Impossible Stunt Planes

How do planes do tricks when flying?

For students in grades K through 6th

‘Impossible Science’ lessons aim to be 75-90 minutes long for grades 3 through 6, and 60-75 minutes long for grades K through 2. The final 15 minutes for K-2 will be filled with a ‘wind down’ drawing activity (see “Evaluate” section for details).

Objectives

By the end of this lesson, students will:

- **know** the specific functions of ailerons, elevators, and rudders in controlling the movement of airplanes.
- **understand** how control surfaces on airplanes manipulate airflow to control roll, pitch, and yaw, allowing airplanes to climb, descend, and turn.
- **be able to** apply their understanding of flight dynamics and airplane design to create paper airplanes capable of performing specific maneuvers and tricks.

Big Ideas:

- When flying, airplanes need to be able to climb, descend, and turn. To accomplish this, airplanes have several segments that allow them to rotate around their access, go up and down, or turn left and right.
    - **Ailerons** are attached to the wings of the airplane. They are able to extend from the plane and rotate up or down to allow the plane to turn.
    - **Elevators** are attached to the small wings mounted on the tail of the airplane. As the name implies, these help the plane climb up or descend downward.
    - The **rudder** is attached to the vertical part of the plane’s tail. It allows the pilot to change which way the nose of the plane is pointed - left or right.
- Different **wing designs**, when combined with these segments, allow for airplanes to complete different tasks. For example, fighter planes have short, swept-back wings that

allow them to travel very fast, while commercial planes have long, wide wings to capture as much air as possible to lift their heavy payloads as safely as possible.

- **Weight,** or how heavy an aircraft is, and **weight distribution,** or how the weight of the aircraft is spread out, also heavily impact how a plane flies.

Essential Questions:

- How do airplanes turn?
- How do ailerons, elevators, and rudders work to control an airplane's movement?
- Why is it important for airplanes to have different wing designs, and how do these designs impact their performance?
- How does the distribution of weight affect an airplane's ability to perform maneuvers such as climbs, descents, and turns?
- What scientific principles allow an airplane to execute complex maneuvers like loops and rolls?

Engage:

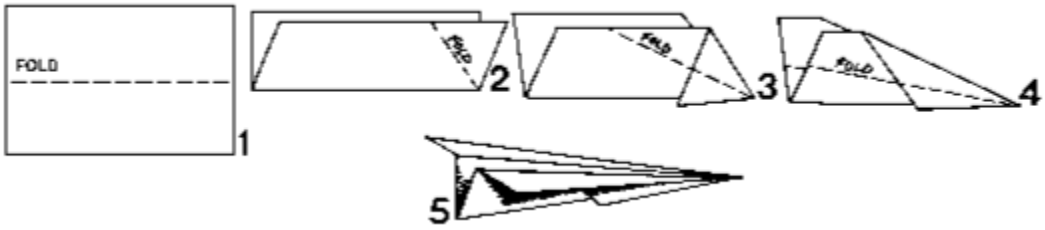
Warm Up Activity

Ask students to share the things that flying objects and animals have in common. Write those attributes on the board or on chart paper.

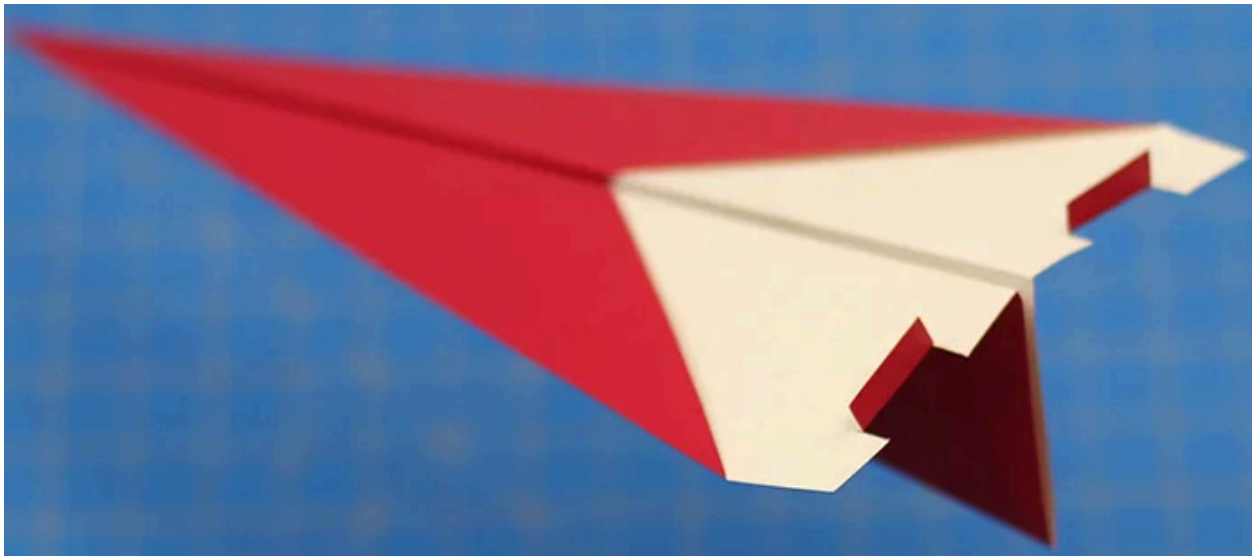
Impossible Science Demo - Loop-de-Loop Airplane

Includes "Teach Like A Magician" progression of steps with recommended script.

- Prior to the demo, fold two paper airplanes according to the following instructions.



- On one of the paper airplanes, cut two elevator flaps into the wings, and bend them upwards. Hide this plane from the students' view.



- Invite students to try and throw the unaltered paper airplane in a loop de loop pattern.
- After a number of failed attempts, use sleight of hand to swap the planes out. Then, throw the altered airplane in the loop-de-loop pattern.

Think | Pair | Share

- *Think [1-2 min]:* Ask students to, individually, consider how they think this illusion works. Then, under Prompt #1 in their workbooks, have them model their answer.
- *Pair [1-2 min]:* Students pair up and take turns sharing their thoughts. They ask each other questions after sharing and formulate their combined responses to the question prompts.
- *Share [2-3 min]:* The larger group comes together and the pairs take turns summarizing their combined responses. On the board or chart paper, write down a couple of statements that summarize the group's various hypotheses.

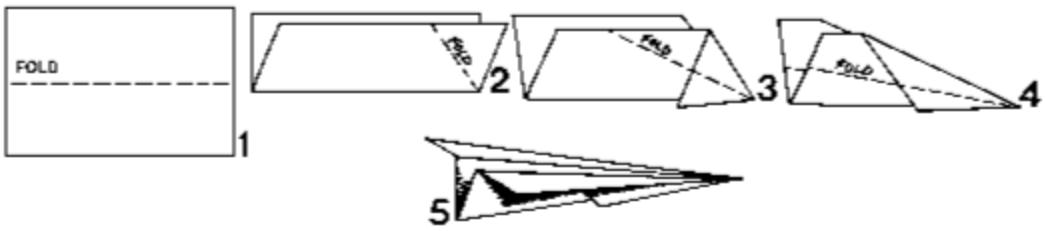
Explore:

Activity 1 - Airplane Controls [20 minutes]

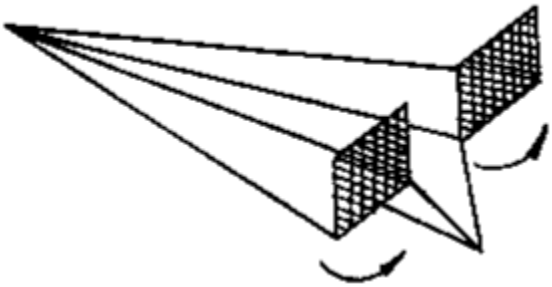
Students will work individually on this activity. Distribute the materials listed under "Activity 1" on the Materials page.

Students will explore how airplanes use flaps, ailerons, and rudders to change their direction in air.

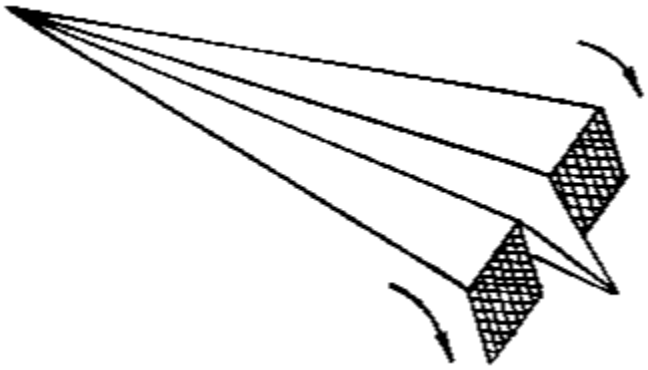
- Project the directions for assembling the simple paper airplane and guide learners through the process.



- Ask students to predict how this paper airplane will fly. Then, invite them to test-fly their paper airplanes.
    - *This design is meant to travel quickly through the air in a straight line. If their plane does not do this, they may need to retry folding the plane, working to make sure there is symmetry between the same folds on each side.*
- Instruct students to fold the back edges of the paper airplane upwards. Then, ask them to predict how the airplane will fly.

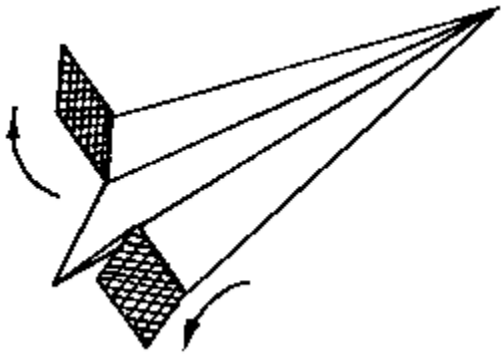


- Have students test-fly their airplanes with the back edges folded up.
    - *Their airplanes will fly upwards. Some might even complete a full loop.*
- Instruct students to fold the back edges of the paper airplane downwards. Then, ask them to predict how the airplane will fly.



- Have students test-fly their airplanes with the back edges folded down.
    - *Their airplanes will fly downwards. Some might even complete a full loop.*

- Instruct students to fold the back edges of the paper airplane so that one edge is pointed upwards and the other is pointed downwards. Then, ask them to predict how the airplane will fly.

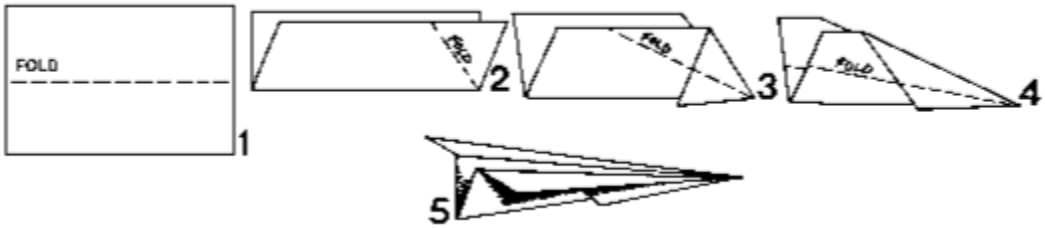


- Have students test-fly their airplanes with the back edges folded in opposite directions.
    - *Their airplanes will spiral, or tumble, either clockwise (left flap upwards) or counterclockwise (right flap upwards)*

Activity 2 - Airplane Controls, Part 2 [20 minutes]
Students will work individually on this activity. Distribute the materials listed under "Activity 2" on the Materials page.

Students will experiment with changing the size of the flaps on the plane to see how that changes the performance of the plane. They will then experiment with the angle of the flaps.

- Project the directions for assembling the simple paper airplane and guide learners through the process.



- Instruct students to make new flaps for this plane that are **bigger <u>or</u> less than** the ones they made for Activity 1.
- Students will then repeat the steps of Activity 1, comparing how the changed flap size affects the overall performance of their planes.
    - *Larger flaps should cause the plane to experience more drag, thus making the twists and turns more sharply than smaller flaps permit.*
- Invite students to experiment with changing the angles of the flaps and seeing how doing so affects the performance of their paper airplanes.

- *The less bent the flaps are, the weaker their influence is on the turning/twisting of the airplanes when compared to more bent flaps.*

At this point, have students return to their workbooks and, under Prompt #2, attempt to explain with a model and words how this activity might help explain how to make a paper airplane turn, spiral, or flip.

Activity 3 - Launch! [20 minutes]
Students will work in pairs on this activity. Distribute the materials listed under "Activity 3" on the Materials page.

Students will build three different paper airplanes meant to do a trick (barrel roll, flip, boomerang, etc.) and test how they fly using a simple airplane launcher.

- Students will, as a pair, design and make three different paper airplanes based on their observations from Activities 1 and 2
- Once the planes are finished, students will insert one paperclip into each plane at the nose of the plane such that the long, straight part of the paperclip either sticks out through the body of the plane or wraps around the nose of the plane.


- Secure the paperclip in place with a stapler,making sure that one side of the staple wraps around the paperclip in the process.
    - *Note: Those students who have pushed the paperclip through the bottom of their planes may need to further secure the paperclip with tape around the hold to prevent tearing.*
    - *If staplers are not available, use tape.*
- Loop one of the rubber bands through the other so that they form a chain.


- Loop one end of the rubber band chain around the paperclip on the paper airplane. Holding the other end of the rubber band chain, pull back on the paper airplane and let go to launch the plane.
    - *Some learners may struggle to do this safely. Consider looping the other end of the rubber band chain around a pencil or pen to provide spacing between the student's hands and the rubber bands.*


- Test fly all three paper airplane designs to see if they achieve the desired trick when using the launcher. If not, try throwing them with your hands instead.
    - *If planes still do not achieve desired effect, speak to students about the alignment of their flaps and how they might fly the planes differently. Sometimes, a soft and gentle launch in a specific direction is needed.*

Explain:

Watch and Discuss [10 minutes]

Link: ***3 ways an airplane can turn | Discovery Space***

Define and clarify the following terms while watching the above video. Pause video and elaborate on definitions as deemed necessary based on student engagement, using the "Big Ideas" and "Essential Questions" as a guide:

- Ailerons
- Rolling
- Pitching
- Elevators
- Yaw

- Rudder

At this time, have students return to their journals and, under Prompt #3, explain with models and words how the Activity experiments demonstrate how the three different types of airplane extensions - rudders, ailerons, and elevators - help an airplane turn and do tricks like the loop-de-loop in the Impossible Science Demo.

Elaborate:

Experiment - Paper Airplane Stunt Show [20 minutes]:
Students will work in groups of 4 for this activity. Distribute the materials listed under "Experiment" on the Materials page.

Working in groups of 4, students will design and put together a paper airplane stunt show!

Each student in the group will design and make a paper airplane capable of doing **at least two tricks.** They will then work with their group mates to choreograph an air show where each student will get to show their airplanes doing both students.

Encourage students as they work on their stunt shows with the following guiding questions:

- What type of trick are you attempting to do?
- What's the best kind of wing and flap design to achieve your trick?
- For this trick, would a slow, hand-guided throw be best, or should you use the airplane launcher?
- How might your trick look cool with another person's trick in your group? For example, what if you both did backflips at the same time!

Share Out:
Invite groups to take turns sharing their paper airplane stunt shows with the rest of the group!

Modify / Extend:

Modified Activity 1:

Extension Activity - Flapless Boomerang Plane [15 minutes]:
Students will work individually on this activity. Distribute the materials listed under "Extension 1" on the Materials page.

Students will make a paper airplane that uses launch angle, wing curvature, and weight distribution (instead of flaps) to fly like a boomerang.

- Project the step-by-step instructions for how to fold the super boomerang paper airplane. Guide students through the steps.
    - *Students may struggle to understand specifically how to bend their paper into an arc/semicircle.*
- Test fly the boomerang plane!
    - *This plane is a bit tricky to throw. Students will want to hold the plane just behind the thickest portion at the front and throw the plane across their bodies while tilted at an angle.*

Evaluate:

Under Prompt #4 in their workbooks, challenge students to explain how their paper airplane stunt tricks work using models and words. Challenge older students to provide written descriptions using the vocabulary from the day's lesson.

Materials

Impossible Science Demo (per class)

- Paper (2 sheets)
- Scissors

Activity 1 (per student)

- Paper
- Scissors
- Tape

Activity 2 (per student)

- Paper
- Scissors
- Tape

Activity 3 (per student pair)

- Paper (~3 sheets)
- Scissors
- Tape
- Paperclip
- Rubber bands (x2)
- Pen or Pencil

Experiment (per group of 4)

- Paper (~8 sheets)
- Scissors
- Tape
- Paperclips
- Rubber bands (x2) - can be reused from Activity 3

Modify 1

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Extension 1

- Paper
- Super Boomerang Airplane instructions