CURRICULUM GUIDE FOR
Rocks and Minerals
(Based on STC Rocks and Mineral Kit)

Wallingford Public Schools
Fourth Grade Science

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<td>Materials List</td>
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</tbody>
</table>

### Teacher Background Notes

These science content background notes were created for teacher use only. We anticipate that these notes will provide you, the teacher, with some useful background information as you facilitate inquiry activities for your students. These notes are not meant to be an overview of the unit,
but as background information for you that go beyond the content of this particular unit. These notes should not be replicated for your students; however, you may share some of the content when appropriate for the developmental level of your students.

**Inquiry Investigation:** Classifying, Sorting and Identifying Rocks and Minerals

Inquiry Investigation

**Appendixes:**
A. FQR
B. Recipe for Making Rock Candy
C. Rock Information Organizer
   - Unit Example
D. Rock Cycle Diagram 1
E. Rock Cycle Diagram 2
F. Rock Cycle Diagram 3
G. Rock Cycle Diagram 4
H. Rock Cycle Diagram 5
I. Minerals at Home
J. Exploratorium’s Description of Inquiry
K. Map of IFI Inquiry Structure (3 Phases of Inquiry Diagram)
UNIT SUMMARY

Students explore the differences and similarities between rocks and minerals by investigating samples of these Earth materials and by performing a series of mineral tests similar to geologist’s field tests. Students will discover how rocks are formed and changed. Non-fiction literatures resources will be used to assist students in uncovering common uses of rocks and minerals. Inquiry skills will be emphasized during these explorations.

STAGE 1- STANDARDS/GOALS

What should students understand, know, and be able to do? Stage one identifies the desired results of the unit including the related state science content standards and expected performances, enduring understandings, essential questions, knowledge and skills.

<table>
<thead>
<tr>
<th>Enduring Understandings</th>
<th>Essential Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insights learned from exploring generalizations via the essential questions.</strong> (Students will understand THAT…)</td>
<td>Inquiry used to explore generalizations</td>
</tr>
<tr>
<td><strong>Overarching Enduring Understandings:</strong></td>
<td></td>
</tr>
<tr>
<td>• Science is the method of observation and investigation used to understand our world. (K-12)</td>
<td>• How is inquiry used to investigate our environment?</td>
</tr>
<tr>
<td>• Inquiry is the integration of process skills, the application of scientific content, and the critical thinking to solve problems. (K-12)</td>
<td>• How do rocks and minerals cycle through our environment?</td>
</tr>
<tr>
<td>• The environment is a complex assemblage or interacting and evolving chemical, physical, and biological processes. (K-12)</td>
<td>• What are the similarities and differences between rocks and minerals?</td>
</tr>
<tr>
<td>• Earth’s materials (rocks and minerals) are formed and may undergo change by certain conditions, such as erosion or metamorphism, and can occur over various amounts of time. (K-12)</td>
<td>• How are rocks and minerals used?</td>
</tr>
<tr>
<td><strong>Unit Specific Enduring Understandings:</strong></td>
<td>• What story of Earth’s history can we gather from rocks and minerals?</td>
</tr>
<tr>
<td>• The unique physical and chemical properties of rocks and minerals make them useful.</td>
<td>• How is weathering the preparation for erosion?</td>
</tr>
<tr>
<td>• Rocks and minerals are limited resources.</td>
<td></td>
</tr>
</tbody>
</table>
Knowledge and Skills
What students are expected to know and be able to do
The knowledge and skills are aligned with Wallingford’s Scope and Sequence.

Knowledge
The students will …
- K1. Differentiate between rocks and minerals
- K2. Classify rocks and minerals by their properties
- K3. Relate the physical properties of rocks to their potential uses
- K4. Identify the environmental conditions during the formation of sedimentary, igneous, and metamorphic rocks.
- K5. Relate the properties of rocks to the possible environmental conditions during their formation.
- K6. Describe the physical changes that occur in rocks and minerals as a result of weathering and erosion.

Skill
The students will...
- S1. Generate investigable and non-investigable questions.
- S2. Observe rocks and minerals and describe commonalities and differences among them.
- S3. Classify, based on observations of properties
- S4. Predict
- S5. Design an investigation
- S6. Conduct simple investigations
- S7. Employ simple equipment and measuring tools.
- S8. Organize appropriate and accurate measurements and observations, using
  - Graphic organizers
  - Charts and graphs
  - Illustrations or diagrams
  - Journaling
- S9. Draw conclusions based on data, observations, or findings.
- S10. Communicate results or information in an appropriate manner, using
  - Presentations
  - Visuals
  - Simple reports

Content Standard(s)
Generalizations about what students should know and be able to do

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The Changing Earth: How do materials cycle through the Earth’s system?</td>
<td>B5: Describe the physical properties of rocks and relate them to their potential uses</td>
</tr>
<tr>
<td>3.3 Earth materials have different physical and chemical properties.</td>
<td>- Rocks and minerals have properties</td>
</tr>
</tbody>
</table>
that may be identified through observations and testing; these properties help determine how the earth materials are used

<table>
<thead>
<tr>
<th></th>
<th>B6: Relate the properties of rocks to the possible environmental conditions during their formation.</th>
</tr>
</thead>
</table>

### Scientific Inquiry

- **B INQ.1:** Make observations and ask questions about objects, organisms and the environment.
- **B INQ.2:** Seek relevant information in books, magazines, electronic sources of information.
- **B INQ.3:** Design and conduct simple investigations.
- **B INQ.4:** Employ simple equipment and measuring tools to gather data and extend the senses.

### Scientific Literacy

- **B INQ.6:** Analyze, critique, and communicate investigations using words, graphs and drawings.
- **B INQ.7:** Read and write a variety of fiction and non-fiction science-related texts.

### Common Misconceptions Children Have

*By identifying misconceptions early, teachers can design appropriate lessons to address and change student misconceptions.*

- Some children either call everything a rock or call everything a mineral.
- Some children don’t know that rocks are formed from minerals.
- Students don’t recognize that rocks and minerals are used in materials and products that they use.
### STAGE 2 - DETERMINE ACCEPTABLE EVIDENCE

How will we know if students have achieved the desired results and met the content standards? How will we know that students really understand? Stage two identifies the acceptable evidence that students have acquired the understandings, knowledge, and skills identified in stage one.

<table>
<thead>
<tr>
<th>Performance Task(s)</th>
<th>Other Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authentic application in new context to evaluate student achievement of desired results designed according to GRASPS. (Goal, Role, Audience, Setting Performance, Standards)</td>
<td>Other methods to evaluate student achievement of desired results.</td>
</tr>
</tbody>
</table>

- You are a geologist who has been given 3 mystery minerals. You have been asked to identify them. Design a plan that will help you name the mineral and its uses. (see lesson 15 STC manual)

**See Next Page For Sample Rubric**

- Maintain a science notebook of investigations by both teachers and students
- Teacher observations
- Rock information organizer for each type of rock - igneous, sedimentary, and metamorphic (see Appendix C)
- Illustrate and explain the rock cycle
- Sample prompts:
  - Summarize how the three different types of rocks are formed.
  - Draw conclusions and defend the best uses for several (3 or more) rock properties.
Mineral Performance Task – Sample Rubric

**TASK:** You are a geologist who has been given 3 mystery minerals. You have been asked to identify them. Design a plan that will help you name of the mineral and its uses.

<table>
<thead>
<tr>
<th></th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PLAN</strong></td>
<td>Complete plan including data record sheet.</td>
<td>Plan is almost complete missing no more than 2 parts and has a data record sheet.</td>
<td>Plan is missing more than 2 parts and does not have a complete data record sheet.</td>
<td>Plan is incomplete and has no data record sheet.</td>
</tr>
<tr>
<td><strong>IDENTIFICATION</strong></td>
<td>Identifies all 3 mystery minerals correctly with evidence.</td>
<td>Identifies 2 of the 3 minerals correctly with evidence.</td>
<td>Identifies 1 of the 3 minerals correctly with evidence.</td>
<td>Does not identify any of the 3 minerals correctly. No evidence is given.</td>
</tr>
<tr>
<td><strong>COMMUNICATION</strong></td>
<td>Works cooperatively with partner and communicates results with clarity and precision.</td>
<td>Works cooperatively with partner most times and communicates results with some clarity and precision.</td>
<td>Has difficulty working with partner and communicates results with little clarity and precision.</td>
<td>Refuses to work with partner and does not communicate results clearly. Lacks precision.</td>
</tr>
<tr>
<td><strong>USE OF EQUIPMENT AND TOOLS</strong></td>
<td>Uses all science equipment properly and safely.</td>
<td>Uses most of the science equipment properly and safely.</td>
<td>Uses very little of the science equipment properly and safely.</td>
<td>Uses none of the science equipment properly and safely.</td>
</tr>
</tbody>
</table>

Comments:
## STAGE 3 – LESSON ACTIVITIES

What will need to be taught and coached, and how should it best be taught, in light of the performance goals in stage one? How will we make learning both engaging and effective, given the goals (stage 1) and needed evidence (stage 2)? Stage 3 helps teachers plan learning experiences that align with stage one and enables students to be successful in stage two. Lesson activities are suggested, however, teachers are encouraged to customize these activities to their own students, maintaining alignment with stages one and two.

The suggested lesson activities are not sequenced in any particular order. Teachers may select which lesson activities will best meet the needs of their students and the unit objectives. Each lesson activity is coded with the corresponding knowledge (K) and/or skill (S) objectives that are found in stage one.

### Essential Questions

Post the essential questions (or some of them) in your classroom to refer back to throughout the unit.

- How is inquiry used to investigate our environment?
- How do rocks and minerals cycle through our environment?
- What are the similarities and differences between rocks and minerals?
- How are rocks and minerals used?
- What story of Earth’s history can we gather from rocks and minerals?
- How is weathering the preparation for erosion?

### Elicit Prior Knowledge

Some suggested strategies include:

- Read “Everybody Loves a Rock” by Byrd Baylor to activate student’s prior knowledge and chart student responses
- Have students browse the science literature books and complete an FQR (see Appendix A). Teacher may need to model FQR strategy before beginning.
- Another option is a Brain Drain – students write for 10 minutes listing all of the facts they think they know about minerals and/or rocks, and then take 5 minutes to write questions they have. Students can then share their facts and questions with the class.

### MINERAL Guided Inquiry Investigation  (Classifying, sorting and identifying different minerals)

Refer to the inquiry template (see page 33-38) and STC Rocks and Minerals Lessons 4-12, 14

Suggested time: 6 lessons plus performance assessment (see page 7 in this document and page 115 in STC Rocks and Minerals manual)

(K1, S2, S3, S6, S7, S8)
- How do scientists identify minerals?
What are the differences and similarities between minerals?
How are minerals used?
How is inquiry used to investigate our environment?

ROCK Guided Inquiry Investigation (Classifying, sorting and identifying different rocks based on color, minerals present, and texture)
Teacher note: Use non-fiction resources along with the rock samples in the kit to identify the names of the rocks and how the rocks were formed. Students can then sort rocks by the three main formation types, sedimentary, metamorphic, and igneous. Unlike, lessons 2-3 in the STC Rocks and Minerals manual students will spend more time using non-fiction resources to identify and better understand how the different types of rocks are formed.

Distribute rocks for students to investigate with their senses. Give them time to record their observations. Then hand out non-fiction materials for further discovery. Provide a randomly arranged list of the 12 rocks to the students. Allow students time to discover the names, uses and how it is formed. During this guided inquiry, introduce the students to the ‘Rock Information Organizer’ (see appendix C). As part of wrap-up, teacher can read and discuss Dave’s Down-to-Earth Rock Shop by Stuart Murphy and Cat Bowman Smith.

Non-Fiction books are needed such as: Eyewitness Books: Rocks and Minerals, Pockets: Rocks and Minerals, Peterson First Guides Rocks and Minerals.
Suggested time: 3-4 lessons
(K2, K3, K4, K5, S2, S3, S9)

- What are the differences and similarities between rocks?
- What are differences and similarities between rocks and minerals?
- How are rocks used?
- How is inquiry used to investigate our environment?
- How do rocks and minerals cycle through our environment?
- What story of our Earth’s history can we gather from rocks and minerals?

Rocks and Minerals and Their Uses
Have students gather examples of the uses of rocks (and minerals). Record this on a class chart. Then the teacher will discuss with the class various uses of rocks and minerals.
Refer to:
- Appendix I Minerals at Home
- Non-fiction resources

Possible uses:
- Paving/building stones - Walk ways
- Counter tops
- Gravestones
- Stone fire place
- Houses, buildings and or foundations
- Trophy
- Sandpaper
- Soap
- Abrasive cleaners
- Defoliants
Teacher Note: Teacher should question the children as to some of the common physical properties.

Common physical properties that relate them to their potential uses:

- Color
- Hardness
- Cost
- Strength between minerals (how it breaks when dropped)
- Heavy vs. light
- Chalk like characteristics
- Hazardous to ingest
- Porous vs. non-porous
- Smoothness
- Scalpel

Teacher Note: Class should come up with rocks for each property. It could show the extreme opposites.

For example:
- Color – granite vs. slate
- Hardness – pumice vs. granite
- Cost – granite vs. sandstone (supply vs. demand)
- Strength between minerals – granite vs. sandstone
- Heavy vs. light – basalt vs. pumice
- Chalk like – limestone vs. marble
- Hazardous to ingest – none
- Porous vs. non-porous – pumice vs. obsidian
- Smoothness – obsidian vs. sandstone

Make rock candy (guided lesson)

( **Teacher note – this activity takes several days to see the desired results so if you choose to do this do it early in the unit. The lesson takes one period but observe for 3 -10 days**) 

Magma that cools very slowly deep inside the Earth tends to form igneous rocks with large crystals. Lava that erupts at the surface of the Earth, or under the oceans, cools very quickly and is likely to form igneous rocks with very tiny crystals. Whether cooled slowly or quickly, all of the crystals in igneous rocks tend to have angular, shape-edged shapes.

This activity demonstrated the formation of two different types of igneous rocks – extrusive and intrusive. An extrusive rock refers to molten lava being extruded at Earth’s surface. The magma has been cooled very quickly which results in small or fine grain crystals. If the magma cools slowly in the subsurface, the igneous rock is termed intrusive; magma cools slowly in subsurface pocket and therefore coarse grain in character (large crystals). This activity demonstrates these differences in crystal size.

When making rock candy let one set up cool at room temperature and let another set-up cool in the fridge. Have students observe the crystals with a magnifying lens, observe the crystals, draw them in their science journals and compare and contrast their shape and size.

(K1, K4, S2, S3, S4, S6, S7, S8, S9)
Suggested time: 1 lesson with follow up observations
See Appendix B for Recipe for Making Rock Candy

- What story of Earth’s history can we gather from rocks and minerals?
- How are different types of igneous rocks (extrusive and intrusive) formed?

**Rock Cycle**
Teacher can show video titled All About Rocks and Minerals by Earth Science for Children (housed in each elementary school media center). Following the video, lead a discussion on the rock cycle using an overhead of the rock cycle. Introduce the words of weathering and erosion. Refer back to notes the students took on their ‘Rock Information Organizers’ (Appendix C) metamorphic, igneous, and sedimentary rocks. Have students explain the “cyclical nature” of the rock cycle. They may refer back to the non-fiction resources for more information or to answer further questions they may have raised.
See appendices: D-H
http://www.msnucleus.org/membership/html/k-6/rc/
(K4, K5, K6, S2, S8, S10)
Suggested time: 1-2 lessons

- How do rocks and minerals cycle through our environment?
- What story of Earth’s history can we gather from rocks and minerals?
- How is weathering the preparation for erosion?

*Weathering* is the wearing away or changing of the form of something as a result of exposure to the elements—wind, rain, sun, and so forth.
*Erosion* is the carrying off of the materials that have been weathered.
*Weathering is the preparation for erosion*

**Fieldtrip of CT Geology with Earth Science Expert**
Take students on a bus tour of various rock formations. For example:
- Great Eastern Border Fault on Rt. 79 – sedimentary and metamorphic rocks
- Lake Quonnipaug (North Madison) – sedimentary and igneous rocks
- Castle Craig found on top of the great Holyoke Lava flow (Hubbard Park)
Earth science teachers at the high school may be able to help organize this field trip.
### LITERATURE RESOURCES

These literature resources have been purchased to supplement the kit and are housed in each elementary school library.

<table>
<thead>
<tr>
<th>Earth Science Literature Circle/Guided Reading Sets (6 copies per school)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarkable Rocks, Ron Cole &amp; Ranger Rick</td>
</tr>
<tr>
<td>Everybody Needs A Rock, Byrd Baylor</td>
</tr>
<tr>
<td>Who Wants A Rock, Michael Kusugak</td>
</tr>
<tr>
<td>Rocks and Minerals, Neil Morris</td>
</tr>
<tr>
<td>Investigating Rocks, Ron Cole &amp; Ranger Rick</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Fiction (1 copy per school)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peterson First Guide Rocks and Minerals, Frederick Pough</td>
</tr>
<tr>
<td>A DK Pocket: Rocks and Minerals, Sue Fuller</td>
</tr>
<tr>
<td>Eyewitness Books: Rocks and Minerals, R.F. Symes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Earth Science Read Alouds (1 copy per school)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pebble In My Pocket, Meredith Hooper</td>
</tr>
<tr>
<td>If You Find A Rock, Peggy Christian</td>
</tr>
<tr>
<td>Rocks In His Head, Carol Hurst</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>All about Rocks and Minerals, Earth Science For Children</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teacher Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Amazing Earth Model Book, Donald Silver</td>
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</table>

<table>
<thead>
<tr>
<th>Video Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>All About Rocks and Minerals, Earth Science for Children * at each school library</td>
</tr>
<tr>
<td>Where the Garbage Goes, Fred Levine’s Original</td>
</tr>
<tr>
<td>BFI Recyclery, Schoolworks Presents a Video Field Trip</td>
</tr>
<tr>
<td>Earth Science in Action-Minerals, Schlessinger Science Library</td>
</tr>
<tr>
<td>Weathering and Erosion, Schlessinger Science Library</td>
</tr>
<tr>
<td>All About Land Formations, Schlessinger Science Library</td>
</tr>
<tr>
<td>Land Formations, Schlessinger Science Library</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Related Materials:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature Circle/Guided Reading Sets (6)</td>
</tr>
<tr>
<td>Ring of Fire, Newbridge</td>
</tr>
<tr>
<td>The Magic School Bus Inside the Earth, Joanna Cole</td>
</tr>
<tr>
<td>The Restless Earth, Melvin Berger</td>
</tr>
<tr>
<td>The Magic School Bus Blows Its Top, Joanna Cole</td>
</tr>
<tr>
<td>Volcanoes - Mountains of Fire, Eric Arnold</td>
</tr>
<tr>
<td>Rock and Rolling, Philip Steele</td>
</tr>
</tbody>
</table>
### Materials List
#### Rocks and Minerals – Grade 4

(Revised August 204
(Based on the STC Rocks and Minerals Kit)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Teachers guide, Rocks and Minerals (STC)</td>
<td>16 samples of Rocks</td>
</tr>
<tr>
<td>20</td>
<td>Student books</td>
<td>1. granite</td>
</tr>
<tr>
<td>1</td>
<td>Bottle whiteout</td>
<td>2. gneiss</td>
</tr>
<tr>
<td>1</td>
<td>Sharpie marker</td>
<td>3. conglomerate</td>
</tr>
<tr>
<td>1</td>
<td>Waxed paper</td>
<td>4. limestone (fossiliferous)</td>
</tr>
<tr>
<td>1</td>
<td>Plastic wrap</td>
<td>5. shale</td>
</tr>
<tr>
<td>100</td>
<td>Note cards</td>
<td>6. sandstone (pink with layers)</td>
</tr>
<tr>
<td>1 set</td>
<td>Rocks and Mineral Cards</td>
<td>7. obsidian</td>
</tr>
<tr>
<td>1 box</td>
<td>Sugar</td>
<td>8. basalt</td>
</tr>
<tr>
<td>1</td>
<td>Measuring cup</td>
<td>9. pumice</td>
</tr>
<tr>
<td>6</td>
<td>Spoons</td>
<td>10. slate</td>
</tr>
<tr>
<td>1</td>
<td>Roll of white string</td>
<td>11. marble</td>
</tr>
<tr>
<td>20</td>
<td>Popsicle sticks</td>
<td>12. schist (with garnet)</td>
</tr>
<tr>
<td>1</td>
<td>Hot pot</td>
<td>16 samples of Minerals</td>
</tr>
<tr>
<td>30</td>
<td>9 oz lg mouth cups</td>
<td>A. feldspar</td>
</tr>
<tr>
<td>1</td>
<td>Vinegar</td>
<td>B. quartz (hexagon crystal)</td>
</tr>
<tr>
<td>30</td>
<td>Goggles</td>
<td>C. galena (cubic form) <strong>(encased in plastic resin)</strong></td>
</tr>
<tr>
<td>10 pc</td>
<td>Limestone</td>
<td>D. calcite (Icelandic Spar)</td>
</tr>
<tr>
<td>10pc</td>
<td>Quartzite</td>
<td>E. fluorite</td>
</tr>
<tr>
<td>15</td>
<td>Flashlights</td>
<td>F. graphite</td>
</tr>
<tr>
<td>30</td>
<td>AAA batteries</td>
<td>G. hematite (black specular)</td>
</tr>
<tr>
<td>30</td>
<td>Hand lenses</td>
<td>H. gypsum (massive form/alabaster)</td>
</tr>
<tr>
<td>30</td>
<td>Flexible Magnets</td>
<td>I. magnetite (lodestone)</td>
</tr>
<tr>
<td>31</td>
<td>Deli containers w/Lids</td>
<td>J. muscovite</td>
</tr>
<tr>
<td>15</td>
<td>Black streak plates</td>
<td>K. sulfur (crystalline)</td>
</tr>
<tr>
<td>15</td>
<td>White streak plates</td>
<td>L. talc</td>
</tr>
<tr>
<td>15</td>
<td>No. 12 steel nails</td>
<td>M. haltite</td>
</tr>
<tr>
<td>8</td>
<td>Trays</td>
<td>N. gypsum (massive and fibrous/satin spar)</td>
</tr>
<tr>
<td>1</td>
<td>Roll masking tape</td>
<td>O. gypsum (bladed selenite crystal aggregate in desert rose form)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P. quartz (pink massive crystals)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q. hematite (red variety)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R. biotite</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S. gypsum (clear selenite crystal)</td>
</tr>
</tbody>
</table>
Safety Considerations

Galena is a form of lead sulfide, a compound that commonly occurs in the earth's crust. An attractive mineral with interesting physical properties, galena is widely used in earth science classes. We recommend that teachers take the following safety precautions when using the galena samples in the STC Rocks and Minerals Kit:

- Inform students that galena like all compounds containing lead is poisonous if it is taken internally.
- Do not allow students to take galena samples out of the classroom.
- Encase galena samples with clear enamel or Clear Cast polyester resin. This will avoid skin contact with galena.
- In science, materials should never be tasted.
- Caution students to be careful not to scratch themselves or the furniture when using the nail for the hardness test.
Teacher Background Notes

These science content background notes were created for teacher use only. We anticipate that these notes will provide you, the teacher, with some useful background information as you facilitate inquiry activities for your students. These notes are not meant to be an overview of the unit, but as background information for you that go beyond the content of this particular unit. These notes should not be replicated for your students; however, you may share some of the content when appropriate for the developmental level of your students.

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Part I: The Minerals
Part II: The Rocks
Part III: Notes on Rock Cycle, Weathering, Erosion and the Water Cycle
Part IV: Useful Thoughts
Part V: Useful Websites

Part I: The Minerals

The uses for each mineral are from the following source:

Physical Properties Used for Mineral Identification

Color – pigment of fresh mineral surface in white light
“fresh” = clean and un tarnished (tarnished color can be mentioned but it is not the true color of the mineral)

Streak – color of mineral in powdered form on an unglazed porcelain plate (“streak plate”)

Luster – how a fresh mineral surface reflects light (NOT how it transmits light)
“metallic” – looks like a shiny metal
“submetallic” – looks like a duller metal
“nonmetallic” – all others, e.g.,
glassy or vitreous
dull or earthy
pearly, silty, waxy
resinous
adamantine (sparkly)
Crystal Habit – growth shape
  Single crystals – cubes, prisms, rhombohedrons, dodecahedrons, tabular, acicular
  Crystal masses – granular masses, crystalline masses, botryoidal masses

Cleavage/Fracture – how minerals break (determined by observation, not breking)
  “cleavage” = breakage in a planar fashion, broken surfaces are flat
described according to how many different directions of cleavage there are and
how good the cleavage is (i.e., how smooth the surface is )

  “fracture” = breakage in a nonplanar fashion, broken surfaces are
  rough – irregular fracture
  curved or rounded – conchoidal fracture
  pointed – hackly fracture

Hardness – mineral’s resistance to scratching. A substance that is harder than another will
scratch it. A relative hardness scale (Moh’s Scale) is used as a reference in determining
hardness.

Moh’s Scale
  1 = Talc 6 = orthoclase
  2 = gypsum 7 = quartz
  3 = calcite 8 = topaz
  4 = fluorite 9 = corundum
  5 = apatite 10 = diamond

Common Scale
  2.5 = fingernail
  3.5 = copper penny
  5.5 = glass or steel knife

Specific Gravity – “heftiness” = weight of volume of minerals/wt. Of same volume of water

Special Properties – taste (DO NOT ALLOW STUDENTS TO TASTE SPECIMINES), feel,
smell, magnetism, reaction to acid, striations, double refraction, play of
colors

A. Feldspars
Commonly are found in many rock types that are used as aggregate and dimension. These
minerals are also used in glass making and in the manufacture of ceramics including dinnerware,
floor tiles, plumbing fixtures, and electrical insulators. In powder form, feldspars are used as
filler in paints, plastics, and rubbers. Common feldspars include microline, orthoclase, and
albite.

  Microline
  Chemical Formula: KAlSi$_3$O$_8$
  Crystal System: Triclinic
  Luster: vitreous
Color: commonly pink to white
Streak: white
Habit: compact, cleavable masses
Cleavage/Fracture: 2 good cleavages at ~90° → brick shape
Hardness: 6
Specific Gravity: low (2.6)
Special Characteristics: exsolution lamellae
Occurrence: widespread, all rock types
Uses: porcelain

Orthoclase
Chemical Formula: KAlSi$_3$O$_8$
Crystal System: Monoclinic
Luster: vitreous
Color: commonly pink to white
Streak: white
Habit: compact, cleavable masses
Cleavage/Fracture: 2 good cleavages at ~90° → brick shape
Hardness: 6
Specific Gravity: low (2.6)
Special Characteristics: Carlsbad twins are common
Occurrence: most commonly igneous
Uses: ceramics

Albite
Chemical Formula: NaAlSi$_3$O$_8$
Crystal System: Triclinic
Luster: vitreous
Color: commonly white
Streak: white
Habit: compact, cleavable masses
Cleavage/Fracture: 2 good cleavages at ~90° → brick shape
Hardness: 6
Specific Gravity: low (2.6)
Special Characteristics: Polysynthetic twins are common → surface striations
Occurrence: silicic igneous rocks, pegmatites, sedimentary and metamorphic
Uses: ceramics

B. Quartz
Chemical Formula: SiO$_2$
Crystal System: hexagonal
Luster: vitreous
Color: clear, purple, rose, smoky, milky varieties
Streak: none
Habit: commonly hexagonal prisms with pyramidal terminations or crystalline masses
Cleavage/Fracture: conchoidal fracture
Hardness: 7
Specific Gravity: low (2.6)
Special Characteristics:
Occurrence: widespread, all rock types (abundant in granite, slate, schist, gneiss, and quartzite)
Uses: Widely used in many industries. It is quarried to provide the raw materials for making glass and to serve as the source of elemental silicon. The applications for silicon include manufacture of semiconductors for the electronics industry and silicone rubber caulking compound to seal around doors, windows, and bathtubs. Also used as an abrasive or polish, filler in plastics, paints, and related materials, and in the form of sand, as aggregate in asphalt, mortar, and concrete. Synthetic quartz is used in the electronics industry to make electronic oscillators and pressure-sensing devices.

C. Galena
Chemical Formula: PbS
Crystal System: isometric
Luster: metallic
Color: gray
Streak: gray
Habit: cubic crystals common, irregular masses
Cleavage/Fracture: cubic cleavage
Hardness: 2-3
Specific Gravity: high (7.5)
Special Characteristics:
Occurrence: hydrothermal veins
Uses: Galena is an important ore of lead as well as silver. The lead that is extracted is most commonly used in industry, such as lead-acid batteries in electrical systems of cars, airplanes, and garden tractors. Lead oxide was used in pants, but now is hazardous and is no longer used.

D. Calcite
Chemical Formula: CaCO₃
Crystal System: Rhombohedral
Luster: vitreous to pearly
Color: clear to various pale colors
Streak: white
Habit: rhombic, scalenohedrons also common, wide variety
Cleavage/Fracture: rhombic
Hardness: 3
Specific Gravity: low (2.7)
Special Characteristics: fizzes readily with cold HCl, slightly soapy feel
Occurrence: sedimentary and metamorphic rocks (marble, fossil fragments)
Uses: As an industrial mineral, it is used as an essential raw material in the manufacture of cement. Usually found in the form of limestone, it is ground and mixed with pulverized silicon and aluminum rich rock (shale). When calcite is heated, CO2 is headed off to produce quicklime, which is mixed with sand and water to form mortar. Lime can also be used in the steel industry as a flux, in paper manufacture, waste water treatment, industrial flue gas desulfurization, soil stabilization, asphalt manufacture, sugar refining, and as a soil amendment. It is also used as a mild abrasive in kitchen and bath cleaners. Calcite is also found in pharmaceuticals – pulverized calcite commonly makes up antacids and calcite is used as a source of calcium. Calcite is often pulverized and added to cattle feeds to improve digestion and is added to poultry feed to improve the quality of the eggshells. Calcite is a major mineral in marble, which is commonly used to create monuments and sculptures and as dimension stone for architectural purposes.

E. Fluorite
Chemical Formula: CaF₂
Crystal System: Isometric
Luster: vitreous
Color: highly varied
Streak: white
Habit: cubic crystals and crystalline masses
Cleavage/Fracture: “octahedral” cleavage – 4 directions at diagonals to the cube sides
Hardness: 4
Specific Gravity: low (3.2)
Special Characteristics: slightly soapy feel
Occurrence: hydrothermal veins
Uses: Primarily fluorite acts as a source of fluorine, which is used in chemical processes. Fluoride is added to drinking water, toothpaste, and mouthwash. It also is used as a flux in steelmaking and other metallurgical processes. Clear fluorite is commonly used for optical purposes.

F. Graphite
Chemical Formula: C
Crystal System: Hexagonal
Luster: metallic luster
Color: gray - black
Streak: gray - black
Habit: flaky masses
Cleavage/Fracture: one perfect cleavage
Hardness: 1 – 2
Specific Gravity: low (2.2)
Special Characteristics: greasy feel, soils hands, marks paper
Occurrence: metamorphic (slate and schist)
Uses: Most commonly used as “lead” in pencils. Also used as a lubricant in locks or other applications where oil would accumulate dirt and gum the works. Other uses include brake pads for automobiles and trucks, electrical resistors for electronics, gaskets, lubricating oil additive, refractories, and mold-release coating for metal castings.

G. Hematite

Chemical Formula: Fe₂O₃
Crystal System: Rhombohedral
Luster: dull to metallic
Color: commonly red or gray
Streak: blood red
Habit: commonly irregular, micaceous or fossiliferous masses, crystals usually tabular but rare
Cleavage/Fracture: irregular, may show parting
Hardness: 5.5 – 6.5
Specific Gravity: high (5.3)
Special Characteristics: specular hematite may contain bits of magnetite making the sample slightly magnetic
Occurrence: weathering product of Fe-minerals, metamorphic rocks mostly but may occur in igneous and sedimentary rocks
Uses: Most important ore of iron but is also used as a pigment and polishing abrasive. As a black crystal, it is cut as a gem.

H. Gypsum

Chemical Formula: CaSO₄ ⋅ 2H₂O
Crystal System: Monoclinic
Luster: vitreous to silky
Color: commonly clear
Streak: white
Habit: tabular or fibrous masses common, swallowtail twins common
Cleavage/Fracture: one perfect, two good cleavages
Hardness: 2 scratched with fingernail
Specific Gravity: low (2.3)
Special Characteristics: soapy, waxy feel
Occurrence: marine evaporite deposits
Uses: gypsum wallboard – gypsum wallboard is used to cover interior walls of most houses, apartments, and offices in North America. To make the wallboard, the gypsum is heated to drive off the water and is then ground to form stucco. Stucco is mixed with water and other fibers to form slurry that is extruded and wrapped with heavy paper to make wallboard. Also used in portland cement to control the setting rate. It also acts as a soil amendment to improve soil structure and workability by providing calcium and sulfur to plants. Calcined gypsum is used as a dietary supplement for sulfur in people and animals. Used to make casts to support broken bones and dental molds. Fine-grained gypsum (Alabaster) is commonly used for ornamental stone or sculptures but is commonly not used because of its softness.
I. Magnetite
Chemical Formula: Fe$_3$O$_4$
Crystal System: Isometric
Luster: metallic to submetallic
Color: gray – black
Streak: gray
Habit: octahedrons and irregular masses
Cleavage/Fracture: irregular
Hardness: 6
Specific Gravity: moderately high (5.2)
Special Characteristics: highly magnetic
Occurrence: igneous and metamorphic rocks and black sands
Uses: This mineral is mined in many areas as an ore of iron from which cast iron and steel are derived. It is also used as a filter media and black pigment. Crushed it can be used as aggregate to make high-density concrete for applications that include nuclear reactors.

J. Muscovite
Chemical Formula: KAl$_2$(Al$_3$Si$_3$)O$_{10}$(OH)$_2$
Crystal System: Monoclinic
Luster: vitreous
Color: colorless to pale shades
Streak: none
Habit: forms in sheets and books
Cleavage/Fracture: one perfect cleavage
Hardness: 2 – 2.5
Specific Gravity: low (2.8)
Special Characteristics: elastic folia
Occurrence: widespread, all rock types (granite, slate, schist, gneiss, quartzite, sandstones)
Uses: Muscovite was used as a substitute for glass because the thin cleaved sheets are transparent. It is frequently used now for viewing windows in industrial furnaces and ovens. It is also used to make capacitors, transistors, insulators, and the windows on microwave tubes used in microwave ovens. It is also used as a filler in plastic, paint, and wallboard cement, coatings on wallpaper to produce a silky luster, mold release agents in the manufacture of automobile tires, and as a constituent of drilling mud used when drilling for oil and gas. Common products also include nail polish, lipstick, and eye shadow.

K. Sulfur
Chemical Formula: S
Crystal System: Orthorhombic
Luster: silky, resinous
Color: intense yellow
Streak: pale yellow
Habit: cryptocrystalline masses and pyramidal crystals most common, also botryoidal and stalactitic masses
Cleavage/Fracture: conchoidal to uneven
Hardness: 1 – 2
Specific Gravity: low (2.1)
Special Characteristics: slightly soapy feel, “match” smell
Occurrence: volcanic craters, hydrothermal veins, bacterial precipitate
Uses: Sulfur is primarily used to manufacture sulfuric acid, which is used in many chemical processes. Uses of sulfuric acid include the manufacture of phosphatic fertilizer, leaching copper from copper ore, and many other chemical processes. It may also be added to soil as a nutrient.

L. Talc
Chemical Formula: Mg₃Si₄O₁₀(OH)₂
Crystal System: Monoclinic
Luster: pearly to greasy
Color: commonly white to apple-green
Streak: white
Habit: flaky masses
Cleavage/Fracture: one perfect cleavage
Hardness: 1 – scratched by fingernail
Specific Gravity: low (2.7)
Special Characteristics: soapy feel, flexible folia
Occurrence: low grade metamorphic rocks, alteration of Mg silicates
Uses: talcum powder, ornamental, ingredient in roofing, paint, ceramics, paper, rubber, insecticides.

M. Halite
Chemical Formula: NaCl
Crystal System: Isometric
Luster: vitreous
Color: clear to various pale colors
Streak: white
Habit: cubic crystals, crystalline masses
Cleavage/Fracture: cubic
Hardness: 2.5
Specific Gravity: low (2.1)
Special Characteristics: salty taste, slightly soapy feel
Occurrence: marine evaporite deposits
Uses: Commonly used to flavor food and as a preservative. It is also used in metal processing, tanning and leather treatment, pharmaceuticals, paper manufacturing, and to help keep roads and sidewalks free of ice in the winter.

P. Quartz
Chemical Formula: SiO₂
**Crystal System:** hexagonal  
**Luster:** vitreous  
**Color:** clear, purple, rose, smoky, milky varieties  
**Streak:** none  
**Habit:** commonly hexagonal prisms with pyramidal terminations or crystalline masses  
**Cleavage/Fracture:** conchoidal fracture  
**Hardness:** 7  
**Specific Gravity:** low (2.6)  
**Special Characteristics:**  
**Occurrence:** widespread, all rock types (abundant in granite, slate, schist, gneiss, and quartzite)  
**Uses:** Widely used in many industries. It is quarried to provide the raw materials for making glass and to serve as the source of elemental silicon. The applications for silicon include manufacture of semiconductors for the electronics industry and silicone rubber caulking compound to seal around doors, windows, and bathtubs. Also used as an abrasive or polish, filler in plastics, paints, and related materials, and in the form of sand, as aggregate in asphalt, mortar, and concrete. Synthetic quartz is used in the electronics industry to make electronic oscillators and pressure-sensing devices.

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**Q. Hematite**  
**Chemical Formula:** Fe$_2$O$_3$  
**Crystal System:** Rhombohedral  
**Luster:** dull to metallic  
**Color:** commonly red or gray  
**Streak:** blood red  
**Habit:** commonly irregular, micaceous or fossiliferous masses, crystals usually tabular but rare  
**Cleavage/Fracture:** irregular, may show parting  
**Hardness:** 5.5 – 6.5  
**Specific Gravity:** high (5.3)  
**Special Characteristics:** specular hematite may contain bits of magnetite making the sample slightly magnetic  
**Occurrence:** weathering product of Fe-minerals, metamorphic rocks mostly but may occur in igneous and sedimentary rocks  
**Uses:** Most important ore of iron but is also used as a pigment and polishing abrasive. As a black crystal, it is cut as a gem.

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**R. Biotite**  
**Chemical Formula:** K(Mg,Fe)$_3$(Al$_1$Si$_3$)O$_{10}$(OH)$_2$  
**Crystal System:** Monoclinic  
**Luster:** vitreous to splendent  
**Color:** commonly dark brown  
**Streak:** white to pale brown  
**Habit:** forms in sheets and books  
**Cleavage/Fracture:** one perfect cleavage  
**Hardness:** 2.5 - 3
Specific Gravity: low (2.8 – 3.2)
Special Characteristics: elastic folia
Occurrence: widespread, all rock types (granite, schists, geisses)
Uses: Vermiculite is a hydrated alteration product of biotite. Expanded vermiculate is used as an insulation material, a filler in gypsum wall board or other construction materials. It is most commonly used as an additive to potting soil in house plants.

Part II: The Rocks

Description of rocks are from the following source:

Location of rocks in the state of Connecticut are from the following sources:

The Igneous Rocks – Basalt, Granite, Obsidian, and Pumice

Basalt (sample H)
– Basalt is a dark, fine grained, extrusive igneous rock that is composed of mainly silicate minerals rich in iron and magnesium. Note: silicates are minerals made of silicon and oxygen. Minerals include pyroxenes and plagioclase
-Most magmas are derived from partial melting of the upper mantle and form basalt, which is a dark, relatively dense igneous rock that makes up most of the world’s oceanic crust. Magnesium and iron are two heavy elements that are present in basalt that give the rock the dark color and high density. Basalt also contains water; the water that is present in the rock lowers the melting point. Wet basalt recycled into the mantle melts easily, but the new magma contains less magnesium and iron, and becomes enriched in lightweight silicon and oxygen.
-“They are the most widespread of all the igneous rocks. Most basalts are volcanic in origin and were formed by the rapid cooling and hardening of the lava flows. Some basalts are intrusive having cooled inside the Earth's interior” (definition is from http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Igrocks/Igrock2.html). Basalt can be seen as it is part of the Higganum Dike at Hurd State Park and can be seen from Castle Craig in Meriden and Kettletown State Park in Southbury.

Granite (sample A)
– Granite is a coarse-grained, light colored, intrusive igneous rock made of quartz, orthoclase, sodium-rich plagioclase, mica and hornblende. “Granite forms as magma cools far under the earth's surface. Because it hardens deep underground it cools very slowly. This allows crystals of the four minerals to grow large enough to be easily seen
by the naked eye. Granite is an excellent material for building bridges and buildings because it can withstand thousands of pounds of pressure. It is also used for monuments because it weathers slowly. Engravings in the granite can be read for hundreds of years, making the rock more valuable. Granite is quarried in many places in the world including the United States. The State of New Hampshire has the nickname "Granite State" because of the amount of granite in the mountains of that beautiful state. The Canadian Shield of North America contains huge outcroppings (surface rocks) of granite” (definition is from http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Igrocks/Igrock3.html).

Obsidian (sample G)
– Obsidian is volcanic glass, formed from magma that has cooled quickly when it reaches Earth’s surface (extrusive). “The lava cools so quickly that no crystals can form. When people make glass they melt silica rocks like sand and quartz then cool it rapidly by placing it in water. Obsidian is produced in nature in a similar way. Obsidian is usually black or a very dark green, but it can also be found in an almost clear form. Ancient people throughout the world have used obsidian for arrowheads, knives, spearheads, and cutting tools of all kinds. Today obsidian is used as a scalpel by doctors in very sensitive eye operations” (definition is from http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Igrocks/Igrock6.html).

Pumice (sample I)
– “Pumice is a very light colored, frothy volcanic rock. Pumice is formed from lava that is full of gas. The lava is ejected and shot through the air during an eruption. As the lava hurtles through the air it cools and the gases escape leaving the rock full of holes. Pumice is so light that it actually floats on water. Huge pumice blocks have been seen floating on the ocean after large eruptions. Some lava blocks are large enough to carry small animals. Pumice is ground up and used today in soaps, abrasive cleansers, and also in polishes” (definition is from http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Igrocks/Igrock10.html).

The Sedimentary Rocks – Conglomerate, Limestone, Sandstone, and Shale

Conglomerate (sample C)
– A conglomerate is a sedimentary rock composed mainly of pounded pebbles, cobbles, and boulders. Recognized by rounded grains in a finer-grained matrix. “Conglomerate is a clastic sedimentary rock that forms from the cementing of rounded cobble and pebble sized rock fragments. Conglomerate is formed by river movement or ocean wave action. The cementing agents that fill the spaces to form the solid rock conglomerate are silica, calcite, or iron oxides” (definition is from http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Serocks/Sedrock2.html). Can be seen in Portland on Route 66.
Limestone (sample D)
– Limestone is a sedimentary rock made mainly of calcium carbonate (calcite) that is either precipitated out of seawater or available from carbonate shell debris. “Limestone is the most abundant of the non-clastic sedimentary rocks. Limestone is produced from the mineral calcite (calcium carbonate) and sediment. The main source of limestone is the limy ooze formed in the ocean. The calcium carbonate can be precipitated from ocean water or it can be formed from sea creatures that secrete lime such as algae and coral. Chalk is another type of limestone that is made up of very small single-celled organisms. Chalk is usually white or gray in color. Acids can easily dissolve limestone. If you drop vinegar on limestone it will fizz” (definition is from http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Serocks/Sedrock6.html).

Sandstone (sample F)
– Sandstone is a sedimentary rock made up of sand-sized particles, usually quartz and few feldspars, cemented together in solid rock. “Sandstone is a clastic sedimentary rock that forms from the cementing together of sand sized grains forming a solid rock. Quartz is the most abundant mineral that forms sandstone. Calcium carbonate, silica, or iron has been added to the water that is in contact with the sand grains. These minerals grow crystals in the spaces around the sand grains. As the crystals fill the gaps the individual sand grains are now transformed into a solid rock” (definition is from http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Serocks/Sedrock8.html). Can be seen in Portland on Route 66 or at the Buckland Hills Mall in Manchester.

Shale (sample J)
– Shale is a layered sedimentary rock made up of mud-sized grains (tiny) such as clays, micas, and quartz. Shales can be broken easily into thin, parallel layers. Shale is ground up for use in making bricks and cement. Can be seen in Portland on Route 66 and at Beseck Mountain in Middlefield and Platt Farms Preserve in Southbury.

The Metamorphic Rocks – Gneiss, Marble, Schist, and Slate

Gneiss (sample B)
– Gneiss is a metamorphosed rock that is recognized by compositional banding, big crystals that include quartz, feldspars, micas, amphiboles, and garnet. “It is a high grade metamorphic rock. This means that gneiss has been subjected to more heat and pressure than schist. Gneiss is coarser than schist and has distinct banding. This banding has alternating layers that are composed of different minerals. The minerals that compose gneiss are the same as granite. Feldspar is the most important mineral that makes up gneiss along with mica and quartz. Gneiss can be formed from a sedimentary rock such as sandstone or shale, or it can be formed from the metamorphism of the igneous rock granite. Gneiss can be used by man as paving and building stone” (http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Merocks/Merock5.html). Gneiss can be seen at Gillette Castle State Park in East Haddam and Bolton Notch.
State Park in Bolton and Chatfield Hollow State Park in Killingworth and Day Pond State Park in Colchester.

**Marble (sample K)**

– Marble is a metamorphic rock that results from the metamorphism of limestone. Recognized because it has large calcite crystals and lacks layering. “Marble is metamorphosed limestone or dolomite. Both limestone and dolomite have a large concentration of calcium carbonate (CaCO3). Marble has many different sizes of crystals. Marble has many color variances due to the impurities present at formation. Some of the different colors of marble are white, red, black, mottled and banded, gray, pink, and green. Marble is much harder than its parent rock. This allows it to take a polish, which makes it a good material for use as a building material, making sink tops, bathtubs, and a carving stone for artists. Today, headstones are made from marble and granite because both of these rocks weather very slowly and carve well with sharp edges. Marble is quarried in Vermont, Tennessee, Missouri, Georgia, and Alabama” (definition is from http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Merocks/Merock2.html). Marble has also been quarried in the Town of East Canaan, Connecticut.

**Schist (sample L)**

– Schist is a metamorphosed rock that is recognized by a bit of a wavy look, big crystals made of micas, garnets, quartz. Minerals vary depending on amount of metamorphism. “It is a medium grade metamorphic rock. This means that it has been subjected to more heat and pressure than slate, which is a low-grade metamorphic rock. The individual grains of minerals can be seen by the naked eye. Many of the original minerals have been altered into flakes. Because it has been squeezed harder than slate it is often found folded and crumpled. Schists are usually named by the main mineral from which they are formed. Bitotite mica schist, hornblende schist, garnet mica schist, and talc schist are some examples of this” (definition is from http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Merocks/Merock4.html). Can be seen at Bolton State Park in Bolton and Day Pond State Park in Colchester.

**Slate**

– Slate is a metamorphosed rock that is recognized by very flat layering and tiny crystals of clays, micas, and quartz. “Slate is a fine-grained metamorphic rock with perfect cleavage that allows it to split into thin sheets. Slate usually has a light to dark brown streak. Slate is produced by low grade metamorphism, which is caused by relatively low temperatures and pressures. Slate has many uses. One use for slate was in the making of headstones or grave markers. Slate is not very hard and can be engraved easily. The problem with slate though is its perfect cleavage. The slate headstones would crack and split along these cleavage planes. This is not a desirable attribute for a head stone. Slate was also used for chalkboards. The black color was good as a background and the rock cleaned easily with water. Today it is not very advantageous to use this rock because of its weight and the splitting and cracking over time” (definition is from http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Merocks/Merock3.html).
Part III: Notes on Rock Cycle, Weathering, Erosion and the Water Cycle

Sources Include:

**The Rock Cycle**

The rock cycle is the continual creation, destruction, and recycling of rock into different forms. This process is driven by plate tectonics, solar energy, and gravity. At the beginning of the rock cycle, molten rock is driven upward from the Earth’s mantle to the surface by tectonic forces. The magma is less dense than the cooler rock, allowing it to rise to the surface. The magma will cool and crystallize into a rock, which is termed igneous rock. Igneous rock may be weathered by physical or chemical processes. These processes of weathering will result in the rock being dissolved or broken into smaller pieces, which will later be eroded and accumulate into layers of sediment. Once these particles of sediment that have weathered harden under sufficient pressure, they will form sedimentary rock. Through the rock cycle, an igneous or sedimentary rock may either be weathered further or it may be subjected to more tectonic forces. If the rock is subjected to tectonic forces, the rock (any type) may be driven back into the mantle. If the rock is not re-melted and is simply transformed due to heat and pressure, the rock is considered to be metamorphic.

**Extrusive vs. Intrusive**

Igneous rocks can either be termed extrusive or intrusive (volcanic rocks or plutonic rocks). Extrusive refers to magma being extruded at Earth’s surface; the magma (once on the surface it is referred to as lava) has been cooled very quickly, which results in small crystals (example: obsidian and basalt) or fine grained crystals. If the magma cools slowly in the subsurface, the igneous rock is termed intrusive. Intrusive rocks (example: granite) cool slowly in subsurface pockets and are therefore coarse-grained in character.

**Weathering/Sedimentation**

Igneous rocks exposed to the Earth’s surface react with surface gases and liquids and become weathered. Weathering involves both chemical and physical processes that alter and break the rock into particles at the site where it is exposed. Loose debris may then be transported away from the site of weathering by flowing water, wind, gravity, and glaciers. The processes of sediment transport are called erosion. Gravitational attraction causes loose rock particles to sift down through water bodies and the atmosphere to settle in depressions on the ocean floor and on landmasses – process known as sedimentation.

Physical weathering refers to the mechanical fragmentation (break up) of rocks and minerals. Physical weathering processes include exfoliation jointing, thermal expansion, disintegration associated with plant growth, and frost weathering.

Chemical weathering refers to the chemical alteration of rocks and minerals. During chemical weathering, water, ions, and oxygen react with exposed mineral surfaces. The general chemical weathering process is the reaction of unweathered minerals in crustal rocks with water, acidic solutions, and oxygen from the hydrosphere, biosphere, and atmosphere. (Rain...
is naturally acidic. Water combines with the carbon dioxide in the atmosphere, which results in carbonic acid.) Both types of weathering are enhanced by biological processes. Weathering occurs in place. Once the rock has been weathered, it is more easily carried away by moving medium such as wind, water, and ice. The removal and transport of this material by these processes is called erosion.

**Erosion** is the general name for all processes that transport loosened Earth material downhill or downwind; it results from the action of water, wind, glacial ice, and gravity. Erosion caused mainly by gravity is called mass wasting. The two most important factors that contribute to soil erosion is the degree of the slope and the amount of bare soil that is exposed. The steeper the slope and the less the amount of cover, the greater the rate of soil erosion and runoff of water.

### Part IV: Useful Thoughts


**On the Rocks...**

- The impact of humans on the rock cycle is very small compared to the impact of geologic processes, but for the hydrologic cycle human impact is affecting the quality of our environment over a period of years to centuries.
- Because sedimentary rocks do not solidify from a molten state, their time of origin is inferred through stratigraphy and radiometric dating of igneous rock that has intruded or buried a sequence of strata.
- The oldest rocks discovered on Earth have been radiometrically dated at about 3.96 billion years, and the oldest minerals at 4.3 billions years. However, from dating meteorites, which are between 4.4 billion and 4.6 billion years old, scientists have found that the solar system, including Earth, formed nearly 4.6 billion years ago.

### Part V: Useful Websites

2004. <http://www.wesleyan.edu/ctgeology/LISproject/connecticut_rocks.htm> (This website is great for demonstrating how rocks form and where in Connecticut they can be found.)


MINERAL GUIDED INQUIRY INVESTIGATION
Classifying, Sorting and Identifying Minerals

This guide is a tool for helping you plan an inquiry activity. The prime factor is that your students get the opportunity to practice choosing their own question and planning and carrying out an investigation to find out what they can learn from investigating that question.

Approx. Time: 7 lessons

<table>
<thead>
<tr>
<th>Related State Content Standard(s):</th>
<th>Related State Expected Performance(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.3 Earth materials have different physical and chemical properties.</strong></td>
<td>B5: Describe the physical properties of rocks and relate them to their potential uses.</td>
</tr>
<tr>
<td><em>Rocks and minerals have properties that may be identified through observations and testing; these properties help determine how the earth materials are used.</em></td>
<td>B6: Relate the properties of rocks to the possible environmental conditions during their formation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Related Enduring Understanding(s):</th>
<th>Related Essential Question(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Science is the method of observation and investigation used to understand our world. (K-12)</td>
<td>• How is inquiry used to investigate our environment?</td>
</tr>
<tr>
<td>• Inquiry is the integration of process skills, the application of scientific content, and the critical thinking to solve problems. (K-12)</td>
<td>• What are the similarities and differences between rocks and minerals?</td>
</tr>
<tr>
<td>• The environment is a complex assemblage of interacting and evolving chemical, physical, and biological processes. (K-12)</td>
<td>• What are the similarities and differences between minerals?</td>
</tr>
<tr>
<td>• The unique physical and chemical properties of rocks and minerals make them useful.</td>
<td>• How are rocks and minerals used?</td>
</tr>
<tr>
<td>• Rocks and minerals are limited resources with specific uses.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What simple content objectives/goals do you want to accomplish with this investigation? (see district curriculum documents)</th>
<th>What simple process skills do you want to improve with this investigation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1: Differentiate between rocks and minerals (and rocks).</td>
<td>S1: Generate investigable and non-investigable questions.</td>
</tr>
<tr>
<td>K2: Classify rocks and minerals by their properties.</td>
<td>S2: Observe rocks and minerals and describe commonalities and differences between</td>
</tr>
</tbody>
</table>
| K3: Relate the physical properties of minerals (and rocks) to their potential uses. | them.  
S3: Classify based on observations of properties.  
S4: Predict the identity of the minerals and rocks.  
S5: Design an investigation to help answer an investigable question.  
S6: Conduct simple investigations.  
S7: Employ simple equipment and measuring tools.  
S8: Organize appropriate and accurate measurements and observations.  
S9: Draw conclusions based on data, observations, or findings.  
S10: Communicate results in a group share. |

What phase of this investigation will you provide the most modeling/templates/mini-lessons/scaffolding for better skill development?

**Part One: Minerals**  
After exploration time with the equipment, mini-lessons may need to be conducted on the following:  
1. color  
2. streak  
3. hardness (soft/medium/hard)  
4. luster  
5. light (transparent/translucent/opaque)  
6. magnetic  
7. shape  
8. texture

Materials/Resources:

**Part One: Minerals**  
See *STC Kit* Rocks and Minerals Lessons 4-12, and 14.

All available non-fiction reading materials related to kit

**Websites:** See teacher’s background notes.

What kinds of investigations do you anticipate students designing?

Students will conduct hands-on investigations and research using non-fiction materials to identify different the 12 mineral samples.
PHASE 1 – Observing and Questioning

**INQUIRY STARTERS**

- What is the launching activity or inquiry starter for the investigation?
- What will be your inquiry starter prompt? How will you “invite” your audience to work with the materials?
- What materials will you use for the inquiry starters?
- How will you elicit and collect or display student’s questions? Will they share questions orally? In writing?
- **Choosing investigation questions**: How will you help your students determine which questions they can choose from to investigate? How will you or the students form investigation groups?

<table>
<thead>
<tr>
<th>Time/ Materials</th>
<th>Task</th>
<th>Hints</th>
</tr>
</thead>
</table>
| 5 minutes       | ● Setting the context (identifying properties of minerals).  
● Teacher does not explain the properties at this time, just inform the students that they will be performing tests which lead to the identification of minerals. | ● This inquiry focuses on sorting and investigation skills as well as content.  
● Students should use their science journal to record their observations, findings, and notes. |
| 15 minutes.     | ● Distribute minerals (approx. 12 samples per group – Letters A-L) and a hand lens to each group.  
● Have students sort their minerals into groups with similar characteristics.  
● Have students share how they sorted their minerals with their peers. | ● Encourage students to record their observations and characteristics used for sorting into their science journal.  
● You may need to provide a mini-lesson on how to organize their information in their journal.  
● Challenge students to find as many ways as they can to sort their minerals. |
| Minerals and a hand lens | 45 minutes | Introduce the testing equipment found in the kit such as the pen light, magnet, streak plates, penny, nail, wax paper, tin foil, and plastic wrap.  
● Have students find more ways to sort their minerals with the addition of the other testing equipment. | Try not to explain how to use the science equipment yet. Allow students to explore and discover.  
● When visiting small groups encourage students to sort by categories such as:  
  ○ color |
| 15 minutes | **Chart paper** | **Markers** | **After groups share the teacher should synthesize the categories used by the students to sort their minerals. If no group discovered a particular property listed below, the teacher should introduce the students to this property at this time.**  
- color  
- streak p #25  
- hardness (soft/medium/hard) p#37  
- luster (metallic, glassy, waxy) p#33  
- light p#29  
- (transparent/translucent/opaque)  
- magnetic p#41  
- shape (hexagon crystal, cube, thin flat layers, no special shape) Teacher’s Manual p#97-98  
- texture  

Students will be curious as to what minerals they have been exploring with. Given the materials the students have been exploring with and the list of properties (see above bullets) students can now start testing the minerals and collecting data to help them identify the samples’ names using mineral identification cards/books.  
- Pose the following question to the students: How do we determine  

| **If all of the properties are not discovered by the students, the teacher will sort his/her minerals and ask students to determine the category used.**  
| **These properties should be recorded in student journals.** |
PHASE 2 – Planning and Investigating

INVESTIGATION

- What additional materials will you introduce? How will you introduce additional materials participants can use to study the phenomena?
- How will you manage/organize materials, set up and clean up?
- How will you support the groups in planning their investigation? Will you provide criteria or planning sheets?
- How will you facilitate during the investigation?

<table>
<thead>
<tr>
<th>Time/Materials</th>
<th>Task</th>
<th>Hints</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 minute</td>
<td>• Based on the question, “How do we determine which mineral samples we have?” have students develop a plan they will follow to identify each mineral sample.</td>
<td>• You may need to review the different properties of minerals.</td>
</tr>
<tr>
<td></td>
<td>• Conduct mini-lessons on the different properties of minerals, showing students how to safely use the testing equipment and introduce related vocabulary.</td>
<td></td>
</tr>
<tr>
<td>45 minutes</td>
<td>• Brainstorm criteria for a detailed plan with class. Their plan should include testing their minerals for the eight different properties. Do not provide a data chart for students. Encourage students to create their own data chart.</td>
<td>• Your brainstormed list of items in a detailed plan may include items such as:</td>
</tr>
<tr>
<td></td>
<td>• Teacher can formatively assess the students’ observations and data charts. It may be necessary to model a lesson on observations and/or recording. For example, discuss how many properties they will be testing (8) and discuss how many minerals they will be testing (12). This will help guide them to the size and organization of their data table.</td>
<td>o Question o Detailed directions – with numbered/sequenced steps o Revise plans when changes are made o List of materials w/ quantities o Jobs – if assigned o Must be reproducible (someone else should be able to duplicate the investigation and get same results o Labeled diagrams or drawings o Prediction / hypothesis</td>
</tr>
<tr>
<td></td>
<td>• Have students revise their plans, as</td>
<td>• Teacher can use a planning template or allow students to create their own plan. If you use a planning template,</td>
</tr>
</tbody>
</table>
needed, and start their investigation.

| 45 minutes | • Students follow their plan and conduct their investigations.  
  • Remind students to document revisions to their plan and record all observations and further questions. |

| 45 minutes | • Once students are done testing, give them the mineral identification cards to predict the name of each mineral – see pages 111-113 in the STC Rocks and Minerals manual.  
  • Students will be using their test results along with non-fiction material to identify the names of their minerals and its use  
  • Use the non-fiction resources to verify the name of the mineral (find evidence of the name) and its use.  
  The answers are found on page 48 of the teacher manual. |

| 45 minutes | • Teacher introduces non-fiction material and mineral identification cards - See Teacher’s Manual page ##111-113. |

| **PHASE 3 – Interpreting Results and Communicating** |

**SHARING RESULTS AND PROCESSING FOR MEANING**

- How will investigation groups present what they have learned from their investigations? (Visual, oral presentation, combination, etc.) How will you decide the order of the presentations? (By similar questions, content goals, random, etc.)
- How will the facilitator synthesize the knowledge and findings of the participants for the group?

<table>
<thead>
<tr>
<th>Time/ Materials</th>
<th>Task</th>
<th>Hints</th>
</tr>
</thead>
</table>
| 40 minutes      | • Share overhead of mineral identification cards to verify the names as a class.  
  • Have students compare their data to the mineral identification cards and discuss why there may have been some differences. Discuss how |

|       |       | • This lesson will be followed by the performance assessment (mystery minerals – lesson 15 in STC manual) |

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Adopted by Board of Education April 25, 2005  
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different samples may not exactly match the properties presented on the identification cards.
Fact, Question, Reaction
(FQR)

Purpose: This strategy helps readers reflect and glean important information and deepen understanding through questioning.

Procedures:
1. Read an informational text.
2. Write down any facts that you learned, questions you have, or reactions on a sticky note.
3. Make a three column chart, labeled Facts, Questions, Reactions and put the sticky notes into the columns.
4. Reflect on the questions. Were some of them answered in the text? In your head? Or do you need to do further research or investigations?

<table>
<thead>
<tr>
<th>Fact</th>
<th>Questions</th>
<th>Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recipe for Making Rock Candy

Appendix B

www.michigan.gov Release Date: January 01, 2001

Make Rock Candy

For centuries people have been attracted to the sweet taste of sugar. Sugar from sugar cane, grown in areas with tropical climates, has been used since at least 300 A.D. In Michigan, Native American peoples made the first sugar—maple sugar from the sap of maple trees. In the 1700s a German chemist discovered sugar in beets. Farmers in the thumb area of Michigan began growing sugar beets in 1896. Michigan's "thumb" became the home to sugar companies such as Pioneer Sugar and Monitor Sugar in the early 20th century.

Whether produced from maple trees, sugar cane or sugar beets, sugar is one of the main ingredients in candy. Rock candy is crystallized sugar that's fun to eat. Here's a recipe for making Rock Candy at home.

You will need:  
An adult to help you

You will need to boil water and sugar together on a stove and pour it into a glass jar to do this project. If spilled, this mixture can cause VERY BAD BURNS. Be careful!

These utensils

- Measuring cup and spoon
- Large heavy metal sauce pan
- Long wooden stirring spoon
- Clean glass jar (a tall, sturdy one such as a pint or quart canning jar, mayonnaise jar or pickle jar)
- Piece of cotton string (clean!)
- Popsicle stick, pencil, or skewer
- Paper clip
- Thick pot holders
- Candy thermometer

These ingredients

- 1 cup water
- 2 cups of granulated sugar
- A few drops of your favorite candy flavoring such as peppermint, cherry or lemon, more drops = stronger flavor (optional)
- A few drops of food coloring, more drops = darker color (optional)

Directions

1. Tie one end of the piece of string around the middle of the stick or pencil. Cut the string, if necessary, so that it is a little shorter than your jar.
2. Moisten the string with a little water and roll it in the sugar. Put the paper clip on the end of the string to help it hang straight down. Lay the stick over the top of the glass jar so that the string hangs down inside the jar. The end of the string should not touch the bottom of the jar.
3. Cook the candy mixture. (Here's where you need an adult to help!)
a. Put the cup of water into the sauce pan and heat until it boils.
b. Add 2 cups of sugar to the boiling water while stirring. Keep stirring until the sugar dissolves. (If you have a candy thermometer the temperature of the sugar water should reach 240 degrees Fahrenheit.)
c. Remove pan from heat. If you want to add flavoring or color, stir it in now.
d. Pour the hot mixture into the jar.

4. Let the sugar water sit for a few days where no one will bother it. The crystals will begin to form along the string in a few hours. Let them grow for 3 to 10 days (or more). There are two things that will make the largest crystals:
   a. Making a thick sugar water mixture (Be sure you put in the whole 2 cups of sugar, or even a little more.)
   b. Letting them grow for more days

5. When you're ready to eat the rock candy, take the candy-covered string out of the jar. Break the pieces apart and enjoy. Store left-over candy in a covered container. (Some adults like to flavor tea or coffee by putting a piece of rock candy in the cup. Maybe you shouldn't use purple coloring if you want to share your candy with them!)

6. Remember to brush your teeth!
# Rock Information Organizer

*Appendix C*

<table>
<thead>
<tr>
<th>Essential Characteristics</th>
<th>Illustration</th>
</tr>
</thead>
</table>

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**Vocabulary Word**

<table>
<thead>
<tr>
<th>Examples</th>
<th>Uses</th>
</tr>
</thead>
</table>
### Rock Information Organizer - Example

**Appendix C**

<table>
<thead>
<tr>
<th>Essential Characteristics</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Rock formed from cooled magma</td>
<td></td>
</tr>
<tr>
<td>• Extrusive rocks are cooled outside the earth’s surface</td>
<td></td>
</tr>
<tr>
<td>• Intrusive are cooled inside the earth’s surface</td>
<td></td>
</tr>
<tr>
<td>Draw a volcano and label where intrusive and extrusive would be</td>
<td></td>
</tr>
</tbody>
</table>

#### Vocabulary Word

**Igneous Rock**

<table>
<thead>
<tr>
<th>Examples</th>
<th>Uses of the rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Obsidian</td>
<td></td>
</tr>
<tr>
<td>• Granite</td>
<td></td>
</tr>
<tr>
<td>• Pumice</td>
<td></td>
</tr>
<tr>
<td>• Basalt</td>
<td></td>
</tr>
<tr>
<td>Buildings, monuments, bridges, scalpels, soaps, abrasive cleaners</td>
<td></td>
</tr>
</tbody>
</table>
Rock Cycle Diagram 1

Appendix D

Rock Cycle Diagram 2

Appendix E

http://www.wm.edu/geology/virginia/rockcycle.gif

http://www.cotf.edu/ete/modules/msese/earthsysflr/rock.html
THE ROCK CYCLE
THE ROCK CYCLE

IGNEOUS
- Uplift Cooling Crystallization
- Magma / Lava
- Minerals Melt
- Extreme Heat & Pressure
- Deeper Burial

Weathering

Erosion
- Deposition
- Burial
- Pressure & Cementing

SEDIMENTARY
- Deeper Burial

Heat and Pressure

METAMORPHIC
- Minerals begin to Fuse

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At the Exploratorium Institute for Inquiry our work in science education is deeply rooted in the belief that human beings are natural inquirers and that inquiry is at the heart of all learning. The work that we do with educators is designed to give them an opportunity to personally experience the process of learning science through inquiry. Our hope is that this experience will stimulate their thinking about how to create classrooms that are supportive environments for children's inquiry.

Inquiry is an approach to learning that involves a process of exploring the natural or material world, that leads to asking questions and making discoveries in the search for new understandings. Inquiry, as it relates to science education, should mirror as closely as possible the enterprise of doing real science.

The inquiry process is driven by one's own curiosity, wonder, interest or passion to understand an observation or solve a problem.

The process begins when the learner notices something that intrigues, surprises, or stimulates a question—something that is new, or something that may not make sense in relationship to the learner's previous experience or current understanding.

The next step is to take action—through continued observing, raising questions, making predictions, testing hypotheses and creating theories and conceptual models.

The learner must find her or his own pathway through this process. It is rarely a linear progression, but rather more of a back and forth, or cyclical, series of events.

As the process unfolds, more observations and questions emerge, giving occasion for deeper interaction and relationship with the phenomena—and greater potential for further development of understanding.

Along the way, the inquirer collects and records data, makes representations of results and explanations, and draws upon other resources such as books, videos and the expertise or insights of others.

Making meaning from the experience requires reflection, conversations and comparison of findings with others, interpretation of data and observations, and the application of new conceptions to other contexts. All of this serves to help the learner construct new mental frameworks of the world.

Teaching science using the inquiry process requires a fundamental reexamination of the relationship between the teacher and the learner whereby the teacher becomes a facilitator or guide for the learner's own process of discovery and creating understanding of the world.
Map of IFI Inquiry Structure
(3 Phases of Inquiry Diagram)

**INQUIRY STARTER**
raising questions from observing engaging materials

**FOCUSED INVESTIGATION**
planning and investigating questions

**PROCESS FOR MEANING**
thinking about and communicating what you learned

content goal