30 minutes

Grades 6–8, 9–12

Build a Better Boomerang

Learn the principles that govern the flight of a boomerang and apply engineering methods to improve the performance of a boomerang.

Instructions

In this activity, students compare flight of a commercial boomerang to that of one they make themselves.

1. Demonstrate how the commercial boomerang works according to the instructions for that specific model (you may need to go outside).
2. To show how to produce aerodynamic lift, blow on the upper surface of a piece of paper held at one end. Compare the side view curve of the paper in this demonstration with the side view of the boomerang airfoil.
3. Ask the students: why do you think the boomerang curves back to the thrower?
4. Optional: Illustrate this effect with the bicycle wheel gyroscope and turntable. Place a volunteer student on the turntable and give the student the bicycle wheel gyroscope to hold. Spin the wheel and ask the student to tilt the handles. The torque produced will be translated by the gyroscope into precession that will cause the student and wheel to turn in a circle. (If a small gyroscope is used, suspend one end of the gyroscope's axle with a string. The gyroscope will precess in a circle.)

Materials

PER CLASS:

- ☐ 1 commercial boomerang
- ☐ Optional: Bicycle wheel gyroscope, turntable, or swivel chair

PER STUDENT:

- ☐ Stiff paper or file folders
- ☐ Pencils
- ☐ Rulers
- ☐ Scissors
- ☐ Boomerang pattern (included in this activity)

5. Cut out the pattern for the boomerang

6. Trace the pattern onto one half of a manila folder.

7. Cut the boomerang out of the folder.

8. Fly your boomerang by holding one wing of the boomerang between your thumb and index finger. Keeping the boomerang vertical, give it a spin as you throw it straight ahead. The boomerang will travel straight out from you a few feet or more, circle, and come back. By the time it returns, it will be spinning on a level plane. Catch the boomerang by clapping it between your hands or by thrusting your finger into the hole.

9. Try throwing the boomerang horizontally and observe its flight. Warp the boomerang's wings to see what effect the curvature has on the flight.

10. Have students construct and test their ideas for improving their boomerangs. For example, students may experiment with the wing design or shape of their boomerang.

Guiding Questions ?

Why do you think the boomerang curves back to the thrower?

How does the flight of your boomerang compare to the commercial version?

What could you do to improve the performance of the boomerang?

Engineering & Science Connections

- Torque is the twisting force that causes the boomerang to rotate. Precession happens when a spinning object starts to rotate about an axis that is perpendicular to the axis of the original spin. Toy tops, gyroscopes, and riding your bike are all examples of precession at work.

- Bernoulli's principle explains how aerodynamic lift keeps a boomerang in flight. Just like an airplane, a boomerang has two wings, both with an airfoil shape. This airfoil shape causes rushing air to move faster over the top of the wings, which creates upward air pressure.

- Engineering studies have led to design changes that have dramatically increased boomerang performance. For example, computer-aided drawing programs have been used to create optimal wing designs, and new materials like carbon fiber have been used to increase durability.

This activity was provided by NASA Johnson Space Center, Houston, Texas 77058

Four-Wing Boomerang Pattern