

## EDUCATOR'S GUIDE

# Four Forces of Flight

## Preparation

### Overview and Objectives

This lesson is geared toward families with 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 investigate each force before creating their own miniature flying machines.

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

### Family Discussion Questions

What forces are working against an airplane trying to get off the ground?

What parts of an airplane help it stay in the air?

### 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](#)
- [Rotorcopter visual instructions](#)
- [Rotorcopter template](#)
- Paper clips

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## Lesson

### 1. Introductory Activity

- 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?**
- 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?**
- 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.

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?**
- **How do engineers make sure their flying vehicles can resist gravity?**
- Ask participants to state which force helps airplanes get off the ground and resist gravity.

Lift:

- Discuss Bernoulli's Principle with participants..
  - **Where might engineers have gotten the idea for the shape of an airfoil?**

- Ask participants to list vehicles that have airfoils on them.

Drag:

- Discuss with participants the two major types of drag.
  - **Is there ever a time that drag could be useful?**
  - **When could drag be used to engineers' advantage?**

Thrust:

- Participants will discuss Newton's Third Law of Motion.
  - **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

- Participants will use the [visual instructions](#) to cut and fold their rotocopter templates. Tossing the rotocopter in the air showcases the four forces of flight on a small scale. Ask participants where they see each force of flight.

## Asynchronous Adaptation

Participants will self-guide through the [slideshow](#) and answer questions on slides 12, 15, 17 and 19. They can then create their own [rotocopter](#) using the [visual instructions](#).

## Extension Activities

To deepen participant 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#:~:text=Th>

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[e%20first%20manned%20flight%20was.de%20Rozier%20and%20Francois%20Laurent.&text=George%20Cayley%20worked%20to%20discover.of%20the%20body%20to%20control.](#)

Four Forces:

[https://www.nasa.gov/audience/foreducators/k-4/features/F\\_Four\\_Forces\\_of\\_Flight.html#:~:text=These%20same%20four%20forces%20help.thrust%2C%20drag%2C%20and%20weight.](https://www.nasa.gov/audience/foreducators/k-4/features/F_Four_Forces_of_Flight.html#:~:text=These%20same%20four%20forces%20help.thrust%2C%20drag%2C%20and%20weight.)

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