

Weathering of Rocks and Minerals

Standard #3240-05	Students will investigate changes in the earth's crust and climate.	<i>Topic:</i> Earth Changes <i>Course:</i> #3240
Objective #3240-0501	Model changes in the earth's surface	
ILO's	1a Makes observations and measurements 2b Formulates research questions 2e Analyze data and draw inferences 2g Construct models and simulations	

Description of Activity

Title: Weathering of Rocks and Minerals

Overview: Skill building introductory labs will help students learn how to measure volume and mass of rocks in preparation for their experiment. Then each student will receive a sample of rock common to their general area. Each student or group of students will design an experiment to show how chemical and/or physical weathering might breakdown their rock in nature.

Duration of Activity: The skill building labs will take 50 min. periods each, research and development of the experiment should take another 50 minute period, and setting up the experiment will take another 50 minute period. Some of the experiments may need to "set" for several days before final measurements are made.

Materials and Resources: Carbonate rocks (limestone, marble) as well as granite, sandstone or shales would be good rocks to provide. They need to be about 8 cc. in size. Carbonated water (carbonic acid), a heat source, tongs, containers and a freezer will be necessary.

Background Information

Weathering is nature's way of breaking down rocks into smaller particles. Weathering is a slow, continuous process that affects all substances exposed to the atmosphere. There are two major types of weathering, mechanical and chemical. Mechanical weathering causes the parent rock to break into smaller fragments without changing the chemical makeup of the rock. Chemical weathering is the process of changing the makeup of the parent rock through chemical reactions.

Most chemical weathering is caused by water. Water can dissolve most minerals that hold rocks together. Some rocks dissolve very easily in water and are called soluble. Oxidation is the process in which oxygen chemically combines with another substance. The result of oxidation is the formation of an entirely different substance. When carbon dioxide dissolves in water, a weak acid called carbonic acid is formed. This acid can dissolve some types of minerals. Another acid that causes chemical weathering in rocks and minerals is sulfuric acid. Sulfuric acid emitted from factories causes acid rain. Acid rain corrodes, or wears away, rocks, metal, and other materials. Plants are also known to produce weak acids that dissolve minerals.

There are several different agents, or causes of mechanical weathering. Temperature, frost action, organic activity, and abrasion are examples. Temperature variations over a period of time allow the rock to expand and contract repeatedly causing curved-shaped pieces to break off. Frost action occurs as water seeps into tiny

cracks in the rock and freezes at night. As the ice expands it breaks rock fragments free. Organic activity occurs as plant roots slowly pry apart the rock as the plant grows larger. Abrasion caused by blowing winds weathers rocks by rounding sharp and protruding edges to smooth surfaces.

Teaching and Learning Strategies

A discussion of the breakdown of rock would be a good way to begin this experiment. The formation of the earth from its molten rock beginnings to its current form indicates that changes have taken place. In order to measure changes, instruments have to be used. Allow students to complete the "Volume Lab" and the "Mass Lab" to ensure they know how to properly use the measuring devices indicated.

The two skill building labs will help the students know how scientific measurements are made. The "Volume Lab" will give them some knowledge about the eventual products of weathering (soil). As the students begin to discuss their own experiment, it is important to stress that they must model natural processes in their procedures. This will avoid the quick and easy "hit it with a hammer" approach. You may want to discuss a definition of chemical and mechanical weathering at this time but do not give them more information. To ensure inquiry they should have to think about what forces exist in nature.

Development of Laboratory Skills and Tools

The two skill building activities are included. Each has specific safety procedures and write-up forms. It is assumed that basic lab safety guidelines have been outlined previously and students know where emergency equipment is. If students are using a piece of equipment for the first time, its' use and safety issues should be discussed. In this experiment heat and acids may be used. Have appropriate tongs and goggles available. Student forms and a teacher page are included on the following pages.

Invitation to Learn

Provide each student or group of students with their rock sample. Give them time to handle it. Have them imagine this rock in an outdoor setting. Ask the question: What forces are breaking down this rock and how could you prove it?

Hand out the Student Designed Experiment form and give students time to work on it. Show them what materials you have available and indicate that they are free to use other materials with your approval. When they have a plan, go over it with them and initial it.

As students set-up their experiments, determine a time line for finishing it.

Summary of Learning

Multiple Choice

1. Which of the following is NOT considered an agent of physical weathering?

- a. abrasion
- b. carbonation
- c. frost action
- d. organic activity

answer: b

2. What causes most chemical weathering?

- a. abrasion
- b. roots of plants
- c. sulfuric acid
- d. water

answer: d

Essay:

1. What natural forces produce weathering in our state?
2. What is the difference between mechanical and chemical weathering?

Verification and Communication of Results:

1. Have students rank the types of weathering used in their class by how effective it was. (what percent of the rock weathered)
2. Have students write a life story for their rock and read it to the class or publish in a journal.

Student Designed Experiment

TITLE: Weathering of Rocks and Minerals

PURPOSE: What forces are breaking down this rock and how can I prove it?

PREDICTION: (What is a possible answer?)

MATERIALS: (What will I use to find out and what safety equipment do I need?)

PROCEDURES: (What steps will I take to find out?)

instructor approval _____

DATA: (What happened?)

ANALYZE RESULTS: (What does my data mean? Will a graph help? Is there more than one way to view the data? Could I have done something differently?)

CONCLUSIONS: (What did I learn?)

Student Designed Experiment Scoring Rubric

RESPONSE	CRITERIA	RATING
Exemplary	Completes all steps. Experiment has a control, logical and clear procedures, data is recorded and thoroughly analyzed. Graphs are present. Prediction made. Conclusions thorough and thoughtful.	6
Competent	Completes all steps. Experiment may lack control, procedures lack thoroughness. Data is recorded, analysis not complete. Conclusions too brief.	5
Satisfactory	Completes nearly all steps. Control missing, procedures lacking or illogical. More than one variable present. Data recorded but poorly analyzed. Conclusion does not accurately sum up experiment.	4
Nearly Satisfactory	Completes most steps. Procedures missing. Data recorded but not analyzed. Conclusion missing.	3
Fails to Complete	Most steps missing. Data recorded but procedures do not indicate it's origin. Conclusion missing.	2
Fails to Begin Effectively	Directions not followed. Nearly all steps missing. Doesn't show understanding of how to develop experiment.	1
No Attempt Made	Does not begin experiment.	0

Teacher Page

Skill building lab for "Weathering of Rocks and Minerals"

Description: Students will learn three ways to find the volume of an object. They will calculate the percentage of air in sand using their volume measurements. They will see the relationship between the smaller the graduations on a measuring device and its increase its accuracy.

Materials: Rock, marble, overflow jar, 100 ml graduated cylinders(2), baby food jar, beaker, sand, rectangular block of wood (about 3 by 4 by 5 cm, it's nice if they are about the same volume as the baby food jar), ruler, sand, bucket for wet sand

Student Background Information: Volume is the amount of space something takes up. It can be measured three ways. If an object is rectangular, the length, width and height can be measured with a metric ruler. The three numbers multiplied together are the volume in cubic centimeters. For irregularly shaped solids, water displacement can be used. The volume of a certain amount of water in a graduated cylinder or other measuring device is first measured. The object is dropped in. The change in water level is it's volume. If an overflow jar is available, the jar is filled, a graduated cylinder placed under the spout, the object dropped in and the overflow is measured. Volume of liquids can be measured by pouring the liquid into a graduated cylinder or beaker.

Teacher Background Information: (Do not share with students until after the lab) The smaller the graduations on the measuring device the more accurate your measurement will be. A milliliter is the same amount of volume as a cubic centimeter.

The volume of air in sand can be calculated by adding 40 ml of water to 40 ml of dry sand. The water will fill the air spaces in the sand and the top surface will be at about 65 ml. Since it would have been 80 ml without the air, the air must take up 15 ml of the sand. By dividing 15 ml of air by the 40 ml of dry sand, the percentage of air in sand is found. It is usually about 30%.

Safety suggestions: If the students can find a way to hurt themselves on this one, they were going to do it anyway. To ensure safety of your graduated cylinders, make sure the rocks are too big to fit in them. Plastic graduates are always a good idea in the junior high classroom.

Title: Volume Lab

Purpose: To practice finding the volume of different types of items and to see how much air is in sand.

Materials: rock, marble, wood block, baby food jar, 2 graduates, ruler, sand, overflow jar, 250 ml beaker.

Procedure:

1. Use length x width x height measurements to find the volume of the wood block.
2. Use the graduated cylinder and water displacement for the marble. Try the same measurement of the marble using the beaker instead of the graduate. It doesn't matter how much water you start with, just leave room for it to rise.
3. Use the overflow cup, the graduate and water displacement for the rock.
4. Use direct measurement to see the volume of the baby food jar. Use graduate.
5. For sand: Place 40 ml of dry sand in the 100 ml graduate. Add 40 ml of water and let it soak in. Record the final volume.

Prediction: (How much air do you think is in sand)

Data:

1. wood block:

length _____
width _____
height _____
volume _____

2. marble(using graduate)

beginning volume of water _____
final volume _____
volume= _____

marble (using beaker)

beginning volume of water _____
final volume _____
volume= _____

3. rock (using overflow jar)

volume in grad _____

4. baby food jar= _____

5. sand + water= _____

Analysis:

1. Which had more volume-the marble or the rock?
2. Which had more volume-the wood block or the baby food jar?
3. How much air did the sand have? (subtract your final volume from 80ml)
4. What percentage of sand is air? Divide air space(from #3) by amount of sand (40 ml) and multiply by 100%.
5. When would the overflow jar be more practical for water displacement?
6. What is the relationship between ml and cubic centimeters?

7. How would you find the volume of the following:

- a. a glass of milk
- b. a book
- c. a pencil

Conclusion:

Teacher Page

Skill building activity for "Weathering of Rocks and Minerals"

Title: Rock Mass

Description: This lab will help students understand how a balance works. It will provide practice and introduce them to the idea of precision in measurements.

Materials: large rock (200-300 g), small rock (10-20 g), balance

Student Background: Students will need to be instructed as to how the balance works and how to properly handle one. They should be acquainted with the concept of "zeroing" the balance and should have guided practice on it as well as finding the mass of an object before they start the lab.

Teacher Background: Precision can be defined as the ability to measure something repeatedly and get an answer within a certain range. Students will have difficulty understanding how it is different from accuracy. To get accurate measurements would require a standard measure that most classrooms do not have. Therefore, students may not know the accurate answer but they may learn to be precise in their measurements. For most measurements this is adequate. Depending on the type and degree of maintenance your balances have students may be expected to be precise within a certain range (hopefully less than a gram for small objects) The size of the object affects precision. Larger objects will have a lower precision and greater range of possible masses.

Students should find that alternating the rocks and moving the riders on the balance will result in a greater discrepancy between masses. To be precise they should discover that it helps if the riders are not moved between massing and the object is placed in the same place on the pan of the balance each time. Your balances may have their own peculiarities. These points can be brought out in the post lab discussion.

Safety Suggestions: Few hazards exist as long as students do not throw the rocks.

Title: Rock Mass

Purpose: To see if our balances will always mass the same object the same way.

Materials: large rock, small rock, balance

Procedure:

1. Zero your balance.
2. Mass the small rock, then the large rock.
3. Redo #2 four more times. Be sure to alternate small rock then large.
4. Mass the small rock 5 times in a row.
5. Mass the large rock 5 times in a row.

Prediction: (will the balance mass each object the same each time?)

Data:

object	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
small rock					
large rock					
small rock					
large rock					

Analysis:

1. Did you get the same mass each time when you alternated the rocks?
2. What was the biggest difference you found between the mass on the small rock when you alternated it? (subtract highest reading from lowest)
3. What did you notice about the mass of the small rock when you didn't alternate it?
4. What was the biggest difference for the large rock when you alternated it?
5. What did you notice about the mass of the large rock when you didn't alternate it?
6. Is the balance more precise for large or small objects?
7. When is your balance going to be the most precise?
8. What does precision mean?

Conclusion: