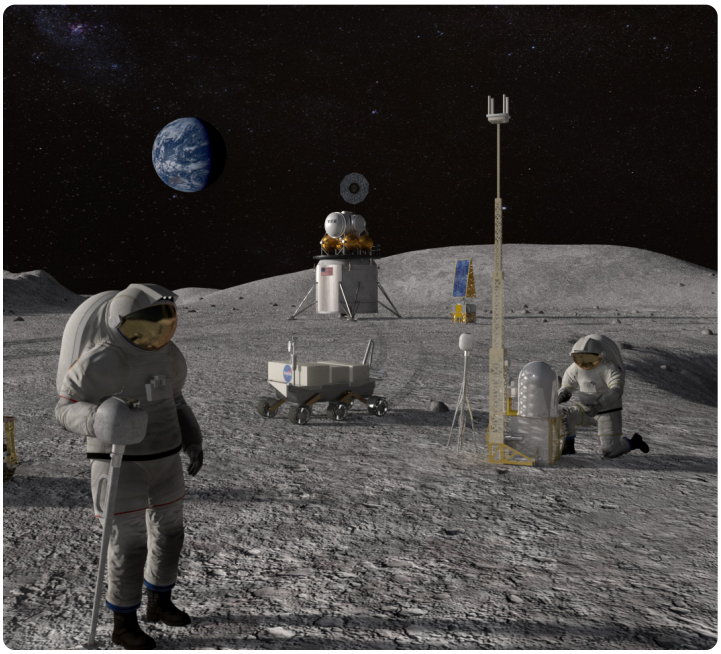
NASA STEM ACTIVITY

IMPACT CRATERS

National Aeronautics and Space Administration

BACKGROUND

The Artemis 3 mission will land the first woman and next man on the southern pole of the Moon. Our orbiting platform, Gateway, will give us the opportunity to land in almost any location we choose using an ascent/descent vehicle that will be docked with the station. The location on the “bottom” of the Moon, along with the high rims of the craters, make it possible for there to be permanently shadowed regions that contain water and ice. Traveling to this region will help us identify areas rich in water and other resources, and how to best use those materials available to us on the lunar surface.



CHALLENGE

In this activity, you will model and measure aspects that affect the appearance of impact craters.

MATERIALS

- Marbles or other objects such as steel shot, ball bearings, golf or wooden balls
- A high-walled pan. Pans should be plastic, aluminum or cardboard. Do not use glass. Pans should be at least 7.5 cm deep. Basic 10"x12" aluminum pans or plastic tubs work fine, but the larger the better. A larger pan may allow you to drop more marbles before having to resurface the target materials.
- Any dry powdery material that can look like the Moon's surface. It is important that the materials allow you to create different kinds of layers, and to use contrasting colors.
- Ruler or measuring tape
- Digital or food scale
- Newspaper or other covering to protect floors (if inside)

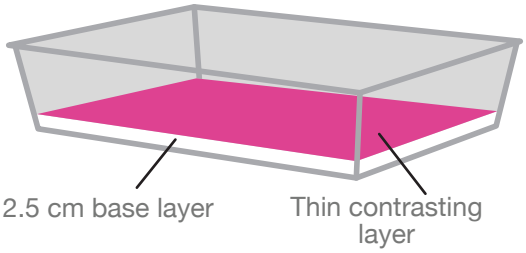
LUNAR SURFACE MATERIALS

- **All purpose flour**: Reusable in this activity and can be preserved in a covered container.
- **Baking soda**: Reusable in this activity, even if colored, by adding a clean layer of new white baking soda on top. Keeps indefinitely in a covered container. Baking soda mixed (1:1) with table salt also works.
- **Corn meal**: Reusable in this activity but probably not recyclable. Keeps only in freezer in an airtight container.
- **Sand and/or corn starch**: Mixed (1:1), sand must be very dry. Keeps only in freezer in airtight container.
- **Dry tempera paint, powdered drink mix, cocoa powder, or glitter**: Sift on top using screen or flour sifter. A contrasting color to the base materials gives striking results.

PREPARING YOUR LUNAR TEST SURFACE

Look at craters in pictures of the Moon or other planetary bodies. Brainstorm.
How do you think craters were formed?
What do you think affected the appearance and size of the craters and ejecta?

Crater images can be found in NASA's searchable image catalog at:
www.nasa.gov/multimedia/imagegallery/index.html



1. Spread newspapers under the pan(s) to catch spills or consider doing the activity outside. Replace the paper when you switch impactors.
2. Fill the pan with your chosen material to about 2.5 cm and smooth the surface so it settles evenly.
3. Sprinkle a fine layer of a dark, contrasting material evenly until it completely covers the surface.
4. Practice dropping the impactors before you record the data. It's best to record data before trying to remove the impactor.

CRATERING PROCESS

1. Measure the mass of each impactor. Record the mass on the data chart.
2. Drop impactor #1 from a height of 30 cm onto the prepared surface.
3. Measure the diameter and depth of the resulting crater.
4. Note the presence of ejecta (rays). Count the rays, measure and determine the average length of all the rays.
5. Record measurements and any other observations you have about the appearance of the crater on the data chart. Complete three trials and compute the average values.
6. Repeat steps 2 through 5 for impactor #1, increasing the drop heights to 60 cm, 90 cm and 2 meters. Complete the data chart for these as well.
7. Now repeat steps 1 through 6 for two more impactors. Use a separate data chart for each impactor.
8. Graph your results by creating two graphs.
9. Graph #1: Average crater diameter vs. impactor height or velocity.
10. *Graph #2: Average ejecta (ray) length vs. impactor height or velocity.*

Tip: On the graphs you can use different symbols (e.g., dot, triangle, plus, etc.) for different impactors, to make your data easier to read.

LEARNING ABOUT MOON CRATERS

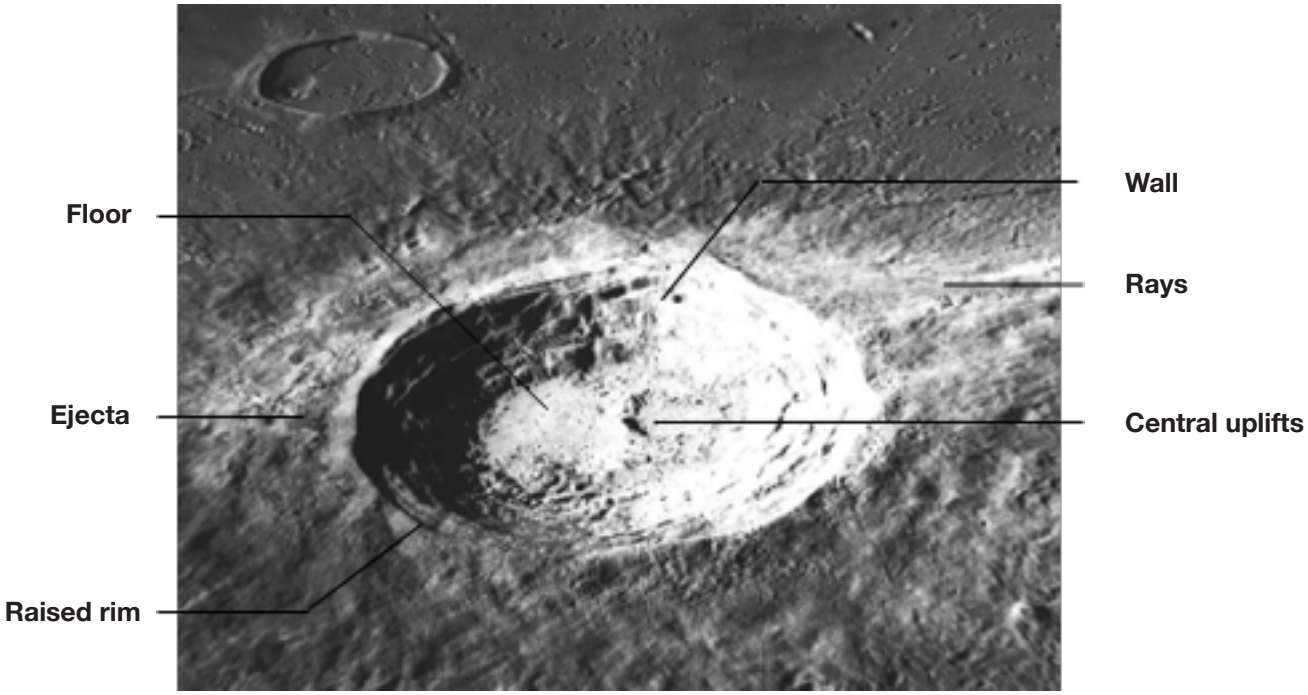
The circular features so obvious on the Moon's surface are **impact craters** formed when **impactors** smashed into the surface. The explosion and excavation of materials at the impacted site created piles of rock (called **ejecta**) around the circular hole as well as bright streaks of target material (called **rays**) thrown for great distances.

Two basic methods forming craters in nature are:
1) impact of a **projectile** on the surface and:
2) Collapse of the top of a **volcano** creating a crater termed caldera. By studying all types of craters on Earth and by creating impact craters in experimental laboratories geologists concluded that the Moon's craters are impact in origin.

The factors affecting the appearance of impact craters and ejecta are the size and velocity of the impactor, and the geology of the target surface. By recording the number, size, and extent of erosion of craters, **lunar geologists** can determine the ages of different surface units on the Moon and can piece together the geologic history. This technique works because older surfaces are exposed to impacting **meteorites** for a longer period of time than are younger surfaces.

WHAT TO LOOK FOR

Typical characteristics of a lunar impact crater are labeled on this photograph of Aristarchus, 42 km in diameter, located West of Mare Imbrium.



- **Floor**: Bowl shaped or flat, characteristically below surrounding ground level unless filled in with lava.
- **Ejecta**: Blanket of material surrounding the crater that was excavated during the impact event. Ejecta becomes thinner away from the crater.
- **Raised rim**: Rock thrown out of the crater and deposited as a ring-shaped pile of debris at the crater's edge during the explosion and excavcation of an impact event.
- **Walls**:Characteristically steep and may have giant stairs called terraces.
- **Rays**: Bright streaks starting from a crater and extending away for great distances. See Copernicus crater for another example.
- **Central uplifts**: Mountains formed because of the huge increase and rapid decrease in pressure during the uplifts impact event. They occur only in the center of craters that are larger than 40 km diameter. See Tycho crater for another example.