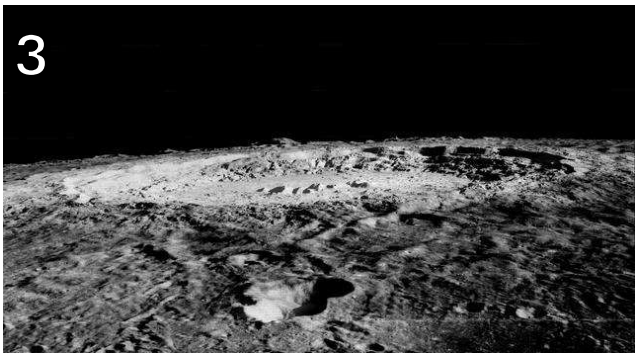
Name: _____

# Investigating Impacts

## Engage

Examine the pictures of different craters on the Earth and Moon.







1. How do you think each of these craters formed?

2. What variables might affect the shape and size of a crater that formed and that we see today?

3. What could planetary scientists learn by studying craters on the Earth, Moon, or other planetary bodies?

## Explore

Plan and carry out an impact investigation using flour or corn starch, cocoa powder, a large pan, hard objects of various sizes, masses, densities, and shapes (marbles, washers, rocks, etc.), string, ruler, and/or measuring tape, and a scale. Consider how you will explore the variables, such as those listed in the table below, that affect crater formation using your plan. Make observations of the different shapes and sizes of the craters that form. Also, measure and record the diameter and depth of the craters, noting the differences caused by changing variables.

Write down your plan for how to set up your model and your procedure for investigating impacts.

Also, create a table like the one below. Adapt it to include the variables you are testing.

| Object | Mass (g) | Drop Height | Crater Description (shape, features, etc.) | Crater Diameter | Crater Depth |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

At the end of your investigation, also draw the surface of your model after completing all the impacts.

## Explain

Now that you have created many impact craters, answer and discuss the following:

1. Explain how impact craters are formed. Include the word “gravity” in your explanation.

2. How did crater size change when items of different mass (i.e., weight) were dropped from the same height?

3. How would you state the general relationship between an item’s mass and the crater size?

4. How did the size of the items affect the crater sizes?

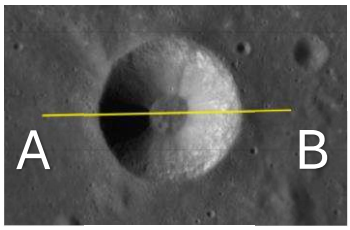
5. How would you state the general relationship between an item’s size and the crater size?

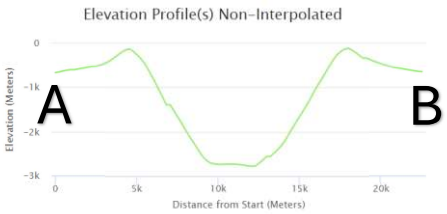
6. What are some ways your model is similar and what are some ways your model is different than real impact processes?

7. How might the craters be different if we were to conduct this experiment on the Moon? Explain your thinking.

8. How might the craters be different if you threw the objects (which would likely result in the objects traveling faster) rather than dropping them?

9. It is helpful to graph the height of craters by creating an elevation profile. Below is an example of an elevation profile along the yellow line.




Explain what would happen to the elevation if you were walking along the yellow line starting from the left at point “A” to point “B.”

## Elaborate

Use the NASA Moon Trek application to apply what you have learned so far about impact craters to real craters on the Moon and other planetary bodies.

1. Either visit https://trek.nasa.gov/moon/ on your own computer or follow along with your teacher to travel around the Moon.
2. Explore the surface of the Moon using the following functions:
    a. Zoom in and out using your mouse, or the plus and minus sign on the bottom left toolbar.
    b. Hold and drag the map to move around.
    c. Explore different types of maps you can view. Use the Projection button ( ) on the bottom left toolbar to change between 3D Globe, North Pole Map, Global Map, and South Pole Map.
    d. Turn on the Nomenclature function on the bottom right within the Basemaps toolbar ( ). This will show you the names of the lunar features, including crater names.
3. From your general exploration of the surface of the moon, write down five observations related to the craters you see on the NASA Moon Trek application. What are some things you can say for sure about the craters? What are some things you have questions about regarding those craters?

4. Explore specific craters on the moon to learn more about the different shapes of craters (also called crater morphology). Use the Global Map Projection and turn on the Nomenclature feature.
    a. Select the Fly To button ( ) in the bottom right side of the screen and type in “Dawes.”
    b. Use the + button or your mouse to zoom in to see the edges of the crater clearly.
    c. Fill in the table, Exploring Craters on the Moon with NASA Moon Trek, about the crater.
    d. Use the menu button ( ) on the top right to select “Calculate Distance.” Select “Line” and draw a line across the largest part of the crater, from rim to rim. The line may need to be drawn diagonally to do this.

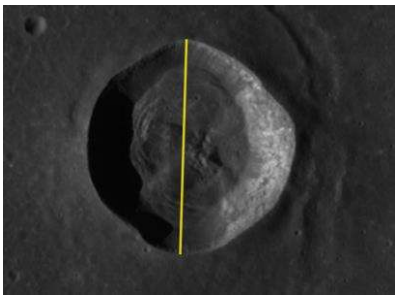


**Figure 1** Example of using the line tool to calculate the diameter of Dawes crater

e. To remove the line, click on the line and select "remove marker."
f. Use the menu button (☰) on the top right to select "Calculate Distance." Select "Polyline" and click around the crater to calculate the circumference.

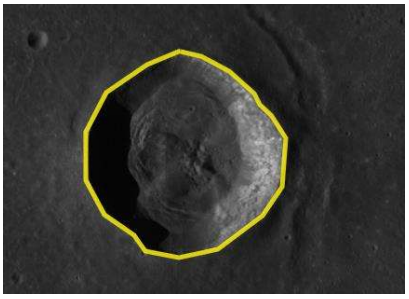


**Figure 2** Example of using the polyline tool to calculate the circumference of Dawes crater

g. To remove the circle, click on the line and select "remove marker."
h. Use the menu button (☰) on the top right to select "Crater Elevation Profile" and "Line." Draw a line from outside the crater rim, across the crater, to the other side of the crater.

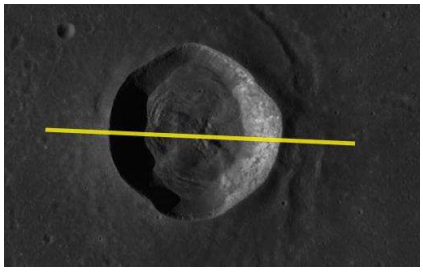


**Figure 3** Example of the Calculate Elevation Profile to view the cross section of Dawes crater

i. Explore the elevation profile that is shown and explain the shape in the table. Remember, the elevation profile shows the height of the crater along the yellow line.
j. To remove the line, click on the line and select "remove marker."

5. Repeat step 4 for all the craters listed in the table.
6. You examined two types of craters so far, simple and complex.
   a. Based on your observations, infer which types of craters are simple craters and which are complex.

b. Come up with your own definitions for each type of crater based on your inferences.
Simple crater

Complex crater

7. Explore the surface of the moon and find one other example of each type of crater. Write the name and make observations in the table for each one.
8. Now explore craters on Mars using: https://trek.nasa.gov/mars/
9. Use the same procedure as step 4 to fill in the table, Exploring Craters on Mars with NASA Mars Trek, about the craters listed.
10. Based on your definitions earlier, draw conclusions about the type of crater each of the three Martian craters listed in the table represents.

11. Discuss your results and crater definitions with classmates.
    a. How are your results similar and how are they different?

    b. If your results differ widely, go back and explore the craters together and come to a consensus.
    c. As a class, decide upon definitions of each crater type and corresponding examples of each.

**Exploring Craters on the Moon with NASA Moon Trek**

| Crater Name | Crater Shape Description | Crater Diameter | Crater Circumference | Draw the elevation profile |
|---|---|---|---|---|
| Dawes | | | | |
| Moltke | | | | |
| Tycho | | | | |
| Copernicus | | | | |
| Clavius | | | | |
| Theophilus | | | | |
| | | | | |
| | | | | |

**Exploring Craters on Mars with NASA Mars Trek**

| Crater Name | Crater Shape Description | Crater Diameter | Crater Circumference | Draw the elevation profile |
|---|---|---|---|---|
| Gale | | | | |
| Zunil | | | | |
| Cassini | | | | |

## Evaluate

1. Share what you learned about impact crater formation using words and pictures.

2. Share what you learned about crater shapes (morphologies) using words and pictures.

3. Use evidence from your observations to argue if craters on the Moon are more similar to those on Earth or those on Mars. What evidence leads you think craters on these two surfaces are more similar?

4. Imagine an asteroid hits Earth and creates a simple crater. Now imagine this same asteroid instead hits Mars, which has about one-third of Earth's gravity and a much thinner atmosphere. How might the crater differ on Mars compared to Earth? Consider factors such as the size and depth of the crater, the ejection of materials, and the appearance of the crater rim. Explain your thinking.

5. What questions do you now have about impact processes, craters, and debris?