

# PAPER AIRFOILS



*A physicist is a scientist that explores and identifies the basic principles that govern the structure and behavior of matter, the interactions between energy and matter, and the generation and transfer of energy.*

*Physicists at Idaho National Laboratory work with nuclear reactors. The work they do involves working with particles so small that they cannot be seen without the use of scientific equipment. The work done at INL cannot be conducted without special equipment, but the principles of physics can be seen all around us. One example of physics is seen when dropping objects from the same height. In this experiment you will change the shape of a piece of paper to observe the different effects that surface area has on free fall.*

## GRADE LEVELS: K-5

### VOCABULARY:

**Air Foil:** *An airfoil is like a slice of a wing. Because of its shape, it produces lift. Wings are shaped like teardrops. A wing's top is curved, and its bottom is flat. Since the top is curved, the air on top of a wing moves faster than the air on the bottom.*

**Air Resistance:** *forces that are in opposition to the relative motion of an object as it passes through the air.*

**Control:** *the sample that remains the same throughout the experiment. The control must always remain the same or equal in order to receive accurate results.*

**Experiment:** *a scientific procedure undertaken to make a discovery, test a hypothesis, or demonstrate a known fact.*

**Physics:** *branch of science that deals with the structure of matter and how the fundamental constituents of the universe interact*

**Surface Area:** *a measure of the total area that the surface of the object occupies.*

## MATERIALS

- 4 sheets of plain, white copy paper
- Open space

# PROCEDURE

1. Grab a piece of white copy paper (8 X 11 ½). Holding the paper by the short edge, release it at two different heights, above your head and at arm's length.

**Does the paper perform the same way each time it is released at the same height?**

2. Step 1 is the control. All future steps will be compared to the control as we test the hypothesis. Hypothesis: If the shape of the paper changes, then the paper will fall differently, because there is different air resistance.
3. Put the control piece of paper off to the side. The remaining sheets of paper will be used to test the hypothesis.
4. With the second sheet of paper, using the short side of a paper, make a fold about 1-inch wide. Keep folding the paper in on itself until you are about ¼ the way up the paper. Leave the paper folded and grab your control paper. Drop both papers.

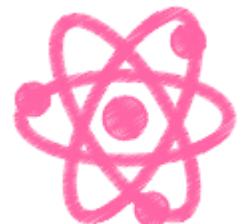
\*\*\*Each time a paper is dropped, grab the paper by the short, unfolded edge and drop both sheets of paper at the same time.

5. Put the original and ¼ folded paper to the side. Grab a new sheet of paper and make 1-inch folds until about ½ way up the paper. When making the folds, do not flip back and forth like folding a fan. Fold the paper over itself until the ½ point. Grab the ¼ folded paper. Now drop the ¼ and ½ folded papers at the same time, over your head and at arm's length.

**How does adding more folds make a difference?**

6. Put both of those papers aside. Grab a new sheet of paper, start folding until you are ¾ the way up the paper. Grab the ½ sheet of paper in one hand and the ¾ paper in the other hand. Drop both at the same time from over your head and at arm's length. Once again, how does adding more folds make a difference?
7. Put the ½ paper to the side. Now, turn the ¾ paper sideways. On the unfolded sides of the paper, fold each edge in about 1 inch. You have completed your airfoil.
8. Now grab your control piece of paper, at the same time drop your control piece of paper and the airfoil from arm's length and over your head.

**Which paper is the first to reach the ground?**



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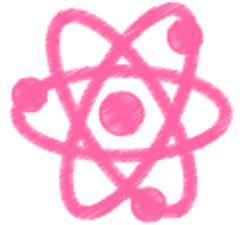
# THE SCIENCE BEHIND IT

*Small particles and gasses make up air. An object with a greater surface area will fall more slowly through the air, as it must deal with the resistance or friction of the air. Increase the surface area and the object will fall more slowly. Decrease the surface area and it will fall faster.*

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## EXTENSIONS

- *Get a new piece of paper, try making a smaller airfoil by folding the paper even more! Try another test between the two folded airfoils and the unfolded paper.*
- *Try using a heavy piece of paper for your control, then use one of the airfoils.*
- *Throw the paper (instead of dropping it), increasing the speed. Is there a difference in how fast the paper falls?*
- *Does it make a difference if you are outside or inside?*
- *Try using a different thickness of paper and compare their speed to a regular piece of paper.*



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## RESOURCES

- <https://public.inl.gov/STEMHelpWanted/Brochure/index.aspx?page=16>
- <https://www.physicsclassroom.com/class/newtlaws/Lesson-3/Free-Fall-and-Air-Resistance>

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