CHALLENGE 3
LEADER NOTES

Down to the Core

CHALLENGE: Design and build a device that can take a core sample from a potato.

LEARNING GOALS: *Science:* Potential and kinetic energy, force (i.e., Newton's 2nd Law); *NASA:* Tools that sample the composition of planets, moons, and asteroids; *Engineering*: Design process

NASA CONNECTION: Many NASA spacecraft collect rock and soil samples to learn about a planet's, moon's, or asteroid's chemistry, potential to support life, and geologic history.

GET READY AHEAD OF TIME

- If possible, make a few different kinds of corers to stimulate kids' thinking.
- **Cut potato slices.** Slice potatoes for kids' testing. Slices should be 1 centimeter (½ inch) thick.
- **Get the videos.** Go to pbskids.org/designsquad/links/solarsystem. Download the *Down to the Core,* Allison Bolinger, and NASA videos. Be prepared to project them. If you're unable to show videos, review the handout's overview and steps and tell kids about the NASA work described in the overview and in Step 1.
- **Photocopy.** Copy the handout and performance assessment rubric.

MATERIALS (per corer)

- 12 craft sticks
- 4 flexible plastic straws
- 6 small (i.e., ¾-inch) or 4 medium (i.e., 1-inch) binder clips
- 8 rubber bands
- 2 potato slices (1 cm [½ inch] thick)
- Tape (any kind)
- Optional: 1 paper cup (6-ounce or larger)
- Optional: 1 sharp pencil for poking holes in the cup
- Optional: a wide straw that the flexible straw fits into

In *Down to the Core*, kids design and build a device that drives a straw into a potato to take a core sample.

1 INTRODUCE THE CHALLENGE (10 minutes)

Set the stage

- Ask: What are some examples of people taking samples? (*Cooks sample the food they prepare. Scientists studying what the climate was like in the past take cores from ice and trees. Doctors sample human tissue to detect diseases like cancer. Geologists sample rock to locate oil and mineral deposits.)*
- Tell kids the challenge and show them the *Down to the Core* video.

Relate it to NASA missions

Show the *Curiosity* rover animation. At 4:25 in the clip, point out the rover's sampling and analysis techniques. Tell kids that rock and soil samples reveal a lot about a planet's, moon's, or asteroid's chemistry, potential to support life, and geologic history.

Kids can add binder clips to the plunger. When pulled back against the rubber bands, the added weight (i.e., mass) gives the plunger more potential energy, enabling it to do more work.

2 BRAINSTORM AND DESIGN (10 minutes)

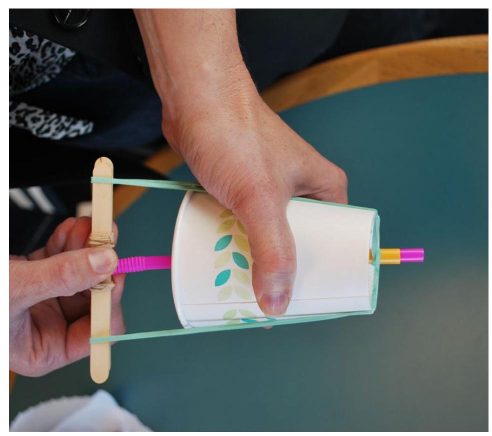
Identify the problem. Have kids state the problem in their own words (e.g., build a tool that can cut out a piece of potato).

Demonstrate the activity's sampling technique. Pick up a slice of potato and drive a straw through it. Show kids how the straw cut a sample out of the potato. Tell them that when NASA can't send a person into space to collect samples, it has to be done mechanically.

Show kids different kinds of coring devices. If you made sample corers, show kids your collection. This will give them ideas for frames (cup, craft sticks, cardboard), ways to hold the frame together (rubber bands, tape, binder clips), ways to connect the straw and crosspiece (tape, rubber bands, clamping), and how to connect the plunger (i.e., the straw connected to the crosspiece) to the frame. If you don't have samples, review the ideas on the handout.

Review the corer's key components

- What does the potato slice represent? *(The surface of a planet, moon, or asteroid)*
- What part will do the cutting? *(The straw)*
- What will you use to drive the straw into the potato? *(Rubber bands)*
- How will you hold the rubber bands and plunger? *(With a frame)*



Kids can use a wide straw as an outer casing to stabilize the thin straw sliding up and down inside. This is similar to how the outer casing in a push-pop ice cream treat stabilizes the flimsy ice cream.

3 BUILD, TEST, EVALUATE, AND REDESIGN (30 minutes)

If any of these issues come up, ask questions to get kids thinking about how they might solve them.

- **If the straw tip bends or breaks…** Have kids snip off the deformed end or use a new straw.
- **If the straw won't penetrate the slice…** Tell kids to add rubber bands to increase the force of the plunger. Or suggest that they add some binder clips to the plunger to increase its weight (i.e., mass). With more weight there is more potential energy when the plunger is pulled back against the rubber bands, enabling the straw to do more work.
- **If the straw bounces off the potato…** Have kids make a guide for the straw. For example, kids can run the straw through a hole poked in the bottom of a paper cup, similar to how the barrel of a clickable ballpoint pen keeps the tip steady. (See photos.)

When kids stretch the rubber bands, they build up potential energy. When they release the plunger, this potential energy changes to kinetic energy. When the straw hits the potato, the kinetic energy changes to mechanical energy and does work.

4 DISCUSS WHAT HAPPENED (10 minutes)

Emphasize key elements in today's challenge by asking:

- **Engineering:** What features helped your coring tool be effective? (*Answers will vary.*)
- **Science:** Your coring tool turns potential (stored) energy into kinetic (motion) energy. Explain how it does this. (*When kids stretch the rubber bands, they build up potential [stored] energy. When they release the rubber bands, the potential energy changes to kinetic [motion] energy. When the straw hits the potato, the kinetic energy changes to mechanical energy and does work. With more potential energy, the straw can penetrate more deeply and do more work.*)
- **NASA:** Why are NASA scientists interested in sampling planets, moons, and asteroids? (*Rock and soil samples reveal a lot about a planet's, moon's, or asteroid's chemistry, potential to support life, and geologic history. NOTE: Surface materials can change when they are exposed to wind and water or can mix with other materials [e.g., soil]. For the most reliable analysis, scientists want to get samples from below the surface.*)
- **Career:** Show kids the engineer profile featuring Allison Bolinger. One day, astronauts will visit asteroids and other planets and moons. As a spacewalk flight controller and trainer, Allison gets astronauts ready to work outside a spacecraft. They need to know how to use their tools while floating weightlessly in a bulky spacesuit. Download the profile sheet for fun facts, discussion prompts, and extension ideas.

EXTEND THE CHALLENGE

- **Build a spaceship.** Have kids add space-related components to their coring tools. For example, duct tape can represent solar panels. Kids can add rockets, fins, radio dishes, and other instruments to represent spacecraft components.
- **Add a way to easily remove the sample from the straw.** Have kids figure out how to push or blow a sample out of the straw.

CURRICULUM CONNECTIONS

Use *Down to the Core* to engage, explain, and extend student understanding of the following topics:

- **Potential, kinetic, and mechanical energy.** In this challenge, kids store energy (called potential energy) by stretching rubber bands. When they release the straw, this potential energy turns into motion (kinetic) energy and moves the straw forward. The straw's kinetic energy is then converted to mechanical energy when the straw penetrates the potato.
- **Newton's 2nd Law.** Adding weight (i.e., mass) to the plunger gives it more potential energy when you pull the plunger back against the rubber bands. More potential energy enables the plunger to do more work. This demonstrates Newton's 2nd Law—force equals mass times acceleration. Since acceleration is roughly the same for each trial, force is directly related to mass.

Down to the Core

To find water, interesting minerals, or even life, you have to dig into a planet, moon, or asteroid. When NASA can't send a person to collect samples, they send spacecraft with tools that can take samples.

We challenge you to...

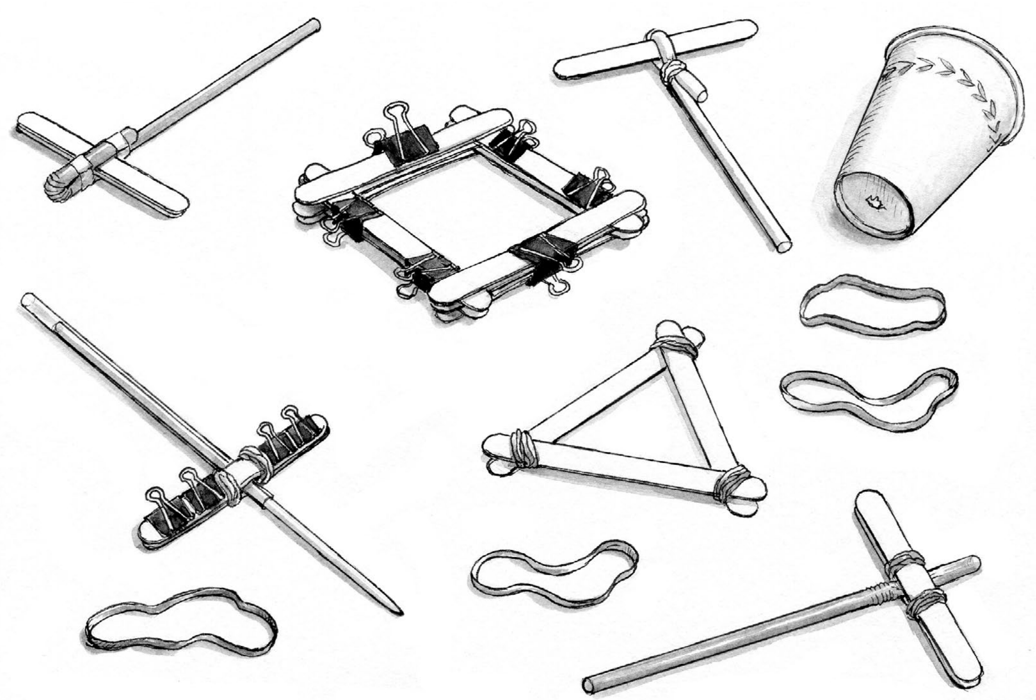
...design and build a tool that can take a core sample from a potato.

1. Identify the problem and brainstorm

- What will you use to drive the straw into the potato (i.e., the "asteroid")?
- What kind of frame can you make to hold the rubber bands and straw?

2. Design and build

Below are some ideas for coring tools. Invent your own design or improve on one of these.



Materials (per corer)

- 12 craft sticks
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- 6 small (i.e., ¾-inch) binder clips
- 8 rubber bands
- 2 potato slices (1 centimeter [½-inch] thick)
- Tape (any kind)
- Optional: a wide straw that the flexible straw can fit into
- Optional: 1 paper cup (6-ounce or larger)
- Optional: 1 sharp pencil

Words to use

- **potential energy:** *Stored energy*
- **kinetic energy:** *Motion energy*
- **asteroid:** *One of the many small, rocky bodies that orbit the sun and lie between Mars and Jupiter. They range in size from less than a kilometer (half a mile) to nearly 800 kilometers (500 miles).*

3. TEST, EVALUATE, AND REDESIGN

- **If the straw tip bends or breaks…** Snip off the broken end or use a new straw.
- **If the straw doesn't go into the potato…** Try adding more rubber bands. Also, boost the plunger's force by adding weight, such as binder clips.
- **If the straw bounces off the potato…** Make a guide for the straw.

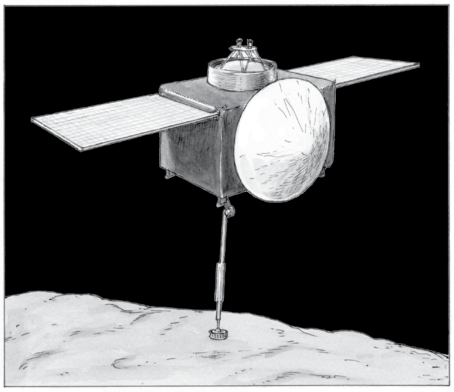
Check out NASA's missions at nasa.gov

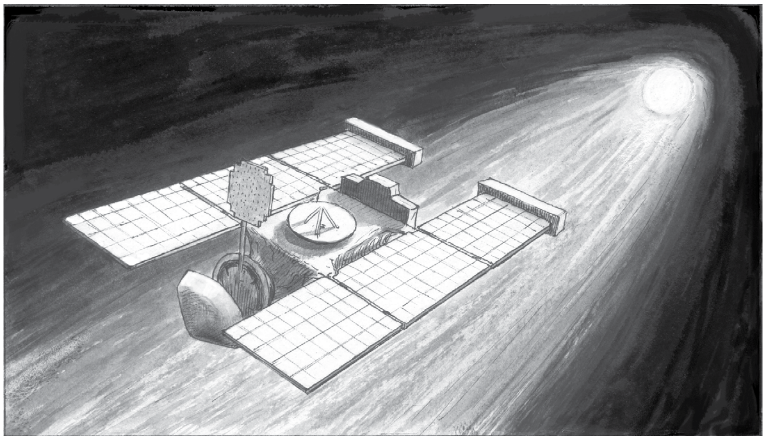
4. TRY THIS NEXT!

- Invent an easy way to remove the sample from the straw.
- Make your coring tool into a spaceship. Add rockets, fins, solar panels, radio dishes, and other spaceship components.

NASA EXPLORES SPACE

Osiris Rex will collect samples from asteroids. It uses a tool similar to your corer. Scientists study asteroids to learn about what the solar system was like when it formed five billion years ago. *Osiris Rex* will launch in 2016, with samples returning to Earth in 2023. Think about becoming a NASA scientist, and you could do research with these samples!





The *Stardust* spacecraft collected dust grains from the gases coming off a comet called Wild 2. *Stardust* then returned to Earth, delivering thousands of comet grains.

Visit the *Design Squad Nation* website at pbskids.org/designsquad.

MAJOR FUNDING NSF PROJECT FUNDING NORTHROP GRUMMAN Foundation S. D. BECHTEL, JR. FOUNDATION STEPHEN BECHTEL FUND ADDITIONAL FUNDING

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DESIGN CHALLENGE PERFORMANCE ASSESSMENT RUBRIC

Challenge name: ______________________________

Names of team members: ______________________________

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Identifying the problem(s) and brainstorming solutions	Showed a clear understanding of the problem(s) to solve. Independently brainstormed solutions.	Needed some teacher direction to define the problem(s) and brainstorm possible solutions.	Needed lots of teacher direction to define the problem(s). Little if any independent brainstorming.	**Points:**
Working as a team member	Worked well together. All team members participated and stayed on task.	Some team members were occasionally off task.	Most team members were often off task and not cooperating or participating fully.	**Points:**
Using the design process	Team brainstormed many design ideas and tested and improved the design. Final design complete or nearly complete and shows creative problem solving.	Some team members were occasionally off task.	Team brainstormed few design ideas and did little testing or redesigning. Final design lacks clear design idea(s).	**Points:**
Processing the science and engineering	Team gave a strong presentation of its solution to the challenge and showed clear understanding of the science concepts and design process.	Team gave a basic presentation of its solution to the challenge and showed basic understanding of the science concepts and design process.	Team gave a weak presentation of its solution to the challenge and showed little understanding of the science concepts and design process.	**Points:**
				Total Points:

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