CRATERS ON THE MOON

Background Information

Craters form on the **moon** when asteroids or **meteoroids** in space crash into its surface. Craters form because the collision causes a massive impact which then causes the underlying material to fly out due to an explosion where the two surfaces meet. Craters are most famous for existing on the moon, but they also form on Earth. In fact, about 4.1 to 3.8 billion years ago, there was an event termed the Late Heavy Bombardment. This was a period of roughly 200 million years where there was an increased amount of meteor collisions with Earth, and the scars are still visible today. Additionally, the Chicxulub Crater in Mexico is only 66 million years old and still present today. This impact was so massive, it left a crater 200 km wide! It is also thought to be connected to the eventual extinction of most of the dinosaur species Earth once had.

Thus, it is apparent that the transfer of **energy** is an important aspect in crater formation, as it can have wide-reaching impacts. Energy is the measurement of the ability to do work on an object, in other words, it is the strength or power needed to move, heat, or change something. We know that in collisions, as an object moves more quickly toward another, the amount of energy present in the collision will also increase. Heavier (and typically larger) objects also tend to fall faster than lighter objects when gravitational pull is factored into the equation, resulting in an increased speed. The connection of these concepts is vital for scientists to make accurate predictions about meteoroids that may be approaching Earth's surface in the future.

Next Generation Science Standards (NGSS) Met:

- 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.

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Objective

Students will understand that craters form when objects impact the moon's surface. Students will hypothesize about the craters that will form when objects with different sizes and shapes collide with the moon's surface. Students will be able to observe and analyze craters created by each object they drop on their own "moon surface" and explain how the mass and shape correlate to the different types of craters they observe.

Key Vocabulary:

- **Moon:** an object that orbits a planet, in this case, Earth
- **Crater:** a large bowl-shaped cavity
- **Meteoroid:** small rocks or metals moving in space
- **Impact:** one object forcibly coming into contact with another object
- **Energy:** the strength or power needed to, in this case, move something

Materials Needed:

- Baking trays/pie tins (1 per group)
- Flour (2-4 lb)
- Sprinkles (3 oz)
- Cocoa powder (8 oz)
- Rocks, marbles, and other small, irregularly shaped objects (ex. pennies, chapstick, an eraser topper)
- Pens/pencils
- Meter stick
- Worksheet and moon photos
- Paper towels/wet wipes

Fun Fact: Asteroids and meteorites often hit the moon with so much speed and energy they can leave a crater 10 times their size!

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Preparation:

1. Gather all of the needed materials.
2. Split the objects and baking supplies evenly among the number of groups (3-4 students/group). Each group should have a small, medium, and large (<2 inch) sized object.

Note: *This lesson typically requires about 45 minutes.*

Timeline and Procedures:

- 5 minutes - Put students into groups of 3-4 and give each group a photo of the moon's surface. Instruct them to write down their observation on their worksheet and hypothesize about the order of the three identified craters, the speed the crater hit the surface with, and the size/shape of the object that made the crater.
- 7.5 minutes - Students share their photo and hypothesis with the class. After sharing, ensure students understand that any craters superimposed on top of another crater must have been more recent. Explain the craters are caused by meteoroids and introduce the definition if needed.
- 5 minutes - Students are given their materials and instructed on how to create their "moon surface." Model this for the students.
    - First, create about an inch-thick layer of flour.
    - Then, scatter some sprinkles on top, they represent rocks on the moon.
    - Lastly, put a thin layer of cocoa powder on top of the whole surface, the color difference will help students visualize their craters.
- 15 minutes - Pass out the "meteoroid" items to the groups. Instruct students to drop the items from different heights determined with a meter stick. Students should record their observations on their worksheet. Students should form a relationship between height, speed, energy, and crater size.
- 7.5 minutes - After observing their own craters, students will switch their craters with another group. Each group should now write down their observations about the other groups' craters and use inference to hypothesize what type of object could have created the craters.
- 5 minutes - Students will share their hypothesis for each crater and the original group will present the actual objects used to create each crater.

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Ways to Expand This Lesson:

- Consider using a protractor and string to allow students to gently toss the items from an angle to create a different type of crater. They should record their observations and form a hypothesis that establishes a connection between the angle the item is tossed from and the shape of the resulting crater.
- Enable students to drop their item onto their "moon surface" from a staircase or other tall height, if possible. Once the item has stopped moving, have them inspect the crater and compare it to the previous craters. Students can also construct simple parachutes using paper or tissues and attach them to their objects before dropping them from the smaller height. They should continue to theorize about the connection between speed, crater size, and energy.

Note: The correct order (oldest crater to newest crater) of the craters in the photos is as follows:

Photo 1: BAC or ABC
Photo 2: ACB or CAB
Photo 3: ABC or ACB
Photo 4: CBA or CAB
Photo 5: CBA or CAB

Tip: We conducted an informal assessment pre- and post- completion of the lesson. The assessment strategies we used are listed below:

<u>Pre-Assessement</u>

- Ask students to draw a crater on the moon's surface and label each part of their drawing
  - Students likely won't include the meteorite that caused the crater in their drawing, so consider asking them where the meteorite might have gone after the impact.

<u>Post-Assessement</u>

- Students did a three minute free write/draw about the process of crater formation with arrows showing the direction of energy flow before, during, and after the collision between the meteorite and the moon.

Photo 1

Photo 2

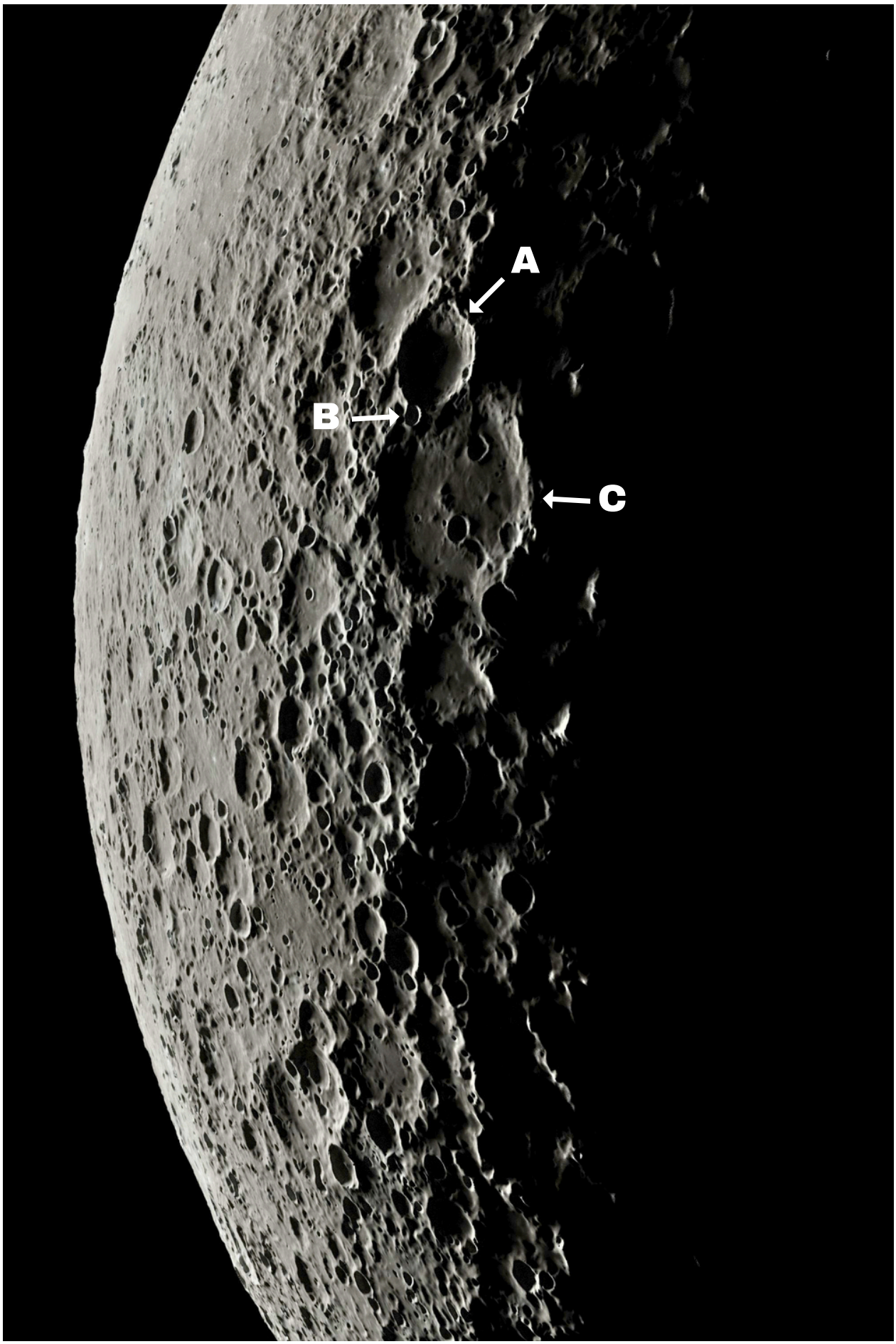

Photo 3

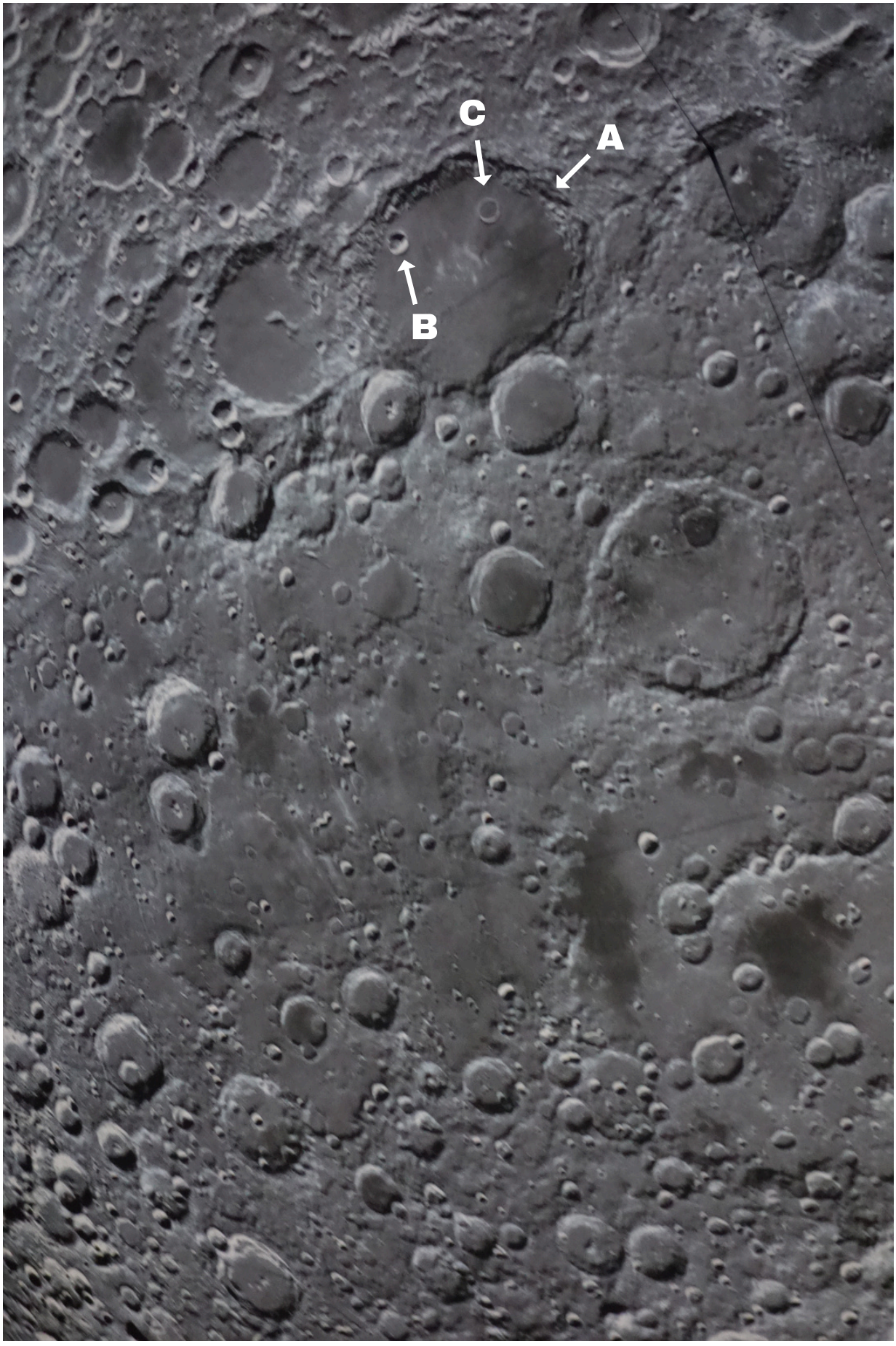

Photo 4

Photo 5

Crater Exploration

Name: _____

Activity 1:

Draw a picture!

Crater 1: _____ Crater 2: _____ Crater 3: _____

Observations: _____

_____

What kind of object could make this crater? _____

Activity 2:

Item 1: _____ Item 2: _____ Item 3: _____

Predictions: _____

_____

_____

Draw a picture!

Record each item and the height they're dropped from below. Draw a small picture of each crater that forms.

	Items		
Heights			

Write a sentence connecting "meteorite" size/mass, speed, and energy.

A large/heavy meteorite will have a _____ (small or large) speed as it falls toward the surface of the moon. If a meteorite has a _____ (small or large) speed, it will hit the moon's surface with a _____ (small or large) amount of energy. This means large, heavy meteorites have a _____ (small or large) amount of energy.

Activity 3:

Observations: _____

_____

What kind of objects could make these craters? _____