Seventh Grade Science Overview

	First Semester	Second Semester
Science	Variables and controlled experiments Movement of Earth and moon Astronomy Geology Weathering and erosion Plate tectonics Student-led scientific theory	Global climate change Meteorology Water cycle Atmosphere pressure and wind patterns Earth's resources Human population growth Biodiversity and habitat loss Student-led scientific inquiry

Grade 7
Earth Science
Teacher Manual

Oak Meadow

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Introduction

In this exploration of our dynamic Earth and its neighboring celestial bodies, students will get their hands dirty, use their imaginations, and get wrapped up in the details of astronomy, geology, meteorology, weathering and erosion, oceanography, and resource management.

This is an introductory course designed to spark interest, begin conversations, and teach skills in observation, experimentation, inquiry, and hypothesizing. The student coursebook does not hold the answers to all questions; in fact, some questions can only be answered by the student.

The use of additional research is always encouraged whenever the student is motivated to learn more. In addition to library resources, we have collected online resources, which can be found at www.oakmeadow.com/curriculum-links/.

While doing independent research, it may be helpful to remind students that the internet is unpredictable when it comes to quality and verifiability. Advise students to always evaluate sources in terms of reliability and relevance. The student coursebook includes information about this in the appendix.

Our hope is that students will develop a growing wonder and appreciation for the incredible power and detail that is revealed through a study of Earth Science. We think Earth is fascinating and wish you and your student an enjoyable, empowering, and eye-opening study of our planet.

Note about Workload

Please note that there are a wide variety of assignments included in this course to give students many options for engaging with the material. **Students are not expected to complete every single assignment.** You can help your student determine which assignments to focus on each week, based on the student's interests, strengths, and areas needing development. You might also give your student the option to complete some of the written assignments orally. Keep an eye on the workload as your student progresses, and make adjustments so that the student has time for meaningful learning experiences rather than rushing to try to get everything done. If your student is enrolled in Oak Meadow School, please consult with your teacher when making adjustments to the workload.

Lesson 1

Observation and Measurement

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.

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

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.

doing research online. You'll find a list of online resources at www.oakmeadow.com/curriculum-links/. You can use these links to learn more about lesson topics.

Your student may benefit from discussing the reading selections with you to help clarify the information. You can ask questions to prompt a discussion or an expanded explanation. Depending on your student, you may want to suggest that the reading be done in sections rather than all at once.

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 sidewalk, 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.

   Let the student make initial judgments about how detailed to get with the descriptions. Look for the use of specific language that is objective (anyone observing this detail would agree on its attributes). If the student is using subjective language (language that conveys personal feeling or judgment), point this out and discuss ways in which the observation can be described objectively.

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?

   Students might mention any of the following tools and explain how they would be useful: magnifying glass, ruler, watch, thermometer, binoculars, measuring cup, or weight scale. If students have difficultly thinking of tools, you can ask questions to prompt them: How much does that stick weigh? How big is that rock? How quickly did the squirrels race up the tree trunk?

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.

Students might change the volume of the paper ball by making it larger (a looser ball) or smaller (a tighter ball). The volume has changed but the mass has not (the paper still weighs the same as it did when it was flat because no matter has been added or taken away). When a piece of the paper is torn off, the paper's mass has decreased. There is not as much "stuff" there as there was in the beginning. The student's demonstration should include definitions of mass and volume, and a clear explanation of what is happening.

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.

   The object with the greater mass has the greater density because it has more matter in the same amount of space (volume). Density is a measure of how tightly the molecules are packed into a space. If, in the same amount of space, one substance has more mass than another, it will also have greater density. Density is calculated by dividing an object's mass (usually expressed as weight on Earth) by its volume or size. Students should provide an example, such as two balls of equal size, but one made out of yarn and one made out of clay. The clay ball has a greater mass and density, even though the balls are the same volume.

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 the *Earth Science Lab Manual*. 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.

Lab investigations provide students with an opportunity to develop scientific skills and practice the scientific method. Look for students to follow the procedure with care, take accurate measurements, and record their observations in an organized manner. Summaries and conclusions should include the use of scientific terminology and concepts. See the lab manual for the full description of each lab investigation.

Option 1 Lab Investigation: Water Clock

Water was sometimes used to measure time before clocks and watches were invented. In this investigation, you will make a water timer.

Conclusions

1. Write a summary of the procedure you followed in this investigation and how successful it was.

   The procedure should be summarized with key elements noted, such as the calibration process that preceded the experiment.

2. What worked well? What was difficult?

   Look for students to reflect on how well the investigation worked.

3. What might you do differently next time in order to make a more accurate or useful water clock?

   Ideas for what to change or improve should be specific. This is a good question to use as a basis for a discussion or brainstorming activity.

4. Based on your lab investigation, do you think a water clock can be an accurate way to measure time? Why or why not?

   Answers will vary. Students should explain the reasoning behind their opinion.

Option 2 Lab Investigation: Comparing Volume and Mass

This investigation explores volume and mass.

Conclusions

1. Look at your drawings of the first three containers you made for Procedure I. Did the volume of water the container held remain the same when you altered its shape? Did the mass of the clay change when you altered its shape? Explain your answer.

   The volume of water the container held probably changed when the shape was altered. The mass of the clay did not change because no clay was taken away or added.

2. Look at the two 1-cup bowls you made for Procedure II. The containers both hold the same volume of liquid (they are the same size on the inside even if they are not the same shape). Do the two empty bowls have the same mass? Explain your answer.

   The bowls do not have the same mass because one ball of clay was larger than the other, so one bowl has a greater mass even though they both hold the same volume of water (they are the same size on the inside).

3. Explain what these two procedures demonstrate about mass and volume.

   Answers will vary. Students may mention that a malleable container can be shaped to hold different volumes of liquid without changing the mass of the container, and different masses of a substance can be formed to hold the same volume.

4. Can you think of another way to demonstrate mass or volume? If you were teaching someone about the concepts of mass and volume, how might you modify these procedures to make them more effective?

   Students are encouraged to be creative here. If the student's answer doesn't clearly demonstrate the concepts of mass and volume, ask them to elaborate or explain their answer so you can understand their thinking better and assess whether they have grasped the concept. This can be an opportunity to brainstorm or discuss ideas with other students or the teacher.

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.

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

The activities in this course are optional. Students are encouraged to choose those that interest them. See the coursebook for the full description of each activity.

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.

   Quantitative observations are measurable and include numbers such as weight, time, speed, or height. Qualitative observations are descriptions of attributes such as color, texture, smell, or sound.

2. Explain the relationship between mass, volume, and density. You don't have to give the formulas; just explain things in your own words.

   Mass is the amount of matter in an object, measured as the pull of Earth's gravity on matter. Volume is the amount of space an object takes up. Density is the amount of matter per volume (the amount of substance in the space).

3. What are the three most common states of matter on Earth? Give an example of each, and explain how they are different.

   The three most common states of matter on Earth are solid (such as a table or an eyelash), liquid (such as water or honey), and gas (such as steam or oxygen). Solids have a definite

shape and and volume. Liquids have a definite volume, but will assume the shape of the container. Gases will change shape and volume depending on the container.

4. Describe the three steps of a scientific argument.

   The three steps of a scientific argument are 1) make a claim based on research; 2) provide evidence (data) to support the claim; and 3) show your reasoning for how the data support the claim.

5. What is the difference between an observation and an inference?

   An observation is something that is objectively detected or measured. An inference is an explanation about what the data might indicate. Inferences are based on evidence (observations and data) but are not facts; they are logical deductions or conclusions that may explain what happened.

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				

Lesson

2

Scientific Method

Learning Objectives

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

- Explain the steps of the scientific method.
- Identify the variables being controlled and the variable being tested in a controlled experiment.
- Differentiate between causation and correlation.

ASSIGNMENT SUMMARY

- [ ] Complete the reading selections.
- [ ] Apply the scientific method.
- [ ] Identify the difference between correlation and causation.
- [ ] Lab Investigation: Celery Experiment
- [ ] Complete lesson 2 test.

Reading

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

- Scientific Method
- Variables and Controlled Experiments
- Causation and Correlation

Remember to check the curriculum resource links at www.oakmeadow.com/curriculum-links/ to learn more about lesson topics.

You may want to ask questions about the reading to prompt a discussion and make sure your student understands the material.

Assignments

Scan through the assignments, lab investigation, test, and reading selections before you begin to get a sense of what you'll be doing and how long it will take. It's best to do a few assignments at a time and then take a break instead of trying to get everything done at once.

1. Imagine you are conducting an experiment to answer the question "Can a paper bag hold more weight when it is dry or when it is wet?" Answer the following questions about how you would apply the scientific method to conduct this experiment.

a. State a hypothesis for this experiment.

A hypothesis might be "A wet paper bag will not be able to hold the same amount of weight as a dry paper bag," or "The wetter a paper bag becomes, the more easily it will break when weight is added." The hypothesis should be clear and testable.

b. Create a list of materials. Be as precise as possible. For instance, what size paper bag would you use? How many would you need for your experiment? What would you use for a weight?

Sample materials list: 10 paper lunch bags, pan of water, bag of apples (to use as weights)

c. Explain the procedure you'd follow for testing your hypothesis. What would you do first? What next? Write down the procedure step by step, including how long to soak the bags that you are getting wet, and how many times you will try the experiment (how many wet bags will you test? How many dry bags?). Will you try the experiment with two or more types of wet bags (for instance, bags that have soaked for 5 minutes, bags that have soaked for 15 minutes, and bags that have soaked for 30 minutes)? Remember, every aspect of the experiment needs to be controlled as much as possible, so write down your procedure very clearly.

The step-by-step procedure should be very specific and clearly worded. You might want to follow the instructions and do the experiment—this will usually show the student where more clarity is needed.

d. What observations will be recorded? This experiment uses two different groups: dry bags and wet bags. Imagine you are doing the experiment—what will you write down? If possible, create a data table that has labeled rows and columns that show what data will be collected.

Data collected will include type of bag (dry or wet) and how much weight it could hold before breaking (number of apples, for example). If a data table is created, it should show how many trials to do.

e. In this experiment, what are the elements that you controlled? What would be exactly the same each time the experiment is repeated?

The controlled variables are the size, shape, and weight of the bag and the type of weight. These should all be the same. The dry bags should all be equally dry, and each group of wet bags should all be equally wet.

f. If all the elements are exactly the same each time you do the experiment, what is the one thing that is different? What is the variable you are testing?

The isolated variable is the moisture content. That is the one factor that changes, so the difference between the strength of the dry bag and the strength of the wet bag is what is being tested.

2. A cause-and-effect relationship or causality (A always leads to B) is difficult to prove because there are often many factors involved. Answer the following questions about causation and correlation.

Both of the following examples show correlation, not causation, because even though the two events (A and B) are often found together, one does not cause the other to happen every time.

a. More ice cream is sold during the summer than during the winter. Does this show correlation or causation? Does A (hot weather) always lead to B (eating ice cream)? Explain your answer.

b. People who stand in line use their cell phones more often than people who are not standing in line. Does this show correlation or causation? Does A (waiting in line) always lead to B (using a cell phone)? Explain your answer.

3. In the early 1900s, it was noticed that villages with a high number of babies being born also had a high number of storks in the town. Did the presence of more storks cause more babies to be born? Did more babies being born cause more storks to appear? Was there correlation or causation? (Actually, there were more houses in these villages to house all the new families, and storks like to nest near chimneys, so more storks lived there.) Draw a comic, poster, or illustration that uses this example (or another one) to explain the statement "Correlation does not imply causation."

   The student's drawing should be easy to understand, labeled as needed to explain the difference between correlation and causation. Hopefully, students will have fun with this assignment!

Lab Investigation

Complete the following lab investigation using the steps of the scientific method (full instructions are found in the lab manual).

- **Lab Investigation: Celery Experiment**

Use good scientific habits by taking careful observations and measurements, recording your data in an organized way, and using precise, detailed language.

Lab Investigation: Celery Experiment

This investigation tests how quickly water travels through a plant's stem to its leaves (this is called capillary action).

Conclusions

1. Write a summary of your results. What do you observe? How fast did the colored water get absorbed by the celery?

   The results should be reported with accurate measurements and clear descriptions.

2. Did the rate of absorption (how quickly the water was absorbed) increase or decrease as time went by?

The student's answer should match their results.

3. Did you observe anything that surprised you? For instance, did the dye help you see the internal structure of the celery more clearly?

   Answers will vary.

4. Write a conclusion explaining whether or not the experiment answered the guiding question. How might you do it differently if you were to repeat this experiment in the future?

   Look for students to articulate that measuring how far the colored water moved up the stem demonstrated the rate at which the plant absorbs water, and to make note of ways in which the experiment might be changed, either to improve its effectiveness, to gather more data (for instance in smaller time increments), or to gather new data (for instance seeing if water with oil in it is absorbed at the same rate as plain water).

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. List and explain each of the steps in the scientific method.

   The steps of the scientific method are as follows:

   Question: The problem or question is usually the result of an observation a person makes about something they have noticed that they do not know the explanation for.

   Hypothesis: The hypothesis is an educated guess as to the reason or answer for the observed behavior or question.

   Procedure: The procedure describes how the experiment will be conducted step-by-step.

   Results: The observed results form the data collected from performing the experiment.

   Conclusion: A conclusion is the interpretation of what the results indicate, including what may have influenced the results.

2. How is the scientific method similar to the logical thinking one does for the accomplishment of any project or task? Give an example from your own experience.

   Usually a person makes a guess about what will work, and then goes through the steps to test their "hypothesis." Afterward, the person will consider the results and draw conclusions about whether or not the process worked or was effective. Sometimes a hypothesis is tested over and over to be sure of the results. Students are asked to give an example; sample responses might include making adjustments to a hat so it stays on in high winds, experimenting with the sugar to lemon ratio in lemonade, or trying out different building designs when constructing a block tower.

3. What is a controlled experiment? What is being "controlled"? Include an example with your explanation.

   A controlled experiment carefully monitors each factor, keeping all factors the same except one, which is being tested. Testing for one factor at a time eliminates the influence of variables in the results and conclusions. An example might be doing a seed growth experiment in which all seeds are treated the same except for the amount of sunlight they get.

4. In your own words, explain the difference between correlation and causation.

   This is a very tricky concept and many adults confuse the two. Correlation refers to a relationship between two events, which may be incidental, and causation indicates a proven cause-and-effect relationship where one event always leads to another (A always causes B). Many events are correlated even though they do not directly influence one another or have many factors influencing them.

5. How can causation be proved?

   Causation is very difficult to prove, and scientists use methodical, repeated, controlled experiments to try to prove or disprove causality.

Learning Checklist

Your student may be filling out the learning checklist in the coursebook. You can keep your own notes on this checklist, and use the student's checklist to note where the student needs help or where there are discrepancies (for instance, the student might report feeling competent with recording accurate measurements but you notice that this area still needs work).

SKILLS	Developing	Consistent	Competent	Notes
Follow the steps of the scientific method				
Identify variables in a controlled experiment				
Record accurate measurements				
Differentiate between correlation and causation				
Use scientific terminology in explanations				

Lesson

6

Earth's Movement

Learning Objectives

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

- Describe the three motions of Earth.
- Explain the relationship between the tilt of Earth's axis and the seasons.
- Demonstrate how day and night and the seasons occur on Earth.

Reading

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

- Earth's Rotations and Revolutions
- Seasonal Cycles

If you come across a concept that you have trouble grasping, discuss it with an adult or ask questions. Another way to help you understand a concept more clearly is to explain it to someone. Their questions will help you realize which elements you understand and can explain fully and which elements are still murky in your mind.

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Explain the difference between an equinox and a solstice.
- ☐ Explain the difference between the two equinoxes.
- ☐ Draw a diagram showing Earth's position relative to the sun at different times of the year.
- ☐ Lab Investigation: Earth's Movement
- ☐ Optional Activity: Sundial
- ☐ Complete lesson 6 test.

Assignments

1. What is the difference between an equinox and a solstice?

   The equinoxes (spring and autumn) are when the days and nights are of equal length all over the world. The solstices (winter and summer) are when there is the greatest difference between the length of the day and night; these differences are most noticeable the further away from the equator one travels.

2. What is the difference between the vernal equinox and the autumnal equinox?

   Earth is positioned at the same angle in relation to the sun for both equinoxes, and the days and nights are equal length. The difference is only in name: the vernal (spring) equinox is experienced during the transition from winter to summer, and the autumnal equinox is experienced during the transition from summer to winter. When it is the vernal equinox in the Southern Hemisphere, it is the autumnal equinox in the Northern Hemisphere.

3. Draw a diagram that shows Earth's positioning in relation to the sun during the equinoxes and solstices.

   The diagram should be clearly labeled to show the different positioning of Earth at different times of the year (refer to the diagram in the coursebook).

Lab Investigation

Complete the following (see the lab manual for instructions).

- **Lab Investigation: Earth's Movement**

If possible, perform your demonstration in front of an audience (or videotape it) and explain what is happening. (You might want to practice this first.) You can answer the questions on video or in writing. Remember to use correct terminology and precise language.

Lab Investigation: Earth's Movement

In this investigation, you will model how Earth's tilt, spin, and orbit combine to create our daily and yearly cycles.

Conclusions

Answer the following questions using scientific terminology and complete sentences.

1. If the two points on the globe's surface where the knitting needle passes through represent the North Pole and the South Pole, what does the entire knitting needle represent?

   The knitting needle represents Earth's axis, an imaginary line around which Earth rotates.

2. What does the tilting of the knitting needle represent?

   This represents the fixed tilt of Earth on its axis, which does not vary as Earth revolves around the sun.

3. When spinning your model, what does this spinning movement represent?

   It represents Earth's rotation on its axis.

4. Why does the sun appear to rise in the east and set in the west?

   The sun appears to rise in the east because of the direction in which Earth spins on its axis.

5. When you spin your model to show day and night, how many hours does one rotation represent?

   24 hours

6. Explain how your model demonstrates the difference between the summer solstice and the winter solstice.

   Students should give a clear explanation of the position of Earth in relation to the sun at each solstice, and differentiate between the Northern and Southern Hemispheres. At the summer solstice in the Northern Hemisphere, the North Pole is at its closest point to the sun; this coincides with the winter solstice in the Southern Hemisphere, when the South Pole is at its furthest point from the sun.

Activities

The following activity is optional.

Activity: Sundial

See the coursebook for a full description of this optional activity.

Test

1. Explain why we have day and night.

   Day and night are the result of Earth rotating on its axis, toward and away from the sun.

2. How long does it take Earth to make one rotation on its axis? How long to make one revolution around the sun?

   It takes 24 hours for one Earth rotation, and one year for Earth to complete one revolution in its orbit around the sun.

3. If it is the summer solstice in the Northern Hemisphere, is it also the summer solstice in the Southern Hemisphere? Explain your answer.

   No, it can't be the summer solstice in both hemispheres at once. When it is the summer solstice in the Northern Hemisphere, it is the winter solstice in the Southern Hemisphere. This is because the summer solstice happens when one pole is at its closest point to the sun, at which point the opposite pole will be at its furthest from the sun.

4. Describe the three ways that Earth moves through space.

   Earth rotates on its axis, orbits around the sun, and moves through the galaxy along with the sun and the rest of the solar system.

5. Explain the relationship of the tilt of Earth's axis and the seasons. What would happen if Earth's axis were perpendicular and not tilted?

   This question may present a challenge for students because it is not explained in the text, so students will have to make this connection on their own. If Earth was not tilted toward or away from the sun at any point in its orbit, it would be as though every day was an equinox. All days and nights would be identical in length, and there would not be the extreme variations of winter and summer, with their longer and shorter days and nights.

6. When it is March 21, is it the vernal equinox or the autumnal equinox? Explain your answer.

   This question also asks students to apply their knowledge as it is a tricky question. The answer is that it depends on where you are. March 21st is the vernal (spring) equinox in the Northern Hemisphere, and the autumnal equinox in the Southern Hemisphere.

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
Differentiate between Earth's rotations and revolutions				
Model how Earth's tilt and orbit create seasonal cycles				
Model how Earth's rotation creates sunrise and sunset				
Demonstrate how the seasons differ in the Northern and Southern Hemisphere				

Lesson 17/18

Scientific Inquiry: Modeling Design and Procedure

Lesson Objectives

- Research ways to model a natural phenomenon.
- Design and create a model.
- Reflect on project design and learning experience.

Assignments

For your third Scientific Inquiry, you will create a model of a natural phenomenon. This unit focused on Earth's structure, the rock cycle, weathering, fossilization, erosion, plate tectonics, and mountains. You can model a landslide, tsunami, earthquake, volcano, crystallization, liquefaction, or any other phenomenon that intrigues you! As always, you have two weeks to complete your project. Feel free to work with others to make this a collaborative modeling project.

See the lab manual for full instructions.

- **Scientific Inquiry: Modeling Design and Procedure**

In this project, you will be designing, creating, and testing a model, and then having someone else create an identical model by following the procedures you have written down. You will need two sets of materials (one set for your initial model, and another for the second model).

Complete the project reflection afterward.

By now, your student will probably be getting more comfortable with the process of project design and reflection. Review previous project reflections to identify phases the student may need extra help with.

ASSIGNMENT SUMMARY

- ☐ Research a natural phenomenon and ways to model it.
- ☐ Design your own modeling project and discuss your ideas to refine the design.
- ☐ Create a model and record your procedure in detail.
- ☐ Share the project with others.
- ☐ Reflect on project design and learning experience.

Lesson 23

Wind and Atmospheric Pressure

Learning Objectives

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

- Draw a diagram showing the relationship between air pressure and wind patterns.
- Explain why wind currents move in a circular pattern.
- Identify how temperature affects air pressure.

Reading

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

- Atmospheric Pressure
- Wind Patterns

View additional resources on the curriculum resource links page.

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Draw diagrams to illustrate concepts related to wind patterns.
- ☐ Use the science behind wind patterns in a creative assignment.
- ☐ Predict a result based on air pressure.
- ☐ Lab Investigation: Homemade Barometer
- ☐ Lab Investigation: Expanding Air
- ☐ Complete lesson 23 test.

Assignments

1. Scientists often use diagrams to help illustrate different concepts. Draw labeled diagrams or pictures that explain the following statements. Use additional resources to get ideas about how to represent these statements visually.

   The following diagrams should clearly illustrate the statements below. Artistic skill is not necessary. Drawings should be labeled and have arrows indicating direction.

   a. Air has weight and exerts pressure on everything with which it comes in contact.

   b. The atmosphere is like an ocean of air above us, exerting air pressure equally in all directions.

   c. Earth's rotation influences the direction of wind currents.

   d. Atmospheric pressure decreases as altitude increases because warm air molecules expand and rise and cold air molecules condense and sink.

2. Write a story, poem, song, or play that takes place either on an ocean shore, a mountain, or in a valley where air currents behave in a generally predictable way. In your story or poem, the wind should play an important role. Include the scientific explanation of what is happening with the wind as part of your story.

   Look for a creative use of the following scientific phenomenon. As the land heats in the morning and the air over it rises, cooler air rushes from water toward land, creating onshore breezes; as the land cools in the evening, the cooler, heavier air over the land moves toward the warmer, lighter air over the water, creating offshore breezes. Similarly, mountaintops warm before valleys, so in the morning, the cooler air in the valley will rush up toward the warm, rising air at the mountaintop, creating a valley breeze; in the evening, the air patterns are reversed, and the cool mountaintop air rushes down toward the warmer valley, creating a mountain breeze.

3. Try to imagine the following, keeping in mind that warm air expands and cool air contracts. What do you think would happen if you poured a few ounces of very hot water into an empty plastic bottle (such as a gallon milk jug or one liter bottle), screwed on the top very tightly, and then allowed the bottle to cool? Can you predict the results? Write down your prediction, and then explain the science behind it. If possible, try this experiment after you make your prediction and see what happens. Include your actual results with your prediction and explanation.

   Predicting results is a scientific skill. Some students may struggle with this; if so, help guide them through the process of connecting concepts they have learned to physical phenomenon. Conducting the experiment is highly recommended after predictions have been made as this is the best way to help students grasp the connections between what they know and what happens in the physical world.

   When a plastic bottle is sealed tightly with hot water inside, the expanded state of the gas (air) is confined in its low pressure state. As the water inside cools, the gas contracts. Since the bottle is sealed and the sides are flexible, the bottle will crumple inward, pulled by the higher air pressure of the cooled gas.

Lab Investigation

Complete both of the following labs.

- **Lab Investigation: Homemade Barometer**
- **Lab Investigation: Expanding Air**

Full instructions are in the lab manual. Use specific language and scientific terminology when writing your conclusions.

Lab Investigation: Homemade Barometer

Barometers are used to measure air pressure. Here's a simple homemade barometer you can make to watch how it works.

Data Table: Barometer Readings

Check that regular readings have been recorded on the data table, and that observations are explained with precise, detailed language.

Conclusions

The weight of the air pushing down on the water makes it climb up the bottle neck. The greater the atmospheric pressure, the higher the water will climb. A rising barometer indicates rising air pressure and predicts fair weather conditions. A falling barometer indicates falling air pressure and predicts rain.

Write a brief summary of your results and whether or not your homemade barometer seemed to match the prevailing weather conditions.

Results will vary but hopefully the student's results will match the statements above, showing rising air pressure during fair weather and falling air pressure during cloudy or stormy weather. Look for precise descriptions, accurate terminology, and logical reasoning.

Lab Investigation: Expanding Air

This lab investigation lets you see the effects of warm air rising and expanding, and cool air sinking and contracting.

Conclusions

1. What did you observe? Summarize your results.

   The summary should be written using objective language. The balloon should have collapsed as the air inside the bottle cooled and expanded as the air inside the bottle warmed.

2. Using scientific terms, explain what happened.

   Warm air expands and rises, pushing up into the balloon and making it expand. Cool air contracts and sinks, drawing back down into the bottle and making the balloon collapse.

3. Predict what would happen if you let the bottle and balloon sit at room temperature for a while. Explain your reasoning.

   Predictions will vary but hopefully students will understand that once the air returns to room temperature, the balloon will be back to the original position, half-filled with air. If students have trouble making a prediction or predict something different, ask them to explain their reasoning. This will help point to areas of confusion. After the prediction is

made, encourage students to continue the experiment, letting the bottle return to room temperature to see what happens.

Test

1. What is air pressure?

   Air pressure is the weight of air in the atmosphere pressing down toward Earth.

2. How does the air pressure change as you go up into higher elevations?

   Air pressure decreases as elevation increases.

3. Why is the air pressure of cool air greater than the air pressure of warm air?

   Cool air molecules are close together, condensed into a smaller space, so they are heavier and exert more pressure. Warm air molecules are further apart, expanded into a larger space, so they are lighter and exert less pressure.

4. What does air pressure have to do with wind currents?

   Air pressure is related to wind currents because warm air rises, allowing cooler, denser air to move in beneath it. These changing patterns of pressure based on temperature cause wind currents.

5. Why do the winds on this planet move in circular patterns?

   Earth's rotation on its axis causes winds to move in circular patterns in a phenomenon called the Coriolis effect.

6. Imagine you are in a sailboat. Since you have only the wind to propel your boat, what time of day would it be easiest for you to set sail from shore into the ocean? What time of day would be easiest to return to shore, based on the wind? Explain your answer.

   Evening is the easiest time to set sail from the shore because offshore breezes are pushing cool air from the land toward the warmer sea air. Morning is the easiest time to return to shore because onshore breezes are pushing cool air from the ocean toward the warmer air over land.

7. Describe the difference between a mountain breeze and a valley breeze. Why do these wind currents behave as they do? Include information about related scientific concepts to support your answer.

   As a mountaintop warms, cooler air in the valley will rush up toward the warm, rising air at the mountain top, creating a valley breeze. As a mountaintop cools, the air rushes down toward the warmer valley, creating a mountain breeze. Valley breezes usually occur early in the day as the top of the mountain warms before the valley. Mountain breezes usually occur late in the day as the top of the mountain cools before the valley.

8. If a low pressure air mass was approaching, would you expect rain or sun in the forecast? Why?

   A low pressure systems often predicts rain because low pressure means warm air is rising, collecting lots of moisture as it expands. This warmer, moist air condenses into cloud formations, often bringing rain.

9. Which barometer would you expect to have the higher reading, one at sea level or one at the top of a mountain? Why?

   Sea level, where the full weight of the atmosphere is pressing down, has more air pressure than high elevations, where the air is less dense because there is less of it pressing down from above. Barometric readings are higher at sea level, and generally decrease with elevation.

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
Define air pressure				
Explain how temperature affects air pressure				
Relate air pressure to wind currents				
Identify causes of offshore and onshore breezes				
Identify causes of valley and mountain breezes				
Use knowledge of air pressure to predict weather				
Diagram concepts related to wind currents and air pressure				