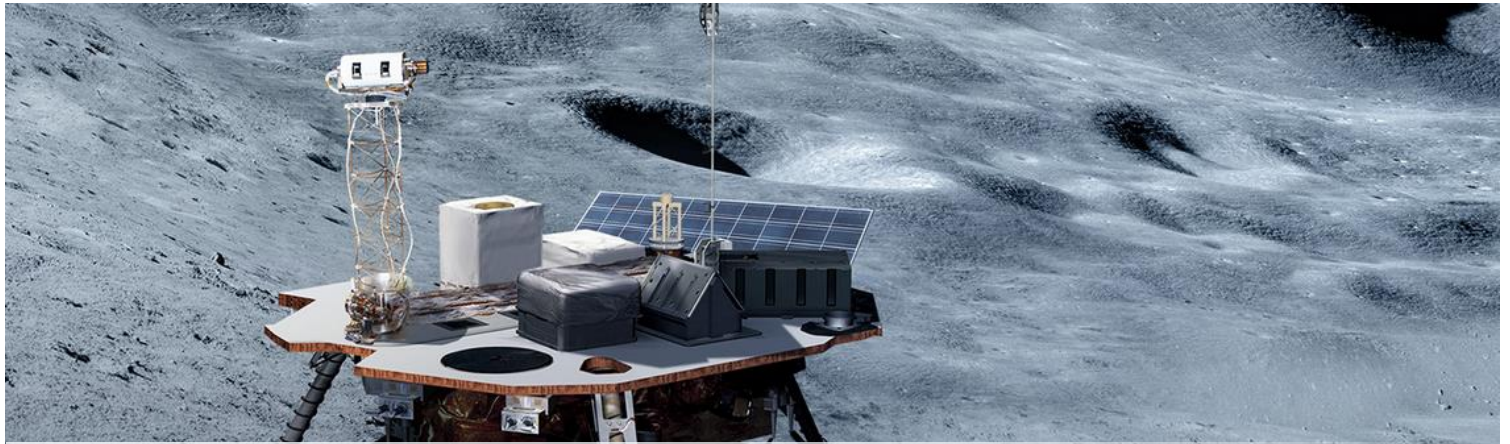




Digging on the Moon

NASA STEM – Hands-on Activity

Background Information

As NASA travels to the Moon and beyond, a sustainable infrastructure must be established to ensure a lasting lunar presence. This will allow for greater exploration and study of the Moon. Astronauts will live and work in space for longer periods of time, which means that their access to supplies will be less immediate. What if we could generate products from materials that are contained within the Moon's regolith (lunar soil)? This practice is called in-situ resource utilization (ISRU). Before Artemis astronauts land on the Moon, robots will scout the surface and collect information about the lunar South Pole. The data the robots gather will help scientists understand existing in-situ resources as well as assist in NASA's search for water at the Moon's poles. Additionally, robots could help identify and assess the abundance and quality of water in lunar areas expected to contain ice.

In this activity, participants will be challenged to compare the properties of ice with simulated icy-regolith, like the icy-regolith found on the Moon's south pole and design a robot drill that will drill down into the simulated icy-regolith.

Career Connection

Developing new technologies with robotics is an emerging field of study. The use of robotics in space requires a team of people with diverse expertise and specialized skills working together to develop the technology necessary to enable communication between the robot, astronauts, and Earth. Below are a couple of examples of the types of careers that will help in this effort:

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Grade Range:
6-12



Time Needed:
60 Minutes



Materials List for Drill Bot (per team):

- Battery powered toothbrush (check discount stores for this item)
- Foam noodle or plastic cup
- Rubber bands
- Electrical tape
- Metal washers or pennies
- Plastic spoon
- Craft sticks
- Chop sticks
- Push pin
- Paper clips
- Eye protection

- **Robotics** careers develop, implement, and maintain technologies that deploy robotics. These types of careers focus on programming and smart manufacturing to ensure everything operates safely and efficiently.
- **Resource Extraction and Mining Technology** careers focus on the efficient extraction of natural materials. This includes exploration, drilling, mining, and geosciences.

Materials List for Simulated Icy-Regolith

- Container (e.g., ice cube tray, plastic cup)
- Sand
- Water

Activity Procedures

Preparation:

1. Gather and prepare all listed supplies.
2. Group students into teams of three to five.
3. Prepare water for icy-regolith:
 - Fill half the container with water and half with sand. Place the container in the freezer overnight.
 - Simulated icy-regolith must be used immediately once taken out of the freezer.
4. Assemble the drill bot using the instructions on the last page of this activity as an example.

Safety

Ensure:

- Participants are mindful of any potential student allergies regarding the supplies used in this activity.
- Participants wear eye protection when building and digging in the simulated icy-regolith.
- Participants practice safe cutting techniques and scissor handling when building their robot drill (drill bot). Confirm participants carefully support the piece being cut and are careful with placement of the supporting hand.
- Participants avoid moving about the room with scissors or other sharp objects.
- Participants tape the terminal ends of the batteries with electrical tape when they are not stored in their original packaging.
- Participants tape all bare wire and exposed electrical connections with electrical tape.
- Participants review their build with the educator before turning it on.

Procedure

5. Allow students to see all the materials before building their drill bot.
6. Have student teams create a sketch of their proposed drill bot, complete with labels and descriptions of the materials used.
7. Have students keep in mind the following questions:

- How will you ensure that the digging device will not break?
- What mechanism will you use to ensure that the drill is breaking up the water ice?

After reviewing each group's drawing, allow students to retrieve the needed materials to construct their drill bot.

8. Have teams construct their drill bot and ensure students are following safety protocols. Their drill bot must use only one device for digging (e.g., chopsticks, craft sticks, paper clip).
9. Once students have created their own drill bot, allow them to test it on the simulated icy-regolith. Ensure teams are not adding any additional weight to their drill bot and are not using their hands to move the drill around. The vibration should move the drill.
10. Ask these guiding questions as the teams work:
 - Is the design working as expected?
 - What can be improved to change it?
 - What are the weaknesses in the design, and what can be done to overcome the weaknesses?
 - Do you think additional weight needs to be added to the drill? If so, where would you add it?

Challenge Questions

- What are some of the difficulties your team faced during the initial design and build process, and how did you overcome them?
- Were you surprised at how difficult it was to drill through simulated icy-regolith?
- What impressed you about another team's model?
- How were you able to improve your design? What changes did you make, and how did they improve your drill bot's performance?

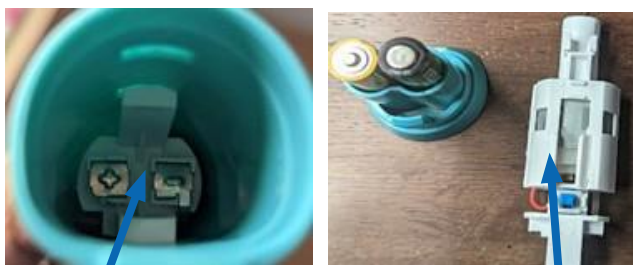
Extension

- Have participants design and create a drill bot using simple machines or a robotics kit.
- Include a small object in the icy-regolith, such as a penny, for the students to excavate with their drill bot.

Directions for assembling the drill bot:

1. Assemble all supplies needed.
2. Use eye protection for this step. Remove the bottom end of the electric powered toothbrush. Remove the battery compartment. The motor will be underneath the battery compartment. Do not use a sharp object to pop the motor loose.
3. There will be two separate compartments that will need to be taped together with electrical tape for a complete motor.

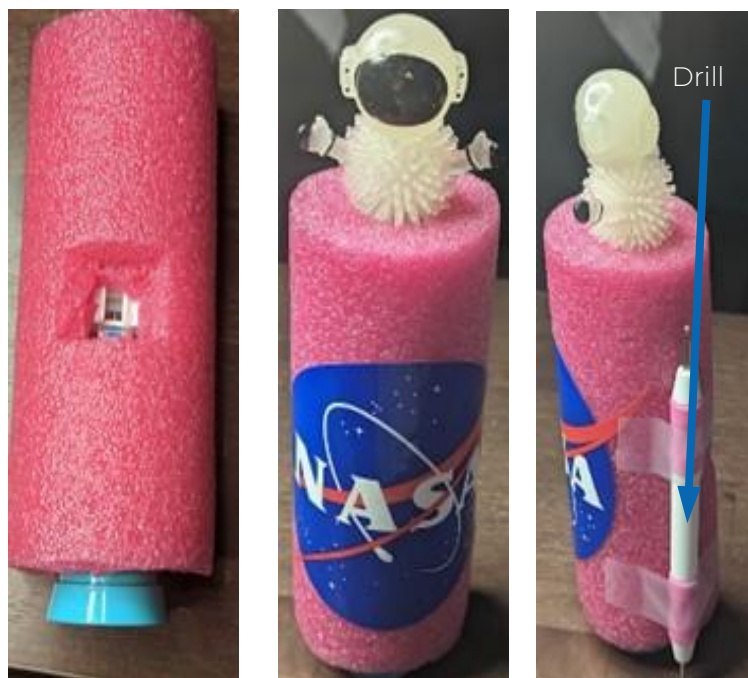
Note: Each toothbrush motor looks different, so the motor removed may not look like the one below.



Motor to be removed Battery Compartment Motor



Battery Compartment Electrical Tape Motor



Alternatives to using an electric toothbrush include:

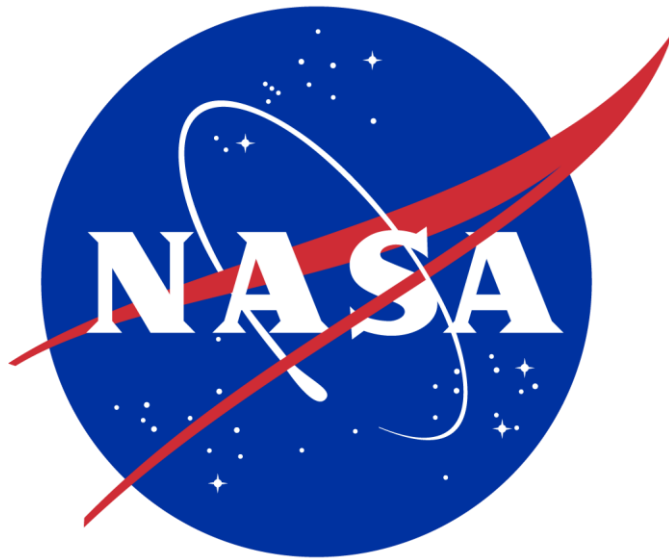
- Battery Packs: 1.5V AA Battery Holder Case with on/ off switch
- Motors: Vibration motor DC 1.5-6V 5200 RPM
- AA Batteries

4. Once the motor and battery compartment are taped together using electrical tape, insert the two parts into your noodle. *Note: It is easier to cut a small hole in the front of the noodle to allow access to the on/off switch for the motor.* All exposed connections must be taped. The power must be off and completely taped with electrical tape to cover all exposed wires and conductive (metal) parts and exposed connections. All students must have the educator review their "build" before it is used to ensure all exposed conductive parts have been taped.

1. Test to make sure that the drill bot can move easily before adding the drill or any decorations.
2. Add your drill and test it using the water ice provided. The students will decide what their drill will be (e.g., plastic spoon, craft stick, etc.).

Here are some examples of problems students may encounter and some suggestions:

- The drill bot moves too fast around the icy-regolith.
 - The students should consider adding some weight (washers or pennies may be used). Students need to determine where the weight should be added to make the drill bot more stable.
- The motor is not rotating freely.
 - The students can enlarge the hole of the foam noodle to allow for more vibration for movement.



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