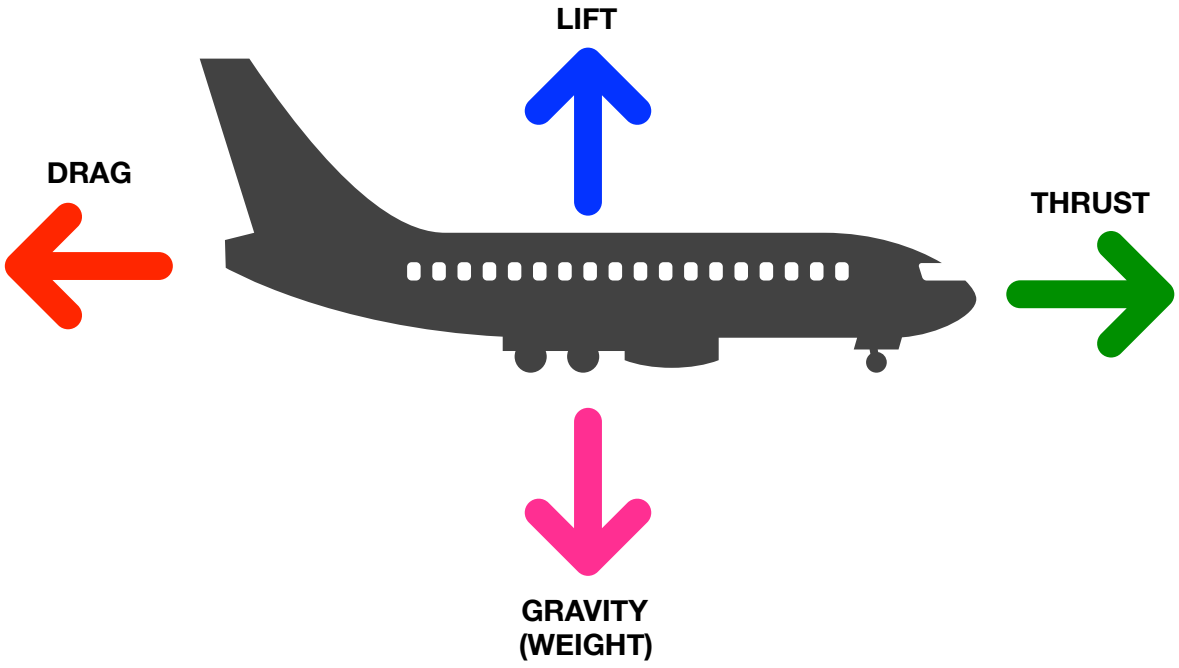
Fifth Grade
Extension Activities

The Forces of Flight

Everything that flies is affected by 4 forces of flight: gravity, lift, drag, and thrust. How these forces are balanced will determine the way an object flies. For example, a parachute slows a person down by increasing the amount of drag, while a jet is built with powerful engines to increase thrust and designed aerodynamically so there is as little drag as possible. Each of these forces has a strength and direction as it acts on an object in flight.



Build a Parachute:

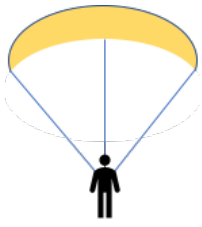
Drag is a force that slows a flying object down. It is caused by friction between the flying object and the air around it. Experiment with the force of drag by building a parachute that floats slowly to the ground.

Materials:

Look around your house for materials that you think would make a good parachute. Coffee filters, paper, napkins, plastic bags, or fabric could all work well. Grab a few options and test which material is the best. What do you notice these objects have in common? You may also need some string, tape, and scissors.

Try This:

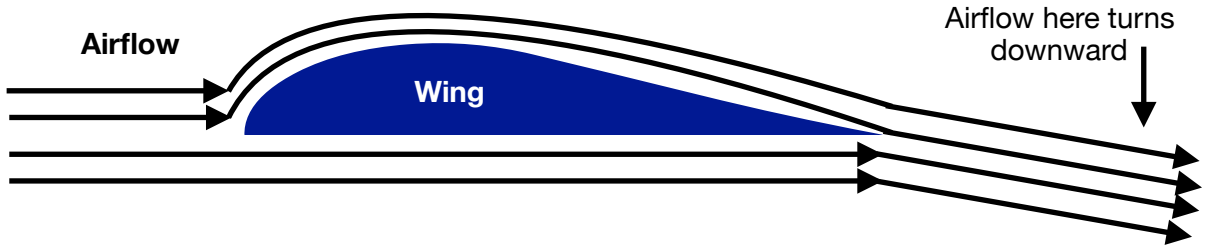
Using your materials, make a parachute that you can drop from a high height. Measure how long it takes your parachute to reach the ground by using a timer or stopwatch. Record your results. After three or more tests, change your design to see if you can make your parachute fly even slower by increasing the amount of drag. For an extra challenge, if you have a small action figure or Lego person, you can attach them to your parachute to add extra weight. What do you notice happens?



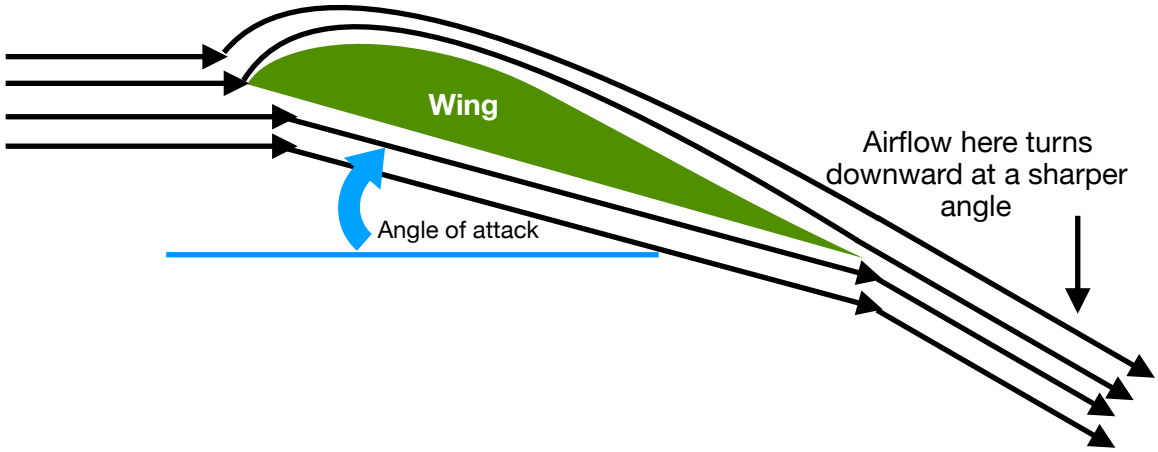
The Forces of Flight

Ever wonder how an airplane stays in the air? The secret is all in the balancing of the 4 forces of flight. Let's take a look at the force of **lift** next**.** The wings of an airplane create lift by turning the air and directing it downward.

Airplane wings are airfoil shaped, which means they are curved at the top. As air moves along the top of the wing, it curves along with the shape of the wing and leaves the back of the wing in a slight downward angle. The air on top of the wing also affects the air underneath, turning it in a downward direction as well. The airplane wing pushes the air down as it moves, and the air pushes the wing up. This is because of Newton's 3rd Law of Motion, which states: for every action (force) there is an equal and opposite reaction.



There are a couple of ways to **increase the amount of lift**. The first way is to increase the speed that the wing approaches the air (go faster on the runway). The second way is to increase the **angle of attack**. This is the angle of the wing, relative to the airflow. Increasing the angle of attack also increases the downward angle of the airflow at the back of the wing. A larger push downward means a larger push upward.



Make a Connection:

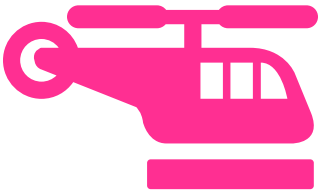
You may have noticed this phenomenon before if you've ever ridden in a car with your hand out of the window. If your hand is flat, you'll feel it staying steady in the wind. However, if you tilt your fingers up slightly toward the sky, your hand will lift up. When you do this, you are increasing the angle of attack. You may also feel the force of drag increase as well. If you tilt your fingers up too much, the force of drag will overpower the force of lift and your whole arm may move backwards.

The Forces of Flight

The next force of flight we can look at is **gravity**, the force that pulls everything towards Earth's surface. It is the same force that causes planets to orbit the sun. The more massive an object is, the stronger its gravitational pull.

Create a Paper Helicopter

Experiment with the force of gravity by using our paper helicopter template.



Materials:

- Helicopter template
- Scissors
- 1 paperclip

Try this:

1. Cut out, trace, or draw the helicopter template onto a separate piece of paper.
2. Take note of the dotted lines and the solid lines.
3. Cut on the dotted lines.
4. Fold on the solid lines.
5. Try dropping your helicopter from a high height (as high as you can reach, off the top of a staircase, while *carefully* standing on a chair, etc.) Observe what happens as gravity pulls your helicopter to the ground.
6. Add a paper clip to the narrow (folded) end of the helicopter.
7. Try dropping your helicopter from the same height as you did before. What do you notice about how your helicopter flies this time? Do you notice a difference?

Questions to Ask your Student:

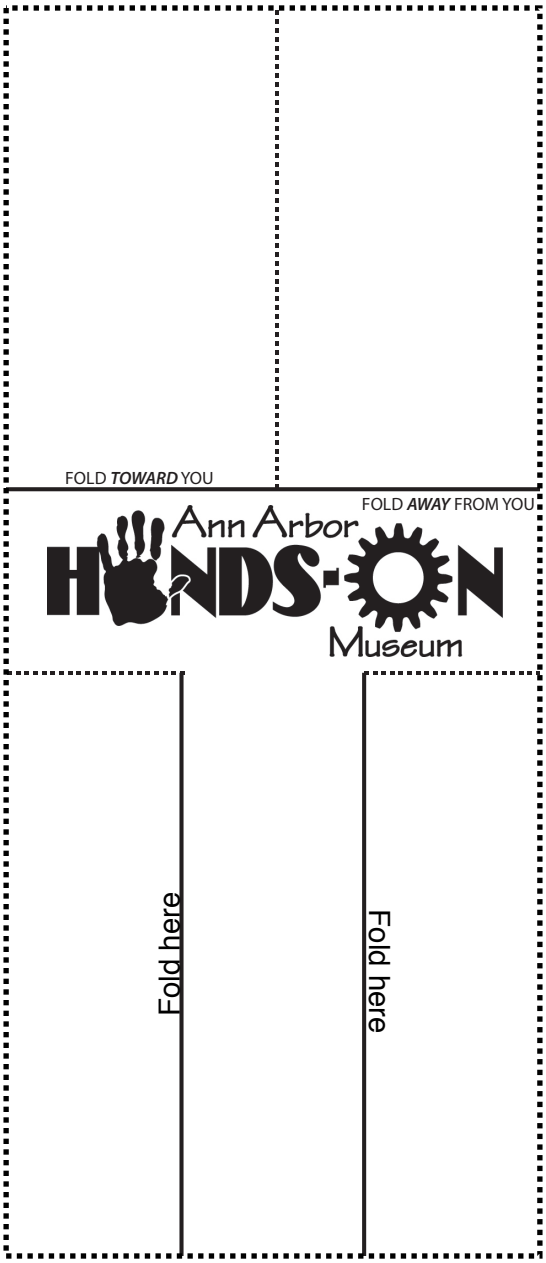
- Try bending the wings in opposite direction. What happens?
- Does the drop height affect the motion?

Want to Know More:

Gravity affects all objects on Earth. As an object falls to the ground, the air in our atmosphere pushes back against the object and slows it down. This force is called air resistance or drag. On Earth, the more mass something has, the faster it will fall to the ground because it is harder for the air to push back on the object, which means there is less air resistance. If you try dropping your helicopter without the paperclip, you'll notice that it may flit down to the ground, rather than dropping straight down. Once you add the paperclip, your helicopter has more mass and drops quickly to the ground.

A scientist from the 1500s named Galileo had a theory that if you dropped two objects of different weights in a vacuum where there is no air, the objects would fall at the same speed and hit the ground at the same time, because there is no air resistance. For example, in a vacuum, a hammer and a feather dropped from the same height would land at the same time. In fact, NASA astronauts tried this exact experiment when they landed on the moon in 1971. The moon was a great testing location because there is no air to breathe and very little atmosphere. If you would like to see a video of this experiment, search YouTube for "Apollo 15 Galileo Experiment".

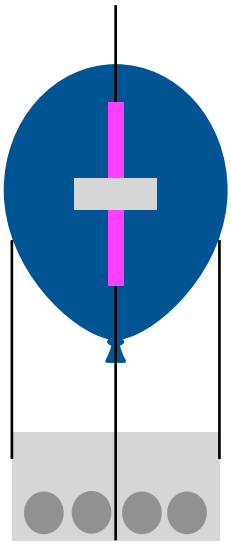
Paper Helicopter Template



The Forces of Flight

The final force of flight we can look at is **thrust.** This is the force that propels an object forward. Engines and propellers provide thrust for planes, your arm provides thrust if you throw a baseball, and built up pressure can provide pressure in a rocket engine.

Hot Air Balloons:
Experiment with how weight affects thrust for a flying object.



Materials:
- Balloon
- String (avoid using string that is fuzzy or rough like yarn or twine)
- Ziplock bag
- Something lightweight that you have multiple of (ex. paperclips, dimes, dice, board game pieces, hair pins, etc.)
- Tape
- Straw
- Scissors
- Measuring tape

Try This:
This activity will work best in a room that has a hard floor (non-carpeted).

1. Find a spot high on an empty wall and tape one end of the string securely. Measure the string down to the floor and add 5-10 extra inches. Then cut the string.
2. Thread a straw onto the string, stretch taut, and tape the string to the floor. Make sure the string is pulled very tightly, otherwise your experiment may not work.
3. Cut two more pieces of string, 12 inches long each. Tape one end of each string to the top corners of the Ziploc bag.
4. Blow up the balloon and use the measuring tape to measure how big around it is. Take note of this measurement. **Do not tie the balloon.** Tape the other ends of the strings to your balloon so the bag hangs below the mouth part of the balloon (similar to a hot air balloon).
5. Tape the straw to the balloon with the mouth part of the balloon pointed down and bring it all the way down to the floor. Count down and release the balloon.
6. Mark on the string where the balloon traveled to and measure the height. Record your data.
7. Try the experiment again, except this time add 2 items to your bag to make the bag heavier. When you inflate the balloon, make sure it measures the same size as during the first test. What do you notice?
8. With each test, add 2 more items to the bag. Record how high your balloon travels for each test. What do you think will happen every time you add more weight to the balloon?
9. Stop testing when your balloon stops traveling up the string.

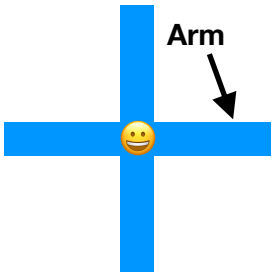
Want to Know More?
For this experiment, thrust comes from air escaping out of the balloon and pushing on the air around the balloon. The more weight you add to the balloon, the more thrust you will need to raise the balloon into the air. The same rule applies to other flying objects, like space rockets and airplanes. The bigger and heavier the flying object is, the more thrust will be needed to keep it flying.

Make Your Own Boomerang
Make a simple boomerang with two strips of cardboard.

Ann Arbor HANDS-ON Museum

Materials:

- One empty cereal box. If you don't eat cereal, any box of a similar weight and size will work.
- Ruler or measuring tape
- Scissors
- Tape
- Markers, crayons, or colored pencils



Try this:

1. Cut two strips of the same length and width out of your cereal box. Generally, strips about 12 inches long and 1 inch wide work pretty well.
2. Arrange the strips so that they look like a plus (+) sign.
3. Tape them together so the strips do not come apart. It's best if you put tape on both the front and the back. Now your boomerang has 4 arms.
4. Trim or round both corners of each arm of your boomerang. This will ensure your boomerang corners are not too sharp.
5. Mark one side of your boomerang with your name or a small drawing. We will call this side of your boomerang the "FACE SIDE".
6. Decide which hand you will throw your boomerang with. This is usually your dominant hand (or the same hand you use to throw a ball).
   - If you throw with your right hand: while looking at the FACE SIDE of your boomerang, gently fold the right side corners of each arm away from you. Don't make the creases too hard. You should make 4 total folds.
   - If you throw with your left hand: while looking at the FACE SIDE of your boomerang, gently fold the left side corners of each arm away from you. Don't make the creases too hard. You should make 4 total folds.

7. Place your boomerang on a table so the FACE SIDE is towards the ceiling. Gently bend each of the arms up towards the ceiling so that your boomerang looks like a shallow bowl. Be gentle, you don't want to crease the arms of your boomerang too much.
8. Now your boomerang is ready to throw. Find an open space where you won't hit another person. Hold your boomerang vertically between your thumb and index finger, with the FACE SIDE towards the side of your face. Your elbow should be at a 90 degree angle.
9. Throw the boomerang by extending your elbow and wrist down towards the floor in one quick motion, similar to how your would throw a paper airplane. Try flicking your wrist for maximum spin.
10. See if your boomerang flies back toward you after you release it. Throwing a boomerang is a little tricky and takes some practice. Be persistent and keep trying if it doesn't work the first time.

Want to Know More?

Boomerangs are really exciting to build and learn about because they use the four forces of flight to work in a way this is surprising. A boomerang has the lift and thrust of an airplane, but because it rotates as it flies, it lifts itself up each rotation. When it reaches the end of its range, the boomerang actually turns around returns.