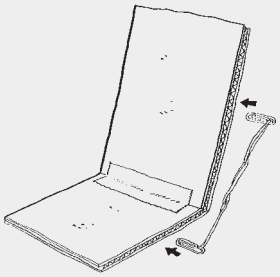
SKY GLIDER CHALLENGE

The Challenge: Build a blimp that travels in a straight path across the room.

Preparation

- ☐ Copy the *Sky Glider* handout (one per student).
- ☐ Visit pbs.org/designsquad and download the following video clips from the "Teacher's Guide" page: ***Air Resistance*** (1 minute), ***Axis of Rotation*** (1 minute), and ***Design Process: Testing the Axis*** *of Rotation* (1½ minutes). Be prepared to project them.
- ☐ Set up 3–4 launching stations. For each station, you'll need 2 sheets of corrugated cardboard (approx. 11x17 inches), duct tape, rubber bands, and paper clips.
- ☐ Gather these materials (per team of two):
  - *Sky Floater* balloons
  - clear tape
  - copier paper
  - scissors
  - small paper clips



Launching Station
Insert the paper clips so the rubber bands gently lift the launcher's back.

1 Introduce the challenge (5 minutes)

- Tell students that today's challenge is to build a blimp that can travel a straight path across the room. Point out how this activity is similar to the *Band Cam* challenge: The blimp must be neutrally buoyant and travel in a predictable way.
- Ask: Who might be interested in using blimps? *(People interested in moving heavy loads and using energy-efficient transportation. Blimps also make excellent eyes-in-the-sky for things like filming sporting events, TV broadcasts, surveillance, search-and-rescue missions, and observing wildlife.)*

2 Brainstorm (10 minutes)

Brainstorm air resistance

Tape together the wide faces of two balloons. Set them in motion using the launcher. Point out that the device launching the balloons is an example of one object transferring its kinetic energy to another.

- What keeps this pair of balloons from going across the room? *(Air resistance)*
- Drop a sheet of paper, first with the wide face perpendicular and then with it parallel to the floor. Ask: Which has the most ***drag*** (i.e., a force that resists an object's movement)? *(There is more drag when the wide face is parallel to the ground, and the paper falls more slowly.)*
- What are some things that are streamlined to cut easily through air or water? *(Sports cars, blimps, submarines, planes, fish, birds, etc.)*
- To reduce drag and move efficiently through the air, which face of a balloon should face forward? *(The narrowest one, so that it can slice through air)*
- What could you use to firmly hold two balloons in this orientation? *(A paper tube or tubes)*
- Show ***Air Resistance*** in which the *Design Squad* teams discuss how drag slows down flying objects.

First, students make a neutrally buoyant blimp out of two balloons. Many used a paper tube to connect their balloons.

Then, students use a rubber band-powered launching station to gently set their blimps in motion.

Next, students get their blimps to "fly" straight and far by streamlining them and lengthening their axis of rotation. Some students used fins to help their blimps travel straight.

Finally, in *Making It Real*, students discuss the science and engineering behind their designs and describe how they are thinking and working like engineers.

Brainstorm axis of rotation

- Show ***Design Process: Testing the Axis of Rotation.*** Point out how the Purple Team's blimp is held at just one point, making it easy for the blimp to spin.
- Spin the two balloons with your hands. Ask: Why do they spin so easily? *(They have a short **axis of rotation**—the point around which an object spins. Also, there is little force, such as air resistance, stopping the spin.)*
- What shape do objects that must travel long distances through the air—such as javelins, footballs, arrows, and rockets—have in common? *(They are much longer than they are wide.)*
- Show ***Axis of Rotation,*** in which the *Design Squad* teams stabilize a boat by lengthening its axis of rotation. In *Sky Glider*, students will lengthen the axis of rotation to help their blimps travel straight.

Brainstorm the design process

- Brainstorm ways to make a blimp from two balloons so it will have low air resistance. *(Students should suggest designs that have as little material as possible hitting the air as the blimp moves forward.)*
- Brainstorm ways to make a blimp from two balloons so it will travel straight and not spin. *(Students should suggest designs where there is a wide separation between the balloons.)*

3 Summarize the problem to solve (5 minutes)

- Break the larger challenge into its sub-challenges. Ask: What are some of the things you'll need to figure out as you make your blimp? *(How to: attach the two balloons; make them neutrally buoyant; launch them gently; keep them on a straight course; streamline them so they fly far; etc.)*
- To promote creative thinking and foster a sense of ownership, have students pair up and brainstorm their own ways of turning the materials into a blimp that can glide straight and far. Distribute the handout and have them sketch their ideas.

4 Build, test, and redesign (30 minutes)

Here are some strategies for dealing with issues that may come up during building:

- **Travel far:** Have students make streamlined designs to reduce air resistance.
- **Travel straight:** In our testing, students found that fins helped a blimp glide straight. As a blimp begins to veer from a straight course, the fin's wide side begins to hit a lot of air, taking advantage of drag and producing a force that helps the blimp resist turning. (NOTE: Wings only provide lift at high air speeds. Buoyant, lighter-than-air craft, such as blimps, go too slowly to make use of wings, so wings just add unnecessary, burdensome weight.)
- **Launch the same way:** Remind teams to launch their blimps the same way every time (i.e., use the same launcher, start from the same position, etc.). Otherwise, it's hard to know what affects a blimp's flight—a design change, the launcher, or the launching technique.
- **Record data:** Have teams record the distance traveled and keep track of any rising, falling, spinning, or traveling in an arc.
- **Storage:** Keep blimps intact until you finish the *Making It Real* session.