

## INSTRUCTIONAL GUIDE

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**Background**

The balloon helicopter is a classic toy with a simple design. The physics that explains its motion, though, can be difficult to explain. Students will observe the motion of the helicopter and study its construction before applying Newton's 3<sup>rd</sup> Law twice to explain how it moves.

Newton's 3<sup>rd</sup> Law says that every force is opposed by an equal and opposite force. This lab will reinforce the idea that the two forces involved in this law are applied to different objects.

**Set-Up**

When an ordinary balloon is inflated and let go, the balloon exerts a force on the air in it, forcing it to move out the stem of the balloon. The air, in turn, exerts a force on the balloon, forcing it to move in the opposite direction.

The helicopter kit diverts the air sideways, through the helicopter blades. The blade forces the air sideways, and the air forces the blade back the other way. This force causes the blades to spin.

The spinning blades push downward on the air around them as they move. The air around them exerts a corresponding upward force on the blades. This upward force from the air in the room is what causes the helicopter to fly.

**Lab Activity****Educational Objective**

Use Newton's 3<sup>rd</sup> Law to explain the motion of a balloon helicopter.

**Lab Tip**

Students should have experience drawing force diagrams before doing this lab.

**Pre-Lab Question:**

1. State and briefly explain Newton's Third Law.

**Materials:**

Balloon Helicopter Kit, Balloon

**Procedure:**

1. Fill the balloon with air. (Do not attach the helicopter kit yet.) Hold the balloon with the stem pointing up and let it go. Describe what happens.
2. Draw a diagram of the balloon and the air in the balloon during the motion. Show the forces on the air and on the balloon. Describe the effect of these forces on the air and on the balloon.
3. Attach the helicopter kit to the balloon and inflate it. Hold the balloon with the stem (and helicopter kit) pointing up, and let it go. Describe what happens.
4. Examine the helicopter kit. Draw a diagram of the helicopter blades and the air from the balloon during the motion. Show the forces on the air and on the balloon. Describe the effect of these forces on the air and on the blades. (You can ignore the part of the air that goes through the center whistle.) Hint: to explain the balloon's motion, you must show 2 forces on the helicopter blades. Don't forget about the air in the room.

**Optional Extension**

5. A Harrier Jump Jet can use its jet engines to force air backward (like a normal jet) or down. Draw diagrams of the forces on a Jump Jet hovering over the ground and a Jump Jet accelerating forward. Be sure to describe what is exerting each force on the jet.

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