Newton's Third Law

Whenever an object A exerts force on an object B, then the object B exerts force on the object A of equal magnitude but opposite direction.

In other words, the force of A on B is equal in magnitude and opposite in direction of the force of B on A.

In short: **For every action, there is an equal and opposite reaction.**

$$F_{A\ on\ B} = -F_{B\ on\ A}$$

All forces result from interactions = Forces always come in pairs

There are two types of interactions:

1. Contact Interactions- ______________________________

2. At-a-distance Interactions- ______________________________

Examples:

1. While driving down the road, a firefly strikes the windshield of a bus and makes a quite obvious mess in front of the face of the driver. This is a clear case of Newton's third law of motion. The firefly hit the bus and the bus hits the firefly. Which of the two forces is greater: the force on the firefly or the force on the bus?

2.For years, space travel was believed to be impossible because there was nothing that rockets could push off of in space in order to provide the propulsion necessary to accelerate. This inability of a rocket to provide propulsion is because ...

a. ... space is void of air so the rockets have nothing to push off of.
b. ... gravity is absent in space.

c. ... space is void of air and so there is no air resistance in space.

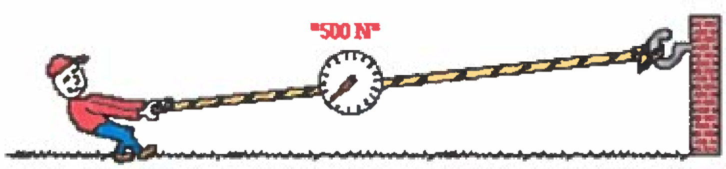
d. ... nonsense! Rockets do accelerate in space and have been able to do so for a long time.

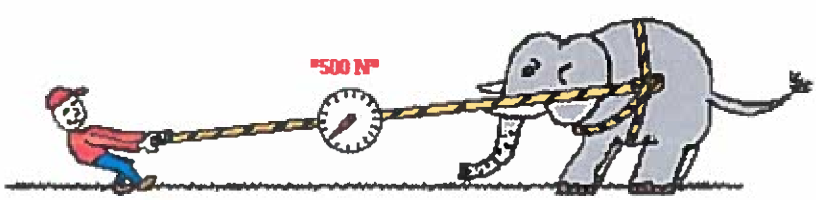
3. Many people are familiar with the fact that a rifle recoils when fired. This recoil is the result of action-reaction force pairs. A gunpowder explosion creates hot gases that expand outward allowing the rifle to push forward on the bullet. Consistent with Newton's third law of motion, the bullet pushes backwards upon the rifle. The acceleration of the recoiling rifle is ...

a. greater than the acceleration of the bullet.
b. smaller than the acceleration of the bullet.

c. the same size as the acceleration of the bullet.

4. In the top picture (below), Kent Superstrong is pulling upon a rope that is attached to a wall. In the bottom picture, the Kent is pulling upon a rope that is attached to an elephant. In each case, the force scale reads 500 Newton. Kent is pulling ...



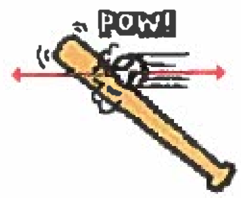


a. with more force when the rope is attached to the wall.
b. with more force when the rope is attached to the elephant.

c. the same force in each case.

Identifying Action and Reaction Force Pairs

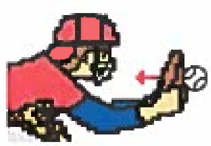
According to Newton's Third Law, for every action force there is an equal (in size) and opposite (in direction) reaction force. Forces always come in pairs - known as "action-reaction force pairs." Identifying and describing action-reaction force pairs is a simple matter of identifying the two interacting objects and making two statements describing *who is pushing on whom* and in what direction. For example, consider the interaction between a baseball bat and a baseball.



The baseball forces the bat to the left; the bat forces the ball to the right. Together, these two forces exerted upon two different objects form the action-reaction force pair. Note that in the description of the two forces, the nouns in the sentence describing the forces simply switch places.

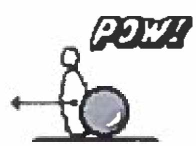
Consider the following three examples. One of the forces in the mutual interaction is described; describe the other force in the action-reaction force pair.

1.



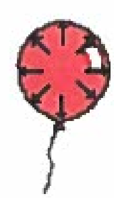
Baseball pushes glove leftwards.

2.



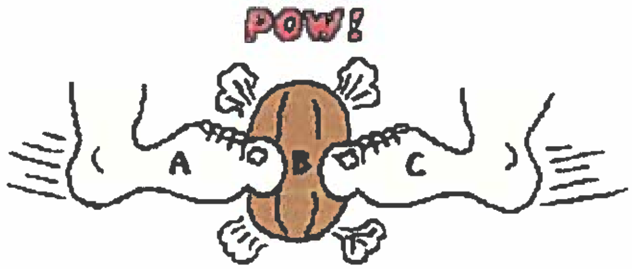
Bowling ball pushes pin leftwards.

3.

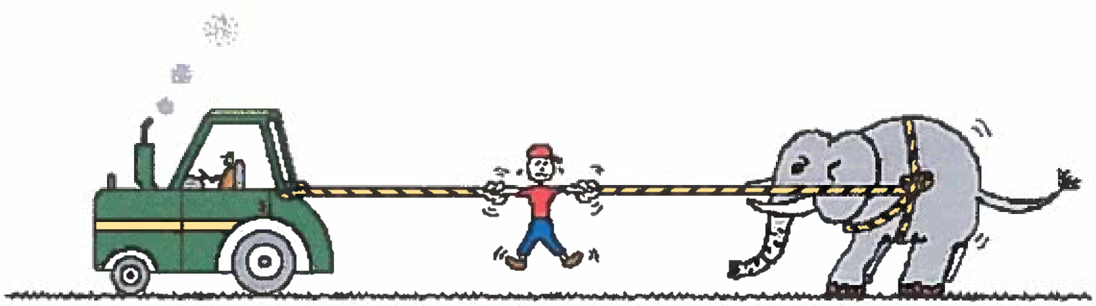


Enclosed air particles push balloon wall outwards.

4. Consider the interaction depicted below between foot A, ball B, and foot C. The three objects interact simultaneously (at the same time). Identify the two pairs of action-reaction forces. Use the notation "foot A", "foot C", and "ball B" in your statements. Click the button to view the answer.



5. Identify at least six pairs of action-reaction force pairs in the following diagram.



Textbook: p 104 #28-31. Read p105-106, work through the example problem 4. Answer #32 and 33 p106