

Overview

Student teams will learn about the four forces of flight and will do a simple experiment to illustrate Bernoulli's principle of lift. They will construct a basic paper airplane that will show these four forces in action. Students will put into practice techniques of construction and throwing so that they will be better prepared to accurately hit a target during the competition.

Materials Needed

1. Discarded 8 1/2" X 11" copy paper from the recycling bin (You will use LOTS! It is possible that the younger children will have trouble seeing their folds on the printed paper – in this case, you may want to use fresh copy paper. Although we suggest that children put their names on the planes, you can instead use colored paper – one color per team. You make the call!)
2. Standard roll of 3/4" masking tape for marking floors and making planes
3. Rulers & Scissors (1 each per student team)
4. Large metric tape that can measure at least 10 meters
5. Long hallway/gym/area where planes can be thrown
6. (Optional) Resources (on-line or from other sources) for paper-airplane-building
7. Paper Airplane Building Worksheets & Troubleshooting Sheets
8. Paper cut to 2" X 10" (1 per student)
9. Pencils/pens to label planes with student names (1 per student)
10. Clipboard and copies of the Master Data Sheet to record results

Teacher Preparation/Set Up:

1. Make sure you have a designated LARGE/LONG space reserved to use for this activity.
2. **Teacher Hint:** *If you have never experimented with paper airplanes before, know that this is a somewhat chaotic activity! If you can have one LARGE space to do the making and flying, it will help. That way, students can rotate between making planes, testing them, and adjusting them. We've included "scripted" instructions for making the first plane together, but you may wish to have the students try their own designs from the start and just "play." Parent help is a good thing here!*
3. Practice making and throwing a few of these planes beforehand so that YOU understand what's going on with them.
4. Practice the "Bernoulli's Principle" activity beforehand yourself so you can see where to hold the paper to get the best effect.
5. Determine a "launching line" on the floor of your space. Lay down a strip of masking tape at one end of the hall to mark this line.
6. To make measuring easier, you may wish to tape down lines at every meter from 1 – 15 meters.
7. Make a target for yourself. Get a large piece of paper or poster board and put a large black dot in the center. You will tape this "target" on the floor at a distance of 5 meters to start out with. Since the contest target can be located anywhere from 5 – 12 meters, you should change the target distance occasionally during the practice.

Procedures

Part I: Introduction – The Forces of Flight

1. Say: "Have you ever watched the birds soar above you and wondered how they could stay afloat for so long without their wings getting tired? How about an airplane...how could such a heavy object defy the force of gravity and get so high up in the air so quickly? Today we're going to practice making some neat paper airplanes for the upcoming Science Olympiad, but first, we've got to learn about the forces of flight that birds AND airplanes use

to stay in the air. You'll then be able to use what you learn to help you make the BEST paper airplane ever!"

- a. Grasp one end of the strips of 2" X 10" paper and set it just against your chin, below your mouth. Ask the students what will happen when you blow across the paper: "Will the paper go up or down?" (Most of the students will say that the paper will go down because you are "pushing" the paper down with your breath.)
- b. Hand out the strips of paper to the students and say, "OK, let's all try this together now to see what the paper will do."
- c. If it's done right, the paper will fly up. Make sure you model this so you blow forcefully across the top of the paper – it should rise. Ask: "Why do you think this happens?"
- d. Say: "A man named Bernoulli discovered that fast-moving air has less pressure than slow-moving air. You just saw what we call "Bernoulli's Principle" in action!" (You may wish to write "Bernoulli's Principle" on the board.) "When we blow hard across the top of the paper, we make the air move fast. The paper rises because the pressure under our "wing" is greater, pushing the paper up. This is the force of LIFT that a plane uses to go up." (Write the word LIFT on the board with an UP arrow.)
- e. Ask: "If LIFT is the force that makes a plane go up, what force pulls on the plane to hold it on the earth?" (GRAVITY – write this word on the board)
- f. "Wings give an airplane LIFT, but they don't drive it forward. THRUST is the force that does that." (Write the word THRUST with a forward arrow.)
- g. "Finally, the airplane pushes against the air as the plane moves forward, creating a force we call DRAG." (Write word on board with a backward arrow.)
- h. "When THRUST overcomes DRAG and LIFT overcomes GRAVITY, the plane rises and we have **FLIGHT!** These same forces are at work if we are flying real planes or paper airplanes."

Part II: Making a Prototype Paper Airplane

1. "Say: "Now, we are ready to make our paper airplanes. Wait until we all have our materials. Each team of two will receive materials to make two planes, but you should follow the instructions on the worksheet to make your first plane. The teachers will walk around to give help to those who need it, and older students should help the younger students with their planes. **YOU ARE NOT TO FLY ANY PLANES AT THIS TIME! WAIT UNTIL WE ARE ALL FINISHED AND THEN WE WILL GO TO THE LAUNCHING AREA TOGETHER TO TRY THEM OUT.**"
2. Hand out these materials to each team of two: 2 sheets of paper, 2 pieces (5 cm long each) of masking tape, rulers, something to write with, and a worksheet.
3. Student teams should begin making their planes, following the steps on the worksheet. Teachers should circulate to help. As students finish with a plane, they should be encouraged to help others who are not done. After the first planes are done, students should try to experiment to make second planes, using their own designs.
4. When all teams have made two planes, stop the class and tell them to LABEL each of their planes with their names. (Very important!) Now you're ready to test.

Part III: Launching the Planes - Practice

1. Take the students to the Launch Area and explain the procedure for launching toward the target. We suggest that you tell the students that they are **ALWAYS THROWING IN THE SAME DIRECTION** for safety. Students should **NEVER** be walking toward those who are throwing airplanes. **AT NO TIME** should students be throwing airplanes at other students.
2. If you have a large space, all students can throw at one time, retrieve their planes, then return to the Launching Line *via the sides of the area*.
3. If you only have a hallway, students might throw in small groups, retrieve their planes, and return before the next volley.

Part IV: Launching the Planes – Making Adjustments

1. Call the students to attention and discuss which planes got nearest the target. Ask the students who flew those planes what they did to achieve the desired results. Was it holding the plane in a certain spot while launching? Amount of force while launching? Is there anything else you can do to the plane? Adjust the stabilizers? Add/subtract weight with more tape/less tape/no tape? Add ailerons? This would be a good time to introduce students to the Troubleshooting Page.
2. Allow students to do something different to their planes if necessary before the next launch.
3. IMPORTANT: After 3 or 4 flights, the planes get pretty “beat up” – the nose gets bent up and smashed and the planes don’t fly straight – hence, the need to keep making more planes!

Part V: Launching the Planes with Measurement

1. Student teams will line up at the Launching Line. Each student will take his/her turn at throwing a plane toward the target.
2. Teacher will measure the distance from the center dot on the target to the SPOT THE PLANE FIRST LANDS. (Parent “spotters” would be good for this!) Use the large metric tape measure to get an exact measurement. Record this number on the Master Data Sheet.
3. Teacher will record this measurement for each of the two students on the team. As the event states, the “score” will consist of the two team members’ distances added together. The team with the lowest score will be the winner during the actual competition.

Part VI. Closure/Wrap-Up

1. As time permits, students should be given more opportunities to practice throwing, adjusting, and measuring their distances. Try to stop work a little before the end to have students clean up.
2. In closing, encourage the students to practice what they learned at home. Remind them that the Internet and the Public Library both contain great sources for new plane designs.