Cater Creation
Teacher Version

Adapted from "Exploring Space & Cyberspace: Live From Mars" Resource Book and NASA's "Mars Activities: Teacher Resources and Classroom Activities – Mud Splat Craters" located at mars.jpl.nasa.gov/classroom/pdfs/MSIP-MarsActivities.pdf

Introduction & Purpose

This activity explores the formation of impact craters on a planet's surface. By understanding the processes involved in cratering, and how several variables such as mass, velocity, size of projectile, angle of approach, and surface material at impact affect the features of craters, scientists have been able to learn much about the history and surface of the Earth and other planets. In the five experiments of this activity, students will vary each of the variables listed above to determine how they affect crater features.

Note: The fifth part of this experiment involves mud, making it potentially messy. Secure a good location in order to perform the fifth component, such as outside or somewhere you can lay out plastic sheeting. Use old shirts to keep students' clothes as clean as possible, or request the students dress in clothing that can get dirty.

Objective

Students will determine through experimentation how five variables affect the features of an impact crater.

Materials Needed

- ★ Flour
- ★ Cocoa
- ★ Fairly clean dirt
- ★ 3 balls the same size (approx. 1" across) but of differing weights / masses
- ★ 3 marbles / balls of different sizes
- ★ Large tub or pan *(plastic dishpans or double layer foil roasting pans work best)*
- ★ Plastic sheeting *(to keep the floor clean if you're inside)*
- ★ Aprons or old front button shirts *(to protect clothes)*
- ★ Water pitcher filled with water *(to create mud)*
- ★ Large spoons to mix the mud
- ★ Sturdy plastic spoons
- ★ Baby wipes or paper towels to clean mud off skin
- ★ Broom and dustpan
- ★ Ruler and meter stick
- ★ Pens or pencils
- ★ Crater Creation Answer Sheet (in Student Version)
- ★ Idaho TECH Lab Notebook

Procedure

The Student Version contains detailed directions for the students to use, which have been reproduced below so you may plan accordingly.

1. Have the team read through the background material and look at the illustrations provided in their Activity Book. Fill the large tub or pan with flour approximately 3" deep, sprinkling a little cocoa on the surface to help make changes more visible.

2. Have the team collaborate to form a hypothesis about each cratering test prior to conducting the tests described in steps #3 and #5 *(this activity contains a total of 5 cratering tests)*.

3. **Closely supervise** *(to prevent messes)* while the students conduct the four cratering tests described below. We suggest that you assign or have the team members choose roles for the experiments, and have the members rotate to different roles so each member can obtain experience in each role. One team member can record measurements and observations, one member can drop the balls / marbles / mud into the tub, one or two members can describe the resulting crater to the recorder, and the final one or two members can measure the crater diameters. The team has a list of questions in their Student Activity Book for use in recording observations and measurements in their Lab Notebook. When making observations, have them refer to the illustrations included in their Activity Book, and encourage the use of the feature terminology (i.e., rim, ejecta blanket, ray pattern, wall, floor, central peak). Have the students smooth out the flour and sprinkle additional cocoa on the surface before each crater attempt.

Experiment #1: How mass affects impact craters

- Using the 3 balls that are the same size but differing masses, drop the first ball into the flour from a height of 2 meters. Record the diameter of the crater created.
- Repeat the process with the remaining 2 balls. Be sure that each ball is dropped from the same height above the box.

Experiment #2: How velocity affects impact craters

- Using the largest marble, drop it into the flour from a height of 10cm. Record the diameter of the crater created.
- Repeat the process with the same marble dropped from 1 meter above the box and 2 meters above the box.
- From a height of 2 meters above the box, *throw* the marble into the box and record the diameter of the crater created.

Experiment #3: How size of projectiles affects impact craters

- Using the 3 different sized marbles, drop the smallest marble into the flour from a height of 2 meters. Record the diameter of the crater created.
- Repeat the process with the remaining 2 marbles. Be sure that each marble is dropped from the same height above the box.

Experiment #4: How angle of approach affects impact craters

- ★ Using the largest marble, throw it into the flour with a moderate amount of force. Record the shape and diameter of the crater created.
- ★ Using the same marble and the same amount of throwing force, repeat the process while varying the angle of the marble's approach. Be sure that the height from which the marble is thrown remains constant.

4. The next experiment involves making craters in mud, so it is encouraged to do this part of the activity outside or in an area where the floor can be covered with plastic sheeting. Have the students wear aprons or old shirts over their clothes to keep them clean. We recommend that you **closely supervise** your students during this experiment –*do not allow them to fling mud at each other!*

5. Have the students empty the tub or pan of flour and then mix the dirt with some water in the tub or pan to create mud. Use only a little water so the mud will not become soupy. Then have the students complete the fifth experiment.

Experiment #5: How the type of surface material at impact affects impact craters

- ★ Scoop a spoonful of mud out of the pan.
- ★ Carefully fling the mud back into the box.
- ★ Record the diameter of the crater created. Repeat this several times.
- ★ How do these craters compare to the craters you created in the flour?

6. When the students have completed all five experiments, have the students compare their results with their original hypotheses and form a statement for each test that explains their results (i.e., the larger the mass of a meteorite, the larger the diameter of the crater formed). You may wish to help them get started on forming these explanations by giving them an example for the first experiment. Encourage the team to write their explanations in the Lab Notebook.

Note: The results of this activity are often surprising to students. Most expect the craters to have an oblong shape on extremely wide angles of impact. In fact, all craters seen on the Moon or on Earth are basically circular. This is because on impact an explosion occurs, and the forces associated with the explosion are always spherically symmetrical. The explosion is caused by the fact that the ground does not stop a large meteorite instantly upon its moment of impact. As it descends below the surface, frictional heating increases the temperature of a meteorite much more than the frictional heating of the atmosphere had done previously. Heating is so rapid that an explosion can occur. Imagine trying to change quickly all of the energy of a room-sized meteorite traveling at 30,000 mph into heat!

Further Explorations

1. Have students go on-line and check out Malin Space Science Systems' page on Martian Craters (www.msss.com/http/ps/crater.html). There are great pictures of different kinds of craters on this web site!

2. Have students download images of craters from different planets. Ask them to explain how these craters may have formed, pointing out examples of new and older craters.

3. Have the students research the theory about the giant impact which many people believe led to the extinction of the dinosaurs.