Wizards of Wright

Lesson: Flight – Testing Weight and Balance

Use WOW! Lesson Intro to begin.

Background Info for Wizards:	This activity will help students review the forces of flight, and learn the basics about airplane design. They will also explore how weight and balance effect flight. They will make paper airplanes, and then make their own Styrofoam glider.
Materials:	- Paper Airplane packets - blank paper - Styrofoam food trays - Glider template - plastic knives - sand paper For students to share: - binder clips - paper clip - clay
Lesson Time: 60 minutes	Introduction: 5 minutes Guided Lesson: 5 minutes Student Activity #1: 15 minutes Student Activity #2: 30 minutes Conclusion: 5 minutes
Learning Targets:	Students will compare a paper glider model with a Styrofoam glider flight. Students will use variables to conduct an experiment.
Introduction for Students: 5 minutes	Understanding Flight. This section is written assuming that students have studied/have an understanding of the Forces of Flight. **Ask students**: What do you already know about lift, thrust, drag and weight? **Ask students**: Have you ever thrown a Frisbee? It flies because of four forces. These same four forces help an airplane fly. The four forces are lift, thrust, drag, and weight. - As a Frisbee flies through the air, lift holds it up.

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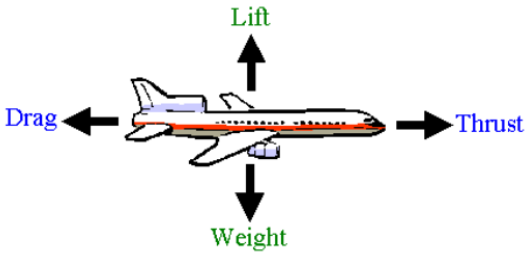
- You gave the Frisbee thrust with your arm.
- Drag from the air made the Frisbee slow down.
- Its weight brings the Frisbee back to Earth again.

Remind students that when the thrust produced by an airplanes engine is greater than the force of drag, the airplane moves forward. When the forward motion is enough to produce a force of lift that is greater than the weight, the airplane moves upward.

The way the four forces act on the airplane make the plane do different things.
- Each force has an opposite force that works against it.
- Lift works opposite of weight.
- Thrust works opposite of drag.
- When the forces are balanced, a plane flies in a level direction.
- The plane goes up if the forces of lift and thrust are more than gravity and drag.
- If gravity and drag are bigger than lift and thrust, the plane goes down.
- Just as drag holds something back as a response to wind flow, lift pushes something up.
- The air pressure is higher on the bottom side of a wing, so it is pushed upward.


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<td>Guided Lesson:
5 minutes</td>
<td>When working with new models or products, engineers test, make changes, test again, make more changes until they have a successful design. When engineers use the design process they have the opportunity to make mistakes and fix them, so they end up with the best, and safest aircraft possible. When they use small models for their work, it doesn't cost as much as it would to constantly test with full-size airplanes.

Using models was an early design plan used by the pioneers of aviation. They did not build a "flying machine" one day and immediately take off into the air - that would have been too dangerous. The early inventors and engineers, people like the Wright Brothers, began with learning about flight by using kites and gliders. They started experimenting with wing shapes and sizes. They ran tests to see how much weight their kites and gliders could carry.</td>
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	Ask students: What is the difference 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. As engineers we will be responsible for designing gliders that can either travel a long distance or stay airborne for a long time. 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. 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. Flight control systems manage flight direction. Elevators make the nose of the airplane pitch up and down and a rudder is used to move the nose left and right. Airplanes also use ailerons to roll the airplane, and stabilizers to straighten it out. (show plane pic)
Student Activity #1: 15 minutes	Let's take everything we have learned and put into action. Give students the packet on paper airplanes, and several pieces of blank paper. Students may work on their own or with a partner and may build any or all of the paper airplanes included. If students know a design for a different paper airplane, encourage them to share it with the class. As students build and test their paper airplanes ask them questions about the lift, thrust, drag, and weight of their plane, and how it affects the height and time of the flight, and the landing. Are there modifications they can make to increase the flight length or time?
Student Activity #2: 30 minutes	Gently toss a Styrofoam tray into the air and ask the students to describe what happened. Did it fly? Would it work as a Frisbee? Instead of flying, it drops. The ability that Styrofoam has to be lightweight and strong makes it a great material to use in making gliders. Hand out the materials and the direction sheet. Explain how to cut the wings, fuselage, and elevator from the Styrofoam. 1. Demonstrate cutting out the parts using a serrated plastic knife. - Another way to cut out the parts is by punching a series of holes approximately 2 mm apart around the outside edge of each piece and then

	pushing the piece out. - A sharp pencil can be used to punch the holes. 2. Use sandpaper to sand the edges smooth. 3. Have students assemble the glider by inserting the wings and elevator into the fuselage slots. Remind students to be careful when testing their gliders. Can you set up a spot in the room where testing can be? - Tell students that the weight must be balanced before it will fly. - They should test their glider before adding weight and balance. They can add weight to the model using paper clips, binder clips, or clay. - Attach the paper clip or clay to the nose of the glider. - If a binder clip is used, attach it to the bottom of the fuselage. - Does more than one clip make an effect? - Move the weight forward or backward on the fuselage to determine the best weight and balance for the glider. The best weight and balance combination can be defined as one that allows the glider to fly the greatest distance.
Conclusion: 5 minutes	Review the 4 forces of flight, the difference between a plane and a glider, and the parts of a plane. 1. Is weight and balance important on "real" airplanes? Yes, all airplanes are required to have correct weight and balance. The total weight of the cargo and passengers has to be within a certain limit and has to be balanced. 2. How did your glider fly before you changed its weight and balance? 3. How did changing weight and balance affect your flight?

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