Chapter 11: Motion

Warm-Up (Aug. 26)

1. What is speed?
2. What is acceleration?
3. What is the difference in speed and velocity?

Section 11.1 – Distance and Displacement

To describe motion accurately and completely, a frame of reference is necessary.

A frame of reference is a system of objects that are not moving with respect to one another.

Relative motion is movement in relation to a frame of reference.

Are the people in the cars moving?

Distance

Distance is the length of a path between two points.

It is helpful to express distances in units that are best suited to the motion you are studying.

Distance

What unit would you use to measure the length of someone's hair?

Centimeters (cm)

What unit would you use to measure from McDonough to Atlanta?

Kilometers (km)

What unit would you use to measure the length of a room?

Meters (m)

Displacement

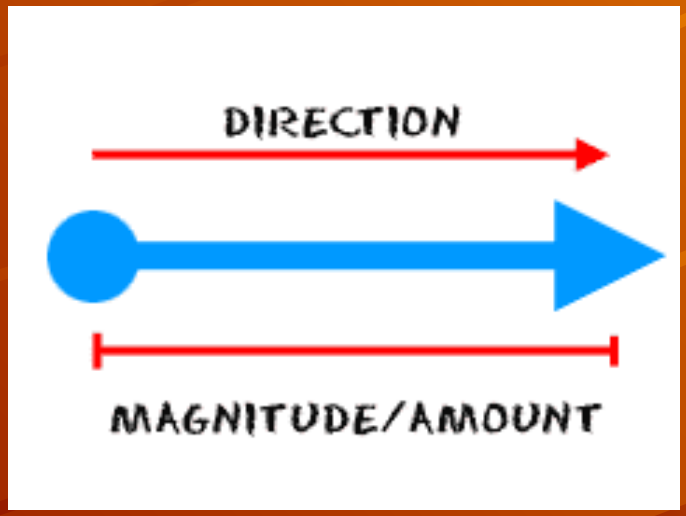
Displacement is the direction from the starting point and the length of a straight line from the starting point to the ending point.

Combining Displacements

Displacement is a vector.

A vector is a quantity that has magnitude and direction.

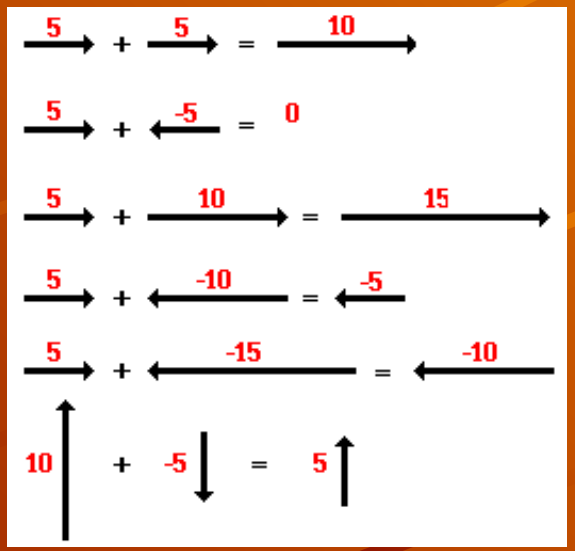
Add displacements using vector addition.



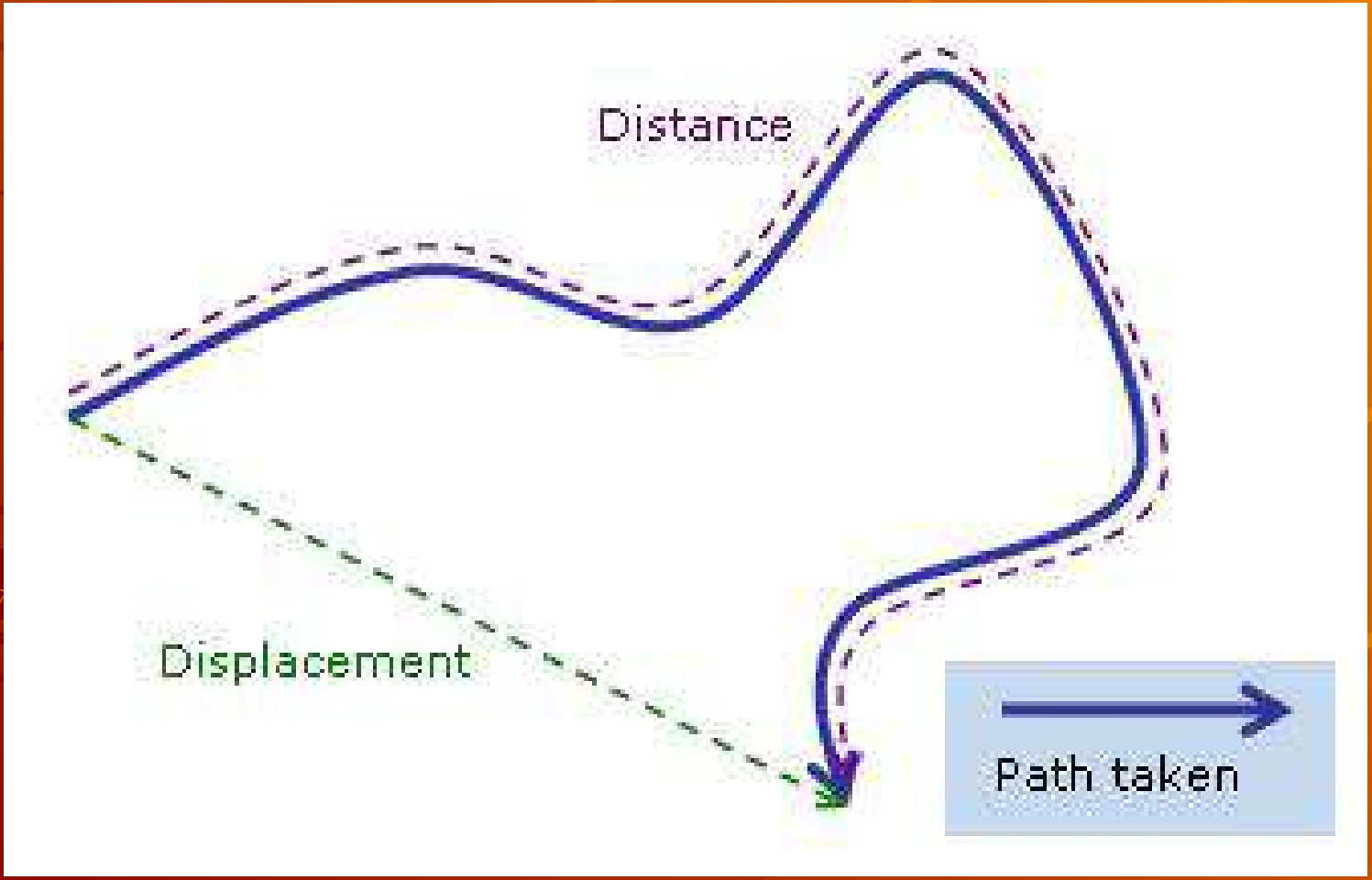
Combining Displacements

When two displacements, represented by two vectors, have the same direction, you can add their magnitudes.

If two displacements have opposite directions, the magnitudes subtract from each other.

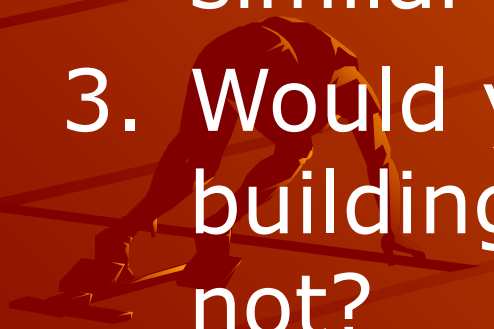


Distance vs. Displacement



Section 11.1 Assessment

1. What is a frame of reference? How is it used to measure motion?
2. How are distance and displacement similar and different?
3. Would you measure the height of a building in meters? Why or why not?



Warm-Up (Aug. 27)

1. If 2 people are running the same speed next to each other and they look at each other, what is their relative speed?
2. What is the difference in distance and displacement?
3. What does the yellow line represent? What does the

green line represent?

(distance or displacement)

Section 11.2 – Speed and Velocity

Speed is the ratio of the distance an object moves to the amount of time the object moves.

The SI unit of speed is meters per second (m/s).

Average Speed

Average speed is the total distance traveled (d) divided by the time (t) it takes to travel the distance.

$$\text{Average speed} = \frac{\text{total distance}}{\text{total time}}$$

Sample Problems

While traveling on vacation, you measure the times and distances traveled. You travel 35km in 0.4hr, followed by 53km in 0.6hr. What is your average speed?

Total distance = 35km + 53km = 88km
Total time = 0.4hr + 0.6hr = 1hr

$$S = \frac{d}{t} = \frac{88km}{1hr} = 88km/hr$$

Sample Problems

A person jogs 4.0km in 32min, then 2.0km in 22min, and finally 1.0km in 16min. What is the jogger's average speed?

d = 4.0km + 2.0km + 1.0km = 7.0km
t = 32min + 22min + 16min = 70min

$s = \frac{d}{t} = \frac{7.0km}{70min} = 0.10km/min$

A train travels 190km in 3.0hr, and then 120km in 2.0hr. What is its average speed?

d = 190km + 120km = 310km
t = 3.0hr + 2.0hr = 5.0hr

$s = \frac{d}{t} = \frac{310km}{5.0hr} = 62km/hr$

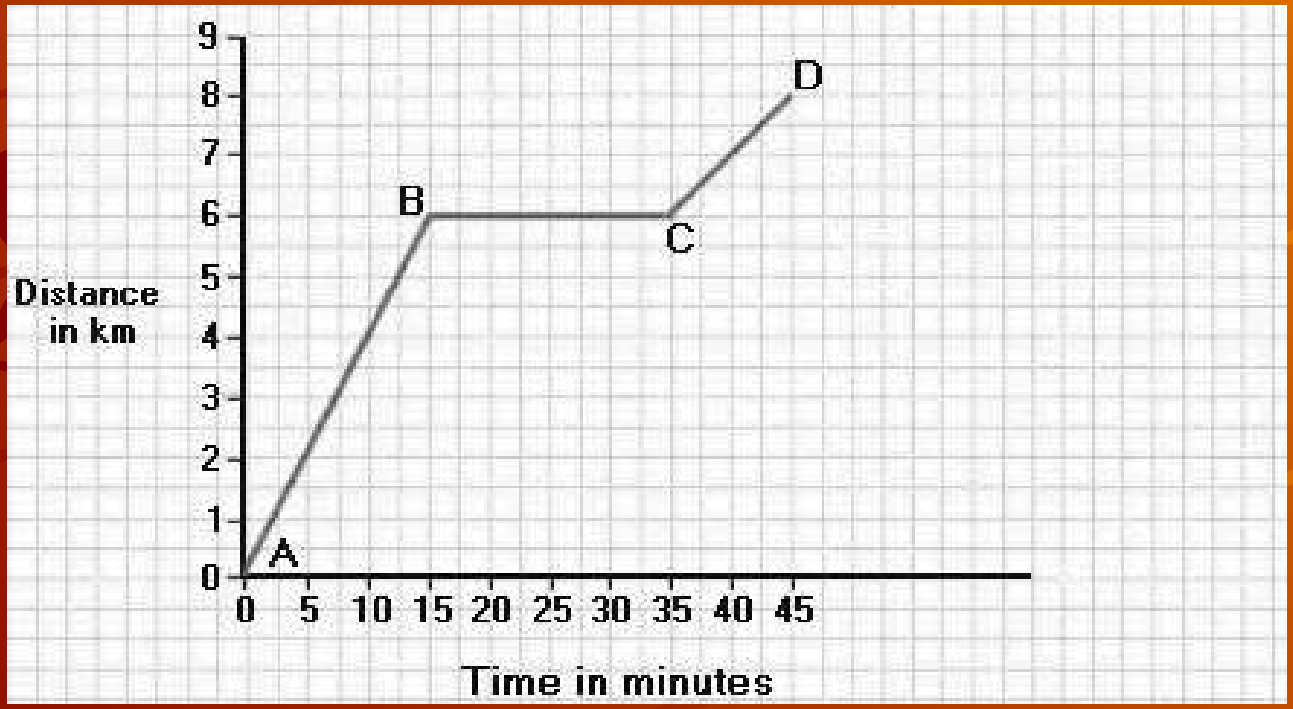
Instantaneous Speed

Instantaneous speed is the rate at which an object is moving at a given moment in time.

For example, you can describe the instantaneous speed of a car by looking at the speedometer.

Graphing motion

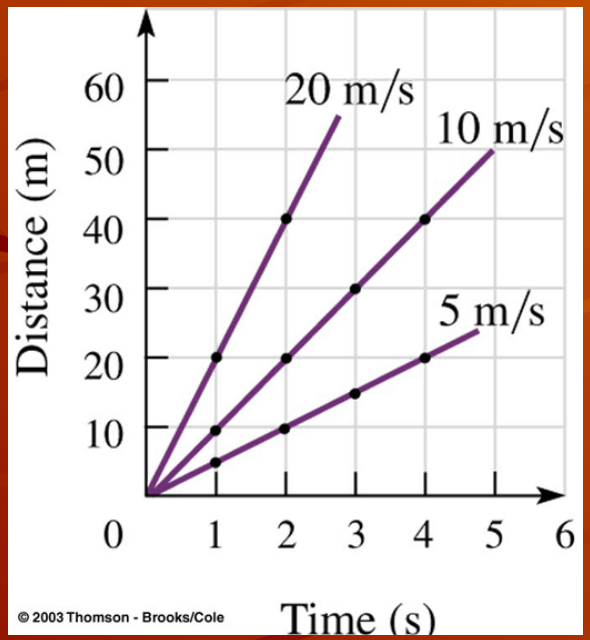
The slope of a line on a distance-time graph is speed.

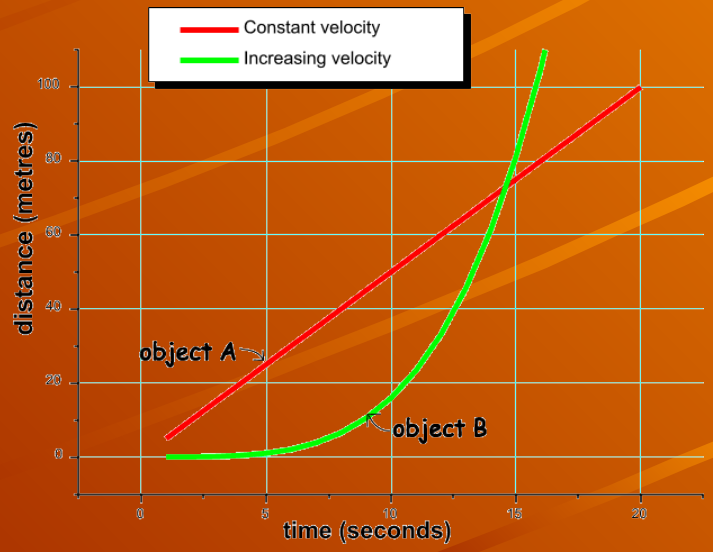


Graphing motion

The steeper the slope of the line, then faster the speed.

Straight lines represent constant speed.





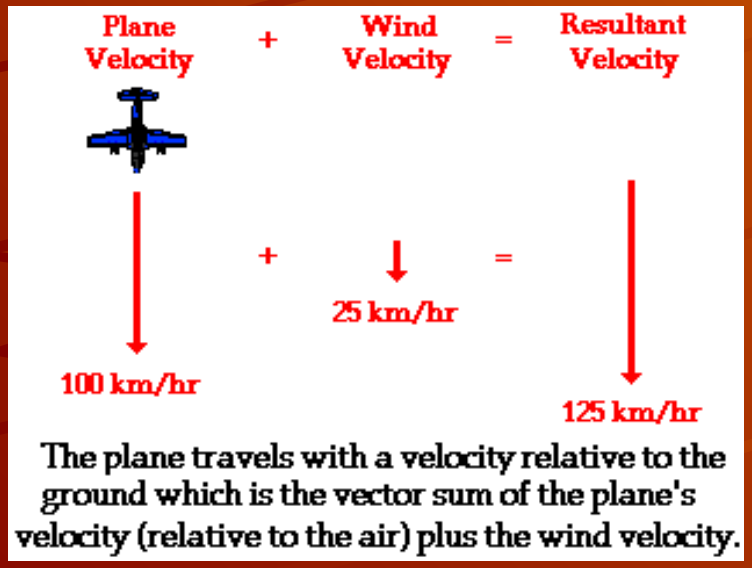
Velocity

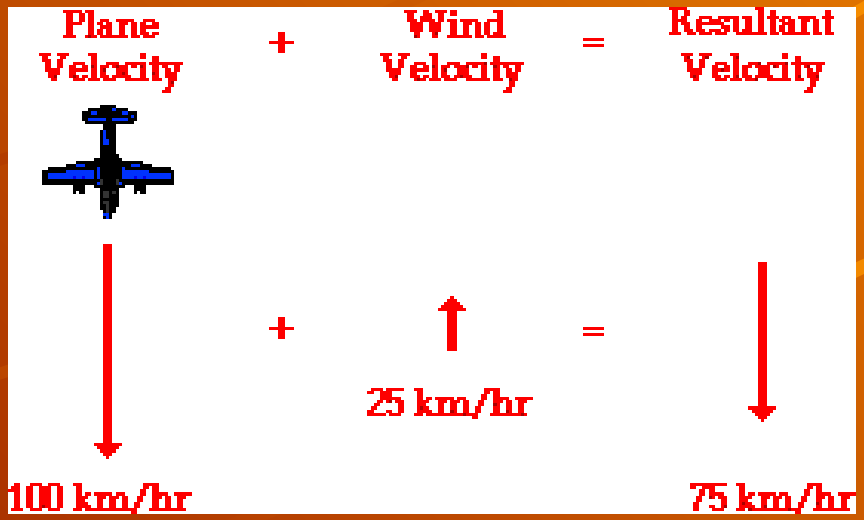
Velocity is a description of both speed and direction. Velocity is a vector.

A change in velocity can be a result of a change in speed, direction, or both.

Combining velocities

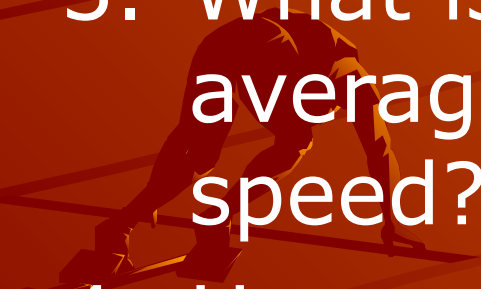
Two or more velocities add by vector addition.





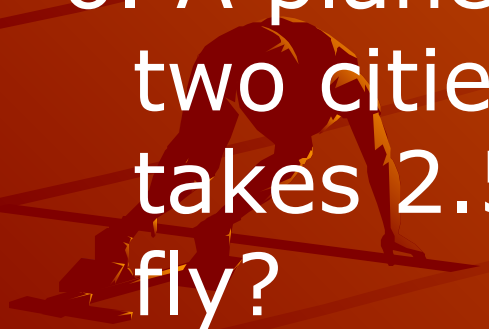
Section 11.2 Assessment

1. What does velocity describe?
2. What shows the speed on a distance-time graph?
3. What is the difference between average speed and instantaneous speed?
4. How can two or more velocities be combined?



Section 11.2 Assessment

5. Does a car's speedometer show instantaneous speed, average speed, or velocity? Explain.
6. A plane's average speed between two cities is 600km/hr. If the trip takes 2.5hr, how far did the plane fly?



$$s = \frac{d}{t} \quad d = s \times t \quad d = 600\frac{km}{hr} \times 2.5hr = 1500km$$

Warm-Up (Aug. 28)

1. What is the formula to solve for time?
2. If someone travels 50m north in 30s, then what is his or her velocity?
3. What two ways can we combine vectors (Ex. Same direction, opposite direction)?

Section 11.3 - Acceleration

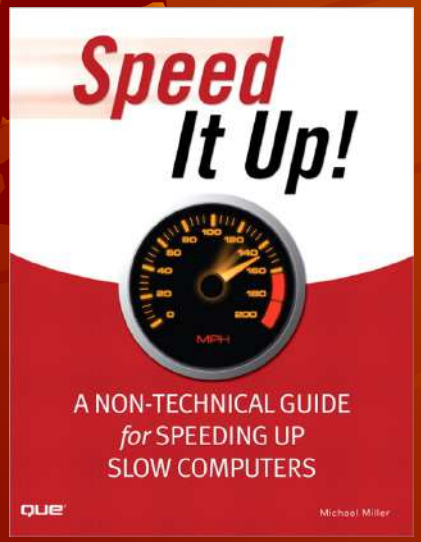
The rate at which velocity changes is called acceleration.

Acceleration can be described as changes in speed, changes in direction, or changes in both.

Changes in Speed

Acceleration can be either an increase or a decrease in speed.

Deceleration is an acceleration that slows an object's speed.



Free Fall

Free fall is the movement of an object toward the Earth solely because of gravity.

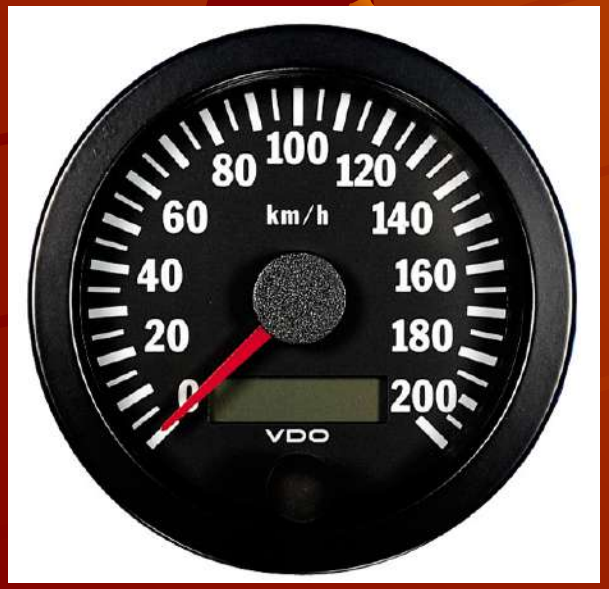
Objects falling near Earth's surface accelerate downward at a rate of $9.8 m/s^2$.

Changes in Direction

Although you may have a constant speed, a change in direction means you are accelerating.

Constant Acceleration

Constant acceleration is a steady change in velocity. That is, the velocity changes by the same amount each second.



Acceleration

You calculate acceleration for straight-line motion by dividing the change in velocity by the total time.

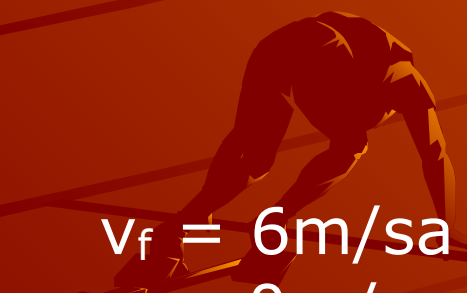
The SI unit for acceleration is m/s^2.

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{total time}}$$

$$a = \frac{v_f - v_i}{t}$$

Sample Problems

A ball rolls down a ramp, starting from rest. After 2 seconds, its velocity is 6m/s. What is the acceleration of the ball?



v_f = 6m/s
v_i = 0m/s
t = 2s

$a = \frac{v_f - v_i}{t} = \frac{6m/s - 0m/s}{2s} = 3m/s^2$

Sample Problems

A car traveling at 10m/s starts to decelerate steadily. It comes to a complete stop in 20s. What is its acceleration?

$v_i = 10m/s$ $\quad a = \frac{v_f - v_i}{t} = \frac{0m/s - 10m/s}{20s} = -0.5m/s^2$

$v_f = 0m/s$

$t = 20s$

An airplane travels down a runway for 4.0s with an acceleration of $9.0m/s^2$. What is its change in velocity during this time?

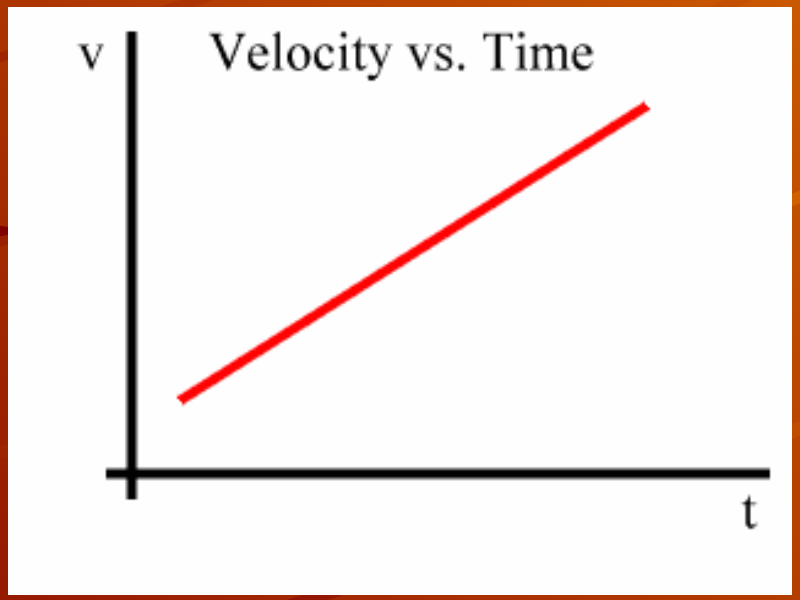
$a = 9.0m/s^2$ $\quad a = \frac{v_f - v_i}{t}$ $\quad v_f - v_i = a \times t = 9.0\frac{m}{s^2} \times 4.0s = 36m/s$

$t = 4.0s$

Graphs of Acceleration

The slope of a speed-time graph is acceleration.

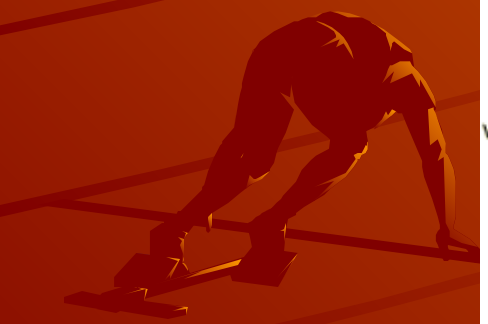
Constant acceleration is represented by a straight line.

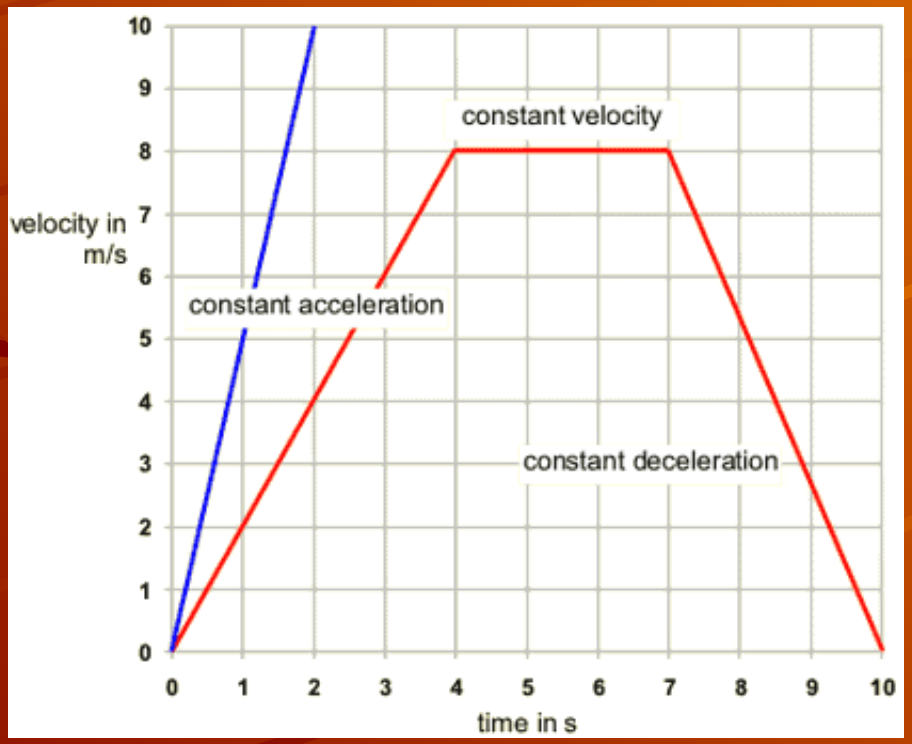


Graphs of Acceleration

A horizontal line represents constant speed.

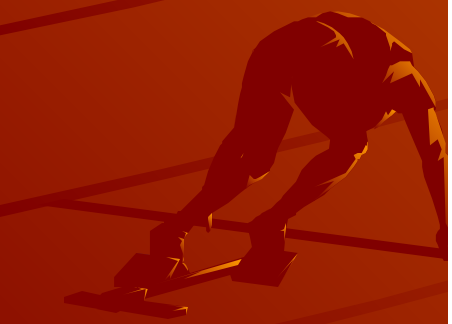
If the slope of a line is negative, then the object is slowing down.

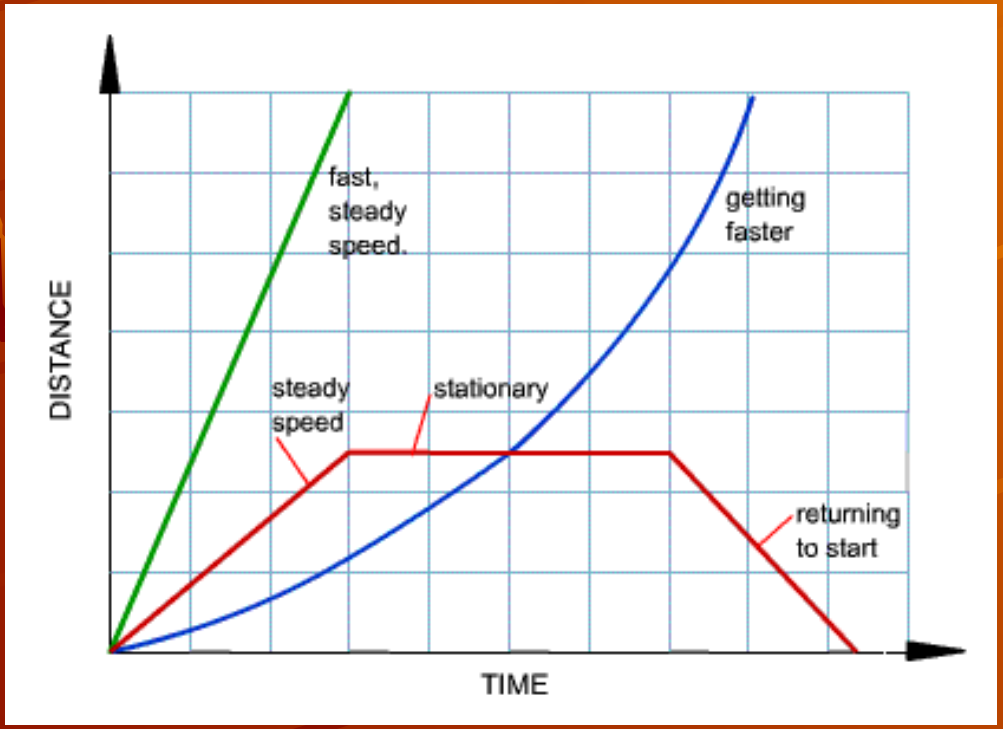




Acceleration

On a distance-time graph, acceleration is represented by a curved line.





Instantaneous Acceleration

Instantaneous acceleration is how fast a velocity is changing at a specific instant.

Section 11.3 Assessment

1. Describe three types of changes in velocity.
2. What is the equation for acceleration?
3. What shows acceleration on a speed-time graph?
4. Define instantaneous acceleration.
5. How are deceleration and acceleration related?

Section 11.3 Assessment

6. A train moves from rest to a speed of 25m/s in 30.0s. What is the magnitude of its acceleration?

$v_f = 25m/s$
$v_i = 0m/s$
$t = 30s$

$$a = \frac{v_f - v_i}{t} = \frac{25m/s - 0m/s}{30s} = 0.83m/s^2$$

7. A car traveling at a speed of 25m/s increases its speed to 30m/s in 10s. What is its acceleration?

$v_f = 30m/s$
$v_i = 25m/s$
$t = 10s$

$$a = \frac{v_f - v_i}{t} = \frac{30m/s - 25m/s}{10s} = 0.5m/s^2$$

THE END