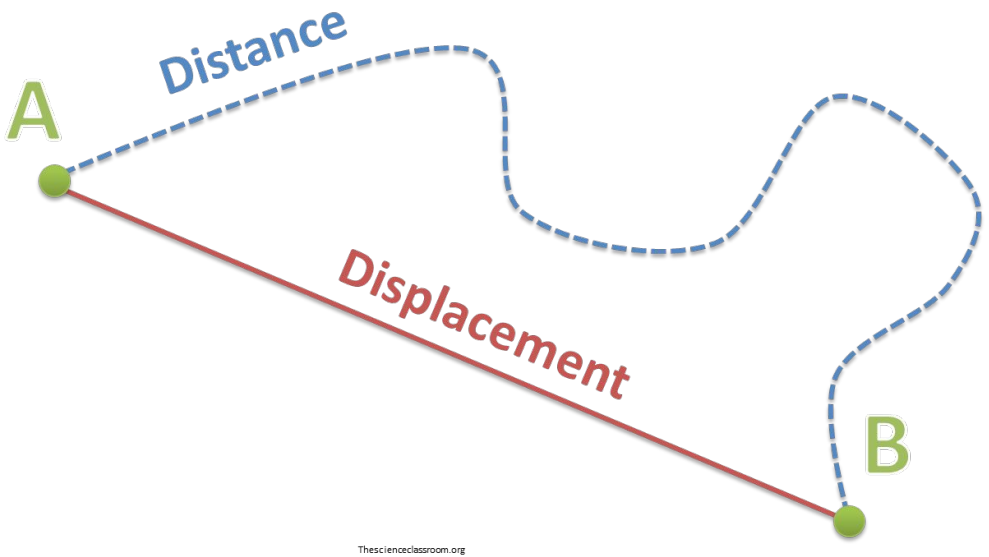
Linear Motion

Review

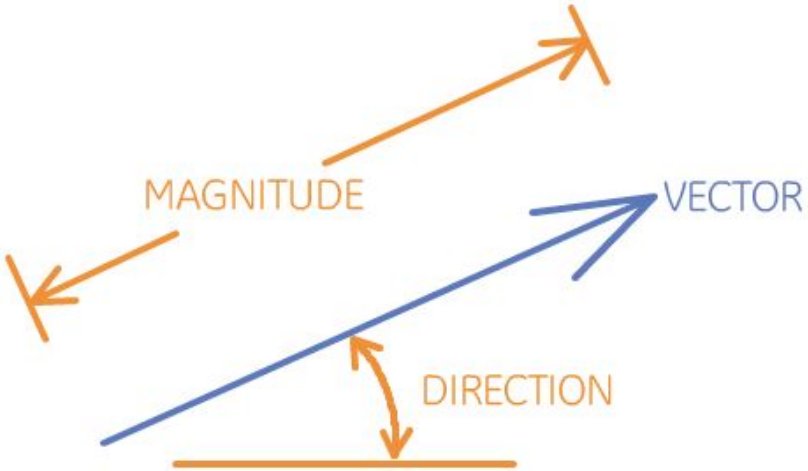
- Distance vs. Displacement
- Scalar vs. Vectors
- Speed vs. Velocity
- Acceleration
- Motion at Constant Acceleration
- Freefall
- Kinematic Equations

Distance vs. Displacement

- Distance is the sum of the total meters someone moved
- Displacement is the distance you are from where you started



Scalars vs. Vectors



- Scalar only includes magnitude
  - Distance is a scalar quantity
- Vector includes magnitude and direction
  - Displacement is a vector quantity

Speed vs. Velocity

Both allude to how fast an object is moving.

To find *average speed*, divide your distance travelled by the time it took you to get to your destination.

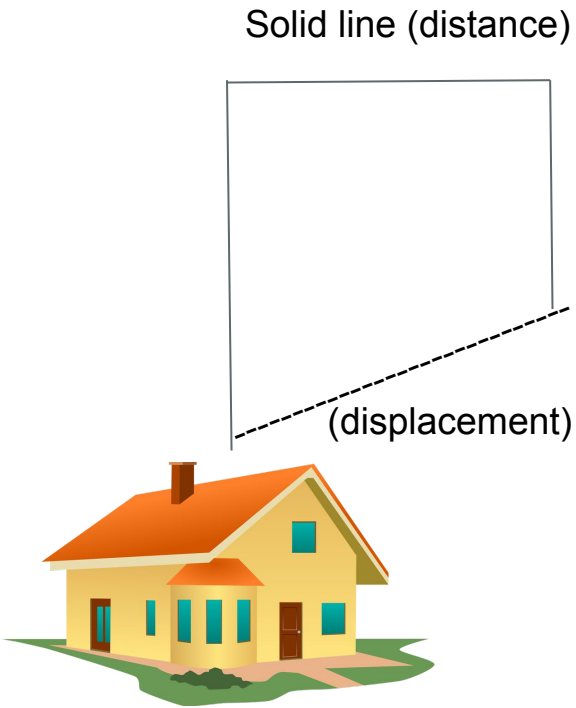
→ $\text{average speed} = \frac{\text{distance travelled}}{\text{time elapsed}}$

Velocity is the magnitude of how fast something is moving and the direction it is moving. It is total displacement divided by time. → $\text{average velocity} = \frac{\text{displacement}}{\text{time elapsed}}$ $\frac{\Delta x}{\Delta t} = v$

Speed vs. Velocity

Common Misconceptions

Speed and velocity are not the same. Speed can be found with displacement and velocity has to be found with displacement. Distance is how much ground an object has covered and displacement is how far out of place an object is.



Acceleration

- **Acceleration** is a change in speed or direction; a measure of how quickly the velocity changes
- Misconception: If the instantaneous velocity is zero, this does not mean acceleration is zero and vice versa
    - If you throw a ball into the air, at the peak of its height its instantaneous velocity is zero, but its acceleration is not
    - If a car is at a constant velocity, its acceleration is zero as well

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

Motion at Constant Acceleration

- Average and instantaneous acceleration are the same if acceleration is constant

$$v_f = v_o + at$$

$$x_f = x_o + v_o t + \frac{1}{2}at^2$$

$$v_f^2 = v_o^2 + 2a(x_f - x_o)$$

$$x_f = x_o + \frac{1}{2}(v_f + v_o)t$$

Freefall

- All objects accelerate towards the earth under the force of gravity
- Acceleration due to gravity acts on all objects the same regardless of their mass
- Any observed differences are on account of air resistance
- Gravity accelerates objects on Earth at 9.81 m/s^2
- When finding freefall, one can use kinematics

Freefall Misconceptions

1. The question is often asked "doesn't a more massive object accelerate at a greater rate than a less massive object?" No, because every freefalling object has an acceleration of gravity (9.8m/s). More massive objects will only fall faster if there is an appreciable amount of air resistance present.
2. Students also believe that if you throw an object downward that it will accelerate faster if you drop it, but this is not true. The object will not exceed an acceleration of 9.8 m/s no matter what.

Kinematic Equations

Translational	Rotational
$v = v_0 + at$	$\omega = \omega_0 + \alpha t$
$\Delta x = v_0 t + \frac{1}{2} a t^2$	$\Delta \theta = \omega_0 t + \frac{1}{2} \alpha t^2$
$v^2 = v_0^2 + 2a\Delta x$	$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$

*Only use if there is constant acceleration

Free Response Strategies

1. Write down all the given information, and look for the implied information.
    a. Ex.) If the question states that “a car speeds from rest to 3.0 m/s,” we know that the initial velocity is zero.
2. Decide whether or not a part of the given information is actually significant.
3. Underline or circle information that is relevant but not an actual value.
4. Find an equation or equations that connect your given information with the variable that you are trying to find.
5. For free response questions that are related to explaining a concept or determining a value without calculations, you should still use equations. Ultimately, they explaining relationships.
    a. Ex.) F=ma tells us that mass and acceleration are inversely related, meaning that if mass increases, acceleration should decrease and vice versa.

MC Question 1

Freefall/Acceleration:

A ball dropped from rest picks up speed at 12 m/s. After it falls for 4 seconds, how fast is it going?

A. 48 m/s^2
B. 12 m/s^2
C. 3 m/s^2
D. 16 m/s^2

MC Question 2

Speed vs Velocity:

Usain Bolt, the fastest man on the planet, moves from being 100m away from the starting line to 478m away in just 12.0s. What is his average velocity?

a. 31.5 m/s

b. 26.7m/s

c. 100m/s

d. 15.5m/s

MC Question 3

You walk 60 meters from your house and back again. What is your displacement?

a. 120 m
b. 60 m
c. 0 m
d. 30 m

MC Question #4

A super frog jumps to a height of 2.20 meters. What was the speed of the frog when it took off?

a. 6.57 m/s
b. 43.2 m/s
c. 13.1 m/s
d. 86.4 m/s

MC Question #5

A tennis ball is thrown into the air. Which of the following statements is true about the ball at the instant where it is at maximum height?

a. It has constant velocity.
b. It is speeding up.
c. It is changing direction.