NATIONAL MUSEUM OF THE UNITED STATES AIR FORCE™

Scale and Ratio with Paper Airplanes

Students will learn about the forces of flight and practice the mathematical principles of scale and ratio by constructing different sizes of paper airplanes and recording/comparing their flying distance.

Learning Objectives:

The students will:

- Build a paper airplane following written and verbal instructions.
- Build a similar airplane, half-scale and double in size.
- Develop line graphs that show the different tests
- Reach a conclusion about how size affects the distance flown.

Purpose:

Students will construct a paper airplane and a similar one half scale in size. The distance each airplane will fly will be compared. Students will learn about the forces that effect flight and how different sizes can change the movement of an object. Students will conduct multiple tests and construct a line graph to draw inferences on why one design might fly better than the other.

Background:

Airframes all abide by scientific theories that are still difficult to comprehend but scientists speculate that there are certain reasons as to why this occurs. They speculate that laws, effects, and principles of nature all make up this scientific theory of flight. First we want to discuss the four forces that effect flight. These are thrust, drag, weight, and lift. Thrust is a force that moves an aircraft in the direction of the motion, drag is the force that acts opposite of motion, weight is the force caused by gravity, and lift is the force that holds the airplane in the air. All of these forces are composed of different scientific theories that play a role into the way they operate. These small tests help to understand the basic premise of the four forces of flight and how all aspects of size and weight can affect all four. For further information on the four forces of flight and other factors, look for the **Resources** section.

Grade Level: 6 – 8

Ohio Learning Standards/Science (2018)
Expectation of Learning
Nature of Science

Physical Science
6.PS.3: Energy: kinetic & potential
6.PS.4: Motion: speed & direction
7.PS.3: Energy can be transformed
8.PS.2: Force can act to change motion

Ohio Learning Standards/Mathematics (2017)
Number System
6.NS.1: Interpret & compute quotients of fractions
6.NS.3: Fluently add, subtract, multiple & divide

Ratios and Proportional Relationships
6.RP.1: Understand the concept of ratio
7.RP.2: Recognize and represent proportional relationships

Expressions & Equations
8.EE.5: graph proportional relationships

Materials Required:

- Paper airplane patterns
- Construction Paper (18” x 24”)
- Paper (8 ½” x 11”)
- Scissors
- Measuring tape
- Cellophane tape
- Colored pencils
- Pencils

Procedure:

A. Warm-up

1. Discuss symmetry. Explain that is important to keep the wings symmetrical.

2. Discuss similarity. Explain that it is important to measure carefully.

3. Review the four forces of flight (lift, drag, thrust, weight).

B. Activity

1. Student should receive three pieces of 18"x 24" construction paper, 8 1/2" x 11" paper, and pencils to conduct these experiments.

2. With the 8 ½" x 11" paper, use the template on the last page to make the original paper airplane.

3. Take the original sized paper airplane dimensions and determine how to make it ½ scale.

4. Cut out the half sized paper airplane using another sheet of construction paper.

5. Take the original sized paper airplane and determine how to double its size.

6. Use the attached Paper Airplane Instruction sheet (see pages 4 - 5) to construct each airplane.

7. Students will fly each plane a total of five times, recording the distance each time in a log.

C. Wrap up

1. After all testing is completed, students will construct a line graph that contains the number of trials by the distance flown.

2. Mark each line with the respective paper airplane size or a designated color.

3. Underneath the line graph, students will write a paragraph as to why one airplane might fly farther than the other.

4. Students will compare their results with their classmates. Discuss the results.

Assessment/Evaluation:

Students' airplanes will be checked for accuracy in scale. Students can be evaluated by teacher observation of student's participation in the activity.

Resources:

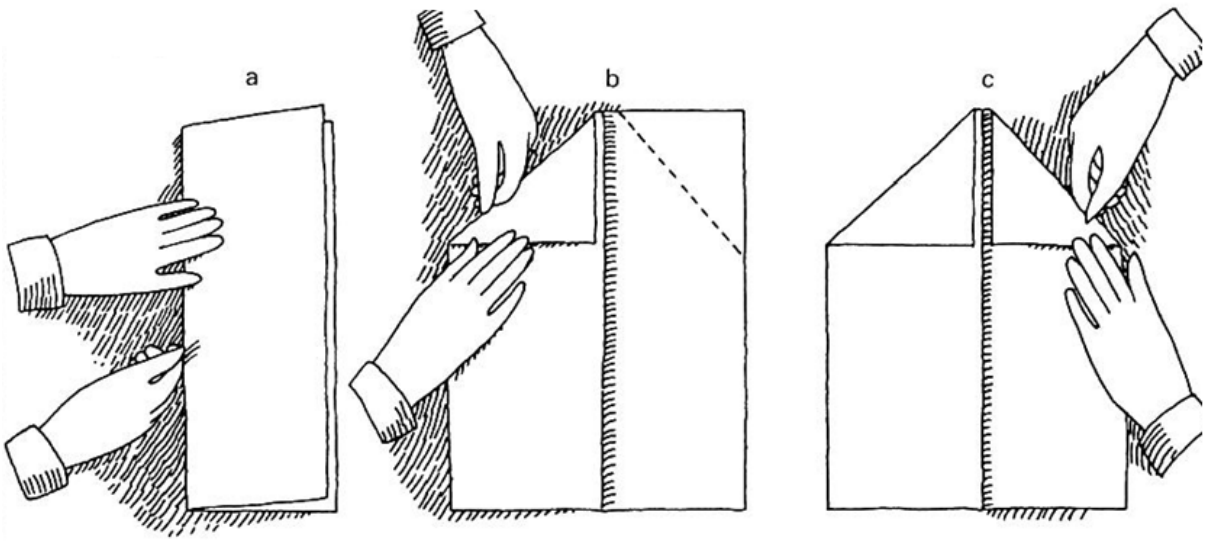
https://www.grc.nasa.gov/www/k-12/airplane/bga.html

https://www.nasa.gov/sites/default/files/atoms/files/four_forces_5_8.pdf

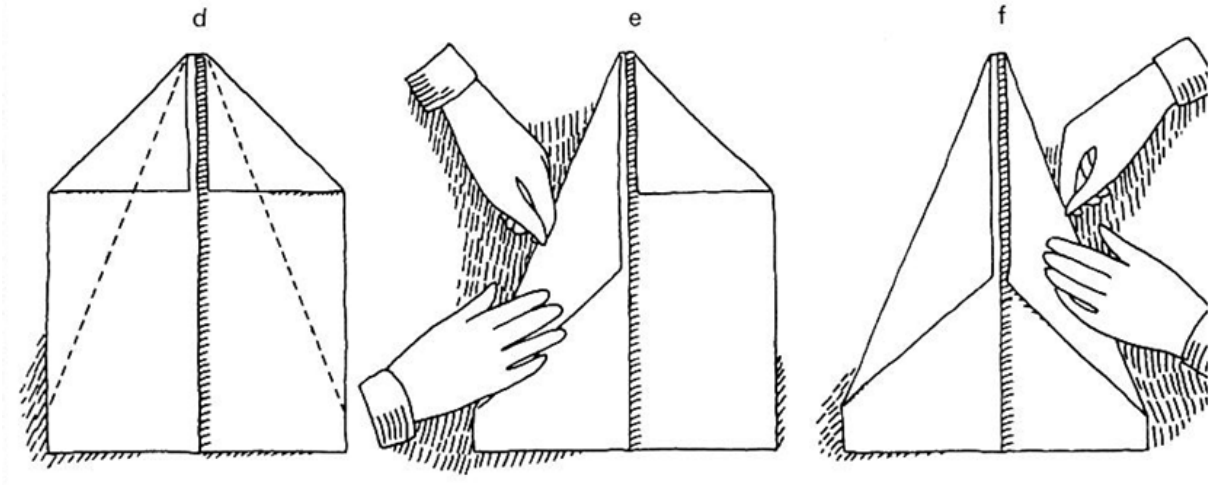
https://emptyeasel.com/2017/12/11/how-to-scale-up-a-drawing/

https://www.wikihow.com/Scale-a-Drawing

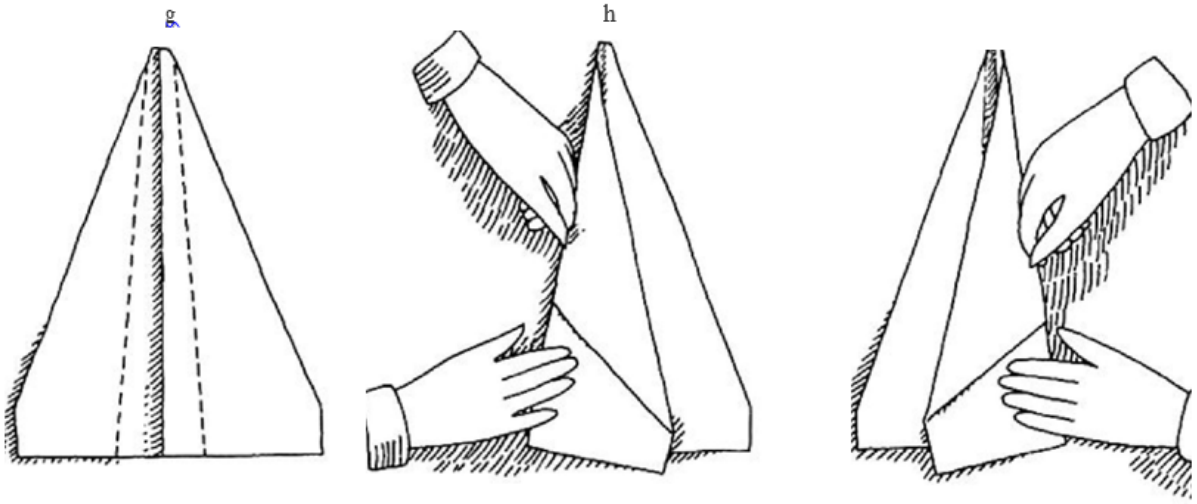
Let's make a paper airplane and see how these forces work in flight. Use a sheet of 8 ½" x 11 inch paper



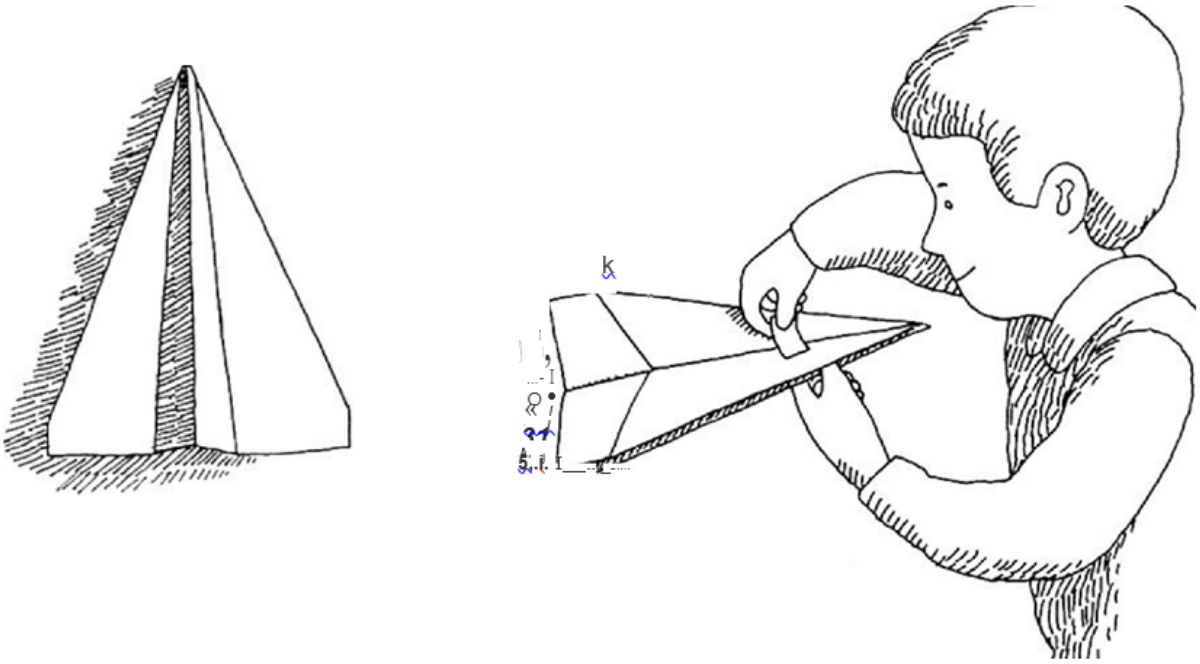
Fold the paper in half lengthwise (a). Run your thumbnail along the fold to crease it sharply. Open the paper and fold one corner down toward the center (b). Fold the other corner down in the same way (c).



Fold one side gain toward the center (e) along the dotted line shown in drawing (d). Fold the other side (f) along the other dotted line. Make sure the folds are sharply creased.



Turn the paper over. Fold one side over (h) along the left-h and dotted line shown in drawing (h). Open the paper. Fold the other side over (i) along the right-hand dotted line in drawing (g). From the bottom your plane should like the one from the drawing.



Use a piece of cellophane tap e to hold the body of the plane together and to give the wings a slight upward tilt.

Made by _____

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