

Science & Literacy Activity

GRADES 6-8

OVERVIEW

This activity, which is aligned to the Common Core State Standards (CCSS) for English Language Arts, introduces students to scientific knowledge and language related to meteorites. Students will read content-rich texts, visit the Arthur Ross Hall of Meteorites and use what they have learned to complete a CCSS-aligned writing task, creating an illustrated text about how meteorites provide clues to planetary formation and the makeup of Earth's interior.

Materials in this activity include:

- Teacher instructions for:
 - Pre-visit student reading
 - Visit to the Ross Hall of Meteorites and student worksheet
 - Post-visit writing task
- Text for student reading: "Meteorites: Clues to Planetary Formation"
- Meteorites Classification Charting Exemplar
- Student Worksheet for the Ross Hall of Meteorites visit
- Student Writing Guidelines
- Teacher rubric for writing assessment

Common Core State Standards:

WST.6-8.2, WST.6-8.8, WST. 6-8.9
RST.6-8.1, RST.6-8.2, RST.6-8.4, RST.6-8.7,
RST.6-8.10

New York State Science Core Curriculum:

PS 1.1c

Next Generation Science Standards:

PE MS-ESS1-3

DCI ESS1.B: Earth and the Solar System

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.

SUPPORTS FOR DIVERSE LEARNERS: An Overview

This resource has been designed to engage all learners with the principles of Universal Design for Learning in mind. It represents information in multiple ways and offers multiple ways for your students to engage with content as they read about, discuss, view, and write about scientific concepts. Different parts of the experience (e.g. reading texts, or locating information in the exhibit) may challenge individual students. However, the arc of learning is designed to offer varied opportunities to learn. We suggest that all learners experience each activity, even if challenging. We have provided ways to adapt each step of the activities for students with different skill-levels. If any students have an Individualized Education Program (IEP), consult it for additional accommodations or modifications.

1. BEFORE YOUR VISIT

This part of the activity engages students in reading a non-fiction text about meteorites. The reading will prepare students for their visit by introducing them to the topic and framing their investigation.

Student Reading

Have students read "Meteorites: Clues to Planetary Formation." Have them write notes in the large right-hand margin. For example, they could underline key passages, paraphrase important information, or write down questions that they have.

Have students complete a classification chart where they list the types of meteorites, their properties and what we learn from them. Types of meteorites should include the three main groups: stony meteorites, iron meteorites, and stony-iron meteorites, as well as the subgroups for stony meteorites (chondrites and achondrites) and stony-iron meteorites (mesosiderites and pallasites).

After completing the chart ask:

- How can studying meteorites from planets, the Moon, and large asteroids help scientists understand Earth's interior? *(Answers may include: Meteorites from planets, the Moon, and large asteroids show evidence of accretion and differentiation. Meteorites from differentiated bodies in particular are useful in helping scientists understand the makeup of Earth's core and mantle.)*

- What are some things that the study of meteorites has helped us understand about our solar system? (*Answers may include: Meteorites can provide evidence of the processes of accretion and differentiation that helped form the planets and other bodies in the solar system. Chondrites have not changed since they formed and therefore can give us clues about elements that exist in our solar system, provide clues about what conditions were like in the early solar system, and can help us determine the age of the solar system.*)
- Why are we able to learn different things from different types of meteorites? (*Answers may include: Even though meteorites are all rocks from space, they are not all alike. The different types give us different information. The type of information that we can get from them depends on the processes that they or their parent bodies have undergone.*)

Students can work in pairs, small groups, or as a class. During discussion, remind them to use evidence from the text to explain their thinking and to use specific examples.

SUPPORTS FOR DIVERSE LEARNERS: Student Reading

- “Chunking” the reading can help keep them from becoming overwhelmed by the length of the text. Present them with only a few sentences or a single paragraph to read and discuss before moving on to the next “chunk.”
- Provide “wait-time” for students after you ask a question. This will allow time for students to search for textual evidence or to more clearly formulate their thinking before they speak.
- After the reading, show students the following demonstration to help illustrate the concept of differentiation:
amnh.org/exhibitions/permanent-exhibitions/earth-and-planetary-sciences-halls/arthur-ross-hall-of-meteorites/promos/hall-of-meteorites-for-educators/exploring-density

2. DURING YOUR VISIT

This part of the activity engages students in exploring the Ross Hall of Meteorites.

Museum Visit & Student Worksheet

Explain to students that they will be using worksheets to gather all the necessary information on what meteorites reveal about planetary formation and the makeup of Earth’s interior. Provide students with a copy of the Hall Map and let them know that they will be focusing on the Center Area to explore iron meteorites and the “Building Planets” section to explore stony-iron and stony meteorites. You may want them to bring colored pencils to use when sketching. Tell students that back in the classroom they will refer to these notes when completing the writing assignment.

SUPPORTS FOR DIVERSE LEARNERS: Museum Visit

- Review the Student Worksheet with students, clarifying what information they should collect during the visit.
- Have students explore the hall in pairs, with each student completing their own Student Worksheet.
- Encourage student pairs to ask you or their peers for help locating sources of information. Tell students they may not share answers with other pairs, but they may point each other to places in the hall where answers may be found.

3. BACK IN THE CLASSROOM

This part of the activity is to engage students in an informational writing task that draws on the pre-visit reading and on observations made at the Museum.

Writing Task

Distribute the Student Writing Guidelines handout, which includes the following prompt for the writing task:

Based on the article “Meteorites: Clues to Planetary Formation,” your visit to the Ross Hall of Meteorites and your discussions, write an illustrated essay in which you:

- define “meteorite”
- name the three main groups and explain how the different types of meteorites provide evidence for planetary formation and the makeup of Earth’s interior
- include a labeled illustration of at least one meteorite from each of the three main groups

Support your discussion with evidence from your reading and the Ross Hall of Meteorites.

Go over the handout with students. Tell them that they will use it while writing, and afterwards, to evaluate and revise their essays.

Before they begin to write, have students use the prompt and guidelines to frame a discussion around the information that they gathered in the Ross Hall of Meteorites and compare their findings. They can work in pairs, small groups, or as a class. Referring to the writing prompt, have students underline or highlight all relevant passages and information from the reading, the charting exercise, class discussion and their notes from the hall that can be used in their response to the prompt. Instruct each student to take notes on useful information that their peers gathered as they compare findings. Students should write their essays individually.

SUPPORTS FOR DIVERSE LEARNERS: Writing Task

- Re-read the “Before Your Visit” assignment with students. Ask what they saw in the hall that helps them understand what meteorites reveal about planetary formation and Earth’s interior.
- Allow time for students to read their essay drafts to a peer and receive feedback based on the Student Writing Guidelines.

Student Reading

Meteorites: Clues to Planetary Formation

What is a meteorite?

In simplest terms, a meteorite is a rock that falls to Earth from space. The word meteorite refers only to those rocks that survive the trip through the atmosphere and reach Earth's surface.

Meteorites are rocks, but not like Earth rocks. Most meteorites are far older. They provide some of the only samples we have of other objects – planets, asteroids, and possibly comets – in our solar system. Some meteorites even contain tiny particles that formed around other stars that existed before our Sun. Studying meteorites helps us understand how the solar system and the bodies in it formed.

Where do meteorites come from?

Our solar system began to take shape some 4.6 billion years ago. At that time, the Sun and planets as we know them now did not exist. Back then a large cloud of gas and dust known as the solar nebula swirled around the developing Sun.

As the solar system formed within this swirling cloud, countless small objects collided and stuck together. Gradually, they formed larger and larger bodies such as asteroids and planets.



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An artist's rendering of the early solar system.

Some meteorites are pieces of planets, the Moon, and some large asteroids that show evidence of partial or complete melting within those bodies. This melting was the result of intense heat and pressure that occurred as the objects accreted. Accretion is when materials come together under the influence of gravity to form a planet, moon, asteroid, or comet. When the materials came together and the body increased in size, the heat and pressure increased. This caused melting. As this melting occurred, layers separated out in a process called differentiation. Dense metallic materials sank to the center where it crystallized to form the core. Less dense materials formed the mantle. Further melting formed the outer rocky crust. Meteorites from these differentiated bodies are rare finds but very valuable because they help us understand how planets formed and what their deep interiors are made of.

What does studying different types of meteorites tell us?

Meteorites are all rocks from space. But they are not all alike. There are three main groups: iron meteorites, stony meteorites, and stony-iron meteorites. Each group of meteorites is split into many more classes and types. The class or type depends upon the minerals they contain, their chemistry and their structure. The different types provide us with information about a range of processes that occurred earlier in our solar system's history.

1. Stony Meteorites

The most common meteorites are stones. They could easily be mistaken for ordinary rocks from Earth. Stony meteorites fall into two main groups. Chondrites – the more common type, are the oldest rocks formed in our solar system. These ancient stones offer a record of the solar system in its infancy. Since many have not changed, scientists use the age of these rocks to determine the age of our solar system. They are clues to what conditions were like when the solar system was young. They also give us hints about the elements that exist in our solar system.

Achondrites are pieces of planetary bodies that partially melted while they were in space, as described above. Studying these meteorites teaches us about the history of melting planetary bodies like Earth, the Moon, and the other rocky planets and moons.

2. Iron Meteorites

The meteorites known as irons are more than ninety-eight percent metal. Almost every iron meteorite comes from the iron core of an asteroid or planetary bodies. As described above, the iron core formed when the asteroid differentiated. Studying these meteorites is one of the ways that scientists know that Earth has a core made of nickel and iron metal. The other planets have metal cores as well.



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3. Stony-Iron Meteorites

Stony-iron meteorites are a mixture of metal and rock. There are two different kinds: mesosiderites and pallasites. The stony-iron meteorites called mesosiderites form when asteroids collide. In the crash, the molten metals and solid pieces of silicate rocks of both asteroids get mixed. Because of that, mesosiderites may record the history of both meteorites.

Other stony-iron meteorites are called pallasites. Pallasites contain green crystals of the mineral olivine that are surrounded by metal. These meteorites are extremely rare. They make up less than one percent of all known meteorites. Some scientists think that they resemble the material that makes up the boundary between Earth's core (made of metal) and mantle (made mostly of olivine).

Meteorites Classification Charting Exemplar

Have students complete a classification chart where they list the types of meteorites, their properties, and what we learn from them. Types of meteorites should include the three main groups: stony meteorites, iron meteorites, and stony-iron meteorites, as well as the subgroups for stony meteorites (chondrites and achondrites) and stony-iron meteorites (mesosiderites and pallasites).

TYPES OF METEORITES

STONY METEORITES	IRON METEORITES	STONY-IRON METEORITES
<ul style="list-style-type: none"> • most common type of meteorites • easily mistaken for Earth rocks <p>Chondrites:</p> <ul style="list-style-type: none"> • more common type • record of early solar system • many have not changed <p>Achondrites:</p> <ul style="list-style-type: none"> • pieces of planetary bodies that melted while in space • studying them teaches us about the history of melting planetary bodies like Earth and the Moon 	<ul style="list-style-type: none"> • are more than 98% metal • almost all come from iron core of an asteroid or planetary body • formed as a result of differentiation • one of the ways that scientists know that Earth has a core of nickel and iron metal 	<ul style="list-style-type: none"> • mixture of metal and rock • two different kinds <p>Mesosiderites:</p> <ul style="list-style-type: none"> • form when asteroids collide • metal and silicate get mixed in the collision • record the history of both asteroids <p>Pallasites:</p> <ul style="list-style-type: none"> • contain green crystals of olivine surrounded by metal • very rare • may resemble the boundary between Earth's core (made of metal) and mantle (made mostly of olivine)

Student Worksheet

Sketch and label at least one example of each type of meteorite. Be sure to note (1) the name of the meteorite, (2) what planetary body it came from, and (3) how it provides evidence for the makeup of Earth's (or other planetary body's) interior. You can also note any interesting features or characteristics.

stony meteorite

stony-iron meteorite

iron meteorite

Student Writing Guidelines

Based on the article “Meteorites: Clues to Planetary Formation”, your visit to the Ross Hall of Meteorites and your discussions, write an illustrated essay in which you:

- define “meteorite”
- name the three main groups and explain how the different types of meteorites provide evidence for planetary formation and the makeup of Earth’s interior
- include a labeled illustration of at least one meteorite from each of the three main groups

Support your discussion with evidence from your reading and the Ross Hall of Meteorites.

Use this checklist to ensure that you have included all of the required elements in your essay.

- I introduced meteorites.
- I defined the word “meteorite.”
- I clearly named the three main groups of meteorites and described how the different types of meteorites provide evidence for planetary formation and the makeup of Earth’s interior.
- I included a labeled illustration of at least one meteorite from each of the three main groups.
- I only included relevant information about how the different types of meteorites provide evidence for planetary formation and the makeup of Earth’s interior.
- I used information from “Meteorites: Clues to Planetary Formation” to explain how the different types of meteorites provide evidence for planetary formation and the makeup of Earth’s interior in detail.
- I used information from the Ross Hall of Meteorites to explain how the different types of meteorites provide evidence for planetary formation and the makeup of Earth’s interior in detail.
- I used academic, non-conversational tone and language.
- I included a conclusion at the end.
- I proofread my essay for grammar and spelling errors.

Assessment Rubric

Scoring Elements		1 Below Expectations	2 Approaches Expectations	3 Meets Expectations	4 Exceeds Expectations
RESEARCH	Reading	Attempts to present information in response to the prompt, but lacks connections to the texts or relevance to the purpose of the prompt.	Presents information from the text relevant to the purpose of the prompt with minor lapses in accuracy or completeness.	Presents information from the text relevant to the prompt with accuracy and sufficient detail.	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the text.
	AMNH Exhibit	Attempts to present information in response to the prompt, but lacks connections to the Museum exhibit content or relevance to the purpose of the prompt.	Presents information from the Museum exhibit relevant to the purpose of the prompt with minor lapses in accuracy or completeness.	Presents information from the Museum exhibit relevant to the prompt with accuracy and sufficient detail.	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the Museum exhibit.
WRITING	Focus	Attempts to address the prompt, but lacks focus or is off-task.	Addresses the prompt appropriately, but with a weak or uneven focus.	Addresses the prompt appropriately and maintains a clear, steady focus.	Addresses all aspects of the prompt appropriately and maintains a strongly developed focus.
	Development	Attempts to provide details in response to the prompt, including retelling, but lacks sufficient development or relevancy.	Presents appropriate details to support the focus and controlling idea.	Presents appropriate and sufficient details to support the focus and controlling idea.	Presents thorough and detailed information to strongly support the focus and controlling idea.
	Conventions	Attempts to demonstrate standard English conventions, but lacks cohesion and control of grammar, usage, and mechanics.	Demonstrates an uneven command of standard English conventions and cohesion. Uses language and tone with some inaccurate, inappropriate, or uneven features.	Demonstrates a command of standard English conventions and cohesion, with few errors. Response includes language and tone appropriate to the purpose and specific requirements of the prompt.	Demonstrates and maintains a well-developed command of standard English conventions and cohesion, with few errors. Response includes language and tone consistently appropriate to the purpose and specific requirements of the prompt.
SCIENCE	Content Understanding	Attempts to include science content in explanations, but understanding of the topic is weak; content is irrelevant, inappropriate, or inaccurate.	Briefly notes science content relevant to the prompt; shows basic or uneven understanding of the topic; minor errors in explanation.	Accurately presents science content relevant to the prompt with sufficient explanations that demonstrate understanding of the topic.	Integrates relevant and accurate science content with thorough explanations that demonstrate in-depth understanding of the topic.