Mineral Explorers

For Educators

Activities Glossary Standards

Activities

As the Mineral Explorers demonstrate, minerals exist in a variety of beautiful and often strange forms. The world of gems and minerals is a world that hides in plain sight - in museums, jewelry stores, and even in our backyards. Quartz is clear and emeralds are green. It's common knowledge. Or so it seems to be.

By building upon the adventures of the Mineral Explorers, the following activities will help students explore the exciting world of minerals.

Each activity presents an engaging model for educating students in a way that applies principles of mineralogy to fulfill today's common curriculum.

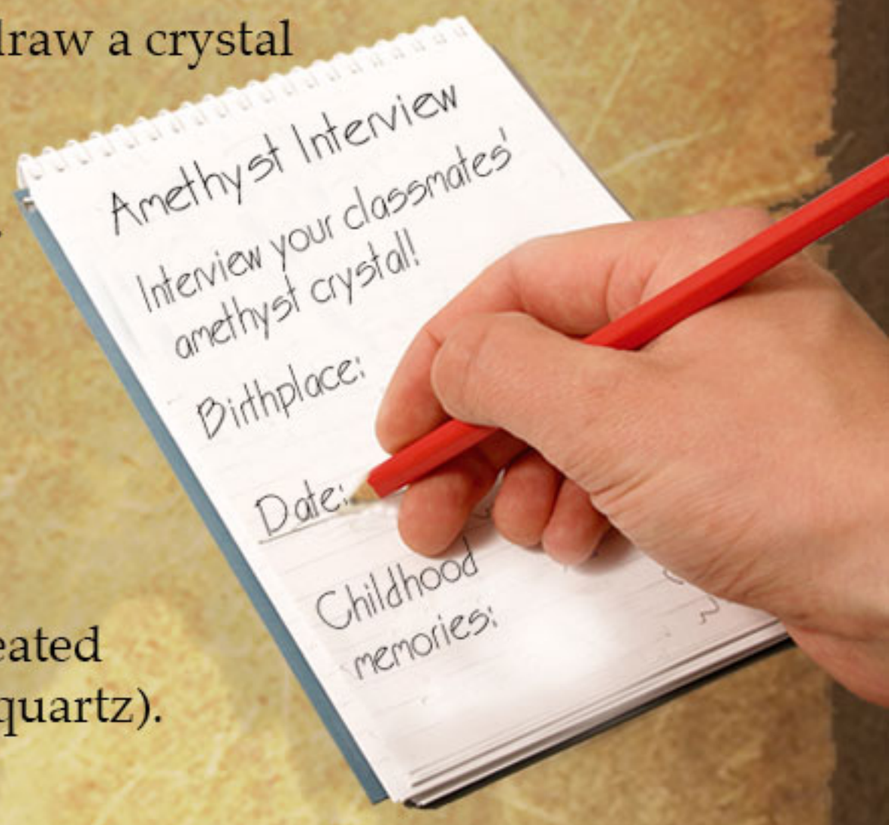
MINERAL EXPLORERS

Educator's Guide

The Life of a Crystal

BACKGROUND:
Minerals, crystals and other precious stones are priced based on their size, quality, and color, among other criteria. But long before they are ever discovered and mined, the crystals were formed in the Earth. This is your chance to tell the crystal's story. Choose one of the minerals from the Mineral Explorers series and dig in!

OBJECTIVES:
Construct a three-dimensional model of a mineral crystal, or draw a crystal using repeated geometric forms.
Research the formation of various minerals.
Use a story-line format to describe the life of a mineral crystal.



MATERIALS:
- Construction paper
- Markers / Colored Pencils
- Glue / Tape
- Scissors

PROCEDURE:
1. Draw or construct the mineral crystal by using simple, repeated gemetric forms (i.e. cubes for silver, hexagonal prisms for quartz).
2. Write a story for the life of a crystal.
   a. What were the necessary conditions for its formation?
   b. Where and when did it form? What was the environment like?
   c. Did your crystal grow? What was its size and shape?
   d. How did humans discover your crystal?
   e. Where was the crystal taken after being discovered? Was it cut or left natural?
   f. Where did your crystal finally end up? Was it sold for a price? Was it worn as jewelry?
3. Using six sheets of construction paper, summarize the key parts of the story by writing / drawing six key events of the mineral's life (similar to a comic strip).
4. For each sheet of paper, write facts about at least one of the following:

-formula	-name	-mythology	-uses	-location
-hardness	-streak	-luster	-formation	-date discovered

OPTIONS:
1. Share the stories or create a classroom display case with the various drawings and models.
3. Write an article for the local newspaper. Interview each other's crystals and take notes.

STANDARDS:
NGSS: (4-ESS1-1, 4-ESS2-1, MS-ESS2-2)
CCSS: (RST.6-8.3, RST.6-8.7, RST.6-8.9, WHST.6-8.2, WHST.6-8.7, RI.4.7)

MINERAL EXPLORERS

ACTIVITY

Crystal Discovery

BACKGROUND:
After touring mines in Arkansas, Bolivia, and Colombia, Thomas returned to his lab with some very amazing mineral specimens. The mineral samples appear to be an assortment of amethyst, clear quartz, and a special type of beryl called emerald. As his newest assistant, he has asked you to organize the minerals into his vast collection. Since the minerals are stored away in bins, you must make sure to accurately describe each one and the environment in which it was found.

OBJECTIVES:
- Describe the process for identifying a mineral.
- Learn how amethysts, ametrines, quartz, and emeralds are formed.
- Use the characteristics of the minerals in order to accurately label the storage bins.

PROCEDURE:
1. Research and summarize the physical and chemical characteristics of amethyst, ametrine, quartz, and/or emerald.

2. Describe where the mineral is formed and how it was mined.

3. Describe and explain how to correctly identify the minerals using tests.

OPTIONS:
1. Using an 8.5"x11" sheet of paper, write a report that describes the contents of each storage bin. Include how the crystals form, their chemical and physical characteristics, and what evidence you have for whether the mineral sample is amethyst, quartz, or emerald. Evidence might include:

-Color	-Hardness	-Chemical Composition
-Streak	-Geometry	-Magnetism

Also, incorporate the location where the crystal was found, and why that would be a significant indicator of the mineral species.

STANDARDS:
NGSS: (MS-PS1-2, MS-PS1-3.)
CCSS: (RST.6-8.2, RST.6-8.3, RTS.6-8.4, RST.6-8.9, WHST.6-8.1, WHST.6-8.4, WHST.6-8.7, WHST.6-8.9, RI.5.7)

CAN YOU DIG IT!? YES!
Your community is home to many rocks and minerals. Bring in rocks from nearby and describe/identify the specimens based on observations and tests.

Mineral Marketing

BACKGROUND:
Upon returning from his most recent trip, Thomas plans to sell several of the raw minerals he acquired. In order to sell the specimens to jewelry stores, collectors, and museums, he needs to advertise the rarity and beauty of the minerals to potential buyers. Since Thomas plans on flying out of the country in a few days, he needs your help to promote the qualities and stories behind one or more of these minerals:

Amethyst	Ametrine	Emerald	Diamond	Tourmaline
Silver	Topaz	Rutile	Quartz	Aquamarine

OBJECTIVES:
Define "mineral" and "crystal," and explain why natural resources are valuable.
Explain how mineral crystals are formed.
Describe the geography of where the crystals are mined.
Describe the cultural significance of the crystals in the native countries and the U.S.

MATERIALS:
- 8.5"x11" Paper (for brochure)
- Color images of the mineral's country
- Posterboard
- Color images of the mineral
- Markers / Colored Pencils
- Traceable map of the country where the mineral was found
- Glue or Tape
- Scissors

PROCEDURE (OPTIONS):
1. Create a brochure that highlights the qualities of the selected mineral, as well as the history behind these precious crystals.

2. Design a window display poster for Thomas's jewelry store so that local collectors will want to come in and hear the stories behind the stones.
   a. Incorporate the native country's themes, maps, and / or images.
   b. Creatively describe the mineral and include images.
   c. Create a tag-line or motto that punctuates the point of the poster.

3. Write a letter to the Gem Gallery at the Smithsonian Museum of Natural History that describes the minerals in terms of their geometric, chemical, and physical qualities that would be ideal for display in a museum. Also, include where the crystals were found, and how Thomas was able to obtain such beautiful specimens.

STANDARDS:
NGSS: (4-ESS2-1, 4-ESS3-1, MS-PS1-2, MS-PS1-3)
CCSS: (RST.6-8.2, RST.6-8.4, RST.6-8.9, RST.6-8.7, WHST.6-8.6, WHST.6-8.7, RI.5.7)

MINERAL EXPLORERS

ACTIVITY

Mineral Identification

BACKGROUND:
When a mineral is unearthed, Mineral Explorers use their vast knowledge and experience to correctly identify their treasure. A deep understanding of minerals does not happen overnight, but it does start by just looking at minerals and asking them questions.

OBJECTIVES:
Learn the steps for identifying a mineral.
Learn to ask questions and perform tests to discover quantifiable characteristics of quartz.

MATERIALS:

- Quartz Crystal
- Construction Nail
- Concrete Nail
- Streak plate
- Sand paper
- Plastic cup
- Penny
- Glass sample
- Scale (up to 300 grams)
- String or paperclip
- Paper

PROCEDURE:
Students are to examine the quartz, ask the following questions, and perform tests.

1. What is the mineral's luster? Describe the appearance using the best term:
   Metallic: Very high reflectance, opaque
   Non-Metallic
   - Submetallic: Medium reflectance, opaque
   - Adamantine: Very high reflectance, transparent
   - Glassy / Vitreous: High reflectance, transparent or translucent
   - Resinous: Medium reflectance, translucent
   - Waxy: Medium reflectance, translucent / opaque
   - Pearl: Low reflectance, translucent / opaque
   - Dull: No reflectance, opaque

2. How many sides does the mineral have? What shape or geometry is this?
3. What color is the mineral? What color is the mineral's streak? Scratch the mineral against the streak plate and take note of the color.
4. Using Mohs hardness scale, what is the mineral's hardness?
   Does a fingernail (hardness of 2.0) scratch the mineral? How about the following:
   - Penny (3.0)
   - Construction nail (5.2)
   - Sandpaper (9.0)
   - Concrete nail (7.5)

   Does the mineral scratch the glass (5.5)?
5. Does the mineral display cleavage? Search for any indications that the mineral would break along flat planes.
6. What is the mineral's specific gravity? The steps in measuring the specific gravity are:
   1. Weigh the mineral (Wa)
   2. Weigh the mineral in water (Ww)
   3. Use the following equation: Wa / (Wa - Ww)

Record all of the findings on paper, and compare with other available minerals.

STANDARDS: NGSS (2-PS1-1, 2 PS1-2, 5-PS1-4)

ACTIVITY

Classroom Treasure

BACKGROUND:
Amethyst and ametrine form over long periods of time beneath the Earth's surface. To build our understanding of this process, we will create our own geode. A geode is a hollow rock lined on the inside with crystals. Geodes are formed when the cavity is filled with a mineral-rich liquid, and then the solution undergoes a sudden change in temperature or pressure.

In contrast to nature, our model will form crystals very quickly (over the course of a few days). Amethyst and ametrine form over much longer periods of time.

OBJECTIVES:
Build and study a model that illustrates the processes involved in the growth of a geode.

MATERIALS:
- Coconut (prepared as below).
- Saturated potassium aluminum sulfate solution

(Potassium aluminum sulfate is available from laboratory supply companies. Ensure that all safety precautions are followed and students wash their hands afterward.)

PROCEDURE:
1. Cut a coconut in half
    a. Clean the white meat out of the coconut shell.
    b. Spray the outside of the coconut shell with lacquer or enamel paint and let dry.
    c. Drill or punch a hole into the top of the coconut.
    d. Silicone the two coconut halves back together.
2. Carefully pour the crystal growing solution into the drill hole.
3. Let the coconut sit for a few days.
4. If the solution has not totally evaporated after several days, pour it out.
5. Using a sharp knife or razor blade cut the coconut in half along the silicone seam.

OPTIONS:
Have students write and respond to the following questions:
1. How is the coconut model similar to the formation of crystals in nature?
2. How is our model different?
3. What conditions are necessary for the formation of crystals?

STANDARDS:
NGSS: (5-PS1-1, 5-PS1-4, MS-ESS2-1, MS-ESS2-2)
CCSS: (RST.6-8.4, RST.6-8.9, RST.6-8.7, WHST.6-8.2, RI.4.7)

Glossary

Axis of Symmetry
Any line through the center of the crystal around which the crystal may be rotated so that after a definite angular turn the crystal form appears the same as before

Carat
A unit weight for precious stones; one carat equals one-fifth of a gram.

Clarity
A crystal's lack of inclusions or defects

Cleavage
The tendency for a mineral to break along characteristic planes. Many minerals break along flat planes, or cleavages—in only one direction, two directions, three directions, or more. Some minerals display no cleavage. Perfect cleavage implies that the mineral easily breaks into flat pieces.

Conchoidal Fracture
Breaks in the form of long, curved surfaces, like the inside of a shell

Crystal
A solid that forms by a regular, repeated pattern of atoms and/or molecules connecting together. In crystals a collection of atoms called the Unit Cell is repeated in exactly the same arrangement over and over throughout the entire material. Crystals are normally formed as a chemical compound which, under suitable conditions, transitions from the state of a liquid or gas to that of a solid.

Crystal Habit
The growth pattern of the crystals of a mineral species, whether individually or as a group. Crystal habits are primarily descriptive words for how a mineral will form with enough space and time.

Crystallographic Axes
Imaginary reference lines constructed through crystals to help explain crystal geometries

Crystal System
The six large groups in which all crystal forms may be organized based upon the number of crystallographic axes and their relationship with one another. The six classes are: (1) Isometric, (2) Tetragonal, (3) Orthorhombic, (4) Hexagonal, (5) Monoclinic, and (6) Triclinic.

Diaphaneity (Clarity)
A mineral's degree of transparency or ability to allow light to pass through it. The clarity depends upon the structure and chemistry of the mineral, as well as its thickness.

Ductility
The ability for a solid material to be stretched into wirelike shapes

Facet
The cuts and flat planes of a crystal that give the stone its brilliance

Fracture
The manner in which a mineral breaks

Geode
A roundish cavity in a sedimentary rock lined with crystallized minerals

Glossary

Hardness
The resistance of a mineral to scratching and abrasion; the Mohs scale (1-10) is typically used to measure hardness

Hydrothermal Vein
A vein formed by the crystallization of minerals from mostly hot water solutions

Inclusion
A foreign matter that is located within a mineral. This may be another crystal, a gas bubble or a pocket of liquid that developed during formation.

Luster (Brilliance)
The way a mineral reflects light and a key step in mineral identification

Malleability
The quality of being moldable or shaped without being broken or fractured

Matrix
The rock and mineral material on which a mineral crystal grows

Mineral
A naturally occurring, inorganic, solid which possesses a characteristic internal atomic structure and a definite chemical composition. Minerals are typically crystalline compounds or elements that have been formed as a result of geological processes.

Mohs Scale
An old, but very useful numerical scale ranging from 1 to 10 that assigns a rating to a mineral according to its hardness. The hardest is 10 (diamond) and the softest is 1 (talc).

Piezoelectric
A property of polar minerals that produces electrically charged extremities when strained

Specific Gravity
How heavy a mineral is compared to the same volume of water

Streak
The color produced by a fine powder of the mineral when scratched on a streak plate. Often it is different than the color of the mineral in non-powdered form.

Symmetry Plane
Any two dimensional surface that, when passed through the center of the crystal, divides it into two symmetrical parts that are mirror images

Termination
The point at the end of a crystal

Trace
Very small amounts are required or present

Unit Cell
The smallest divisible three-dimensional unit of a mineral that possesses the symmetry and all of properties of the mineral when repeated in any direction

Vitreous
Glassy, or shiny like glass

Zoning
The spectrum or distribution of color within a crystal

Common Core State Standards

LANGUAGE ARTS: SCIENCE

RST.6-8.2
Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

RST.6-8.3
Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RST.6-8.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

RST.6-8.7
Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

RST.6-8.9
Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

LANGUAGE ARTS: WRITING

WHST.6-8.1
Write arguments focused on discipline-specific content.

WHST.6-8.2
Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

WHST.6-8.6
Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.

WHST.6-8.7
Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

WHST.6-8.9
Draw evidence from informational texts to support analysis reflection, and research.

READING: INFORMATIONAL TEXT

RI.4.7
Interpret information presented visually, orally, or quantitatively and explain how the information contributes to an understanding of the text in which it appears.

RI.5.7
Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.

MINERAL EXPLORERS

EDUCATION

Next Generation Science Standards

EARTH AND SPACE SCIENCES

4-ESS1-1
Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

4-ESS2-1
Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

4-ESS2-2
Analyze and interpret data from maps to describe patterns of Earth's features.

4-ESS3-1
Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

MS-ESS2-1
Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

MS-ESS2-2
Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

MS-ESS3-1
Construct a scientific explanation based on evidence for how the uneven distribution of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

PHYSICAL SCIENCE

5-PS1-1
Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-3
Make observations and measurements to identify materials based on their properties.

5-PS1-4
Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

MS-PS1-1
Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS1-2
Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MS-PS1-3
Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.