

EDUCATOR'S GUIDE

Four Forces of Flight

Preparation

Overview and Objectives

This lesson is geared toward students in grades 3-8.

Participants will understand the four forces of flight and their effect on aircraft and spacecraft. Engineers must consider the four forces when they are designing flying vehicles. Participants will explore the forces and their effect on different vehicles before building their own kites.

This lesson includes a [slideshow](#) in which an instructor can lead participants through the various forces of flight and movements of an airplane.

Standards

Next Generation
Science Standards
3-PS2.A
MS-PS2.A

Instructional Modalities

This activity was designed for both synchronous or asynchronous instruction.

For **synchronous instruction**, we recommend a platform that allows both for whole class discussion and for students to interact in small groups.

For **asynchronous adaptations**, we provide suggestions for teachers to provide additional support for the activities and for students to share their work with each other.

Materials

- [Four Forces of Flight Slideshow](#)
- [Make a Kite Visual Instructions](#)
- **Four Forces of Flight: Let's Explore [Worksheet](#)**
- **Square piece of paper**
- **Tape**
- **String**
- **Popsicle stick**
- **Streamers**
- **Scissors**
- **Ruler**

Lesson

1. Introductory Activity

- Ask participants to share as many animals or vehicles that fly as possible. Record their answers.
- Discuss the responses with the group:
 - **What shapes do you see on animals that fly? What features help them to move through the air?**
 - **What shapes and features are present on vehicles that fly?**
 - **Do all flying things look the same?**
- Participants will watch three-minute video of the four forces of flight and answer these questions:
 - **What are the four forces of flight?**
 - **How do the forces of flight act on a moving object?**
- As participants respond, encourage them to answer the following:
 - **How does the design of an aircraft help it fly?**
 - **How is thrust created in aircraft and spacecraft?**
 - **Which of the forces of flight are natural? Which are artificial?**

2. Core Activity

- Participants will complete an exploration for each force of flight. They will use the [worksheet](#) to respond to prompts about each force as they follow along on the slideshow. Guiding questions below.

Gravity:

- Instruct participants to drop a pencil or other small object on the ground.
 - **Why doesn't your pencil stay in the air? What is pulling it down?**
 - **How does gravity affect air and spacecraft?**

Lift:

- Display image of family of airfoils for participants. Participants will describe the shapes they see.
 - **Are all airfoils the same?**
- Participants will identify which of the shapes on slide 14 are airfoils.

- **Where might engineers have gotten the idea for the shape of an airfoil?**
- **What other kinds of vehicles have airfoils on them?**

Drag:

- Discuss with participants how drag is created in the air. They may try rubbing their hands together to feel friction.
 - **What might engineers do to limit the drag (friction and resistance) felt by an aircraft?**
 - **Is there a situation where drag might be useful?**

Thrust:

- Participants will look at three major types of thrust on aircraft and spacecraft. They will then list the types of thrust present on each vehicle on slide 18.
 - **What creates thrust when you are driving a car or bus?**
 - **What creates thrust when you are riding a bicycle or scooter?**
 - **How are these forms of thrust different from those on aircraft and spacecraft?**

3. Wrap-up Activity

- Have participants create their own kites. Instruct students to use the [visual instructions](#) to fold the body of the kite, then attach the tether and tail.
 - **How is the kite affected by the four forces of flight?**
 - **What creates the kite's thrust and lift?**
 - **How is the kite similar to or different from the airplanes, helicopters, or spacecraft you have seen?**

Asynchronous Adaptation

Have participants go through the [slideshow](#) on their own and answer the questions on their [worksheet](#). They can share their answers and photos of their kites.

Extension Activities

To deepen student engagement with this content, you may choose to add the following activities :

Intrepid Aircraft

Have participants examine the aircraft in the Intrepid's collection and discuss the impact of the four forces of flight on each one.

Additional Resources/ References

Background Information on

The History of Flight:

<https://www.grc.nasa.gov/www/k-12/UEET/StudentSite/historyofflight.html>

Four Forces: <https://www.nasa.gov/stem-content/four-forces-of-flight/>

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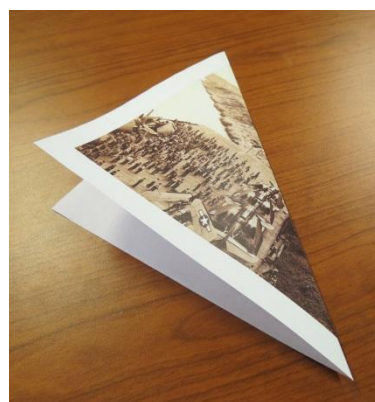
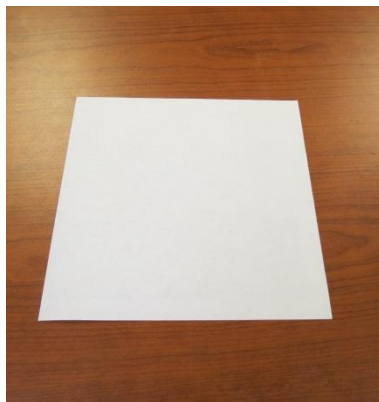


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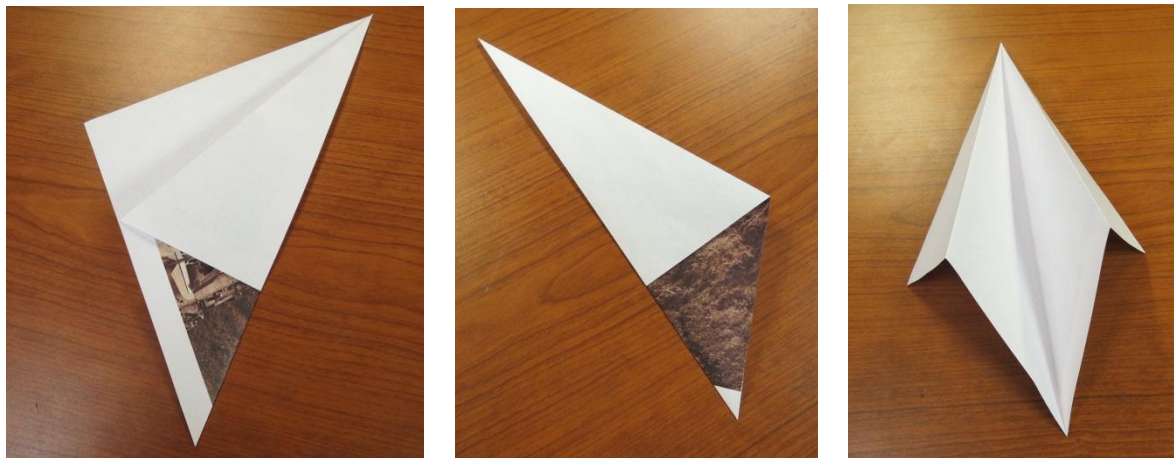
Make a Kite!



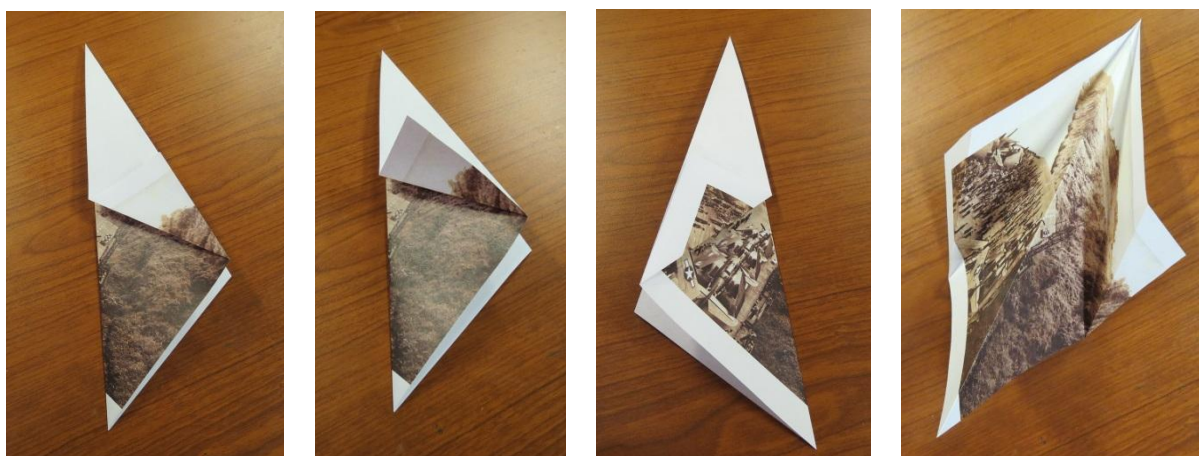
- o Cut copy paper into a square (8.5 inches by 8.5 inches). Optional – have students decorate one side of paper or use paper with images printed on one side.
- o Fold the square in half along the center diagonal line. Fold so that the blank side of the paper is inside, and the color side is visible.



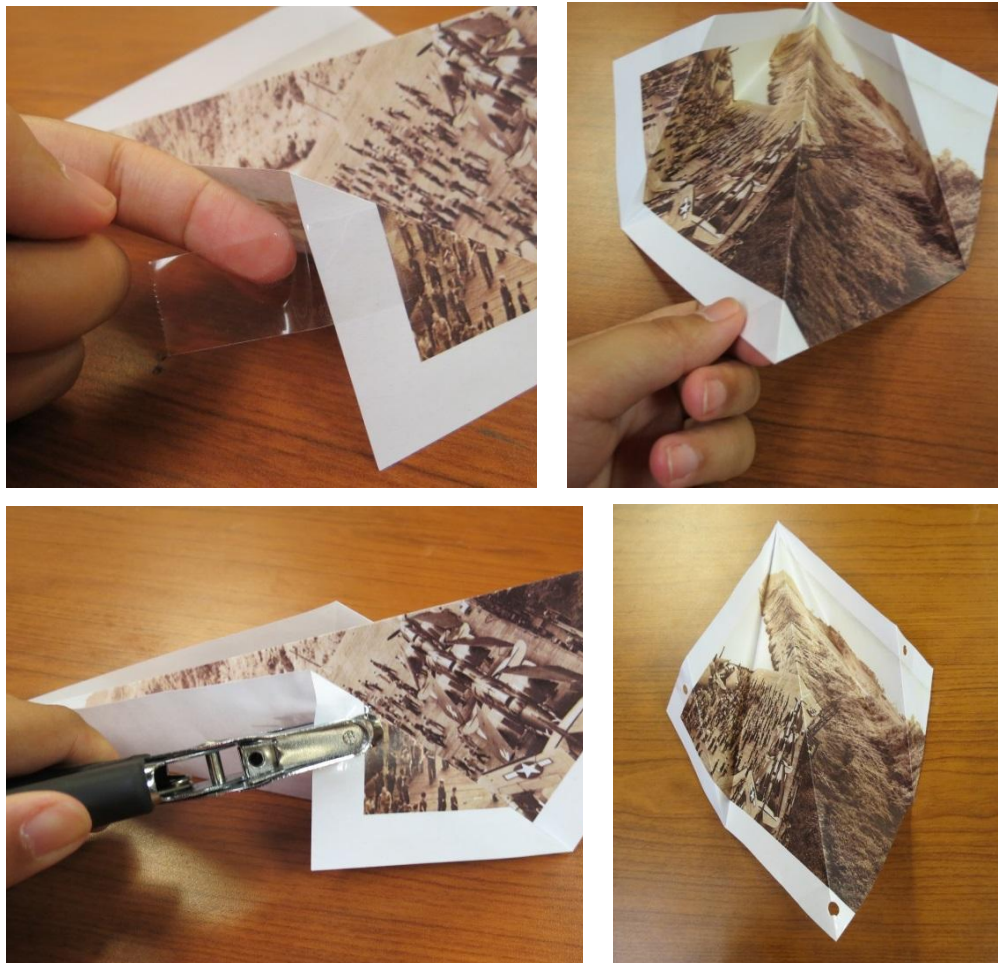
- o Now take one edge and make a fold to the centerline as shown. Turn the paper and repeat this step for the other side.



- o Fold the small corner to the center line. Repeat it for the other side as well.



- o Use some tape to strenghten the small triangle flaps and end point as seen below. After that, use a holepunch or scissors to make holes where you placed tape.



- o Cut two 9 inch strings and one 7 foot string. You'll tie the shorter strings to the two holes on the small triangle flaps. Then tie the other ends of the shorter strings together in the middle.



- o Now, let's make the tail! Cut a piece of streamer and twist one end. Attach it to the end point at the back of the kite (where you punched a hole before)



- o Make the winder by tying one end of the 7 foot string to the center of the craft stick. Tie the other end of the string to the knot joining the 9 inch strings on the kite. Wind the rest of the string around the craft stick.



- o Enjoy your kite! It doesn't take much wind to fly, but make sure you have moving air ☺

b. Circle the images below that feature examples of airfoils.



A Bird's Wing



Wing of the
TBF-1 Avenger



Helicopter Rotors

Drag

a. What might engineers do to limit the drag (friction and resistance) felt by an aircraft?

b. Is there a situation where drag might be useful?

Thrust

a. What creates thrust when you are riding a bike or scooter? A car?

b. Look at the photos below and list the form of thrust each vehicle relies on.

