

Motion and Forces on a Boomerang

Students will learn about motion and forces while making and flying a boomerang.

LESSON PLAN

Learning Objectives:

The students will:

- Learn about the origin of the boomerang
- Make a boomerang from cardstock
- Learn what forces act upon a boomerang in flight
- Determine the throwing style for maximum flight
- Compare the flight variables that change when weight is added to an airfoil

Purpose:

Students will learn about the origin and the science behind boomerangs – especially the force that makes the boomerang return to the thrower. Students will understand the four forces of flight and how they affect an object in motion. They will also learn how to construct, throw and receive a boomerang. Students will make observations on how a boomerang is actually an airfoil.

Introduction:

Boomerangs have been in existence since ancient times and, while appearing to be a simple craft, are actually quite complex in nature. They are probably the world's first heavier-than-air flying machines. A boomerang in flight demonstrates gyroscopic precession, angular momentum, lift, aerodynamic drag, and acceleration! And, contrary to public opinion, a boomerang was never used as a weapon. See the resource section for more information on the history and science behind the boomerang.

Each arm of the boomerang is like a wing, with both a leading and a trailing edge. As it spins, the wing at the top of the rotation has a greater air speed than the airfoil at the bottom of the rotation. These unequal forces result in two actions: the boomerang will shift from vertical to horizontal (establishes lift) because of the greater force on the upper airfoil and precession causes the boomerang to move in a circular path. As the boomerang turns to the right or left (right-handed boomerangs travel and spin counterclockwise and left-handed boomerangs travel and spin clockwise), the boomerang will move from vertical to horizontal until precession becomes minimal and the boomerang finishes its flight.

Grade Level: 8 – 12

[Ohio Learning Standards/Science \(2018\)](#)

Expectation of Learning

[Nature of Science](#)

Physical Science:

[8.PS.2:](#) Forces can act to change motion of objects

High School Physical Science

[PS.FM.1:](#) Motion

[PS.FM.2:](#) Forces

[PS.FM.3:](#) Dynamics

Physics

[P.F.1:](#) Newton's Laws applied/complex problems

[P.F.2:](#) Gravitational forces and fields

[P.F.5:](#) Air resistance and drag

[P.F.6:](#) Forces in two dimensions

[P.F.7:](#) Momentum

Materials Required:

- Cardstock
- Scissors
- Masking tape
- Safety glasses

Procedure:

A. Warm-up

1. Review the concept of the four forces of flight, emphasizing lift and drag.
2. Ask the students if the following statement is true or false: boomerangs were used as weapons. The answer is false. Share (or have students research) a brief history of the boomerang.
3. Explain the flight of a boomerang and demonstrate how it flies. (Practice and refine your own technique before using this lesson with students.)
4. Explain the tuning process by bending the wings just a little (uniformly on each airfoil). Too much bend will cause greater drag and slow the rotation. Just a slight bend is needed.

B. Activity

You may choose to use the following website (<https://www.wired.com/story/how-to-make-a-roomerang/>) to make an indoor boomerang or follow the instructions below:

1. Trace the master pattern on the tag board and cut it out.
2. Bend to tune for test flight.
3. Go to a large open indoor area (such as the gymnasium). Create a clear test area and allow students to fly the boomerangs one at a time.
4. To fly the boomerang, hold the boomerang vertically. Make a fist and hold one blade between your thumb and index finger. Bend your wrist back, so the boomerang nearly touches your forearm. Snap your wrist, spinning the boomerang straight out in front of you and releasing at eye level with your arm fully extended. The boomerang should be vertical, straight out from your body.
5. Change the bend of the airfoils and note the results.
6. Add a 4 cm strip of masking tape to one airfoil. Note the change in flight path. Continue to add masking tape to another airfoil and note the change in flight path.

Assessment/Evaluation:

Students will report and discuss their findings.

Resources:

Boomerangs:

<https://www.wired.com/story/how-to-make-a-roomerang/>

<http://hyperphysics.phy-astr.gsu.edu/hbase/brng.html>

<https://www.math.uci.edu/~eesser/papers/justboom.pdf>

<https://www.popularmechanics.com/science/a4809/4219929/>

<http://www.rangsboomerangs.com/boomerang-list/boomerang-history>

<http://www.rangsboomerangs.com/about-boomerangs>

<http://www.rangsboomerangs.com/boomerang-list/how-a-boomerang-works-2>

<https://www.nma.gov.au/defining-moments/resources/earliest-evidence-of-the-boomerang-in-australia>

<https://www.newworldencyclopedia.org/entry/Boomerang>

Four Forces of Flight:

<https://www.grc.nasa.gov/WWW/K-12/airplane/forces.html>

<https://www.thaitechnics.com/fly/principle.html>



Boomerang Pattern

