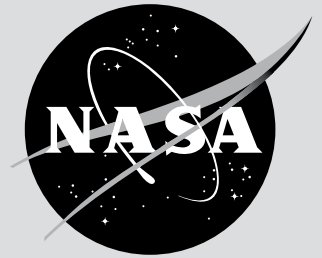


HEAVY LIFTING



Living on the moon gets expensive fast. Shipping things from Earth costs about \$25,000 a pound! No wonder NASA plans to use materials found on the moon, such as calcium compounds to make cement and nitrogen compounds to fertilize crops. To mine materials like these, astronauts use cranes for digging and moving heavy or bulky loads.

WE CHALLENGE YOU TO...

... design and build a crane and see how heavy a load it can lift.

BRAINSTORM AND DESIGN

Think about things that might affect how heavy a load your crane can lift.

- How will you keep the crane's arm from breaking off the box as it lifts a load?
- How will you stop a heavy load from pulling the arm to the left or right?
- How will you wind and unwind the cable so the hook can go up and down?

BUILD

- 1. First, make the arm.** The arm holds the string up and away from the crane's body. Use one, two, or all three cardboard strips to design your arm. Then attach it to the box.
- 2. Next, make a take-up reel.** Figure out how to make a take-up reel that lets you shorten and lengthen the cable. (Optional: add a crank to turn the take-up reel.)
- 3. Finally, add the string, hook, and cup.** Run the string through the arm. Attach it to the take-up reel and hook. Poke holes in each side of the cup near the rim. Make a handle for the cup and slip it onto the hook.

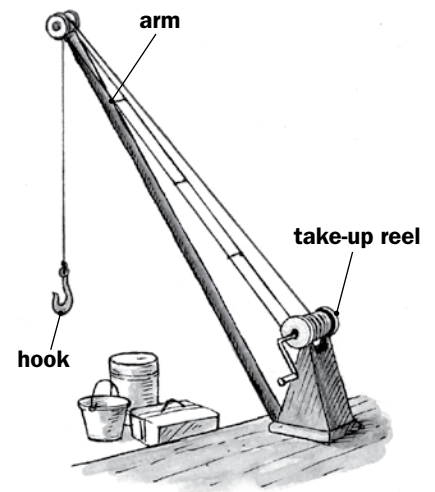
MATERIALS (per crane)

- cardboard box (shoebox size or bigger)
- 3 strips of corrugated cardboard (2 x 11 inches/5 x 28 cm)
- paper clip
- large paper cup
- 3 sharpened pencils
- scissors
- smooth string (e.g., fishing line or kite string)
- tape
- weights (e.g., batteries, pennies, marbles, or gravel)

TEST, EVALUATE, AND REDESIGN

Ready to test? Add weight to the cup. What's your crane's breaking point? Engineers improve their designs by testing them. The steps they follow are called the design process. Try some ideas and build an improved version. If:

- **the load rips the arm off the box**—Reinforce how it attaches. Add cardboard supports. Or cut slits in the box to hold the arm. Also, add tape to the top and underside of the box.
- **the arm crumples**—Start over with new cardboard. Also, use several pieces of cardboard for an arm, either all together or spaced apart.
- **the load pulls the arm to the side**—Use extra cardboard or string to add support.
- **the crank handle bends or slips**—If it slips, tape it or attach it more firmly. If it bends, reinforce it.

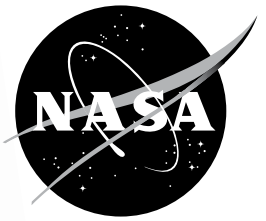
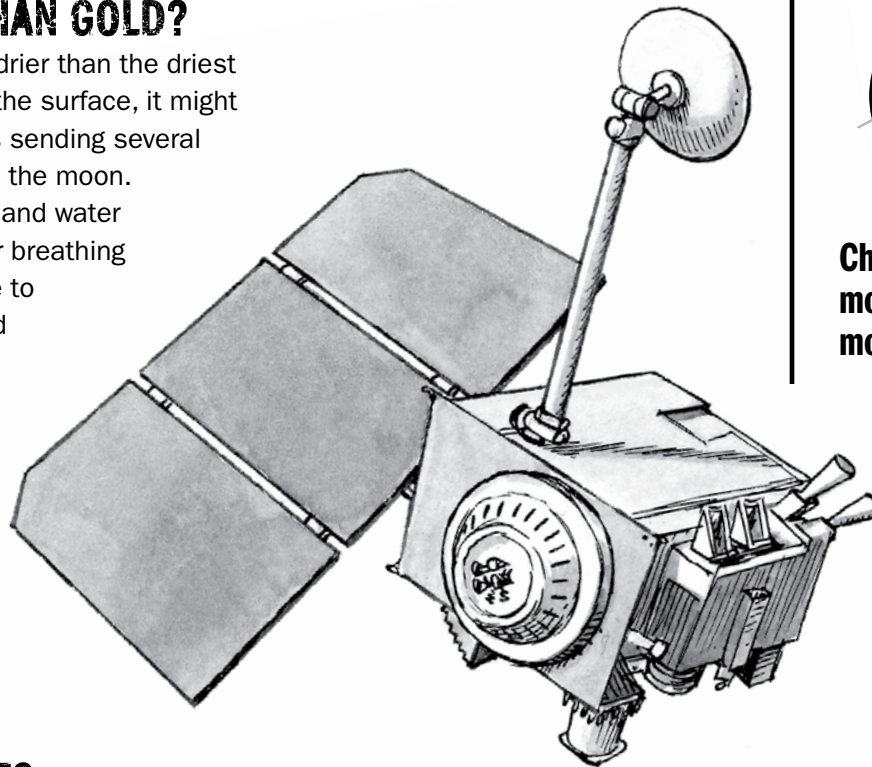


This hand-operated crane shows you the parts you'll need to include on your crane.

MORE PRECIOUS THAN GOLD?

The surface of the moon is drier than the driest desert on Earth. But under the surface, it might be a different story. NASA is sending several spacecraft to look for ice on the moon. Ice can be made into water, and water can be made into oxygen for breathing and fuel for the return home to Earth. If the spacecrafts find ice, one way to extract it is to use cranes.

NASA's Lunar Reconnaissance Orbiter (right) will study the moon's surface to find ice. If there's ice, cranes will help astronauts mine it.

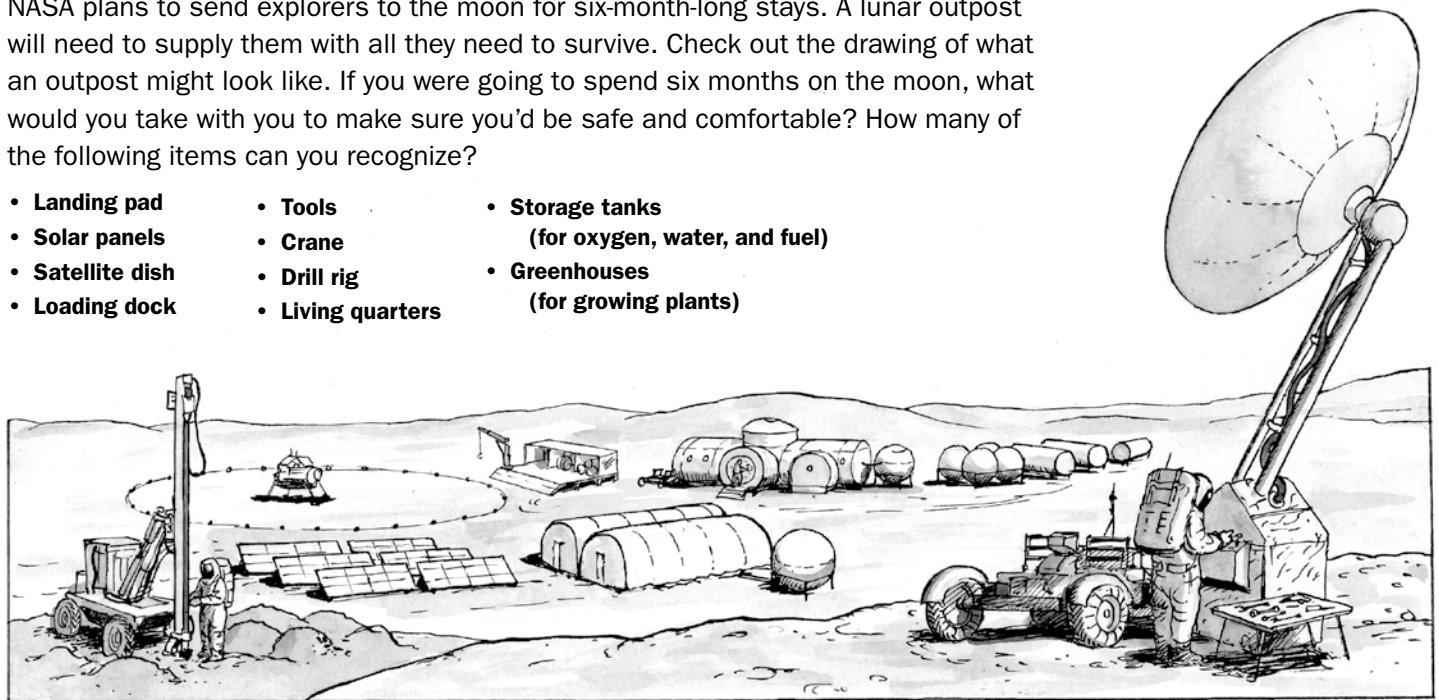


Check out NASA's moon missions at moon.msfc.nasa.gov.

HOME SWEET HOME?

NASA plans to send explorers to the moon for six-month-long stays. A lunar outpost will need to supply them with all they need to survive. Check out the drawing of what an outpost might look like. If you were going to spend six months on the moon, what would you take with you to make sure you'd be safe and comfortable? How many of the following items can you recognize?

- Landing pad
- Solar panels
- Satellite dish
- Loading dock
- Tools
- Crane
- Drill rig
- Living quarters
- Storage tanks (for oxygen, water, and fuel)
- Greenhouses (for growing plants)



Watch **DESIGN SQUAD** on PBS or online at pbs.org/designsquad.



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