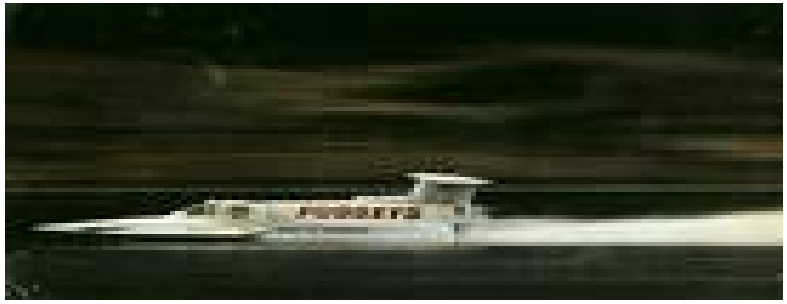
During which time was her speed the fastest?

If Robin had continued skating at the same speed, how far would she have skated at 18 seconds?

Nascar driver, Jeff Gordon has a car that is one of the fastest on the circuit. If it travels 600 miles in 4 hours, what is his cruising speed?

The fastest car on Earth, an English made Thrust SSC would win every Nascar race in America. If it takes 0.5 hours (30 min) to travel 380 miles, what is its speed?

The Spirit of Australia, a hydroplane boat, made speed records by traveling 239 miles in 0.75 hours (45 min). What is its record-breaking speed?



The fastest train on Earth, the TGV from France, can travel at faster speeds than trains in the United States. During a speed test, the train traveled 800 miles in 2.5 hours. What is its speed?

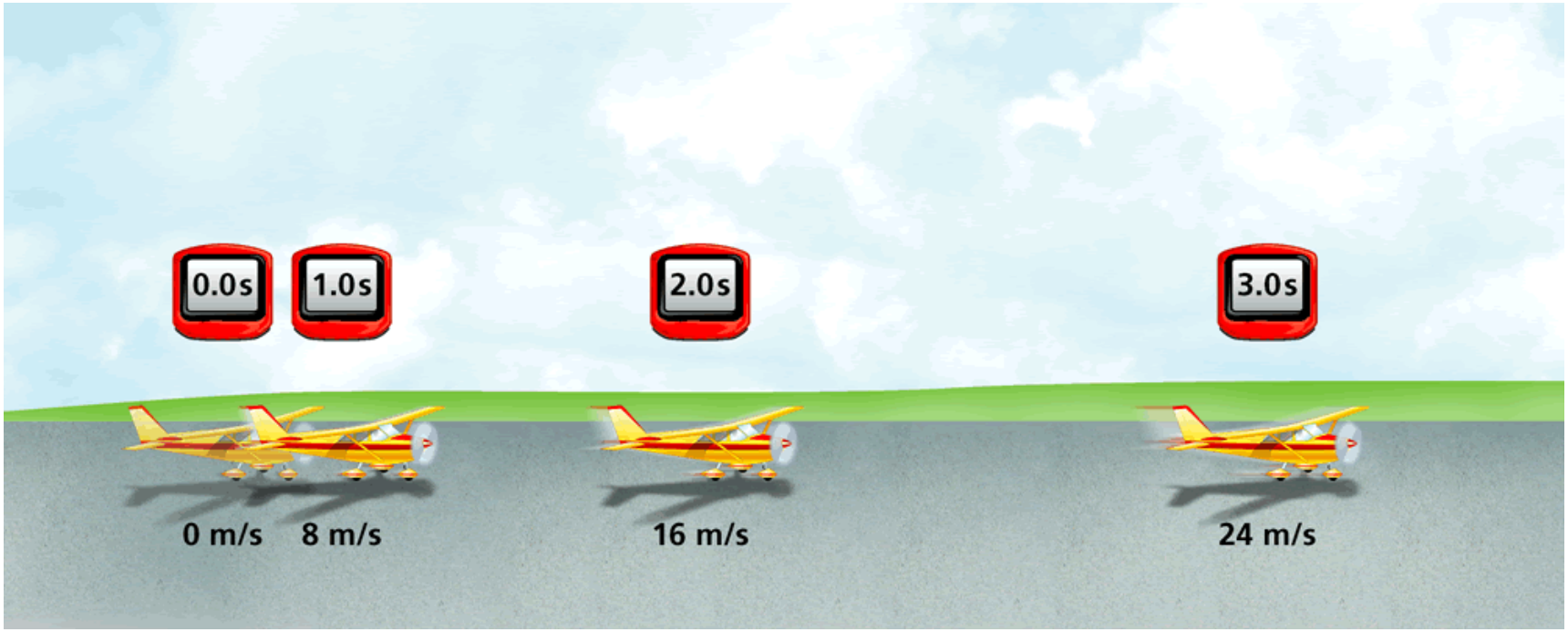
The fastest plane ever made, the Lockheed SR71, was able to travel 2200 miles per hour. Based on this speed, how far could it travel in 2 hours?

Acceleration

- In science, acceleration refers to increasing speed, decreasing speed, or changing direction.
- Decreasing speed is also referred to as negative acceleration.
- Any object that is moving in a circle (Merry-Go-Round, the moon) is accelerating because it is constantly changing direction (even if its speed stays constant).

Calculating Acceleration

To determine the acceleration of an object moving in a straight line, divide the change in speed (final speed - initial speed) by the amount of time it took the speed to change.



Calculating Acceleration

As a roller-coaster car starts down a slope, its speed is 4 m/s. But 3 seconds later, at the bottom, its speed is 22 m/s. What is the acceleration of the roller coaster car?

Read and Understand

What information have you been given in the problem?

Initial speed = 4 m/s

Final Speed = 22 m/s

Time = 3 s

Calculating Acceleration

As a roller-coaster car starts down a slope, its speed is 4 m/s. But 3 seconds later, at the bottom, its speed is 22 m/s. What is the acceleration of the roller coaster car?

Plan and Calculate

What are you trying to calculate?

The acceleration of the roller-coaster car

What is the formula you should use?

Acceleration = **(Final speed – Initial speed)/Time**

Perform the calculation.

Acceleration = **(22 m/s – 4 m/s)/3 s = 18 m/s/3 s**

Acceleration = 6 m/s^2

The roller-coaster car's acceleration is 6 m/s^2.

Calculating Acceleration

As a roller-coaster car starts down a slope, its speed is 4 m/s. But 3 seconds later, at the bottom, its speed is 22 m/s. What is the acceleration of the roller coaster car?

Look Back and Check

Does your answer make sense?

The answer is reasonable. If the car's speed increases by 6 m/s each second, its speed will be 10 m/s after 1 second, 16 m/s after 2 seconds, and 22 m/s after 3 seconds.

Math Practice

Calculating Acceleration

Practice Problem

Q. A falling raindrop accelerates from 10 m/s to 30 m/s in 2 seconds. What is the raindrop's average acceleration?

A. (30 m/s – 10 m/s) ÷ 2 seconds = 10 m/s^2

Math Practice

Calculating Acceleration

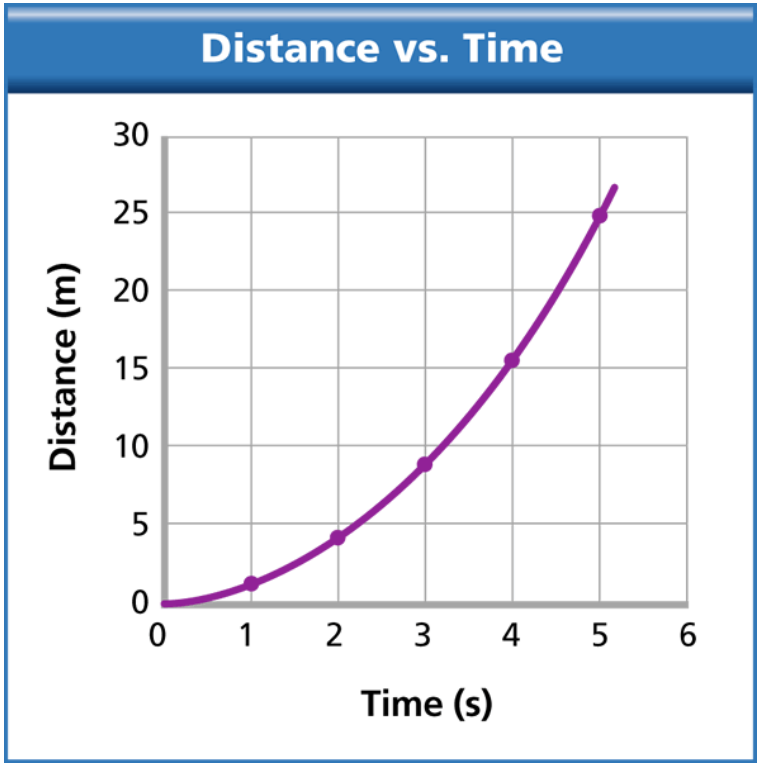
Practice Problem

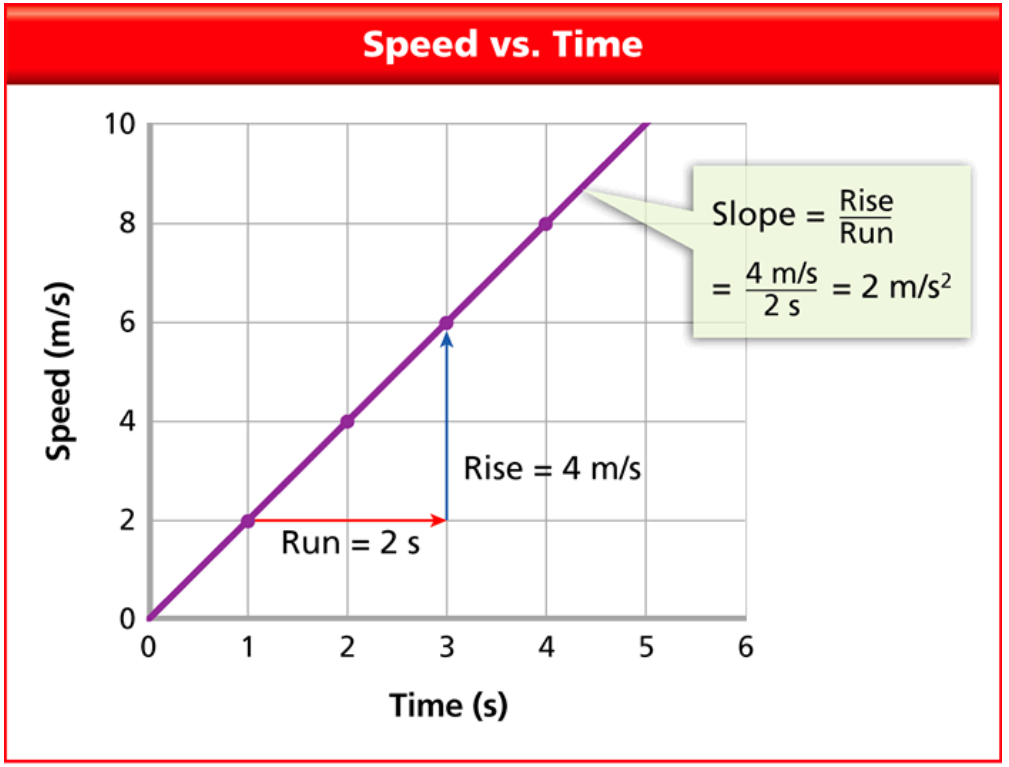
Q. A certain car can accelerate from rest to 2.7 m/s in 9 seconds. Find the car's average acceleration.

A. (2.7 m/s – 0 m/s) ÷ 9 s = 2.7 m/s ÷ 9 s = 0.3 m/s^2

Graphing Acceleration

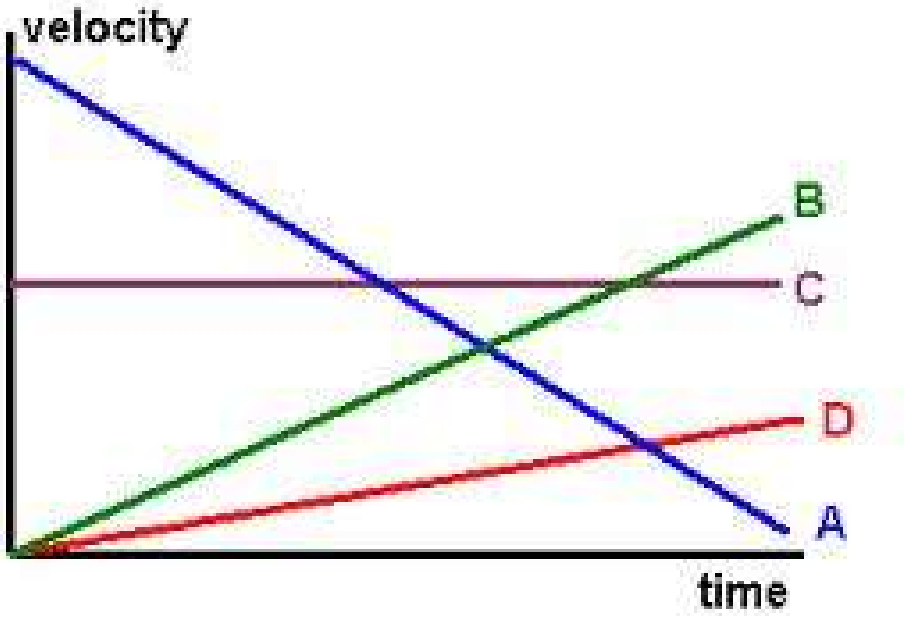
You can use both a distance-versus-time graph and a velocity versus-time graph to show the motion of an accelerating object.





Graphing Acceleration

The slope (rise over run) of a velocity-vs-time graph is the acceleration.



*A downward slanted line on a velocity vs time graph indicates **decreasing speed**. The slope of the line is the negative acceleration.*

*An upward slanted line on a velocity vs time graph indicates **increasing speed**. The slope of the line is the acceleration.*

*A horizontal line on a velocity vs time graph indicates **constant speed (zero slope = zero acceleration)**.*

*An upward slanted line on a velocity vs time graph indicates **increasing speed**. The slope of the line is the acceleration.*