Newton’s Third Law of Motion

Overview: Newton’s Third Law of Motion states that for every action, there is an equal and opposite reaction. This means that for every interaction, there’s a pair of forces action on the objects, which are equal in size and opposite in direction. (Want to know a secret? Forces *always* come in pairs!)

What to Learn: The way to change how something is moving is to give it a push or a pull. The size of the change is related to the strength, or the amount of "force," of the push or pull.

Materials

- friends
- rocks
- wagon
- balloon

Lab Time

1. Now let's work with Newton's Third Law: For every action, there is an equal and opposite reaction. If this first experiment doesn’t work, don’t worry about it. You need a fairly low-friction skateboard or wagon to make this work. If you’re lucky enough to live where there’s snow and ice, you might suit up the kids on skates and try this outdoors, because ice is very low-friction.
2. Sit in the wagon or on the skateboard (please do not stand up).
3. Throw the heavy thing as hard as you can. (Please be careful not to hit anybody or anything!)
4. At this point, you should know what should happen, so what do you think? If you said that the throw forward would move you backward, you’re right! Next time you're in a small canoe, toss a rock and see what happens to you and your boat. (Any guesses?)

Newton's Third Law of Motion Data Table

Trial Number	**Time Traveled** *(feet or meters?)*	**Distance Traveled** *(feet or meters?)*

To find your average speed, divide the distance traveled by the time. For example, if it takes 3 seconds to travel 5.6 feet, then my average speed is 5.6 / 3 = 1.87 feet/second.

Reading

Forces come in pairs. When you stand up, your weight is pushing down on the floor as much as the floor is pushing back up on your feet. When you stretch out your arms and push the wall, the wall pushes back with the same amount of force every time. This is Newton's Third Law: For every action, there is an equal and opposite reaction.

A force is a push or a pull, like pulling a wagon or pushing a car. Forces come from interactions. Some forces come from contact interactions, like friction, tension in a spring, applied forces, and more. Other forces are "action at a distance" interactions, like gravitational, electrical and magnetic forces. When two objects interact with each other, whether or not they physically touch, they exert forces on each other. This holds true for rockets orbiting the moon, bugs that splat on the windshield, and kids on roller skates who crash into you.

Rifles "recoil" when fired, which is a classic example of action-reaction paired forces. The recoil happens when the gunpowder explosion creates hot gases that expand and push the bullet forward. The force that the rifle feels is

equal to the force that the bullet feels, but since the bullet is tiny, it can move with a high acceleration. The rifle, which has a larger mass, doesn't accelerate quite as quickly, but you can still feel it in your shoulder as the rifle recoils.

Exercises Answer the questions below:

1. What is Newton's Third Law?
2. Give three examples of forces in pairs.
3. A rope is attached to a wall. You pick up the rope and pull with all you've got. A scientist walks by and adds a force meter to the rope and measures you're pulling with 50 Newtons. How much force does the wall experience?
4. Can rockets travel in space if there's nothing to push off of? Explain your answer.

Answers to Exercises: Newton's Third Law of Motion

1. What is Newton's Third Law? (For every action, there is an equal and opposite reaction.)
2. Give three examples of forces in pairs. (You sitting in a chair, your weight balanced by the chair pushing back on you; the chandelier hanging from the ceiling is balanced by the tension in the chain holding it up; your weight on quad roller skates is balanced by the ground pushing back with an eighth of your weight on each wheel).
3. A rope is attached to a wall. You pick up the rope and pull with all you've got. A scientist walks by and adds a force meter to the rope and measures you're pulling with 50 Newtons. How much force does the wall experience? (50 Newtons!)
4. Can rockets travel in space if there's nothing to push off of? Explain your answer. (This was a common misconception that rockets can't accelerate in space. Rockets accelerate because they burn fuel and push the hot gases out the back end to propel themselves forward in the opposite direction.)