ROUGH SCHEDULE

3:15pm - 3:25pm --- outline of experiment and ppt on science concepts
3:25pm - 4:10pm --- Breakout rooms
    3:25pm - 3:30pm --- make sure students have supplies - construct flubber or crater trays if student did not pick up kit
    3:30pm - 3:40pm --- set up glacier experiment
    3:40pm - 3:50pm --- meteor/crater experiment
    3:50pm - 3:55pm --- check on glaciers
    3:55pm - 4:10pm --- additional crater play or go through images of glaciers/craters
    4:10pm --- final glacier check before end of session
4:10pm - 4:15pm --- Reconvene class and close out

MAKING CRATERS

Adapted from https://www.lpi.usra.edu/education/explore/LRO/activities/craterCreations/

Some meteorites have enough energy and mass that when they hit the Earth, they make a large circular indentation in the surface called an impact crater. Impact craters can take on various shapes based on the meteorites' size and the speed they hit the Earth. Try this activity to learn more about meteorites and impact craters.

Supplies Provided in Kits:

- Tin tray with layer of oatmeal, flour, and cocoa
- Meteors: marshmallows, sugar balls, and candy cane kisses

Supplies Provided by student:

- Pen/Pencil
- Newspaper, tarp or trash bag to prevent messes
- Additional cocoa for resurfacing (optional)
- Ruler, or meter stick (optional)

Introduction and Prompting Questions:

- Explain that the trays have oatmeal with flour then cocoa on top
    - oatmeal –earth's upper mantle
    - flour – continental crust
    - cocoa – top soil/dirt
- *When the meteor falls, what do you think it will do to the surface?*
- *[after dropping first meteor] What happened to the soil? Why?*
- *What do you think will happen if the meteor is faster/dropped from higher height?*
- *How are their craters different? How are they similar?*
- *What does the pattern of "dirt" around your craters look like?*

Instructions:

1. Spread the newspaper on the floor or table and place the tin tray in the center.
2. Select your first rock to be a meteorite.
3. If using a meter stick/ruler, select a height to drop the "rock" from and then drop the rock into the pan at this height.
4. Carefully remove the rock from the flour.
    1. the student can leave the meteors if they are too difficult to remove – use your discretion
5. Observe the crater it made (the cocoa powder will help you see how the surface moved).
6. Without fixing the surface of the flour, select another "rock" to drop into the flour.
7. Drop it from the same height as you did with the previous rock (but drop it away from the first crater).
8. Compare its crater with the first crater.
9. Continue dropping the rest of your "rocks" at the same height using the same flour surface. Drop them so that they each make their own separate crater and don't overlap.
    1. if the student has other objects they would like to try as "meteors" encourage them to select items that are different from the ones provided (i.e. heavier, larger surface area, strange shape)
    2. Try dropping the same rock from varying heights onto the same bed of flour.
        1. if the student has access to cocoa (with permission from their parents), they can resurface their trays with additional cocoa sprinkles lightly on the top
10. Observe and compare each of the craters.
    1. try to get the students to note what properties of the meteors help to make larger craters

Concepts:

- You are simulating what happens to the Earth's surface when large meteorites hit the surface – the formation of impact craters.
    - Cocoa powder represents the very top layer of the Earth and shows how debris is ejected during the formation of the impact crater, also known as *ejecta*.
- By studying the patterns in which lower levels of dirt and rock were tossed up by the impact, scientists can make estimates about how big the meteorite originally was. (Meteors often get incinerated upon impact or disappear over time.)
- Meteorites that survive their fall to the surface can also often tell us about where they came from by the type of rock and other chemicals they contain.
    - For example, scientists have found some meteorites that are made up of the same material as the moon.
- Why doesn't Earth's surface look like that of the moon?
    - Aside from most of the rock burning up in the Earth's atmosphere before it can hit the surface, craters on Earth often vanish over time as the Earth's surface changes from the flow of liquid water, scraping glaciers, lava-spewing volcanoes or other agents.

- The moon doesn't have a very active surface, so meteor craters or even footprints from astronauts are likely to stay as they are for a very long time.

FLOWING GLACIERS

Adapted from: https://www.lpi.usra.edu/education/explore/ice/activities/ice_action/flubber/

Glaciers not only transport material as they move, but they also sculpt and carve away the land beneath them. ... The ice erodes the land surface and carries the broken rocks and soil debris far from their original places, resulting in some interesting glacial landforms.

Supplies Provided in Kits:

- A softball softball size blob of Flubber to be the "glacier"
- Piece of foam core for "glacier" to slide across
- Pint sized Ziploc baggie

Supplies Provided by Students:

- Permanent marker
- Ruler
- Water (optional)
- Pencil or pen

Introduction and Prompting Questions:

- What are the three states of matter? *Solid, liquid, and gas.*
- In what state of matter is ice? *Solid.*
- Can a solid flow? *Accept all answers for now*.
- **[after handling glacier]** Do they think Flubber is a solid? Why or why not?
    - *Accept all answers for now. In our experiences liquids change shape to fill the container holding them. Solids maintain their shape. Liquids tend to flow; solids tend to break.*
- What are some words they would use to describe Flubber? Is it hard or soft? Is it gummy, gooey, or sticky?
    - If they used words like mushy and gooey, share with them that these are words that describe Flubber's *viscosity. Viscosity* is the measure of a fluid's resistance to flow. The more *viscous* a substance the stiffer it is and the more that it will resist flowing
- Is their Flubber rigid or flexible? *Flubber is very "malleable," meaning it is very pliable, or bendy.*
- How might they make Flubber flow — or change shape — quickly? Slowly?
- **[as the students make a rectangular "glacier"]** What is a real glacier made of? *Ice.*
    - Is ice a solid, liquid, or gas? *Solid.*
    - Does ice move? Does it flow? *Answers will vary.*
- What do they think will happen to the Flubber if they leave it on the board for a while?

- Will it change?
- How quickly or slowly might it change?
- **[reviewing glacier movement]** What do they observe? How do their observations compare to their predictions?
- What happened to the mark they made on their Flubber? *The middle of the mark (and the middle of their Flubber flow) advanced a lot!*
- Did the edges of the Flubber advance from where they started to another location farther down the board?
- How did it do that? *The Flubber flowed.*
- How did the flubber flows at various angles, or slopes, differ from one another?
- **[If you showed photos]** Does their Flubber flow resemble any of the photographs they viewed? *Yes. It looks like the advancing glacier.*
- How is Flubber similar to ice? *It is a solid. It flows very slowly.*

Instructions:

- Have the students remove their "glacier" from the ziplocks
- Invite them to remove the "glacier" and feel it.
    - Have them roll it around in their hands.
- Have the students try to break the "glacier", mold it into a ball, flatten it etc
    - if the "glacier" is not moving well, have the students add a bit of water to it
- Review the properties of the "glacier"
    - *viscous* (thick), and *malleable* (bendy), and it can break
- Have the students place their foam board at any angle
    - this can be within the tray or elsewhere on their desk
    - try to have each student in your group do a different angle so they can compare with each other
- Have the students make the "glacier" into a 5X6 inch rectangle - or any kind of rectangle
- Draw a line across the center of the "glacier" with a marker
- Place the "glacier" at the top center of their boards
    - sometimes the "glacier" likes to role off the board - may need to adjust board angle
- Draw a line on the board that is even with the bottom of their "glaciers"
    - Have the students label the line with the time
- PAUSE AND MOVE TO METEOR EXPERIMENT
- After every 10 min, have the students return to their "glaciers" and mark where the end of their "glaciers" have moved
    - Have the students label this line with the time as well
- (optional) Have the students show off and compare their "glaciers"
- (optional) Picture Guide Activity

Concepts:

- Ice is a solid. However, under pressure and over long periods of time, it flows. Glaciers and ice sheets slowly move. The movement of the ice sheet over the south geographic pole carries the markers away from the geographic South Pole.

- How does a glacier or ice sheet form? Glaciers can form anywhere that snow falls and stays (accumulates). Enough snow must fall that it accumulates over time, and does not go away in the summer. Eventually the light snow flakes get compacted as they get buried under more and more snow — they become ice. As more and more ice accumulates, it eventually begins to flow. In the case of glaciers, they often flow down a mountain valley.
- Glaciers never go backwards! They always flow "forward" with gravity, regardless of if they are growing or getting smaller. When glaciers accumulate mass faster than they lose it through ablation (melting or sublimation of ice), they grow and their leading edge(s) advances. When they lose mass faster than they accumulate snow, their mass decreases and their leading edge(s) retreats.

Optional Picture Guide Activity:

- Antarctica's Amundsen Scott South Pole Station
    - *The research base, Amundsen Scott South Pole Station. The different buildings include dormitories, research laboratories and offices, a library, a cafeteria, maintenance facilities, and more. The long wide strip between the groupings of buildings is an airstrip where planes land. Most people and materials arrive at the station by plane.*
        - What is the ground made of that the station is built on? *Ice! About 98% of Antarctica is covered by giant sheets of ice and glaciers.*
    - *Markers marking the geographic South Pole. The markers are stuck in the ice sheet.*
        - What is the geographic South Pole? *It marks the location where Earth's imaginary axis of spin or rotation intersects Earth's surface. Earth spins around this point.*
        - The geographic South Pole does not change position; it is always located in the same place. Yet every year, a new marker has to be put into place to mark the spot. This new marker is about 33 feet (10 meters) from the marker of the year before.
    - Picture # 4 shows the markers from 1996, 1997, and 1998. The 2008 marker that is over the geographic south pole is about 330 feet (100 meters) away from the 1998 marker.
        - Why does a new marker have to be placed? If the geographic South Pole is always in the same place, and no one moves the poles away, what moves? *The ice in which the markers are placed must move or flow.*
    - Picture #5: *A glacier that is flowing between mountains.*
        - How does a glacier or ice sheet form? *Glaciers can form anywhere that snow falls and stays (accumulates).*
- “Retreating” glaciers
    - Qori Kalis Glacier in Peru. What do the two pictures show? *The same glacier but in different years.*
        - What do they observe about the glacier in this pair of images? *The glacier is not growing or moving forward or advancing. Its edge or nose is retreating or appears to be going backwards.*
        - How might this happen? Remind the children how glaciers form and grow.

        - What do they think happens if a glacier stops getting snow, or gets less snow, or begins to melt faster than it gets snow? *The glacier will shrink and its edge, or nose, will retreat.*
    - What do they observe is happening to the glaciers over time? *They are all retreating or getting smaller.*
    - What do the children predict will happen to these glaciers in another 10 years? *Answers will vary.*
    - Why might the glaciers all be getting smaller? *Answers will vary. Some children may suggest that our temperatures are getting warmer*