Balloon Helicopter

AIR-610

Student Learning Objectives:

- Students will construct and launch the Balloon Helicopter to examine the principles of flight and Newton's Three Laws of Motion.
- Students will manipulate variables to pilot the Balloon Helicopter so that it touches an air target and/or sets down on a landing pad.

Classroom Activities

ACTIVITY 1: Good to Go

Teams: Three or four students per team

Materials: Balloon Helicopter kit, stopwatch, and meter stick. *Additional balloons with different capacities/shapes can be added to test variables.*

Procedure:

- Ask students to create a data table where they will record data for the flight duration and performance of two separate tests: Balloon Only and Balloon Helicopter. *Depending on grade level you may need to direct this.*
- Test 1: Provide students with just the balloon and red plastic nozzle. Insert the wide end of the nozzle into the opening of the balloon. Stretch it to fit.
- Inflate the balloon and pinch off the neck with your thumb and forefinger.
- With the opening upward, release the balloon one meter from the floor. Instruct students to record the results and repeat. Encourage your students to make observations and collect ample data for each trial. *What direction does it move? This data could be in the form of pictures, written descriptions, flight duration time, distance traveled, and height.*

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- Test 2: Assemble the rotor portion of the helicopter. The blades are notched so it fits only in one direction. Have students look closely at the assembled rotors and sketch a picture on the back of their data tables. *There should be attention to details show the shape, slight slant, and texture of the blades. Remind students to compare and contrast the two trials.*
- Inflate the balloon, pinch off the neck of the balloon with your thumb. Insert the nozzle into the rotor.
- With the balloon opening upward, release the balloon helicopter one meter from the floor. Instruct students to record the results and repeat. Encourage your students to make observations and collect ample data for each trial. *What direction does it move? How do the blades interact with the air moving over the blades? This data could be in the form of pictures, written descriptions, flight duration time, distance traveled, and height. Try taking slow-motion videos with a phone if possible.*

Take it further: Explore Newton's Laws of Motion. Ask students to design their own experiments to test flight duration, flight direction, effects of different sized/shaped balloons, etc.

Reflection and analysis: How did the action and reaction of the escaping air change the flight with and without the rotors? How are Newton's Laws of Motion demonstrated in the flights? What forces are the Balloon Helicopter blades being subjected to? What energy transfers occur? What variables can be manipulated by each team to test an idea about the flights of the Balloon Helicopter? *Have students refer to "Newton's Three Laws of Motion" on page 4 and "Fun Facts" on page 5 to look more closely at how the laws of motion can be seen in the flight.*

ACTIVITY 2: Target Challenge

Teams: Three or four students per team

Materials: Balloon Helicopter kit, stopwatch, meter stick, landing pad (bullseye target), air target (balloon hanging from a string). *Additional balloons with different capacities/shapes can be added to test variables.*

Classroom Activities

continued

Procedure:

- Challenge teams to manipulate variables in order to touch two targets: a balloon that is hung up in the classroom (air target) and a landing pad placed on the ground (bullseye target).
- Ask students to create a data table to track their trials. Be sure they are utilizing Newton's Three Laws and the data from each trial to guide their Balloon Helicopter in the right direction.
- After students have developed a strategy to hit the ground and air targets, conduct a classroom competition. Require each team to explain and justify their strategies based on data and solid science. The pre-flight explanations may be done as a verbal explanation, PowerPoint presentation, or as a scientific storyboard with diagrams. *Have students refer to "Newton's Three Laws of Motion" on page 4 and "Fun Facts" on page 5 to collect background information and evidence to support their explanations.*

NGSS Correlations

Our Balloon Helicopter and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

3-PS2-2

Students can use the Balloon Helicopter to make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

Middle School

MS-PS2-2

Students can use the Balloon Helicopter to plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

High School

HS-PS2-1

Students can use the Balloon Helicopter to investigate and analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

Newton's Three Laws of Motion

Newton's First Law of Motion…

states that an object at rest will remain at rest unless acted on by an unbalanced force. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

How does it relate to the helicopter flight?

A helicopter will stay on the ground until a force creates lift. With rotors in motion, the helicopter stays airborne until another force—gravity or drag—acts on it.

Newton's Second Law of Motion…

states that acceleration is produced when a force acts on a mass. The greater the mass (of the object being accelerated), the greater the amount of force needed (to accelerate the object). This is also expressed using the equation **F = ma**.

How does it relate to the helicopter flight?

The main forces acting on a helicopter in flight are the weight of the helicopter, the torque of the rotors twisting, and the aerodynamics of lift and drag as the helicopter moves through the air. At any time, these forces affect flight: **Torque = Force x Distance and Angle of Attack** (the angle between the rotors [airfoil] and the direction of the relative wind).

Newton's Third Law of Motion…

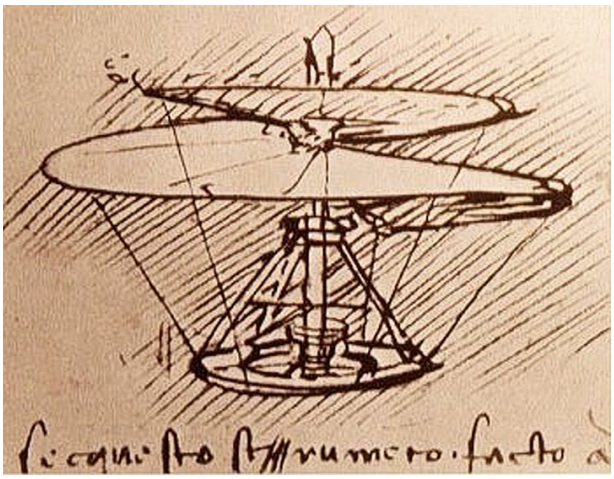
states that for every action force there is an equal and opposite reaction force. This law is also known as "The Law of Action and Reaction."

How does it relate to the helicopter flight?

A helicopter can lift off the ground only when its rotors twist at a rate that allows lift. The angle of the rotor pushes against the air, and the air in turn pushes against the surrounding air, creating lower pressure above the helicopter rotors. Lift opposes gravity and thrust opposes drag.

Fun Facts

Leonardo da Vinci (1452-1519) sketched this helicopter-like flying machine in the early 1500's. There was no engine shown and this machine never flew. Many of his ideas were hundreds of years ahead of his time; long before the materials and technology necessary were available to build one.



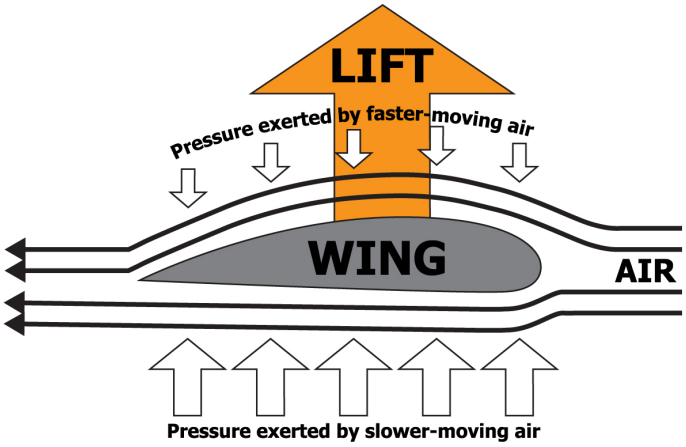
"Once you have tasted flight,
you will forever walk the earth
with your eyes turned skyward,
for there you have been,
and there you will always
long to return."

~ Leonardo da Vinci

Helicopters do not need a runway because they can take off vertically. They do this by spinning a set of thin wing-shaped rotor blades at a high speed to create lift. They have a "Tip Jet" that enhances propulsion generated by burning fuel and compressed air pushing upward on the rotors.

Aerodynamics is the science that deals with air moving against an object, for example: wind filling the sails of a sailboat or an aircraft moving through the air.

Daniel Bernoulli (1700-1782) was a Swiss doctor and mathematician who showed that when air flows faster over the curved surface of an aircraft wing, the reduced pressure on the top of the wing creates lift, thus flight is possible. This is referred to as Bernoulli's Principle.



An airfoil is any surface that provides a useful aerodynamic force when moved through air, air moves over it or a combination. Wings, sails, and rotors are all superb examples. Even a boomerang is an airfoil.

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To extend your lesson, consider these Educational Innovations products:

HandCopters (AIR-430)
To launch, place the HandCopter's plastic shaft between both hands and spin counterclockwise. These colorful copters can be used for dozens of scientific investigations. Why won't the HandCopter work if launched clockwise? How does this simple 'toy' illustrate the Bernoulli Principle? Students can test different variables to determine what will make the HandCopter stay aloft longer or fly straighter. Illustrate the principles of gravity, force, and motion as well as the principles of flight including camber, lift, center of gravity, and momentum.

3-2-1 Blast Off! Kit (KIT-321)
Our 3-2-1 Blast Off! workshop on forces and energy has become a standing-room-only event at NSTA conferences. Over the years, hundreds of teachers have asked us to develop a kit that bundles our much-loved demonstrations of things that go 'bump' in the day! Kit includes comprehensive teaching instructions and enough hands-on components for up to 10 students. (Safety glasses recommended.) We've also created memory-refresher videos that walk you through each of the demonstrations, so you'll be up to speed and ready to Blast Off in just minutes!

Rocket Balloons (RKT-165/170/175/180)
A great way to demonstrate basic principles of Newton's Laws to students. In order for a rocket to be stable the center of gravity must be forward of the center of pressure. Balloons are inherently unstable which is why they swirl around in every direction when you allow the air to escape. Rocket balloons are properly weighted to create stability.

Reaction Rocket (RKT-625)
This rubber ball launcher and plastic rocket may look simple, but they're a sure-fire way to provoke a WOW reaction—and introduce students to Newton's Laws. Hold the top of the launcher and drop it straight down onto a hard surface. The rocket shoots up dramatically higher than its original drop height. Explaining energy conversion was never this easy...or this much fun!