**STEM Challenge: Flight**
Story Book Science at Home Activity

What you need

- One piece of paper
- One pair of scissors
- One set of instructions for building a paper airplane, included on the final page of this activity guide

Preparation

Follow instructions below to participate in this STEM Challenge. Additional instructions for building a paper airplane are included on the final page of this activity guide.
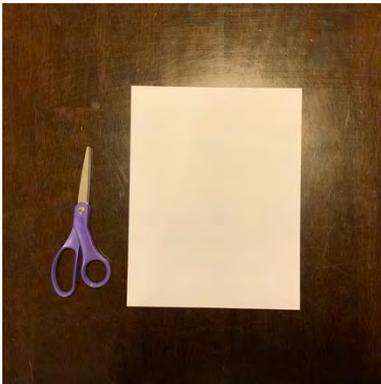
Step 1. Gather materials.

Step 2. Fold the piece of paper in half, lengthwise. Make sure the fold is sharp! Afterwards, unfold the paper. You will notice a long line in the center of the page.
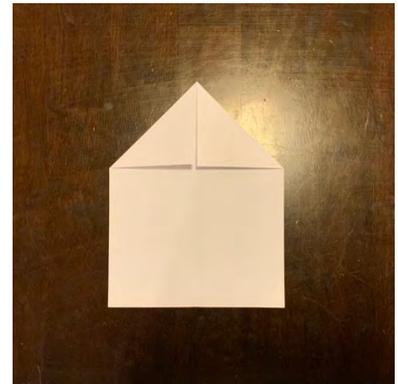
Step 3. Fold down the top left corner of the paper until it meets the center line. Repeat with the top right corner.
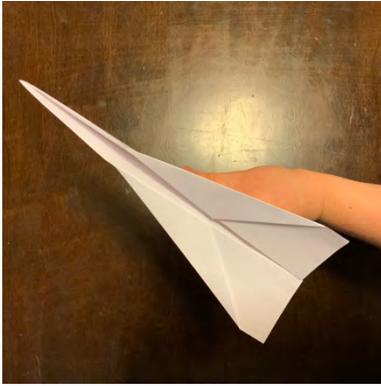

Step 4. Fold the left corner until it meets the center line. Repeat with the right corner.

**Step 5.** Fold the plane in half along the center line.

Step 6. Fold a wing down. The bottom of the wing should line up with the bottom of the plane. Repeat on the other side.

Step 7. Throw the plane forward, and see how far it travels. Do this a couple of times making sure that the paper plane has not been damaged in flight and that the plane is thrown in the exact same way each time.

Step 8. Now, change the plane's design and increase the drag! Use scissors to make a one-inch cut on the back of a wing, along the fold that was made during Step 6. Then fold the cut up. Repeat on the other side.
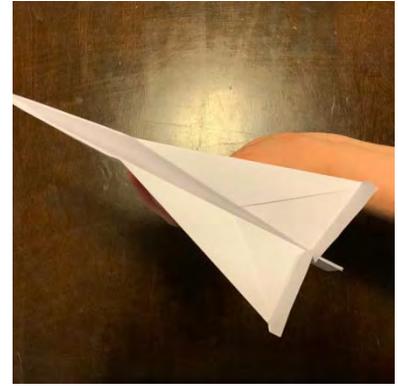
Step 9. Throw the plane forward again, just like you did before, but with the new modifications to your plane's design.

Activity modified from "Soaring Science: Test Paper Planes with Different Drag" by Science Buddies from *Scientific American*.

What to do

Study the results of the flights of the two different airplane designs. Did one design fly farther than the other? Which one flew farther? Why do you think that happened?

Now, try a new challenge. Create new designs for your paper airplane and explore how those designs impact flight. What happens if you use different types of paper to design your airplane? What happens if you add additional weight to your plane? Will additional weight impact the force of gravity? How do your designs increase or decrease other forces?

What is happening?

A force is a push or a pull. There are four forces of flight that act on a plane. Those forces are gravity, lift, drag, and thrust. Gravity is a downward force on a plane. So, the force of gravity pulls the plane down, towards the earth. Lift is an upward force on a plane. Lift occurs because the plane is moving through the air and is affected by things like the shape and size of the plane and its parts, including the wings. Lift and gravity are opposing forces, so they are opposite. Gravity pulls the plane down, while lift pushes the plane up. Drag is a force that pushes against the plane as it moves in the air. Drag occurs because the plane is moving through the air. The more air that is caught by the plane because of its design, the greater the drag. Thrust is a force that pushes a plane forward as it moves in the air. Thrust is provided by a plane's engine. Drag and thrust are opposing forces, so they are opposite. Drag pushes the plane backwards, while thrust pushes the plane forwards.

Although these forces can't be seen, airplanes have to be carefully designed so that the upward force of lift is greater than the downward pull of gravity and the thrust is greater than the drag, all while maintaining the safety of the plane and the people and things in it!

Information from "Four Forces on an Airplane" and "Dynamics of Flight" from National Aeronautics and Space Administration (NASA).
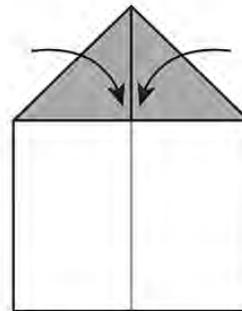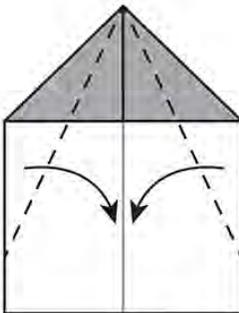
Assembly Instructions
Basic Dart

Step 1
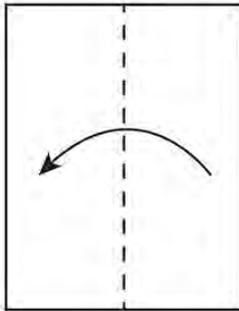
Printed side down.
Fold paper in half
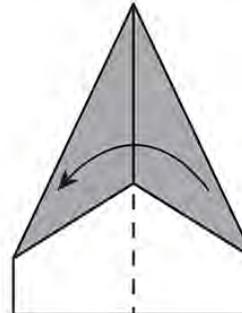lengthwise and crease it.
Now, unfold the paper.

Step 2

Fold down top corners
inward to the center line.
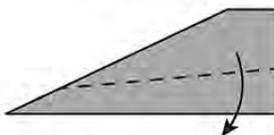
Step 3

Fold the two edges
toward the center line,
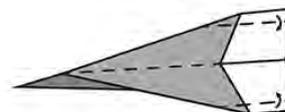as shown.

Step 4

Fold the plane in half.
Turn the plane 90 degrees
as shown in step 5.

Step 5

Fold wings down along
white line.

Step 6

The Basic Dart is now
complete. Bend up the
tailing edge of the wings
for lift if it has a tendency
to nose-dive.

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If you follow these instructions for the activity, stop after finishing Step 5. Image from the Air Force Research Laboratory.