Ohio Standards Connections:
Earth and Space Sciences

Benchmark D
Identify that the lithosphere contains rocks and minerals and that minerals make up rocks. Describe how rocks and minerals are formed and/or classified.

Indicator 1
Describe the rock cycle and explain that there are sedimentary, igneous and metamorphic rocks that have distinct properties (e.g., color, texture) and are formed in different ways.

Lesson Summary:
As an introduction to the rock cycle, students will complete a written pre-assessment. Students then participate in an activity where they characterize a rock. Based on this exposure to characterizing rocks, students design a list of characteristics of rocks to use for identifying unknowns. Students learn the characteristics of igneous, sedimentary and metamorphic rocks in cooperative learning groups, and learn about the roles that the rocks play in the rock cycle. Finally, students get to apply their knowledge about rocks to samples of unknowns.

Estimated Duration: Six hours

Commentary:
This lesson helps students become knowledgeable about the three major classifications of rocks and their relationships in the rock cycle. Open classroom discussion helps students understand how to classify rocks. A classroom exercise employing the jigsaw strategy helps students teach one another the similarities and differences among igneous, metamorphic and sedimentary rocks. This lesson helps develop several scientific skills such as organizing material for understanding, observing and charting, analyzing and classifying data.

This lesson was field tested by teachers across the state of Ohio. Some of the teacher comments about this lesson were:
- "This lesson had a good flow and was very student centered. It promoted inquiry and application."
- "The students were in control of their learning and enjoyed the different method of learning."
- "The students were very excited about science class! They enjoyed sharing their information with each other and designing games. Several students brought buckets and bags of rocks to look at."
Pre-Assessment:
The purpose of the Pre-Assessment is to get students to engage and to assess where students’ entry points are. Have students write for 5 minutes their answer to the following question: What is a rock?

Scoring Guidelines:
This pre-assessment is not to be graded.

Post-Assessment:
• Tell the students that they are going to design a game that will require players to describe the rock cycle and explain the properties of sedimentary, igneous and metamorphic rock.
• Print copies of Attachment A, Post-Assessment Rubric, and distribute to students to help them design their games. Impress upon students that their games need to include descriptions of the rock cycle. The games must also describe how each type of rock looks and provide examples of each.

Scoring Guidelines:
Use the rubric in Attachment A, Post-Assessment Rubric, as a guideline for assessing student work.

Instructional Procedures:
Part 1: Pet Rock Activity
1. Give each student a rock for this exercise.
2. Based on their rock, have students fill out the Attachment B, My Rock Graphic Organizer. Remind students to make detailed observations for the next step.
3. Facilitate a class discussion about characteristics of rocks. As the students generate ideas, records them on the board.
4. Have students brainstorm ways to organize the list of characteristics into categories.

Instructional Tip:
• Help students understand that what they are doing is called classification. Tell students that these characteristics are used to sort different kinds of rocks into groups.
• Have each student consider his/her personal goal: “What I want or need to know about rocks.” After deliberation, have each student record their goal in their notebooks.
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Part 2: Jigsaw Activity

Instructional Tip:
Use vinegar or extremely diluted HCl solution for the tests listed in the keys.

The steps below involve the jigsaw strategy for cooperative learning. See the “Research Connections” section for more information about the jigsaw method. Before starting the jigsaw exercise, decide how many characteristics of rocks the students should consider. It is wise to keep it a small number so that students are not overwhelmed by information.

1. Have students count off and divide into groups (six students per group). These groups are called base groups. Each student in a group will be responsible for a kind of rock. Within each group, two students will be responsible for igneous rock, two for metamorphic rock and two for sedimentary rock. Let students decide who will be responsible for each type of rock.

2. Provide a variety of resources about rocks such as field guides, books, computer programs and the Internet. Alternatively, take the class to the school library. Using the resources provided by the teacher and Attachment C, Rock Chart, instruct students to investigate the properties of their specific type of rock. Remind students to list two to four properties on their copy of the Rock Chart.

3. Have a representative from each base group go to one of the six jigsaw groups (two igneous groups, two metamorphic groups and two sedimentary groups). Have these groups study and specialize in only one kind of rock. Distribute the appropriate key from Attachment D, Dichotomous Keys, to each group and have them learn to use the key by giving the students rocks within their group to identify.

4. Have students return to their base groups, and instruct them to teach the material that each has learned (their respective Dichotomous Keys). Have the base group put together a procedure for identifying unknown rocks. Throughout the process, move from group to group.

5. Distribute seven, unidentified, numbered rock samples to each base group. Tell the students to pass samples around the group while each student, using the group’s procedure, attempts to identify each rock. The group should reach a consensus for the identification for each rock sample.

6. Once each rock has been identified, students should go back and decide where the rock falls in the rock cycle. Each group should use a copy of Attachment E, Rock Cycle Diagram, to place each numbered rock in the rock cycle.

7. Facilitate a class discussion about the difficulties in classifying the unknowns.

8. Facilitate the charting of the characteristics of the seven rock samples for the class. Again, use the format found in Attachment C, Rock Chart. Advise students to make adjustments to their personal Rock Charts if there are conflicts. Finish with the classification of the rock samples.

9. Facilitate a discussion to help the students understand how the seven rocks are related to one another through the rock cycle.
10. Have students evaluate their personal goals for this lesson. If they have not met their goals, have them establish plans and assignments for locating missing information. You may choose to pursue this as an assignment or extension.

11. Proceed to the post-assessment.

**Differentiated Instructional Support:**
Instruction is differentiated according to learner needs to help all learners either meet the intent of the specified indicator(s) or, if the indicator is already met, to advance beyond the specified indicator(s).

- Give students two different kinds of rocks (igneous, metamorphic and sedimentary). Have them list the characteristics of each and try to differentiate between them.
- Give students different objects (including a rock). Have students list characteristics of each and try to define the characteristics of a rock.
- Have students create rock cards (like baseball cards with characteristics and significant features) for various rocks, then have students use the cards to create categories based on characteristics.
- Have students write stories about different rocks, personifying differentiating characteristics of the rocks to help them remember the differentiating characteristics as well as to make the differences more pronounced.

**Extensions:**
- As a challenge, provide each team a set of three rocks that have similar composition (e.g., sandstone, granite and gneiss). Explain that these rock samples have similar composition and that on our dynamic planet one rock type can change over time. Ask each team to decide which rock came first, then second, and then third and be prepared to justify the order of choice.
- Plan field trips to see rock formations, glaciation and rock samples.
- Plan virtual field trips and locate Web sites to explore the rock cycle.
- Have students investigate careers involving rocks, e.g., archaeologist, geologist, natural history museum personnel, jewelry maker. This experience could include speakers.
- Instruct students to imagine that one of the three types of rock has been removed from the rock cycle. Have students explain in detail the impact this will have on the cycle. Student research should include:
  - How it will impact each of the other rock types in the cycle.
  - Where in the world this will have an impact? (Use a map)
  - How other natural areas will be impacted.
  - How the man-made structures and materials that are currently in existence will be impacted.
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**Homework Options and Connections:**
- Have students prepare a personal rock collection, including rock type and location where the sample was found.
- Challenge students to prepare a list of items in and around the home made out of rock.

**Materials and Resources:**
The inclusion of a specific resource in any lesson formulated by the Ohio Department of Education should not be interpreted as an endorsement of that particular resource, or any of its contents, by the Ohio Department of Education. The Ohio Department of Education does not endorse any particular resource. The Web addresses listed are for a given site’s main page, therefore, it may be necessary to search within that site to find the specific information required for a given lesson. Please note that information published on the Internet changes over time, therefore the links provided may no longer contain the specific information related to a given lesson. Teachers are advised to preview all sites before using them with students.

*For the teacher:* Textual material on the rock cycle, igneous rock samples, metamorphic rock samples, sedimentary rock samples, pictures of rocks, rock guide books, chart paper, droppers and vinegar (or diluted HCl).

*For the students:* Textual material on the rock cycle, igneous rock samples, metamorphic rock samples, sedimentary rock samples, pictures of rocks, rock guide books, chart paper, droppers and vinegar (or diluted HCl).

**Vocabulary:**
- igneous rock
- luster
- magma
- metamorphic rock
- properties of rocks
- rock cycle
- sedimentary rock

**Technology Connections:**
- Locate and use computer programs that help students take notes and organize data.
- Lead virtual field trips on software or on the Internet.
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Research Connections:

Reading in the content area is a necessary and important part of the science curriculum. The jigsaw strategy is one method that can be used to help students acquire factual information. Students become familiar with textual information in an efficient, timely way. It also enables students who do not read as quickly or comprehend as well to be familiar with the material at the same time as their peers. Finally, this strategy allows students who do not articulate easily to take an active role in the learning/teaching process. Jigsawing enables teachers to easily ascertain that students have been attentive to necessary concepts and important vocabulary.


Identifying similarities and differences enhances students’ understanding of and ability to use knowledge. This process includes comparing, classifying, creating metaphors and creating analogies and may involve the following:

- Presenting students with explicit guidance in identifying similarities and differences;
- Asking students to independently identify similarities and differences;
- Representing similarities and differences in graphic or symbolic form.

Nonlinguistic representations help students think about and recall knowledge. This includes the following:

- Creating graphic representations (organizers);
- Making physical models;
- Generating mental pictures;
- Drawing pictures and pictographs;
- Engaging in kinesthetic activity.

Cooperative learning grouping has a powerful effect on student learning. This type of grouping includes the following elements:

- Positive interdependence;
- Face-to-face promotive interaction;
- Individual and group accountability;
- Interpersonal and small group skills;
- Group processing.

Setting objectives and providing feedback establishes a direction for learning and a way to monitor progress. This provides focus on learning targets and specific
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information to allow the student to make needed adjustments during the learning process, resulting in increase student learning

General Tips:
• When students work in groups during the jigsaw activity, you should move from group to group to observe and question if you hear incorrect statements or conclusions.
• Prior exposure to the rock cycle occurs at Grade 3, Earth Science Standard, Benchmark C, Indicators 1, 2, and 3.

Attachments:
Attachment A, Post-Assessment Rubric
Attachment B, My Rock Graphic Organizer
Attachment C, Rock Chart
Attachment D, Dichotomous Keys
Attachment E, Rock Cycle
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### Attachment A

**Post-Assessment Rubric**

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Good</th>
<th>Poor</th>
<th>Unacceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rock cycle description</strong></td>
<td>One rock form can be changed into either of the other two forms. Igneous rocks form from melted rock. Sedimentary rocks form from erosion and deposition. Metamorphic rocks are changed by heat and pressure.</td>
<td>One part of the rock cycle description has been omitted, or one part of the description is incorrect or incomplete.</td>
<td>Two parts of the rock cycle description are omitted or incorrect, or one part has been omitted and one part of the description is incorrect or incomplete.</td>
<td>Three parts of the rock cycle description are either omitted, contain incorrect information, or are incomplete.</td>
</tr>
<tr>
<td><strong>Sedimentary rock explanation</strong></td>
<td>Properties: 1) visible grains that have been cemented together, 2) dull luster mass that hasn’t been flattened. At least two examples.</td>
<td>Only one property has been identified correctly or only one example has been used. Everything else is correct.</td>
<td>Neither property is identified correctly, or no correct examples are used, or only one property and one example is correct.</td>
<td>Only one property or one example was presented correctly. Everything else is omitted or presented incorrectly.</td>
</tr>
<tr>
<td><strong>Igneous rock explanation</strong></td>
<td>Properties: 1) visible crystals of two or more minerals melted in a random pattern, 2) glassy or frothy mass. At least two examples.</td>
<td>Only one property is identified correctly or only one example is used. Everything else is correct.</td>
<td>Neither property is identified correctly, or no correct examples are used, or only one property and one example are correct.</td>
<td>Only one property or one example was presented correctly. Everything else is omitted or presented incorrectly.</td>
</tr>
<tr>
<td><strong>Metamorphic rock explanation</strong></td>
<td>Properties: 1) visible crystals of one or more minerals melted in a layered pattern, 2) dull luster mass that is flattened. At least two examples.</td>
<td>Only one property is identified correctly or only one example is used. Everything else is correct.</td>
<td>Neither property is identified correctly, or no correct examples are used, or only one property and one example are correct.</td>
<td>Only one property or one example was presented correctly. Everything else is omitted or presented incorrectly.</td>
</tr>
<tr>
<td><strong>Game directions</strong></td>
<td>Purpose of game is stated. Materials listed. How game begins and order of play is described. Directions are sequential.</td>
<td>All aspects of the game directions are provided except one is omitted or presented unnecessarily.</td>
<td>Only two aspects of the game directions are provided and presented clearly.</td>
<td>Only one aspect of the game directions is provided and presented clearly.</td>
</tr>
</tbody>
</table>
Attachment B
My Rock Graphic Organizer

Name ______________________________
Date ________________________
Period _________________

Directions: Fill in the lines with specific characteristics of your rocks. Don’t forget to use one line to tell where your rock was found.

Picture of my Rock

I found ___ people in class with rocks that are like mine.
## Attachment C
### Rock Chart

<table>
<thead>
<tr>
<th>Rock sample</th>
<th>Identity of rock</th>
<th>2-4 properties of rock</th>
<th>Identity found using which dichotomous key?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
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<td>7</td>
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<td></td>
</tr>
</tbody>
</table>
### Dichotomous Key for Sedimentary Rocks

1. Rock contains grains
2. Rock does not contain grains
   - 2. Rock bubbles when acid (HCl) is applied
   - 3. Rock does not bubble when acid (HCl) is applied
3. The grains are larger than sand
4. The grains are not larger than sand
   - 4. The grains are round
   - 5. The grains are not round
5. The grains are sand sized
6. The grains are smaller than sand
   - 6. The rock is black
   - 7. The rock is not black

<table>
<thead>
<tr>
<th>Sedimentary Rocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limestone</td>
</tr>
<tr>
<td>Conglomerate</td>
</tr>
<tr>
<td>Breccia</td>
</tr>
<tr>
<td>Sandstone</td>
</tr>
<tr>
<td>Shale</td>
</tr>
<tr>
<td>Coal</td>
</tr>
<tr>
<td>Chert</td>
</tr>
</tbody>
</table>

### Dichotomous Key for Igneous Rocks

1. Grains in rock are sand sized or smaller
2. Grains in rock are larger than sand
   - 2. Rock looks like black glass
   - 3. Rock does not look like black glass
3. Rock floats on water
4. Rock does not float on water
   - 4. Rock is dark colored
   - 5. Rock is not dark colored
5. Rock contains quartz
6. Rock does not contain quartz
   - 6. Rock contains quartz
   - 7. Rock does not contain quartz
7. Rock is mostly dark colored
8. Rock is mostly light colored

<table>
<thead>
<tr>
<th>Igneous Rocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obsidian</td>
</tr>
<tr>
<td>Pumice</td>
</tr>
<tr>
<td>Basalt</td>
</tr>
<tr>
<td>Rhyolite</td>
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<tr>
<td>Andesite</td>
</tr>
<tr>
<td>Granite</td>
</tr>
<tr>
<td>Gabbro</td>
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<tr>
<td>Diorite</td>
</tr>
</tbody>
</table>

### Dichotomous Key for Metamorphic Rocks

1. Rock is layered
2. Rocks is not layered
   - 2. Rock breaks into layers
   - 3. Rock does not break into layers
3. The grains are very small
4. The grains are not very small
   - 4. Rock bubbles when acid (HCl) is applied
   - 5. Rock does not bubble when acid (HCl) is applied

<table>
<thead>
<tr>
<th>Metamorphic Rocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gneiss</td>
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<tr>
<td>Slate</td>
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<tr>
<td>Schist</td>
</tr>
<tr>
<td>Marble</td>
</tr>
<tr>
<td>Quartzite</td>
</tr>
</tbody>
</table>
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Attachment E
Rock Cycle