HELPING HAND

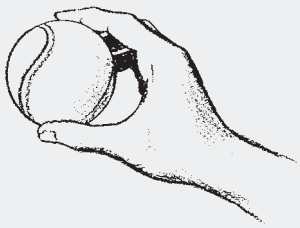
CHALLENGE 5
LEADER NOTES

The Challenge
Build a device that lets you grab different objects and drop them into a container that's at least two feet away.

In this challenge, kids (1) follow the design process to build a grabber that can reach at least two feet; (2) develop a way to open and close the grabber's jaw; and (3) figure out how to connect the "jaw" to a stick.

1 Introduce the challenge (5 minutes)
Begin by telling kids the challenge. Then get them thinking about what they need to do to make a squeezing motion. Ask:

- What's the difference between scooping and grabbing? (*When people scoop, they get a lot of something all at once and lift the items up as a group. When people grab, they get only one or two things at a time and handle them with more control.*)
- What kind of motion do you do to squeeze something? (*An opening and closing motion*)
- How does the design of your hand help you grip things? (*Your thumb and fingers give you two sides to put something in between. The muscles in your fingers can apply a pinching pressure.*)



- What other parts of the body can make a squeezing action? (*Jaw, arms, legs, elbows, feet, toes, tongue, lips, chin, eyelids*)
- What are some devices that people use to grasp things without actually touching them? (*Devices include: cooking tongs, chopsticks, hair clips, tweezers, a pooper scooper, pliers, binder clips, and a carpenter's vise*)
- What do all grabbing devices have in common? (*They all have two parts—or arms—that can go on each side of the item being grabbed. They also have a way to press these arms together to make a pinching motion. Some, like pliers and scissors, have a pivot connecting the two arms. The arms rotate [i.e., swivel or sweep] around the pivot.*)
- Tell kids that with each of these devices, the arms act as levers. A **lever** is a rigid bar that pivots around a fulcrum. In these devices, the **fulcrum** is the point around which the two arms swivel. Show kids a pair of pliers or scissors. Tell them that each blade is a lever arm and that the rivet holding the two blades together is the fulcrum.

2 Brainstorm and design (10 minutes)
Show kids the materials and ask, "How can you use these materials to build a device that lets you grab (not scoop) an object?" After discussing their ideas, have them sketch their designs on a piece of paper or in their design notebooks.

DESIGN SQUAD

SHOW KIDS THE RELATED TV EPISODE

Photo: Helen Tsai

In Helping Hand, kids figure out how to build a device to grab things. Show them the Water Dancing episode in which *Design Squad* teams compete to build swim fin prosthetics for a double-amputee dancer who performs underwater. Get it online at pbs.org/designsquad.

Photo: Natalie Hebshie

A grabber needs to have parts that can go on each side of an item and a way to pinch these parts together.

Photo: Natalie Hebshie

Engineers dream up creative, practical solutions and design and build things that change the world and make a difference.

Photo: Natalie Hebshie

Testing reveals things about a design and about the materials. Kids can use this information to improve a design.

3 Build, test, evaluate, and redesign (35 minutes)

Distribute the challenge sheet and have kids begin building. If any of the following issues come up, ask kids questions to get them thinking about how they might solve their problems.

- Jaws don't open or close. *Make sure kids have a way to both open and close the jaws. Sometimes they build one way but not the other. Next check that nothing is blocking the jaw's movement, that the two jaws can slide easily past each other, and that the jaws turn smoothly around the pivot.*
- Objects fall out of the jaw. *Check that the jaw closes firmly and completely enough to actually hold something. If the pressure is too gentle, brainstorm ways to strengthen it. Also see if the jaw's gripping surface can reliably hold on to things. If not, add cardboard to make it wider, sandpaper to increase the friction, or toothpicks to bite into an object.*
- The jaws bend, bow, or twist. *An opening-and-closing system using rubber bands and string can put a lot of stress on the jaws. Reinforce the jaws with something stiff, like extra cardboard or wooden skewers. Also, check if the jaws are longer than necessary. A jaw system with short arms is far less likely to bend than one with long arms.*
- The jaws don't work at the end of the stick. *Make sure the opening-and-closing system actually works. Sometimes a system looks good and works when a kid directly moves the parts but doesn't when there's no hand actually operating the parts at the end of the stick.*

4 Discuss what happened (10 minutes)

Have kids talk about their designs and how they solved any problems that came up. Emphasize key themes in this challenge—levers and mechanical squeezing systems—by asking questions such as:

- What are some situations where having a longer reach would be handy? (*When someone needs to get something that's out of reach*)
- Where can you find examples of levers in your grabbers? (*Many grabbers will have an arm or two that swings around a pivot. In these grabbers, each arm is a lever.*)
- What's an example of when you had to do something a few times to get the jaws to work the way you wanted? (*Answers will vary. But point out that engineers always revise their early ideas. It's part of the design-build-test process. Testing reveals things about a design and the materials. Engineers use that information to improve a design.*)

FOR EVENTS

This activity works best as a facilitated activity. We don't recommend using it at an event.

HELPING HAND

DESIGN SQUAD™ PBS®

as built on TV™

pbs.org/designsquad

YOUR CHALLENGE

Design and build a device that lets you grab different objects and drop them into a container that's at least two feet away from you.

BRAINSTORM & DESIGN

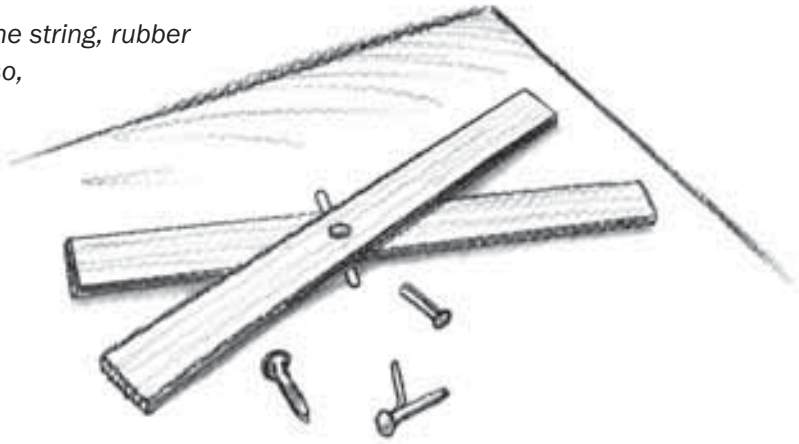
Look at your materials and think about the questions below. Then sketch your ideas on a piece of paper or in your design notebook.

1. Using these materials, what can you build to grab objects that are two feet away from you?
2. How will your grabbing device open and close so it can grip an object and let it go?
3. How will you attach your grabber to the end of the stick?
4. How will you control your grabber when it's at the end of the stick?

BUILD, TEST, EVALUATE & REDESIGN

Use the materials to build your grabber. Then test it by trying to pick up different objects. When you test, your design may not work as planned. When engineers solve a problem, their first solution is rarely their best. Instead, they try different ideas, learn from mistakes, and try again. Study the problems and then redesign. For example, if your grabber's jaws:

- have a weak grip—*Increase their force. Each arm of the jaw is a* **lever***—a bar that pivots around a* **fulcrum***. In this case, the fulcrum is the brass fastener. Change the strength of your jaw's grip by adjusting the length of the arms and the fulcrum's position. (See illustration.)*
- keep dropping things—*Make sure that the jaws close enough to actually hold something. Also see if the jaw's gripping surface is big enough and shaped right to have a firm grip.*
- bend or twist—*Reinforce them with something stiff. Also, check if the jaw's arms are longer than necessary—short arms don't bend as easily as long ones.*
- don't work at the end of the stick—*Make sure the string, rubber bands, and moving parts aren't getting stuck. Also, move the jaws with your hands. If they don't work the way they should, readjust the parts.*



MATERIALS (per person)

- 4 brass fasteners
- corrugated cardboard
- hole punch
- objects to pick up (e.g., tennis balls, cotton balls, plastic soda bottles, and paper cups)
- 2 rubber bands
- sandpaper
- scissors
- string
- tape (duct or masking)
- 4 toothpicks
- 4 wooden skewers
- yardstick (or long paint stirrers for 5-gallon buckets, a thin wooden slat, or lath 2–3 feet long)

TAKE IT TO THE NEXT LEVEL

- Supersize me! Build a grabber that can pick up two objects at once.
- Smooth moves! Add a second motion to your grabber, such as making the stick that holds the jaws able to bend like an elbow or extend another two feet and then retract.

MAKE IT ONLINE

Blast me a marshmallow, would ya?
Build an air-powered marshmallow launcher out of plastic pipe and marshmallows. See how on Make Magazine's project page at makezine.com/designsquad.

ENGINEERING IN ACTION

There's something unique about four-year-old Michael—he has four hands! Born with six inches of his left arm missing, Michael wears a standard prosthetic (i.e., artificial) hand. It has some limitations—Michael can pick up and hold things but can't squeeze or press very hard. Michael's father wanted him to be able to do more with his prosthetic hand and have some fun in the process. With this in mind, he contacted engineers at the Open Prosthetics Project. Together, they built Michael two more hands—hands unlike any you've seen! One is a dinosaur puppet. Michael grips things by controlling its jaws. The other is a fishing rod. Michael uses it to catch fish as well as to reel in stray toys. Michael's father continues to think up and build more hands for Michael. "Once you have the training," he says, "you can conceive, design, and build whatever your imagination pictures."

DESIGN SQUAD PBS

Watch the DESIGN SQUAD Water Dancing episode on PBS or online at pbs.org/designsquad.

cpb intel Education NCEES National Council of Examiners for Engineering and Surveying NOYCE FOUNDATION NORTHROP GRUMMAN Foundation IEEE

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