Grade 7
Earth Science

Oak Meadow
Coursebook

Oak Meadow, Inc.
Post Office Box 1346
Brattleboro, Vermont 05302-1346
oakmeadow.com

Item #b075110
ISBN 978 16 84270 87 3
v.0917

Grade 7

Table of Contents

Introduction ix

Course Materials ix

How the Course Is Set Up ix

How to Get the Most Out of This Course x

For Students Enrolled in Oak Meadow School xi

Unit 1: Scientific Habits

Lesson 1 Observation and Measurement 3

Observation and Change

Objective Observations and Inferences

Scientific Argument

Systems of Measurement

Mass, Volume, and Density

States of Matter

Lesson 2 Scientific Method 15

Lab Investigation: Celery Experiment 17

Scientific Method

Variables and Controlled Experiments

Causation and Correlation

Lesson 3/4 Scientific Inquiry: Observation and Measurement 25

Unit II: Space

Lesson 5 Perspective 29

- Activity: Explore NASA
- Spaceship Earth
- Earth's Spheres
- Earth's Hemispheres
- Map Projections

Lesson 6 Earth's Movement 39

- Activity: Sundial
- Earth's Rotations and Revolutions
- Seasonal Cycles

Lesson 7 Earth's Moon 47

- Activity A: Moon Story
- Activity B: Moonscape
- Earth's Moon
- Moon's Rotations and Revolutions
- Solar and Lunar Eclipses
- How the Moon Influences Tides

Lesson 8 Our Solar System 59

- Activity A: Life on Another Planet
- Activity B: Planet Game
- Activity C: Star Gazing
- Earth's Sun
- Planets of Our Solar System

Lesson 9 Astronomy 69

- Activity A: Visit a Planetarium or Science Museum
- Activity B: Star Party
- Astronomy
- Classifying Stars
- The Life of a Star
- Constellations

Lesson 10/11 Scientific Inquiry: Guiding Questions 79

Unit III: Earth

Lesson 12 Earth's Structure 83

- Activity: Rock Recognition
- Earth's Layers
- Rocks, Minerals, and Elements
- Classifying Rocks
- The Rock Cycle

Lesson 13 Weathering and Fossilization 91

- Activity A: Weathering Poem
- Activity B: Mud Detective
- Activity C: Fossil Impressions
- Activity D: Natural History Museum
- Weathering
- Fossilization
- Rocks as Clues to the Past
- How Old Is It?
- Geologic Time Periods

Lesson 14 Erosion 101

- Soil Composition
- Layers of Soil
- Types of Erosion

Lesson 15 Plate Tectonics 111

- Activity A: Quaking Crossword
- Activity B: Earthquakes in the News
- Activity C: Creative Writing
- Earthquakes... 114
- Tectonic Plates... 115
- Seismology.. 119

Lesson 16 Mountains and Volcanoes 121

Activity: Appalachian Trail

Mountains

Volcanoes

What Causes a Volcanic Eruption?

Mountains and Volcanoes Under the Sea

Lesson 17/18 Scientific Inquiry: Modeling Design and Procedure......131

Unit IV: Meteorology

Lesson 19 Atmosphere 135

Activity: Atmosphere Poem

Structure of the Atmosphere

Composition of Air

Earth's Cycles of Oxygen, Carbon, and Nitrogen

Lesson 20 Climate 143

Activity A: Tree Rings

Activity B: Weather Stories

Climate Science

Natural Factors Influencing Climate

Earth's Climate History: Snowball Earth and Hothouse Earth

Global Climate Change

Lesson 21 Water Cycle...151

The Water Cycle

Lesson 22 Clouds...155

Activity: Raindrops

Cloud Formations

Clouds and Precipitation

Humidity and Dew Point

Lesson 23 Wind and Atmospheric Pressure 165
- Atmospheric Pressure
- Wind Patterns

Lesson 24 Meteorology 171
- Meteorology and Weather Forecasting
- Cold and Warm Fronts
- Jet Stream

Lesson 25 Extreme Weather 179
- Thunderstorms and Tornadoes
- Hurricanes, Typhoons, and Cyclones
- Other Extreme Weather Events

Lesson 26/27 Scientific Inquiry: Controlled Experiment 183

Unit V: Environmental Science

Lesson 28 Earth's Resources 187
- Activity: Conservation Challenge
- Earth's Cycles
- Natural Resources
- Energy Sources
- Energy Use and Conservation

Lesson 29 Water Sources 195
- Water: Earth's Most Precious Resource
- Groundwater

Lesson 30 Earth's Oceans 199
- Activity: Aquarium Scavenger Hunt
- Oceans and Marine Life
- Ocean Currents

Lesson 31 Human Population Growth 207

- Activity: Story of Population Growth
- Human Population Growth
- Population as an Environmental Issue 211

Lesson 32 Human Impact on the Environment 213

- Water and Soil Pollution
- Air Pollution
- Ozone Depletion
- Reducing Our Carbon Footprint

Lesson 33 The Living Earth 221

- Activity: Ecosystem Model
- Biodiversity
- Habitat loss
- Earth as a Living Organism

Lesson 34/35 Scientific Inquiry: Scientific Argumentation 229

Lesson 36 Final Essay and Reflection 231

Appendix

- Finding Reputable Sources 234
- Citing Your Sources 234
- Plagiarism 236
- Materials List 237

Grade 7

1 Observation and Measurement

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Record detailed observations in an outdoor setting.
- ☐ List helpful observation tools and explain their purpose.
- ☐ Demonstrate how volume can change without altering mass.
- ☐ Explain the relationship between volume, mass, and density.
- ☐ Lab Investigation:

  Option 1: Water Clock

  Option 2: Comparing Volume and Mass
- ☐ Optional activities:

  Activity A: Human Clock

  Activity B: Calculating Density
- ☐ Complete lesson 1 test.

MATERIALS

☐ Option 1 Lab Investigation: Water Clock

an empty plastic milk container (or any other clear container that you can puncture)

large pan or bucket

metric ruler

marker

clock or watch

sewing needle or push pin

☐ Option 2 Lab Investigation: Comparing Volume and Mass

modeling clay

metric ruler

towel

☐ Activity B: Calculating Density

book

scale

metric ruler

Learning Objectives

At the end of this lesson you will be able to:

- Demonstrate good scientific observation skills.
- Record scientific measurements accurately.
- Demonstrate and explain the relationship between mass, volume, weight, and density.

Reading

Read the following sections (found in Reading Selections at the end of this lesson).

- Observation and Change
- Objective Observations and Inferences
- Scientific Argument
- Systems of Measurement
- Mass, Volume, and Density
- States of Matter

Before you begin reading, glance over the length of the reading selections in this week's lesson. You will find quite a bit of reading! You might already be familiar with some of the information, and some of it will probably be new to you. It's a good idea to read one or two sections and then take a break before reading more. That way, you are more likely to remember what you read, rather than just trying to cram it all in at once.

In addition to the reading selections in this coursebook, you are encouraged to learn more about topics you are interested in by visiting the library, reading newspapers and scientific journals, and doing research online. You'll find a list of online resources at oakmeadow.com. Click on the Resources tab, and then click on Curriculum Resource Links. You can use these links to learn more about lesson topics.

Assignments

Before you begin your assignments, read them through to get a sense of what you'll be doing and how long it will take. This will help you manage your time better. Just like with the reading, you may want to do a few assignments at a time and then take a break instead of pushing to get them all done at once. You have a full week to complete these assignments, so there's no rush.

1. For your first assignment, you'll be conducting an outdoor observation in a natural setting. This might be your yard, a nearby park, woods, a tree in the middle of the sideway, a pond, or a stream. Bring a notebook and pencil, and sit quietly for a few minutes while you observe the natural surroundings. Use as many senses as you can. Look carefully for all the details you can notice, and then close your eyes for a bit to tune into other senses.

   Write down a general description of the area in which you are observing, and then write a detailed description of one part of the area or an object within the area you are observing. Be as specific as you can, and use clear, objective language.

2. List any tools or instruments that would be useful in making a more detailed analysis of your observation and briefly explain why they would be useful. What would you do with them?

3. Take two pieces of paper of identical size and weight and crumple them into two loose balls of similar size. Demonstrate how you can change the volume of one without changing its mass. Then, tear a piece off one of the papers, and crumple it back into a ball so that it matches the size of the second ball. Have you changed its mass or volume?

   If possible, conduct your demonstration in front of someone else, and explain what is happening in scientific terms. Alternately, you can video your demonstration and explanation, or you can put your explanation in writing or in audio form. Make sure to define mass and volume as you are describing what happened.

4. Explain why it is always true that if two objects have the same volume but one object has a greater mass than the other, the object with the greater mass will also have a greater density. Give an example that is different than the examples in the reading section. You can do a video or audio recording or write down your explanation and example.

Lab Investigation

Choose one of the following lab investigations to complete.

- Option 1 **Lab Investigation: Water Clock**
- Option 2 **Lab Investigation: Comparing Volume and Mass**

All lab investigations are found in lab manual, *Lab Investigations: Earth Science*. Read each through completely before making your choice. Assemble all your materials before you begin. Use good scientific habits by taking careful observations and measurements, recording your data in an organized way, and using precise, detailed language.

Activities

The following activities are optional, and are offered to give you more ways to explore the lesson material. These activities are not required. Feel free to choose whatever looks interesting to you.

- Option A: Human Clock
- Option B: Calculating Density

Activity A: Human Clock

Find three people of different ages, preferably at least ten years apart and of the same gender. You might choose yourself, a parent, and a grandparent, or you might choose friends, siblings, and neighbors. Ask these people if you could study their hands, faces, and hair. Look carefully at their hands (both the palm and the back of the hand), and notice the size, lines, knuckles, skin texture, etc. Pay attention to the changes that seem to occur in a person's hands over time. Look carefully at each person's face and hair, noticing the skin texture, hair color, lines, etc. Ask these people to share changes they have been aware of in their own hands, face, and hair over time. Record any findings or patterns. Write or draw a descriptive piece of work that shows how you think your own hands, hair, or face will change over time.

Activity B: Calculating Density

Materials

- book
- scale
- metric ruler

Procedure

1. Measure, in centimeters, the length, width and height of the book.
2. Using the formula of volume = length × width × height, calculate the volume of the book in cubic centimeters.
3. Measure the book's mass by weighing it on the scale, and then convert the weight into grams (one pound = 454 grams).
4. Calculate the book's density using the formula density = mass ÷ volume. Your answer should be in grams per cubic centimeter.

Test

Answer the following questions using the knowledge you have gained in this lesson. Use correct terminology and refer to scientific concepts to support your answer whenever possible.

1. Explain the difference between quantitative and qualitative observations and give an example of each.
2. Explain the relationship between mass, volume, and density. You don't have to give the formulas; just explain things in your own words.
3. What are the three most common states on matter on Earth? Give an example of each, and explain how they are different.
4. Describe the three steps of a scientific argument.
5. What is the difference between an observation and an inference?

Learning Checklist

This learning checklist can be filled out by either you or the adult who is supervising your work. This checklist will help you keep track of how your skills are progressing and what you need to work on. You or your home teacher can also add notes about where you'd like help.

Here is what the different headings mean:

Developing: You still need to work on this skill.

Consistent: You use this skill correctly most of the time.

Competent: You show mastery of this skill.

Please remember that these skills continue to develop over time so you aren't expected to be able to do all of them yet. The main goal is to be aware of which skills you need to focus on.

SKILLS	Developing	Consistent	Competent	Notes
Describe observations in detail				
Record accurate measurements				
Summarize procedure and what it demonstrated				
Demonstrate and explain the relationship between mass, volume, and density				
Use scientific terminology in explanations				

For Enrolled Students

You will be sending your work from this lesson to your Oak Meadow teacher at the end of lesson 2. In the meantime, feel free to contact your teacher if you have any questions about the assignments or the submission process.

Reading Selections

Observation and Change

Science describes what we know about our world. We learn about the world by observing what is happening all around us. We observe through our senses: we watch, we listen, and we feel. Then we reach conclusions about what it all means: we make sense out of the world.

Observing and exploring Earth is about being receptive to what lies all around us. It is observing closely with our eyes, ears, nose, hands, and full body sense as fully as we can. However, most of us depend almost entirely upon our eyes. But there is so much going on that our eyes cannot perceive. What goes on beneath the surface of Earth? What forces are carving and molding the face of Earth? There is the world of little things that we can just barely see. There is the world of things so big, our eyes cannot see the whole.

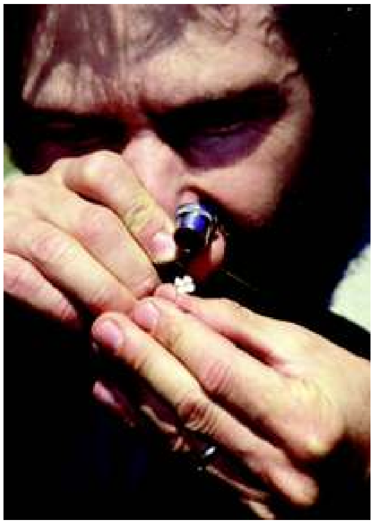
What is it that happens when we observe? What is it that we are noticing? How is it that our senses perceive what is happening?

What our senses notice are *changes*. Living things grow, die, move, change size, shape, and place. When we notice anything, it is usually because there has been some change. Sometimes we notice that there has been no change when one was expected. Changes or lack of change often form the bulk of scientific observation.

With practice, the right tools and the guidance of teachers and scientists, we can make our senses work more clearly in providing information to our brains. This way we can sense changes and know what to do in a particular situation. The more complete the information, the more sound our conclusions.

Objective Observations and Inferences

By closely observing something, we gather information about it. This information becomes *evidence* or *data*, which we need to record as accurately as possible. When gathering data, it's important to remain *objective*. This means reporting only what you observe, rather than what you think to be true or guess might be happening. Scientists use very careful, detailed language to describe their observations. This helps them make sure their data is accurate.



Forest Service botanist Mark Jaunzems takes a close look at one of the plants in the Sand Dunes area of the Hiawatha National Forest, MI.

Observations often have an element of measurement in them; these are *quantitative* observations. Measurements of quantity, weight, volume, or speed are all measurable observations. Quantitative data always involve numbers and require accuracy. *Qualitative* observations describe the attributes of something, such as its texture, color, smell, or sound. These observations require very detailed, precise, descriptive language.

Once data is collected through qualitative and/or quantitative observations, scientists often study it to find patterns or differences. They make *inferences* based on their interpretation of the data. Inferences are explanations or conclusions that are based on reason and evidence rather than opinion or feeling. Even though inferences are based on factual evidence, they are not fact but rather an educated conclusion about why something might have happened or what might happen in the future.

Roylene Rides at the Door-Waln, NRCS, Resource Conservationist taking an inventory of pasture grasses

Scientists are careful not to claim these inferences are fact because they may or may not be correct. For instance, a scientist might say, "In the feral cat population studied, female cats had an average of 3.5 litters per year, resulting in an average of 22 kittens per year per cat being introduced into the feral cat population. This suggests that a spay and release program targeting the female feral cats will significantly reduce the overall feral cat population." The first statement is factual information that is objectively observable, and the second statement is an inference, a logically-drawn conclusion about what the data indicates might happen. It is correct to say that the data "suggests" that the population would be reduced but it would be incorrect to

USDA Photo Library: Observation is part of research projects.

claim that the population *would* be reduced; there's no way of knowing for sure what will happen until they try it.

Scientific Argument

In developing your scientific skills, pay particular attention to honing your objective observations, using accurate details and careful measurements. At the same time, work on drawing conclusions based on your interpretation of the data, and using your data to support your claims. This is called a *scientific argument*; you should be able to "argue" or prove every inference or conclusion you state using the data you collected. Here are the steps to making a scientific argument:

1. Make a claim based on your research.
2. Provide evidence (data) to support your claim.
3. State your reasoning for how the data supports the claim.

The first step, the claim, is your inference or conclusion, based on reason and data. Make sure your inferences are specifically identified with phrases such as "this suggests," "it appears," and "it seems likely." Never state an inference or claim as a fact—scientists are very careful about that! If you did the feral cat study above, your claim might be "A spay and release program targeting the female cat population can significantly reduce the feral cat population in one year." Notice this claim says it "can," not that it "will" ("can" means it might or it might not).

In the second step, you compile your data into a form that is easy to grasp and make sense of. For instance, rather than sharing a collection of numbers from your research, you might find an average of the number of feral kittens born in one year, or show the percentage of the feral cat population that is female. Charts, graphs, and data tables are excellent ways to provide evidence to support your claim.

USDA Photo Library: Soil scientist Eton Codling observes the changes in corn growth on manured soil treated with alum residue.

The third step requires you to communicate clearly the logical reasoning process behind your claim. You'll explain what the data "tells" you, and why this makes you think that your claim is accurate.

Just like everyone, scientists have opinions and biases. Each person has a unique point of view, based on their life experiences. However, even when making observations, interpreting data, making claims, and providing scientific argumentation, scientists try very hard to keep their opinions and feelings separate from their scientific study. This is another important quality of a scientist.

Systems of Measurement

To communicate what we learn about the world we must have a common language. Measuring is a way of comparing different aspects of the world using a common language. We make comparisons to measure changes and differences in the world.

Imagine that you are holding a rock in your hand. If you were asked to describe it, how would you do it? You might describe its color, shape, size, or weight. It might be hard or crumbling, rough or smooth. Scientists make these same types of observations, then describe what they have observed. They do this through measurements. Units of measure make it possible to compare things according to certain qualities they possess.

When we think of measuring, we often think of size or weight or quantity. Time is another important measurement for science. Many experiments are designed to record observations over a period of time. Clocks and watches are common tools used to measure time. Old ways of measuring time utilized different tools: the sun's shadow falling on the face of a sundial, or the sand

There are thousands of measuring tools that have been invented. This rainfall simulator and test plot at Cottonwood SD enabled technicians to measure water runoff rates and collect soil samples in a WEPP cropland field study.

falling through a tiny opening in an hourglass. The hours, minutes and seconds are the common units of measure of time.

Scientists all over the world use the metric system as the common “language” of measurement. A meter is the basic unit of length in the metric system. It was originally defined as one ten-millionth of the distance on Earth’s surface from the North Pole to the equator. To understand just how much distance there is in a meter, look at a doorway in your house—most doorways are about one meter wide and about two meters high. To measure short lengths, scientists use the centimeter (1/100 of a meter) or the millimeter (1/1000 of a meter). To measure longer lengths, scientists use the kilometer, which is equal to 1000 meters. If you are unfamiliar with the metric system, take some time to learn about it or review what you know.

Measurements of all types rely on accurate numbers as well as a unit label. If we say something travels at a rate of 15, what does that mean? 15 kilometers per hour? 15 meters per second? We would need to include the unit label in order for the measurement to make sense.

Mass, Volume, and Density

Mass, volume, and *density* are three measurements that scientists frequently make. The *mass* of an object is the amount of “stuff” it contains. It is often measured in grams or kilograms. Many people think of mass and weight as the same because you can easily convert your weight in pounds to metric units and you will have mass. But they really are different. Weight can be defined as the measure of the pull of gravity on a particular object. The mass of a car does not change if you crush the car. It will take up a smaller amount of space (volume) but it will still have the same mass and weight. It you took that same car up into space, away from Earth’s gravity, it would have a different weight, but still have the same mass. Mass is the same at any altitude, on the moon, in the water, anywhere!

Volume is a scientific measurement of size, the amount of space that an object takes up. It is measured in cubic units, such as cubic centimeters. Here is the formula for calculating volume:

$$\text{Volume} = \text{length} \times \text{width} \times \text{height}$$

If two objects have the same size and shape, they will have the same volume. They may have a different mass or weight, but they will have the same volume. That means they both take up the same amount of space. Imagine you had a balloon the exact shape and size of a soccer ball. The balloon would be a lot lighter and its mass would be less than the ball, but its volume would be the same.

Density is the relationship of mass to volume. Objects that have more substance per volume have a greater density than objects with less substance per volume. Density is a measure of how tightly the molecules of whatever it is (gas, liquid or solid) are packed into a space. The matter in a tennis ball

Liquids take the shape of their containers. In a chemistry lab, liquid measurement tools are calibrated in the metric system.

is more compact than the matter in a balloon of the same size, so we say the tennis ball has more density. Or think about a rock that is the exact size and shape of a ping pong ball. The two objects have the same volume, but their mass per volume is very different. The rock is denser than the hollow ping pong ball, so it has more mass and weight. If you crush the ping pong ball, its volume is reduced—it takes up less space, even though it still weighs the same and has the same mass because we didn't take away any of its substance; we just changed its shape. However, because we changed its volume, we also changed its density. The ping pong ball is now much more dense than it was before because it is the same amount of substance packed into a smaller space.

Density is calculated by dividing an object's mass by its volume:

$$\text{Density} = \text{mass} \div \text{volume}$$

Many people confuse mass with volume. They think that if an object has a large volume (size) it must have a large mass (weight). If you have a pillow and a rock of the same size (volume), it is easy to tell which has the greater mass. If two objects have the same volume but one has a greater mass, it will have a greater density. You can probably guess which has the greater density: rock or pillow? What happens if you kick the pillow? What happens if you kick the rock? The pillow will not put up much resistance, but you are liable to break your toe on the rock. Not only does the rock have more mass, but it also has a greater density.

Don't worry if you find these concepts challenging at first! We will be working with them throughout the course and you will have plenty of time to develop a solid understanding of these important scientific measurements.

States of Matter

Matter is anything that has mass and volume. Matter is anything that takes up space, no matter how small. It includes everything of substance in the universe. Matter exists in several different forms. The types we find most commonly on Earth are solid, liquid, and gas, so it's essential to have a clear idea of the difference between them.

A *solid* has a definite shape, size, and volume. A rock, a piece of ice, and a block of wood are all considered solids.

A *liquid* has a definite volume, but will always assume the shape of its container. Water or oil will change shape as you pour it from one container to another. A round bowl will give the water inside it the same round shape. But put the same amount of water in a tube or hose, and its shape will change to be the same as its enclosure. The volume has not changed but the shape has.

A *gas* has no definite volume or shape. A gas will take the same shape as its container, but it will spread out to fill the entire volume of any shape container, so its volume can change, depending on the conditions.

Grade 7

12 Earth’s Structure

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Draw and describe the layers of Earth.
- ☐ Identify minerals used in everyday life.
- ☐ Observe and describe rocks, and try to classify them.
- ☐ Complete sky journal observations and conclusions.
- ☐ Lab Investigation: Sedimentation
- ☐ Lab Investigation: Rock Cycle
- ☐ Activity: Rock Recognition
- ☐ Complete lesson 12 test.

MATERIALS

☐ Lab Investigation: Sedimentation

sand, dirt, and tiny pebbles (about a handful, total)

glass jar

water

spoon

Learning Objectives

At the end of this lesson, you will be able to:

- Describe the layers of Earth’s structure.
- Explain how rocks, minerals, and elements are related.
- Name the three basic types of rocks and explain how each was formed.
- Demonstrate the rock cycle.

Lab Investigation: Rock Cycle

- beeswax, crayons, or colored chewy candy in several colors (such as jelly beans or Starburst)
- knife
- small plastic bag
- heavy book
- tin foil
- cast iron skillet or heavy oven-proof pan

Reading

Read the following sections (found in Reading Selections at the end of this lesson).

- Earth's Layers
- Rocks, Minerals, and Elements
- Classifying Rocks
- The Rock Cycle

Make sure to check out additional resources related to these topics on the curriculum resource links page at oakmeadow.com.

Assignments

In all assignments in this course, use accurate scientific terminology (such as the highlighted words found in the reading section).

1. Draw a picture and describe in your own words the layers that make up the structure of Earth. Or you can create a model of Earth and all of its layers using modeling clay. Make sure each layer is visible, and label the layers with flagged toothpicks. Add a short description of each layer.
2. List three minerals that are used around your house (make sure to say what items they are found in).
3. Find three different rocks that come from three different locations. Observe each rock carefully, and then describe each one in words, including what type of rock you think it is (igneous, sedimentary or metamorphic), and why you think falls into that classification of rock.

4. Make your final entries in your sky journal this week—you should have four weeks of data, and have observed one full moon cycle. Return to lesson 9 and answer the questions found in the conclusion section to complete the lab investigation.

Lab Investigation

Complete both lab investigations below:

- **Lab Investigation: Sedimentation**
- **Lab Investigation: Rock Cycle**

Use specific language and scientific terminology when writing your conclusions.

Activities

Here is an optional activity to extend your exploration of rocks.

Activity: Rock Recognition

1. Collect twelve different rocks and put them into a bag.
2. Close your eyes, reach in the bag, and choose a rock.
3. With your eyes closed, explore its shape, texture, and hardness through touch and smell. After you feel you are familiar with your rock, put it back in the bag without looking at it.
4. Next, open your eyes, empty your bag of rocks onto the ground, and locate your rock.
5. Continue this exercise until you feel comfortable with observing and identifying rocks through senses other than your vision.

Test

1. Explain the differences between Earth's crust, mantle, outer core, and inner core.
2. How are rocks, minerals, and elements related to one another?
3. Name the three types of rocks and tell how each was formed.
4. Describe the rock cycle.

Learning Checklist

Use this learning checklist to keep track of how your skills are progressing. Include notes about what you need to work on.

SKILLS	Developing	Consistent	Competent	Notes
Classify rocks according to observations				
Differentiate between the three types of rock				
Explain the rock cycle				
Identify patterns in data from long-term observations (sky journal)				
Record accurate measurements in lab investigation				
Use scientific terminology to explain observed phenomena				
Explain concepts demonstrated by lab investigation				

For Enrolled Students

At this halfway point in the first semester, this is a good time to check in with your teacher if you have any concerns about your pace in moving through the lessons.

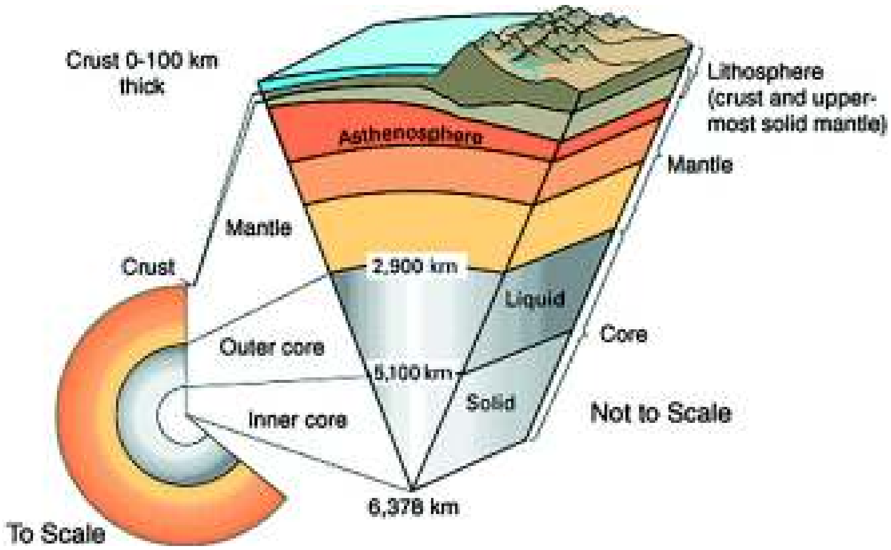
You may share lesson 12 with your teacher now, or wait and include it with your submission of lessons 13 and 14.

Reading Selections

Earth's Layers

If we could cut Earth in half, we would be able to see what it is like on the inside. Our planet is made up of layers of different materials and densities. Earth surface, where we live, is part of an outer shell called the *crust*. There are two types of crust. The *continental crust* is where there are land masses. Underneath the thin layer of soil, the continental crust is mostly granite but includes many types of rock. Underneath the oceans is the *oceanic crust*, which is mostly made basalt, a type of dense volcanic rock, making the oceanic crust denser than the continental crust.

Think of the volume of the entire planet. The crust is an extremely thin layer wrapping around this huge mass. In some locations, the crust is as thin as six kilometers, and in other places it is as



thick as sixty kilometers. Even at the thickest point, however, it is very thin in comparison with the entire diameter of Earth. If you used a globe for comparison, the crust is thinner than the outer layer of paint.

Below the crust is the *mantle*, a dense, hot layer of semi-solid rock approximately 2,900 km thick. It is the largest of the layers, measuring about 85% of Earth's volume. The mantle is hotter and denser than the crust because temperature and pressure inside Earth increase with depth. When the temperature gets hot enough, the rock begins to melt and flow beneath Earth's crust. The mantle contains molten (melted) minerals and elements. The upper mantle is more solid than the lower mantle. Together, the upper mantle and the crust form Earth's lithosphere. The lower mantle may move more slowly even though it has a higher temperature; scientists think this may be due to the increased pressure at those great depths.

At the center of Earth lies the *core*, which is nearly twice as dense as the mantle because its composition is metallic; it is mostly composed of iron and nickel, which are called *heavy metals* because they are so dense. Earth's core has two layers: a 2,200 km-thick liquid *outer core* and a 1,250 km-thick solid *inner core*. As Earth rotates, the liquid outer core spins, creating Earth's magnetic field.

Rocks, Minerals, and Elements

The crust of Earth is made up of rocks, and rocks are primarily made up of *minerals*, and minerals are made up of *elements*. Elements are *atoms*, which are the smallest building blocks of matter. Minerals are made of one or more elements, and rocks are made up of one or more minerals.

Almost all elements can be found in Earth's crust. Most of the crust is comprised of eight elements: oxygen, silicon, aluminum, iron, calcium, sodium, potassium, and magnesium. These elements occur in most of the rocks we find on the surface of Earth.

Minerals are identified by their characteristics or *properties*, such as color, mass, and density. All minerals are naturally occurring, solid, and have an ordered internal structure (that means their atoms are arranged in an orderly, repeating pattern). However, minerals vary greatly in appearance and properties. For instance, diamond crystals have a different shape than salt crystals or quartz crystals. Some minerals are magnetic (magnetite), some are metals (gold), and some have fantastic coloring or create rainbow colors in the sunlight (opals, diamonds, and other gemstones). These different properties help us tell one mineral from another.

A *geologist* is a scientist who studies the elements, minerals, and formations of Earth. Geologists collect samples and determine what elements they are made of. This information can explain the history of an area and what types of changes have occurred in the area over many thousands of years. Geologists study mountains and valleys and determine how they were formed.

Minerals are found in many ordinary household items. For instance, clay is used to make flower pots, dishes, and vases. Iron is molded into cast iron pans, and two metals, iron and chromium, are combined to make forks, knives, and spoons. Toothpaste often includes fluoride, which is made from the mineral fluorite. Gold and mica are two minerals used in making electronics and computers. Quartz is the main ingredient in things made of glass, such as windows and drinking cups. And salt is a mineral that we consume every day!

Mining is the extraction of useful minerals from Earth's crust. Some minerals, like copper, iron, or aluminum, are used for building dams, bridges, roads, and buildings, and for making tools. Some minerals, like coal, oil, or uranium, are used for generating energy. It is important to realize that all of these minerals are available in limited quantities on Earth. Earth is only so big and so is the availability of all minerals.

Classifying Rocks

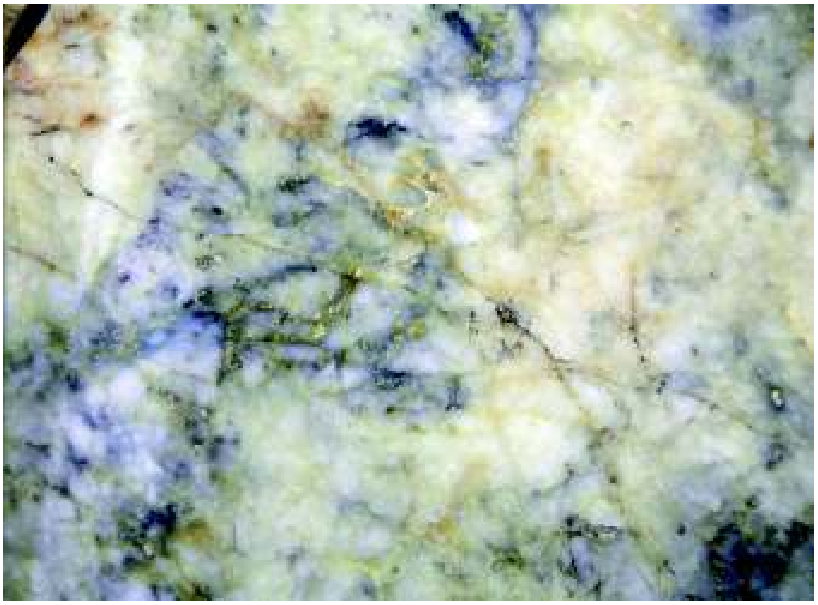
Rocks are made of minerals, and different types of rock have different types and amounts of minerals. Geologists classify rocks according to the way in which they were formed. There are three primary classifications of rocks.

Sedimentary rocks form over time where there is water or where bodies of water once existed. Particles of rock, sand, and gravel, as well as skeletons and shells of sea creatures, settle on the bottoms of lakes and oceans. As more layers pile up and press the particles together, minerals in them act like cement and harden into layers of rock. This process is very slow; it takes millions of years. Chalk, limestone, and sandstone are all examples of sedimentary rocks, which is layered and easily broken. Sedimentary rock often contains fossils and is found in places that used to be

Sandstone formations in Arizona (Photo credit: Greg Bulla)

underwater. The Grand Canyon in the United States includes spectacular layers of sedimentary rocks.

Metamorphic rocks are the results of the immense heat and pressure inside Earth, which can cause chemical changes in rocks that transform (or *metamorphose*) their characteristics. Metamorphic rock is very hard, and may have layers or bands of different color which indicate it formed from



Marble (Photo credit: James St. John)

different types of minerals being fused or stuck together. This process can take millions of years. Marble is a metamorphic rock, transformed from the sedimentary rock limestone by the intense heat and pressure inside Earth. Slate is another type of metamorphic rock.

Igneous rocks are created when molten rock inside Earth cools and hardens. Igneous rock can also form when hot magma comes out of Earth and cools on its surface. When molten rock begins to cool, it changes in both form and texture, sometimes turning shiny or glossy. Granite is a common igneous rock made up of the minerals quartz, feldspar, and mica. Quartz, basalt, and obsidian (which is sometimes called volcanic glass) are also igneous rocks.

Obsidian (Photo credit: Kevin Walsh)

The Rock Cycle

The three different types of rock can change into one another. In fact, rocks are constantly changing! Any rock you find may have once looked completely different. A rock may change in many ways and may even repeat changes over and over again. A rock on the surface of the planet will be slowly ground down into sediment that gets buried and changed into sedimentary rock. As it gets pushed further underground, it can eventually change into a metamorphic rock under pressure and heat. More heat may turn it into a molten form, which might then cool into an igneous rock. These rocks underground may be flung onto the surface through volcanic action, where the weathering process starts breaking it down again.

The effects of nature can chip and break apart the strongest igneous or metamorphic rock into sand, that can reform into sedimentary rock. Because rocks continually change form, we call this never-ending process the *rock cycle*.