National Aeronautics and
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Langley Research Center
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Educational Product	
Educators	Grades 3-5

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The NASA SCI Files™ The Case of the Disappearing Dirt

**A Lesson Guide with Activities in
Mathematics, Science, and Technology**

Please Note: Our name has changed! The NASA "Why" Files™ is now the NASA SCIence Files™ and is also known as the NASA SCI Files™.

http://scifiles.larc.nasa.gov

The Case of the Disappearing Dirt lesson guide is available in electronic format through NASA Spacelink - one of NASA's electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address: **http://spacelink.nasa.gov/products**

A PDF version of the lesson guide for NASA SCI Files™ can be found at the NASA SCI Files™ web site: **http://scifiles.larc.nasa.gov**

The NASA Science Files™ is produced by the NASA Center for Distance Learning, a component of the Office of Education at NASA's Langley Research Center, Hampton, VA. The NASA Center for Distance Learning is operated under cooperative agreement NCC-1-02039 with Christopher Newport University, Newport News, VA. Use of trade names does not imply endorsement by NASA.

NEC Foundation of America

www.nec.com

Busch Gardens Williamsburg, VA

www.buschgardens.com

www.cnu.edu

www.swe.org

www.sbo.hampton.k12.va.us

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A Lesson Guide with Activities in Mathematics, Science, and Technology

Segment 1

Segment 2

Segment 3

Segment 4

For additional information about the NASA SCI Files™, contact Shannon Ricles at (757) 864-5044 or **s.s.ricles@larc.nasa.gov**.

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Registered users of the NASA SCI Files™ may request a Society of Women Engineers (SWE) classroom mentor. For more information or to request a mentor, e-mail **kimlien.vu@swe.org**

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Program Overview

In *The Case of the Disappearing Dirt*, the tree house detectives are puzzled when they realize that some of their beach is missing! With the upcoming beach volleyball tournament, the detectives realize how important it is to find and replace the missing sand because the missing sand could cost the city thousands of dollars! Dr. Textbook informs the detectives that sand is a mineral, so they head to the Houston Museum of Natural Science where they visit Mr. Joel Bartsch to learn about the properties of minerals and how to identify them. During a quick stop at Dr. D's lab, the tree house detectives also discover how the multiple Earth systems all work together. With no answer to the problem in sight, the detectives decide that more research is necessary.

As the tree house detectives continue their research, Kali goes to NASA Johnson Space Center in Houston, Texas where she talks to Mr. John Gruener about plate tectonics. With the help of some very edible props, Kali learns how Earth recycles its materials to create new rocks and minerals. Next stop is the Lunar Lab, where Kali visits Ms. Andrea Mosi and is invited to view some extra special rocks! Ms. Mosi also discusses the three types of rocks found on Earth and explains how the rock cycle works.

Tony and Dr. D go to Alaska for the Salmon Fishing Derby. While enjoying the rugged beauty of Alaska, Dr. D explains the differences between mechanical and chemical weathering. The tree house detectives begin to put the pieces together, but the answer to the beach erosion problem still eludes them, so once again they decide to do additional research.

As the quest to solve the mystery of the missing sand continues, Tony offers to help by going to Mountain View Elementary School in Anchorage, Alaska to learn how mountains are formed. Now that the detectives know how mountains are built, they decide that they need to learn how mountains are broken down. So Tony is off again, this time to talk with Dr. Kristine Crossen at Exit Glacier near Anchorage about the various processes of weathering and erosion. Meanwhile, the detectives back at the beach continue to practice for the upcoming volleyball tournament while Tony enjoys the fishing derby and even learns how to ride a dog sled!

Finally, after much research, the tree house detectives think they have solved the problem, and they begin looking for any new obstructions that could have caused the beach erosion. When they don't find any new structures, they become discouraged but decide to go back to the problem board one more time. The detectives all agree to do just a little more research, and soon they find an article about some very "hot spots" on the beach. The detectives visit Dr. Jesse McNinch at the Virginia Institute of Marine Science (VIMS), and he shows them the new amphibious vehicle VIMS uses in beach research.

With a triumphant "splash," the detectives solve the case and go to share their findings with Dr. D. Now that they finally understand what caused the beach erosion, the detectives get ready for their volleyball tournament, with the hopes of playing well and maybe even winning a few games!

National Science Standards (Grades K – 4)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Unifying Concepts and Processes				
Systems, orders, and organization	✖	✖	✖	✖
Evidence, models, and explanations	✖	✖	✖	✖
Change, constancy, and measurement	✖	✖	✖	✖
Form and Function	✖	✖	✖	✖
Science as Inquiry (A)				
Abilities necessary to do scientific inquiry	✖	✖	✖	✖
Understanding scientific inquiry	✖	✖	✖	✖
Physical Science (B)				
Properties of objects and materials	✖	✖	✖	✖
Life Science (C)				
Organisms and their environments	✖	✖	✖	✖
Earth and Space Science (D)				
Properties of Earth materials	✖	✖	✖	✖
Changes in Earth and sky	✖	✖	✖	✖
Science in Personal and Social Perspective (F)				
Type of resources	✖	✖	✖	✖
Changes in environment	✖	✖	✖	✖
Science and technology in local challenges	✖	✖	✖	✖
History and Nature of Science (G)				
Science as a human endeavor	✖	✖	✖	✖

National Science Standards (Grades 5 – 8)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Unifying Concepts and Processes				
Systems, order, and organization	✖	✖	✖	✖
Evidence, models, and explanations	✖	✖	✖	✖
Change, constancy, and measurement	✖	✖	✖	✖
Form and function	✖	✖	✖	✖
Science as Inquiry (Content Standard A)				
Abilities necessary to do scientific inquiry	✖	✖	✖	✖
Understanding scientific inquiry	✖	✖	✖	✖
Physical Science (B)				
Properties and changes of properties in matter	✖	✖	✖	✖
Motions and forces	✖	✖	✖	✖
Transfer of energy	✖	✖	✖	✖
Earth and Space Science (D)				
Structure of the Earth system	✖	✖	✖	✖
Earth's history	✖	✖	✖	✖
Science and Technology (Content Standard E)				
Abilities of technological design	✖	✖	✖	✖
Understanding science and technology	✖	✖	✖	✖
Science in Personal and Social Perspectives (Content Standard F)				
Science and technology in society	✖	✖	✖	✖
History and Nature of Science (Content Standard G)				
Science as a human endeavor	✖	✖	✖	✖
Nature of science	✖	✖	✖	✖

National Mathematics Standards (Grades 3 - 5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Number and Operations				
Understand numbers, ways of representing numbers, relationships among numbers, and number systems.	✖			
Understand meanings of operations and how they relate to one another.	✖			
Compute fluently and make reasonable estimates.	✖			
Algebra				
Understand patterns, relations, and functions.	✖			
Analyze change in various contexts.	✖	✖	✖	✖
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement.	✖	✖	✖	✖
Apply appropriate techniques, tools, and formulas to determine measurements.	✖	✖	✖	✖
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.	✖	✖	✖	✖
Develop and evaluate inferences and predictions that are based on data.	✖	✖	✖	✖
Problem Solving				
Build new mathematical knowledge through problem solving.	✖	✖	✖	✖
Solve problems that arise in mathematics and in other contexts.	✖	✖	✖	✖
Apply and adapt a variety of appropriate strategies to solve problems.	✖	✖	✖	✖
Monitor and reflect on the process of mathematical problem solving.	✖	✖	✖	✖
Communication				
Analyze and evaluate the mathematical thinking and strategies of others.	✖			
Connections				
Recognize and apply mathematics in contexts outside of mathematics.	✖			

International Technology Education Association
(ITEA Standards for Technology Literacy, Grades 3 – 5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Nature of Technology				
Standard 1: Students will develop an understanding of the characteristics and scope of technology.	✖	✖	✖	✖
Standard 2: Students will develop an understanding of the core concepts of technology.	✖	✖	✖	✖
Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.	✖	✖	✖	✖
Technology and Society				
Standard 6: Students will develop an understanding of the role of society in the development and use of technology.	✖	✖	✖	✖

National Technology Standards (ISTE National Educational Technology Standards, Grades 3 – 5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Basic Operations and Concepts				
Use keyboards and other common input and output devices efficiently and effectively.	✖	✖	✖	✖
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	✖	✖	✖	✖
Social, Ethical, and Human Issues				
Discuss common uses of technology in daily life and their advantages.	✖	✖	✖	✖
Technology Productivity Tools				
Use general purpose productivity tools and peripherals to support personal productivity, remediate skill deficits, and facilitate learning throughout the curriculum.	✖	✖	✖	✖
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	✖	✖	✖	✖
Technology Communication Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	✖	✖	✖	✖
Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.	✖	✖	✖	✖
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	✖	✖	✖	✖
Technology Research Tools				
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	✖	✖	✖	✖
Use technology resources for problem solving, self-directed learning, and extended learning activities.	✖	✖	✖	✖
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	✖	✖	✖	✖
Technology Problem-Solving and Decision-Making Tools				
Use technology resources for problem solving, self-directed learning, and extended learning activities.	✖	✖	✖	✖
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	✖	✖	✖	✖

National Geography Standards, Grades 3 - 5

Standard	Segment 1	Segment 2	Segment 3	Segment 4
The World in Spatial Terms				
Standard 1: How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information	✖	✖	✖	✖
Places and Regions				
Standard 4: The physical and human characteristics of places	✖	✖	✖	✖
Standard 5: That people create regions to interpret Earth's complexity	✖	✖	✖	✖
Standard 6: How culture and experience influence people's perception of places and regions	✖	✖	✖	✖
Physical Systems				
Standard 7: The physical processes that shape the patterns of Earth's surface	✖	✖	✖	✖
Human Systems				
Standard 10: The characteristics, distributions, and complexity of Earth's cultural mosaics	✖	✖		
Environment and Society				
Standard 14: How human actions modify the physical environment	✖	✖	✖	✖
Standard 15: How physical systems affect human systems	✖	✖		
The Uses of Geography				
Standard 17: How to apply geography to interpret the past	✖	✖	✖	✖
Standard 18: How to apply geography to interpret the present and plan for the future	✖	✖	✖	✖

The NASA SCI Files™
The Case of the
Disappearing Dirt

Segment 1

While practicing for an upcoming beach volleyball tournament, the tree house detectives discover that the sand on their beach is disappearing! Replacing the sand is just too expensive, so the detectives decide that they must investigate this mystery. First, Dr. Textbook helps them to understand where sand comes from and then they set off to the Houston Museum of Natural Science to check out some amazing minerals with Mr. Joel Bartsch. Next stop is Dr. D's lab, where they learn about the various Earth systems and how they all work together.

Objectives

The student will

- analyze the origins of sand and investigate the connection between parent rocks and sand.
- identify the crystal systems found in minerals.
- observe crystal growth.
- distinguish between rocks and minerals based on physical appearance.
- identify minerals based on their specific gravity, hardness, and streak color.
- interpret the chemical formulas of minerals.
- demonstrate how minerals are extracted from the rock that contains the mineral.
- understand the uses of rocks and minerals.
- investigate the biology of a tide pool habitat.

Vocabulary

atmosphere – thin blanket of air surrounding the Earth, containing gases (oxygen, nitrogen, and trace gases), solids, and liquids that affect the Earth's climate

biosphere – the part of the world in which life such as plants and animals can exist

crystal – a solid having a distinctive shape because its atoms are arranged in repeating patterns

gem – a mineral highly prized because it is rare and beautiful

geosphere – the physical elements of the Earth's surface, crust, and interior

high tide – the highest level of the tide; the time when the tide is highest

hydrosphere – the surface waters of the Earth and the water vapor in the atmosphere

low tide – the lowest level of the tide; the time when the tide is lowest

mineral – a naturally occurring, nonliving solid with a definite structure and chemical composition

ore – minerals or rocks that contain a useful substance, such as a metal, that can be mined at a profit

sand – loose material in grains produced by the natural breaking up of rocks

system – a group of objects or units that combine to form a whole and that work together

tide – the periodic change in the surface level of the oceans due to the gravitational forces of the Sun and Moon on Earth

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 1 of *The Case of the Disappearing Dirt*, read the program overview (p. 5) to the students. List and discuss questions and preconceptions that students may have about sand, beach erosion, minerals and their formation, and systems.
2. Record a list of issues and questions that the students want answered in the program. Determine why it is important to define the problem before beginning. From this list, guide students to create a class or team list of three issues and four questions that will help them better understand the problem. The following tools are available in the "Educators" area of the NASA SCI Files™ website. To locate them, click on the "Educators" menu bar on the home page, then click on "Tools" and then "Instructional Tools." You will find them listed under the "Problem-Based Learning" tab.

   Problem Board—Printable form to create student or class K-W-L chart

   Guiding Questions for Problem Solving—Questions for students to use while conducting research

   Problem Log & Rubric—Printable log for students with the stages of the problem-solving process

   Brainstorming Map—Graphic representation of key concepts and their relationships

   The Scientific Method and Flowchart—Chart that describes the scientific method process
3. Focus Questions—Questions at the beginning of each segment that help students focus on a reason for viewing. These questions can be printed ahead of time from the "Educators" area of the web site in the "Activities/Worksheet" section under "Worksheets" for the current episode. Students should copy these questions into their science journals prior to viewing the program. Encourage students to take notes while viewing the program to answer the questions. An icon will appear when the answer is near.
4. "What's Up?" Questions—Questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. These questions can be printed from the "Educators" area of the web site in the "Activities/Worksheet" section under "Worksheets" for the current episode.

View Segment 1 of the Video

For optimal educational benefit, view *The Case of the Disappearing Dirt* in 15-minute segments and not in its entirety. If you are watching a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Students should work in groups or as a class to discuss and list what they know about sand, beach erosion, minerals and their formation, and systems. Have the students conduct research on minerals and how minerals turn into sand. Brainstorm for ideas about how sand is deposited onto beaches and what could be causing it to disappear on the tree house detectives' beach. As a class, reach a consensus on what additional information is needed. Have the students conduct independent research or provide students with the information needed.
4. Have the students complete Action Plans, which can be printed from the "Educators" area or the tree house's "Problem Board" area in the "Problem-Solving Tools" section of the web site for the current online investigation. Students should then conduct independent or group research by using books and Internet sites noted in the "Research Rack" section of the "Problem Board" area in the tree house. Educators can also search for resources by topic, episode, and media type under the "Educators" main menu option "Resources."

5. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. The variety of activities is designed to enrich and enhance your curriculum. Activities may also be used to help students "solve" the problem along with the tree house detectives.
6. Have the students work individually, in pairs, or in small groups on the problem-based learning (PBL) activity on the NASA SCI Files™ web site. To locate the PBL activity, click on the tree house and then the "Problem Board." Choose the "2003–2004 Season" and click on "Coasting Away".
   - To begin the PBL activity, read the scenario ("Here's the Situation") to the students.
   - Read and discuss the various roles involved in the investigation.
   - Print the criteria for the investigation and distribute.
   - Have students begin their investigation by using the "Research Rack" and the "Problem-Solving Tools" located on the bottom menu bar for the PBL activity. The "Research Rack" is also located in the tree house.
7. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess student progress. In the beginning, students may have difficulty reflecting. To help them, ask specific questions that are related to the concepts.
8. Have students complete a "Reflection Journal," which can be found in the "Problem-Solving Tools" section of the online PBL investigation or in the "Instructional Tools" section of the "Educators" area.
9. The NASA SCI Files™ web site provides educators with general and specific evaluation tools for cooperative learning, scientific investigation, and the problem-solving process.

Careers

gemologist
jeweler
miner
mineralogist
museum curator

Resources (additional resources located on web site)

Books

Demas, Corrine: *Disappearing Island*. Simon and Schuster, 1999, ISBN: 068980539X.

Fuller, Sue and Christopher Maynard: *Backpack Books: 1,001 Facts about Rocks and Minerals*. DK Publishing, Inc., 2003, ISBN: 0789490439.

Jacobs, Marian: *Why Do the Oceans Have Tides?* Rosen Publishing Group, 2003, ISBN: 082395272X.

Kittinger, Jo S.: *Look at Minerals: From Galena to Gold*. Scholastic Library Publishing, 1999, ISBN: 0531159256.

Murphy, Stuart J.: *Super Sand Castle Saturday: Measuring*. Harper Collins Children's Books, 1998, ISBN: 0064467201.

Prager, Ellen: *Sand*. National Geographic Society, 2000, ISBN: 0792271041.

Ricciuti, Edward: *National Audubon Society First Field Guide to Rocks and Minerals*. Scholastic, Inc., 1998, ISBN: 0590054848.

Squire, Ann: *Growing Crystals*. Scholastic Library, 2001, ISBN: 0516269844.

Symes, R.F.: Eyewitness: *Rocks and Minerals*. DK Publishing, Inc., 2000, ISBN: 0789458047.

Symes, R.F. and R. Harding: *Eyewitness: Crystal and Gem*. DK Publishing, Inc., 2000, ISBN: 0789457644.

Video

Eyewitness: Rocks and Minerals

Web Sites

Mineral Gallery
This web site provides detailed information, color pictures, and classifications of minerals found throughout the world.
http://mineral.galleries.com/minerals/by_name.htm

USGS: Mineral Information
Use this web site to find statistics and information on worldwide supply, demand, and flow of minerals and materials essential to the U.S. economy, the national security, and protection of the environment.
http://minerals.usgs.gov/minerals/

The Dragon's Cave Mineral Search
Enter the Dragon's Cave to find and learn all about this dragon's unusual collection of Earth's natural treasures: minerals. The Mineralogical Society of the United Kingdom hosts this site.
http://www.minersoc.org/pages/education/dragons_cave/entercave.html

Women in Mining: Mineral Resources for Teachers
This site, sponsored by Women in Mining, is dedicated to educating students, teachers, and the general public about the importance of minerals and contains an outstanding collection of hands-on activities.
http://www.womeninmining.org/

Mineral Information Institute (MII)
The purpose of MII's educational programs is to help teach students about the importance of our natural resources. Through these free educational resources, students will learn how we use these resources every day. The site also includes homework help for students.
http://www.mii.org/

SeaWorld/Busch Gardens Sand Lab
Investigate sand from different locations and classify it according to a sand key. Use a series of web sites to help learn more about sand.
http://www.seaworld.org/just-for-teachers/lsa/i-024/pdf/4-8.pdf

National Geographic for Kids: Crazy Crystals
Grow some amazing crystals with the help of an adult.
http://www.nationalgeographic.com/ngkids/trythis/tryfun1.html

Earth Science Lessons
This site contains a collection of earth science activities for elementary students that was written by members of the Volcano World Educational Team. A link to a mineral gallery is also available.
http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/lesson.html

NASA: Earth Observatory
Visit this web site to learn more about the atmosphere, hydrosphere, biosphere, geosphere, and the cryosphere and how they all work together to form a system.
http://earthobservatory.nasa.gov/odysseyofthemind/index.html

Activities and Worksheets

On the Web

Magic Salt Crystal Garden

Grow some amazing crystals using common household materials.

Getting Specific About Minerals

Using simple tests for hardness, streak color, and specific gravity, identify unknown mineral samples.

Calling All Systems

Learn about the various Earth systems and how they work together.

Sandbox Stories

Purpose

To analyze the origin of sands

Background

Sand grains form when an existing rock is destroyed by weathering and erosion. Sand is identified by composition, grain size, roundness, and sorting. Since sand comes from a "parent rock" or source rock, it is possible to determine what kind of rock produced the sand. Some sands, such as the black lava beaches in Hawaii or the white sands of New Mexico, are distinctive because of their color. Sand can also be identified by the grain roundness. By examining grains with a microscope or hand lens, the presence or absence of sharp edges and corners can be seen. Sand grains come in a variety of sizes. Poorly sorted sands will contain a wide range of grain diameters. Well-sorted sands will have similar size grains. As sand grains are transported by wind or water, the grain size tends to decrease, roundness increases, and sorting increases.

Materials

index cards
sand samples *(may be obtained from sandboxes, rivers, beaches, hardware stores)*
wide, clear packing tape
hand lens or microscope
wire tea strainers or pieces of screen wire
empty plastic soda or water bottles
science journal

Procedure

1. Observe the sand sample carefully.
2. Record your observations in your science journal.
3. Using the screen wire or tea strainer, sift your sand sample.
4. Determine whether your sample has grains that are of similar size or many different sizes.
5. Using metrics, estimate the sizes of the sand grains.
6. Record your observations.
7. Cut a small circle in the center of an index card.
8. Cover one side of the hole with clear packing tape. See diagram 1.
9. Turn the card so the sticky side of the tape is facing up.
10. Sprinkle a sample of the sand on the sticky tape.
11. Using a second piece of tape, cover the sample by sealing the sand sample between the two pieces of tape, making a "sand slide."
12. Put the sand slide under the microscope or use a hand lens to examine the sand sample.
13. Observe the sample, taking note of the shape (round or angled) and size of the grains. Record your observations.
14. Fill a plastic bottle 2/3 full with water.
15. Pour 60 mL (about 4 tablespoons (tbsp)) of sand into the bottle.
16. Shake well until the water is muddied.
17. Observe the water and record your observations.
18. Place the bottle where it will not be disturbed and let it stand for 24 hours.
19. Observe the bottle the next day and record your observations.

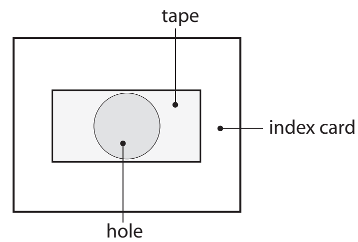


Diagram 1

Conclusion

1. How is sand formed?
2. What connection does sand have to a parent rock?
3. How is sand transported?
4. Explain any details you were able to determine about your sand sample: origin, parent rock, length of time it has "traveled," and so on.

Extension

Remember that sand grain size tends to decrease, roundness increases, and sorting increases the longer the sand is transported by wind and water. Use your scientific observations to write a story about your sand sample. Describe the parent rock. Tell where it could be found and how it began to weather. Tell where the sand was found and how it was transported to that spot. Illustrate your story.

Crystallizing Crystals

Purpose

To identify the six crystal systems found in minerals and learn about examples of minerals contained in each system

Materials

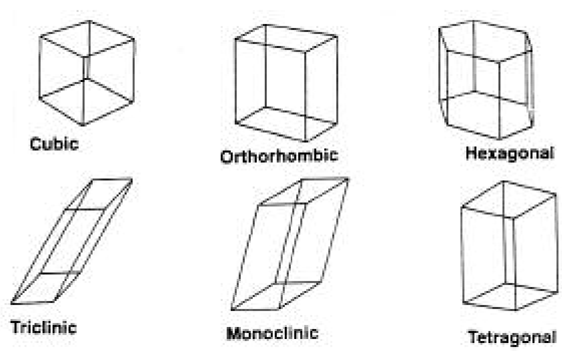
zipper plastic bag
protractor
52 gumdrops
78 round toothpicks
paper towels
diagrams of the 6 crystal systems
hand lens
mineral samples
scissors (optional)

Background

Under the right conditions, atoms or molecules arrange themselves in definite ways to produce solids that have smooth, flat surfaces. Each separate piece of the mineral follows the same pattern and is called a crystal. Mineral crystals can be classified in one of six different crystal systems: cubic, hexagonal, orthorhombic, monoclinic, tetragonal, and triclinic. During the formation of some minerals, impurities (trace elements) occur that create color variation in the mineral. This unique addition of trace elements can create minerals that are very desirable, such as rubies, emeralds, and amethysts. These minerals are called gemstones.

Examples of crystal systems can be found in the following minerals:

- cubic – diamond, pyrite, galena, fluorite, halite, garnet
- hexagonal – graphite, quartz, hematite, dolomite, calcite, corundum
- orthorhombic – sulfur, olivine, topaz
- monoclinic – borax, gypsum, hornblende, muscovite, talc, malachite
- tetragonal – anatase, zircon
- triclinic – turquoise, kyanite



Procedure

1. Look at the crystal systems diagrams and determine how each is constructed.
2. Using gumdrops and toothpicks, build a model of each system.
   a. Break or cut toothpicks to the various lengths needed for each side.
   b. Use the gumdrops as the corner pieces to connect the toothpicks in each model.
   c. Use a protractor to achieve the correct angle of each side.
3. Observe the model and determine what two-dimensional geometric shape (such as rectangle, square, hexagon, etc.) is represented in the system.
4. In the Crystal Chart on page 21, record how many times each shape is repeated in the system.
5. Draw a picture of the crystal system.
6. Note any other observations in the space provided in the Crystal Chart.
7. Choose two different mineral samples and examine each with your hand lens.
8. After observing the minerals, form a hypothesis as to which type of crystal system is in each sample.
9. Use mineral identification books or a web site to determine if your hypothesis is correct.

Crystallizing Crystals (concluded)

Crystal Chart

Crystal Model	Geometric Shape *Number of Repeats*	Picture of Crystal	Notes
Cubic			
Hexagonal			
Orthorhombic			
Monoclinic			
Tetragonal			
Triclinic			

Mineral Sample 1:

Mineral Sample 2:

Conclusion

1. What geometric shapes are found in each crystal system?
2. How does the geometric shape affect the use of the mineral?

Extension

Interview a local jeweler. Find out how and where precious gems are cut. Ask what special considerations a jeweler must make based on the crystal structure of the gem.

Put together a pamphlet about the gemstones that have been chosen to represent each birth month. What do the gemstones represent? Where are they found?

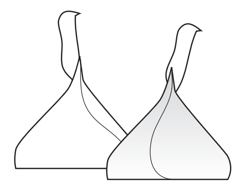
Rock or Mineral?

Purpose

To distinguish between a rock and a mineral based on physical appearance, including the presence or absence of phases

Materials

hand lens
one plain chocolate Hershey's Kiss® *(silver foil wrapping)* per student
one almond chocolate Hershey's Kiss® *(gold foil wrapping)* per student
rock and mineral samples



Background

A mineral is normally defined as a solid crystalline substance formed by natural and usually inorganic processes. Inorganic means that it is made up of material that is neither plant nor animal. Minerals have a definite chemical composition and a particular atomic pattern. Because a mineral is made up of entirely the same elements throughout, it is considered physically and chemically homogeneous. Rocks are made of one or more minerals. All minerals are rocks, but not all rocks are minerals. Some rocks, like coal, are organic because they were formed from plants. About 2,000 different kinds of minerals are known, but only 200 of them are commonly mined.

Procedure

1. Carefully unwrap your gold and silver chocolate pieces. Place them on the correct foil wrapper so as to remember which one is which.
2. Bite and eat one half of the silver sample.
3. Place the remaining half on the silver paper.
4. Observe the inside of the sample.
5. Record your observations in your science journal. Be sure to include observations using all the senses!
6. Now bite and eat one half of the gold sample.
7. Place the remaining half on the gold paper.
8. Observe the inside of this sample.
9. Record your observations in your science journal.
10. Based on your observations, determine which sample is a mineral and which one is a rock.
11. Using a hand lens, carefully look at each sample.
12. Classify each sample as a rock or a mineral.

Conclusion

1. How do scientists determine the difference between rocks and minerals?
2. Is concrete more like a rock or a mineral? Why?

Extension

1. Using books and other reference materials, make a list of the ten most common minerals and where they are found. On a world map, place a different color sticker for each mineral near the place where it is found.
2. Visit the Mineral Institute's web site at *http://www.mii.org* . Make a list of common rocks and minerals. Identify the uses for each. Did you know there are rocks in your toothpaste and minerals in your lights? Research how much of each rock or mineral the average American uses in a year and make a graph depicting your findings.

"Mocking" Minerals

Purpose

To identify the chemical composition of minerals

Background

Minerals can be identified by their chemical makeup or chemical formula. The chemical formula is a type of shorthand that helps scientists avoid writing out impossibly long descriptions. For example, the formula for zircon is $ZrSiO_4$. This formula means that one unit of $ZrSiO_4$ is one part zirconium (Zr), one part silicon (Si), and four parts oxygen (O). The formula is much like a "recipe" for making a mineral.

Procedure (Teacher)

1. In a large bowl, stir flour and oatmeal together for about 30 seconds.
2. Combine the remaining ingredients in the bowl and mix thoroughly.
3. Knead (work with your hands) until well mixed.
4. If the mixture appears to be too sticky, add more flour until it is no longer sticky but not too stiff.
5. Pinch off a small amount of dough and shape it into a ball the size of a large marble. Make enough for each student to have one.
6. Assign a color of decorating sprinkle to each element and create a class chart like the one below.

SPRINKLES COLOR	ELEMENT	SYMBOL
red	Iron	Fe

7. Create a class chart or student sheet with the formula for each mineral.
8. Write the formula for each mineral on index cards (one per card).
9. Give each student an index card and a ball of dough on a paper towel.
10. Make the sprinkles and measuring spoons accessible to the student.
11. Create a viewing area for the mock minerals by having napkins or small paper plates lying out for each student to place his/her mineral on. Be sure to number each sample area 1, 2, 3, and so on.

Materials

- 2 cups flour
- 4 cups oatmeal
- 1 cup water
- 1 cup white corn syrup
- 1 cup peanut butter
- 1 cup nonfat powdered milk
- 1 cup confectioner's sugar
- cake decorating sprinkles, various colors *(one for each element in your chemical formulas)*
- mixing bowl
- mixing spoon
- measuring spoons
- rock samples *(with bright mineral mixes)*
- cards with chemical formulas

Procedure (Student)

1. Read the chemical formula on the index card.
2. Using the chart created by your teacher, determine which colors of sprinkles are needed to make your mineral.
3. Place approximately 1 mL (1 teaspoon) of sprinkles for each color needed and for each part. For example, if you are making a mock mineral of zircon, add 1 mL of one color to represent the zirconium atom, 1 mL of a different color to represent the silicon, and 4 mL of a third color to represent the four atoms of oxygen in a molecule of zircon.
4. Wash your hands with warm soapy water for at least 15 seconds.
5. Mix the sprinkles throughout the dough and reshape into a ball.
6. Divide the ball in half.
7. Put one half of the mineral on display within the mock rock viewing area. Place your card face down behind your sample. What happens to the second half?

Materials (Students)

- 1 ball of dough
- sprinkles of various colors
- small cup
- paper towel

"Mocking" Minerals (continued)

8. Using the element chart, identify the elements in each of the mock minerals.
9. Estimate the amount of each element that was used to create the mineral. For example, if you observe more of one element than another, then estimate whether it was 2, 3, or more parts of that element.
10. Based on your observations and by using a chart with the chemical formulas for each mineral, match each mock mineral to its mineral name.
11. Once all students are finished predicting, have the teacher or a student turn over the cards and check your answers.

Conclusion

1. How do scientists identify the chemical makeup of a mineral?
2. What does each capital letter in a formula represent?
3. What does the number in the subscript (below the line) mean?
4. In the chemical formula FeS_2, how many atoms or parts are represented by the formula?

Extension

Make a drawing or model to illustrate each of the mineral formulas. Write a short description of what the formula means. Find out what each of the minerals might be used for and where they are found.

"Mocking" Minerals: Formula Chart

Chemical Formulas

Mineral	Formula	Common name
Copper	Cu	
Diamond	C	
Gold	Au	
Chalcopyrite	$CuFeS_2$	Copper Iron Sulfide *(most common copper mineral)*
Hematite	Fe_2O_3	
Halite NaCl	Rock salt	
Fluorite	CaF_2	
Calcite	$CaCO_3$	Lime
Opal	SiO_2H_2O	
Pyrite FeS2	Fool's Gold	
Quartz	SiO_2	
Corundum	Al_2O_3	Aluminum Oxide
Galena	PbS	Lead Ore
Zircon	$ZrSiO_4$	
Smithsonite	$ZnCO_3$	Zinc Carbonate

There's Iron in My Cereal?

Materials

240 mL iron-fortified cold cereal
480 mL hot water
magnet stirrer
bowl or large glass
science journal
balance

Purpose

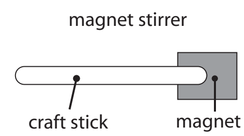
To demonstrate how minerals are extracted from rock

Background

Valuable minerals must often be extracted from the rock that contains them. Several different methods are used to separate the mineral(s) from rock. Metals, such as copper, uranium, and gold, may be extracted by using processing methods such as gravity separation, flotation, or caustic (acidic) water rinses. Gold panning is an example of gravity separation. When a gold pan is stirred or agitated, the heavier mineral drops to the bottom of the pan and the lighter rocks wash away. Other metals that have magnetic properties, such as iron, are extracted with the use of high-powered magnets. The rocks are pulverized or melted at high temperatures and the magnet is used to remove the mineral particles. Metallic iron is sometimes added to fortified cereals and other food products.

Teacher Prep

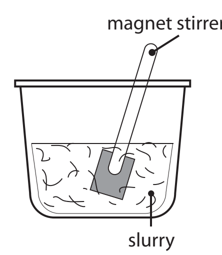
For each student or group of students, paint a magnet with white epoxy paint and allow it to dry completely. Use hot glue or superglue to attach the magnet to a craft stick.



In this experiment, add cold or warm water to make a slurry. The longer the cereal is stirred, the more complete the iron removal. Usually 30 minutes give the maximum iron recovery.

Procedure

1. Put the cereal in the bowl.
2. With adult supervision, carefully add the hot water.
3. Stir the mixture with the magnet stirrer until the cereal is soggy and a mush or slurry is formed.
4. If working in a group, take turns stirring. After 10 minutes, remove the magnet and observe the end.
5. Record your observations in your science journal
6. Repeat steps 4 and 5 at 20- and 30-minute intervals.
7. After 30 minutes, scrape off any substance attached to the magnet and find its mass.
8. Compare the amount with the content of iron listed on the box.



Conclusion

1. What are the dark particles on the magnet?
2. Why is iron added to foods?
3. What other foods might be iron fortified?
4. How much iron is recommended in an adult's daily diet?
5. What effect would crushing the cereal before adding the water have on the iron recovery time?

Extension

1. Try iron extraction from other iron-fortified foods, such as an iron rich drink or cooked hot cereal.
2. Find out what other minerals are important for good health. Investigate how we obtain those essential minerals. Find out about foods that may have been developed to provide essential minerals such as orange drinks or instant breakfasts.
3. Check out this web site and learn about the dietary requirements of astronauts. Plan your own astronaut meals. *http://www.space.com/teachspace/module_astronaut_0900/dining_0900.pdf*

Answer Key

Sandbox Stories

1. Sand is formed when rocks weather or break down into smaller pieces. The pieces are either fragments of the original rock or pieces that have separated into the individual minerals that make up the rock.
2. Sand is the same chemical makeup as the parent rock.
3. Sand is transported by wind, water, animals, or humans.
4. Answers will vary.

Crystallizing Crystals

1. The six crystal structures are made up of squares, cubes, rectangles, rectangular prisms, parallelograms, trapezoids, and hexagons.
2. The shape of the crystal determines the fracture planes of the mineral, which tells how the mineral will break into pieces. Jewelers must study the crystal formations and cut gemstones along these fracture planes to avoid destroying the gem.

Rock or Mineral?

1. Scientists must determine if the sample is physically and chemically homogeneous. If the rock's chemical composition is the same throughout, it is a mineral.
2. Concrete is more like a rock because it is composed of many different things, such as sand, pebbles, and limestone.

"Mocking" Rocks

1. Scientists use a type of chemical shorthand known as a formula.
2. Each capital letter represents a different element that can be found in the mineral. An element is a substance that contains only one kind of atom and cannot be broken down into simpler substances.
3. The number in the subscript tells us how many parts or atoms of that particular element are found in each molecule.
4. There is one atom of iron (Fe) and two atoms of sulfur (S) for a total of three atoms.

There's Iron in My Cereal?

1. The dark particles are actually slivers of iron.
2. Iron is an essential mineral for good health. It is added to foods to improve the healthy benefit of the food.
3. Although iron can be found naturally in red meats, poultry, and dried beans, many foods such as cereals, instant drinks, and even vitamin supplements have added iron.
4. The recommended dietary allowance for iron is 18 mg per day for adults. Children should have between 12 and 14 mg. Iron is essential for the development of strong muscles and the production of blood.
5. Crushing the cereal would shorten the iron recovery time.

On the Web

Magic Salt Crystal Garden

1. The original salt crystals will be more angular and well defined.
2. As the liquid evaporates from the salt solution, the small particles of blue powder are left behind. These particles become the "seed" around which the salt begins to recrystallize. As more liquid evaporates, more salt crystals begin to attach themselves to the growing formation.
3. Answers will vary.
4. White.
5. Salt is used for seasoning, as a preservative, and as a melting agent. Salt was also used in ancient bartering systems.

Getting Specific About Minerals

1. The streak test is important because it can help to identify minerals that often look similar to other minerals. The powder left behind by the streak test is often a different color than the visible colors of the mineral. The streak is made by the elements that make up the mineral, and the color is often unique to that mineral.
2. The scratch test can be used to determine the hardness of a mineral.
3. Because we know the specific gravity of water (1), we can use it to compare the volume of the mineral sample.