

FUTURE U.

Boeing 360: Forces of Flight Experience

Objectives

Students will be able to:

- **Understand** the forces of flight and consider how they are applied to various aircraft.
- **Create** a model plane, complete with flight control surfaces, and investigate how these can be used to control a plane's movement.
- **Develop** a journal entry that details their inaugural flight and the maneuvers they used to safely take-off, fly, and land.

Grade level

6–8

Overview

During the Boeing 360 Forces of Flight Experience, students will take off as they explore the principals of flight. They will learn about the forces of lift, weight, thrust, and drag and consider their effect on a variety of aircraft—including hot air balloons, rockets, helicopters, and airplanes. They will also have the opportunity to explore how these forces of flight can be harnessed to control a plane as they operate a flight simulator. They will ultimately apply what they have learned to create their own model airplane and detail the decisions they made to safely operate their very first flight.

Materials

- Devices with Internet access, one per every two students
- Boot Up handout, one per student
- Printer paper/blank paper, one per every two students
- Experience handout, one per student
- Reorient #1 handout, one per student
- Reorient #1 activity materials, for student pairs:
 - Straw, 1
 - Scrap paper, several sheets
 - Scissors, 1
 - Tape, 1
- Reorient #2 handout, one per student

Boot Up

Tell students that they are about to participate in a simulation in which they learn about the forces of flight, as well as why and how things fly. Before they do, they'll experiment with flight on their own to see what they already know.

Distribute a Boot Up handout and a blank piece of paper to pairs of students, and review the handout's directions together. Show students where they can test their paper airplanes once they are created.

When students are finished, lead them in a discussion around the forces that they believe must have been acting on their plane in order to make it fly through the air and then descend to the ground. Once several students have shared, tell them they will learn more when they participate in the 360 Forces of Flight Experience.

Experience

Distribute an Experience handout to every student and review the instructions. Explain that each student will be responsible for taking notes on this sheet as they move through the 360 Forces of Flight Experience.

Reorient

Two activity options are available for students to summarize, apply, and synthesize their learning:

Reorient #1

In the 360 Experience, students were introduced to the forces of flight and some of the control surfaces that pilots can use to manipulate these forces to fly an aircraft. Students will now create a second airplane model that includes some of these control surfaces and they will decide how these control surfaces should be used to maneuver their plane in various ways.

Reorient #2

Students will explore some of the different Boeing commercial airplanes that pilots can fly. They will then select one plane, and they will imagine that they just flew this aircraft for the very first time. They will apply what they learned throughout the 360 Experience as they write a journal entry that replays this flight and includes details such as take-off and landing maneuvers, a challenge they encountered, and their personal reflections.

National Standards

Next Generation Science Standards

- MS-PS2-2: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- Disciplinary Core Idea: PS2.A: Forces and Motion
The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)

Standards for Technological Literacy

- 18.G. Transportation vehicles are made up of subsystems, such as structural propulsion, suspension, guidance, control, and support, that must function together for a system to work effectively.

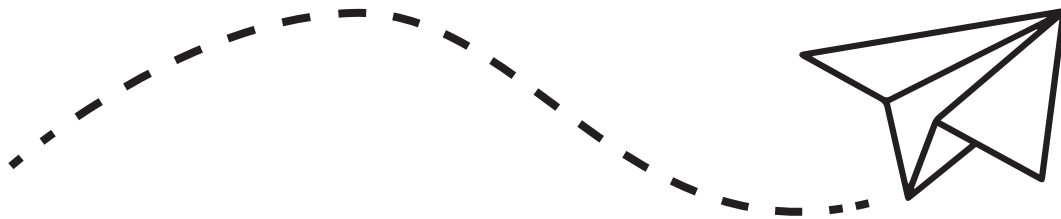
Common Core English Language Arts Standards

- CCSS.ELA-LITERACY.CCRA.W.3 Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details and well-structured event sequences.

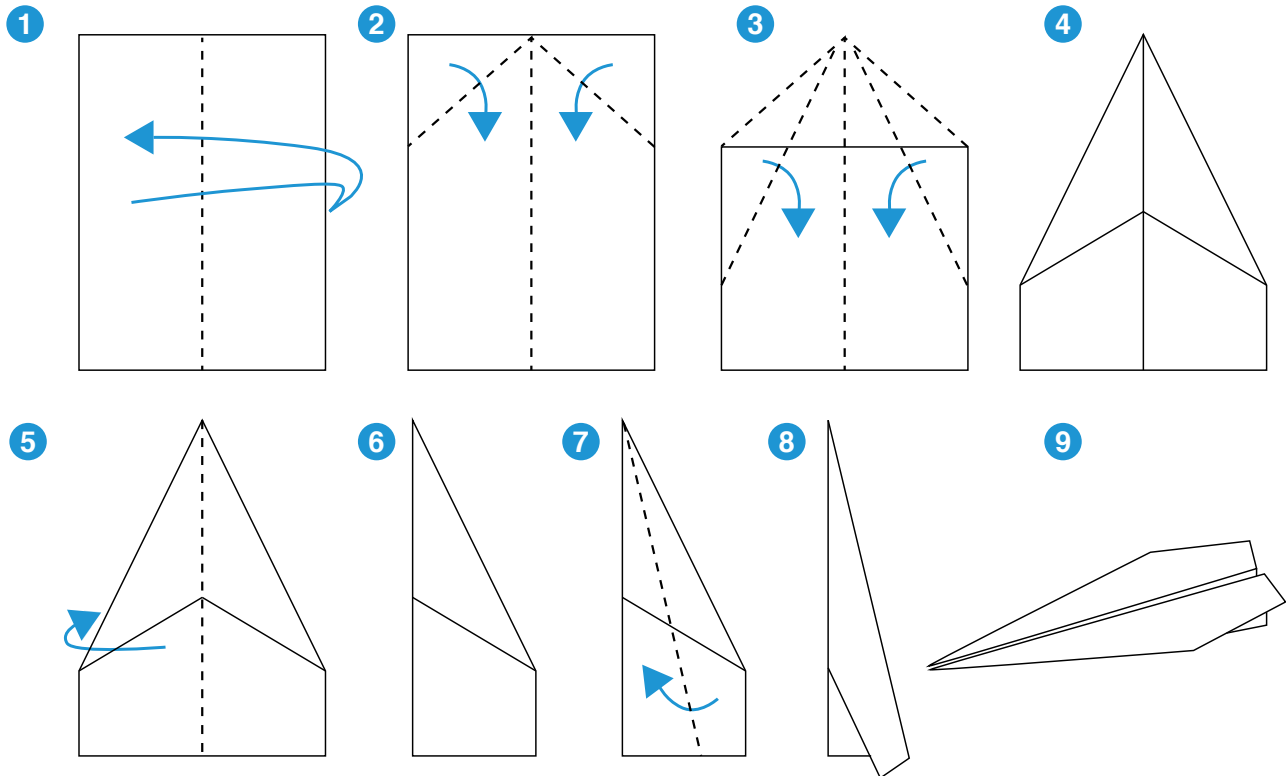
Directions:

1. Use a separate piece of paper to create a paper airplane. You may follow the directions below *or* you may use another design that you already know how to create.
2. Throw your airplane several times and observe it as it flies. What *forces** do you think may be acting on this plane as it glides through the air? Think especially about why the airplane eventually falls to the ground. Explain your thinking by labeling the diagram below.

Remember: A force is any push or pull on an object. Forces may cause an object to slow down, accelerate, or stop moving.



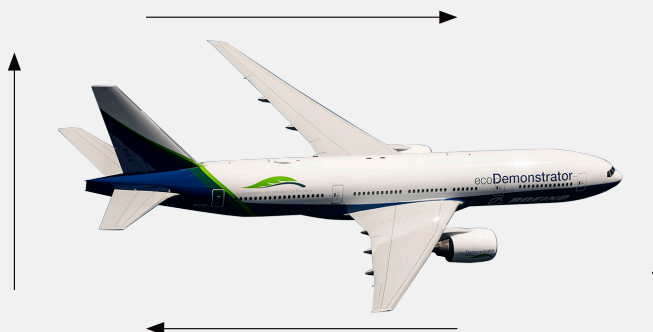
Create a Paper Airplane Instructions:



Flight Training Notes:

Directions: During the 360 Experience, you will learn all about the forces of flight and how airplanes can fly. Read through the three parts below and then jot notes in each section as you make your way through the Experience.

Part 1: There are four main forces that affect things that fly. Label each of the arrows surrounding the plane.

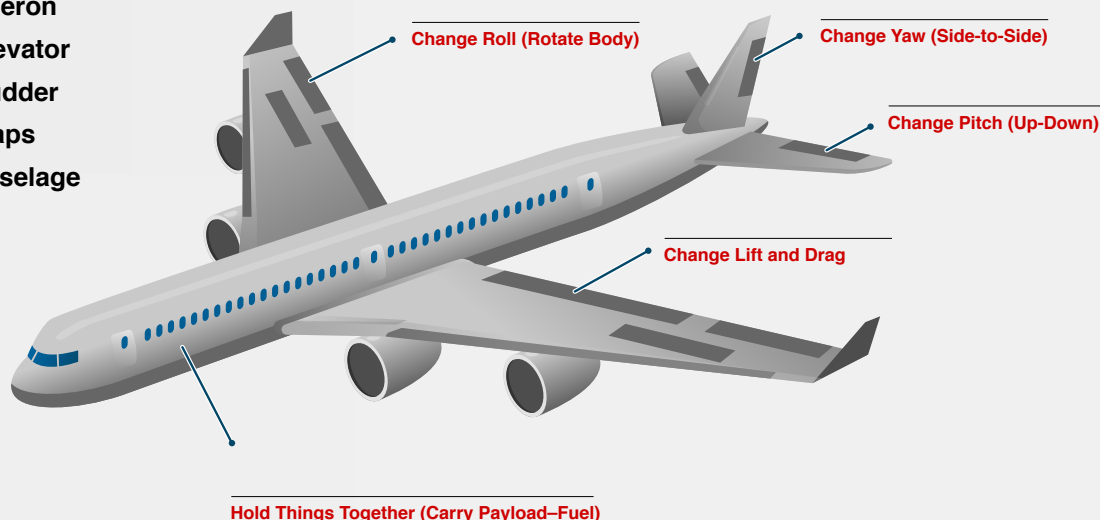


Part 2: Lift and thrust are forces that enable vehicles to fly, and these forces can be generated (or created) in different ways. As you learn about hot air balloons, airplanes, helicopters, and rockets, jot notes about how they generate lift and force:

How can vehicles generate LIFT ?	How can vehicles generate THRUST ?

Part 3: Planes are designed with control surfaces, which enable a pilot to harness the forces of flight and control the plane. As you learn more about these different parts, use the word bank to label the plane below!

Aileron
Elevator
Rudder
Flaps
Fuselage



Directions: Follow the directions below to create a plane with flight control surfaces.

Part 1: Construct

1. Work with a partner to use your straw, paper, tape, and scissors to create a new paper airplane with flight control surfaces. In addition to wings and a fuselage, your plane must include:

Ailerons (2)

Elevators (2)

Rudder (1)

Flaps (2)

Tips:

- Use your labeled plane on your Experience handout notes to help you.
- Consider using your materials in the following ways:
 - Fuselage: Straw
 - Wings: Several layers of paper
 - Ailerons, elevators, rudder, and flaps: Make slits (or small cuts) in the paper so you can fold these parts up or down or right or left.

2. Once your plane is constructed, give it a few test flights. Observe how it flies and modify its design, if needed, so it flies as smoothly as possible.

Part 2: Flight

Now consider what you know about a plane's flight control surfaces. For each scenario listed below, think about what the pilot should do with each part of the plane. Then, use your model plane to test your ideas for each scenario, and circle the actions you recommend. If you do *not* circle a command, the pilot will assume that the control surface does not move.

Flight Scenario 1: Decrease drag for take-off

Right Aileron	Left Aileron	Right Elevator	Left Elevator	Rudder	Right Flap	Right Flap
Up	Up	Up	Up	Up	Up	Up
Down	Down	Down	Down	Down	Down	Down

Flight Scenario 2: Tilt the nose up

Right Aileron	Left Aileron	Right Elevator	Left Elevator	Rudder	Right Flap	Right Flap
Up	Up	Up	Up	Up	Up	Up
Down	Down	Down	Down	Down	Down	Down

Flight Scenario 3: Roll the plane to the left

Right Aileron	Left Aileron	Right Elevator	Left Elevator	Rudder	Right Flap	Right Flap
Up	Up	Up	Up	Up	Up	Up
Down	Down	Down	Down	Down	Down	Down

Flight Scenario #4: Roll the plane to the right

Right Aileron	Left Aileron	Right Elevator	Left Elevator	Rudder	Right Flap	Right Flap
Up	Up	Up	Up	Up	Up	Up
Down	Down	Down	Down	Down	Down	Down

Flight Scenario #5: Tilt the nose down

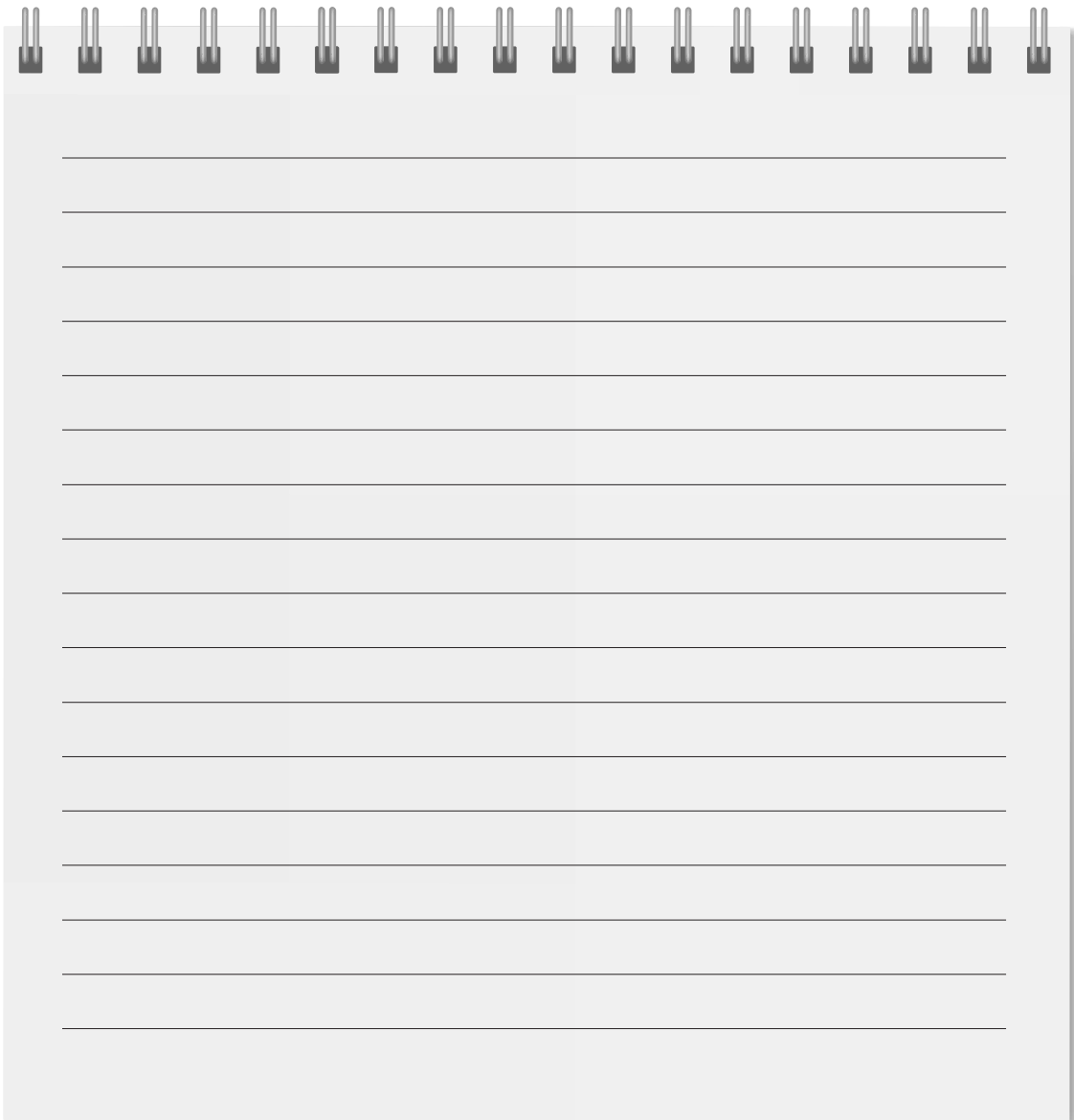
Right Aileron	Left Aileron	Right Elevator	Left Elevator	Rudder	Right Flap	Right Flap
Up	Up	Up	Up	Up	Up	Up
Down	Down	Down	Down	Down	Down	Down

Flight Scenario #6: Increase drag for landing

Right Aileron	Left Aileron	Right Elevator	Left Elevator	Rudder	Right Flap	Right Flap
Up	Up	Up	Up	Up	Up	Up
Down	Down	Down	Down	Down	Down	Down

Directions: Now that you understand the forces acting upon a plane *and* many of the plane features that exist to make flight possible, it's time to pick a plane to fly!

1. Browse the planes highlighted at boeing.com/commercial and choose one that catches your eye.
2. Then imagine that you have just flown this plane for the very first time. Below, write a journal entry describing your flight experience while all of the details are still fresh in your mind. Be creative and include:
 - Your departure and destination cities
 - The plane you flew and a description of it
 - How you maneuvered the plane to take off safely
 - A description of the flight, including at least one challenge you encountered and how you handled it
 - How you maneuvered the plane to land safely
 - Your thoughts and feelings as you flew this plane for the first time



A spiral-bound notebook with a grey cover and white pages. The notebook is open to a blank page with horizontal lines for writing. The spiral binding is visible on the left side.