Wizards of Wright

Lesson: Rocketry - Testing Pressure with Balloon Rockets

Use WOW! Lesson Intro to begin.

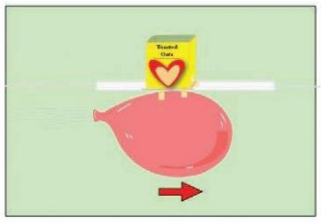
Background Info for Wizards:	Students will experiment with propelling a balloon across the room using air pressure. In this activity, students create a makeshift rocket out of a balloon by inflating and increasing the air pressure inside the balloon. When the balloon is released, air rushes out and propels it forward. If the students had the *WOW! Newton's Second Law of Motion* Lesson they did this balloon rocket setup, but testing is different.
Materials:	- balloons (different shapes and sizes) - clips to keep balloons closed - straws - string (long enough to cover at least 10 feet) (nylon, fishing line, cotton, twine) - 2 chairs or other objects that can hold an end of the string on opposite sides of a room - marker - cargo (paper clips, clay, mini bean bags) - cereal boxes (small individual), construction paper, or other material to make a lightweight cargo container For teams to share: - tape, glue, scissors, and other materials for construction - digital scales - measuring tape - stopwatches Make sure the string is set up in an area of the room where students will not be walking through, so they do not disturb the setup **or trip**!
Lesson Time: 55-60 minutes	Introduction: 5 minutes Guided Lesson: 10 minutes Student Activity: 30 minutes Conclusion: 10 minutes

Learning Targets:	Students will review Newton's Laws, force and thrust. Students will learn about pressure/air pressure. Students will create a cargo carrier and attach it to their balloon rocket. They will continue testing by changing variables. (different shapes and sized of the balloon, angling the launch, using a different type of string, changing cargo mass)
Introduction for Students: 5 minutes	**Ask students to explain what they already know about Sir Isaac Newton and the Laws of Motion.** **Ask students to explain what they already know about force and thrust.** **Ask students to explain what they already know about rockets.** Review: In order for a rocket to be launched into space, some kind of force must be used to push it. A force can be push or pull on an object. Thrust is the kind of push that propels a rocket. Two of Newton's Laws relate to force, and therefore to thrust. Which ones? Newton's 2nd Law - shows us the relationship between an object's mass, its acceleration, and force. Newton's 3rd Law – teaches us that for every action there is an equal and opposite reaction.
Guided Lesson: 10 minutes	When two objects interact, both objects exert a force on each other. The sum of those forces determines whether an object will move or not. For example, when you sit on a chair you are exerting a force on that chair: your weight is pushing down on the chair. But what force causes you to stay seated and not keep moving down to the ground? The chair is exerting an equal and opposite upward force on your body, which we know because you remain at rest. It is only when two forces are acting in equal and opposite directions that an object will remain at rest. This is an example of the laws that Isaac Newton came up with almost 400 years ago. Newton's Third Law says that for every action, there is an equal and opposite reaction. This means that any time there is any kind of force, there is another force of equal size and strength pushing back against it. The force of the chair pushing up on your body is exactly the same strength as the force you exert on the chair.

	Blow up a balloon and use as an example, as you are talking. When you blow up a balloon, you are filling the balloon with gas particles (oxygen). The oxygen molecules move freely within the balloon and may collide with one another. As you continue to blow it up, more gas is added to the balloon, the number of gas particles in the balloon increases, as well as the number of collisions. As the number of collisions increase, so does the pressure within the balloon. Newton's Third Law helps to explain how rockets work. Rockets create a force acting in one direction in order to propel themselves forward. As the rocket accelerates in one direction, a force of the same magnitude is exerted in the opposite direction, pushing the rocket through the air. This force is known as thrust. The pressure inside the balloon will serve as our fuel for the rocket. The pressure *inside* the balloon becomes greater than the pressure *outside* of the balloon. When you release the opening of the balloon, gas quickly escapes to equalize the pressure. As the gas is released from the balloon and pushes against the outside air, the outside air pushes back. The rocket is propelled forward by the opposing force, thrust. Think of being in a pool and pushing off the wall. As you straighten your legs, you push against the wall of the pool. You move forward because the wall pushes back. The pair of forces here is your feet pushing against the wall, and wall pushing back in the exact opposite direction. Ask students about some other things that make an object move. For example, a car, a bat hitting a baseball, or a runner. Can students identify the pairs of equal and opposite forces of the movements they see around them?
Student Activity: 30 minutes	*Students will transport their cargo while attached to balloons across a suspended string.* Explain the activity to students, show them what materials are available, and pass out the Data Recording Sheets. Ask students to think about how balloon shapes and sizes, and cargo weight will affect the speed of the balloon. A few students on the team can be building the cargo carrier while others set up their testing station. It will give them more testing time, if they split the jobs.

Task #1: Students build a device to safely transport people or cargo from one area of town to another.
- Only discuss how they may accomplish this task and offer hints **as needed**.

Task #2: Have students tie one end of the string to one chair, thread their straw onto the string, then tie off the other end on the other chair. Pull the chairs apart until the string is taut.
- Tie the ends of the string to something sturdy – desk to desk, chair to chair.
(Try for @10 feet.)



Task #3: Secure the cargo carrier to the straw.

To Test:
1. Inflate balloon. Use a clip to secure the end of the balloon.
2. Tape the balloon to the straw.
3. Add cargo, and check for balance.
4. Release the balloon.
5. Discuss your observations.
6. Test several times.

Tips:
- Using a balloon pump helps the students inflate the balloons to the proper and consistent size.
- Make sure the string is level for beginning tests.
- Binder clips help the students keep the balloon inflated until ready to race.

Continued Tests:

1. Students should try the activity with balloons of different shapes and sizes.
   - Does this change the results?
   - Or, inflate the same type of balloon to different sizes.
   - Have students measure the circumference of the balloon with a tape measure and run multiple trials at each circumference.
   - Students can chart their results (i.e. balloon circumference vs. distance traveled) to see if there is a connection.

Ask students if they can explain their results.

2. For more of a challenge, try angling the string up so the balloon rocket has to climb to reach the end! Students can try the experiment on flat,

	downward, and upward sloped strings to see how the angle of the string changes the results. 3. Have students experiment with friction by testing different types of string: nylon, fishing line, cotton, twine, etc. - Does the cargo device move just as easily over each type of string? - Why or why not? 4. How does the cargo mass affect its movement? - Have students test a number of times with the same setup but add mass to the balloon rocket each trial (paper clips, clay, and mini bean bags can easily be weighed, added, and removed to any setup).
Conclusion: 10 minutes	Have students clean up and return any reusable materials. Discuss all testing results, force and pressure, and the connections to Newton's Laws of Motion.

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