Wizards of Wright

Lesson: Newton's Third Law

Use WOW! Lesson Intro to begin.

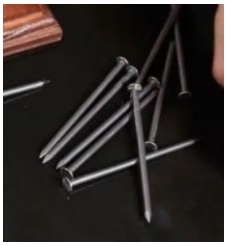
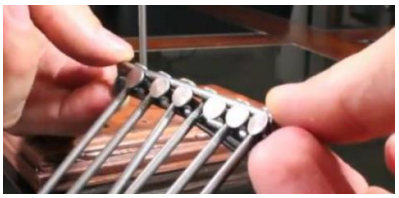
Background Info for Wizards:	Sir Isaac Newton was one of the greatest scientists and mathematicians that ever lived. He was born in England and lived from 1643 to 1727, and was raised by his grandmother. During his college studies he found an interest in math, physics, and astronomy. Newton's ideas have shaped our learning about motion, gravity, the diffraction of light, and forces. His accomplishments laid the foundations for modern science and revolutionized the world. If the students had the previous *WOW!* lessons they were introduced to Sir Isaac Newton, Aristotle and Galileo Galilei. They learned about and experimented with Newton's 1st Law of Motion, Gravity, Force and Inertia; and Newton's2nd Law of Motion, Force, Mass and Acceleration.
Materials:	Student Activity #1: scooters and toning balls Student Activity #2: styrofoam food trays, small plastic stirrers (round cross section) – 2 per group, Flexi-straws – 3 per group, 4- or 5-inch round balloons, balloon pump per group, masking tape, pencils, scissors, rulers, meter stick or measuring tape, sandpaper Wizard Demonstration #2: Newton's Cradle Student Activity #3: Balancing Nails kits for groups
Lesson Time: 60-75 minutes	Introduction: 5 minutes Guided Lesson #1: 5 minutes Wizard Demonstration #1 and Student Activity #1: 10-15 minutes Guided Lesson #2: 5 minutes Student Activity #2: 15-20 minutes Wizard Demonstration #2: 5 minutes Guided Lesson #3: 3-5 minutes Conclusion and Student Activity #3: 10-15 minutes
Learning Targets:	
Introduction for Students: 5 minutes	**Ask students what they already know about Sir Isaac Newton.** **Ask students to explain Newton's 1st and 2nd Laws of Motion.** The first law says that an object at rest tends to stay at rest, and an object in motion tends to stay in motion, with the same direction and speed. This law is often called "the law of inertia".

	This means that there is a natural tendency of objects to keep on doing what they're doing. All objects resist changes in their state of motion. In the absence of an unbalanced force, an object in motion will maintain this state of motion. The second law says that the greater the mass of an object, the more force it will take to accelerate that object. This also means that the harder you kick a ball the farther it will go. It is best stated in an equation that relates an object's mass and acceleration to the amount of force involved to cause motion. Force equals mass times acceleration. F = ma. The third law states that for every action (force) there is an equal and opposite reaction. In other words, if object A exerts a force on object B, then object B also exerts an equal force on object A. Think of it as an action and a consequence – the second action happens, because the first action caused it.
Guided Lesson #1: 5 minutes	Using the idea that for every action, there is an equal and opposite reaction, let's think about how rocket engines work. As the rocket engines are lit, they produce a downward thrust, which results in the upward direction of the rocket launch. If a rocket shoots particles in one direction the rocket travels in the opposite direction. The action caused the reaction. *If students had the WOW! in the Classroom Newton's 2nd Lesson, remind them of the balloon racer activity they did. They taped a balloon to a straw, and raced 2 balloons on strings. This activity is also a great example of Newton's 3rd Law.* **It is a simple action-reaction experiment.** When you blow up a balloon you are filling it up with air that is under pressure. When the air escapes from the balloon (when you let go of it) the escaping air exerts thrust or force on the balloon which propels it forward. The air escapes backward – the balloon races forward. Action – reaction. Or more formally known as Newton's Third Law of Motion.
Wizard Demonstration #1 and Student Activity #1 : 10-15 minutes	*In our first demonstration, we will have 2 students work together. One student sitting on the scooter tosses the toning ball to his or her partner, causing the scooter and the student to move backwards in the opposite direction. The harder the student is able to throw the toning ball, the farther and faster the scooter and the student will travel in the opposite direction.* Choose 2 volunteers for the first demonstration.

	1. Have student 1 sit on the dolly/scooter, with their feet pulled up and out of the way. 2. Hand student 1 a toning/medicine ball. 3. Have student 1 toss the toning/medicine ball to student 2. What happens? Allow the pair to "play catch" for a moment. Every throw and catch should move the student on the scooter backwards, showing every action has an equal and opposite reaction. **Ask students:** What does it show us? Did you see an equal and opposite reaction when the toning ball was tossed? Have more students take a turn.
Guided Lesson #2: 5 minutes	Let's compare what we just saw to what we discussed with rockets. In this case, the student on the scooter is the rocket and the toning ball is the engine. Can they explain that? **Ask the students:** What was the reaction? The student moving backwards. **Ask the students:** What caused that to happen? The action was the force/exertion of the ball. **Ask the students:** Can you use what you know about Newton's 2nd Law to explain this as well? The reaction is based on the acceleration of the throw. Sometimes there is confusion between Newton's 2nd and 3rd Law. When a boxer punches an opponent, and the opponent flies backwards there is an action and a reaction. **Ask the students**: Why is this an example of Newton's 2nd Law? And not his 3rd? The action and reaction are not opposites. (For every action there is an equal and opposite reaction. The punch (the action) is in the same direction as the staggering opponent (the reaction). It is Newton's 2nd Law because the acceleration of the object (the staggering opponent) is in the same direction as the force (the punch).
Student Activity #2: 15-20 minutes	(The teacher may be doing our extension activity with these racers after you have left. Check with the teacher if she wants to keep the racers.) Working in groups, students will construct "rocket racers". After building their rocket racer, students will conduct trials to see how far they can go.

	Show students what they will be using, and talk through the directions before giving them the materials. You probably don't have time to build one yourself, to show as a demo. Pass out the materials, the Activity Sheet and directions, and the template page. As students are preparing their racers, you can prep the room. We need a smooth floor. Stretch out a straight, 10 meter-long line of masking tape, and make a mark at 10 cm intervals (this will help students calculate their distance quickly). Students will line up their racers at the start (two groups per trial) and fill up their balloons using a balloon pump (have students use the same number of pumps – you may want to test the balloons ahead of time to determine how many pumps it takes to adequately fill the balloons). Students will record the distance their racer travels. Help them work together – take turns pumping, measuring, and recording. Students will complete three trials and have the option to modify their racer to improve performance between each trial. <u>Discussion</u> - Have a few students share their rocket racer and their results. Would it be a good idea for automobiles to be powered by rocket engines? How are the wheels on a rocket racer similar to and different from wheels on a regular automobile? What types of modifications would students like to make that weren't available to them?
Wizard Demonstration #2: 5 minutes	Many students have seen or can explain what happens with a Newton's Cradle. <u>Try to keep them from giving it all away for anyone that is seeing it for the first time</u>. **Ask students**: Can you explain why this object is named after Isaac Newton? **Ask students**: How can Newton's Cradle show his 3rd Law of Motion? When raising one ball, this is *the action*. Then release it. The collision sends one ball away from the center. That is *the reaction*. The kids can easily see that one ball *(<u>action</u>)* causes one ball *(<u>reaction</u>)*. Have students **<u>predict</u>** what will happen as you continue scaling the demonstration up, adding another ball to the action. Two in the action, causes two in the reaction. Have students **<u>predict</u>** what will happen when you get to three balls as the action. What will happen since there are only two balls that could be involved in

	the reaction? Many think that the reaction is that the remaining two balls (those struck) will fly higher than any of the other reactions. Some may be surprised when they see three balls in the action, and three balls as part of the reaction. A lot of the students will have an ah-ha moment when the see the reality of the reaction.
Guided Lesson #3: 3-5 minutes	Let's think about all of Newton's Laws as we explain the simple act of walking. 1. Before you start walking you are an object at rest that needs a force (pushing on the floor with your foot) to become an object in motion. Once in motion, a force is required to stop walking, such as gravity and/or friction. 2. Your forward motion (acceleration) is based upon how hard you are pushing with your foot on the ground (force) and how much you weigh (m). The harder you push, the faster you go. If you were to pick another student up while you are walking you would need to push harder on the ground with your foot if you wanted to maintain your current speed, otherwise you would slow down. 3. When you push against the ground with your foot towards your rear an opposite reaction of you moving forward is produced. Your forward speed is directly related to how hard your foot pushes.
Conclusion and Student Activity #3: 10-15 minutes	Review what the students have learned. - What is Newton's 1st Law of Motion? - What is Newton's 2nd Law of Motion? - What is Newton's 3rd Law of Motion? - What did you learn about Sir Isaac Newton? Let's do one last activity to talk about gravity. Every item has a center of gravity. Every person has a center of gravity as well. Simply put, the center of gravity is the determining factor in balance. If the center of gravity is in balance, then so is the object. However, if the center of gravity is thrown off balance then the object will either be supported or will topple! When there are opposing forces to an object, if they are equal and opposite, the object will balance. Each group will get a Balancing Nails kit. The object is to balance a bunch of nails on the head of a single nail. All of the nails have to be balanced at the same time and cannot touch anything but the top of the nail that is stuck in the base.

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