Activity 2 Bernoulli in Action

Materials List

- ❑ Copy paper cut into 1" x 11" strips - one per student
- ❑ Science Notebooks

Assessment

The students will answer the question, "Why does the strip of paper rise when you blow air over it?" in their Science Notebooks.

Directions

1) Explain to the students that they are to be scientists, much like Daniel Bernoulli and Sir Isaac Newton, and will experience air pressure for themselves.

2) Have the students predict what will happen if they hold a strip of paper to their mouths and blow over the top of the paper. You can write their prediction on chart paper or have them think-pair-share their ideas.

3) Hand out a strip of paper to each student. Hold one end of the strip of paper pinched between your pointer finger and your thumb. The strip should fall over your hand on the outside. Ask the students what the strip of paper looks like from the side (Answer: An airfoil). Demonstrate how to blow by placing your strip between your chin and lower lip. Ask the students to blow forcefully over the top of the paper strip. The paper will rise due to less pressure on the top and more pressure under the paper. Without telling the students, discuss why they think this happens.

4) Explain to the students that the wing of an airplane is much like the strip of paper experiment; air goes over the wing quickly and does not push down with much pressure. The air below is slower and has higher pressure, which lifts the strip into the air. Students can draw and describe what happened when they blew over the top of the strip in their Science Notebooks.

Constructed Response

Why does the strip rise when you blow air over it?

Wing on a String

Materials List

- ❑ One 24" piece of string for each student
- ❑ One 2" piece of drinking straw for each student
- ❑ Transparent tape
- ❑ Student Work Page 4, "Wing on a String"
- ❑ "Identifying the Four Forces - Lift" Work Page
- ❑ Hand-held paper punch
- ❑ Long-Term Project
- ❑ Lesson Three Rubric
- ❑ Science Notebooks

Assessment

Students will complete the Student Work Page 4 about the "Wing on a String." They will also record the arrow that represents lift on "Identifying the Four Forces - Lift" Work Page that will be kept for students to complete in the rest of the lessons.

Directions

1) Explain to the students that they will be putting both Newton's and Bernoulli's theories into action by creating a simple airfoil, which will react to the movement of air around it.

2) Pass out a string and piece of paper for each student. Ask students to bend, not fold, the paper in half widthwise ("hamburger fold") and tape the ends together with transparent tape. This will create an airfoil shape.

3) Using a paper punch, punch a hole in the middle of the paper on the non-taped end, approximately one inch from the edge of the paper. Students may reform the airfoil by sliding their hand inside the opening and rounding the front of the airfoil again.

4) Each student should then slide a piece of string through a piece of straw. They will slide the straw through the holes of the airfoil to allow the airfoil to slide on the string. Put a piece of tape on the straw to fasten it to the airfoil.

5) On the Student Work Page 4, have students draw and predict what will happen to the airfoil if they spin it at arm's length while holding each end of the string vertically.

6) Move to an area that gives each student room to spin. Holding the string vertically at arm's length, have students spin their body and arms to see what will happen to the airfoil. The curved side of the airfoil must face the direction of the turn. Also, have the students turn in the direction of the hand that is on top of the string. (The airfoil will rise because of lift.)

7) Students can also run with the wing or watch as the wing rises with a stiff breeze outside. The wing will also rise when put in front of a floor fan.

8) Question the students to see if they can tell why the airfoil reacted like it did. Refer students back to the airfoil on the board and how the difference in pressures create lift.
NOTE: Students will discover that if the airfoil starts out with the leading edge slightly up or the string is slightly tilted to about 10 degrees, the airfoil will rise faster. This is called angle of attack. A good example of this is a kite's angle of attack when flying in the air. Airplanes will stall if the angle of attack is too vertical because air cannot travel over the wing as needed.

9) Students should complete the Student Work Page 4, using arrows to illustrate how the wing moved.

10) Hand out "Identifying the Four Forces - Lift" Work Page. Students should be able to fill out the upward arrow representing lift. Also, students will answer the question, "How do airplanes fly?" on the bottom of this sheet. Collect this paper, as students will fill out the other arrows and add to their written answers.

Long-Term Project

Beginning with Lesson Three: Lift, students will become aerospace engineers. Taking into account what they learned about lift, students will design an airplane and explain how lift affects the plane. Students may design their planes however they want.

As new forces are learned, students will modify their design.

Each time a new design is created, note students' understanding of each force of flight. Students may keep their designs from the previous force and add on to them or make brand-new designs. Assess using Lesson Three Rubric.

Constructed Response

Compare the behavior of your wing on a string to that of the wing on an airplane.

Next Generation Science Standards

3-PS2-1.
Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-1)

3-PS2-2.
Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

3-PS2-3.
Ask questions that can be investigated based on patterns such as cause and effect relationships.

4-PS2-1.
Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (4-PS2-1)

4-PS2-2.
Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

Ask questions that can be investigated based on patterns such as cause and effect relationships.

3-5-ETS1-1.
Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2.
Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3.
Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

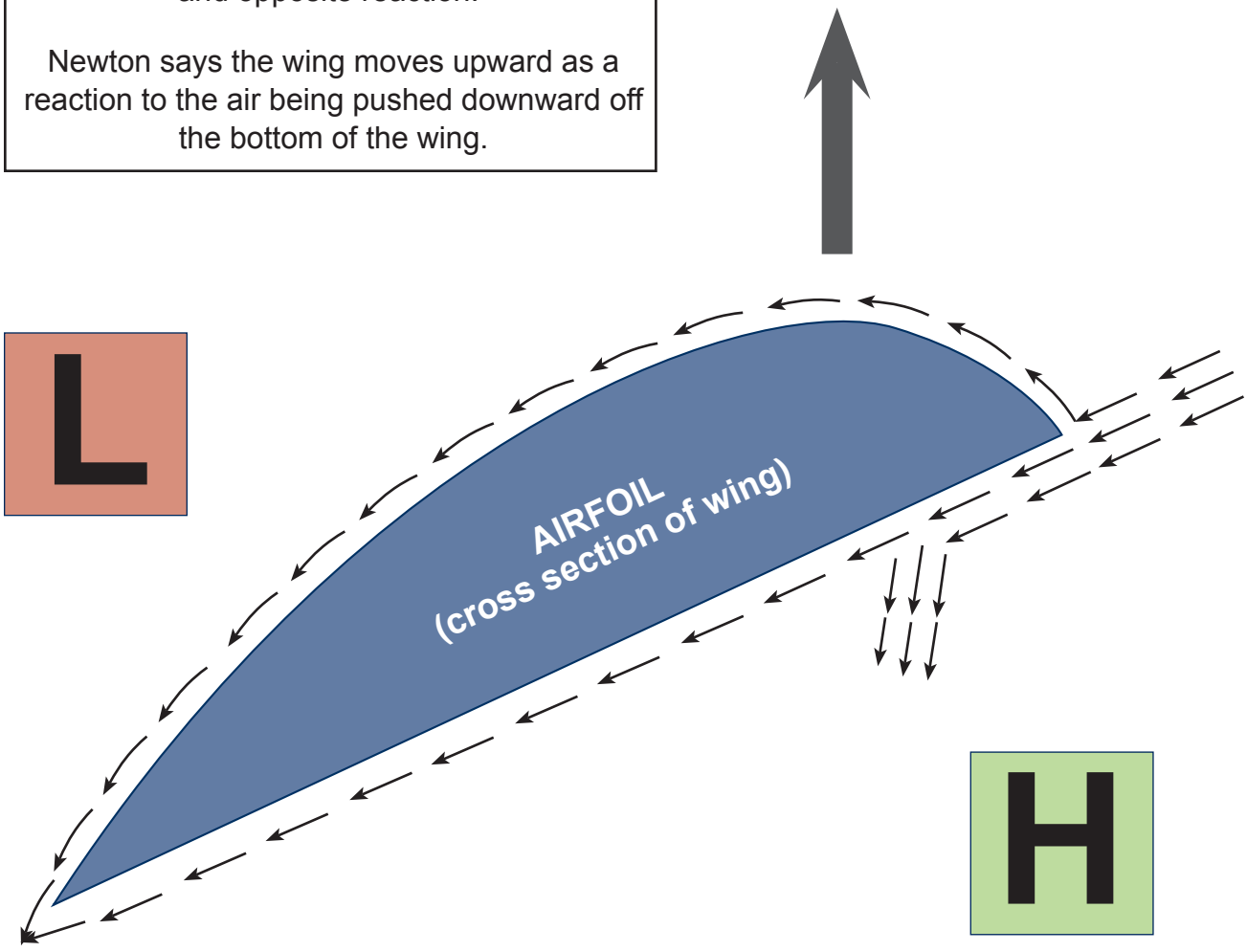
Airflow Over and Under Airfoil

Diagram: Lesson 3.1

Newton's Third Law

"For every action there is an equal and opposite reaction."

Newton says the wing moves upward as a reaction to the air being pushed downward off the bottom of the wing.



Key

- ← Airflow Lines
- H High Pressure
- L Low Pressure

Bernoulli's Principle

The air on the top of the airfoil needs to travel more quickly because it has a greater distance to travel. Bernoulli says that faster air creates low pressure. The air under the airfoil is traveling more slowly, which creates a high-pressure area. The wing rises into the high-pressure area.