SKY FLOATER CHALLENGE

THE CHALLENGE

Make a balloon hover at eye level for five seconds, and then make it move by creating air currents. Students will learn about the engineering design process.

GRADE LEVEL

Middle school

DISCUSSION

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 a blimp – a balloon that can fly wherever you want.

In 1783, two Frenchmen invented the hot-air balloon; later that year, the French physicist Jean Pilatre de Rozier made the first manned balloon flight. The early balloons were at the mercy of the prevailing winds. In 1852, Henri Giffard built the first powered airship: a 143-ft (44-m) long, cigar-shaped, gas-filled bag with a propeller, powered by a 3-horsepower steam engine. Later, in 1900, Count Ferdinand von Zeppelin of Germany invented the first rigid airship.

Materials *(per team or student)*

- 1 helium-filled Mylar balloon
- paper clips of various sizes
- large binder clip for anchoring a balloon (optional)
- scissors
- clear tape
- corrugated cardboard (about 8 inches square)

Extra:

- large garbage bags for storing the balloons (12 fit in a 42-gallon bag)

If you have high ceilings, use 2 brooms as "jaws" to capture escaped balloons.

NOTE: *You can get Mylar balloons at party stores, florists, dollar stores, drug stores, and supermarkets, often for a dollar each. Multiple class sections can use the same balloons for Sky Floater. Have students clean off their balloons at the end of the period so they're ready for the next class. Helium-filled Mylar balloons reliably provide lift for a week.*

ACTIVITY – DESIGN & BUILD

Step One: Make It Hover

Students' goal is to weight the balloon to make it neutrally buoyant. Add weights (paper clips) one at a time. When it floats in the same space for 5 or more seconds, consider it neutral.

Brainstorming Tips:

- **Ask:** How can you stop a balloon from floating upward? (Add weight.)
- Tell them to tie the balloon ribbon in a bundle close to the neck of the balloon so it doesn't drag on the floor or catch on things.
- If drafts are an issue, have students: use their bodies to block currents, not move around too much near the balloon, and work away from air vents, doors, and windows.
- Stop everyone after 15 minutes.

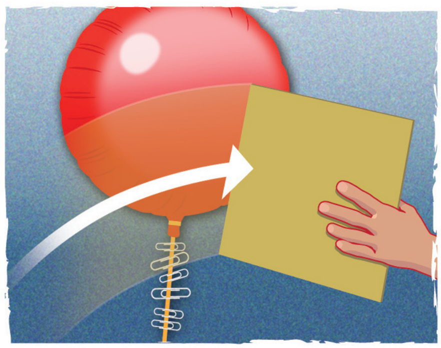
Process the science and engineering.
Ask:

- What affects this balloon? (Gravity and lift)
- What do you know about these two forces when a balloon is ***neutrally buoyant*** (i.e., when it hovers)? (The force of gravity equals the force of lift.)
- Why do the balloons rise? (Air is denser than helium—it has more particles per unit volume than helium does. The denser air pushes the less-dense helium aside, producing an upward force called a ***buoyant force.***)
- How is neutral buoyancy an example of Newton's 1st Law? (If the forces of lift and gravity are equal and opposite, the balloon won't rise or fall.)
- What steps of the **engineering design process** did you use to make the balloon neutrally buoyant? (Identified the problem; brainstormed how to make the balloon hover; tested different ways to weight the balloon; refined our systems; shared solutions.)

Step Two: Explore Air Pressure

Give the class a "driving" lesson. Borrow a neutrally buoyant balloon from one of your students. Ask the class to predict: How will this balloon move when I fan a piece of cardboard next to the balloon but not at it? Demonstrate by taking a square of cardboard and sharply sweeping it alongside the balloon in one swift motion (i.e., no fanning back and forth). Surprise! The balloon moves unexpectedly toward where you swept the cardboard. Repeat on the other side, and above and below the balloon.

Explain that the balloon is surrounded by air. When you sweep the cardboard beside the balloon, you temporarily remove some of the 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. By creating a succession of low-pressure air pockets, kids can move the balloons around the room a few inches at a time. End by demonstrating that rapid fanning at a balloon makes it hard to control the balloon's movement. Fanning results in chaotic air currents. They will move a balloon, but in an unpredictable way

Which moves the balloon best: one swift stroke? Fanning? Big swoops? Quick swipes?

Have students experiment with different techniques for moving a balloon in a circle around a partner. If time permits, they could also do an obstacle course up and over an object, or race other teams. *Remember: don't touch the balloon!*

CONNECT TO ENGINEERING

Because gas provides the lift in an airship or blimp, rather than a wing with an engine as in an airplane, airships can fly and hover without expending fuel or energy. Furthermore, airships can stay aloft anywhere from hours to days — much longer than airplanes or helicopters. These properties make blimps ideal for such uses as covering sporting events, advertising, and some research, like scouting for whales.

In 1925, Goodyear Tire & Rubber Company began building airships of the blimp design. These aircraft were used for advertising and military purposes (such as surveillance and anti-submarine warfare) throughout World War II. The U.S. military used blimps in their operations until 1962.

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