30 minutes

Grades 6–8

Pilot a Balloon

Make a balloon hover at eye level, and then steer it around by creating air currents.

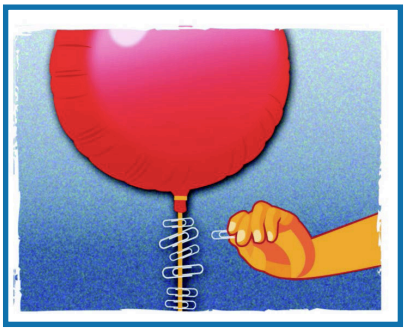
Instructions

Students first make a helium balloon neutrally buoyant—finding equilibrium between gravity and lift—and then explore air pressure as they fan the air around the balloon to move it.

1. Challenge students to make their balloon hover: instruct them to add weights (paper clips) one at a time to their balloon. When it floats in the same space for 5 or more seconds, consider it *neutrally buoyant* (the force of gravity equals the force of lift).

2. As students work, ask: What are some ways to stop drafts from moving the balloon? If students don't think of it, instruct a volunteer to demonstrate using his or her body to block currents, avoiding moving around too much near the balloon. They may also realize that they need to avoid working near air vents, doors, and windows.

3. Stop everyone after 10 minutes, discussing the forces at work to keep the balloons neutral (gravity and lift being in equilibrium).

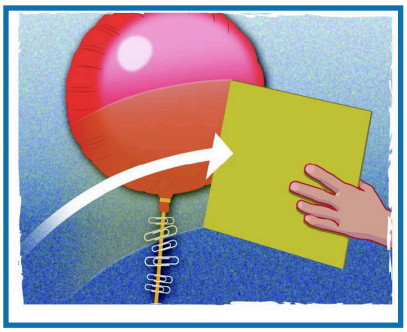


Materials

PER TEAM OR PER STUDENT:

- ☐ 1 helium-filled Mylar balloon
- ☐ Paper clips of various sizes
- ☐ Scissors
- ☐ Clear tape
- ☐ Corrugated cardboard (about 8" square)
- ☐ Large garbage bags for storing balloons (optional)
- ☐ 2 brooms to use as "jaws" to capture escaped balloons (if you have high ceilings)

4 Next, borrow a neutrally buoyant balloon and a volunteer. Ask the class to predict: How will this balloon move when the student fans a piece of cardboard next to the balloon but not directly at it?



5 Demonstrate by taking a square of cardboard and instructing the student to sharply sweep it alongside the balloon in one swift motion (i.e., not fanning it back and forth).

6 Tell each student to see what happens if they make one sharp, swift swipe next to their balloon, on the other side, above, and below it.

7 Discuss what the students saw, asking: Why does the balloon move toward the place where the cardboard was fanned? Explain that the balloon is surrounded by air. Sweeping the cardboard beside the balloon temporarily removes some air, producing an area with fewer air molecules (i.e., lower pressure). Surrounding air molecules rush in to equalize the pressure, carrying the balloon with them.

8 Invite students to move the balloons around the room a few inches at a time by creating a succession of low-pressure air pockets. If time allows, have them experiment with different techniques for moving a balloon in a circle around a partner.

9 Discuss students' observations of rapidly fanning the balloon. They will see that it's hard to control the balloon's movement. Fanning results in chaotic air currents. It will move a balloon but in an unpredictable way.

Engineering & Science Connections

- Helium is a lighter gas than air, which is why helium balloons float up. The denser air pushes the less-dense helium aside, producing an upward force called a buoyant force.
- Balloons drift wherever the wind takes them. But when engineers add a way to control where the balloon goes—for example, by adding an engine—that makes an airship or blimp: a balloon that can fly wherever you want.
- Because gas provides the lift in an airship or blimp, rather than a wing with an engine thrust as in an airplane, airships can fly and hover without expending fuel or energy. They can stay aloft much longer than airplanes or helicopters, making them ideal for such uses as covering sporting events, advertising, and some research, like scouting for whales.
- Blimps used to get their lift from hydrogen gas, which is easier to make than helium, but highly flammable. In 1937, a passenger blimp named the Hindenburg caught fire and crashed during landing. Passenger blimps lost their appeal after the Hindenburg disaster, and now helium is used in blimps rather than hydrogen.

Guiding Questions ?

What is happening in the room to make it difficult to get the balloon to stay still and hover?

Which techniques work best to steer your balloon around your partner?

What motions help to counteract the swishing of other students in the room so that you are successfully steering your balloon?

This activity was provided by Design Squad Global.
DESIGN SQUAD NATION is produced by WGBH Boston. Major funding is provided by the National Science Foundation. Project funding is provided by Northrop Grumman Foundation and S. D. Bechtel, Jr. Foundation, Additional funding is provided by United Engineering Foundation (ASCE, ASME, AIChE, IEEE, AIME). This DESIGN SQUAD NATION material is based upon work supported by the National Science Foulndation under Grant No. EEC-1129342. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation,