Environmental Science Institute
UNIVERSITY OF TEXAS AT AUSTIN

Title: Impact Craters

Subject: Science

Grade Level: 4th - 8th

Purpose: To determine the factors affecting the appearance of impact craters and ejecta.

Materials

- 1 pan
- Lunar surface material
- Tempera paint, dry
- Sieve or sifter
- Balance
- 3 impactors (marbles or other spheres)
- Meter stick
- Ruler, plastic with middle depression
- Protractor
- Data Chart for each impactor
- Graph paper

Making an hypothesis

1. After looking at photographs of the Moon, how do you think the craters were formed?
2. What do you think are factors that affect the appearance of craters and ejecta?

Preparing a "lunar" test surface

1. Fill a **pan** with **surface material** to a depth of about 2.5 cm. Smooth the surface, then tap the pan to make the materials settle evenly.
2. Sprinkle a fine layer of **dry tempera paint** evenly and completely over the surface. Use a **sieve** or **sifter** for more uniform layering.
3. What does this "lunar" surface look like before testing?

Cratering Process

1. Use the **balance** to measure the mass of each **impactor.** Record the mass on the "**Data Chart**" for this impactor.
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. Make 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 this impactor. Note that the higher the drop height, the faster the impactor hits the surface.
7. Now repeat steps 1 through 6 for two more impactors. Use a *separate*Data Chart for each impactor.
8. Graph your results. Graph #1 is Average crater diameter vs. impactor height or velocity. Graph #2 is Average ejecta (ray) length vs. impactor height or velocity. **Note**: on the graphs, use different symbols (e.g., dot, triangle, plus, etc.) for different impactors.

Results

1. Is your hypothesis about what affects the appearance and size of craters supported by test data? Explain why or why not.

2. What do the data reveal about the relationship between crater size and velocity of impactor.

3. What do the data reveal about the relationship between ejecta (ray) length and velocity of impactor.

4. If the impactor were dropped from 6 meters, would the crater be larger or smaller? How much larger or smaller? Explain your answer. (Note: the velocity of the impactor would be 1,084 centimeters per second.)

5. Based on the experimental data, describe the appearance of an impact crater.

6. The size of a crater made during an impact depends not only on the mass and velocity of the impactor, but also on the amount of kinetic energy possessed by the impacting object. Kinetic energy, energy in mostion, is described as:
   $K = ½(mv^2)$ where, **m** = mass and **v** = velocity.
   During impact, the kinetic energy of an asteroid is transferred to the target surface, breaking up rock and moving the particles around.

7. How does the kinetic energy of an impacting object relate to crater diameter?

8. Looking at the results in your Data Tables, which is the most important factor controlling the kinetic energy of a projectile, its diameter, its mass, or its velocity?

9. Does this make sense? How do your results compare to the kinetic energy equation?

10. Try plotting crater diameter vs. kinetic energy as Graph #3. The product of mass (in grams) and velocity (in centimeters per second) squared is a new unit called "erg."

Impact Craters Data Charts

drop height=30 cm (velocity=242 cm/s)					
	trial 1	trial 2	trial 3	total	average
crater diameter					
crater depth					
average length of all rays					

drop height=60 cm (velocity=343 cm/s)					
	trial 1	trial 2	trial 3	total	average
crater diameter					
crater depth					
average length of all rays					

drop height=90 cm (velocity=420 cm/s)					
	trial 1	trial 2	trial 3	total	average
crater diameter					
crater depth					
average length of all rays					

drop height=2 meters (velocity=626 cm/s)					
	trial 1	trial 2	trial 3	total	average
crater diameter					
crater depth					
average length of all rays					

Impact Craters Graph Paper

Use this or another graph paper to plot **Average Crater Diameter vs. Impactor Velocity**, **Average Ejecta (ray) Length vs. Impactor Velocity**, and **Crater Diameter vs. Kinetic Energy.**