Out of This World! - Week 7

Grades 3-5

Day 2: Making an Impact

Teacher/Parent Background:

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
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 surfaces 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.

Overview:

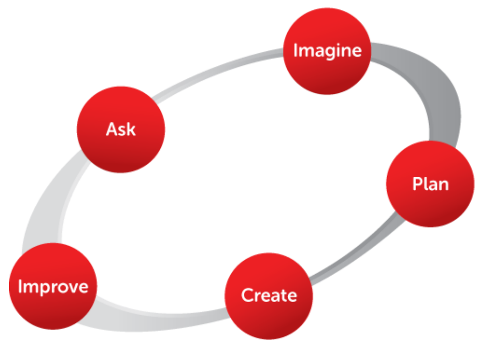
In this activity, learners will explore how craters formed on the surface of the Moon in order to gather background information needed to complete an engineering design challenge in which they need to design and build a spacecraft that can land in one of the Moon's craters without injuring astronauts or damaging the spacecraft.

Related Standards:

- **Develop, revise, and use models** based on evidence to **construct explanations** about the movement of the Earth and Moon within our solar system.

Key Terms:

- moon - a natural satellite of a planet
- satellite - an object that stays in an orbit around a planet
- crater - dish-shaped pits formed when objects from space struck the moon's surface
- engineering design process - a set of steps engineers use to propose solutions to problems



Engineering Design Process

- floor - part of a crater that is bowl shaped or flat, characteristically below surrounding ground level unless filled in with lava
- ejecta - blanket of material surrounding the crater that was excavated (dug up and tossed outward) during the impact event
- 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 excavation of an impact event
- walls - characteristically steep part of a crater that may have giant stairs called terraces
- rays - bright streaks starting from a crater and extending away for great distances
- 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.

Materials List:

- *Making an Impact* handout
- marbles or other objects such as steel shot, ball bearings, golf balls, etc.
- 1 high-walled pan (plastic, aluminum or cardboard - at least 7.5 cm deep)
- a variety of dry, powdery materials in different hues that can look like the Moon's surface (flour, baking soda, corn meal, sand, corn starch, powdered drink mix, cocoa powder, glitter, etc.)
- ruler or measuring tape
- digital or food scale

- newspaper or other covering to protect floors

Activity Description:

1. Revisit the engineering design challenge that the student is exploring this week, emphasizing the focus on locating a crater for the landing site:
    - NASA is looking to further explore the Moon, in particular, several craters observed while orbiting the moon during previous trips. Testing and studying these craters may help NASA identify areas on the Moon that are rich in water and other resources to determine how to best use those materials while on the lunar surface.
    - Before they can even consider sending a spacecraft and astronauts, NASA must locate safe landing sites within a crater.
    - Once they find one, they need to design and build a spacecraft that can land there without injuring astronauts or damaging the spacecraft.
2. Using the *Making an Impact* handout, prompt the student to make observations about the number and type of craters on the Moon.
    - What do you notice about the number and locations of craters on the Moon?
        - There are nine craters (visible side of the Moon) located across the surface of the Moon.
    - Are all the craters on the Moon the same? Why or why not?
        - The craters on the Moon are various sizes. Some contain mountains and some do not.
    - How do you think the craters formed?
        - The craters formed when objects (asteroids, meteors, comets, etc.) crashed into the Moon.
    - What do you think affected the appearance and size of the craters?
        - The size and speed of the objects hitting the Moon would impact the appearance and size of the craters. Larger objects would create larger craters. Objects traveling at high speeds might make deeper craters or through more dirt farther from the center of the crater.
3. Guide the student to confirm or refute his/her predictions about what affects the appearance and size of craters by conducting a simulation:
    - Spread newspaper under the pan to catch spills or consider doing the activity outside.
    - Fill the pan with your chosen material (flour, corn starch, etc.) to about 2.5 cm and smooth the surface so it settles evenly.
    - Sprinkle a fine layer of a dark, contrasting material (i.e., cocoa powder) evenly until it completely covers the surface.

- Measure the mass of each impactor (i.e., marble, steel ball, golf ball, ball bearing, etc.) using the scale. Record the mass on the *Making an Impact* data chart.
- Drop impactor #1 from a height of 30 cm onto the prepared surface of the pan.
- Measure the diameter and depth of the resulting crater.
- Note the presence of ejecta (rays).
- Record any other observations you have about the appearance of the crater on the data chart.
- Repeat steps for impactor #1, increasing the drop heights to 60 cm, 90 cm and 200 cm. Complete the data chart for these as well.
- Now repeat for two more impactors. Use the data chart to record measurements and observations for each impactor.

Closure:

Encourage the student to use the collected data to develop and support a claim (explanation) about what causes differences in the appearances of craters. This can be accomplished by graphing the data (evidence) and looking for patterns (reasoning):

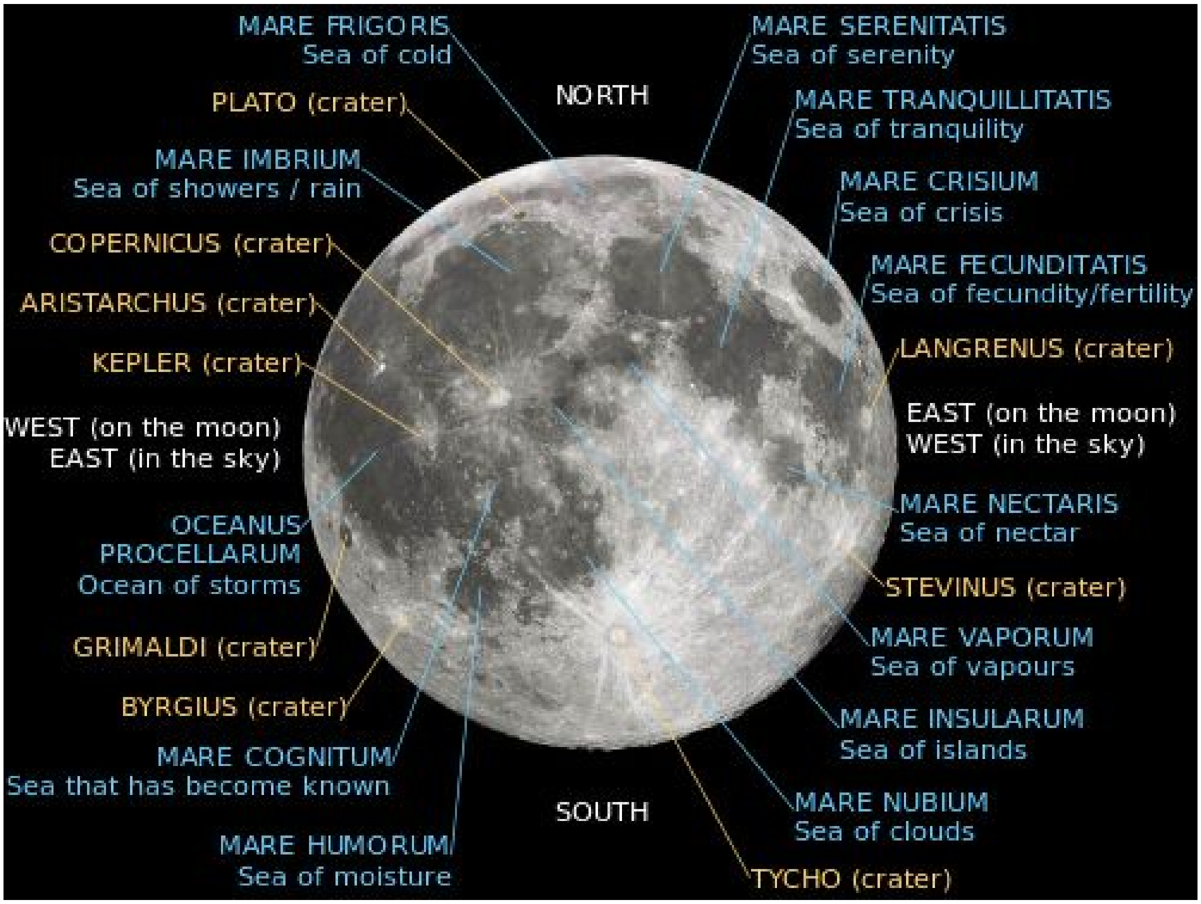
- crater diameter and depth vs. impactor drop height
- crater diameter and depth vs. impactor mass

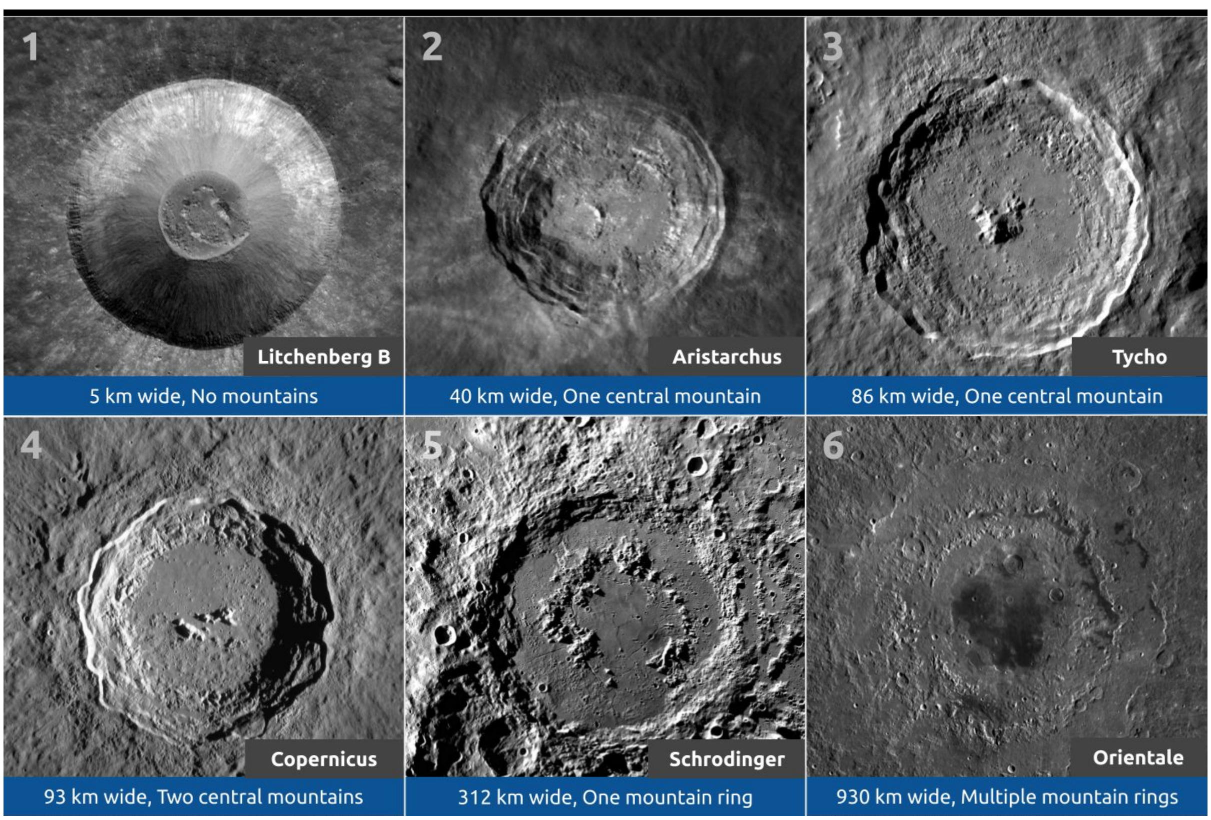
Extension:

Why Does the Moon Have Craters?

An asteroid or meteor is more likely to hit Earth because Earth is a lot bigger than the Moon, giving a meteoroid more area to hit! But we can see many thousands of craters on the Moon and we only know of about 180 on Earth. Why is that?

Making an Impact





Data Table

Type of Impactor & Distance Dropped	Impactor Mass (g)	Crater Diameter (cm)	Crater Depth (cm)	Ejecta Present (yes or no)	Other Observations
(30 cm)					
(60 cm)					
(90 cm)					
(200 cm)					
(30 cm)					
(60 cm)					
(90 cm)					
(200 cm)					
(30 cm)					
(60 cm)					
(90 cm)					
(200 cm)					

Crater Diameter & Depth vs. Impactor Drop Height

Crater Diameter & Depth vs. Impactor Mass
