



Velocity and Acceleration

Motion

- What is motion?
 - A change in the position of an object over time.
- How do you know something has moved?
 - You use a reference point!
 - A stationary (not moving) object such as a tree, street sign, or a line on the road.

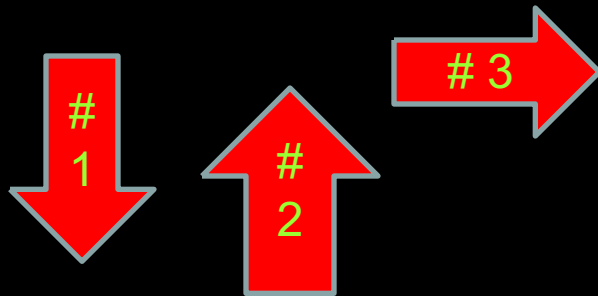
- What causes an object to move?
 - A FORCE!
 - ALL motion is due to forces acting on objects!
- What is a force?
 - A push or a pull

What is a net force?

- The total combination of the forces acting on an object is called NET FORCE.
- Can more than one force act on an object at the same time?

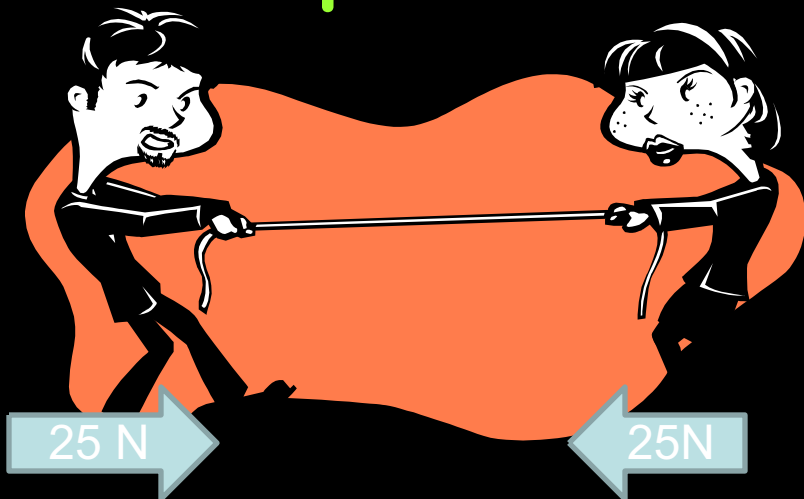
Yes

Example: Gravity is pulling you down to Earth, the ground is supporting you, and your legs moving you forward as you run during PE



Balanced Force

- A balanced force is one in which the net force equals ZERO.
- Do you think there will be any motion?
– NO!
- Examples:



Unbalanced Forces

- An unbalanced force is one in which the net force is greater than zero.
- Do you think there will be any motion?
 - YES!
- Examples:



- Only an Unbalanced force can change the motion of an object.
- Example: Your dog can cause you to move if he pulls with enough force.

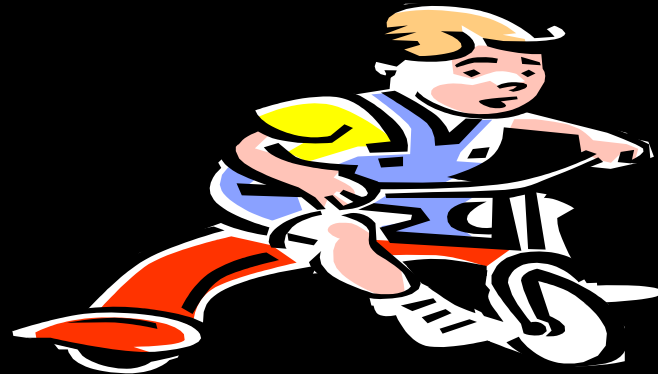
His force is greater than the force you're using to stay in place



What would happen if an unbalanced force acted on an object that's already in motion?

- It will change the speed or direction of the object.
- Example: Your little brother is riding his tricycle. You run up behind him and give him a push.

Your force adds to the existing force causing him to speed up.



Unbalanced forces can act in the same direction.

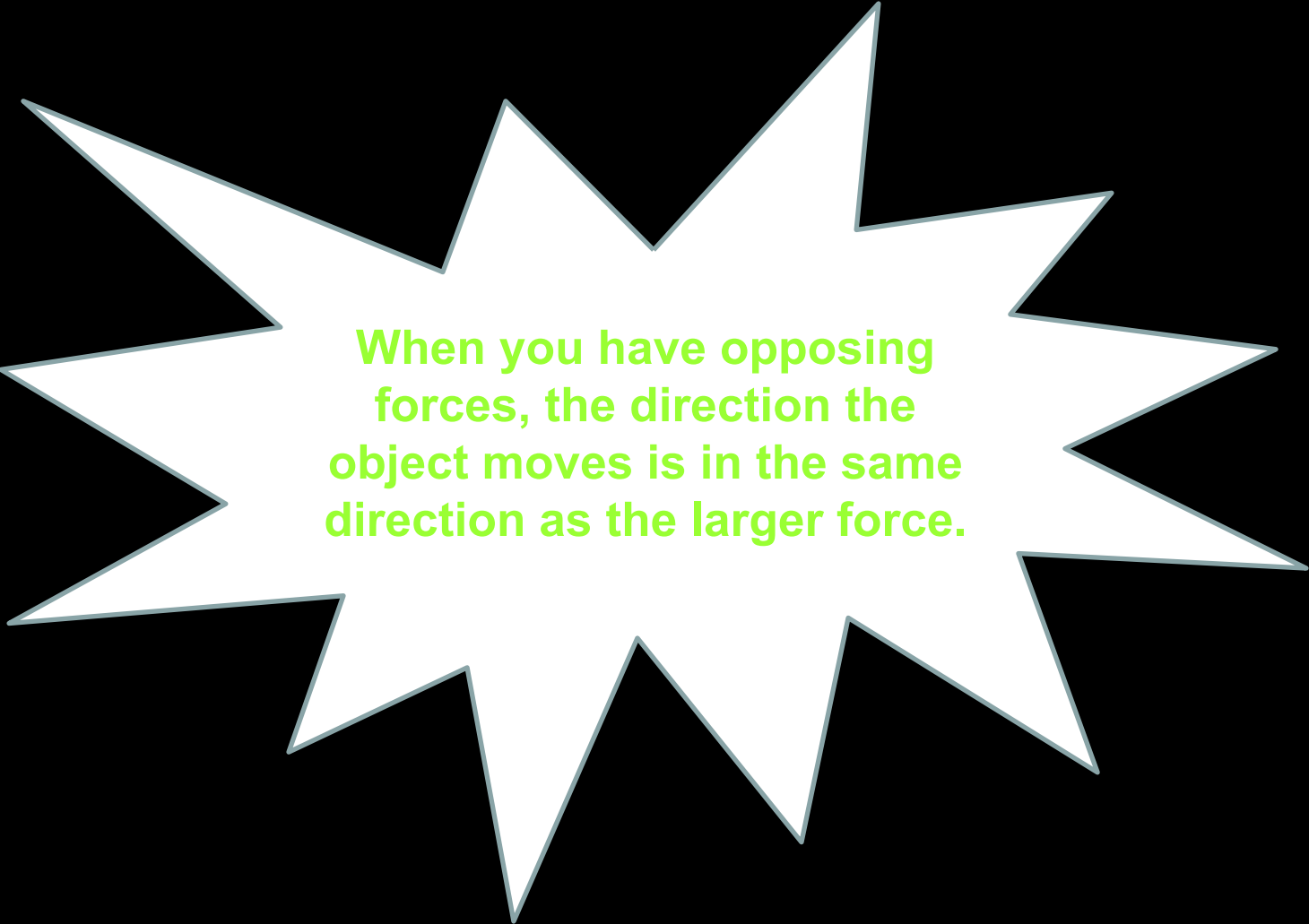
- Example: You're pushing a cabinet across the room with a force of 15 N. You're friend is pulling with a force of 10 N.
- What is the NET FORCE?
25N
- What direction is the cabinet moving?
To the right



Unbalanced forces can act in opposite directions

- Example: Two dogs are tugging on a rope. One dog pulls with a force of 20N and the other pulls with a force of 25N.
- What is the NET FORCE?
5 N
- What direction is the rope moving?
To the right





When you have opposing forces, the direction the object moves is in the same direction as the larger force.

Speed

- What is speed?
 - How fast an object moves.
- How can you tell how fast your car is going?
 - Look at the speedometer (miles per hour)
 - This tells us exactly what we need to know to find the speed of an object!



Determining Speed

- Need to know
 - The distance the object moves (miles, kilometers, etc.)
 - The amount of time needed to travel that distance (hours, seconds, etc.)



Formula for Speed

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

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

Example of different speeds over time.

Time
2 Hours

Distance
120 kilometers

Speed
60 kilometers per hours

Distance
80 kilometers

Speed
40 kilometers per hours

Road Trip!

- When you're driving, are you going the same speed at all times?
 - No! - Traffic lights, construction, etc.
- So we're actually finding the object's AVERAGE speed.



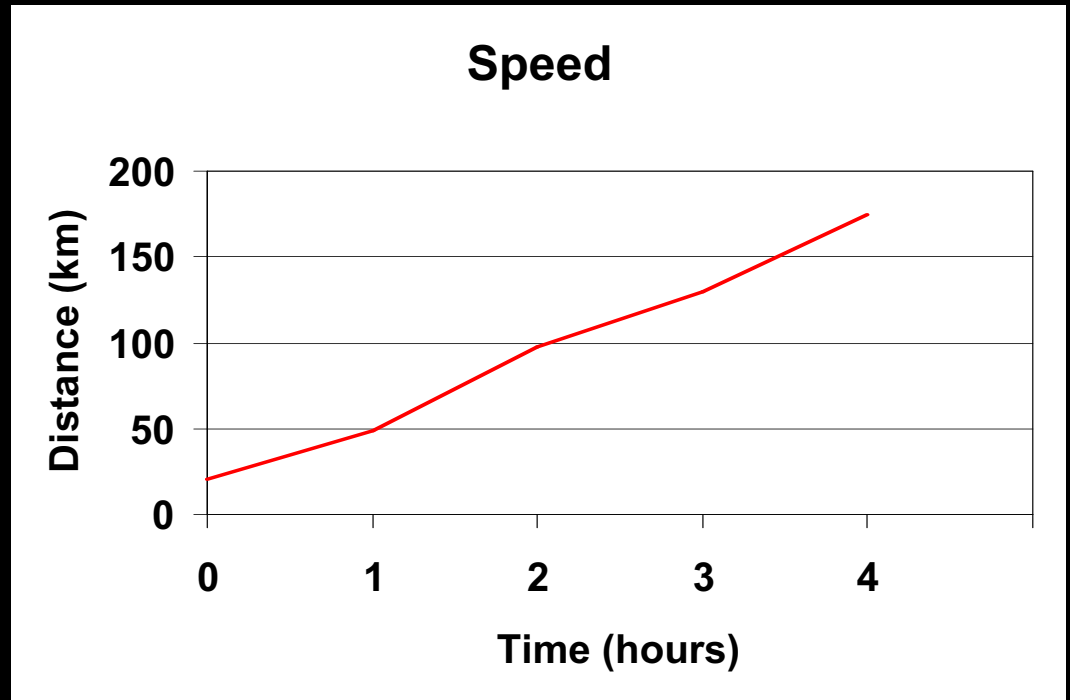
Example:

- It takes 2 hours for a car to travel 100 kilometers.
- What's the car's speed?
 - 50 kilometers per hour (100 km / 2hours)
 - However, it's very unlikely that the car traveled 50 km/h for the entire trip.
 - Sometimes the car moved slower, sometimes faster.
- So we've found the car's average speed.



Graphing Speed

- Speed can be shown on a graph of distance versus time.
 - Remember: these are the two things you need to know to find speed.
- Why isn't the line straight?



What is velocity?

- Velocity is the speed of an object in a particular direction.



Brain Teaser:

- Two cars are traveling at 50 km/h on the same highway for 2 hours.
- After two hours, the cars are 200 km away from each other.
- How is this possible?
 - The cars were traveling in opposite directions!



- What is the difference between speed and velocity?
- Speed tells us the distance and time, but not the direction of the object.
- When you include the object's direction, you're describing the velocity, not speed.



Brain Teaser Again:

- Two cars are traveling at 50 km/h on the same highway for 2 hours.
- The velocity of one car is 50 km/h east, and the velocity of the other car is 50 km/h west.
- Now it's easy to see how the cars ended up 200 km away from each other!



Changes in Velocity

- How can you change an object's velocity?
 - Change its speed or direction.
- Example:
 - If a sailboat's speed goes from 4 knots to 7 knots, its velocity has changed!
 - If the sailboat continues moving at 7 knots but changes direction, its velocity has changed again!



What is Acceleration?

- Acceleration is the rate at which an object's velocity changes.
- What's an example of an object accelerating?
 - A car speeding up after stopping at a stop sign.
- But acceleration is the rate of change in VELOCITY...



What else can cause an object to accelerate?

- A change in direction
 - Every time you turn a corner, or change direction, you are accelerating!
- What if you slow down?
 - It's still changing your speed, so YES, you are accelerating (negatively).



Formula for Acceleration

- Average Acceleration = $\frac{\text{final velocity} - \text{starting velocity}}{\text{time}}$

$$A = \frac{v_2 - v_1}{t}$$

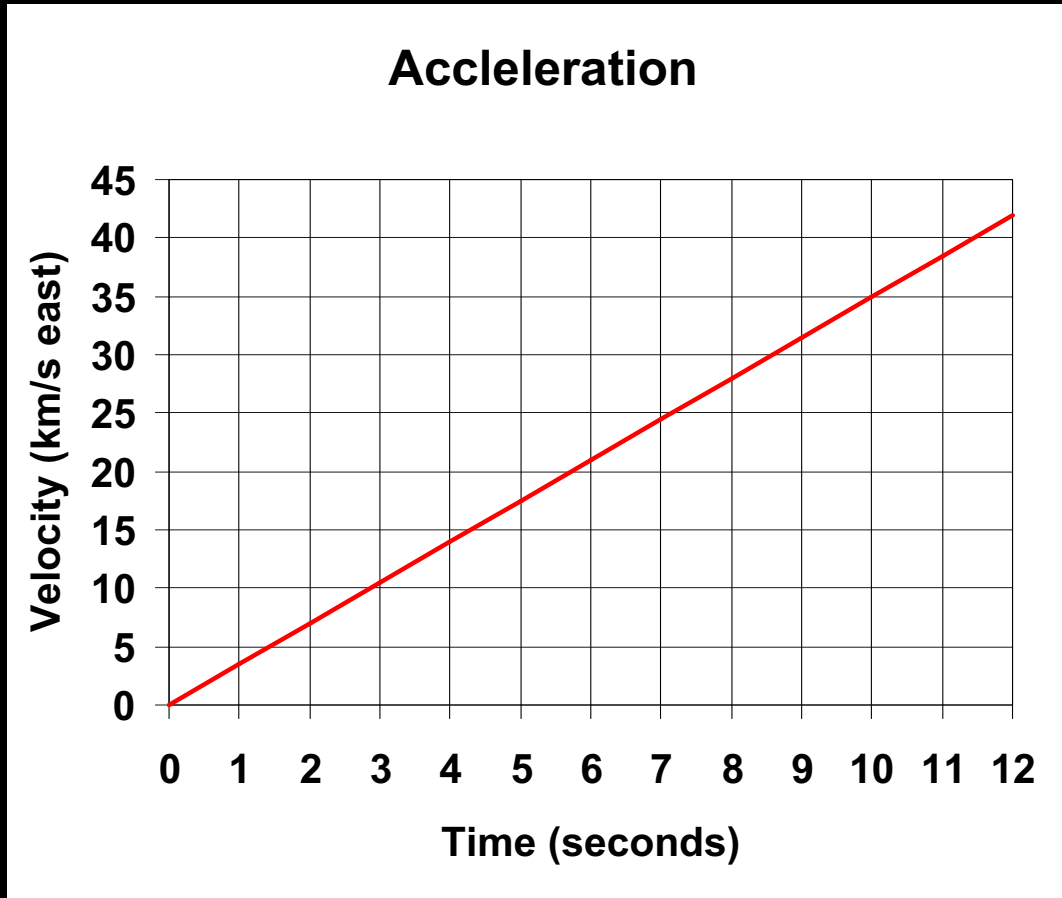
- Acceleration recorded in units such as meters per second squared (m/s^2)

Example

Time (seconds)	Velocity (m/s east)
0	0
1	5
2	10
3	15
4	20

- How much does the car accelerate in the first second?
- The second?
- Third?
- So every second, the car's velocity increases by 5 m/s.

Another Example:



- What was the car's velocity at 10 seconds?
- Find the car's average acceleration (in 10 seconds) using the formula.

Velocity and Acceleration Review

1. Which of the following is an example of changing acceleration?
 - a. A train traveling 65 miles per hour south
 - b. A boat sailing west at 5 knots
 - c. A person jogging at 3 meters/second along a winding path
 - d. A car stopped at a red light

2. Which of the following is NOT needed to determine the velocity of a moving truck?
 - a. The mass of the truck
 - b. The distance it travels
 - c. The time it takes to travel that distance
 - d. The direction in which it travels

3. An object accelerates if its

- a. Speed remains constant
- b. Direction changes
- c. Mass remains constant
- d. Motion can be plotted on a graph

4. What is the average speed of an object that travels 100 meters in 20 seconds?

- e. 4 m/s
- f. 8 m/s
- g. 5 m/s
- h. 10 m/s