BLIMP JET CHALLENGE

The Challenge: Add a jet-propulsion system (i.e., a balloon) so that a blimp flies straight and far under its own power.

NOTE: *In Blimp Jet, there are many more variables than in Sky Glider. Because it can take many rounds of testing to get a blimp to travel a straight path, students must be patient and be able to work precisely.*

Preparation

- ☐ Visit pbs.org/designsquad and download the following video clips from the "Teacher's Guide" page: ***Newton's 3rd Law*** (1 minute) and ***Thrust & Newton's Laws*** (1 minute). Be prepared to project them.
- ☐ Gather these materials (per team of two). See page 44 for suppliers.
  - blimps from previous challenge
  - 4 sheets of paper
  - clear tape
  - balloon pump
  - scissors
  - 6 drinking straws (narrow and wide)
  - 12- to 16-inch latex party balloon (Long "rocket" balloons also work but hang down awkwardly.)

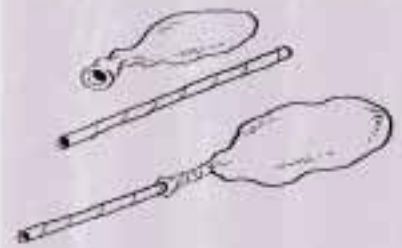
1 Introduce the challenge (5 minutes)

- Tell students that today's challenge is to add a jet propulsion system (in this case, a party balloon) so their blimps fly under their own jet power. Hold up a latex party balloon and a straw and make a jet. (See illustration.) *(Mention that the straw can help control how fast air escapes from the balloon.)*
- How can you use this jet to provide ***thrust***—a pushing force—to a blimp? *(Attach the jet to the blimp. To assure that the end of the jet stays pointing exactly where students want it to point, they should attach it to a stable, easy-to-access place, such as the frame connecting the two Mylar balloons. Demonstrate how to use a pump to inflate the balloon. Point out how the straw lets you inflate the balloon without having to detach the jet from the blimp.)*
- What force does the jet's thrust overcome? *(Inertia and air resistance [i.e., drag])*

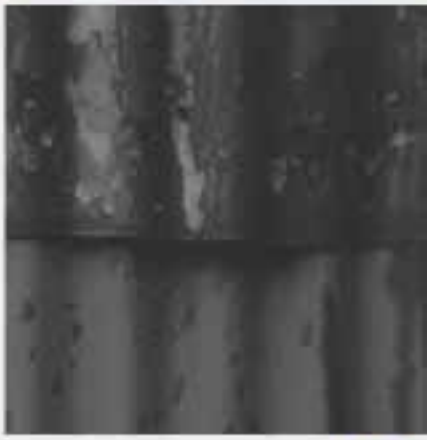
2 Brainstorm (10 minutes)

Brainstorm Newton's 3rd Law

- How is this jet an example of Newton's 3rd Law? *(Inside a sealed balloon, the air pushes out equally on all sides, so there is equal force on all parts of the balloon. But when you open the neck of the balloon, the air rushes out of the hole. When this happens, one area of the inside surface—the area with the hole—has less pressure on it than the other parts. The forces inside the balloon are now unbalanced—there is a greater force pushing on the area opposite the hole. So, the balloon moves in the direction of the greater force—the area opposite the hole. Since the balloon is attached to the blimp, this unbalanced force also pushes the blimp forward.)*
- Which way should the straw point? *(Opposite the direction students want the blimp to travel. Very small adjustments of where the straw points have a noticeable effect on how the blimp travels. This is why students must be willing to work carefully and precisely.)*



Make a blimp jet
To propel a blimp, make a "jet." Fit a straw into the balloon's neck. Seal it tightly with tape.



An inflated jet makes a blimp look ungainly, but it doesn't significantly impair the blimp's flight.

Students attach paper fins to help a blimp fly straight. This particular design won't travel as far as a more streamlined blimp, due to air resistance.

Accomplishing the challenge—getting a blimp to travel straight and far—gives kids a real sense of achievement.

- Watch both ***Newton's Laws*** videos. In one, the *Design Squad* teams use Newton's 3rd Law to propel and steer a fan-propelled boat. In the other, they build a flying football goalpost and grapple with balancing gravity and thrust. Discuss how their blimp jet similarly provides thrust using an action-reaction principle. Also point out the importance of reducing weight.

Brainstorm the design process

- Brainstorm good places to attach the jet. *(A bottom-heavy blimp is more stable; make sure the air stream flows freely and is not blocked by blimp parts.)*

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 add a jet to your blimp? *(Decide how to: mount the jet; inflate the balloon; make minor adjustments easily; document each test flight to understand how to modify the blimp and jet; etc.)*
- To promote creative thinking and foster a sense of ownership, have students pair up and brainstorm their own ways to add a jet.

4 Build, test, and redesign (30 minutes)

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

- **Modify the balloon pump:** Tips on commercial balloon pumps are too big to fit into straws. Insert a thin straw into the pump tip and seal it with tape. Now the thin straw can slip into a balloon jet's straw.
- **Make blimps neutrally buoyant:** To compensate for the added weight of the balloon jet, students will need to adjust their blimps to make them neutrally buoyant again.
- **Orient the blimp:** Top-heavy blimps don't stay level. Encourage students to tape the balloon jet toward the bottom of the blimp.
- **Tape the jet firmly in place:** The balloon jet wiggles if kids tape it in only one place. To anchor it well, students should tape it to the frame in at least two places.
- **Control the jet power:** The amount of air leaving the balloon jet makes a difference. If air escapes too quickly, the initial thrust is powerful, but it rapidly peters out. If the air escapes too slowly, there's too little thrust to overcome inertia and air resistance. Students might need to modify the straw to adjust the rate of the escaping air. Just make sure that the end of their straw still fits into the pump. Overfilling balloons will, of course, pop them. More air is not always the answer!
- **A second class period?** Students can achieve success in one class period and have a fun, memorable experience with Newton's 3rd Law. But devoting two sessions to *Blimp Jet* will really let students refine their systems.