# Newton's 3rd Law of Motion

# Forces and Interactions

Until now, we have regarded a “force” as a “push” or a “pull.”

Every force is part of an *interaction* between two objects. Examples:

1. You push on a wall and the wall pushes back on you.
2. Your head bumps a soccer ball and the soccer ball bumps your head.
3. An athlete pulls up on a barbell and the barbell pulls down on the athlete.
4. The compressed air in a balloon pushes the balloon surface outward and the balloon surface pushes the compressed air inward.

Notice Object 1 pushing (or pulling) on Object 2 creates a reaction where Object 2 pushes (or pulls) back on Object 1.

# Newton's 3rd Law of Motion

For every "action" there is an equal and opposite "reaction."

Whenever one object exerts a force on another object, that other object exerts an equal sized force on the first object in the opposite direction.

$$\vec{F}_{BA} = -\vec{F}_{AB}$$

(The force on 'B' due to 'A' is equal and opposite to the force on 'A' due to 'B'.)

Identify "action-reaction" pairs by switching the nouns in the subscripts.

# Examples

What are the :reactions” to the following “actions”?

Action: Tires push backward on road.

Reaction: Road pushes forward on tires.

Action: Earth pulls down on book.

Reaction: Book pulls upward on Earth.

Action: Book pushes down on the table.

Reaction: Tables pushes up on book.

# Summarizing Newton's 3 Laws of Motion

1. An object at rest remains at rest and an object in motion remains in a state of uniform motion unless acted upon by a net force.

2. The acceleration of an object is directly proportional to the net force acting on the object and inversely proportional to the mass of the object. That is,

$$\vec{a} = \frac{\vec{F}_{net}}{m}$$

3. For every action, there is an equal and opposite reaction. That is,

$$\vec{F}_{BA} = -\vec{F}_{AB}$$