NEWTON'S THIRD LAW

If two objects interact, the magnitude of the force exerted on object 1 by object 2 is equal to the magnitude of the force simultaneously exerted on object 2 by object 1, and these two forces are opposite in direction.

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An alternative statement of this law is that *for every action, there is an equal and opposite reaction.* When two objects interact with one another, the forces that the objects exert on each other are called an *action-reaction pair.* The force that object 1 exerts on object 2 is sometimes called the *action force,* while the force that object 2 exerts on object 1 is called the *reaction force.* The action force is equal in magnitude and opposite in direction to the reaction force. The terms *action* and *reaction* sometimes cause confusion because they are used a little differently in physics than they are in everyday speech. In everyday speech, the word *reaction* is used to refer to something that happens *after* and *in response to* an event. In physics, however, the reaction force occurs at exactly the same time as the action force.

Because the action and reaction forces coexist, either force can be called the action or the reaction. For example, you could call the force that the car exerts on the barrier the action and the force that the barrier exerts on the car the reaction. Likewise, you could choose to call the force that the barrier exerts on the car the action and the force that the car exerts on the barrier the reaction.

Action and reaction forces each act on different objects

One important thing to remember about action-reaction pairs is that each force acts on a different object. Consider the task of driving a nail into wood, as illustrated in **Figure 8.** To accelerate the nail and drive it into the wood, the hammer exerts a force on the nail. According to Newton's third law, the nail exerts a force on the hammer that is equal to the magnitude of the force that the hammer exerts on the nail.

Figure 8
The force that the nail exerts on the hammer is equal and opposite to the force that the hammer exerts on the nail.

The concept of action-reaction pairs is a common source of confusion because some people assume incorrectly that the equal and opposite forces balance one another and make any change in the state of motion impossible. If the force that the nail exerts on the hammer is equal to the force the hammer exerts on the nail, why doesn't the nail remain at rest?

The motion of the nail is affected only by the forces acting on the nail. To determine whether the nail will accelerate, draw a free-body diagram to isolate the forces acting on the nail, as shown in **Figure 9.** The force of the nail on the hammer is not included in the diagram because it does not act on the nail. According to the diagram, the nail will be driven into the wood because there is a net force acting on the nail. Thus, action-reaction pairs do not imply that the net force on either object is zero. The action-reaction forces are equal and opposite, but either object may still have a net force acting on it.

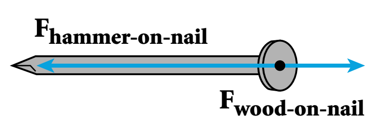

Figure 9
The net force acting on the nail drives the nail into the wood.