# Newton’s 3rd Law of Motion

# Forces and Interactions

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

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

1. You push on wall and the wall pushes back on you.
2. Your heads 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 how Object 1pushing (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.

$$\mathbf{F_{BA}} = -\mathbf{F_{AB}}$$

(The force on 'B' due to 'A' is equal and opposite to the force '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 pushed forward on tires.

Action: Earth pulls down on book.

Reaction: Book pulls up on Earth.

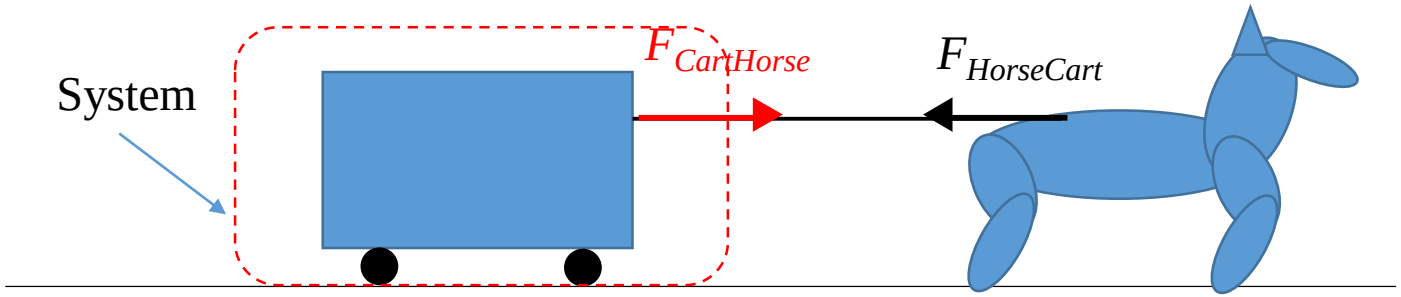
Action: Book pushes down on table.

Reaction: Table pushes up on book.

# Defining the System

In order to identify what force is accelerating your system, you first have to define what your system is.

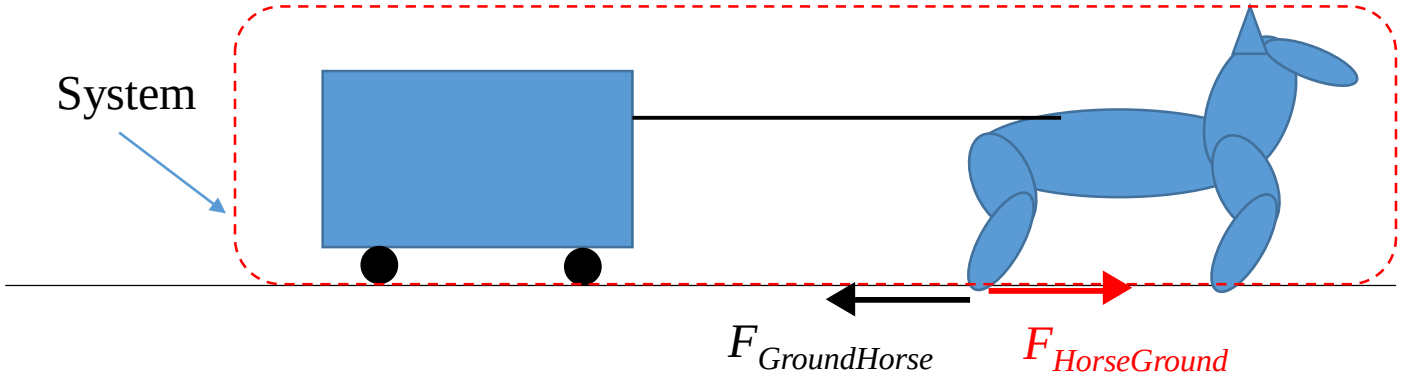
What is the force the accelerates the system shown?




Answer: $F_{CartHorse}$ (The force on the cart due to the horse, of course.)

# Defining the System

What is the force the accelerates THIS system?




Answer: $F_{HorseGround}$ (The force on the horse due to the ground.)

# Summarizing Newton 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 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,

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