Wizards of Wright

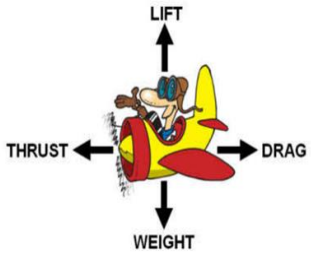
Lesson: Forces of Flight – Glider Testing

Use WOW! Lesson Intro to begin.

Background Info for Wizards:	This lesson will use our balsa wood gliders (also used in the Manufacturing Lesson) so students can experiment with the forces of flight, and an airplane's movements while in the air. By adding mass or even post it notes, students can change the variables and hopefully get their glider to fly farther, and stay in the air longer.
Materials:	- toy plane - balsa wood glider for each student - masking tape For groups to share: - scissors - measuring tape - stopwatches - digital scale - post it notes - binder clips - clay
Lesson Time: 45-60 minutes	Introduction: 5-7 minutes Guided Lesson #1: 10 minutes Guided Lesson #2: 5 minutes Student Activity: 15-20 minutes Conclusion: 5 minutes
Learning Targets:	Students will be introduced to a history about the Wright brothers. Students will learn about the 4 forces that affect flight. Students will be able to describe an airplane's movements through the air.
Introduction for Students: 5-7 minutes	**Ask students**: What do you already know about Orville and Wilbur Wright? They invented the airplane. They were the first to make a successful flight, with a pilot at the controls, with an aircraft powered by an engine. In December of 1903, Wilbur Wright stood on the beach in Kitty Hawk, North Carolina watching his brother Orville in an airplane above him. Orville flew the

	world's first successful piloted engine-powered airplane. They chose Kitty Hawk because it put them up on a hill, there were nice windy breezes, and the area was sandy which would help soften the landings in case of a crash. The first flight went for 120 feet, and Orville stayed in the air for 12 seconds. As the brothers made more flights that day, the flights began to last longer. The Wright brothers probably never thought that over 100 years later there would be close to 44,000 flights and 2.7 million airline passengers in the air every day! Some trips used to take months by boat and train, but today we can fly from one side of the world to the other in just hours. Wilbur was born in Indiana in 1867 and Orville was born in Dayton in 1871. They, and their 5 brothers and sisters grew up in Indiana and Ohio, moving back and forth a few times with their family. Orville and Wilbur loved to invent things and got interested in flying when their dad gave them a toy helicopter. Then they experimented with making their own helicopters and building and flying kites. They also built and experimented a lot with model gliders. **Ask students**: What's the different between a glider and an airplane. - A glider is an aircraft that floats in the air, creating its own lift, and does not use an engine. Completing this first flight wasn't easy or simple for the Wright brothers. They experimented for years with gliders, working on the perfect wing design, modeling them after studying birds. They also worked on better propellers and a lightweight engine. Using models helped the Wright Brothers learn more about balancing and positioning the weight of airplanes. If the nose, or front, of the plane is too heavy, that weight will pull the airplane into a forward dive. The weight needs to be evenly distributed for safety throughout the wings, fuselage, and tail. *(You'll want to remind them of this later.)* Model airplanes are used to develop designs and test ideas in aviation. The information engineers learn makes airplanes safer, perform better, and more efficient. Thanks to the successful experiments of Orville and Wilbur the airplane is recognized as one of the greatest inventions of all time.

Guided Lesson #1: 10 minutes	**Give students the vocabulary page to fill in as you are going over all of the new words.** In order to work with things that fly, and experiment with our own gliders, we really need to have an understanding of flight. (Use toy plane or glider for examples.) There are words that we need to be able to use correctly. (there are posters for visual examples) The four forces of flight are what keep an airplane up in the air. They enable the plane to go up and down, forward, and then slow it down. 1. Airplanes fly because they are able to generate a force called ***Lift*** which normally moves the airplane upward. The wings create most of the lift used by airplanes and is the force that holds an airplane in the air. - Lift is caused by the airplane's forward movement, which is produced by the thrust of the engine(s). 2. ***Thrust*** is the force that moves an aircraft in the direction of the motion. Aircraft use propellers, jet engines, or even rockets to cause thrust. How does it happen? There is an action (air is pulled in), and then a reaction (air is pushed out in the opposite direction). *(relate to Newton's Law)* 3. ***Drag*** is the force that slows down the forward motion of the airplane. - You have felt drag before. It's that feeling when you put your hand out of a moving car window and feeling it pull back. It's the force that acts opposite to the direction of motion, so it tends to slow an object down. *(relate to Newton)* 4. ***Weight*** is the force created by gravity, and is the downward pull toward the earth. When you jump up and down, it's your weight that brings you back down.

	The four forces of flight are what makes the plane move in different ways. - Each force has an opposite force, and it balances that movement and works against it. - Lift works opposite of weight. - Thrust works opposite of drag.  - When the forces are all balanced, the plane is level. - When lift and thrust are stronger than gravity and drag: the plane goes up. - When gravity and drag are stronger than lift and thrust: the plane goes down. - The air pressure is higher on the bottom side of a wing, and this helps push it upward. There are other words you need to learn to describe an airplane's movements through the air. ***Roll*** – This happens by moving the wings up and down. ***Pitch*** - This happens when the nose of the plane moves up and down. ***Yaw*** – This is when the nose of the plane moves from side to side.
Guided Lesson #2: 5 minutes	The Wright Flyer was the first airplane to complete a takeoff and landing using a pilot to control the direction and altitude of the flight. Experimenting with different designs showed that for the safest and most balanced flight the weight needs to be evenly distributed. The **wings**, **fuselage**, and **tail** are designed to balance and interact with each other. (show picture) All planes have ***wings***. The wings are shaped with smooth surfaces that are slightly curved, and when air moves around and under the wing it produces the upward lift for the airplane. To continue that lift, the plane needs *ailerons*. They are connected to the wings and through hinges they are pushed downward to push the air down and make the wing tilt up. We also know that the shape of the wing determines the speed and altitude of the plane. The ***fuselage*** is the body of the plane. It is generally a long tube shape. The wheels/landing gear are attached to the fuselage. The plane's stability comes from the ***tail*** at the rear of the plane. There's a vertical stabilizer – the *rudder* that affects the plane turning right or left (*yaw).*

	And there's a horizontal stabilizer – the *elevator*, used to move the plane up or down (*pitch*). Quickly check that they have filled in the vocabulary words accurately.
Student Activity: 15-20 minutes	Give students a Data Sheet. 1. Have the teacher organize the class into pairs or groups of four students. Students will all test their own glider, but the partner or group is good for discussion and brainstorming. 2. Mark a starting line on the floor with masking tape. Set up targets. You will use this for the control test, and the students will use it for their tests. (Desks may need to be moved out of the way.) 3. Determine baseline controls: To begin, establish the controls for a basic (unadjusted) glider. **(Wizard only.)** Assemble one glider to use as the sample for control testing. (Explain steps as you put it together. Discuss fragility.) - Measure how far the glider traveled. - This is the distance control. - Record results on the board so students can record it on their Data Sheets. Repeat this process to find the average time of flight. - This is the time control. - Record results on the board so students can record it on their Data Sheets. 4. Pass out gliders to each student. Before they build their glider, have them write their name on the fuselage. Review how to put the glider together. **<u>These can break easily. Warn students to be careful.</u>** 5. Working in their groups, have students discuss adjustments that they would like to design to increase either the distance or flight time of their gliders. 6. Using the materials provided (cut post it notes, binder clips, clay) add flaps and mass to the glider. They should help each other measure and time their flights. - Remind students that they can make adjustments to the wings, the fuselage, and the tail.

	- Have students make predictions on whether the gliders will reach the target. - Point out that moving the wing forward or backward in the slot changes the center of weight and balance and can affect the way the airplane flies.
Conclusion: 5 minutes	Review with students what they learned about the Wright Brothers, the 4 forces of flight, the control surfaces, and what they control. Ask students to share what gave them a successful flight. Encourage them to use the new vocabulary words as they do. Discuss the flight test results. Which adjustment helped the aircraft reach the target the best? Which adjustment affected their flight distance and time in the air best? Why? Did your predictions improve?

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