Wizards of Wright

Lesson: Straw Rockets

Use WOW! Lesson Intro to begin.

Background Info for Wizards:	Students will build their own straw rockets using straws, paper, and modeling clay. They will launch using our straw rocket launchers. They will need space around the room to safely test/launch their straw rockets. Speak with the teacher before the lesson, in case things need to be moved around, or set up elsewhere.
Materials:	- example of final straw rocket - drinking straws - clay - construction paper or index cards - scissors - transparent tape - rocket launchers - tape measures - gaffers tape - eye protection - clipboards - digital scales - rulers
Lesson Time: ***55-60 minutes***	Introduction: 5-10 minutes Guided Lesson #1: 5 minutes Guided Lesson #2: 5 minutes Guided Lesson #3: 5 minutes Student Activity #1: 15 minutes Guided Lesson #4: 5 minutes Student Activity #2: 15 minutes Conclusion: 5 minutes
Learning Targets:	Students will experiment with force and pressure. Students will be able to connect changes in momentum to force; and changes in force to momentum.
Introduction for Students: 5-10 minutes	**Introduction for 3rd and 4th grade students.** **Ask students**: What is a rocket? A rocket is an object (usually thin and shaped like a cylinder) that has an engine, burns fuel, and is able to carry equipment and people into space.

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	Ask students: What do you know about how a rocket works? A rocket needs an engine to create energy. When the engine burns fuel it causes a really hot gas to be pushed out of the rocket – if you ever watch a rocket launch you will see smoke and flames coming out of the end of the rocket. As all of this is forced out of one end, and the rocket's reaction is to move forward/upward in the opposite direction. The Straw Rockets we will experiment with today work in the same way, but instead of using hot gases, we will use air pressure from our launchers. **<u>Introduction for 5th-9th grade students.</u>** **Ask students**: Do you know how a rocket works? A hot gas is pushed out of the rockets' nozzle at such a high speed and force that the rocket is pushed forward and upward. A Rocket is a hallow cavity keeping a gas under pressure. Inside the rocket's engine, when the fuel is burned, it causes the gas to heat up. A small opening at one end allows the gas to escape in one direction – providing thrust. **Thrust** allows this force to overtake gravity and propel the rocket skyward. This is an explanation of Newton's 3rd Law of Motion, which states that for every action, there is an equal and opposite reaction. The Action - The rocket pushes the gases down, and The Reaction – the gases push the rocket up. Most historians believe that rockets were invented by the Chinese around the 11th century. By the 13th century, rockets spread to the Middle East. They were known as fire arrows. Early rockets were tubes stuffed with gun powder. When ignited, the gun powder exploded and produced hot gases that "pushed" the tube. Eventually the use of rockets spread worldwide for warfare and entertainment (fireworks). We have a better understanding of Rocketry, over the last 300 years, because of Sir Isaac Newton. What have you learned about his Laws of Motion that will help you explain Rocketry? - 1st Law: For a rocket to lift off the launch pad, force must be exerted to unbalance the other forces. - 2nd Law: The rate at which the rocket leaves the pad will be determined by its mass, fuel, and the force of the fuel being burned. - 3rd Law: The motion of the rocket away from the launch pad is equal and opposite to the thrust of the engine.

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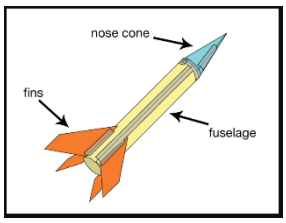
	The Straw Rockets we will experiment with today work in the same way, but instead of using hot gases, we will use air pressure from our launchers.
Guided Lesson #1: 5 minutes	Think of catching a speeding baseball. - To stop the baseball, you have to push back on it to bring it to a halt. - You can feel this force in your hands and your arm as you catch the ball. - Now, if you want to throw the ball back in the direction it came from, you have to exert even more of a force – first you have to stop the ball, and then you have to speed it up in the other direction. Either way, to change the ball's motion, you have to exert a force – a push – on it. A rocket works based on this same idea. Inside a rocket engine, we have a lot of hot gases from burning the rocket's fuel. We can push these gases out of the back of the rocket by exerting a force on them (this force comes from the high-pressure combustion process of the fuel). We are effectively changing the motion of these gases because they start out at rest and end up moving away from the rocket. This means that we are exerting a force on the gases, because this is the only way to change their motion.
Guided Lesson #2: 5 minutes	Let's talk about the most important parts of the rockets we will build. (You should have an example to show.)  We will need the **rocket body** – sometimes called a body tube and sometimes called the fuselage. The body holds the propellant (a combination of fuel and a chemical similar to oxygen) and the rocket engine. We will also need a **nose cone**. The nose cone should have a rounded shape, to minimize friction. This is where the cargo is, sometimes called the payload. This can be astronauts, satellites, or other materials. Our rockets also need **fins**. Airplanes have wings, but rockets have fins. Fins keep the rocket stable and flying straight. As the designer and engineer you will need to consider the size, shape, number and placement of your fins. They are almost always at the rear of the rocket. The addition of fins to the rockets helps ensure stability. As air flows over the rocket, it exerts a force on anything which it touches. The parts of the rocket with the most area feel the strongest forces, because there is more surface for the air to push against. By adding fins to a rocket, we are increasing the area at the

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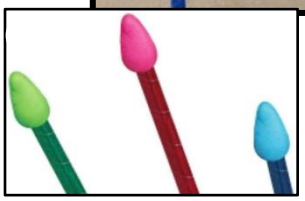
	rear/bottom end of it; this means that if the rocket starts to waver off-course, the wind flowing past will hit its fins and straighten it out.
Guided Lesson #3: 5 minutes	**How does this work?** (Show students the launcher and a straw rocket example as you talk.)  The launcher shoots a jet of air out of the launch tube. This jet of air travels up into the rocket, but since the rocket is sealed at the top by the nosecone, the air is deflected and sent racing back in the other direction. Since the direction of motion of the air changes, we know that we are exerting a force on it, and since the rocket exerts a force on the air, the air must exert a force on the rocket. Thus the rocket feels a thrust upwards and flies off of the stand.
Student Activity #1: 15 minutes	The first thing we need to do is build our rocket. Pass out the materials and direction sheet and guide them through each step.   1. Knead the clay to soften it, and carefully shape the clay. Students need a piece of clay around the size of a grape (3-5 oz.) to begin with. They should weigh the clay using the digital scale, and record it on their data sheet. Press clay onto the straw and shape into a nosecone shape. - Let's all make them "pointed" for the first test (like the pencil erasers you can add to the end of your pencil.) - We can try other shapes and weights later as different variables. Make sure that the clay is solidly attached to the straw and makes a good seal. Suggest to students that some of the clay go into the straw, this will help it stay on. The outside edge between the straw and the nose cone should be sealed carefully with the clay. (pull down a little)

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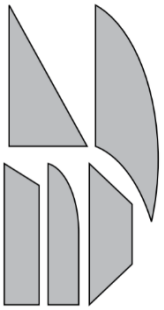
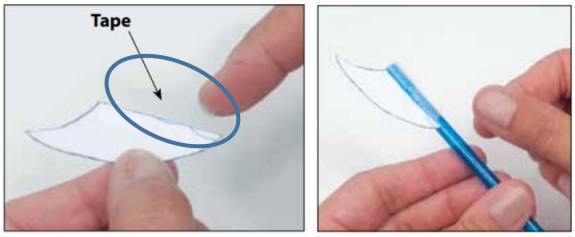
	2. Tell students to draw their fin shape on an index card. They can use the template included. Rockets normally have 2-4 fins. - Let's all make small triangular fins first. - We can try other shapes later as different variables. - We can try different numbers later as variables too. Using scissors, cut out the fins.  Fin Design 3. Tape or glue fins onto the bottom of the rocket (opposite from the nosecone), trying to space them evenly around the rocket's circumference. Use a piece of tape the length of the edge of the fin to connect it to the rocket body. Place the tape on the edge of one fin. Repeat this for all the fins.  Attach the fins so they are evenly spaced around the straw. Do not have any excess tape or glue hanging off the rocket. As students are finishing their rockets, set up rocket launchers. (Launchers are known to shift…so if you put a piece of gaffers tape on the floor, the students can line it up in the same place for every launch.) Things to watch for: designing identical fins and mounting them in a logical arrangement on the rocket.
Guided Lesson #4: 5 minutes	Demonstrate for students the appropriate way of launching rockets. 1. Make sure launchers are on flat, solid surfaces. 2. Place the straw rocket on the launch tube. - If the **launch tube** moves, carefully move it and the rocket back in line with the desired direction angle. 3. Adjust the angle of the **launch tube** to the desired degree mark. 4. Raise the **launch rod** to the desired height.

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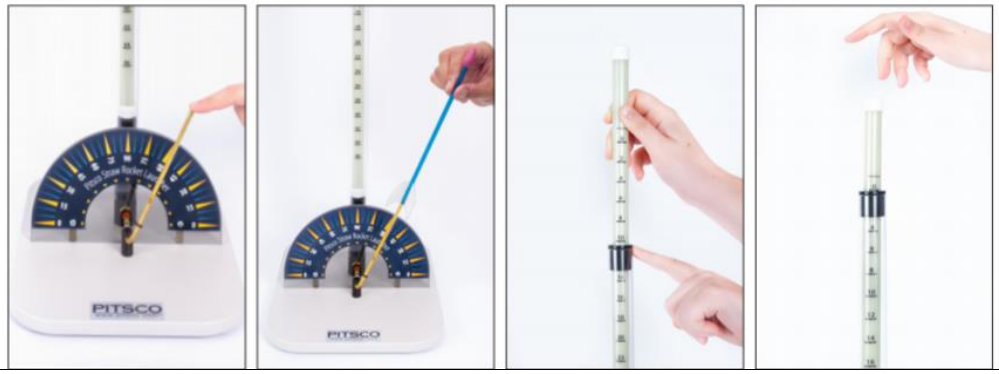
	- By varying the launch rod height, which is calibrated in centimeters, students can control the distance of the rocket's flight. 5. To launch, release the **launch rod** so that it falls to the bottom of the cylinder. - This action compresses the volume of air in the cylinder and forces it out the launch tube, blasting the rocket away from the launcher. - When rockets are launched, simply release or drop the launch rod. - **Avoid forcing the rod into the cylinder.** Can students explain the connection between the hot exhaust gases and the air in these launchers? Be sure that all students have eye protection when the launchers are in use. 
Student Activity #2: 15 minutes	Students will be launching in groups of 4. Ask the teacher to assign their roles…this will make it go quicker than if you do it, or if you ask the kids to decide. 1. *Safety Officer* - Makes sure each launch is safe. Before the launch, the safety officer must make sure the field is clear, and that no one is in the way of getting hit. 2. *Launch Officer* – Makes sure the launcher edge is straight against the tape, and ensures the launch rod is released, not forced or slammed. 3. *Measurement Officer* - Measure the distance that the rocket has traveled, and report that information to the student that launched. 4. *Information Officer* – Make sure that students in your group are reminded to record their data after each launch (on their own paper). Watch for variables that might throw off the experiment, and make sure that each student tests their rocket three times.

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	Give each student a data sheet. Allow them to have time to discuss and answer the 2 questions on their data sheet. Each student should launch three times. As they are launching, make sure you go around and check that students are doing their job.
Conclusion: 5 minutes	Did rockets generally fly straight? Why? What are the important parts of a rocket? What makes a rocket fly? What is a force? How do fins work? We have a second lesson using Straw Rockets that tests different variables. What kinds of variables do you think would be best to test?
Tips:	- The students should never launch straw rockets at people. - Before launching a straw rocket, clear all people from the rocket's flight path. - When launching the rockets, the launch rod simply needs to be released or dropped. Avoid forcing the rod into the cylinder. - The straw should fit over the tube and be able to slide freely up and down. If the straw is too loose, air will leak between the straw and the tube, decreasing the distance the rocket will travel. - Launches need to be performed on a smooth, flat surface.

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