Space Rocks!

Museum Scavenger Hunt Lesson Plan

CALIFORNIA ACADEMY OF SCIENCES

Objectives

By the end of this activity students will be able to:

1. identify impact craters based on the features
2. describe reasons why evidence of impacts may change on various solar system bodies.
3. create and use timelines that combine different scales.

Materials

- Space Rocks! scavenger hunt (one copy per student)
- Clipboards (one per student, optional)
- Pencils (one per student, optional)

Note: This activity has an "extra credit" portion on the 3rd page. Suggestions for using the Extra Credit found in Wrap-up section.

Scientific Terms for Students

- **meteorite:** A meteoroid that survives its passage through the Earth's atmosphere and lands upon the Earth's surface.
- **impact:** the striking of one thing against another; forceful contact; collision
- **crater:** a bowl-shaped depression, or hollowed-out area, produced by the impact of a meteorite, volcanic activity, or an explosion
- **impact crater:** a crater which is the result of a collision between a large body, such as a planet or satellite, and a smaller body such as an asteroid or meteorite.

Background for Educators

Space Rocks: Asteroid, Meteoroid, Meteor or Meteorite
In space, a large rocky body (larger than 10 meters in diameter) in orbit about the Sun is referred to as an **asteroid**. Whereas a much smaller particles (less than 10 meters in diameter) in orbit about the Sun are referred to as **meteoroids**. Once a meteoroid enters the Earth's atmosphere and vaporizes, it becomes a **meteor** (i.e., shooting star). If a small asteroid or large meteoroid survives its journey through the Earth's atmosphere and lands on the Earth's surface, it is then called a **meteorite**.

Impact Craters
An impact crater is formed when an object like an asteroid or meteoroid crashes/collides into the surface of a larger solid object like a planet or satellite. To form a true impact crater, this

object needs to be traveling extremely fast, many thousands of miles per hour! When a solid object crashes into something at these extreme speeds, it forms a crater regardless of how hard the object is. Smaller objects immediately vaporize and create an enormous shockwave through the ground that melts and recrystallizes rock. All that is left is a big hole in the ground and some reconfigured rocks. Sometimes the object is large enough for only part of the object to vaporize so that small pieces remain after impact.

Impacts on Earth

There is a relationship between the size of the object and the frequency of impact events. Small objects collide frequently with Earth's atmosphere, disintegrating before reaching the ground. The larger objects that strike the Earth's surface and leave impact craters happen less frequently. Asteroids with a 1 km (0.62 mi) diameter strike Earth every 500,000 years on average. Large collisions – with 5 km (3 mi) objects – happen approximately once every twenty million years. The last known impact of an object of 10 km (6 mi) or more in diameter was the dinosaur extinction event 66 million years ago.*The Moon and its many impact craters*

The California Academy of Sciences' lunar sample (a piece of the Moon) was brought back from the Apollo 17 expedition in 1972. This was the last human mission to the Moon. This lunar sample was collected between the Sea of Tranquility and the Sea of Serenity. The sample was probably formed 3.7 billion year ago far below the lunar surface, then rose to the crust and solidified.

The moon has a lot more visible impact craters because it doesn't have an atmosphere to burn up smaller incoming space rocks. The moon also does not have liquid water or an active crust (with volcanoes and other forces) to change the surface and remove evidence of past impacts. The Moon once had large volcanic flows in the past that did cover up many of the bigger earlier impacts, but it has been without volcanism for around three billion years.

Why are impact craters hard to see on Planet Earth?

There are three processes that help Earth keep its surface with very little craters. The first is erosion. Erosion can break a crater down to virtually nothing. The second process is tectonics. Because of tectonics, the surface of Earth is recycled many times throughout its long history. As a result, very few rocks on Earth are as old as the rocks on the Moon. The third thing is volcanism. Volcanic flows can cover up impacts craters. This is a major way impact craters get covered up elsewhere in our solar system, but it is less important than the recycling of crust here on Earth. In addition to these three processes, the Earth's surface is mostly covered in water, which affects the impact sites and may also hide evidence of an impact from human eyes.

Barringer Crater (also known as Meteor Crater)

Barringer crater is located outside Flagstaff Arizona. The meteoroid that created the 1219 meter wide (4,000 feet) Meteor Crater in Arizona was probably only about 50 meters (164 feet) in diameter. This really big for a rock falling from outer space, but still only a fraction of the size of the impact crater it created. Scientists estimate that this impact event occurred about 50,000 years ago—long before there were humans living in the area. This is a significant crater

because it was the first crater proven to have been created by a space rock impact, not volcanism. Since then, numerous impact craters have been identified around the world, though Barringer Crater remains one of the most visually impressive.

Educator Prep

1. Consider visiting the Academy before your field trip to try out the scavenger hunt yourself. You can receive free admission when you bring a copy of your reservation to the Academy's ticket window.
2. Make copies of the scavenger hunt for each student. Consider giving each student a clipboard and pencil.
3. Gather pictures of impact craters on Earth to get students thinking about this in more specific ways.
    a. *Note: Look in the "reference section" to find links to sites with impact craters.*
4. Optional: Consider doing an activity on Making craters with mini-meteors from www.scientificamerican.com/article/make-craters-with-mini-meteors-bring-science-home/

Introduction

Students will be exploring the Academy's specimens related to impacts on Earth and other large bodies in our Solar System. Before the field trip, introduce the concept of space rocks, impacts and craters to your students. Encourage your students to brainstorm ideas about what can cause craters on Earth.

Before Your Visit

1. Explain to your students that the field trip to the California Academy of Sciences will include a scavenger hunt through many exhibits to learn about impacts on Earth and throughout our Solar System. During the field trip, they will have their own worksheet to write down their answers to questions about space rocks, impact craters and impacts on the planets.
2. Make a "KWL chart" on the board. After you do the following introductory activities, fill in the list for "What students **k**now" about space rocks and impact craters. Then make a list of questions that they have in the "What do we **w**ant to know?" section. The section on "What we **l**earned" will be filled out after the field trip.
3. Tell the students - let's think about "space rocks," or rocks from outer space. Have them talk to a partner, answering the question "What have you heard about rocks in outer space?"
    a. After students have had a chance to share with a partner, do a large group share out and write down their ideas about what they know in the "K" section of the chart. If questions come up, add to the "W" area of the chart.

   b. If students use terms like asteroids, comets, and meteorites ask them to describe these objects. Have students describe what is similar and what is different between the objects.
4. Then share with your students "this field trip will help us understand what happens when space rocks impact (or collide) with one another."
   a. Ask students to think-pair-share. "What might be some evidence that a space rock collided with or impacted a planet?"
   b. Let the students know that you will share pictures of impact sites with them. Then, share the pictures of impact craters that you collected.
      i. Note: Please do not use pictures of the moon or Barringer crater/ Meteor crater since students will see these at the museum.
      ii. Ask students to describe what they observe about the craters:
         1. What shape are they?
         2. What are some things that the craters have in common? What are some of the differences between two or more of the craters?
         3. Why do you think they are shaped that way?
         4. What questions do you have, or what do you want to know? Add these to the "W" area of the chart.
   c. If you have chosen to do the "mini-meteors" activity, do so now by having your students try to duplicate the different craters they have looked at.

<u>During the Field Trip</u>

1. After determining the number of chaperones, split your class into small group accordingly and assign at least one chaperone to each group.
2. Consider assigning groups to start at different parts of the scavenger hunt so they can spread out. This scavenger hunt is split between five parts of the museum. It is structured so that students can start with any section.
3. Pass out the scavenger hunt print-outs ahead of time.
   a. The scavenger hunt is designed to be a discussion between students, but you may encourage them to also write new and interesting information while they explore.
4. Designate a time to meet back up, allow at least 45 minutes to complete the scavenger hunt. Encourage the groups to explore the rest of the museum after the hunt.
5. If students want to research space rocks more in depth, they can visit the Naturalist Center on Level 3, which features books, computers, and helpful staff.

<u>Wrap-Up</u>

1. Once the scavenger hunt is complete, bring your students together either at the museum or back in the classroom. Have students work in groups or as a class to complete the Extra Credit Timeline section.

    a. For younger grades (3-5): In student groups fill in the dates of events. Have the groups draw, in pencil, the lines on the timeline. Then work as a class to draw the lines on the timeline.
        i. Remind students they can find dates for events on their scavenger hunt.
    b. For older grades (6-8): During the scavenger hunt have students fill in the dates of events. When back as a class, have the students work in teams of two or three to draw the lines on the timeline. When complete, have student-groups share how they decided to draw their arrows on the timeline.
2. Once back in the classroom, have students share their ideas and what they found from the scavenger hunt.
3. Share the story of Shoemaker-Levy 9 comet. Then ask students how their idea of impacts on the gas giant planets is different or the same.
4. Show the "KWL chart" that you started before the field trip. What can be added to the columns? What are something new they "**L**earned" about impacts on Earth and other surfaces from the visit?
5. Conclude the sharing with their new perspectives with the following guiding questions:
    a. How has your definition of space rocks changed
    b. How has your definition of space rocks stayed the same?

Extensions

Sign up for the Distance Learning program, Impacts in the Solar System, where students can talk with an expert about asteroids, comets and meteors.

Next Generation Science Standards

Scientific and Engineering Practices

- **Obtaining, Evaluating and Communicating Information**
    - 3-5: Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices.

Disciplinary Core Ideas

- MS: ESS1.B
    - The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.

Cross-Cutting Concepts

- Scale, Proportion, and Quantity
    - 3-5: Natural Objects exist from the very small to the immensely large.

California Science Content Standards

4th Grade
Earth Sciences
5.a Students know some changes in the earth are due to slow processes, such as erosion, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.

5th Grade
Earth Sciences
5.b Students know the solar system includes the planet Earth, the Moon, the Sun, eight other planets and their satellites, and smaller objects, such as asteroids and comets.

7th Grade
Earth and Life History
4.b Students know the history of life on Earth has been disrupted by major catastrophic events, such as major volcanic eruptions or the impacts of asteroids.

References

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Images of impact craters

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