

Rocks & Minerals

Grade Level or Special Area: Fourth Grade

Written by: Janet Child, John Hancock Charter School, Pleasant Grove, UT and
Laura Wirsig, Belle Creek Charter School, Brighton, CO

Length of Unit: Six lessons, approximately ten days, 45 - 60 minutes per day

I. ABSTRACT

- A. This unit is an in-depth look at the formation of metamorphic, igneous, and sedimentary rocks. The students will use science, language arts, class discussions, activities, and math skills to come to an understanding of how rocks are formed, changed, and used today. This unit uses a variety of approaches to learning, including writing, modeling, experimenting, measuring, and testing.

II. OVERVIEW

- A. Concept Objectives
1. Students understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space. (*Colorado Model Content Standard #4*)
 2. Students understand common properties, forms, and changes in matter and energy. (*Colorado Model Content Standard #2*)
 3. Students understand the processes of scientific investigation and design, conduct, communicate about and evaluate such investigations. (*Colorado Model Content Standard #1*)
- B. Content from the *Core Knowledge Sequence*
1. Fourth Grade Science, Geology: The Earth and Its Changes (pg. 105)
 - a. Rocks
 - i. Formation and characteristics of metamorphic, igneous, and sedimentary rock.
 - ii. Minerals are non-living solids found in nature made of elements. (not in *Core Knowledge Sequence*)
 - iii. Rocks are made of minerals. (not in *Core Knowledge Sequence*)
 - iv. Testing strategies for classifying minerals (not in *Core Knowledge Sequence*)
- D. Skill Objectives
1. The student will describe the differences between minerals and rocks.
 2. The student will sort minerals by shape and color using a magnifying glass.
 3. The student will record observations on charts with existing column headings.
 4. The student will identify properties of minerals and be able to identify certain minerals using specific tests.
 5. The student will create a model of how metamorphic rocks are formed.
 6. The student will create a story using facts about igneous rocks.
 7. The student will describe how an igneous rock is formed.
 8. The student will demonstrate how sedimentary layers of rock are formed.
 9. The student will identify places where layers of sedimentary rock formed.
 10. The student will compare and contrast metamorphic, igneous, and sedimentary rocks.
 11. The student will identify ways metamorphic, igneous, and sedimentary rocks are used today.

III. BACKGROUND KNOWLEDGE

- A. For Teachers
 - 1. *First Field Guide Rocks and Minerals*, National Audubon Society
 - 2. *Rocks, Gems, and Mineral*,. Sita, Lisa
- B. For Students
 - 1. Linear Measure in cm (*Core Knowledge Sequence* p. 102)
 - 2. Weight in grams (*Core Knowledge Sequence* p. 102)
 - 3. Ability to do research on the internet
 - 4. Volcanoes (*Second grade Core Knowledge* pg 39)
 - 5. Important minerals in the earth (such as quartz, gold, sulfur, coal, diamond, iron ore.) (*Second grade Core Knowledge* pg. 39)

IV. RESOURCES

- A. Samples of metamorphic, igneous, and sedimentary rocks. (attainable through FOSS; USGS in Colorado www.usgs.org or 1-888-275-8747; or using a field guide samples may be collected around your home)

V. LESSONS

Lesson One: Minerals vs. Rocks (approximately 45 minutes)

- A. *Daily Objectives*
 - 1. Concept Objective(s)
 - a. Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space. (*CMCS #4*)
 - 2. Lesson Content
 - a. Geology: The Earth and Its Changes
 - i. Minerals are non-living solids found in nature made of elements. (*not in Core Knowledge Sequence*)
 - ii. Rocks are made of minerals. (*not in Core Knowledge Sequence*)
 - 3. Skill Objective(s)
 - a. The student will describe the differences between minerals and rocks.
 - b. The student will sort shapes and colors of the minerals using a magnifying glass.
 - c. The student will list characteristics of rocks.
 - d. The student will list characteristics of minerals.
- B. *Materials*
 - For every student or group of students*
 - 1. Mock Rocks (see list of ingredients in Appendix A)
 - 2. Appendix B : Mineral vs. Rock Data Sheet (one copy per student)
 - 3. Paper plate
 - 4. Large nail
 - 5. Hand lens
 - 6. Crayons or colored pencils
 - 7. Piece of string
 - 8. Metric Ruler
 - 9. 50-ml graduated cylinder
 - 10. Evaporation dish
 - 11. Medicine dropper
 - 12. One small bottle (such as baby food jars or spice bottles)
 - 13. One scale per class
- C. *Key Vocabulary*

1. Mineral: a non-living substance found in nature but has the same chemical make-up throughout
2. Solid: state of matter that has a shape and hardness
3. Geologist: person who studies the earth
4. Mock: imitate or copy
5. Diameter: a straight line passing through the center of a circle
6. Circumference: the length around a circle
7. Depth: distance from top to bottom or from front to back
8. Weight: the amount of heaviness of a person or thing

D. *Procedures/Activities*

Prepare mock rocks a week before beginning the unit (See Appendix A)

1. Ask students if they can name any minerals. If they can't list any give them examples from things they see in nature. (e.g. tree sap – amber, ice, fluoride – fluorite, graphite – pencil, etc.) If possible show examples. Explain that minerals are pure substances made up of only one mineral.
2. Explain that geologists study the earth. One thing that they study is rock. Geologists must make detailed observations of the rocks they discover. Ask students what they might observe about rocks (texture, shape, color, smell, size.) Tell students that these are the properties of the rock. Explain to students that rocks are made up of more than one type of mineral.
3. Show students a mock rock. Tell them that they are going to investigate this mock rock. To mock means to imitate or copy. This rock imitates the properties of a real rock.
4. Explain that geologists try to figure out what kind of rock they are examining. They do this by identifying the various ingredients in the rock. These ingredients are called minerals. The various materials in the mock rock represent different minerals. The goal of the student is to identify each material as a different mineral.
5. Distribute a mock rock to every pair of students. Have them investigate the rock, recording all the properties they observe on their data sheet. (Appendix B) Tell the students to fill out data sheet as you go through the activity together in class.
6. Draw the mock rock and label its parts.
7. Examine the mock rock with the hand lens. Have students explain what they see and complete their measurements to fill in the chart.
8. Break the mock rock in half. Students should use a nail to separate all the different ingredients, sorting them into different piles. List the ingredients on the data sheet. Include descriptions of colors, shapes, and textures. (If the mock rock is very hard, place it in a plastic bag between padding and use a hammer to break it up. Be careful not to pulverize the shells.)
9. Explain that rocks are made up of more than one ingredient, including different minerals. The colored gravel could represent different kinds of minerals. The shells are not observable without breaking the rocks open. They could represent fossils imbedded in some kind of rock. Explain that these rocks are called sedimentary rocks and that you will be discussing what sedimentary rocks are later in the unit.
10. Ask students to describe the leftover material that is too small to be separated with a nail. Ask for ideas on how they might further separate these small pieces. Suggest they might mix this material with water.
11. Collect and clean up mock rock materials.

12. Pass out Rock vs. Mineral Assessment sheet (Appendix C). Have student complete sheet and write what the difference is between a rock and a mineral. Using everyday objects, sort into groups of rocks or minerals and explain why the object was placed in the category.
 13. Collect Assessment sheet.
 14. Assign students to bring in a rock from home for lesson two.
 15. **Possible Extensions/Adaptations/Integration:** In language arts, help the students build vocabulary and become more precise in their descriptions of the minerals and various components of rocks and mock rocks. For example, texture is gritty, rough, smooth, or powdery. Colors are not just white, what shade of white? Grey-white, eggshell white, golden-yellow, lemon-yellow, speckled, banded, spotted, or streaks? Shapes include faces, edges, cubes, rectangular prisms, and other geometric terms.
- E. *Assessment/Evaluation*
1. Satisfactory completion of Appendix C

Lesson Two: Exploring Minerals (two days, approximately 45 minutes per day)

- A. *Daily Objectives*
1. Concept Objective(s)
 - a. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations. (*CMCS #1*)
 2. Lesson Content
 - a. Geology: The Earth and Its Changes
 - i. Testing strategies for classifying minerals (Not in the *Core Knowledge Sequence*)
 3. Skill Objective(s)
 - a. The student will record observations on charts with existing column headings.
 - b. The student will identify properties of minerals and be able to identify certain minerals using specific tests.
- B. *Materials*
1. Have each student bring in a rock (note: have some on hand for those who forget)
 2. Hand lens for each student
 3. Hardness Rating Sheet for each student (Appendix D)
 4. Set of four numbered minerals for groups of four students (e.g., 1-Flourite, 2-Gypsum, 3-Calcite, 4-Quartz) *Rock samples are available in the FOSS kits or at USGS in Colorado (www.usgs.org or 1-888-275-8747). You may use a field guide to help you collect rocks around your home.*
 5. Penny, paper clip, nail for each group of four students
 6. Copy of Mohs Hardness Scale (Appendix E)
- C. *Key Vocabulary*
1. Hardness: how easily a substance is scratched or dented
 2. Luster: how shiny a material is
- D. *Procedures/Activities*
- Day 1**
1. Review rocks and minerals. Ask: “What is the difference between rocks and minerals?” Have students retrieve their rocks. Ask: “How can you tell that these rocks are made of more than one material?”

2. Have students compare their rocks with neighbors. How are the rocks the same? How are they different?
3. Have students examine their rocks with a hand lens. How many different minerals can they see in the rocks? What determines differences? Guide them to a discussion of color, texture, and luster (how shiny a material is). NOTE: It would be helpful to have a set of minerals to look at while they are looking at their rocks.
4. Tell the students they are going to have the opportunity to examine some minerals to see if they can identify them by their properties. Put the students in groups of four and give each group a set of four numbered minerals. Have them write a thorough description of each mineral. Tell them to be sure to include properties of color, texture, and luster (how shiny a material is) for each mineral. Allow about ten minutes for this activity.
5. Follow with a class discussion of mineral properties. Write Mineral 1, Mineral 2, Mineral 3, and Mineral 4 on the board and have groups offer characteristics of each mineral. Ask, "What if I was to ask you to hold up the mineral that is **white**? Which one would you hold up? What if I were to ask you to hold up the **rough** one? The **shiny** one? Students may point out that more than one mineral has each of those properties. Draw their attention to the board. (Words such as shiny, rough, and white should appear numerous times.) Tell the students they will perform one more test to identify these minerals.
6. Before beginning the scratch test, ask each group to predict which mineral they think is the hardest. Record the predictions on the board. Give each group a penny, a paper clip (have them pull the paper clip apart to make it straight), and a nail. Hand out the Hardness Rating Sheet (Appendix D) to all students and explain how to use it. Give the group time to test the mineral.
7. After they have tested the minerals and placed X's in the proper places on their Hardness Rating Sheets, give each group a copy of the Mohs Hardness Scale (Appendix E) and have them use it to determine the name of each mineral in its appropriate place on their sheets. They should then finish the sheet by writing the minerals' name in order of hardness (hardest to softest) on the sheet.
8. Have a class discussion and write on the chart tablet each group's list of minerals in the order they determined. How many were correct in their predictions?
9. Collect supplies and recap lesson orally.

Day 2

10. Pass out Rubric for oral report (Appendix F).
11. In the school computer lab have the students work in pairs. Assign or let each pair choose one mineral of their choice. They should collect information to create an oral presentation on that mineral. They will report to the class the mineral's name, description, and use. Their presentation should use visual aids, such as pictures (drawn or printed). Note: You could have the students work in small groups of 3 to 4 if time is a premium. Students with a home computer could research some part and report back to the group. Have some books available to aid with identification.
12. If school does not have computer lab, you may bring in books or have students take their mineral home to gather information.
13. **Special needs** students may draw the minerals and/or verbally describe them to other students who can scribe for them.

E. *Assessment/Evaluation*

1. Students Hardness Rating Sheets: Is information accurate and complete?
2. Observation Check List during collaborative group work. (Appendix G)

3. Oral Presentations Rubric (Appendix F)

Lesson Three: Metamorphic Rocks (approximately 35-45 minutes)

A. Daily Objectives

1. Concept Objective(s)
 - a. Students will understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space.
 - b. Students understand common properties, forms, and changes in matter and energy.
2. Lesson Content
 - a. Rocks
 - i. Formation and characteristics of metamorphic rocks. (Adapted from *Core Knowledge Sequence pg. 105*)
3. Skill Objective(s)
 - a. The student will create a model of how metamorphic rocks are formed.

B. Materials

1. Changing Rocks worksheet (see Appendix H), one per student
2. Changing Rocks activity sheet (see Appendix I)
3. One piece of white paper per student
4. Gray, green, red and black crayons per student or group of students
5. One pair of scissors per student
6. One bottle of glue per student or group of students

C. Key Vocabulary

1. Metamorphic Rock: rock that changes form by heat and pressure in the Earth's crust
2. Marble: a metamorphic rock that is formed when heat and pressure are applied to limestone
3. Slate: a metamorphic rock that is formed when heat and pressure are applied to shale
4. Quartzite: a metamorphic rock that is formed when heat and pressure are applied to sandstone

D. Procedures/Activities

1. Begin by telling the class that there are three types of rocks. Ask them if they know what those types of rocks are. (Metamorphic, Igneous, Sedimentary) Write the types of rocks on the board. Explain to the class that they will learn about Igneous and Sedimentary rocks later in the unit, and that they are learning about Metamorphic rocks today.
2. Ask the students if they know what "morph" means. Give an example if needed. (e.g. The caterpillar morphed into a butterfly.) Explain that morph means to change into something else. Tell the class that metamorphic rocks are rocks that have been changed by heat and pressure. The heat comes from volcanoes and other hot rocks beneath the Earth's surface. The pressure comes from the layers of rock that press down on layers below them. The minerals in the rocks change to form a new rock. Tell them that they are going to do an activity today that will show them how metamorphic rocks are formed.
3. Before you begin the activity, ask the students, "What are some things that go in a salad?" (lettuce, tomatoes, etc.) Write the ingredients on the board as they name them. Ask them if the ingredients are the same after the salad is made, or do they change? (they stay the same) Ask them, "What goes in a cake?" (flour, sugar, milk, eggs, etc.) Ask them if the ingredients are the same after the cake is

- baked. (no, it forms a new substance) Ask them how baking a cake is like making metamorphic rocks. (The ingredients change to make something new.)
4. Tell students that metamorphic rocks form from the other two types of rocks (igneous and sedimentary), and from other metamorphic rocks.
 5. Pass out Changing Rocks Activity Sheet (Appendix I) to each student, along with glue, scissors, and crayons. Pass out the Changing Rocks worksheet (Appendix H).
 6. On the Changing Rocks Activity Sheet, have the students use crayons to lightly color the LIMESTONES gray, the SHALES green-gray, and the SANDSTONES light red. (Lightly shading with the side of a crayon works well.) Cut out the six colored cubes.
 7. Have the students use glue to glue one LIMESTONE on the number 1 box on the Changing Rocks worksheet. Glue one SHALE square on the number 3 box on the Changing Rocks worksheet. Glue one SANDSTONE square on the number 5 box on the Changing Rocks worksheet. Walk around while students are doing this to make sure that the rocks are getting glued in the correct boxes.
 8. Have students pick up the remaining LIMESTONE square. Have them hold it up so that you can do a quick check to make sure they have the correct square. Tell them that they are going to change the limestone into marble.
 9. Have them wad up the LIMESTONE square into a tight ball in their hand. Have them press on the ball to represent pressure and make creases.
 10. Now have them open and spread the square out flat. Have them rub the side of a black crayon over the square. This represents heat and shows the crease patterns. The new MARBLE should have dark veins. Have them glue the MARBLE in the number 2 box, on the Changing Rocks worksheet, next to LIMESTONE.
 11. Now tell the students to hold up the SHALE square. Do a quick check to make sure they all have the correct square. Tell them that they are going to change the shale into slate.
 12. Have the students fold the SHALE square like an accordion, with back and forth folds. You may want to demonstrate this for them. This represents the pressure. After they have folded the square, have them unfold it, and spread it out flat. They need to lightly rub the side of a black crayon over the square to represent heat. The crease marks represent the shale's layers. Have them glue the new SLATE square onto number 4 box on the Changing Rocks worksheet, next to SHALE.
 13. Have the students hold up the SANDSTONE square. Tell them that they are going to change the sandstone into quartzite. Have them crush the square in their hands gently, but not wad it into a ball. This represents pressure. Then have them unfold the square and lightly rub the side of a black crayon over the cube to represent heat. This shows the crease patterns. Have them glue it into the number 6 box on the Changing Rocks worksheet.
 14. Walk around the class and check the worksheets to make sure they were completed correctly.
 15. **Special needs:** Prepare in advance, Changing Rocks Worksheet (Appendix H) with the first set of rocks already on the sheet.
 16. **Extension:** Challenge students to collect as many different kinds of metamorphic rocks as they can. Invite them to label each with a description and display the collection in the classroom. Compare rocks students found.

E. *Assessment/Evaluation*

1. Students' proper completion of the Changing Rocks Activity Sheet (Appendix I).

Lesson Four: Igneous Rock (two days, day 1-45 minutes, day 2- 30 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
 - a. Students understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space.
 - b. Understand common properties, forms, and changes in matter & energy.
2. Lesson Content
 - a. Rocks
 - i. Formation and characteristics of igneous rocks. (Adapted from the *Core Knowledge Sequence pg. 105*)
3. Skill Objective(s)
 - a. The student will create a story using facts about igneous rocks.
 - b. The student will describe how an igneous rock is formed.

B. *Materials*

1. Paper and pencil for each child
2. Identifying Rocks Fact Sheet (Appendix J) per student
3. One small box with lid for demonstration
4. Enough marbles to fill the bottom of the box without over lapping

C. *Key Vocabulary*

1. Igneous Rock: rock formed of molten magma from deep within the Earth or from lava on the surface
2. Magma: molten rock beneath the surface of the earth
3. Lava: hot melted rock that comes out of an erupting volcano or a crack in the Earth's surface
4. Obsidian, Granite, Pumice, and Basalt: Refer to definition of the Identifying Rocks Fact Sheet (Appendix J)
5. Solid: a substance with a definite shape
6. Molecule: the smallest bit into which a compound can be divided
7. Autobiography: the story of a person's own life written by himself
8. Biography: a true, written story about a person's life

D. *Procedures/Activities*

Day 1

1. Begin by asking students if they remember what the three types of rocks are. Review metamorphic rocks from yesterday and ask them if they can identify how metamorphic rocks are formed. Explain to them that today they will be learning about igneous rocks.
2. Tell the students that rocks are classified according to how they were formed. Rocks that are formed from cooling lava or magma are called igneous rocks. Write Igneous on the board.
3. Explain to the students that igneous rocks are formed when magma, or melted rock, from deep inside the Earth rises and cools. Tell them that this cooling may happen below the surface or on the Earth.
4. Explain that when magma cools slowly below the surface, the igneous rock formed may have large crystals, which are very easy to see. Other igneous rocks form on the Earth's surface and cool more quickly. Their crystals are usually extremely small. Tell them that igneous rocks are usually not layered. They may have air holes in them. Or they may be glasslike.
5. Tell them that some common igneous rocks are Obsidian, Granite, Pumice, and Basalt. Refer to Identifying Rocks Fact sheet (Appendix J) for information on each type of rock.

6. Get small box and marbles for class demonstration. You may do this as an entire group. Have students assemble so that they can each see the demonstration. You may wish to do the demonstration more than once so that everyone gets a chance to see.
7. Cover the bottom of the box with a single layer of marbles. The marbles should fit together loosely.
8. Close the lid on the box.
9. Using both hands, lift the box and, while holding the lid secure, shake the box vigorously up and down, then side to side.
10. Quickly set the box on a table, open the lid, and observe the position of the marbles inside.
11. Shaking the box moves the marbles, leaving them in a disorderly arrangement.
12. Explain that as the temperature of liquid rock within the earth increases, the movement of molecules (marbles) in the rock increases. The movement of magma molecules is symbolized in the demonstration by the movement of the marbles as the box is shaken. During volcanic eruptions, liquid rock reaches the earth's surface and cools quickly in a matter of days or even hours. Magma that reaches the earth's surface is called lava. Explain that this rapid cooling of lava means that the molecules don't have time to move into orderly patterns before the rock becomes a solid. This produces igneous rock.
13. Put box and marbles away.
14. Explain to them that they are now going to write a story about an igneous rock. Tell them that they each need to be thinking of one of the types of rocks from their fact sheet (Appendix J) to write their story about. Discuss each type of igneous rock on the fact sheet and list some of the characteristics of each on the board. Tell them that in order to write their story they need to know how their specific type of rock is formed.
15. Use the following ideas as an outline; write a story about how a type of igneous rock is formed. Throughout the story describe how the rock feels as its changing. Have them try to use an interesting or unusual story form. They may write it as an autobiography, biography, song, poem, cartoon, TV show, play, illustrated story, radio show, etc!!! Tell them not to forget a title!
16. Pass out Rubric that they will be graded on for their stories. (Appendix L)
17. Give them the following cues to help them begin their story...
 - a. You start as magma. Are you on the surface (lava), near the surface, or down below the surface?
 - b. Cooling
 - i. Fast or slow?
 - ii. Large or small crystal size; or no crystals?
 - iii. Are any gases trapped inside you?
 - c. What is your overall appearance?
18. **Special Needs:** Allow your special needs students that have trouble writing to draw pictures of all the steps their rock goes through.
19. **Extension:** Make a poster of your rock and the steps that it goes through.

Day 2

18. Read stories in front of class.
- E. *Assessment/Evaluation*
1. Oral presentation of their Igneous Rock Story. (Use Appendix L for grading)

Lesson Five: Sedimentary Rock (approximately 45 minutes)

- A. *Daily Objectives*

1. Concept Objective(s)
 - a. Students understand the processes and interactions of Earth’s systems and the structure and dynamics of Earth and other objects in space.
 - b. Understand common properties, forms, and changes in matter and energy.
 2. Lesson Content
 - a. Rocks
 - i. Formation and characteristics of Sedimentary rocks. (Adapted from the *Core Knowledge Sequence pg. 105*)
 3. Skill Objective(s)
 - a. The student will demonstrate how Sedimentary layers of rock are formed.
 - b. Students will identify places where Sedimentary layers are formed.
- B. *Materials*
1. Glass jar (mason jar or pickle jar) with lid per student or group
 2. Water
 3. Rocks, pebbles, sand, and soil gathered by students
 4. Sedimentary Rock Layers Activity sheet (Appendix K)
 5. Crayons or colored pencils
 6. Plastic pitcher
 7. One ruler for each student
 8. If sediments are not available on school grounds, the teacher will need to bring in sediment samples
- C. *Key Vocabulary*
1. Sedimentary Rocks: a kind of rock that forms by fine grains of sediment combining together, water evaporating leaving behind a mineral, or the buried remains of plants or animals compressed under the ground.
- D. *Procedures/Activities*
1. **NOTE:** It will take several hours for sediments to settle correctly. You may want to plan this lesson for two separate times during the day or two days.
 2. Tell students that they will be learning about sedimentary rocks today. Ask them what “sediment” is, or if they can give an example of where you find sediment (sand, soil, etc.). Tell students that sedimentary rocks are made of different layers. These layers can be pebbles, sand, silt, or fossil fragments.
 3. Tell students that they are going to make sedimentary layers today. Explain that the sedimentary layers that they are making today will be examples of sedimentary rocks shaped by water. Explain that sedimentary rocks can also be formed when rocks are ground up by ice, heat, wind, or water.
 4. Tell students that you will be taking them outside to gather materials. Tell them that they will need to get one handful each of rocks, pebbles, sand, and soil. You may want to model the difference between a rock and a pebble (pebbles are smaller than rocks, and usually are more rounded than rocks). Pass out one plastic baggie to each student. (If the teacher has brought in sediments pass them out at this time.)
 5. Take students outside and give them a time limit of 10 minutes to gather their materials. Make sure to tell them to stay where you can see them.
 6. Bring the students back inside after 10 minutes. Pass out a mason jar and lid to each student or group of students. Be sure to tell them to be careful with the jar and not play with them.
 7. Have students fill the jar one-third full with the rocks, pebbles, sand, and soil.

8. Fill the plastic pitcher with water, and fill each student's jar to about 2 inches from the top of the jar. Have the students put the lids on the jars and make sure they are tight.
9. Pass out the Sedimentary Rock Activity sheet (Appendix K). Have students complete number one on the sheet, which asks them to predict what they think will happen after they shake the jar and give it time to settle.
10. After students have finished writing, have them shake their jars carefully, using both hands, one on top of the jar, and the other on the bottom. Demonstrate for them how to hold the jar.
11. After they have shaken their jars, have them put the jars down and watch what happens to the materials inside as they settle. **This may take several hours. You may want to go back to this activity at the end of the day or after it has settled.**
12. Have students complete number 2 on the Sedimentary Rock Activity sheet, which asks them if their predictions were correct and why or why not.
13. Have students complete number 3 on the activity sheet, which asks them to draw a picture of their jar, color it, and label where the pieces of rock, pebbles, sand and soil are in the jar.
14. Discuss with the class why the layers formed in the jar. (The rocks settled to the bottom of the jar because they were the heaviest. The sand and soil floated in the water for a while, and then settled out. The soil took longer to settle because it was the smallest size and floated in the water longer, so it formed the top layer.) Also discuss how this activity shows layers, just like sedimentary rocks have layers because they are formed when rocks, pebbles, sand and soil settle and are joined together by pressure.
15. Have students complete number 3 on the activity sheet by measuring with a ruler how thick each layer is. You may tell the students to use inches or centimeters, depending on where your class is in their math units.
16. Have students put the jars in a safe place in the classroom to keep for observation until the end of the unit. You will need to clean the jars out at a later date.
17. **Special Needs:** Those with less motor skills may need to be placed with a partner to do the activity.
18. **Extension:** Label and draw places they could find sedimentary rocks in their town.

F. *Assessment/Evaluation*

1. Have the students turn in the completed Sedimentary Rock Activity sheet for you to grade to assess how well they learned the subject.

Lesson Six: Comparing and Contrasting (approximately 45 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
 - a. Students understand common properties, forms, and changes in matter and energy.
 - b. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
2. Lesson Content
 - a. Rocks
 - i. The formation and characteristics of metamorphic, igneous, and sedimentary rocks.
3. Skill Objective(s)

- a. The student will compare and contrast metamorphic, igneous, and sedimentary rocks.
 - b. The student will identify ways metamorphic, igneous, and sedimentary rocks are used today.
- B. *Materials*
- 1. Class set of metamorphic, igneous, and sedimentary rocks (e.g., metamorphic – marble, gneiss, schist; igneous – obsidian, granite, pumice; sedimentary – shale, sandstone, conglomerates)
 - 2. Compare and Contrast Lab sheet for each student (Appendix M)
- C. *Key Vocabulary*
- 1. Metamorphic Rock: rock that changes form by heat and pressure from the Earth’s crust
 - 2. Igneous Rock: rock formed by molten magma from deep within the Earth or lava on the surface
 - 3. Sedimentary Rock: rock that forms by either fine grains of sediment combining together, water evaporating leaving behind a mineral, or the buried remains of plants or animals compressed under the ground
- E. *Procedures/Activities*
- 1. Review definitions of metamorphic, igneous, and sedimentary rocks. Ask students if they remember how each are formed and make a list on the board.
 - 2. Explain that sedimentary rocks are usually formed in bodies of water; they may have fossils in them, and may be layered. Igneous rocks are made from rock that is melted deep inside the earth or from cooled lava. Metamorphic rocks are formed by heat and pressure from other rocks.
 - 3. Pass around a sample of each type of rock and briefly discuss characteristics of each. Refer to Rock Fact sheet for characteristics. (Appendix J)
 - 4. Show students an example of each rock and ask them what it could be used for today. Make a list of uses on the board.
 - 5. Remind students that they need take notes on their fact sheet of the rocks use.
 - 6. Tell the students that granite and limestone are used as building stones. Marble is used for decoration and sculpture. Pumice is used for smoothing rough skin. Sandstone is used for building. Slate is used for chalkboards, roofing tiles, and walkways. Conglomerates are used for gravel roads and drive ways. Gneiss is a strong building stone. Obsidian is used for making tools. Basalt is used for building.
 - 7. With the examples given discuss what metamorphic rocks are generally used for (building and decoration), igneous rocks are generally used for (building, tools, and skin care), and sedimentary rocks are generally used for (chalkboards, drive ways, and roads).
 - 8. Verbally review with students the following items from previous lessons for unit review...
 - a. Formation and characteristics of metamorphic, igneous, and sedimentary rock.
 - b. Minerals are non-living solids found in nature made of elements. (not in *Core Knowledge Sequence*)
 - c. Rocks are made of minerals. (not in *Core Knowledge Sequence*)
 - d. Testing strategies for classifying minerals (not in *Core Knowledge Sequence*)
 - 9. Have students turn in their Rock Fact Sheets (Appendix J) to check for completion of uses.

10. **Special needs:** Give them a copy of the notes in advance to put on their fact sheets.
 11. **Extension:** Learn the processes involved in the rock cycle. An online tutorial is available at <http://www.cotf.edu/ete/modules/msese/earthsysflr/rock.html>. Make a flipbook about how a rock goes through each stage of the rock cycle.
- G. *Assessment/Evaluation*
1. Satisfactory completion of notes on Rock Fact Sheet. (Appendix J)

VI. CULMINATING ACTIVITY

- B. Rock and Mineral Summative Evaluation (Appendix M)

VII. HANDOUTS/WORKSHEETS

- A. Appendix A: Mock Rock Recipe
- B. Appendix B: Rock vs. Mineral Data Sheet and Answer Key (four pages)
- C. Appendix C: Rock vs. Mineral W/S and Answer Key (two pages)
- D. Appendix D: Hardness Rating Sheet
- E. Appendix E: Mohs Hardness Scale
- F. Appendix F: Oral Presentation Rubric on the Mineral Report
- G. Appendix G: Observation Check List
- H. Appendix H: Changing Rocks
- I. Appendix I: Changing Rocks Activity Sheet
- J. Appendix J: Identifying Rocks Fact Sheet (two pages)
- K. Appendix K: Sedimentary Rock Layers Activity (two pages)
- L. Appendix L: Oral Presentation Rubric: Story of a Rock
- M. Appendix M: Rocks and Minerals final test (five pages)
- N. Appendix N: Rocks and Minerals final test answer key (five pages)

VIII. BIBLIOGRAPHY

- A. *Academy Handbook Fourth Grade*. 2003. "Identifying Rocks Activity". Utah State Office of Education.
- B. *Exploring Minerals*. Illinois State Museum Geology Online. Available URL: <http://geologyonline.museum.state.il.us>
- C. McGraw Hill Science 2002, Garth Science, Unit C, pp C6-C7.
- D. National Audubon Society. *First Field Guide: Rocks and Minerals*. New York: Scholastic, Inc, 1998. ISBN: 0-590-05484-8.
- E. Silver, D.; Wynne, P. *The Amazing Earth Model Book*. New York: Scholastic, 1997. ISBN: 0-590-93089-3.
- F. Sita, Lisa. *Rocks, Gems, and Minerals*. New York: Thomson Learning, 1995. ISBN 1-56847-269-2.

Appendix A

Mock Rock Recipe

One week before this activity, make the mock rocks and allow them to dry (do not bake them).

Mix 1 cup white flour, $\frac{1}{2}$ cup salt, and 2 teaspoons of alum together. In a separate bowl, mix $\frac{1}{2}$ cup water, 5 drops red food coloring, 5 drops blue food coloring, and 3 drops yellow food coloring. Add the water mixture to the flour mixture. Knead the mixture until it no longer sticks to the side of the bowl. Add 1 cup coarse sand, and $\frac{1}{4}$ cup aquarium gravel. Knead until it is well mixed. Divide the mixture in 18 equal pieces about the size of a ping-pong ball. Place one ball into the palm of your hand and with your thumb make a small indentation in the center. Place 3 or 4 pieces of seashell (or eggshell), to represent fossils, in the indentation and mold the dough around them. Smooth the surface of the ball and flatten the rock so that it is about 1 cm thick. Let them air dry for a week.

*Note to teachers:

If you do not have the supplies mentioned above, you can also make the mock rocks by combining pieces of gravel or sand with rubber cement or Elmer's glue, and adding pieces of eggshells.

This mock rock activity is a modified version of "Mock Rocks" from the FOSS science module. Kits may be ordered through Delta Education at 1-800-258-1302.

Appendix B, page 1
Rock vs. Mineral Data Sheet

Fill out this sheet as you follow the activity with your teacher.

1. Draw your mock rock, and label the parts that you can see.

2. Fill out the chart below.

	Mock Rock measurements
Diameter	
Circumference	
Depth	
Weight	

3. Now draw your mock rock, after your have broken it, and label the parts that you can see.

4. What is a mineral?

5. What is a rock?

6. How do the different pieces of the rock represent minerals?
Explain

Rock vs. Mineral

As your teacher holds up an object, decide if it better represents a rock or a mineral. Write whether it is a rock or mineral. Then explain why you thought it was a rock or a mineral.

Object	Rock or Mineral	Why?
Hairbrush		
Chalk		
Paperclip		
Notebook		
White paper		
Clock		
Stapler		
Spoon		
Desk		
Globe		

Rock vs. Mineral Answer Key

As your teacher holds up an object, decide if it better represents a rock or a mineral. Write whether it is a rock or mineral. Then explain why you thought it was a rock or a mineral.

Object	Rock or Mineral	Why?
Hairbrush	Rock	It has more than one substance, the bristles and the handle
Chalk	Mineral	It is only made up of one substance; it looks the same throughout
Paperclip	Mineral	It is only made of metal, and it looks the same throughout
Spiral Notebook	Rock	It has more than one substance, the metal spiral, and the paper.
White paper	Mineral	It looks the same throughout, and is all paper
Clock	Rock	It has more than one substance, and letters, and looks different throughout.
Stapler	Rock	It has more than one part. It has the staples and the metal body.
Spoon	Mineral	It is all metal, and looks the same throughout.
Desk	Rock	It has metal and wood.
Globe	Rock	It has metal and wood (or plastic).

Appendix D

Hardness Rating Sheet

Name: _____

Date: _____

Put an X in each box where the object can scratch the mineral or be scratched by the mineral.

	Fingernail	Penny	Paper Clip	Nail
Mineral 1 Name _____				
Mineral 2 Name _____				
Mineral 3 Name _____				
Mineral 4 Name _____				

Write the four minerals in order, from hardest to softest.

- 1.
- 2.
- 3.
- 4.

For each mineral, write at least one thing that this mineral could be used for today. *Hint: Think about its level of hardness.*

This lesson was adapted from the Illinois State Museum Geology Online website at: <http://geologyonline.museum.state.il.us>

Appendix E

Mohs Hardness Scale

Hardness	Mineral	Common Tests
1	Talc	fingernail will scratch it
2	Gypsum	
3	Calcite	copper coin will scratch it
4	Fluorite	glass or penknife will scratch it
5	Apatite	
6	Feldspar or orthoclase	will scratch glass
7	Quartz	
8	Beryl or topaz	
9	Corundum	
10	Diamond	will scratch all common materials

Appendix F

Oral Presentation Rubric on the Mineral Report

Student Name _____

Category	4	3	2	1
Content	Student shows a full understanding on the mineral	Student shows a reasonable understanding of the mineral	Student shows a good understanding of parts of the mineral	Student does not appear to understand the mineral very well.
Stays on Topic	Student stays on topic the whole time	Student stays on topic most of the time	Student stays on topic some of the time	Student does not appear to know what the topic was
Comprehension	Student is able to correctly answer questions asked by classmates about the mineral	Student is able to correctly answer some questions asked by classmates about mineral	Student is able to correctly answer a few questions asked by classmates about the mineral	Student is unable to answer questions asked by classmates about the mineral
Clarity	Student speaks clearly and does not mispronounce words	Student speaks clearly, but mispronounces one word	Student speaks clearly most of the time and mispronounces no more than two words.	Student is hard to understand or mispronounces more than 2 words
Preparation	Student is evidently confident and well-prepared	Student loses their place or stumbles no more than one time	Student loses their place or stumbles over words no more than two times	Student loses their place or stumbles over words more than two times

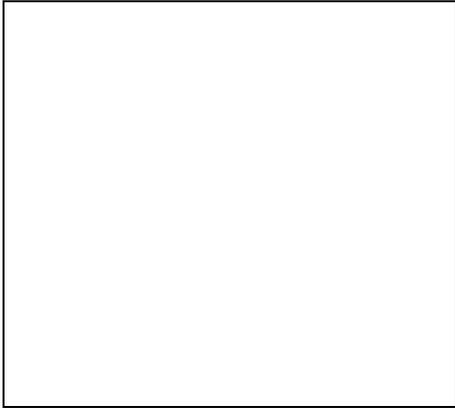
Total Score _____/20

Appendix H
Changing Rocks

Metamorphic rocks are changed by heat and pressure inside the Earth.

Name _____

1



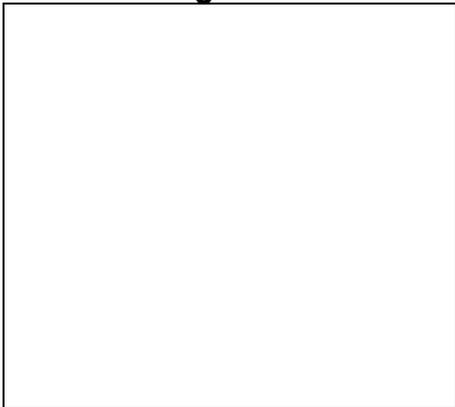
2



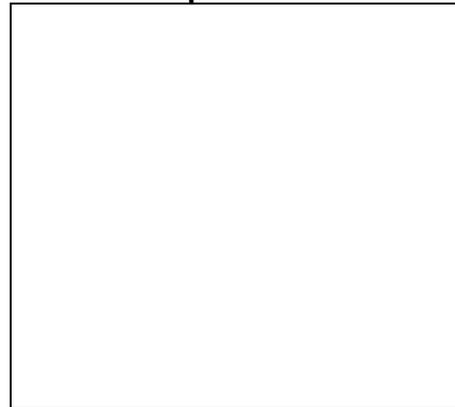
Limestone changes to marble.



3



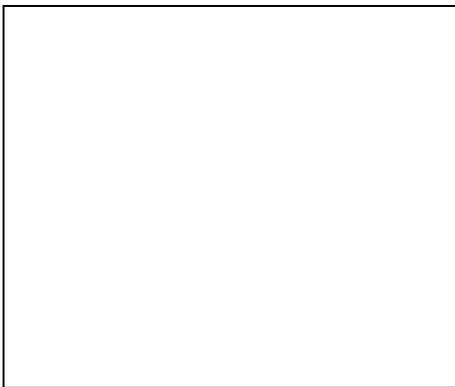
4



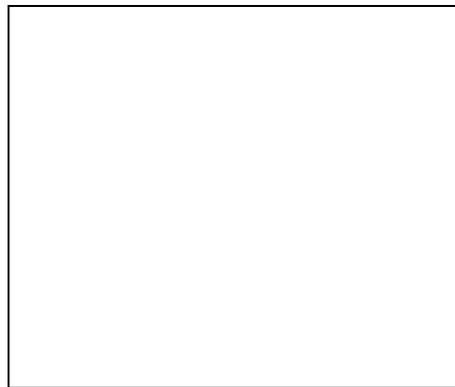
Shale changes to slate.



5



6



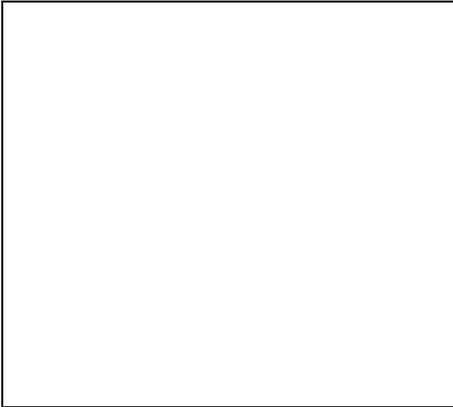
Sandstone changes to quartzite.



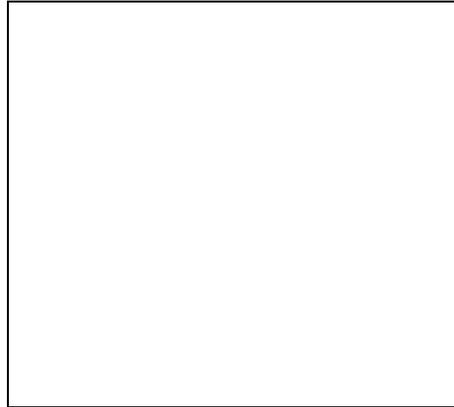
This activity is adapted from "Metamorphic Rocks", page 44-49, in The Amazing Earth Model Book, by D. Silver and P. Wynne.

Appendix I
Changing Rocks Activity Sheet

Limestone



Limestone



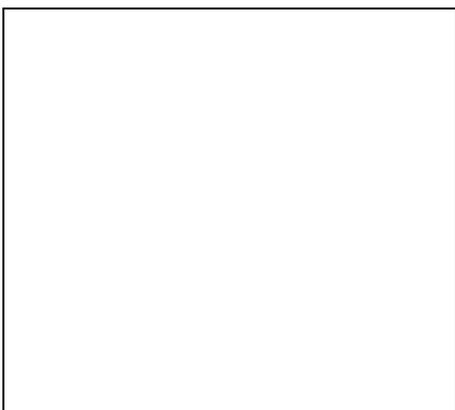
Shale



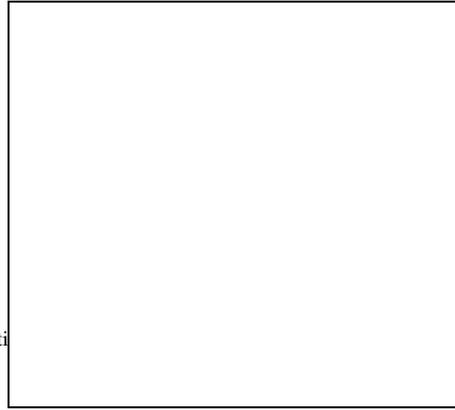
Shale



Sandstone



Sandstone



Identifying Rocks Fact Sheet

Use the following fact sheet descriptions to help you identify different types of rocks.

SEDIMENTARY rocks are formed from small particles of rock and other materials that are created through weathering. Most sediments are deposited by running water. Some are left by wind, glacial ice, or evaporation. The size of the sediments is determined by the speed of moving water. The faster the water, the bigger the rock it can move. Most sedimentary rocks were formed of sediments deposited or left by ancient shallow seas. Sedimentary rocks usually have rounded sediments, or particles. They are often layered. Some common sedimentary rocks are sandstone, conglomerate, and shale.

Shale is formed from particles of clay, which were deposited in deep, quiet waters. It is usually red, brown, or gray. When it is wet it has a "muddy" smell.

Sandstone is formed from particles of sand that were deposited near the shore where there was wave action. It is rough and grainy to touch. It may have fossils in it. Under a hand lens, you usually see sand grains.

Conglomerates are sediments, pebbles, and other size rocks cemented together by minerals from water.

METAMORPHIC rocks are rocks that have been changed by heat and pressure. The heat comes from volcanoes and other hot rocks under Earth's surface. Pressure comes from the layers of rock that press down on layers below them. Metamorphic rocks may have crystals or layers because they are formed from other rocks. Some common metamorphic rocks are marble, gneiss (nice), and schist (shist).

Marble is a large crystal rock formed from limestone. Its color depends on the presence of different minerals. It is generally pink, red, yellow, brown, green, or black.

Gneiss is a coarse or rough rock. It has parallel streaks or bands of minerals in it. It may be formed from a variety of rocks. Including granite and basalt.

Schist is a medium - grained rock. It is formed from shale or slate.

IGNEOUS rocks are formed when magma, or melted rock, from deep inside Earth rises and cools. This cooling may happen below the surface or on the Earth. When magma cools slowly below the surface, the igneous rock formed may have large crystals, which are very easy to see. Other igneous rocks form on the earth's surface and cool more quickly. Their crystals are usually extremely small. Igneous rocks are usually not layered. They may have air holes in them. Or they may be glasslike. Some common igneous rocks are obsidian, granite, pumice, and basalt.

Obsidian is a glass formed from rapidly cooled lava. It forms so quickly there is not time for crystals to grow. It has very sharp edges. Early people found this very useful for making tools such as arrowheads.

Granite is made up of mainly coarse (large) grains of quartz, feldspar, and mica. (Quartz is a colorless, transparent, hexagonal-shaped mineral. Feldspar is a glass mineral. Mica is a translucent or colored mineral that come in thin layers.) The individual grains in granite are large because they formed as the magma cooled slowly deep in the earth. Granite is usually speckled and varies in color from gray to red according to the different amounts of minerals.

Pumice is hardened lava froth. Because the froth contains gas bubbles, the rock is peppered with holes, like a honeycomb. Pumice floats in water.

Basalt is a common igneous rock. The grains in basalt are fine or small. It is often a heavy, dark colored rock. Large pieces of basalt may split into many - sided columns.

Appendix K, page 2

4. Measure the thickness of each layer. Write in the spaces below how thick each layer is in inches or centimeters.

Rock layer _____

Pebble layer _____

Sand layer _____

Soil layer _____

This activity was adapted from the "Sedimentary Rock Activities", at <http://www.coaleducation.org/lessons/sme/elem/6.htm>

Appendix L

Oral Presentation Rubric : Story of a Rock

Teacher Name: _____

Student Name: _____

CATEGORY	4	3	2	1
Uses Complete Sentences	Always (99-100% of time) speaks in complete sentences.	Mostly (80-98%) speaks in complete sentences.	Sometimes (70-80%) speaks in complete sentences.	Rarely speaks in complete sentences.
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
Speaks Clearly	Speaks clearly and distinctly all (100-95%) the time, and mispronounces no words.	Speaks clearly and distinctly all (100-95%) the time, but mispronounces one word.	Speaks clearly and distinctly most (94-85%) of the time. Mispronounces no more than one word.	Often mumbles or can not be understood OR mispronounces more than one word.
Stays on Topic	Stays on topic all (100%) of the time.	Stays on topic most (99-90%) of the time.	Stays on topic some (89%-75%) of the time.	It was hard to tell what the topic was.
Volume	Volume is loud enough to be heard by all audience members throughout the presentation.	Volume is loud enough to be heard by all audience members at least 90% of the time.	Volume is loud enough to be heard by all audience members at least 80% of the time.	Volume often too soft to be heard by all audience members

Total Score /20

Rocks and Minerals Summative Evaluation

Name _____ Date _____

Section I. Knowledge (each question worth one point, with a total of 9 points)
Use the words in the list below to fill in the blanks. Make sure each sentence is capitalized.

mineral geologist hardness luster

metamorphic rock igneous rock sedimentary rock

magma lava

1. If a rock has _____, that means that it is shiny.
2. A _____ is a nonliving substance found in nature that has the same appearance throughout.
3. _____ is hot melted rock that comes out of an erupting volcano or a crack in the Earth's surface.
4. A mineral's _____ determines how easily it can be scratched by various objects.
5. A person who studies the earth is called a _____.
6. Rocks that are formed from other rocks because of heat and pressure deep within the Earth are _____.
7. _____ is formed from molten magma from deep within the Earth or from lava on the Earth's surface.
8. _____ is molten rock deep within the Earth's crust.
9. _____ is formed from either fine grains of sediment combining together, water evaporating and leaving a mineral behind, or compressed buried remains of plants or animals.

Section II. Comprehension (each rock is worth one point, with a total of 10 points)

One the chart below, classify each rock as metamorphic, igneous, or sedimentary. Put a check mark in the correct box. (each rock should only have ONE check)

Rock	Metamorphic	Igneous	Sedimentary
Conglomerate			
Marble			
Basalt			
Pumice			
Sandstone			
Shale			
Gneiss			
Obsidian			
Granite			
Schist			

Section III. Application (each question is worth 2 points, with a total of 8 points)

0=blank or totally wrong 1=partially right 2=completely right

Choose four of the above rocks, and explain what they are used for today.

1. _____

2. _____

3. _____

4. _____

Appendix M, page 3

Section IV. Analysis (each question is worth 2 points, with a total of 8 points)

0=blank or totally wrong 1=partially right 2=completely right

- 1. Write the difference between a rock and a mineral.**
- 2. Identify ways that minerals can be tested. Give at least 2 examples and explain how they are used.**
- 3. During class, you created sedimentary layers by adding rocks, pebbles, sand, and soil to a jar with water. The jar was shook, then allowed to settle standing upright. Identify what happened to the sediments after it had settled and why?**
- 4. Identify the two processes deep within the Earth that form a metamorphic rock.**

Section VI. Evaluation (worth 10 points)

Pick one example of a rock or a mineral. Using your knowledge of that rock or mineral, pretend that you are living the life of the rock or mineral. Describe what your job is (uses of the mineral), where you live (where the rock or mineral is found), and what you would look like (color, luster, etc.).

2 points for uses of the rock or mineral

2 points for where the rock or mineral is found

2 points for what the rock or mineral looks like

2 points for creativity

2 points for correct paragraph form and grammar, punctuation, spelling

Rocks and Minerals Summative Evaluation Answer Key

Name _____ Date _____

Section I. Knowledge (each question worth one point, with a total of 9 points)

Use the words in the list below to fill in the blanks.

mineral geologist hardness luster

metamorphic rock igneous rock sedimentary rock

magma lava

1. If a rock has luster, that means that it is shiny.
2. A mineral is a nonliving substance found in nature that has the same appearance throughout.
3. Lava is hot melted rock that comes out of an erupting volcano or a crack in the Earth's surface.
4. A mineral's hardness determines how easily it can be scratched by various objects.
5. A person who studies the earth is called a geologist.
6. Rocks that are formed from other rocks because of heat and pressure deep within the Earth are metamorphic rocks.
7. Igneous rock is formed from molten magma from deep within the Earth or from lava on the Earth's surface.
8. Magma is molten rock deep within the Earth's crust.
9. Sedimentary rock is formed from either fine grains of sediment combining together, water evaporating and leaving a mineral behind, or compressed buried remains of plants or animals.

Section II. Comprehension (each rock is worth one point, with a total of 10 points)

One the chart below, classify each rock as metamorphic, igneous, or sedimentary. Put a check mark in the correct box. (each rock should only have ONE check)

Rock	Metamorphic	Igneous	Sedimentary
Conglomerate			X
Marble	X		
Basalt		X	
Pumice		X	
Sandstone			X
Shale			X
Gneiss	X		
Obsidian		X	
Granite		X	
Schist	X		

Section III. Application (each question is worth 2 points, with a total of 8 points)

Choose four of the above rocks, and explain what they are used for today.

1. *Conglomerates are used for gravel roads and driveways.*
2. *Marble is used for decoration and for sculpture.*
3. *Basalt is used for building stones.*
4. *Pumice is used for beauty products, such as smoothing rough skin.*
5. *Sandstone is used for building stones.*
6. *Shale is used for chalkboards.*
7. *Gneiss is used for building stones.*
8. *Obsidian is used in tools.*
9. *Granite is used for building stones or sculpture.*
10. *Schist was used for tools in prehistoric times.*

Section IV. Analysis (each question is worth 2 points, with a total of 8 points)

1. Write the difference between a rock and a mineral.

A mineral is made up of elements and looks the same throughout. A rock is made up of minerals and usually looks different throughout.

2. Identify ways that minerals can be tested. Give at least 2 examples and explain how they are used.

Hardness- the mineral can be scratched with various objects such as a penny or a nail to see how easily it can be scratched.

Luster- If the mineral is shiny, then it is metallic. If it is not shiny, it is non-metallic.

Color- The minerals each have a specific color.

Texture- Some minerals are smooth, and others are rough.

3. During class, you created sedimentary layers by adding rocks, pebbles, sand, and soil to a jar with water. The jar was shook, then allowed to settle standing upright. Identify what happened to the sediments after it had settled and why?

The sediments formed layers in the jar. The rocks formed the bottom layer because they were the heaviest. The pebbles formed the next layer, then the sand. The soil formed the top layer because it floated in the water for a while and took longer to settle, because it was the lightest sediment.

4 Identify the two processes deep within the Earth that form a metamorphic rock.

Heat and pressure deep within the Earth form metamorphic rocks.

Section V. Synthesis (worth five points)

Pick an igneous rock and describe the process that it goes through when it forms from either lava or magma. Choose one of the following rocks.

- 1 point for describing your rock at the beginning**
- 1 point for describing the cooling process (fast or slow)**
- 1 point for describing whether it has crystals or not**
- 1 point for identifying whether it has gases or not**
- 1 point for a well-developed paragraph**

Obsidian

Granite

Pumice

Basalt

Obsidian- glass formed from rapidly cooled lava. It forms quickly, and does not form crystals. It does not form a gas.

Granite- made up of mainly coarse (large) grains of quartz, feldspar and mica. The grains are large because they formed from slowly cooling lava. It often has quartz crystals. It does not have gases.

Pumice- cools very quickly, and forms hardened lava froth with no crystals, and has bubbles from gases

Basalt- small grained, cools quickly, has no crystals, but does have gases, which form bubbles

Section VI. Evaluation (worth 10 points)

Pick one example of a rock or a mineral. Using your knowledge of that rock or mineral, pretend that you are living the life of the rock or mineral. Describe what your job is (uses of the mineral), where you live (where the rock or mineral is found), and what you would look like (color, luster, etc.).

2 points for uses of the rock or mineral

2 points for where the rock or mineral is found

2 points for what the rock or mineral looks like

2 points for creativity

2 points for correct paragraph form and grammar, punctuation, spelling

Grade students on whether they have the information required. A good abbreviated example would be:

I am shale. I live in a schoolroom, and my job is to provide a place for the teacher to write with chalk. I am a sedimentary rock, so when I am not working, I can usually be found by a river or stream. I love to sit along the side of the water with my friends. I'm pretty brown, so I don't burn in the sun. I sometimes turn a little gray, though. If I am in the water too long, I get a muddy smell.