SKY FLOATER CHALLENGE

The Challenge: Make a balloon hover at eye level for five seconds, and then make it move by creating air currents.

Preparation

- ☐ Copy the *Sky Floater* handout (one per student).
- ☐ Visit pbs.org/designsquad and download the following video clips from the "Teacher's Guide" page: ***Band Cam Challenge*** (1 minute) and ***Buoyancy*** (1½ minutes). Be prepared to project them.
- ☐ Gather these materials (per student):
  - 1 helium-filled Mylar balloon
  - paper
  - large garbage bags for storing the balloons (12 fit in a 42-gallon bag)
  - paper clips of various sizes
  - large binder clip for anchoring a balloon (optional)
  - scissors
  - clear tape
  - corrugated cardboard (about 8 inches square)
  - 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. However, 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. If you plan to do Sky Glider as well, stagger the unit with your different sections since the first class will need their balloons for at least two days. Helium-filled Mylar balloons reliably provide lift for a week. In our testing, over half our balloons maintained excellent lift for up to two weeks.*

1 Introduce the challenge (5 minutes)

- Tell students today's challenge is to first get a helium-filled balloon to hover and then to move it around the room without anyone touching it. Mention that this challenge is similar to one that the kids did on the *Design Squad* TV show.
- Show ***Band Cam Challenge***, in which the *Design Squad* teams build a blimp to film a stage concert. Point out that in both the classroom and *Design Squad* challenges, kids need to control and direct their balloons.

2 Do Part 1 of *Sky Floater* (10 to 15 minutes)

- Show students the materials. Ask: How can you stop a balloon from floating upward? *(Add weight.)*
- Distribute the handout and have students do Part 1. 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.
- Part 1 takes anywhere from 5 to 15 minutes. Stop everyone after 15 minutes.

3 Process the science and engineering (10 minutes)

Show the ***Buoyancy*** video, which describes how a helium-filled balloon floats. Ask:

- What are the forces affecting 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.)*

The first task is to weight a balloon to make it neutrally buoyant.

Students make their balloons hover at face level for at least five seconds.

Students move their balloons around the room. They use cardboard to create a low-pressure air pocket. Nearby air moves into these air pockets, carrying the balloon with it.

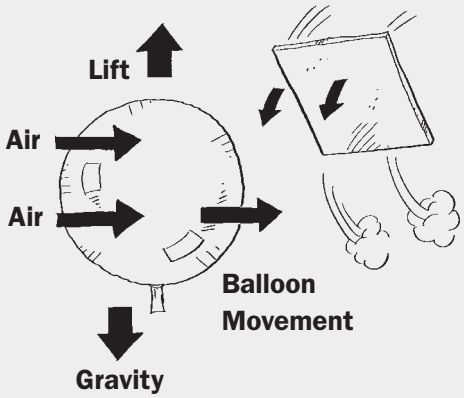
Once they learn how to move their balloons, students step them around a partner, one low-pressure air pocket at a time.

- 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****. In our testing, kids called air a "bully.")*
- 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.)*
- When will the balloon stop rising? *(When it hits the ceiling or rises to a point where the density of the air outside the balloon equals the density of the helium inside the balloon. When these two densities are equal, there is no longer a buoyant force.)*
- What steps of the 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; etc.)*

4 Give the class a "driving" lesson (5 minutes)

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.



5 Do Parts 2 and 3 of *Sky Floater* (10–15 minutes)

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 or race other teams.