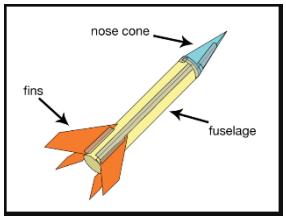
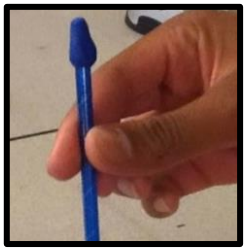
Wizards of Wright

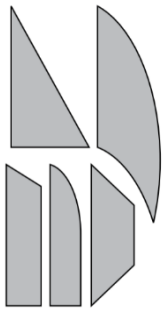
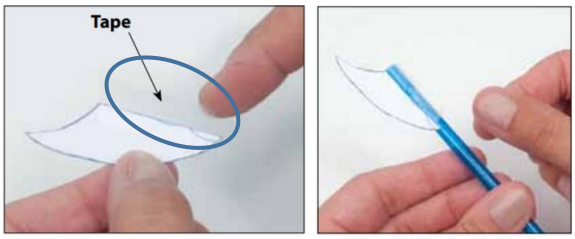
Lesson: Straw Rockets – More Variables

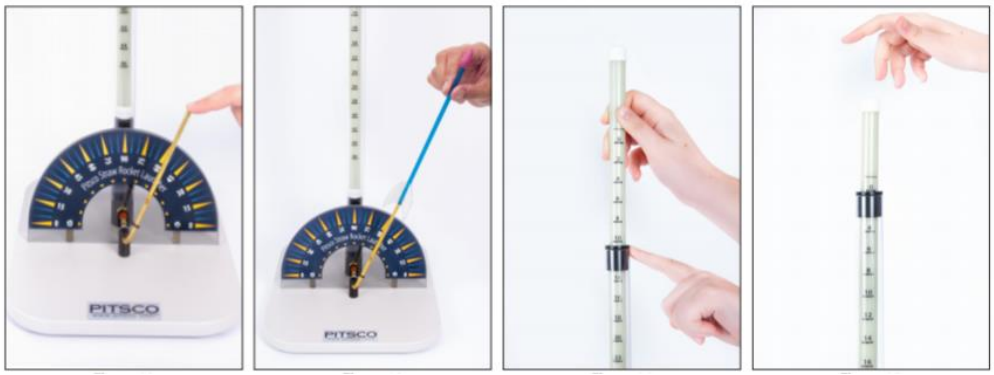
Use WOW! Lesson Intro to begin.

Background Info for Wizards:	Students will build their own straw rockets using straws, paper, and modeling clay. They will test different variables and 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:	- rocket launchers - eye protection - clipboards - example of final straw rocket - drinking straws - clay - construction paper or index cards - scissors - transparent tape - gaffers tape - tape measures - rulers - stopwatches - paper clips - digital scales
Lesson Time: 85-90 minutes *This can be cut down by limiting the number of tests the students do.*	Introduction: 5-7 minutes Guided Lesson #1: 5-7 minutes Variables To Test For: 5-10 minutes Design Constraints: 3-5 minutes Guided Lesson #2: 10 minutes Guided Lesson #3: 5 minutes Student Activity: 30-40 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. Students will experiment with variables, and will be able to discuss results.

Introduction for Students: 5-7 minutes	In our previous lesson we learned what a rocket is and how a rocket works. Review: 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.
Guided Lesson #1: 5-7 minutes	Let's review the parts of a rocket. (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 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.
Variables to test for: 5-10 minutes	Explain to students that today when they design and test their straw rockets, they will be testing different variables.

	Remind them that they can only test one variable at a time. This is a big deal, and something not all students will understand immediately. You may need to focus on this, and give some examples. The student data sheet will give them directions on what variable to test, and how. Go over this packet with them, before they begin to build anything. They will experiment with: 1. rocket lengths 2. nose cone mass 3. launch angles 4. rocket mass 5. fins
Design constraints: 3-5 minutes	Below are the design constraints that need to be applied to every rocket constructed (unless this is the variable they are testing): - Rockets should have a minimum of two fins and a maximum of five fins. - The body of the rocket should be a minimum length of 10 centimeters and a maximum length of 20 centimeters. - The amount of clay used for the nose cone should have a maximum diameter of two centimeters when rolled into a ball.
Guided Lesson #2: 10 minutes	Go over this carefully with students before they have materials. Students should work with a partner. Discuss with them that working together means they don't both have to build and test separate rockets for each variable. They should work together and take turns, but both are responsible for recording data on their own sheets. The first thing they will need to do is build the rocket. Pass out the direction sheets and show them where the rocket materials are laid out. Quickly remind them how to prepare the nosecones and fins.  1. Knead the clay to soften it, and carefully shape the clay. Press clay onto straw and shape into a nosecone shape.  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.

	2. Tell students to draw their fin shape on an index card. They can use the template included. Rockets normally have 2-4 fins. Using scissors, cut out the fins. 3. Tape or glue fins onto the bottom of the rocket (opposite from the nosecone), taking care to space them evenly around the rocket's circumference.  Fin Design 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 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 #3: 5 minutes	Remind 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. 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**. Be sure that all students have eye protection when the launchers are in use. 
Student Activity: 30-40 minutes	Student pairs should complete variable tests. Please move around the room and help students as much as necessary. They may need to be reminded to follow the directions in the data packet, and to record their results.
Conclusion: 5 minutes	After materials are put away, and back in their seats, review what was learned. What were the factors that made rockets go higher?
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. - Varying fin design, placement, and number; body tube length; nose cone shape and mass; and center of gravity can affect the rocket's flight. - Varying the placement of the rocket on the launch tube will affect the rocket's flight. - Launches need to be performed on a smooth, flat surface.

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