National Aeronautics and Space Administration

3…2…1…Takeoff! (Simple)

Exploring the forces of flight on a straw paper airplane | Suggested Grades: K-5

Activity Overview

In this activity, students will construct small paper x-planes and fly them by producing their own thrust, by blowing air through a drinking straw. Students will then examine how the four forces of flight and Newton's Third Law of Motion affected the plane.

Steps

1. Optional: watch instructional video prior to starting activity with students. https://youtu.be/Sk9qmGLr9DQ
2. Review with students Newton's Third Law of Motion, the forces of flight and how these principles affect aircraft. Discuss the X-59 Quiet SuperSonic Technology (QueSST) aircraft and how NASA designs aircraft.
3. Direct the students to the construction technique for making the paper x-plane.
4. Simple X-Plane Instructions:
   a) Give students the *X-59* paper plane template to assemble. Fold the plane image in half on the solid line and tape entire length closed ensuring a **solid seal** (Fig. 1, page 2).
   b) Next, fold the upper end of the paper plane four times and tape tightly together (Fig. 1, page 2).
5. Place straw into the body of the plane and blow into the straw to fly your plane! Have students fly their planes three times and measure the distance the plane travels each time. Have students record the distances and observations about each flight in their data table (page 5).
6. Discuss with students how the four forces acted on their planes and what they did to get their plane to fly farther (blowing harder, changing the angle, etc.). Ask what major improvements to the design could be done to allow their plane to fly farther if given the time.

For videos relating to sound and the X-59, please visit:
https://www.youtube.com/playlist?list=PLTUZypZ67cdvZ3TbQbDiqLdOkrCswmkUZ

Connections

- How do you produce thrust in your daily life?
- Where do you see thrust demonstrated in your daily life?
- Where do you see examples of Newton's Third Law of Motion?

Time: 30 minutes

Materials:

- Paper plane cut-out
- Clear tape
- Scissors
- Meter stick or tape measure
- Drinking straws

NEXT GENERATION SCIENCE STANDARDS

- K-PS2-1
- K-PS2-2
- 3-PS2-2
- 5-PS2-1

For more information and further activities:

- www.nasa.gov/X59
- www.nasa.gov/stem/nextgenstem/aeronaut-x/
- www.nasa.gov/aeroresearch

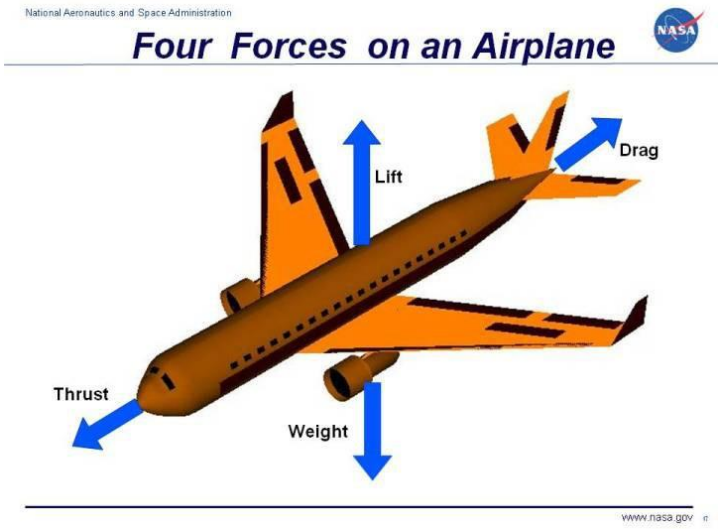
Suggested Lithograph:

Newton's Third Law of Motion

Every action has an equal and opposite reaction. Unlike traditional planes, paper planes do not carry their own fuel. Instead, a sharp puff through the straw momentarily fills the plane tube with "high pressure" air. The tube directs the air back through the opening, producing an action force. The straw planes take-off because of the equal and opposite reaction force (Newton's third law). These two forces are referred to as a force pair. A force pair identifies two interacting objects and describes the direction of the force acting on each object. It is important to note that both forces in the force pair are the same type (e.g. gravitational), are equal in magnitude, and are opposite in direction.

Four Forces on an Airplane

A plane flies because of four forces: lift, thrust, drag and weight. As the plane flies through the air, lift holds it up. Thrust from the engine sends it forward. Drag from the air slows it down. Its weight brings the plane back to Earth again. Each force has an opposite force that works against it. Lift works opposite of weight. Thrust works opposite of drag. When the forces are balanced, a plane flies in a level direction.



Manufacturing of NASA's X-59 QueSST Begins

NASA and Lockheed Martin have now taken a step closer to a future with faster-than-sound air travel over land.

Lockheed Martin Aeronautics Company of Palmdale, California, recently began manufacturing the first part of NASA's X-59 Quiet SuperSonic Technology (QueSST) aircraft. When completed, NASA will use the X-59 to study how reducing the sonic boom heard from traditional supersonic jets to a quiet sonic "thump" could lead to acceptance of supersonic flight over land.

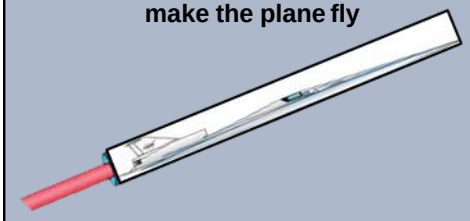
For more information please visit the following website: https://www.nasa.gov/image-feature/langley/manufacturing-of-nasa-s-x-59-quesst-begins

Fig. 1: X-Plane Instructions

Step 1: Fold along solid line and tape

Step 2: Fold end over on the dotted lines and tape

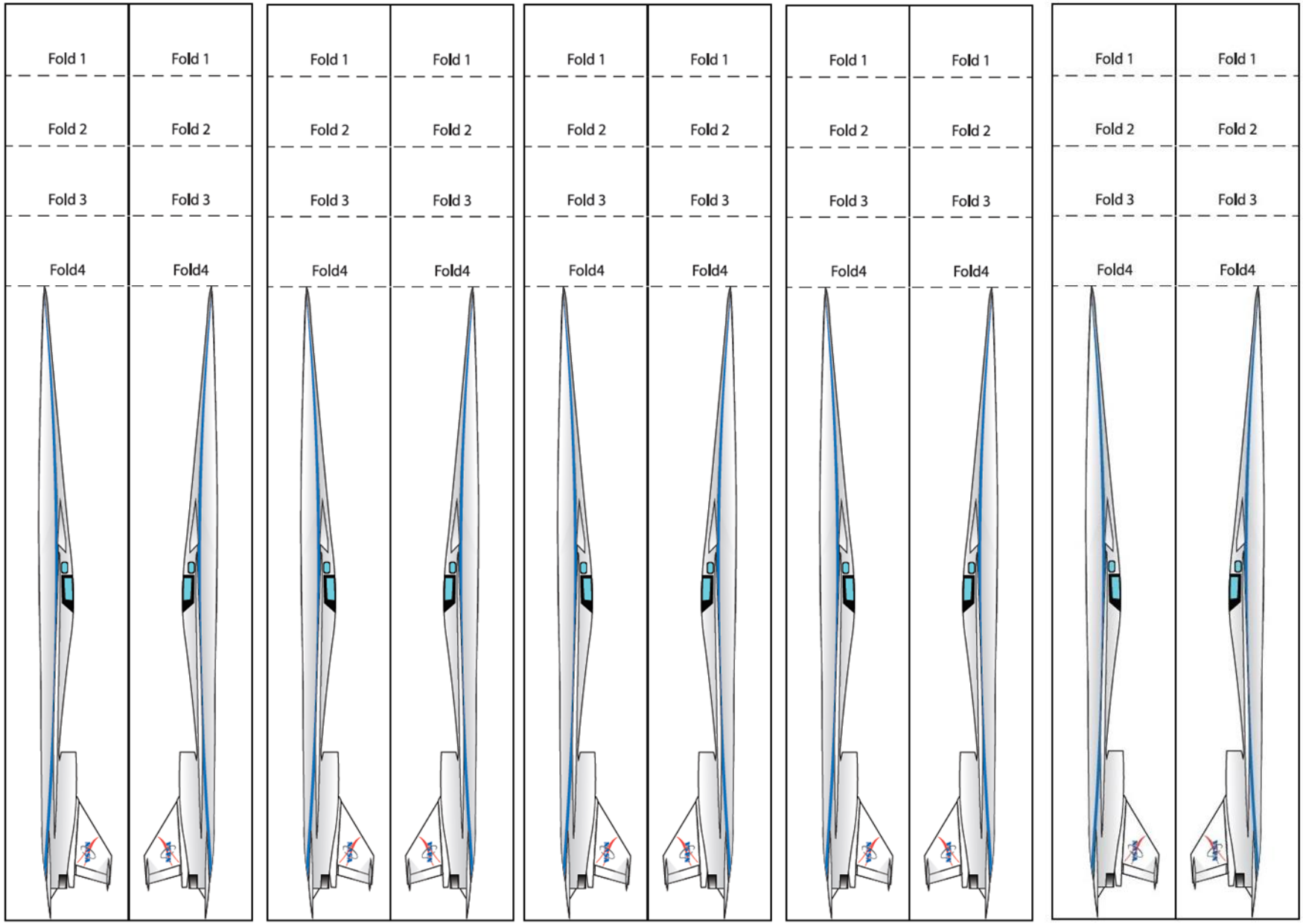
Step 3: Insert straw and blow to make the plane fly



Other Resources:

- https://www.nasa.gov/stemonstrations-newtons-third-law-rocket-races.html
- https://www.youtube.com/watch?v=Sk9qmGLr9DQ
- https://www.nasa.gov/lowboom/new-nasa-x-plane-construction-begins-now

X-Plane Template



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Data Table

	Distance Flown (cm)	Observations
Flight 1		
Flight 2		
Flight 3		

Discussion Questions:

1. How far did your plane fly the first time?

2. Did your plane fly the same distance every time? Why or Why not?

3. What did you do to change how far your plane flew?