Project CONN-CEPT Science Units

Astronomy: Sun, Moon, and Stars (K-2)
The World of Matter (1)
Living Things: Changes, Stages and Cycles (2-3)
Eurekas and Ecosystems (4-5)
Light: A Rainbow of Explorations (4-5)
Sound's Story: H-Ear the Pitch (4-5)
Structure and Function: What's Their Junction? (6)
Weather: The Never-Ending Story (6)
Cells: The Story of Life (7)
Reactions and Interactions (7-8)

Project CONN-CEPT Social Studies Units

Time, Change, and Continuity in History (K)
Local Government (3)
What Makes a Region? An Investigation of the Northeast (4)
Goods, Services, Resources, Scarcity and Systems: An Exploration of State Economics (4-5)
Concepts and Tools of the Geographer (6)
With Liberty and Justice for All: A Study of the U.S. Constitution (6-8)

Units in Preparation

Junior Economist: People, Resources, Trade (1-2)
A Habitat is a Home for Plants and Animals: Needs, Resources, Adaptation and Systems (1-2)
May the Force Be with You: Forces, Motion and Simple Machines (2-3)
Comparing Cultures: Traditions, Dwellings, Language, and Cultural Evolution (2-3)
Peopling of the Americas (4-5)
Going to the Source: Using Primary Resources in United States History (6-8)
Exploring the World's Oceans: Chemistry, Geology and Biology (7)
Reactions and Interactions: Chemical Reactions (7-8)

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PROJECT CONN-CEPT

A Shared Story

The exhibit hall was huge, and publishers' banners, suspended from the ceiling, waved back and forth in the air conditioned room. Hundreds of conference participants filled the aisles. Vendors of curriculum materials, eager to share their colorful and glossy wares with passing teachers and administrators, stood at the edge of their displays offering warm smiles, prizes, and publishers' catalogues.

Charlene and Andrew had carefully planned their tour through the aisles and divided up so that they could see all the materials. They looked forward to their time in the vendor area because they needed curriculum materials in social studies and science for their upper elementary and middle school students. They hoped they would find something good. They wanted coherent, comprehensive units that addressed their state and national standards, had good assessments, required students to think their way through content, provided teachers with teaching strategies, and some guidance regarding how to differentiate the curriculum for students with varied learning needs.

They looked at many cleverly designed curriculum packages and kits. Most materials were collections of episodic learning activities. Some contained coherent learning activities for students, but did not teach to the critical concepts and principles embedded in state and national standards. Other materials, claiming to be comprehensive, did not contain aligned pre- and post-assessments, user-friendly teacher information, suggestions for teaching, or techniques for differentiating. Several kits attended to concepts and principles, but none was comprehensive enough to address all the standards for a particular grade level. At least two kits would be required to cover the prerequisite standards. Worse, the cost for the two kits would not include the price for the consumables that would have to be purchased each year to keep the kits adequately stocked. They could hardly pay for the cost of one kit!

Charlene and Andrew met at the back of the hall and compared notes. They were disappointed because they realized that the high-quality, standards-based curriculum materials they wanted were not in the racks. Now what? Were there other vendors? If so, who were they and how could they be contacted? If there were no vendors with the materials they needed, could they write the needed curriculum themselves? Who could help them? Did the district have money to pay stipends for curriculum development? How could they possibly write all the curricula that was required to address the state assessments?

We dedicate this curriculum unit, as well as others written under this Javits grant, to all the teachers who have had experiences like Charlene and Andrew. We hope the unit presented here will meet the needs of educators who live in real classrooms, contend with real time constraints, prepare students adequately for high-stakes assessments, seek high-quality curriculum materials, and strive to meet the varied learning needs of all their students.

Deborah E. Burns
Jeanne H. Purcell

PREFACE

In 2002, the Connecticut State Department of Education was awarded a Javits grant from the U.S. Department of Education called Project CONN-CEPT. The major focus of grant activities was the creation of standards-based curriculum units, K-8, in science and social studies. These rigorous curriculum units have been created for all students because every child must have access to the highest quality curriculum. At the same time, the units also have a particular focus on the needs of advanced learners—those who know more, learn more rapidly, think more deeply, or who are more innovative in a particular area of study. It was our goal to embed learning opportunities for advanced learners that were tightly aligned with the concepts and principles that guided the unit.

The Parallel Curriculum Model

This standards-based curriculum unit has been designed using the *Parallel Curriculum Model* (PCM) (Tomlinson, Kaplan, Renzulli, Purcell, Leppien, & Burns, 2002). The *Parallel Curriculum Model* is a set of four interrelated designs that can be used singly, or in combination, to create or revise existing curriculum units, lessons, or tasks. Each of the four parallels offers a unique approach for organizing content, teaching, and learning that is closely aligned to the special purpose of each parallel. The four parallels include: the Core Curriculum Parallel, the Curriculum of Practice, the Curriculum of Connections, and the Curriculum of Identity.

The *Core Curriculum* addresses the core concepts, principles, and skills of a discipline. It is designed to help students understand essential, discipline-based content through the use of representative topics, inductive teaching, and analytic learning activities. The *Curriculum of Connections* builds upon the Core Curriculum. It is a plan that includes a set of guidelines and procedures to help curriculum developers connect overarching concepts, principles, and skills within and across disciplines, time periods, cultures, places, and/or events. This parallel is designed to help students understand overarching concepts, such as change, conflict, cause and effect, and patterns, as they relate to new content and content areas. The *Curriculum of Practice* is a plan that includes a set of guidelines and procedures to help students understand, use, generalize, and transfer essential knowledge, understandings, and skills in a field to authentic questions, practices, and problems. This parallel is designed to help students function with increasing skill and competency as a researcher, creator, producer, problem solver, or practitioner in a field. The *Curriculum of Identity* is a plan that includes a set of guidelines and procedures to assist students in reflecting upon the relationship between the skills and ideas in a discipline and their own lives, personal growth, and development. This parallel is designed to help students explore and participate in a discipline or field as it relates to their own interests, goals, and strengths, both now and in the future.

The *Parallel Curriculum Model* also contains a new concept called Ascending Intellectual Demand (AID). Ascending Intellectual Demand offers practitioners a way to think about a discipline and each student's steady, progressive movement from novice to expert within that discipline. As students are ready, teachers ask students for increasing levels of cognition, affect, and application. As such, AID is a framework teachers use to increase the challenge level for students by asking them to behave and act in expert-like ways. (Tomlinson, Kaplan, Purcell, Leppien, Burns, & Strickland, 2006).

This unit has been designed using the Core Curriculum Parallel. Core Curriculum addresses the essential concepts, principles, generalizations, and skills of a subject area. It is designed to help students understand essential, discipline-based content through the use of representative topics, inductive teaching, and analytic learning activities. Although the majority of lessons in this unit have been designed using the Core Curriculum Parallel, it also contains several lessons that provide students with opportunities to explore other parallels that are closely connected to the subject matter.

Our Invitation...

We invite you to peruse and implement this curriculum unit. We believe the use of this unit will be enhanced to the extent that you:

- **Study PCM**. Read the original book, as well as other companion volumes, including *The Parallel Curriculum in the Classroom: Units for Application Across the Content Areas, K-12* and *The Parallel Curriculum in the Classroom: Essays for Application Across the Content Areas, K-12*. By studying the model in depth, teachers and administrators will have a clear sense of its goals and purposes.
- **Join us on our continuing journey to refine these curriculum units.** We know better than to suggest that these units are scripts for total success in the classroom. They are, at best, our most thoughtful thinking to date. They are solid evidence that we need to persevere. In small collaborative and reflective teams of practitioners, we invite you to field test these units and make your own refinements.
- **Raise questions about curriculum materials.** Provocative, compelling and pioneering questions about the quality of curriculum material—and their incumbent learning opportunities—are absolutely essential. Persistent and thoughtful questioning will lead us to the development of strenuous learning opportunities that will contribute to our students' life-long success in the 21st century.
- **Compare the units with material developed using other curriculum models.** Through such comparisons, we are better able to make decisions about the use of the model and its related curriculum materials for addressing the unique needs of diverse learners.
- **Examine PCM as one bridge between general and gifted education.** We believe that the rigorousness of PCM has much to offer *all* students, not just those who may already know, do, or understand at very different levels of sophistication.

ACKNOWLEDGEMENTS

We would like to thank our mentors, Carol Tomlinson and Carolyn Callahan. They have been our constant supporters and guides as we moved into uncharted territory related to curriculum development and differentiation.

Over the years we have been guided by the wise counsel of our curriculum writers: Cheryll Adams, Renee Alister, Karen Berk, Fie Budzinsky, Meagan Bulger, Yvette Cain, Lori Cipollini, Leslie Chislett, Megan Coffey, Edie Doherty, Claire Farley, Kurt Haste, Carla Hill, MaryAnn Iadarolla, Caitlin Johnson, Megan Lamontagne, Donna Leake, Lisa Malina, Kay Rasmussen, Martha Rouleau, Cindy Strickland, Mary Grace Stewart, Kim Turret, Ann Marie Wintenberg, and Karen Zaleski. They have worked tirelessly on their curriculum units and provided us with many insights into the curriculum writing process. Although we had a road map at the outset of the writing process, our writers helped us to craft new roads when the old ones no longer worked. We thank them for their integrity, care, innovativeness, and encouragement.

We thank all of the people who featured into the field testing process. These people include teachers in Cheshire, Hartford and Portland Public Schools. We especially want to thank the following building administrators who supported our work: Tory Niles and John Laverty from Hartford; Linda Cahill and Deborah Granier from Portland; and Steve Proffitt, Diane DiPietro, Sharon Weirsman, Russ Hinkley, Beverly Scully, and Mary Karas from Cheshire. The insights from teachers and administrators helped to make our curriculum units stronger and more practical.

Kim Allen, from Project LEARN, provided us with assistance and support in all of our endeavors and made sure that we stayed the course in solid financial standing. Nancy Wight and Gail Heigel, from Cheshire Public Schools, spent untold hours formatting, typing, duplicating, collating, and distributing the experimental units and ordering the numerous student materials and teacher resources that supplement these lessons. They are the masters of due diligence and attention to detail. We also wish to thank Eileen Williams and Patricia Johnson, from the State Department of Education, for formatting, typing, and preparing the pre-assessments and post assessments for the units. They worked tirelessly for many hours after work and on weekends to meet our deadlines and never lost their smiles.

We thank Cheshire Public Schools and the Connecticut State Department of Education for allowing us to take on this tremendous task and allowing us the hours within day (and night) to accomplish all that was required.

Our families and friends deserve special recognition because they offered unwavering support and encouragement. We recognize they made personal sacrifices, and we hope that we have grown as a result.

Most of all, we would like to thank Judy Walsh on whose shoulders these units truly stand. With the greatest of care and unparalleled thoughtfulness and consideration, Judy has edited each manuscript, worked collaboratively with each author to refine each lesson, written lessons when it was necessary, and provided a sense of humor and her wisdom as a teacher. She is selfless and seeks only to advance each author and the project. In every way, she has been our "North Star" on the project.

Format for the Project CONN-CEPT Curriculum Units

Each Project CONN-CEPT curriculum unit is formatted in the same way and contains four components: an overview, the lessons, a content map, and a comprehensive list of resources required in the unit. The *overview* is a chart that includes the lesson principles, concepts and skills, the time allocation, the standards that are explicitly addressed within each lesson, and a brief description of each lesson. The overview provides potential users with a "snap-shot" of the unit, related standards, and classroom activities.

The *lessons* follow the overview and vary in number depending upon the content area and grade level of the unit. Each lesson is comprehensive and addresses 10 curriculum components: content, assessments, introductory and debriefing activities, teaching strategies, learning activities, grouping strategies, products, resources, extensions, and differentiation activities. For the most part, each lesson provides specific information about each of these components. An aligned pre- and post-assessment is included for the entire unit, and aligned formative assessments are provided at critical junctures in the unit. Additionally, each lesson contains all the required black-line masters and materials.

Many lessons contain two features that are unique to Project CONN-CEPT materials: opportunities for Ascending Intellectual Demands (AID) and talent-spotting activities. Ascending Intellectual Demand is a term used to describe learning opportunities that require students to work at increasing levels of discipline-specific expertise (Tomlinson et al). They are appropriate for any student who demonstrates advanced ability or expertise in a discipline. The AID opportunities are labeled using the acronym AID. Additionally, many lessons contain searchlight opportunities. Searchlight opportunities are rich moments during a lesson for teachers to observe students and note those who appear to have heightened interest in the topic under investigation. To support these students' emerging interests, extension ideas are provided.

A *content map* comes after the lessons. Like the overview, the content chart is a snap-shot of the important knowledge in a unit: the major and minor principles, concepts, skills, themes and guiding questions. Teachers who want in-depth information about the knowledge contained in the unit will find this chart useful.

A comprehensive list of *resource materials* concludes each unit. Although the required materials are also listed at the beginning of each lesson, the comprehensive listing provides teachers with a one-page summary of all the materials and it facilitates planning.

Introduction Weather: The Never-Ending Story – Grade 6

This unit on weather has been designed using the Core Curriculum parallel. Core Curriculum addresses the core concepts, principles, generalizations, and skills of a subject area. It is designed to help students understand essential, discipline-based content through the use of representative topics, inductive teaching, and analytic learning activities. Although the majority of lessons in this unit have been designed using the Core Curriculum parallel, it also contains a number of lessons that provide grade six students with opportunities to explore the methodology of the practicing professional (Curriculum of Practice) as well as a lesson with the Curriculum of Identity that gives students the chance to reflect on themselves as emerging scientists.

The unit contains 26 lessons, plus an introductory lesson and a debriefing lesson that are outlined in the chart below. The first column contains the lesson number and the name of the parallel(s) that the lesson addresses. The second column contains a series of numbers. The numbers reflect the national standards—culled from *National Science Education Standards* (National Research Council, 1996) and *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993)—that are addressed in each lesson and that are listed and numbered below. For brevity's sake, only one or two standards are listed in each row of the chart and represent the major focus of individual sessions. However, the lessons have been designed to build upon each other, and each session builds iteratively upon many of the standards. Connecticut's standards are also referenced here and are cited in the same column.

Column three contains the principles that guide the lesson. The principles—which state relationships among essential concepts—reflect what we want students to know and be able to do upon completing the lessons. They are derived from the standards, reflect both declarative and procedural knowledge, and illustrate the careful attention that has been given to "teasing apart" the complexity of ideas contained within standard statements.

Column four includes a brief description of the lesson. It provides an overview of some of the teaching and learning activities that are designed to occur within the classroom.

National Standards

Earth and Space Science

1. Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soils, and in rocks underground. (*National Science Education Standards*, 5-8)
2. The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different properties at different elevations. (NSES*, 5-8)
3. Clouds, formed by the condensation of water vapor, affect weather and climate. (NSES, 5-8)
4. Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat. (NSES, 5-8)
5. The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. (NSES, 5-8)

Physical Science

6. Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways. (NSES, 5-8)

Scientific Inquiry

7. Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models. (NSES, Science as Inquiry, 5-8)
8. Mathematics is important in all aspects of scientific inquiry. (NSES, 5-8)
9. Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations. (NSES, 5-8)
10. Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories. The scientific community accepts and uses such explanations until displaced by better scientific ones. (NSES, 5-8)

The Scientific Enterprise

11. Accurate record-keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society. (*Benchmarks for Science Literacy*, 6-8)

Systems

12. Thinking about things as systems means looking for how every part relates to others. The output from one part of a system (which can include material, energy, or information) can become the input to other parts. Such feedback can serve to control what goes on in the system as a whole. (BSL**, 6-8)
13. Any system is usually connected to other systems, both internally and externally. Thus a system may be thought of as containing subsystems and as being a subsystem of a larger system. (BSL, 6-8)

*National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

**American Association for the Advancement of Science. (1993). Project 2061: *Benchmarks for science literacy*. New York: Oxford University Press.

Connecticut Related Content Standards

I Scientific Inquiry

Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena.

Scientific inquiry progresses through a continuous process of questioning, data collection, analysis and interpretation.

Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists.

Scientific Literacy

Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science.

Scientific literacy also includes the ability to search for and assess the relevance and credibility of scientific information found in various print and electronic media.

Scientific Numeracy

Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.

Grade 6

6.3 Energy in the Earth's Systems

How do external and internal sources of energy affect the earth's systems?

Variations in the amount of the sun's energy hitting the earth's surface affect daily and seasonal weather patterns.

- Local and regional weather are affected by the amount of solar energy these areas receive and by their proximity to a large body of water.
    - o C 7. Describe the effect of heating on the movement of molecules in solids, liquids and gases.
    - o C 8. Explain how local weather conditions are related to the temperature, pressure and water content of the atmosphere and the proximity to a large body of water.
    - o C 9. Explain how the uneven heating of the earth's surface causes winds.

Grade 4

4.3 Energy in the Earth's Systems

How do external and internal sources of energy affect the earth's systems?

Water has a major role in shaping the earth's surface.

- Water circulates through the earth's crust, oceans and atmospheres.
  - o B 12. Describe how the sun's energy impacts the water cycle.
  - o B 13. Describe the role of water in erosion and river formation.

Module & Lessons	Standards	Lesson principles	Lesson description
Introduction (CORE) 35 minutes	12 CT Standards: I (Expected Performances: C INQ. 7, 8, 9, 10)	• The sun, land, air and water interact to create our local weather. • Parts of a system influence one another.	In the first lesson of this weather unit, students will be introduced to the weather through pictures of different kinds of weather in all geographic areas of the earth. They will see that weather is different in every location. In addition, they will be introduced to the major components of the weather system: the sun, land and water, and the water cycle. Finally, students will have the opportunity to think about why weather is relevant to them.
Lesson 1 (CORE) 40 minutes	2, 4 CT Standards: I (Expected Performances: C INQ. 1, 9, 10)	• Geography influences local weather. • Altitude (elevation) and latitude influence local temperatures. • Local weather is usually warmer in places that are closer to the equator than places that are closer to the North and South Pole. • Local weather is cooler in places that are higher in altitude than places that are closer to sea level.	Students will learn about latitude and altitude and how they affect temperature in this lesson. Students will use a graphic organizer to scaffold their learning about this relationship as well as selected websites, with web cams, to learn about the effect of geography on daily weather.
Lesson 2 (CORE) 1 hour, 20 minutes	2, 7, 9 CT Standards: I (Expected Performances: C INQ. 1, 6, 7, 8, 9, 10)	• Geography influences local weather. • Local temperatures that are recorded over time reveal trends that enable meteorologists to draw conclusions and make predictions about local weather patterns.	Students will continue their exploration of temperature, latitude, and elevation in this lesson. They will learn how to read a newspaper weather map, make a line graph of temperatures, and keep their own temperature log book. The session will include graphing, and be a natural link to the mathematics curriculum.

Module & Lessons	Standards	Lesson Principles	Lesson description
Lesson 3 (CORE/ PRACTICE) 45 minutes	7, 9, 10 CT Standards: I (Expected Performances: C INQ. 5, 10)	• Meteorologists use their senses in order to make observations that help them learn about local weather. • Detailed, careful observations lead to accurate weather predictions.	In this lesson, students will learn how to make observations. At the beginning of the lesson they will talk about how they use their senses to make detailed observations about the world. In the later part of the lesson, they will have the opportunity to put their skills to use by observing key features of the weather.
Lesson 4 (CORE/ PRACTICE) 1 hour 20 minutes	1, 10, 11 CT Standards: I (Expected Performances: C INQ. 3, 5, 9, 10)	• A Beaufort scale estimates wind speed. • Wind speed and wind direction predict local weather. • When winds change direction and speed, it means a change in the weather will usually occur.	Students will learn how meteorologists measure wind and wind speed in this lesson. They will create a hand-held Beaufort scale to help them observe and estimate the force or speed of the wind. They will also use a compass to help them understand how to determine the direction of the wind.
Lesson 5 (CORE/ PRACTICE/ IDENTITY) 40 minutes	3, 7, 10 CT Standards: I (Expected Performances: C INQ. 5, 10) 6.3 (Expected Performances: C 8)	• The altitude and shape of clouds determine how they are classified by type: low, middle and high. • Data about cloud type and the amount of cloud cover predict local weather.	In this lesson, students will learn how to observe clouds and cloud cover. They will discover how to use their observations to record information in their weather journals.

Module & Lessons	Standards	Lesson Principles	Lesson description
Lesson 6 (CORE/ PRACTICE) 40 minutes	1, 7, 10 CT Standards: I (Expected Performances: C INQ. 3, 5, 10)	• Precipitation falls in many forms: rain, snow, hail, sleet, and freezing rain. • Precipitation can be measured with a rain gauge. • Over time, precipitation patterns help to predict local weather.	In this lesson, students will make a rain gauge that they will use to measure the precipitation daily during this weather unit.
Lesson 7 (CORE) 35 – 40 minutes	2, 6, 12 CT Standards: I (Expected Performances: C INQ. 3, 5, 9, 10)	• Air has properties: density, pressure, and temperature. • Air causes pressure. • The pressure of air, or atmosphere, is equal to the weight of the air directly above the point on the earth. • There are many "cells" of air on earth at any given time, each with different pressure. • Air "cells" move from one place to another across the globe. • When cells move and bump into each other, they interact to help create local weather.	In this lesson students will observe a demonstration that will help to make explicit that air has mass or weight that causes pressure. The class provides a background for the next lesson in which students will build their own barometer.
Lesson 8 (CORE) 40 minutes	2, 7, 11 CT Standards: I (Expected Performances: C INQ. 5, 9, 10) 6.2 (Expected Performances: C 8)	• Air /gas has properties: mass or weight, temperature and density. • Our atmosphere contains many different very large "cells" of air that have different pressure readings that move around the globe. • As cells move in the atmosphere, air pressure rises or falls in any given location over time. • Lighter air is warmer and /or more humid. • Heavier air is cooler and/or drier. • A falling barometer (decreasing air pressure) generally means warmer, moist air and/or precipitation. • A rising barometer (increasing air pressure) generally means cooler and/or drier weather. • Changing barometric pressure readings may indicate weather changes.	Students will create their barometer and use it to take air pressure readings.

WEATHER: THE NEVER–ENDING STORY

Module & Lessons	Standards	Lesson Principles	Lesson description
Lesson 9 (CORE/ PRACTICE) 1 hour, 20 minutes + ongoing time (10 minutes) each day	7, 10, 11 CT Standards: I (Expected Performances: C INQ. 5, 10)	• Weather data can be recorded and studied. • Weather predictions are based on trends and patterns that emerge from past data.	Students will learn how to set up their own weather station in this lesson. Although much more sophisticated data about the weather can come from outside sources, students will come to understand that they can collect their own weather information that is sufficient to create accurate weather predictions. For middle school students, this is an important realization and can be a powerful motivating force in this unit.
Lesson 10 (CORE) 50 minutes	5, 12 CT Standards: I (Expected Performances: C INQ. 2, 5, 10) 6. 3 (Expected Performances: C 9)	• The sun makes air move through our atmosphere to create local wind. • The sun releases light energy.	In this lesson students will have the opportunity to complete a pre-assessment for the module on the wind and learn about the sun as well. They will hear Margaret Wise Brown's narrative, *The Important Book*. Then, they will have the opportunity to look at pictures of the sun taken during the continuing NASA SOHO project. Finally, students will have the chance to think about why the sun is central to the weather system and the interaction among land, water, and air.
Lesson 11 (CORE/AID) 40 minutes	5, 6, 7 CT Standards: I (Expected Performances: C INQ. 5, 9, 10) 6.3 (Expected Performances: C 7)	• When sunlight is absorbed by the earth, it is transformed into heat energy which causes changes to earth's surfaces.	Students will extend their understanding of the power of the sun as a source of energy in this lesson. They will witness light energy being transformed from light into heat energy. In addition, they will apply their skill of observation to a demonstration about the power of the sun.
Lesson 12 (CORE/AID) 1 hour, 10 minutes	7, 10, 13 CT Standards: I (Expected Performances: C INQ. 5, 9, 10) 6.3 (Expected Performances: C 9)	• The earth's darker surfaces (e.g., dark soil, asphalt roadways, forests), absorb more sunlight (light energy) than lighter surfaces (e.g., snow, glacier ice) and, as a result, release more heat than the lighter surfaces. • When heat is trapped in our atmosphere, earth gets warmer. This is called the enhanced Greenhouse Effect or global warming. (AID)	In this lesson, the teacher will develop students' understanding of the principle: darker surfaces (e.g., dark soil, asphalt roadways, forests), absorb more sunlight (light energy) than lighter surfaces (e.g., snow, glacier ice) and, as a result, release more heat than the lighter surfaces. Students will participate in a simple experiment—involving black and white paper—that will provide them with the opportunity to construct their own understanding of the absorption rates of different colored surfaces. The black paper represents the darker surfaces on earth, while the white paper represents the lighter surfaces. The lesson also provides an alternate experiment (AID) for students who may already be familiar with absorption rates of different land surfaces and need increasing levels of challenge.

Module & Lessons	Standards	Lesson principles	Lesson description
Lesson 13 (CORE) 40 minutes	1, 8, 10 CT Standards: I (Expected Performances: C INQ. 3, 5, 6, 7, 10) 6.3 (Expected Performances: C 9)	• There is more water on earth than there is land. • Reasonable estimates of very large quantities require careful, logical thinking. • Percents and fractions represent part-to-whole relationships.	Students will learn about the skill of estimation in this lesson. In small groups they will work through an estimation problem as a class. Then they will move on to their lab sheet and follow the instructions to estimate the amount of water and land on earth's surface. Finally, they will share their strategies and their estimation with the class.
Lesson 14 (CORE/AID) 40 minutes	1, 8, 10 CT Standards: I (Expected Performances: C INQ. 5, 6, 7, 10)	• There is more water on earth than there is land. • Graphs, such a line graphs and pie charts, illustrate relationships between/among numbers.	Students will make a visual representation of their estimate about the amount of water and land on earth in this lesson. This session, like the one preceding it, addresses the principle: There is a great deal more water on earth than there is land. In order to construct their own meaning of what a percentage means, they will construct a pie chart of the surface of the earth using 100 1" squares of blue and brown construction paper. (AID) The lesson provides an opportunity for students who need more challenge.
Lesson 15 (CORE/AID) 48 minutes	4, 7, 10, 12 CT Standards: I (Expected Performances: C INQ. 3, 5, 8, 9, 10) 6.3 (Expected Performances: C 8)	• Water gains and loses heat more slowly than land. • Due to the unequal heating of land and water, shoreline areas that border large bodies of water will always be warmer in the winter and cooler in the summer than inland areas. • Interactions among sunlight, land, air, and water cause local weather.	In this session, students will learn about the different absorption rates of land and water. Specifically, water gains and loses heat more slowly than does land. Students will see this important principle at work in a demonstration. They will use graphing to see the different rates of warming and cooling in water and soil. At the end of this demonstration, students will be invited to think about how this difference in absorption rate affects weather. An AID activity to track temperatures in different locations is offered to students who need more challenge.

Module & Lessons	Standards	Lesson principles	Lesson description
Lesson 16 (CORE) 40 minutes	4, 7, 10 CT Standards: I (Expected Performances: C INQ. 1, 3, 9, 10) 6.3 (Expected Performances: C 7)	• When air is warmed, it gets lighter and rises.	Students will construct their knowledge of the invisible and abstract principle: warm air rises from a demonstration involving heated air. Through a subsequent discussion, students will come to see that warm air in the atmosphere behaves in the same way, but on a much larger scale.
Lesson 17 (CORE) 50 minutes	6, 7 CT Standards: I Expected Performances: C INQ. 1, 3, 5, 10) 6.3 (Expected Performances: C 7)	• Cool air sinks.	In this lesson and the next one, the teacher will develop students' understanding of the principle: Cool air sinks. Students will gain understanding of this abstract phenomenon from two demonstrations. In the first demonstration, students will observe how warm water behaves in cool water and vise versa. Once they see this interaction in a water medium, they will observe a second demonstration in the next lesson involving air. As a final step, and through a subsequent discussion, students will come to see that air in the atmosphere behaves the same way, but on a much larger scale.
Lesson 18 (CORE) 40 minutes	6, 7 CT Standards: C INQ. 1, 3, 5, 9, 10) 6.3 (Expected Performances: C 7, C 9)	• When air is cool, it sinks. • When warm air rises, cool air rushes in to take its place. • When cool air rushes in to take the place of warm air, local wind is created. • The greater the difference between the warm and cool air, the more quickly the air will move.	In this last lesson of the module, the teacher will further develop students' understanding of the principle: Cool air sinks. Students will further their knowledge of the abstract phenomenon from a second demonstration involving cold air. Finally through a whole class discussion, students will come to understand that air in the atmosphere behaves the same way as it did in the demonstration, but on a much larger scale.

Module & Lessons	Standards	Lesson principles	Lesson description
Lesson 19 (CORE) 40 minutes	10 CT Standards: I (Expected Performances: C INQ. 8, 9, 10) 6.3 (Expected Performances: C 7, C 9)	• When sunlight is absorbed by the earth, it is transformed into heat energy. • Darker surfaces on earth absorb more sunlight than lighter surfaces and, as a result, release (give off) more heat into the nearby atmosphere than do lighter surfaces. • When air is warmed, it gets lighter and rises. • When warm air rises, cool air rushes in to take its place. • When cool air rushes in to take the place of the warm air, local wind is created.	In this lesson, students will be working on the performance assignment, Tiny Tornadoes, a post assessment for the last 8 lessons.
GT Lesson (CORE) 45 minutes	4, 6, 7, 12 CT Standards: I (Expected Performances: C INQ. 3, 5, 9, 10) 6.3 (Expected Performances: C 7, C 8, C 9)	• When warm air rises and cool air sinks, local winds are produced. • Geography creates local winds. • The unequal heating and cooling of water and land creates sea and land breezes. • The unequal heating and cooling of mountain slopes and valleys creates mountain and valley breezes. • Winds affect air temperature. • Weather is the interaction among geography, the unequal heating of earth, and the water cycle.	This lesson for G/T students builds on their understanding of the behavior of warm and cool air and should be offered after Module 3, Lesson 19. In this demonstration, students will observe that local winds are produced when cool air rushes in to fill the space left by warm air that has risen. In addition, they will learn that local winds are more pronounced in some geographic areas: shoreline communities and mountains and valley communities.
Lesson 20 (CORE) 35 minutes	1, 12, 13 CT Standards: 4.3 (Expected Performances: B 12)	• The sun moves water in a cycle through the living and non-living parts of earth. • The rates of evaporation and precipitation balance each other. • The sun, land, air and water interact in a system to create our weather.	This is an introductory session about the water cycle. Students will work in small groups to develop an understanding of the word cycle. They will be introduced to the notion that water is always in a state of motion as it moves through the earth and atmosphere. The water cycle is the continuous process by which water moves through the living and non-living parts of our earth. It moves from bodies of water, land, and living things on earth's surface to the atmosphere and back to earth's surface. Students will be reminded that the sun is the source of energy that drives the water cycle.

Module & Lessons	Standards	Lesson principles	Lesson description
Lesson 21 (CORE/AID) 1 hour, 30 minutes – 2 hours (2-3 sessions)	1, 5, 7 CT Standards: I (Expected Performances: C INQ. 1, 3, 5, 8, 9, 10) 4.3 (Expected Performances: B 12)	• When water is heated by the sun, tiny particles of water, called water vapor, escape (evaporate) into the atmosphere in gas form.	This is the first session about the water cycle, and it will focus on evaporation. By observing two experiments, students will see that the sun heats earth's surfaces and causes water to enter the atmosphere as water vapor. Students who already understand the process of evaporation will have the opportunity to design their own experiment about this process (AID).
Lesson 22 (CORE) 40 minutes	1, 7 CT Standards: I (Expected Performances: C INQ. 3, 5, 9, 10) 4.3 (Expected Performances: B 12)	• When water vapor cools, it condenses back into liquid water.	This lesson is the first of two lessons about condensation. In this first lesson, students will be provided with two short, small-scale experiments to conduct. Working in pairs, students will be asked to explain what is happening in each. This lesson will serve as a foundation to the next lesson in which students will be looking at condensation in our atmosphere, a much larger-scale process which forms clouds.
Lesson 23 (CORE) 45 minutes	1, 3, 7 CT Standards: I (Expected Performances: C INQ. 1, 2, 9, 10) 4.3 (Expected Performances: B 12)	• Wind carries water vapor throughout the earth's atmosphere. • When warm air containing water vapor rises, the air cools which causes the water vapor to condense in the atmosphere above the earth to form clouds. • Meteorologists classify clouds according their shape and their altitude. • The altitude and shape of clouds reflect atmospheric conditions and can predict local weather.	Different types of clouds will be the focus for this session. Students will learn about the three, general types of clouds and what each type can signal for upcoming weather.

Module & Lessons	Standards	Lesson principles	Lesson description
Lesson 24 (CORE) 1 hour, 30 minutes	1, 3, 7, 11 CT Standards: I (Expected Performances: C INQ. 1, 2, 5, 10) 4.4 (Expected Performances: B 12)	• When the drops of water that form clouds are too heavy to float in the clouds, they coalesce and fall to the ground as precipitation. • Atmospheric conditions near the surface of earth determine the form that precipitation will take: rain, sleet, snow, and hail.	At the outset of this session on precipitation, students will be provided with the opportunity to examine mini-rainfalls in two demonstrations. With an understanding of precipitation as a backdrop, they will be provided with a graphic organizer to understand the "atmospheric anatomy" that leads to different forms of precipitation: snow, rain, sleet, freezing rain, and hail. At the conclusion of this session, students will have the opportunity to compare the rainfall amounts, as recorded in their weather logs, with the average rainfall for this time of year.
Lesson 25 (CORE) 38 minutes	1, 7, 12 CT Standards: I (Expected Performances: C INQ. 3, 5, 9, 10) 4.3 (Expected Performances: B 12)	• The sun causes water to move through our atmosphere in a never-ending cycle. • Precipitation absorbed by the earth becomes either ground water or run-off water. • Run-off water stays on earth's surface and flows into streams, brooks, rivers, lakes or oceans, thereby completing one turn of the water cycle. • Ground water is absorbed by earth and passes through rocks at different rates into ordinary wells, springs, and aquifers. The rate at which water can pass through spaces between earth's rocks is called permeability. • The permeability of a material increases with the size of space between the rocks. • Gravity pulls water in aquifers great distances. • Pressure causes some water in aquifers to return to the surface, in springs and geysers, where one turn of the water cycle is completed. • The amount of water removed by wells and springs must be equal to the amount returned to the ground. If more water is used than is returned, the water table will drop.	This lesson focuses on another aspect of the water cycle: ground water. Ground water refers to water that penetrates the earth's surface and travels through dirt and rocks as it makes its way into wells, springs, and aquifers. Students will observe a demonstration (small models of different types of soil) and make inferences to learn how ground water travels through the earth's crust. In addition, there is an extension activity related to aquifers, which are underground wells.
Lesson 26 (CORE) 1 hour, 15 minutes	1, 6, 7 CT Standards: I (Expected Performances: C INQ. 9, 10) 4.3 (Expected Performances: B 13)	• The sun causes water to move through our atmosphere in a never-ending cycle. • Precipitation absorbed by the earth becomes either ground water or run-off water. • Gravity pulls run-off water over the earth into streams, brooks, rivers, lakes and eventually oceans, thereby completing one turn of the water cycle. • Running water (e.g., streams, brooks, and rivers) is very powerful and erodes—or wears away—soil and changes the earth.	Students learn about a final aspect of the water cycle: what happens to precipitation once it comes back to earth. Precipitation that returns to earth can be categorized as run-off water or ground water. Run-off refers to water which travels over the surface of earth into brooks, streams, rivers, and eventually into lakes and oceans. Ground water refers to water that penetrates the earth's surface and travels through dirt and rocks as it makes its way into underground wells and aquifers.

Module & Lessons	Standards	Lesson principles	Lesson description
Lesson 27 (CORE) 1 hour, 20 minutes	1, 7 CT Standards: I (Expected Performances: (C INQ. 3, 5, 8, 10) 4.3 (Expected Performances: B 12)	• The sun moves water in a cycle through the living and non-living parts of earth. • When water is heated by the sun, tiny particles of water, called water vapor, escape into the atmosphere. • Water vapor cools as it rises in the atmosphere and condenses back into liquid water to form clouds. • When drops of water inside a cloud bump into each other, they clump together (coalesce). • When drops of water become heavy enough, the air can no longer hold them up and they fall as precipitation (rain). • Precipitation falls on every surface of earth to complete one turn of the water cycle.	This session includes a performance assessment for the water cycle module. Using a plastic jar, students are asked to create a small model of the water cycle and explain how their choice of materials will support and sustain the model. A scoring rubric is provided. An optional extension is included in this performance assessment. If time is available, students can observe their model in operation over five days. A worksheet is provided so that students can document their observations. Furthermore, a reflection sheet is included to "jump start" students' thinking about their observations.
Unit Debriefing (CORE) 40 minutes		All principles in unit	In this last session of the unit, students will be reviewing the concept map that has guided their investigation in this weather unit. As written, this unit debriefing is constructed so that students play a large role in the debriefing process. They will work in small groups to synthesize the important concepts and principles for each of the four modules in this unit: geography, predicting weather, wind, and the water cycle. To be expected, student involvement requires time. If time is not available, this debriefing can be conducted by the teacher. Instead of breaking students into small groups, the teacher can highlight and underscore the important concepts and principles in each module.

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National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

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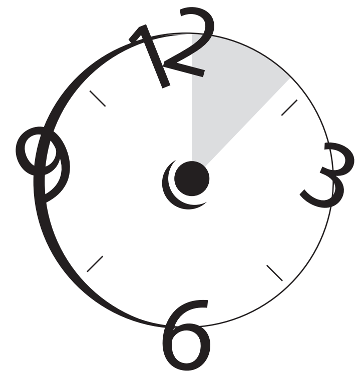
“Introduction”

Introduction

Core

Time Allocation: 35 minutes

Required Materials and Resources on Page 311



Lesson Overview

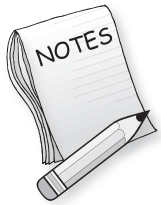
In the first session of this weather unit, students will be introduced to the weather through pictures of different kinds of weather in all geographic areas of the earth. They will see that weather is different in every location. In addition, they will be introduced to the major components of the weather system: the sun, land and water, and the water cycle. Finally, students will have the opportunity to think about why weather is relevant to them.

Guiding Questions

- What is weather?
- How is weather like a system?
- What is interaction?
- What effect does weather have on our daily lives?

BIG IDEA

What are the different ways that weather affects our lives?



Content Goals

Universal Theme

System

Principles and Generalizations

- The sun, land, air and water interact to create our local weather.
- Parts of a system influence one another.

Concepts

- Sun
- Land
- Air
- Water
- Interact
- System

Teacher Information

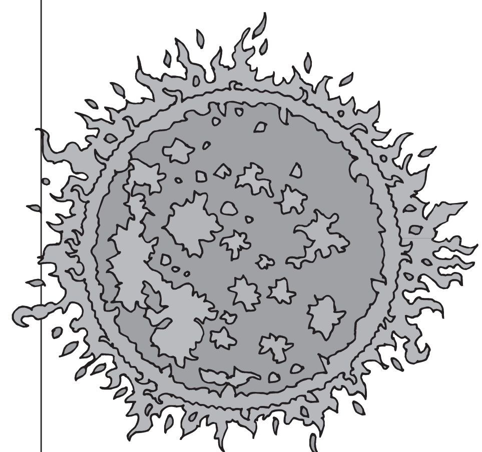
- Weather-A term that refers to current conditions of temperature, precipitation, and wind. Sometimes, it is incorrectly used interchangeably with climate. Climate is the average weather conditions that have occurred over decades. Climate is a more sophisticated topic that will not be covered in this unit.
- System – a collection of things and/or processes that interact to perform some function

Skills

N/A

Materials and Resources

1. Pictures of weather from www.google.com
2. Concept map for the weather unit
3. Six - ten recent news articles about the weather
4. Flip chart paper
5. Markers
6. A picture book of Rube Goldberg machines or downloaded pictures of Rube Goldberg machines from www.google.com



Preparation Activities

1. Make enough copies of the concept map for each student in the class. Place copies of the map at students' desks.
2. Go to google.com Click on the pop-up menu arrow on the google button. Select "google images" from the pop-up menu. Then, type in any weather related words. If you type in hurricanes, for example, 23,000 images are located in 0.3 seconds. If you type in clouds, 111,000 images of clouds are located in 0.11 seconds. Make a collection of weather related images and download them onto your computer. Make sure that you include in your collection pictures that represent the different components of the weather system: the sunlight, pictures of water and land masses, wind, and precipitation.
3. In the same way, locate 2-3 pictures of Rube Goldberg machines. Using google images, type in, Rube Goldberg machines. The search engine located 715 images in 0.06 seconds.
4. Prior to the start of this unit, make a collection of 6-10 current weather-related articles from newspapers and magazines. Begin a bulletin board of the articles. You will want to get students to add to and help you maintain the bulletin board throughout the upcoming unit. The purpose of the bulletin board is two-fold: (1) to peak students' interest in weather and (2) to underscore how much weather influences our lives.

Introductory Activities (5 minutes)

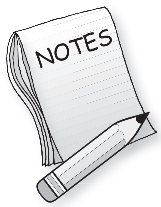
Convene students in a whole group and explain that they are about to begin a new science unit. It is about a topic that they already know a lot about. They live with it every day. It is so powerful a topic that people of all ages everywhere talk about it every day. It is weather. Using the chart paper, ask students to provide you with different ways that weather influences their lives every day. The list will be long and illustrate for students that weather is powerful and affects every aspect of our lives

Pre-assessment

N/A

Teaching and Learning Activities (30 minutes)

1. Keeping students as a whole group, ask for student responses to the following question: What is weather?



2. Listen and accept all responses.

3. Tell students you are about to show them a collection of pictures. They are to think about ways to classify the pictures.

4. Seek responses about their classification schemes. Using Socratic questioning, help them see that the pictures can be categorized as components of the weather system: sun/sunlight, air and land formations, wind, and water in all its forms (puddles, clouds, fog, dew, frost, rain, sleet, hail, and snow).

5. Define system for students. If you like, you can explain the weather system like a Rube Goldberg machine. Explain that his are fanciful and funny, but that all parts interact to perform a function. In the natural world, the parts of the weather system all interact and affect one another to create our local weather. Each part of the system plays an important part in creating the whole.

6. Explain to students that over the course of the next six weeks, they will be studying about the different components of the weather system and learning how they interact to create our daily weather.

7. Their job will be to learn as much as they can about the weather. They will learn: how geography influences weather; how to make simple weather instruments and predict daily weather, how the sun is the source of all our weather; how the unequal heating of the earth causes local wind; and how the water cycle works.

8. Explain that—by the end of the unit—they will understand the concept map that is on their desks.

9. Invite students to look at the map. Using the concept map as a graphic organizer, trace with your finger the interaction among the weather components: the sun heats the earth unequally, which causes local winds. At the same time, the sun is moving water throughout all the living and non-living parts of the earth. The wind helps to move the water that enters our atmosphere.

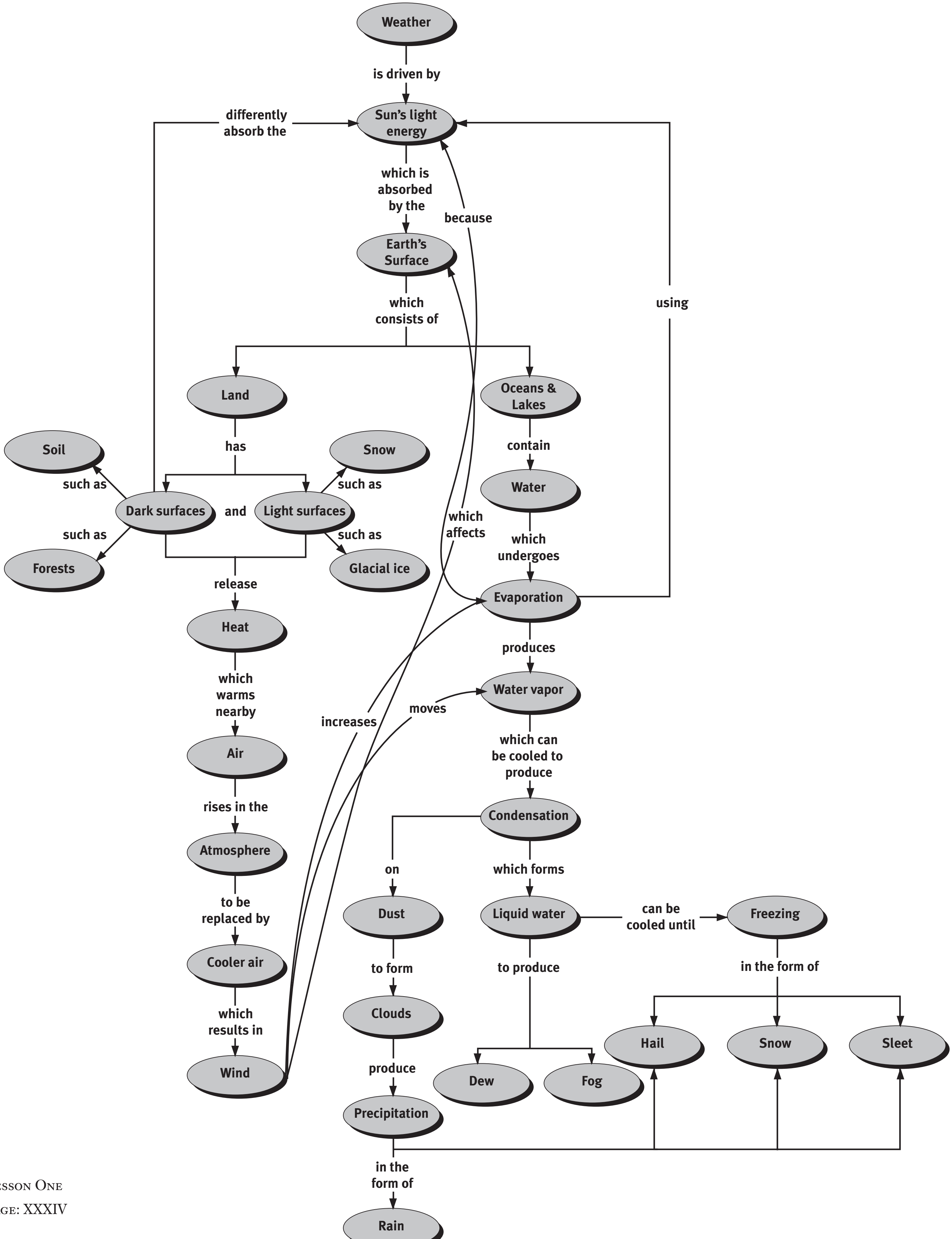
10. Return to the influence that weather has on our lives. Explain to students that you will need their help with a bulletin board that has been started about the effect that weather has on our lives. Point out where you have posted the "starter set" of articles and pictures. Invite students to be looking for articles and pictures that they would like to contribute to this ongoing display.

Products and Assignments
N/A

Extension Activities
N/A

Post Assessment
N/A

Debriefing and Reflection Opportunities
N/A

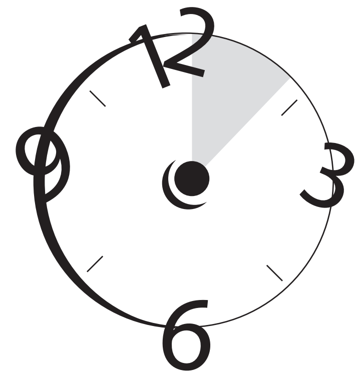

Weather
is driven by
Sun's light energy
differently absorb the
which is absorbed by the
because
Earth's Surface
which consists of
using
Land
Oceans & Lakes
has
contain
Soil
Snow
such as
such as
Water
Dark surfaces
and
Light surfaces
such as
such as
which affects
Forests
Glacial ice
which undergoes
release
Evaporation
Heat
produces
which warms nearby
Water vapor
moves
increases
which can be cooled to produce
Air
rises in the
Condensation
Atmosphere
on
which forms
to be replaced by
Dust
Liquid water
can be cooled until
Freezing
Cooler air
to form
to produce
in the form of
which results in
Clouds
Hail
Snow
Sleet
Wind
produce
Dew
Fog
Precipitation
in the form of
Rain

It's The Geography

Core

Time Allocation: 40 minutes (1 Day)

Required Materials and Resources on Page 311



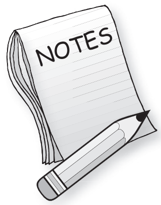
Module Overview

Students began this curriculum unit with an overview about the weather as a system. Specifically, they learned that the sun is the energy source for all our weather and that it interacts dynamically with air, land and water.

Besides the sun, there are other factors that determine daily weather. In this module, students will learn about two important factors that control temperature: latitude and elevation. Latitude is the distance from the equator, while altitude is the height above sea level. Students will construct their understanding of this cause and effect relationship by tracking the daily temperatures of pairs of cities that have been carefully selected to illuminate this principle.

BIG IDEA

Location,
Location,
Location.
1



Lesson Overview

In this session, students will learn about latitude and altitude and how they affect temperature. They will use a graphic organizer to scaffold their learning about this relationship as well as selected websites, with web cams, to learn about the effect of geography on daily weather.

Note: This session will take two days if you find that students are not familiar with longitude and latitude. Spend one session introducing and explaining the concepts of longitude and latitude as "world addresses." Dedicate the next session to the content that is outlined below.

Students may not be familiar with the concept of elevation. You may need to spend time explaining that elevation is another word for height above sea level.

Guiding Questions

- What is the relationship between the daily temperature of a place and its nearness to the equator?
- What is the relationship between the daily temperature of a place and how high it is above sea level?
- What is a cause and effect relationship?

Content Goals

Universal Theme

Location

Principles and Generalizations

- Geography influences local weather.
- Altitude (elevation) and latitude influence local temperatures.
- Local weather is usually warmer in places that are closer to the equator than places that are closer to the North and South Pole.
- Local weather is cooler in places that are higher in altitude than places that are closer to sea level.

It's The Geography

Concepts

- Geography
- Temperature
- Equator
- Latitude
- Elevation
- Altitude
- Sea level
- North Pole
- South Pole
- Cause
- Effect

Teacher Information

- Latitude is the distance from the equator
- Altitude is height above sea level.
- Different altitude, same latitude (approximately) Acapulco, Mexico (altitude: 72 feet; Mexico City, Mexico (altitude: 7,572 feet) Mount Washington, NH (altitude 6,288 feet); Concord, NH (altitude 288 feet)
- Different latitude, same elevation (approximately) Miami Beach, FL (26 degrees N. latitude) Bangor, ME (45 degrees N. latitude) Jakarta, Java (06 degrees S latitude); Juneau, AK 58 degrees N latitude)

Skills

- Find latitude
- Determine altitude
- Identify cause and effect

Materials and Resources

1. A globe, placed on a table where all students can see
2. Two flat maps of the world that show mountains
3. If maps are not available, the following web site has small, but useable maps that show countries, latitude, and the major mountain ranges in the world: http://www.eduplace.com/ss/maps. These maps may be printed and copied for personal or classroom use.

4. Pictures of vacation spots (1) in the mountains and (2) at resorts in the Pacific and Caribbean
5. Enough copies of Cause and Effect Graphic Organizer for each student to have one
6. Sticky notes at each cluster of desks for students to use, as needed
7. Access to a classroom computer to access web cams for the top of Mt. McKinley and Mt. Rainier

Preparation Activities

1. Gather the pictures or brochures from the newspaper or travel bureau.
2. Access the two websites at the tops of Mt. McKinley and Mt. Rainier: Mt. McKinley (Mt. Denali)
   http://akweathercams.faa.gov/wxcams/wxcampublic.php?Location=McKinley
   Mt. Rainier, WA
   http://www.skicrystal.com/img/crystalcams/cmsnowcam.jpg
3. Make enough copies of the world maps.
4. Make enough copies of (1) **Temperature Log: Does Higher Always Mean Colder,** and (2) **Cause and Effect Graphic Organizer.** Place the copies at students' desks.
5. Place maps and sticky notes at students' desks.

Introductory Activities (5 minutes)

- Convene a whole class meeting and arrange students into groups of 3-4. Tell students that they are going to hear two stories that relate to weather. After each story, each group will have a chance to answer a question that you will ask.
- Story 1: The 3 H's: Hazy, Hot and Humid
  The sun is coming up over the horizon on another hot day. You slept with just a sheet last night, and you were still hot. The coolest temperature overnight was 70 degrees. Already, the temperature has started to climb, and the haze just makes it feel hotter.
- Ask students: What else might you feel like on a hot summer morning, when the temperature is already close to 80 degrees, and it is not yet 10:00 AM?
- Hold up pictures of the mountains. Ask students, why do people seek out the mountains as a way to escape the heat of summer?

- Story 2: The Winter Story
  Describe a typical winter day. It is cold outside, about 20 degrees. The sky is overcast, and the wind is beginning to pick up. It whips through your coat and mittens and makes you tuck your head into your coat. Dead, dry leaves scratch and tumble across the sidewalks, and tiny pieces of piercing ice are being hurled to the ground by the wind.
- Hold up the travel brochures from the Caribbean, Hawaii, or the South Pacific. Ask students: What do we know about these places? Why are they popular travel destinations in the winter?

Pre-assessment

N/A

Teaching and Learning Activities (30 minutes)

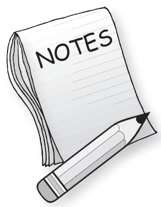
1. Invite students to use sticky notes to write down any questions they might have as the lesson unfolds. Tell students you will answer them at selected times throughout the lesson.

2. Ask students to focus their attention on the globe that you have placed on a table that they can all see.

3. Explain that any location on earth is described by two numbers –its latitude and its longitude. Like their house, each place on earth has a "street address." With respect to the weather unit that they will be studying, they will be concerned mostly with the address that comes from latitude, not longitude.

4. On a globe of the earth, lines of latitude are circles of different size. Show students the globe and point out latitude lines.

5. The longest or "fattest" is the equator, whose latitude is zero, while at the poles–at latitudes 90° north and 90° south (or -90°) the circles shrink to a point. The equator divides the world into the Northern and Southern Hemispheres. The equator is 0 degrees latitude; the North Pole is 90 degrees N latitude; the South Pole is 90 degrees S latitude.
6. Students need to understand that the equator is an imaginary line that designates a location around the "fattest" part of the globe. They will probably know that the daily weather is generally warmer as we move toward the equator and generally cooler as we move away from the equator.



7. Ask students what they have heard about temperatures at or near the equator and listen for any misconceptions. What is important about latitude and daily weather is that places near the equator have temperatures that are warmer, generally, than places that are farther away from the equator, either to the north or south.

8. Ask students: What we can conclude about the relationship between latitude and daily weather? The answer: latitude affects temperature, a feature of daily weather.

9. Give students the following names of countries: Canada, Antarctica, Mexico, and Northern Brazil. Ask students to find them on the map with you. Then, ask students to rank order the countries from coldest to warmest and come to consensus within their groups.

10. Invite students to share any questions they may have written on sticky notes.

11. Ask students what happens to the temperature when you go up a mountain. Students will probably share that it gets cooler the higher you go.

12. Locate Connecticut on the globe. Explain to students that it is considered at sea level. Sea level means little or no elevation. The shoreline of Connecticut has very little elevation. The elevation of Mount McKinley in Alaska has a very different elevation (20, 320 feet). Mt Rainier in Washington State also has a high elevation (11,500 feet). Websites for live mountain cams:
    Mt. McKinley (Mt Denali)
    http://akweathercams.faa.gov/wxcams/wxcampublic.
    php?Location=McKinley

    Mt. Rainier, WA
    http://www.skicrystal.com/img/crystalcams/cmsnowcam.jpg

13. Ask students: How does elevation affect daily temperature? Students will provide a variety of responses, but will see that the higher the altitude, the lower the daily temperature, in general

14. By way of summary share with students that there is the same relationship between daily temperature and altitude and latitude. The higher the altitude or latitude, the lower the temperature.

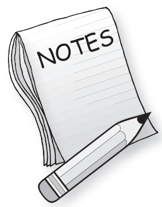
15. Explain to students that the relationship between daily temperature and altitude and latitude can be considered a cause and effect relationship. That is, one event or condition causes, or is associated with, another event or condition.

16. Ask students to look at the graphic organizer, Cause and Effect Graphic Organizer, which is placed at their table. Explain that graphic organizers help people visualize things that may be hard to see and understand. In the graphic organizer that students have, there are two columns. The first column is for cause and the second column is for effect. To better understand the relationship between cause and effect, we can say the words that are under each of the column headings: When (fill in the name of the situation or condition that causes the effect to happen), (describe what happens, the effect).

17. Invite students to try the graphic organizer with altitude and then latitude. "When altitude increases (cause), temperature decreases (effect)." "When latitude increases (cause), temperature decreases (effect)."

Products and Assignments
As a homework assignment, tell students that you want them to think of this unit as a ticket to travel just about any place in the world. Ask them to think of one place they would like to travel for the next session.

Extension Activities
Interested students may be encouraged to pursue why temperature decreases with altitude. On average, for every 1-kiloometer increase in altitude, the temperature decreases 6.5 degrees. This is called the environmental lapse rate, a very sophisticated concept. More information can be found at the following websites:
http://www.uwsp.edu/geo/faculty/ritter/glossary/e_g/environmental_lapse_rate.html
http://www.usatoday.com/weather/wstabil1.htm



Post Assessment
N/A

Debriefing and Reflection Opportunities (5 minutes)
Remind students that they are studying about weather. There are many factors that affect our weather. Share that they began the unit thinking about the all the factors: the sun, land, water and air. Two other factors are elevation and latitude. Ask student, who are still in their small groups, to talk about the cause and effect relationship among temperature, latitude and elevation. Which is the cause? Which is the effect? Why?

Cause and Effect Graphic Organizer

Name: ___________________________________

Subject:__________________________________

Cause	Effect
(When…)	(these events or conditions happen…)
Examples:	
• If you go outside when it is raining…	• You will get wet.
• If you don't fill up the car…	• It will eventually run out of gas.

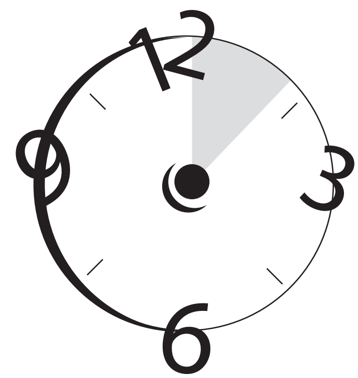
It's The Geography

Core

Time Allocation: 1 hours, 20 minutes

Required Materials and Resources on Page 311

This session will take 2-40 minute periods. In the first time block, cover the content as outlined below. Provide students with the opportunity to collect their data individually, pairs or small groups, either in class or for homework. During the second 40-minute time block, ask students to summarize their individual data sets. Use class time to summarize all the data sets and debrief with students.



Lesson Overview

Students will continue their exploration of temperature, latitude, and elevation in this session. They will learn how to read a newspaper weather map, make a line graph of temperatures, and keep their own temperature log book.

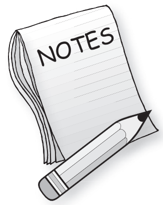
This session will include graphing, and be a natural link to the mathematics curriculum. By sixth grade, students should have an elementary understanding of line graphs.

Guiding Questions

- How do you read temperature information from a newspaper weather map?
- How do you find information about temperature from the Internet?
- How do you construct and read a line graph?
- What is the relationship between the daily temperature of a place and its nearness to the equator?
- What is the relationship between the daily temperature of a place and how high it is above sea level?

BIG IDEA

**Location,
Location,
Location.
2**



Content Goals

Universal Theme

Location

Principles and Generalizations

- Geography influences local weather.
- Local temperatures that are recorded over time reveal trends that enable meteorologists to draw conclusions and make predictions about local weather patterns.

Concepts

- Newspaper weather map
- Line graph
- X axis
- Y axis
- Ordered pair
- Trend

Teacher Information

- Different newspapers have different formats for their weather information.
- Most newspapers give the daily forecast along with the forecast for the next several days.
- Weather pages usually give temperatures around the country and world.
- Many weather pages have a map of the United States that shows temperature and precipitation.
- A line graph is one way to show data and how it changes over time
- The vertical axis is the "up and down" part of a graph
- The horizontal axis is the "left-to-right" number on a line graph
- Coordinates are the ordered pairs of numbers used to make the dots on the line in a line graph.
- The first number in an ordered pair of numbers is plotted on the X-axis; the second number is plotted on the Y axis.
- Different altitude, same latitude
  Acapulco, Mexico (altitude: 72 feet; Mexico City, Mexico (altitude: 7,572 feet)
  - o Acapulco, MX http://weather.noaa.gov/weather/current/MMAA.html

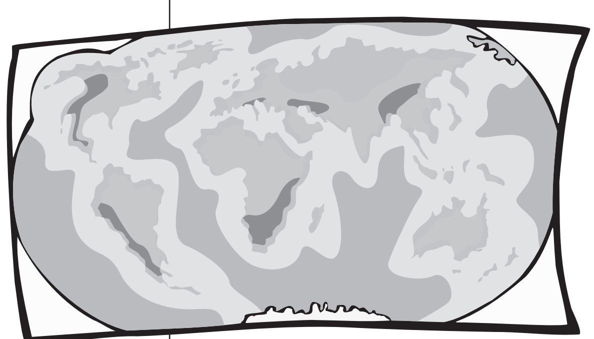
- o Mexico City, MX http://www.wunderground.com/global/MX.html
- o Cuzco, Peru (altitude: 11,300 feet); Lima, Peru (altitude: 394 feet)
- o Cuzco, Peru: http://www.wunderground.com/global/stations/84686.html
- o Lima, Peru http://www.wunderground.com/global/stations/84628.html
- o Mount Washington, NH (altitude 6,288 feet); Hartford, CT (altitude 233 feet)
- o Mount Washington: http://www.wunderground.com/US/NH/Mount_Washington.html
- o Hartford, CT: http://www.wunderground.com/US/CT/Hartford.html

• Different latitude, same elevation

- o Tampa, FL (26 degrees N. latitude) Bangor, ME (45 degrees N. latitude)
- o Tampa, FL: http://www.wunderground.com/US/FL/Tampa.html
- o Bangor, ME: http://www.wunderground.com/US/ME/Bangor.html
- o Jakarta, Java (10 degrees S latitude) Anchorage, AL 62 degrees N latitude)
- o Jakarta: http://www.wunderground.com/global/stations/96745.html
- o Anchorage: http://www.wunderground.com/US/AK/Anchorage/PANC.html

Skills

- Read a newspaper weather map
- Gather world-wide temperature information from the Internet
- Chart ordered pairs of numbers to create a line graph
- Interpret a line graph



Materials and Resources

1. A globe, placed on a table where all students can see.
2. Two flat maps of the world that show mountains.
3. Enough copies of newspaper weather maps so that each group of 3-4 students has one to use.
4. A computer that has Internet access that all students can see.
5. Three-four pieces of blank paper on each cluster of desks
6. Enough copies of **Does Higher Always Mean Colder?** for each pair of students in the class
7. An overhead of **Does Higher Always Mean Colder?** Make sure that you have filled in temperatures on the X-axis and the dates on the Y axis.

8. Two different colored overhead markers
9. Colored pencils or markers for students
10. Enough copies of the rubric that will be used to assess students' line graphs when they are completed: **The Effect of Latitude and Elevation on Local Temperatures**

Preparation Activities

1. Cut out the weather maps from the newspaper. Make sure there is one copy for each group of three-four students. Place the maps into a suitcase that you will bring to class as a prop for the introduction to this session.
2. Place three-four pieces of paper at each group of desks.
3. Go to the weather sites listed below to make sure that you can access the links quickly for students. Pick out one or two sites that look particularly interesting for them.
   - http://cirrus.sprl.umich.edu/wxnet/wxcam.html UM Weather's newly-expanded Weather Cams page provides access to over 800 weather cameras across North America
   - http://www.weatherimages.org/weathercams This is a one-stop weather site. From here, you can get radar and satellite imagery, other weather maps, and cool weather cam views.
   - http://www.mountwashington.org This is the Mount Washington Weather Observatory. The site contains regular updates on weather information and a live cam that looks out on the summit

Misconception Alert: Many students at this age are still very concrete thinkers. They may have trouble understanding that temperature decreases as elevation increases. Some students may think about how hot it gets in their attic, and believe that as you go up, temperature increases. They are lumping closed systems (e.g., the attic) with systems that are open (e.g., the atmosphere). Probe their level of understanding. Then, use Socratic questioning to help them "discover" that temperature decreases as elevation increases. Try posing questions such as the following: Describe your attic. Does it have a roof? Walls? How might this "closed" area affect the temperature? Why do we see pictures of snow-capped mountains? What kinds of clothes do you pack when you plan a climb to the top of a mountain? Why? How is this outside area different from the attic?

Introductory Activities (3 minutes)

Carry a suitcase to the front of the room and place it on a table where all students can see it. Arrange students into groups of three-four. Remind students that their assignment last night was to think of a place they wanted to travel. Ask students to share their destinations. Then, explain that they will be traveling all over the world today to look at temperatures in different places.

Pre-assessment

N/A

Teaching and Learning Activities (40 minutes)

1. Take the weather maps out of your suitcase and distribute one to each cluster of tables.

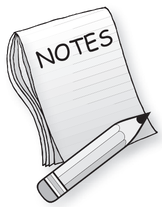
2. Ask how many students have ever looked closely at the weather map in the newspaper. Ask students to share what they have learned from looking at newspaper weather maps. Listen to what students have learned.

   SEARCHLIGHT: Watch and listen for students who are already genuinely interested in the weather, as well as those who seem to perk up with the discussion about weather. Jot these students' names down so that you don't forget. Make sure that you see these students afterwards so that you can show them books and sites related to meteorology that are listed on a separate sheet included with this session.

3. Invite students to spend one minute or so listing all the information that they can see on their weather maps. Tell them that they can use the blank pieces of paper at their desks to make their lists.

4. Review the kinds of information that students have gathered from looking at their newspaper maps.

5. Invite students to think about the Internet and how it can supply us with a great deal of weather information. Explain that there are many weather cams all around the world that show us many different kinds of weather information, including the temperature. Show them one or two of the sites that you picked out at the beginning of this module.



6. Tell students that they will be using the Internet and/or the newspaper to gather information about the temperature of different places in the world. Share with them that their job over the next two weeks is to figure out the effect of elevation and latitude on temperature.

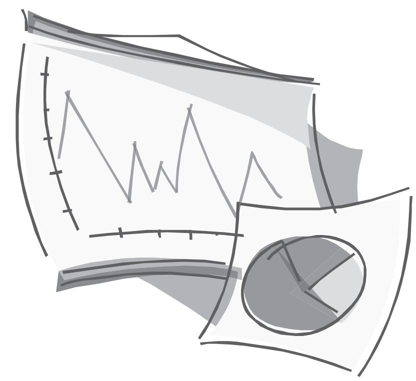
7. Ask students to look at the newspaper maps (*Hartford Courant*) in front of them. Point out three features that will help them in their understanding of weather and help them to complete their long-term graphing project on the effect of latitude and elevation on temperature.

   a. *Colored Maps*. The insert of the Connecticut area shows temperature and cloud cover. The larger map of the U.S. shows temperature, precipitation, and wind pattern and jet stream. Point out each of these features to students.
   b. *The Almanac*. This section shows precipitation for the day before, as well as the precipitation for the last 30 days. The Almanac also traces temperature for the day before and the last 30 days. Point out this feature and explain it to students.
   c. *Around the World*. This section will prove particularly helpful for students in their graphing assignment. All the cities for which they need temperature information are listed on this page. Show students that there are 3 lists of temperatures: New England, National, and World. They will use different lists depending on the pair of cities they have selected.

8. Explain to students that over the next two weeks they will have the opportunity to visit the computer or use the newspaper to gather information about the temperature of a pair of cities. The cities have been chosen carefully so that they can see the effect of elevation and latitude on temperature. Explain that each day you will be bringing in a copy of the weather map from the newspaper and posting the information at a center in the room.

9. Students can work in dyads for this assignment.

10. Share that each pair of students will have to choose where they will be visiting, either a, b, c, or d.
    a. Acapulco, Mexico; Mexico City, Mexico
    b. Cuzco, Peru; Lima, Peru
    c. Mount Washington, NH; Concord, NH
    d. Miami Beach, FL; Bangor, ME
    e. Jakarta, Indonesia; Juneau, AK

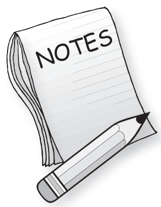


11. Three times a week they will need to visit the center to record information about their cities. For example, if students chose "a," they would have to look up the temperature for both Acapulco and Mexico City. (Be sure to make a record for yourself about the temperatures each day in the targeted cities. You will use your data to check the accuracy of student's completed line graphs.)

12. What will students do with the information once they have their temperatures?

13. Explain that a graph is a special tool that many people use to keep a long-term record of information. It shows how something, like temperature, changes over time. When we look at information or data over time, we can look for trends, a general tendency or movement in the numbers (i.e., early spring temperatures in New England are usually cooler than late spring temperatures). We can learn a lot more about temperature if we keep track of these trends and analyze them over the long-term.

14. Go to the overhead projector. Show students the overhead of the graph form that they will be using to plot their temperatures. Show them the X and Y-axis. The X axis, or the "up and down" axis, represents the temperature. The Y-axis, the left-to-right line, represents time or days. Select a pair of cities and use two colored overhead pens to illustrate for students how they will use the information from the newspaper or internet to plot the temperature. Plot the two points for each city: one from the day before and one from the current day's paper.



15. Show students how to mark the intervals on each axis. Students will probably have to use two-five degree intervals on the temperature axis in order to fit in the range of temperatures that will be required.

16. Make sure that you model what you expect from students in their graphs. Make clear points on the graph to note the ordered pair. In parenthesis under each point, place the ordered pair that the point represents. Then, show students how to connect the two sets of points for each city. Each city should be represented with a different colored pen. The line should not be "too wide," "too narrow," or "dashed." It should be a clear, "smoothed" line. Show them how to create a legend to identify the lines. The legend should be contained in a box in an open area inside the graph. This would be a good time to review the rubric for this assignment.

17. Explain that over time, they will see a trend or pattern emerge from the data they will collect. For now, however, it is a mystery about the real effect of latitude and elevation on temperature.

18. Tell students that they will post their graphs at the end of two weeks, and be invited to summarize their findings about the effect of geography on daily temperature.

19. **SEARCHLIGHT:** For students who show prior knowledge with any of the skills/content introduced here or who learn at a faster pace that their chronological peers, invite them to track a pair of cities from each list above.

Products and Assignments

Students' ongoing worksheets, **Does Higher Always Mean Colder?**

Extension Activities

1. Spend a few minutes with students who seem eager for more information about the weather. Show them the Mount Washington Observatory site. Students may be particularly interested in the pictures of the summit in different kinds of weather. Ask students if they have any particular areas of interest with respect to the weather. Share with them books you have on

the weather, books that are available in the library, or help them search the internet for weather-related information.
http://www.mountwashington.org/weather/index.html

2. Using the attached instruction sheet, **The Museum Guide,** prepare appropriate object labels that answer questions about the relationship between daily temperature and altitude and latitude. The results can be assessed using **Rubric for Module 1: Museum Exhibit.**

Post Assessment

Ask students to keep track of their data for two weeks.

Debriefing and Reflection Opportunities (2 minutes)

1. Convene the students as a whole group. Show them the suitcase again. Suggest to them that over the course of the nest several weeks, they will travel to far places to look at and study the weather. Right now, they are looking at the cause and effect relationship between temperature of a place and its elevation and latitude.

2. Remind them that local weather is a system of complex parts. Factors such as geography and location affect the way the system operates.

TEMPERATURE LOG: DOES HIGHER ALWAYS MEAN COLDER?

Student Names: ____

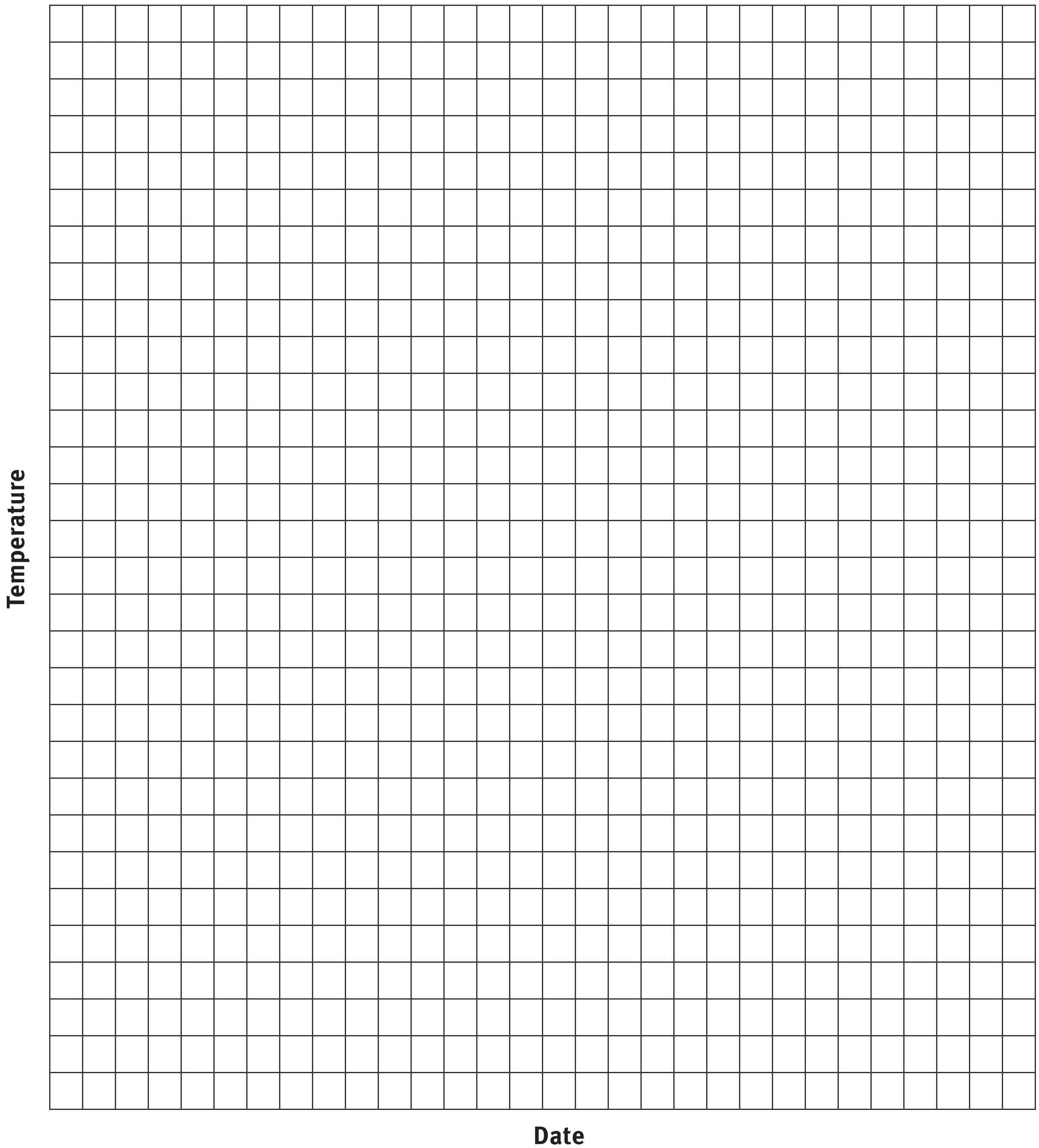
City Names

City 1: ______________________________

City 2: ______________________________

Location for City 1 Latitude Elevation

Location for City 2 Latitude Elevation

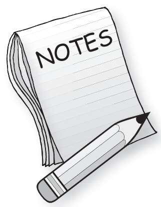

Temperature
Date

Looking for Trends in Your Data

Now that you have gathered your temperature data, take time to study it to look for trends and patterns. Using the space below, summarize what you see about the temperature data for both your selected cities. Make sure you take into account the latitude or elevation of your cities.

Rubric: The Effect of Latitude and Elevation on Local Temperatures

Key Feature	Novice	Intermediate	Advanced	Expert
Axis Identification (10 points)	Units on the X or Y axes are not labeled.	Units on both axes are labeled; some units are unclear, inaccurate or missing.	Units on both the X and Y axes are labeled; one or two units are unclear or inaccurate.	The units on both the X and Y axes are labeled clearly and accurately.
Graph (30 points)	Values for many data point are missing, data points are inaccurate; data lines are not appropriate width, smoothness, or color.	Values for some data point are missing, some data points are inaccurate; portions of data lines are not the appropriate width, smoothness or color.	Values for all data point are complete, 1 or 2 data points are inaccurate; data lines are the appropriate width, smoothness, or color.	Values for all data point are complete; data points are all accurate; data lines are the appropriate width, smoothness, or color.
Legend (10 points)	No legend is provided to identify the two lines.	A legend is provided; it is not accurate; it in not in an open area on the graph.	A legend is provided; it is accurate, but not placed in an open space on the graph.	A legend is provided; it is accurate, and placed in an open space on the graph.
Explanation About Temperature Trends (50 points)	The explanation indicates that the student does not grasp the relationship between daily temperature and altitude and latitude.	The relationship is generally explained, but it lacks clarity and detail.	The explanations for both relationships are generally stated; they are generally correct.	The explanation for both relationships is stated and accurate; it communicates the information clearly. The student understands the similarities between the relationships: as altitude and latitude increase, temperature decreases.
Self-evaluation				



Resources About Weather and Meteorology

Organizations

National Oceanic and Atmospheric Administration, Silver Spring, MD.
www.noaa.gov
This organization broadcasts continuous weather information. It also provides educational materials to teachers. Write:
Educational Affairs Division
National Oceanic and Atmospheric Administration
Room 317
1825 Connecticut Ave, NW
Washington, DC 20235

U.S. Weather Service, Silver Spring, MD
www.noaa.gov
This organization is a branch of NOAA.

National Climactic Data Center, Ashville, NC
www.ncdc.noaa.gov
This organization houses a very large storehouse of weather data, climate records, weather extremes and storm data.

National Hurricane Center, Miami, FL
www.nhc.noaa.gov
This organization uses satellites, radar, airplanes, and weather balloons to predict the magnitude and path of hurricanes.

National Severe Storms Laboratory, Norman, OK
www.nssl.noaa.gov
This weather organization coordinates the effort to track and study tornadoes and other severe storms.

Web Sites About Meteorology

News Channel 8
http://www.wtnh.com/Global/link.asp?L=46075

News Channel 8 is the only station in the state with an educationally-based weather network that serves dozens of schools across Connecticut. SchoolNET 8 allows students to access live weather data and utilize the information in daily science lessons. It also provides News Channel 8 viewers with LIVE, accurate weather information gathered from the schools' weather stations.

Earthwatch Weather on Demand
www.earthwatch.com

El Nino Theme Page
www.pmel.noaa.gov

The Old Farmer's Almanac
www.almanac.com

The Hurricane Hunters
www.hurricanehunters.com/welcome.htm

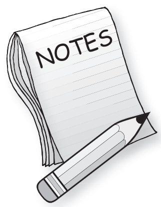
Kids' Weather Page
http://eyewall.met.psu.edu/

One Sky, Many Voices
http://groundhog.sprl.umich.edu

USA Today
www.usatoday.com/weather

The Weather Channel
www.weather.com

"The Weather Dude"
www.wxdude.com



Weatheroffice
www.weatheroffice.com

Live Weather Images
http://www.weatherimages.org

The Museum Guide

You have been asked to help a local science museum that is hosting a special interactive exhibit about weather. They have asked you to be a museum guide for an exhibit that explains the relationship between geography and the daily temperature. The display for which you will be responsible contains several physical relief maps of the world, as well as charts that contain the daily temperature charts for selected cities and locations around the world.

Museum personnel have spoken with you about the kinds of questions visitors often ask at this exhibit. Visitors frequently ask:

1. Why is it always so cold at the South and North Pole?
2. Why is it that we can have snow covered mountains in Peru, which is very close to the equator, where it is hot and humid year round?

They have asked you to create some special note cards, known as object labels, that can be placed at strategic places on the exhibit to answer these two frequently asked questions.

Rubric for Module 1: Museum Exhibit

Key Feature	Novice	Intermediate	Advanced	Expert
Explanation	The descriptions indicate that the student does not grasp the relationship between daily temperature and altitude and latitude.	One relationship is clearly explained, but the other lacks precision and clarity; while it contains some elements of a proficient response, it is incomplete.	The explanations for both relationships are clearly stated and accurate; it is generally correct, complete and appropriate.	The explanations for both relationships are clearly stated and accurate; description is powerful and communicates the information clearly; the explanation contains evidence to indicate that the student understands the similarities between the relationships: as altitude and latitude increase, temperature decreases.
Presentation	Little originality; design is rudimentary.	Some originality and attention to design.	Design shows clear originality and effort; it supports the text.	Design is compelling and enhances the text; it moves the reader through the text.

I Can be a Meteorologist Too

Core/Practice

Time Allocation: 45 minutes

Required Materials and Resources on Page 311

Module Overview

This module is designed to show students how they can make simple weather instruments, use them to record weather data, and make their own weather predictions.

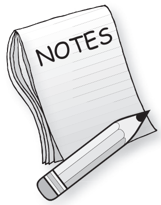
It is completed toward the beginning of the unit in order to stimulate and enhance student motivation for this earth science topic. By placing it toward the beginning of the unit, students will have a longer period of time to collect their data and begin to see trends and patterns emerge from their data.

It begins with a lesson on observation. The remaining four sessions in this module are targeted around key features of the weather: Measuring Wind, Observing Clouds, Measuring Rainfall, and Setting Up the Weather Station. It is assumed that students know how to read an air thermometer and record the temperature using a Fahrenheit scale.

In the lessons of this module, students will be grouped into weather watching teams. These small groups can be heterogeneous or homogeneous, depending upon the learning needs of the particular students.

BIG IDEA

The Power of Observation



Lesson Overview

In this lesson, students will learn how to make observations. At the beginning of the class they will talk about how they use their senses to make detailed observations about the world. In the later part of the lesson, they will have the opportunity to put their skills to use by observing key features of the weather.

Guiding Questions

- What is observation?
- Who makes observations?
- How do we use our senses to learn about the weather?

Content Goals

Universal Theme

Prediction

Principles and Generalizations

- Meteorologists use their senses in order to make observations that help them learn about local weather
- Detailed, careful observations lead to accurate weather predictions.

Concepts

- Meteorologist
- Observations
- Senses
- Accurate

Teacher Information

N/A

Skills

Observe

Materials and Resources

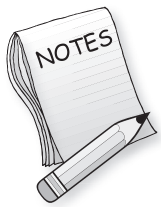
1. Papers at the center of clustered desks for students to use while they are brainstorming
2. Lab sheet
3. Pencils and pens
4. Flip chart
5. Marker

Preparation Activities

1. Make enough copies of **Keeping Our Eyes on the Weather** for students
2. Place 8 x 11 pieces of paper at the center of desk clusters for students to use while they are brainstorming.

Note: Field trials with the lessons in this module revealed several important things about: (1) students' understanding about weather, and (2) their power of observation as it relates to weather. First, students have discrete pieces of information about weather. For example, they know about temperature, that it is windy, or that it is raining. They do not see weather as a system of interrelated parts that interact and affect one another. Where possible, emphasize to students that all the parts of the weather system are connected: the sun interacts with the earth to create heat (temperature); the unequal heating of earth's surfaces causes wind; wind helps to move water thorough our atmosphere.

Second, most sixth grade students will use their sense of sight to make observations about weather. Few students will use a variety of their senses to make keen observations about temperature, wind speed, and wind direction, for example. It will be important to help students expand their sensory observations about weather phenomenon.



Introductory Activities (15 minutes)

- Arrange students into small groups of four and ask students to brainstorm the word, *observation.*
- Record students' thinking on flip chart paper, and hang the paper on the wall for students to see.
- Explains that observation is a skill. "A skill is something we learn to do and get batter at all though our lives, like riding a bike, driving a car, measuring, or thinking. Thinking skills are very important because the more skills we know and the more skilled we get at each, the better we can think our way through problems that we have to solve everyday."
- Invite student to brainstorm different thinking skills they know.
- Explain that observation is a very important skill. "When we observe something, we pay careful and directed attention to something in order to make notes and records. We use our notes and records to learn more about what we are studying."
- Ask students to brainstorm the people who use the process of observation and provide opportunities for them to share. Students will probably conclude that everyone uses observation to a greater or lesser extent.
- Explain that meteorologists use many instruments, but that their most important instruments are their senses. They use their senses to help them understand and predict weather. Tell students that they will be learning about observation in the upcoming lesson.

Pre-assessment (2 minutes)

Use the four-point rubric to informally assess students' observation skills. Use the pre-assessment to gather baseline data about students.

Teaching and Learning Activities (23 minutes)

1. Begin the session with a conversation about the senses: sight, hearing, smell, touch, and taste. Begin with sight, and ask students to share what kinds of things they learn with their eyes each day. Do the same for sound, hearing, smell, and touch.

2. Ask students to explain how scientists might use their senses to tell them about their world. Listen as students generate answers. At the conclusion of this interchange, explain that scientists use their senses to learn about their world, and point out that they never use their sense of taste in their work.

3. Go over the lab sheet, **Keeping Our Eyes on Weather,** with students to ensure that they understand what they will be doing. Point out to them that the four senses are listed on their worksheet to remind them to use sight, hearing, feeling, and smell in their observations. This would be a good time to go over the rubric that you will use to evaluate their observations. Point out to students that you will be looking at the number and variety of their observations.

4. Spend time talking to students about the key features of weather: temperature, wind, precipitation, cloud cover, and sunshine. Ensure that students understand: (1) what each of these features is, and (2) that they will be using their senses to learn about each key feature.

5. Divide students into pairs and take them outdoors, if possible. If it is not possible to go outside, have students try to make observations from a window.

6. Rotate to each of the different pairs of students. Listen carefully. Make sure that students are using as many senses as they can to gather data on all the key features of weather.

7. Have students return to their desks to complete, **Beyond the Data,** on their worksheet.

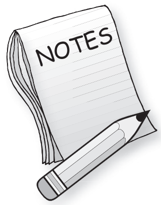
Products and Assignments

Keeping Our Eyes on the Weather

Extension Activities

SEARCHLIGHT: (For any interested student or any student who may be showing the potential for an interest in weather.) Students might like the opportunity to read about Wilson A. Bentley, sometimes called the Snowflake Man. As a child he observed things differently than other children. He was fascinated by all types of precipitation, especially snowflakes. Over his lifetime, he observed and photographed over 5, 000 snowflakes documenting beyond a doubt that no two snowflakes are alike.

http://snowflakebentley.com/
http//snowflakebentley.com/snowflakes.htm
http://www.cloudman.com/snowflake/snowflake.htm



Post Assessment

SEARCHLIGHT: Use the rubric to assess the observation skills of students. Who needs more opportunities to refine his/her skills of observation? Who demonstrates advanced-level skill in observation? For students needing more practice, ask them to practice observation on the playground. When they have made some observations, have them see you to go over what they saw, heard, and felt.

Students who demonstrate a high level of skill with respect to observation can be encouraged to keep a detailed log or journal of their own weather observations, individually or in pairs.

Debriefing and Reflection Opportunities (5 minutes)

Ask students to review the weather features they observed. How many students thought they could observe so many features about the weather? Listen carefully to students.

Explain to students that you want them to think of themselves as very careful scientists. "When you concentrate very hard to make careful and detailed notes about your observations, you are demonstrating a very important skill that meteorologists use."

Close by tying students' work on observation with their unit on weather. "We will be practicing our skills of observation as we learn more about the work of meteorologists and how the sun interacts with the land, air and water to create our weather."

OBSERVATION: KEEPING OUR EYES ON THE WEATHER

Name: ____

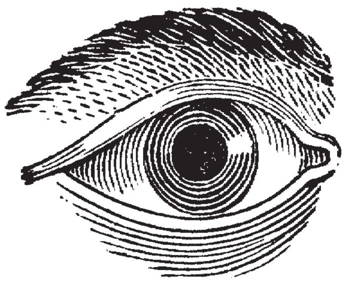
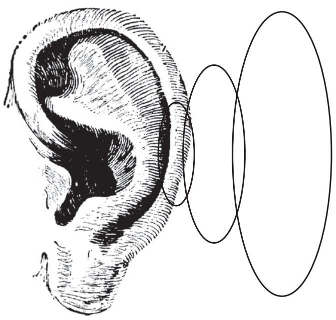
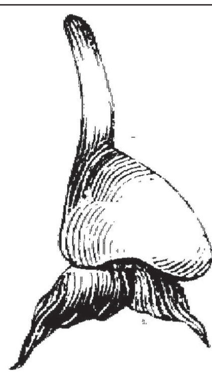
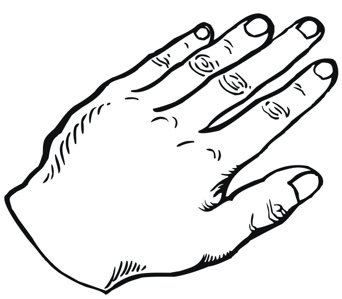
Date: _____________________

Background Information

Weather is all around us. Sometimes it is gentle and calm. At other times, the weather is fierce and blustery. Special scientists observe the weather for us every day and all through the night. These scientists are called meteorologists, and they like to study and forecast the weather. If a thunderstorm, blizzard, or tornado is coming our way, meteorologists like to be able to tell us about it ahead of time so that we can be safe.

How do meteorologists "keep an eye" on our weather? Yes, they use special instruments, like thermometers and rain gauges. You will learn about these special instruments later in this unit. The most important tools that meteorologists use, however, are their senses. They use their eyes, ears, nose and sense of touch, to tell them about the weather. Meteorologists are like all scientists because they use their senses to observe and learn more about the world around them.

Today, you will have a chance to use your senses to observe the weather. You will be observing features such as temperature, wind, precipitation, cloud cover, and sunshine. We will be going outside in just a few moments. It will be your job to write down as many observations as you can about the weather. Note that your observation chart below is divided into four rows, one for each of the senses you will be using. When you make an observation, make sure that you note it under the sense that you used to make the observation.

Sense	Observation
	• • • • • •
	• • • • • •
	• • • • • •
	• • • • • •

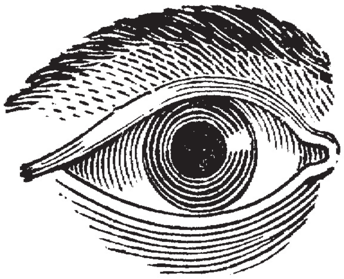
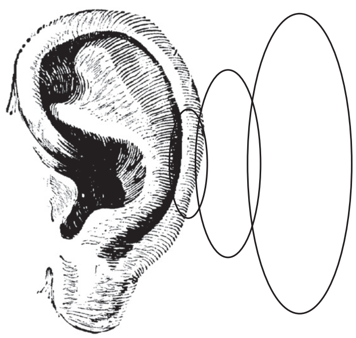
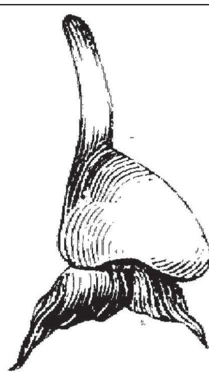
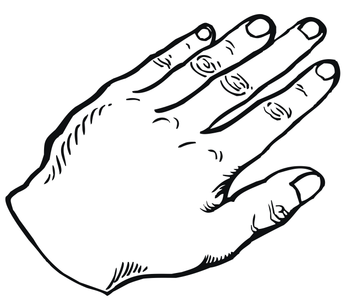
Beyond the Data

1) Review your observations. Which sense did you use the most? The least?

2) Did you use more than one sense to observe the same weather feature? If so, describe which feature and the senses that you used to observe it.

3) Review your list of observations. Make a list of the different weather features that you observed.

WEATHER: THE NEVER-ENDING STORY

Sense	Observation
	• It is so bright my eyes squint. • It is so bright that I can't look up. • It was really cloudless.
	• It was frosty. When I walked, I could feel the grass crunch. • The dead leaves rose in the breeze.
	• The wind transfers to me the smell of tar. • I smell perfume here and not there.
	• When the wind blows, I get goose bumps. • I feel the sun beating on my back.

Beyond the Data

4) Review your observations. Which sense did you use the most? The least?

I used my sight the most and my smell the least.

5) Did you use more than one sense to observe the same weather feature? If so, describe which feature and the senses that you used to observe it.

I used my feeling and hearing.

6) Review your list of observations. Make a list of the different weather features that you observed.

1. **Sun**

2. **Wind**

3. **Clouds**

Rubric for Assessing the Skill of Observation

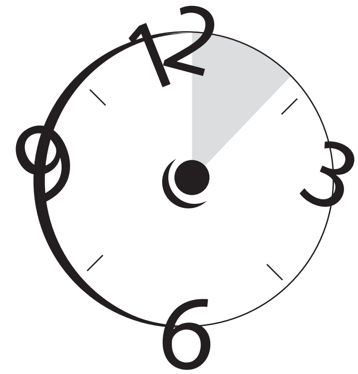
Novice	Intermediate	Advanced	Expert
•The weather is described in a tangential way, but not using any senses. -I wore my coat today because the TV said it would be cold.	• One or more features of the weather are described. • The majority of observations are made using one sensory feature. -It is cloudy. -I see rain -I see trees moving.	• Two or more features of the weather are described. • Two senses are used to describe weather phenomenon. -Rain is falling and hitting against the window. -Rain is falling and smells like the ground. -It is so cold that the snow crunches under my feet.	• All features of the weather are described. • Two or more senses are used to describe weather phenomenon. -Frost is on the windows and melts when I touch it. -The sky looks black, the thunder crashes, and the hard rain hurts my arm. -The sun is bright and warm.

I Can be a Meteorologist, Too

Core/Practice

Time Allocation: 1 hour, 20 minutes

Required Materials and Resources on Page 311



Lesson Overview

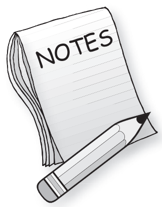
In this lesson, students will learn how meteorologists measure wind and wind speed. They will create a hand-held Beaufort scale to help them observe and estimate the force or speed of the wind. They will also use a compass to help them understand how to determine the direction of the wind.

Guiding Questions

- How can we measure wind?
- How can we determine the direction of the wind?
- What changes in the weather are associated with changes in the wind speed and direction?

BIG IDEA

Measuring Wind: It's a Breeze



Content Goals

Universal Themes

- Evidence
- Explanation
- Change
- Measurement

Principles and Generalizations

- A Beaufort scale estimates wind speed.
- Wind speed and wind direction predict local weather.
- When winds change direction and speed, it means a change in the weather will usually occur.

Concepts

- Wind speed
- Wind direction
- Beaufort scale

Teacher Information

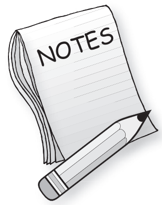
The Beaufort scale was one of the first scales used to estimate wind speeds. The scale was proposed by Britain's Admiral Francis Beaufort. He developed it in 1806 to help sailors estimate the wind speed via observations. The chart on the next page shows the scale

Beaufort Scale

Category	Velocity (mph)	Description	Descriptions for Land Use
0	0-1	Calm	Smoke rises vertically
1	1-3	Light air	Direction of the air shown by smoke drift; not enough wind to affect wind vanes
2	4-7	Light breeze	Wind felt on face; leaves rustle; vanes moved by the wind
3	8-12	Gentle breeze	Leaves and twigs in constant motion; wind extends light, small flag
4	13-18	Moderate breeze	Raises dust and loose paper; small branches move
5	19-24	Fresh breeze	Small trees in leaf begin to sway; wavelets form on inland waters
6	25-31	Strong breeze	Large branches in motion; whistling heard in telegraph wires, umbrellas used with difficulty
7	32-38	Near gale	Whole trees in motion; inconvenience felt when waking against the wind
8	39-46	Gale	Twigs are broken from trees; progress against wind generally difficult
9	47-54	Severe gale	Slight structural damage occurs; shingles blow off roofs
10	55-63	Storm	Trees uprooted, considerable structural damage occurs
11	64-72	Violent storm	Very rarely experienced; accompanied by wide-spread damage
12	73+	Hurricane	Massive damage

Instruments used to measure wind speed

- *Wind vane:* Any of the decorative wind instruments that adorn cupolas. The arrows point in the direction from which the wind is blowing
- *Wind sock:* Used primarily at airports; socks point in the direction that the wind is blowing.
- *Radar:* Electronic devices that track the motion of particles away from and toward the radar
- *Satellite tracking:* Satellites are used to measure the speed of individual cloud elements



Instruments that are used to measure wind speed

- *Anemometer:* Cups are positioned on column so that they can rotate freely in proportion to the wind speed
- *Radar:* Electronic devices that track the motion of particles away from and toward the radar
- *Satellite tracking:* Satellites are used to measure the speed of individual cloud elements

http://www.mountwashington.org/education/index.html
Mount Washington Weather Observatory is the windiest place on earth. Its elevation is 6,288 feet and is located in New Hampshire.

The weather observatory on top of the mountain is built into the rocks at the summit to keep them from blowing away. The highest recorded wind speed is 231 miles per hour, registered on April 12, 1934.

Skills

- Estimate wind speed with a Beaufort scale
- Determine wind direction
- Observe

Materials and Resources

1. Pictures of different effects of wind, see the web address: http://sln.fi.edu/tfi/units/energy/gallery.html
2. One 8" circle template
3. One 5" circle template
4. Sheets of light-colored oak tag
5. Sheets of a colored piece of construction paper
6. Rulers
7. Scissors
8. Markers in different colors
9. Paper fastener (brad) for each student
10. A compass
11. Chalk
12. Enough copies of **Weather Log** for each student in the class.

Preparation Activities

1. Use the 8” template to cut oak tag circles, one for each student in the class
2. Use the 5” template to cut one colored construction paper circle for each student.
3. Place the materials in one location in the room so that students can access them easily. Each student should have a:
    a. An 8” circle from oak tag
    b. A 5” circle from colored construction paper
    c. A brad
4. Locate a weather forecast for this session. Hopefully, it will be good day for outside activity. Check the wind for the day so that you will have some idea of the wind speed and direction for students’ first experience with this weather indicator.
5. Place **Weather Logs** at students’ tables

Introductory Activities (10 minutes)

- Begin this lesson by showing students pictures of current wind instruments. Explain that although we have many high-tech methods for measuring wind direction and speed, many people still use instruments that require observation to interpret both wind speed and direction.
- Meteorologists make observations about wind speed and direction because wind is a key feature of our daily weather and to help them predict the weather.
- Tell students that they will be making a hand-held instrument that will help them make observations about wind. It is called a Beaufort scale.

Pre-assessment

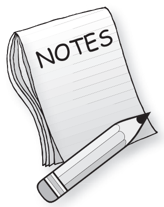
N/A

Teaching and Learning Activities (65 minutes)

1. Assign students to their weather observation teams.

2. Have one member of each pair pick up the supplies for as many Beaufort scales as there are students in the group.

3. When students have their supplies, ask each student take out the larger, light-colored paper circle.



4. Using a ruler (or protractor, if students are familiar with this instrument, have each student divide the white circle into 13 equal wedges or pie pieces (approximately 28 degrees each). If you are making the components of the hand-help Beaufort scale yourself in order to save classroom time, making a template of the wedge and use it to draw the 13 pie-shaped pieces on each plate.

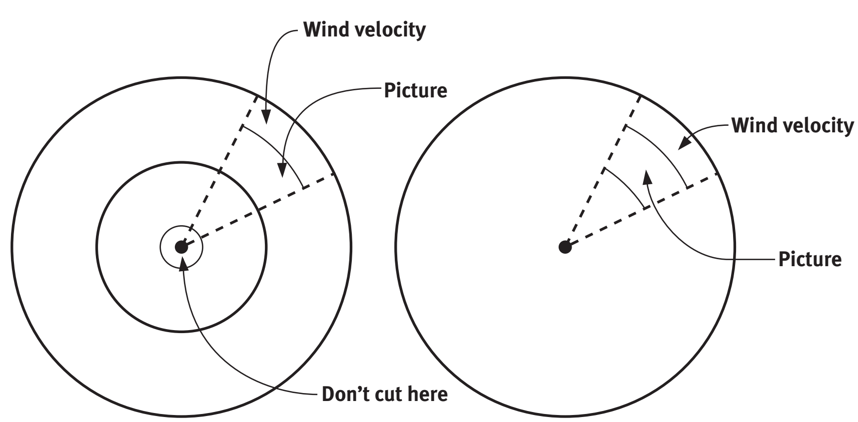
5. Refer to the Beaufort scale provided above.

6. Have students begin their work on the outside edge of the widest part of each segment (e.g., the part that is on the outside edge). Have them label the wind velocity for each segment on the outside edge. Then just below the velocity, invite students to make a drawing that illustrates the wind speed using some of the descriptors provided in the chart.

7. Under each drawing, write the category number (e.g., 0-13), as well as a brief description of the wind, capturing key ideas and descriptors, like "whole trees move."

8. Take the smaller sheet of colored paper. Cut a V-shape pie wedge, the same size as the segment of the smaller circle. Make sure to end the cuts BEFORE reaching the center of the circle. Leave enough of the paper to join it with the paper fastener to the larger, white circle.

9. Place the colored circle over the larger, white circle and join the circles to the paper plate with a paper fastener.



10. Take the students outside, if possible. Have each student take his or her Beaufort scale and **Weather Log.**

11. Take your compass with you, your copy of the **Weather Log,** and a pencil or pen.

12. Working in their small groups, have students use the information on their Beaufort Scales to estimate the wind speed. Check to make sure they all have the same estimate.

13. Take out your compass and invite students to guess which direction is north. Show them the compass and tell them that you are going to mark on the ground with chalk the four points of the compass.

14. Tell them that winds are named after the direction from which they come—north winds blow from the north, etc. With that in mind, invite students to find evidence of the direction of the wind. They could use a flag tree branches, the feel of wind on themselves, etc. Note: Winds can be changeable. There will be times when it is hard to determine the exact direction of the wind.

15. Take out the **Weather Log.** Show students how to record wind speed and direction information on their **Weather Log.**

Products and Assignments

Beaufort scales and completed **Weather Logs** for wind information

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (5 minutes)

Invite students to consider that they now know about two indicators of weather: air temperature and wind: speed and direction. Tomorrow they will learn how clouds are special "windows" on the changing conditions of the atmosphere.

RUBRIC FOR Weather Log

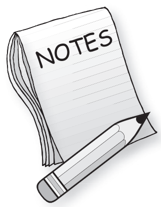
Key Feature	Novice	Intermediate	Advanced	Expert
Completeness	Many entries are missing.	Some entries are missing.	All entries are present.	All entries are present and in great detail.
Accuracy	Many errors are evident in the entries; little attention to detail.	One to two errors were made on the entries; general attention to detail is evident.	All entries are accurate; significant attention to detail is evident.	All entries are accurate and great attention to detail is evident.
Student predictions	Some predictions are missing; little weather information was used to make the predictions.	One or two predictions are missing; some weather information was used to make the predictions; some evidence of cause and effect thinking is evident.	All predictions have been made; predictions reveal the use of some cause and effect relationships among the weather data.	All predictions have been made; detailed analyses of the weather data is evident; predictions reveal strong and clear use of cause and effect relationships.
Student notes and observations	Very few notes and observations are made.	Some notes and observations are made; notes show evidence of thinking about the weather.	Many notes and observations are made; solid use of language to make observations; notes and observations are carefully done; new knowledge is evident.	Many notes and observations are made; notes and observations are carefully done and go beyond expectations; rich use of language to convey observations; many connections are made between past and present learning.

Weather Log

Name: ______________________________ Week of: ______________________________

Date	Time	Temp	Wind		Clouds			Precipitation		Student Next-Day Forecast	Actual Weather
			Speed	Direction	Type	Height	Cover	Type	Amount		

Additional notes and observations:



Weather Log

Name: ______________________________________

Date ____

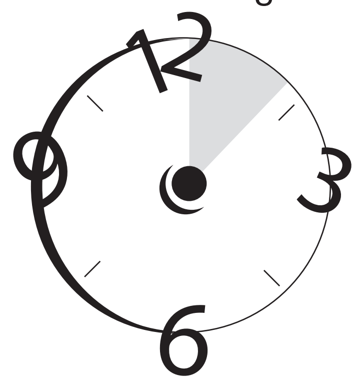
Additional notes and observations:

I Can be a Meteorologist, Too

Core/Practice/Identity

Time Allocation: 40 minutes

Required Materials and Resources on Page 311



Lesson Overview

In this lesson, students will learn how to observe clouds and cloud cover. They will discover how to use their observations to record information in their weather journals.

Guiding Questions

- What are the attributes of clouds that meteorologists use in order to study them?
- How do meteorologists determine the amount of cloud cover?
- What do clouds and cloud cover indicate about the current weather conditions? Future weather conditions?
- Would you like to be a meteorologist?

BIG IDEA

Observing Clouds

Content Goals

Universal Themes

- Evidence
- Explanation
- Change
- Measurement

Principles and Generalizations

- The altitude and shape of clouds determine how they are classified by type: low, middle and high.
- Data about cloud type and the amount of cloud cover predict local weather.

Concepts

- Cloud
- Altitude
- Shape
- Low clouds
- Middle clouds
- High clouds
- Cloud cover
- Cloudless
- Partly cloudy
- Overcast

Teacher Information

See the lessons about clouds in the Water Cycle module of this curriculum unit.

Skills

- Observe
- Classify cloud types
- Estimate cloud cover

Materials and Resources

1. **Cloud Observers' Guide**
2. **Student Weather Log**
3. Pictures of different kinds of clouds: high-level (cirrus), middle-level (altostratus and nimbostratus) and low-level clouds (stratus). Pictures of clouds are in many different kinds of science books or they can be downloaded from web sites below
   http://www.australiasevereweather.com/techniques/simple/cloudobs.htm
   http://www.wildwildweather.com/clouds.htm
4. Blank pieces of paper on students' desks

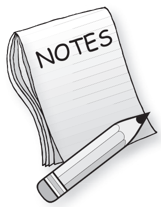
Preparation Activities

1. Make enough Copies of **Cloud Observers' Guide** and **Weather Log** for each student in class.
2. Place the Guide, Log, and blank paper at each cluster of student desks.
3. Check the weather for the session. Hopefully, it won't be raining or snowing hard. If the weather is inclement, plan on doing students' "field work" in the upcoming lesson from a nearby window.
4. Review **Cloud Observers' Guide.** Determine the symbols you want students to use to indicate the height, shape and extent of cloud cover.

Note: In field tests with this unit, students demonstrated that they knew the names of specific types of clouds, such as stratus and cumulous. However, their knowledge was shallow; many had simply memorized the names and did not know that cloud shape and altitude (height in the atmosphere) could be used to predict upcoming weather. When teachers used "low," "middle," and "high" to help students observe the altitude of clouds, students were better able to make sound scientific predictions about upcoming weather.

Introductory Activities (8 minutes)

- Convene a whole class meeting. Explain to students that this lesson is a continuation of the Weather Station module in which they are learning how to make and record weather data. In this particular session, they will learn how to observe clouds and estimate cloud cover. Later in the unit, they will learn how clouds are formed. For now, it is their job to learn about the three different types of clouds and how to assess the amount of cloud cover in the sky each day.



- Ask students, in their weather watching teams, to draw pictures of different kinds of clouds that they have observed on the blank paper provided on their desks. Give students the opportunity to share their drawings. Ask then to think about the differences that they see in the clouds that they have drawn, a perfect segue into the lesson.

Pre-assessment
N/A

Teaching and Learning Activities (30 minutes)

1. Explain that clouds are windows on our atmosphere. As such, they can tell us a great deal about the current conditions in the atmosphere, as well as some signs about upcoming weather.

2. As practicing meteorologists, they are going to have the opportunity today to "read" the clouds and record information about clouds in their weather log.

3. Ask students to read through **Cloud Observers' Guide** in their weather watching teams and to pay particular attention to the "signs" that clouds give us about the atmosphere. Tell them that there are three important signs that they will learn about in their reading.

4. When students have finished reading, review the three important signs: cloud shape, height, and amount of cloud cover in the atmosphere.

5. Show students pictures of selected clouds that you have brought in for them. There is no need to require students to know the scientific names of clouds. You can tell them that they have scientific names and share them with them. In this unit, they will be required to know that there are high-level, mid-level, and low-level clouds. If possible, reference any clouds that students drew in the introduction to the unit.

6. Explain to students that high-level clouds mean fair weather for the immediate future. They are, however, signs that a storm may be approaching in the next 24 hours, especially if students begin to see clouds starting to thicken and descend into the middle levels of the sky.

7. Share that middle-level clouds are thicker than the high-level clouds. They don't look like little balls of cotton or wisps anymore. They are larger, much rounder, even lumpy and grayish. Light rain or snow might fall from these clouds.

8. The low-level clouds can be the real rain or snow makers. They are dark gray and cover the whole sky in sheet-like forms. Precipitation from these clouds is steady, not light and showery. Precipitation can last a good part of the day or night, even longer.

9. Show students how these clouds are illustrated on their **Cloud Type Chart.**

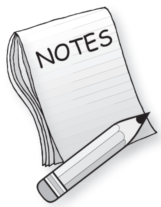
10. Invite students to review with you the symbols that they will use to indicate the current state of the clouds. Explain that they will use the symbols in their **Weather Logs.**

11. Take students outside to practice observing clouds and cloud cover.

    SEARCHLIGHT: This is a wonderful opportunity to observe students who demonstrate an interest or budding interest in science and/or meteorology. Make a mental note to follow up with students who demonstrate an interest in this kind of activity. See the extension section below.

12. Rove from group to group to make sure that students are recording their observations correctly under the cloud section of the weather log and that they are using the correct symbols.

13. Return to the classroom.



Products and Assignments

Each student will have a completed weather log entry

Extension Activities

1. Interested students may want to find out more about clouds in general or Luke Howard, the English chemist who first named clouds. See the resources that accompany this curriculum unit for books about weather. The following websites may also be helpful:

Clouds

- http://vortex.plymouth.edu/clouds.html Contains many pictures of all different types of clouds taken in New Hampshire. Also contains time lapse photography of cloud movement across the sky.
- http://asd-www.larc.nasa.gov/SCOOL/cldchart.html This web page, by NASA, contains many photographs of different types of clouds, as well as a cloud photo gallery created by fourth grade students in Virginia.
- Luke Howard

  http://www.islandnet.com/~see/weather/history/howard.htm
  http://www.weathernotebook.org/howard/
  This website contains some copies of original sketches by Howard

2. As students had the chance in this lesson to practice the work of the meteorologist, have interested students explore the career of the atmospheric scientist or meteorologist. Direct them to the following websites and also have them find some additional sites on their own: http://www.weatherwizkids.com/becoming.htm; http://www.ametsoc.org/AMS/pubs/careers.html; http://www.bls.gov/oco/ocos051.htm. After researching the field, have these students present interesting information about the career, such as the nature of the work, the training and education necessary, the job outlook, and the earnings. Most importantly, have students reflect upon the ways their findings about the career fit or do not fit their strengths and interests.

Post Assessment

N/A

Debriefing and Reflection Opportunities (2 minutes)

Invite students to reflect on their observations. What height were the clouds they observed? What shape did they have? How much of the sky was covered by clouds? What did they predict for tomorrow based on the shape and height of the clouds today? Invite students to look up the forecast for tomorrow. When they wake up tomorrow morning, tell them to look out their window to see if their prediction is correct.

CLOUD OBSERVERS' GUIDE

Name: ______________________________

Date: ______________________________

Background Information

We haven't always known about clouds. A long time ago, people believed that clouds sprang up from vapor given off by objects in the ground. The vapor particles joined together and rose up from the ground in little heaps. It seems almost impossible that people ever believed that clouds formed this way!

Today, we know a lot more about clouds, such as how they are formed and what they signal about upcoming weather. We know more because meteorologists have studied and observed them for many years. Meteorologists have learned that clouds can tell us a great deal about what is happening in the atmosphere and even give us clues about the upcoming weather.

But, how can you observe something that you cannot reach out to touch or feel? We can learn a great deal about clouds by just using our eyes and observing certain cloud attributes, such as shape and height in the sky. There are three important questions that we can ask ourselves to learn about clouds and what they mean:

1. What is the shape of the cloud or clouds?
   - Wispy and feathery (High clouds)
   - Bands or layers of clouds gradually spreading over the sky; thickening (Middle clouds)
   - Flat layers of low, gray clouds (Low clouds)
   - Puffy, white, no towering tops, form during the day, cauliflower-like (Low clouds, called fair weather clouds)
   - Towering, very large, sometimes a flattened top, can have a gray-black color (Vertical clouds, called thunderheads)

2. How high in the sky are the clouds?
   - High (H)
   - Middle (M)
   - Low (L)

3. How much of the sky is covered by clouds: ○
   - Cloudless ◑
   - Partly cloudy ● (half filled-in)
   - Completely overcast

You will use these three questions to help you collect weather information. Each day you will be recording the shape of the clouds, whether they are high, middle, or low-level clouds, and the amount of cloud cover. You will place your observations in your Weather Log. Your teacher will give you one page from your

Weather Log, and will give you some practice observing clouds.
In this weather unit, you will learn to read the "signs" that clouds give us and really amaze your friends and family with your predictions!

Cloud Watcher's Key

Download the cloud key on pg. 2 of the following website:

http://eo.ucar.edu/webweather/cloud3.html

Weather Log

Name: ____________________ Week of: ____________________

Date	Time	Temp	Wind		Clouds			Precipitation		Student Next-Day Forecast	Actual Weather
			Speed	Direction	Type	Height	Cover	Type	Amount		

Additional notes and observations:

Weather Log

Name: ______________________________

Date ______________________________

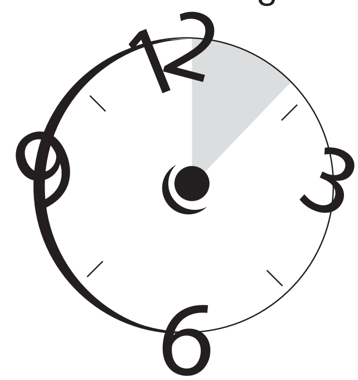
Additional notes and observations:

Making a Rain Gauge

Core/Practice

Time Allocation: 40 minutes

Required Materials and Resources on Page 311



Lesson Overview

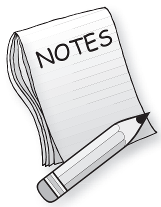
In this session, students will make a rain gauge that they will use to measure the precipitation daily during this weather unit.

Guiding Questions

How can meteorologists determine the amount of precipitation that falls?

BIG IDEA

I can be a meteorologist, too.



Content Goals

Universal Themes
- Evidence
- Explanation
- Change
- Measurement

Principles and Generalizations
- Precipitation falls in many forms: rain, snow, hail, sleet, and freezing rain.
- Precipitation can be measured with a rain gauge.
- Over time, precipitation patterns help to predict local weather.

Concepts
- Precipitation
- Rain
- Snow
- Sleet
- Hail
- Freezing rain
- Rain gauge
- Measurement

Teacher Information

N/A

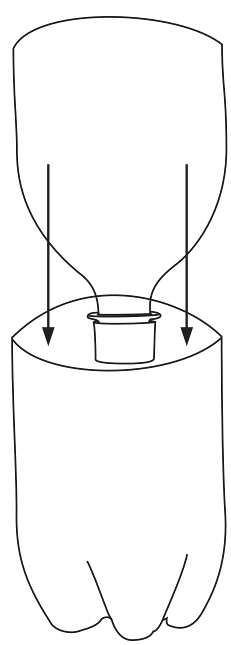
Skills
- Observe
- Read a rain gauge

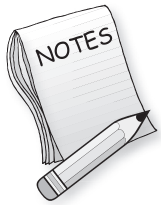
Materials and Resources
1. Seven clear, clean plastic soda bottles, cut in half
2. Seven labels
3. Waterproof markers
4. Six to seven rulers. Try to find rulers that have edges. Avoid rulers that begin their calibrations at each edge. Rulers should be calibrated to eighths of an inch.

5. Six stones for each bottle to keep the bottles upright when placed outdoors
6. One Zip-lock baggie for each group of students
7. One cup of water
8. Enough copies of **Weather Log** for each student
9. Duct tape

Preparation Activities

1. Several weeks before this activity begins, collect seven or so clear, plastic soda bottles.
2. Several days prior to this lesson and using a razor, cut each bottle approximately in half.
3. Turn the top part upside down and insert it, neck down, into the lower half of the bottle. The neck of the bottle neck will funnel precipitation into the bottom half of the bottle and keep out unwanted debris. Complete this procedure for six of the seven bottles. Keep one separate so that you can use it in the demonstration for the class.
4. Place the rain gauges, thermometers, rules, zip lock baggies, duct tape, and markers on table students can easily access them.
5. Place copies of **Weather Log** at students' desks





Introductory Activities (5 minutes)

Convene a whole class meeting. Explain to students that this lesson is part of the module in which they will be recording their own weather data. In the past sessions, they have learned how to record wind speed and direction and cloud data. Today their job will be to learn how to construct and read an easy-to-make rain gauge.

Pre-assessment

N/A

Teaching and Learning Activities (30 minutes)

1. Break students into their weather observing teams.

2. In a demonstration in front of the class, show students how to make the rain gauge.

3. Using the one bottle that you kept for this demonstration, invert the top part of the bottle into the bottom part, so students can see how you created the rain gauge.

4. Then demonstrate how they should write their group's name on the label with the waterproof markers, slip their label inside a baggie, and use duct tape to affix the baggie, with the label inside, onto the bottle's exterior.

5. Next, show students how they will use stones to keep the bottle upright when it is placed outdoors.

6. Place some water inside the bottle to represent rain. Show students how they can use the ruler to measure the precipitation that has "collected" in their rain gauge. Remind students about the importance of making accurate measurements and placing the beginning of the calibrations at either the top or bottom of the collected precipitation. Remind students not to use the edge of the ruler, only the point where the calibrations begin. Students should know how to read a ruler to an eighth of an inch.

7. Invite students to take out the **Weather Log.** Show them the columns for recording precipitation and explain that they need to make two entries: precipitation type (e.g., rain, snow, sleet, hail, freezing rain), and amount of precipitation. Show them how to make the correct entries. (Note: It is assumed that students know the different forms of precipitation.)

8. Explain to students that each time they measure precipitation in their rain gauge, it is important to remember to empty the rain gauge completely.

9. Show them: (1) how to take the rain gauge apart to empty the container, and (2) how to put it back together.

10. Ask students to store their rain gauges until they have made all their instruments and are ready to place them outside in their weather station.

Products and Assignments

Each group of students will have a rain gauge.

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (5 minutes)

Remind students that precipitation is the last indicator of the weather that they are going to be covering. In the next session, they will be setting up their weather station.

Weather Log

Name: ______________________ Week of: ______________________

Date	Time	Temp	Wind		Clouds			Precipitation		Student Next-Day Forecast	Actual Weather
			Speed	Direction	Type	Height	Cover	Type	Amount		

Additional notes and observations:

Weather Log

Name: ____________________________________

Date: _____________________________________

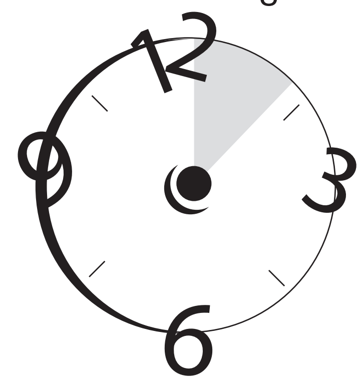
Additional notes and observations:

I Can be a Meteorologist, Too

Core

Time Allocation: 35-40 minutes

Required Materials and Resources on Page 311



Lesson Overview

The final weather indicator that students will observe and record is barometric pressure. Air has pressure, and its change over time and the nature of that change—up or down, slow or rapid—is a key indicator of the movement of air and storm systems. In this session students will observe a demonstration that will help to make explicit that air has mass or weight that causes pressure. The other two properties of air—density and temperature—will not be considered here.

This session provides a background for the next session in which students will build their own barometer. Over the course of the next weeks, students will record daily air pressure to observe trends and patterns with the daily weather.

Guiding Questions

- Does air cause pressure?

BIG IDEA

Air: A Weighty Matter

Content Goals

Universal Theme(s)

- Interaction
- Cause and effect

Principles and Generalizations

- Air has properties: density, pressure, and temperature.
- Air causes pressure.
- The pressure of air, or atmosphere, is equal to the weight of the air directly above that point on the earth.
- There are many "cells" of air on earth at any given time, each with different pressure.
- Air "cells" move from one place to another across the globe.
- When air cells move and bump into each other, they interact to help create local weather.

Concepts

- Air pressure

Teacher Information

N/A

Skills

- Observe
- Understand cause and effect

Materials and Resources

1. The following for each group of 3-4 students:
    - 1 clear, small, plastic vial, with a lid. It should be about the size of a prescription bottle.
    - Water, enough to fill each vial 1/2 full.
    - An *Alka-Seltzer* tablet
    - A small balloon

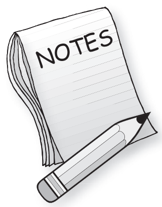
2. A scale that measures weight to the nearest hundredth of a gram. Although one scale will be sufficient, two scales will make the weighing process more efficient for the class.

Preparation Activities

1. Lay out the materials for the student groups.
2. Prepare a set of materials so that you can demonstrate the experiment to the class.

Introductory Activities (5 minutes)

- Convene students into small, heterogeneous groups. Explain:
  - That they are about to explore the last weather indicator that they will be observing and recording: air pressure. Although it is one of the least noticeable weather indicators, air pressure is a very important indicator because differences in air pressure cause global winds and weather changes.
  - That in this session, students will be exploring one of the properties or characteristics of air. It has three properties: mass or weight, temperature, and density.
  - That in this session, they will be exploring the "mass" or weight of air, which causes pressure. Emphasize that mass and weight are not synonyms but, for now, it will be fine to use them interchangeably. As they will come to understand, the atmosphere is made up of many very large "cells" of air that have different weight readings. These weight or mass readings are called air pressure. Air pressure refers to the weight or pressure of the air or atmosphere above any given point. The atmosphere that encircles the globe is made up of many "cells" of air pressure that interact with one another to create weather.
  - That in the next session, they will build their own barometer, which is an instrument that meteorologists use to measure the air pressure.
- Before they get started, invite students to discuss the following question in their small groups: Does air have weight or mass? If so, how do we know this to be true?
- Listen carefully to determine students' understanding about the mass of air and any misconceptions they may have, e.g., that air weighs nothing.



Pre-assessment
N/A

Teaching and Learning Activities (25-30 minutes)

1. Invite students to observe your demonstration and to watch carefully, because they will be repeating the experiment in their respective groups once you have completed it.

2. With your materials in the front of the room, weight them on the scale. Make sure to take the *Alka-Seltzer* tablet our of the foil packet if it is wrapped. If necessary, use your demonstration to reinforce how one uses a scale to calculate the weight of objects.

3. Share with students the weight of all the objects.

4. Insert the *Alka-Seltzer* tablet into the balloon. Then, place the neck of the balloon snuggly over the mouth of the vial.

5. Share with students that you are about to tip the *Alka-Seltzer* tablet into the water in the vial. Invite them to predict what will happen to the weight of the objects as the Alka-Seltzer dissolves.

6. Allow the *Alka-Seltzer* to dissolve.

7. Weigh your materials again.

8. Invite students to be thinking about what happened in the experiment, as they repeat the experiment in their respective groups. Specifically, why does the weight (mass) remain unchanged?

9. Ask one member of each group to come up to collect all the materials (e.g., a balloon, an *Alka-Seltzer* tablet, and a vial, half filled with water). Make sure that each member comes with a piece of paper and pencil or pen. Ask each group member to weigh the materials on his/her way back to the group and record the weight on the piece of paper.

10. Allow students time to complete the activity and weigh the materials once again.

11. Rotate from group to group, listening for students' observations and questions.

12. When students have completed their experiment, reconvene them.

13. Ask them to consider the question: Does gas have weight (mass)? How do they know this to be true? Students should have come to understand that the weight of all the materials remained the same, even though there was a chemical reaction (e.g., the tablet dissolved to form a gas). The chemicals in the tablet reacted with the water and created new substances, one which is a gas. Substances change their nature; the mass before and after stays the same.

14. They should deduce that air has mass or weight.

Products
N/A

Extension Activities
Interested students: Invite any student who is interested to tie off the balloon that is filled with gas that was produced by the reaction with the Alka-Seltzer. Invite them: (1) to observe what happens they drop the balloon and (2) explain why the balloon sinks.

Answer: The balloon should sink toward the floor because it is filled mainly with C02, a by-product of the reaction of the water and the *Alka-Seltzer.* $C0_2$ is heavier than air.

Debriefing and Reflection Opportunities (5 minutes)

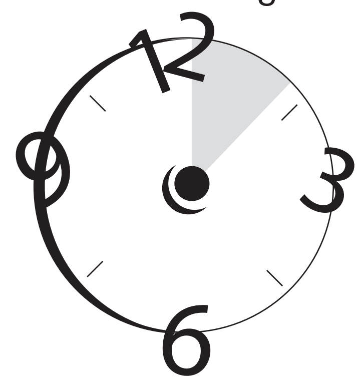
1. While still in their small groups, invite students to reflect on their learning and to write two new things that they learned or that reinforced what they already suspected about air.
2. Ask for volunteers from groups to share.
3. Make sure all new learning is accurate.
4. Explain that scientists record daily pressure with instruments called barometers. Share that students will be building barometers in the next session.

I Can be a Meteorologist, Too

Core

Time Allocation: 40 minutes

Required Materials and Resources on Page 311



Lesson Overview

In this second session on air pressure, students will create their own barometer and use it to take air pressure readings. Two different sets of instructions are provided for building inexpensive barometers. One is similar to the barometer that Italian physicist and mathematician Evangelista Torricelli invented in 1643. His original barometer used a column of mercury 1.2 meters high.

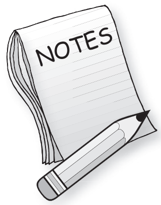
The second lab uses a wide-mouthed jar that is covered with a latex balloon for measuring air pressure. You may elect to use one of the construction methods or use both and invite students to assess the accuracy of each to measure air pressure. (Note: Prior to beginning this lesson, ask students to bring in an empty, clean, wide-mouthed glass jar that has a diameter of 3-4 inches, such as peanut butter, pickles, etc.)

Guiding Questions

- What is a barometer?
- What can air pressure tell us about current and future weather conditions?

BIG IDEA

The Pressure's On: Air Pressure and Barometer Basics



Content Goals

Universal Theme(s)

- Interaction
- Cause and effect

Principles and Generalizations

- Air/gas has properties: mass or weight, temperature and density.
- Our atmosphere contains many different very large "cells" of air that have different pressure readings that move around the globe.
- As cells move in the atmosphere, air pressure rises or falls in any given location over time.
- Lighter air is warmer and/or more humid.
- Heavier air is cooler and/or drier.
- A falling barometer (decreasing air pressure) generally means warmer, moist air and/or precipitation.
- A rising barometer (increasing air pressure) generally means cooler and/or drier weather.
- Changing barometric pressure readings may indicate weather changes.

Concepts

- Barometer

Teacher Information

N/A

Skills

- Observe
- Understand cause and effect

Materials and Resources

1. **The Pressure's On: The Latex Balloon** - Each student will need the following materials:
   • A wide-mouthed glass jar
   • A balloon with the neck cut off

- A rubber band
- A cardboard strip, 10 cm x 25 cm
- A small, wooden shish kebob stick, about 12-15 cm (Substitute a straw if the mass of the stick is too heavy. If you use a straw, cut the end of the straw into a point so that students can take a more accurate reading of the air pressure.)
- Masking or duct tape
- Scissors
- Metric rulers

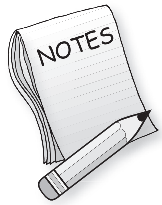
2. The Pressure's On: The Glass Tube – Each student will need the following materials:
   - A glass beaker or jar, with a 3-4" mouth
   - A ruler, centimeters preferable
   - Tape
   - 6-8" of plastic tubing, 1/4 inch diameter
   - A stick of chewing gum
   - Water

Preparation Activities

1. Place students' glass jars out where they can be easily collected. Have a few spare glass jars for students who forget to bring them to school.
2. Lay out the other supplies so students can easily access them.
3. Make sure that enough copies of **The Pressure's On: The Latex Balloon** or **The Pressure's On: The Glass Tube** are available for each member of the class.
4. If you decide to have the class use both methods of construction, make sure you have enough copies of both lab sheets.

Introductory Activities (5 minutes)

Convene students as a whole class. Invite them to recall what they learned about the properties of air in the last session. Share with them that the next thing they will be exploring is how to build a barometer which they will use to measure air pressure daily and observe trends and patterns in the weather.



Pre-assessment
N/A

Teaching and Learning Activities (25 minutes)

1. Assign students to four small lab groups. Students may be grouped heterogeneously or homogeneously.

2. Ask one member of each group to collect all the materials for his or her respective group, including a copy of the appropriate lab sheet.

3. Make it clear to students that each group will complete the lab collectively, but that each group member is responsible for completing a barometer.

4. Invite students to read through the directions. Ask students if they have any questions.

5. Provide students with enough time to make their barometers.

6. Rotate from group to group. Observe students and listen carefully to their thinking in each group. Be listening for students' observations and questions. Scaffold learning when necessary.

Products
Students' Barometers

Extension Activities
Invite interested students to complete additional research on any of the following topics:

- Evangeline Torrecelli
- Aneroid barometers
- Extremes in barometric pressure

Debriefing and Reflection Opportunities (10 minutes)

1. When students have completed their barometers, reconvene them.
2. Ask students to explain how their barometer works.
3. In the case of the jar and latex balloon, students should say that the latex of the balloon is sensitive to the changes in pressure. The stick or straw, glued to the latex, registers the changes in the pressure.

4. In the case of the glass and water tube, the water rises or falls in the tube due to the air pressure on the water in the glass. As air presses down on the water in the glass, the water level in the tube rises. As less air pressure is exerted on the water, the water level falls.
5. In a whole class discussion, invite students to share their thinking about the relationship between the change in air pressure and the weather. A rise in air pressure often means that a high pressure air mass is approaching, bringing with it clearing or fair weather. A fall in air pressure often indicates the approach of a mass of low pressure which brings clouds and precipitation.
6. Share with students that they will be use their barometers to chart, daily, the change in air pressure and compare the change to current weather conditions. They will record their findings in their **Weather Logs.**
7. Today's weather forecasters use aneroid ("without liquid") barometers to measure air pressure. Yet, air pressure is still reported in inches of mercury. For example, if a column of mercury is 29 inches high, the air pressure is "29 inches of mercury." Or "29 inches." Our pressure readings generally range from 29-31 inches of mercury.
8. Most weather maps indicate air pressure in millibars, a second way of reporting air pressure. It is a unit of measure called the Pascal. A hundred Pascals equals one millibar.

The Pressure's On: The Glass Tube
Air Pressure and Barometer Basics

In the last session, you learned that air had different properties. One of the properties is mass or weight. In this lab, you will be constructing your own barometer that you can use to observe and record daily pressure readings.

Materials:

- A glass or beaker with straight sides
- A ruler with inches and centimeters marked off
- Tape
- 8" of clear plastic tubing, 1/4" diameter
- A stick of chewing gum
- Water

Procedures:

1. Stand the ruler in the glass and hold it against the side.
2. Tape the ruler to the inside of the glass, making sure that the numbers on the ruler are facing so that they can be read easily.
3. Then, stand the plastic tube against a side edge on the ruler. Make sure that the bottom end is not touching the bottom of the glass. It should be about 1/2" away from the bottom. You can use your ruler to place the bottom of the tube 1/2" up from the bottom of the beaker or glass. Use tape to secure the tube to the ruler.
4. Chew your gum. While it is getting soft, fill your glass jar about 1/2 full of water.
5. With the gum "pouched" in the side of your mouth, use the plastic tube like a straw and draw some water up into the tube, about 1/2 or 3/4 of the way up.
6. Use your tongue to keep the water trapped in the tube. Then quickly move the gum onto the top of the tube to seal it.
7. Mark on the ruler to record where the water level is in the tube once a day. Note the changes in the water level. Use your daily weather journal to note the changes. Also, make sure to note the weather conditions on each day.
8. Water in the tube rises and falls because of the air pressure exerted on the water. As air "presses down" on the water (increased atmospheric pressure), more water is pushed into the tube and the level rises.
9. As less air pressure is exerted in the water, the level in the tube will fall as water moves down in the tube.
10. Decreasing air pressure signals the approach of a low pressure area, which often brings precipitation.
11. Increasing air pressure foretells the approach of a high pressure area which is often characterized by clearing or fair weather.

The Pressure's On: The Latex Balloon
Air Pressure and Barometer Basics

In the last session, you learned that air had different properties. One of the properties is mass or weight. In this lab, you will be constructing your own barometer that you can use to observe and record daily pressure readings.

Materials:

- A wide-mouth glass jar
- Large balloon, with the neck cut off
- A shish kebob stick, 12-15 cm long, OR
- A straw, 12-15 cm long, with one end cut to a point
- A cardboard strip, 10 cm x 25 cm
- Tape
- Modeling clay
- White glue
- Pencil
- Rubber band

Procedures:

1. If necessary, cut off the neck of the balloon, leaving the "globe" part.
2. Carefully stretch the balloon over the mouth of the jar.
3. Use the rubber band to secure it.
4. Place a dot-size amount of glue on the center of the stretched balloon. Attach the blunt end of the straw or the shish kebob stick to the glue. The pointed end should extend beyond the mouth of the jar and be your pointer.
5. While the glue is drying, fold the cardboard strip lengthwise. Draw a scale along one edge with marks 0.5 centimeters apart.
6. Write High Pressure at the top of the scale and Low Pressure at the bottom.
7. Once you have your barometer in place, tape the barometer and cardboard to a surface so they do not move during the time that you are making observations.
8. Place the barometer in an out-of-the-way place that does not receive a great deal of sunlight.
9. Use your **Weather Log** to make daily observations of the air pressure and weather conditions.

I Can be a Meteorologist, Too

Core/Practice

Time Allocation: 1 hour, 20 minutes

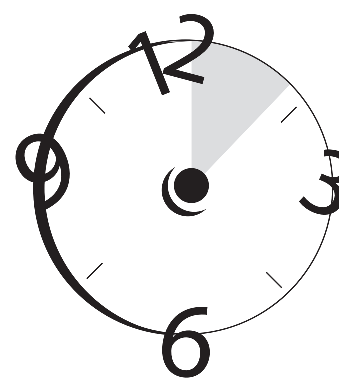
Plus on-going time each day, ten (10 minutes or so) for students to record the weather observations in their individual **Weather Logs** –daily recording can be set up as an anchoring activity.

Sometimes it will be impossible to set up a weather station at school because of safety factors or other related issues. In these cases, students can be invited to set up a weather station at home and track daily weather readings for homework.

Required Materials and Resources on Page 311

Lesson Overview

In this lesson, students will learn how to set up their own weather station. Although much more sophisticated data about the weather can come from outside sources, students will come to understand that they can collect their own weather information that is sufficient to create accurate weather predictions. For middle school students, this is an important realization and can be a powerful motivating force in this unit.

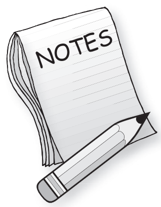


Guiding Questions

- How do meteorologists systematically collect information about key weather features?
- How do meteorologists communicate their findings?

BIG IDEA

Setting Up a Weather Station



Content Goals

Universal Themes
- Evidence
- Explanation
- Change
- Measurement

Principles and Generalizations
- Weather data can be recorded and studied.
- Weather predictions are based on trends and patterns that emerge from past data.

Concepts
- Trend
- Pattern

Teacher Information

N/A

Skills
- Observe
- Read a thermometer
- Read a rain gauge
- Use a Beaufort scale
- Determine wind direction
- Record data
- Make predictions

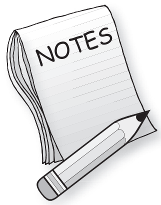
Materials and Resources

1. A place outside the school building that is in the shade for most of the day, safe for students, yet not protected from the natural elements (e.g., rain, wind) for setting up a weather station. Representatives from each weather observation group in the class will take daily weather readings.

2. As many air thermometers as there are groups of students.
3. Broom handles to be used as posts on which the thermometers will be mounted for each group of students
4. Duct tape
5. The six rulers, calibrated to eighths of an inch, with edges
6. Enough stones to prop up the rain gauges from each group.
7. The rain gauges from each group
8. Enough copies of **Weather Log** for each student in the class. Multiple copies of the log will be needed by each student over the course of the unit. Each sheet provides enough space for a student to record one week's data.
9. A sledge hammer
10. Note cards in different colors, a different color for each weather observation team
11. Push pins or tacks

Preparation Activities

1. Locate a weather station on school grounds. Make sure you communicate with the administration that you will be using the site as a weather observation station for the next several weeks. Alert other colleagues to your station and the fact that small groups of students will be taking daily readings about key weather features each day.
2. Prior to visiting the site with students, take the broom handles, along with the sledge hammer or hammer, out to the site. In a shady location, pound the handles into the ground. Make sure the handles are securely situated. Do not pound excessively hard as the handles might splinter.
3. Decide on a time that the readings will be taken. Try to keep the time constant because readings will vary greatly over the course of a day.
4. Plan to check the site regularly. If you plan to draw the compass readings on a nearby sidewalk or blacktop with chalk, it will need to be refreshed frequently. An alternative is to make a more permanent "map" of the directions, such as a waterproof piece of cloth, staked to the ground, with the directions, N, S, E, W, clearly marked.
5. Identify a place in the classroom that will serve as a Weather Bulletin Board. It should be a space large enough to contain the note cards from each weather observation group. It should be corkboard so that students can use tacks or push pins to post their observations. Several students should be able to view the note cards at a time.
6. Place **Weather Logs** at students' tables



Introductory Activities (3 minutes)

Convene a whole class meeting and explain that today is the day students will make their own weather station and begin recording their weather data, and making their own predictions. Their job to day is to listen so that they will understand where the station is located, how to take the weather readings, and how to keep their **Weather Log** up to date.

Pre-assessment

N/A

Teaching and Learning Activities (72 minutes)

SEARCHLIGHT: This entire lesson is an opportunity for student watching. Make mental notes of students who seem particularly good at making observations, recording data, and/or making weather predictions. Invite them to visit any of the websites listed under extension activities. The Mount Washington Observatory provides web visitors with the opportunity to correspond with resident meteorologists about any topic.

1. Tell students where the station is located and that you will be taking them outside in just a few minutes to see where it is.

2. Explain that there is a reason for them to be in their weather observation teams: not everyone will be able to go outside each day to take weather readings.

3. Instead, class members will take turns taking weather measurements.

4. One member from each team will take readings for 5 days. Then another group member will have a turn, and so forth until each group member has had his or her turn.

5. Review the procedures team members should follow when it is their turn to take measurements.

6. Show students the 3 x 5 card they will use to take the measurements and to bring the data back inside. Explain that they will post their data cards on the designated bulletin board in the classroom.

7. Throughout the day, remaining team members will have the opportunity to visit the bulletin board, collect the data, and record it in their **Weather Log.**

8. Identify one student from each group who will take the first set of measurements.

9. Provide each team member with a colored note card.

10. Take the students outside to show them the weather station. Ask students to help you take out all the remaining equipment, such as the rain gauges, thermometers, duct tape.

11. Mount the thermometers on the broom handles.

12. Help students take the first set of measurements. Make sure each team member records the correct information.

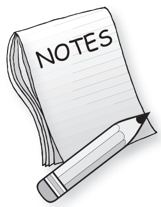
13. Answer any questions students may have.

14. Bring students back inside. Allow weather recorders to post their data and provide an opportunity for remaining students to copy the weather data into their **Weather Logs.**

15. Ask students to bring in copies of the weather maps from local newspapers each day. Ask for other volunteers to post the newspaper maps on the bulletin boards.

Products and Assignments

As time goes by, students will have their completed **Weather Logs.**



Extension Activities

1. http://www.wtnh.com/Global/link.asp?L=46075
   News Channel 8 is the only station in the state with an educationally-based weather network that serves dozens of schools across Connecticut. SchoolNET 8 allows students to access live weather data and utilize the information in daily science lessons. It also provides News Channel 8 viewers with LIVE, accurate weather information gathered from the schools' weather stations.
2. http://www.mountwashington.org
   The Mount Washington Observatory is a private, non-profit, membership supported organization. The Observatory performs hourly weather observations of "the world's worst weather" at the summit of 6,288 foot Mount Washington, the northeast's highest peak and also supports a wide variety of scientific research at its mountain-top facility, including environmental monitoring, atmospheric research, and equipment testing. Additionally, the Observatory is involved in many educational efforts which seek to inform individuals about the many significant aspects of weather, area history, and the mountain environment.

   Below is an example of the detailed weather summaries that are provided daily from the summit.

   Observer's Comments:
   04:16 AM Tue. May 06, 2003 EDT
   Partly sunny skies prevailed up here today, with temps climbing into the 40's. During the afternoon threatening cumulus clouds began forming above us, but they dissolved just as quickly as they formed. It was a memorable moment as I was walking along the Gulfside trail watching two cog trains and their crews working away on the tracks while towering clouds passed overhead; summer must be around the corner. A halo around the sun gave us the sign of some upper level moisture and an approaching warm front. Soon after sunset, the clouds thickened and lowered considerably with an increasing south wind. Visibility remains at 70 miles presently with a low ceiling overhead, but some light snow has begun whipping by on gusts from the south approaching 70 mph. Although temps are below freezing presently, I would bet on a warm, foggy and showery day ahead up here.

> The mystery will be what kind of precipitation we get out of this system; I would expect a smorgasbord until it all turns to rain eventually. Winds should increase through the morning as well, giving us another chance to place bets on a peak gust for this weather system.

Post Assessment
N/A

Debriefing and Reflection Opportunities (5 minutes)
Invite students to think about the system of weather. It is a complex interaction among the sun, air, land, wind and water. Over the next weeks, they will have the opportunity to watch weather "first hand," and make predictions, just like meteorologists. Invite students to share their predictions with family and friends and to keep track of how accurate their predictions are.

Note Card Template

Meteorologist: ____________________________________

Date: __________________________ **Time:** ____________________

Temperature: _______________

Wind Speed: _____________ **Wind Direction:** ________________

Cloud Type: ________ **Height:** _____________ **Cover:** _______

Precipitation Type:__________ **Amount:** ___________

Weather Log

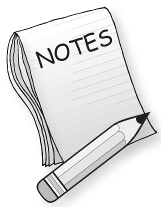
Name: ______________________ Week of: ______________________

Date	Time	Temp	Wind		Clouds			Precipitation		Student Next-Day Forecast	Actual Weather
			Speed	Direction	Type	Height	Cover	Type	Amount		

Additional notes and observations:

RUBRIC FOR Weather Log

Key Feature	Novice	Intermediate	Advanced	Expert
Completeness	Many entries are missing.	Some entries are missing.	All entries are present.	All entries are present and have great detail.
Accuracy	Many errors are evident in the entries; little attention paid to detail.	One to two errors were made on the entries; general attention to detail is evident.	All entries are accurate; significant attention to detail is evident.	All entries are accurate and great attention to detail is evident.
Student predictions	Some predictions are missing; little weather information was used to make the predictions.	One or two predictions are missing; some weather information was used to make the predictions; some evidence of cause and effect thinking is evident.	All predictions have been made; predictions reveal the use of some cause and effect relationships among the weather data.	All predictions have been made; a detailed analysis of the weather data is evident; predictions reveal strong and clear use of cause and effect relationships.
Student notes and observations	Very few notes and observations are evident.	Some notes and observations are made; notes show evidence of thinking about the weather.	Many notes and observations are made; solid use of language to make observations; notes and observations are carefully done; new knowledge is evident.	Many notes and observations are made; notes and observations are carefully done and go beyond expectations; rich use of language is used to convey observations; many connections are made between past and present learning.



Weather Log

Name: ______________________________

Date: ______________________________

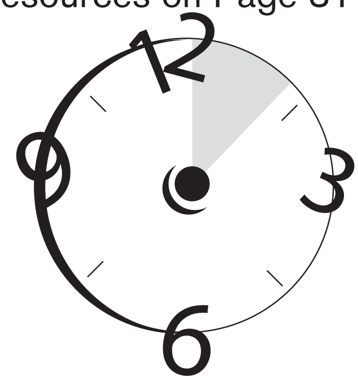
Additional Notes and Observations: ______________

Wind

Core

Time Allocation: 50 minutes

Required Materials and Resources on Page 311



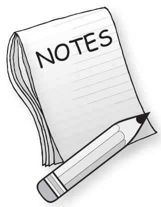
Module Overview

This module provides students with carefully sequenced learning opportunities related to air movement, wind. Students begin their investigation by exploring the sun, the energy source for all weather. Next, they learn that light energy is transformed into heat energy, which is absorbed and released differently by different land forms. Equally important, students learn that water absorbs and releases heat differently than water, which covers over three-quarters of the world. With an understanding of the unequal heating of the globe as a backdrop, students are provided with opportunities to learn about the behavior of warm and cool air, specifically, warm air rises and cool air sinks. With this knowledge, students will deepen their knowledge about the weather as a system. Namely, sunlight, land and air masses, and water all interact with one another to create weather.

Note: Many lessons in this module require the sun. In order to conduct these lessons in an efficient manner, it will be important to skim all the lessons, be alert to upcoming weather, and schedule the lessons accordingly.

BIG IDEA

Hot Spots: The Sun



Lesson Overview

In this lesson students will have the opportunity to complete a pre-assessment for the module and learn about the sun as well. They will hear Margaret Wise Brown's narrative, *The Important Book*. Then, they will have the opportunity to look at pictures of the sun taken during the continuing NASA SOHO project. Finally, students will have the chance to think about why the sun is central to the weather system and the interaction among land, water, and air.

Guiding Questions

- What is the sun?
- What are the most important things about the sun?

Content Goals

Themes

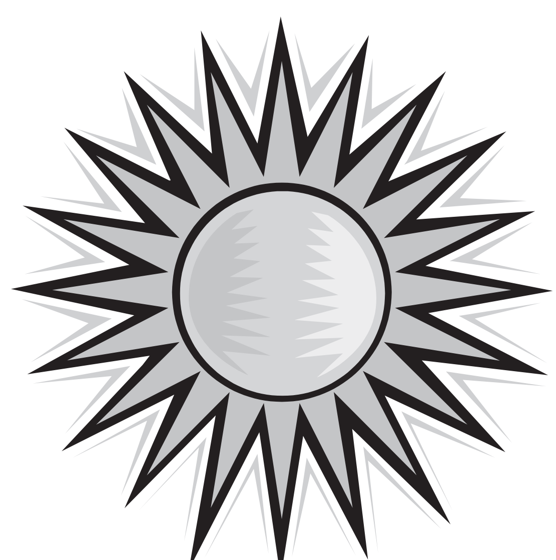
- System
- Cause & effect

Principles and Generalizations

- The sun makes air move through our atmosphere to create local wind.
- The sun releases light energy

Concepts

- Sun
- Star
- Light energy
- Energy
- Air
- Land
- Atmosphere
- Weather
- Interact
- System
- Local wind



Teacher Information
N/A

Skills
- See relationships: land, air, water, and sunlight
- Understand cause and effect

Materials and Resources
1. Flip chart and paper
2. Markers
3. Sheets of paper on the center of clustered desks in the classroom
4. Brown, Margaret Wise. (1990). *The Important Book.* HarperTrophy. (ISBN# 0064432270)
5. **Thinking Sheet** – copies for all students in the class
6. Pictures of wind
7. Pictures of water: oceans, lakes, rivers, rain, snow, ice.
8. Pre-assessment for Module 3: **How Are Local Winds Formed?**

Preparation Activities
1. Copy **Thinking Sheet** for students.
2. Copy the module pre-assessment, **How Are Local Winds Formed?** for students.
3. Visit the websites listed to make sure you are able to pull them up quickly during this session with students.

Note: Field trials with this module introduction revealed that students thought *The Important Book* was for kindergartners and was way "below" them. Be prepared to have a discussion with students about the nature of some picture books. Specifically, picture books can be deceptively simple looking but, in fact, can be very sophisticated in the message they impart. If your students have this reaction, this introductory lesson may require more than the 45 minutes allotted.

Introductory Activities (10 minutes)

Convene a whole class meeting. Explain to students that they are beginning their study of the wind, and it starts with the sun. Ask students why a weather unit might start with the sun, and list student responses on the flip chart. Collect the students' responses and hang the chart on a wall so that students can see it.

Explain that during the rest of the time today, they will be thinking about the meaning of a book, *The Important Book*, by Margaret Wise Brown. Read the book aloud and then ask students, "What's the most important thing about the sun? Ask them to put their answers on **Thinking Sheet.**

Pre-assessment (5 minutes)

- Explain to students that you will be collecting pre-assessment information and the rationale for doing so. Tell them that you will use the information to modify how you will teach the unit and assess their growth over the next several sessions. Ask student to complete the pre-assessment, **How Local Winds Are Formed.**
- Collect students' papers. Keep this baseline data on each student and use it to assess students' growth over the course of this module. You will compare the data contained in this narrative prompt to the data contained in the formative assessment, **Tiny Tornados,** that students complete in the last session of this module.

Teaching and Learning Activities (30 minutes)

1. Assign students to four small groups. While they are moving to their groups, move to the computer.

2. Tell the students that they will be looking at some recent pictures of the sun, which is a star at the center of our universe.

3. Ask students for a definition of star. Follow their train of thinking, using Socratic questioning, until students understand that stars are large balls of burning gases that give off light and heat.
   Of further interest for teachers:
      a. The light emitted from a star is produced in its interior through fusion reactions, "nuclear burning."

b. For more detailed information about stars:
http://hubblesite.org/newscenter/newsdesk/archive/releases/1995/44/
c. Pictures that show the birth of stars:
http://www.astro.cornell.edu/academics/courses/astro201/star_birth.htm

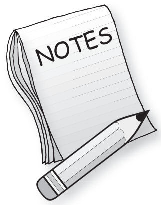
4. Explain that many pictures come from SOHO (Solar and Heliospheric Observatory), a satellite that studies the sun 24 hours a day, 365 days a year without interruptions. Scientists from around the world are studying the sun because they have many unanswered questions about it:

   How big is it?
   How hot is it
   What is it made of?
   How does the sun work?
   Why does it shine?
   What holds up the sun?
   For a complete list of the questions, go to the SOHO Frequently Asked Questions web page http://sohowww.nascom.nasa.gov/explore/faq/sun

5. Invite students to look at the pictures from the websites below. While they are looking at the pictures, ask them to be thinking about the question: What's the most important thing about it?
   http://soho.nascom.nasa.gov/hotshots
   http://soho.nascom.nasa.gov/gallery
   http://www.energyquest.ca.gov/story - then click on chapter 15
   http://umbra.nascom.nasa.gov/images

6. Ask students to work in small groups to compare their ideas about why the sun is important.

7. Rove around the room, making mental notes about the sophistication of students' thinking about the sun. Use the information to "tweak" the discussion that you will jump-start in a few moments about some of the major concepts in this unit: sun, energy, light energy, atmosphere, weather, and system.



8. After three to four minutes, reconvene the students, and engage them in a dialogue about their thinking. Use a flip chart to record their thinking about the most important things about the sun.

9. Weave in the following concepts and definitions, many of which should be familiar to students. Use Socratic questioning to move students' understanding of these concepts forward, if necessary. Field trials indicate you will need to spend time here helping students understand that sunlight does work for us.
   - A star is a celestial object that is made of gas that gives of heat and light.
   - The sun is at the center of our solar system.
   - Explain that the sun is the most powerful source of light energy for earth.
   - You know lots about other kinds of energy (e.g., gasoline for cars, school buses, and motors; electricity for lights, movies, music, and food for our bodies to do work).
   - The sun's light energy does work, too. It dries our clothes; helps plants grow, so that animals can have food; dries puddles; helps to make greenhouses, water, and some of our homes warm.

10. Begin to build a bridge between the important things named by the students and the sun as the driving force behind weather. The sun also starts up all the interactions that make our weather. When things interact, they act upon and affect each other.
    a. Sunlight heats land which causes air to move and become wind (hold up pictures of wind).
    b. Sunlight makes water move through the land and the atmosphere. The movement of water through our atmosphere is called the water cycle (hold up pictures of all kinds of water).
    c. The wind helps to moves water through the atmosphere.
    d. *Atmosphere* is a scientific word for the air that surrounds our planet.

Note: Field trials indicate that previewing these complex interaction with students at this point in the module may be preemptory. If you believe that this content will be overwhelming for students at this time, return to these important interactions contained within 10 and 11 toward the end of the module when students will be more familiar with the concepts and principles and more likely to grasp the complex interactions.

11. The air, wind and water cycle interact with each other to make our weather. Weather is the condition of our atmosphere at a particular time and place. Weather is also a system, a group of interdependent elements or forces that form a complex whole.

12. The sun is the source of energy for our weather system.

13. Provide students with three minutes to talk over in their small groups what they have learned about the importance of the sun.

14. Conclude this potion of the session by asking student to complete the last box on **Thinking Sheet.**

Products and Assignments

Thinking Sheet

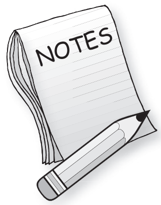
Pre-assessment for Module 3: **How Are Local Winds Formed**

Extension Activities

1. Students can visit any of the websites listed throughout the lesson that deal with Project SOHO.
2. They could also visit any of the sites mentioned earlier in the section about stars.

Post Assessment

Use the four-stage rubric to gauge what students learned about the importance of the sun. Use **Thinking Sheet,** which students will complete below, to assist you to assess students' learning gains.



Debriefing and Reflection Opportunities (10 minutes)

1. Ask students to think back to their first answer to the question: What's the most important thing about the sun? Tell students to complete the last two portions of their **Thinking Sheet.** Finally, invite students to share their latest list of reason about why the sun is so important.
2. Close the session by explaining that for the next several sessions, they will be talking about how powerful the sun is and how it interacts with the land and the air to create our daily weather.

Name:____ **Date:**_________________________

Thinking Sheet: The Most Important Thing About the Sun

First Reasons:

1.
2.
3.
4.
5.

The Reasons I Added to First List:

1.
2.
3.
4.
5.

Name:________________________________ **Date:**____________________

Conclusions Thinking Sheet: The Most Important Thing About the Sun

I changed/did not change my thinking because: ________________________________

RUBRIC FOR ASSESSING THE QUESTION:
What are the most important things about the sun?

Novice	Intermediate	Advanced	Expert
The most important thing about the sun is that it is very dangerous and it is covered with gases.	The sun keeps the earth warm so that it does not have ice all over it.	The sun brings warmth. It would be so cold, we would not be able to live. We would not have seasons like summer.	There are two important things about the sun. It gives us light and warmth. When light hits earth, it makes us warm.

Name:____________________________________ **Date:**______________________

Preassessment for Module 3

This is a pre-assessment for this module on weather. As you know, you will not be graded on your answers. We will use your answers to change the way we learn in our classroom. Please read the question, and then write down your answer in the space below.

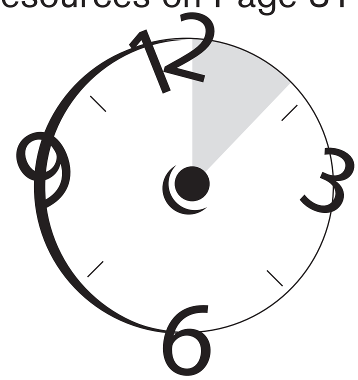
HOW ARE LOCAL WINDS FORMED?

Wind

Core/AID

Time Allocation: 40 minutes

Required Materials and Resources on Page 311



Lesson Overview

In this session, students will extend their understanding of the power of the sun as a source of energy. They will witness light energy being transformed from light into heat energy. In addition, they will apply their skill of observation to a demonstration about the power of the sun. This session reinforces the principle: When sunlight is absorbed by earth, it is transformed into heat energy

Guiding Questions

- What is the energy from the sun?
- How powerful is energy from the sun?
- What happens when sunlight falls on objects?

BIG IDEA

Solar Power: The Weather's Fuel

Content Goals

Universal Themes

- Interaction
- Cause and effect

Principles and Generalizations

- When sunlight is absorbed by the earth, it is transformed into heat energy which causes changes to earth's surfaces.

Concepts

- Light energy
- Heat
- Absorption
- Transformed
- Heat energy

Teacher Information

- The sun is a star.
- Stars are big balls of churning gases.
- We see many stars in the nighttime sky.
- Our sun is the only star that we see in the daytime.
- The sun is much larger than earth
- The sun does not burn like a fire does.
- It is much hotter than a fire.
- Inside the core of the sun, one kind of gas changes into another kind of gas (nuclear fusion AID).

The following web site contains a very simple explanation of nuclear fusion, as well as an animated graphic:

http://www.fusion.org.uk/focus/index.htm

The following three websites provide a much more detailed and sophisticated explanation of nuclear fusion. Most likely, students will require teacher or adult support to understand the content.

http://solar-center.stanford.edu/FAQ/Qfusion.html
http://zebu.uoregon.edu/~soper/Sun/fusion.html
http://zebu.uoregon.edu/~soper/Sun/fusionsteps.html

- When the gases change, they produce light and heat (AID).
- We receive the sun's light on earth.

Skills

- Observe
- Understand cause and effect

Materials and Resources

1. A magnifying glass
2. A piece of paper
3. A sunny window or
4. A sunny location outdoors for students
5. Lab Sheet: **Focusing Attention on Sunlight**, placed in piles on students' desks
6. Sticky notes at each table, enough so that each student can have 4-5 notes.

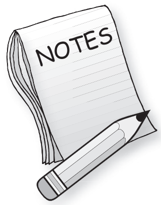
Preparation Activities

1. Make enough copies of **Focusing Attention on Sunlight** for students.
2. Place sticky notes and the lab sheet, **Focusing Attention on Sunlight**, on students' desks.
3. Arrange the demonstration materials at a place in the room near a window so that all students will be able to see. Check to make sure that you will have enough sunlight to focus so that the paper will begin to burn.
4. Check the weather for the next science session in which students will be exploring the different absorption rates of earth's surfaces. Make sure that there is sunny weather forecast for the next session.

Note: Field trials indicate that a tissue or a dried leaf will begin to smoke more readily than paper.

Introductory Activities (5 minutes)

- Convene a whole class meeting. Explain to students that in this lesson they will be studying a different aspect about the sun: its tremendous power. Ask them to remember the session in which they looked at pictures of the sun and asked the question: What's the most important thing about the sun?



- Explain that one of the most important things about the sun is its light, and that students will have a chance to see the tremendous power of its light in action in just a few moments. Their job in this lesson is to make detailed and accurate observations.
- **SEARCHLIGHT:** With respect to the content in this particular lesson, if you have students who seem to understand that light energy can be changed into heat energy, invite them to read about and explore nuclear fusion at any of the websites listed under Teacher Information

Pre-assessment

N/A

Teaching and Learning Activities (30 minutes)

1. Arrange students into dyads. Invite students to read through the lab with their partner so that they know what they will be expected to do.

2. Rotate to students who may be challenged by the reading. Point out the headings and explain what they mean. Explain that they can use their sticky notes to write out questions they have about the content.

3. When students have had time to go over the lab sheet, show them the magnifying glass and the piece of paper that is placed on a nonflammable surface. Hold the magnifying glass so that it captures light, but does not focus it on the paper. Invite students to guess what they will see, hear, and or smell when you hold the magnifying glass high above the paper so that the light is unfocused.

4. Then, hold the magnifying glass well above the paper, making sure the rays are not focused. Invite student to make their observations and record them on the appropriate worksheet.

5. Remind students to write down any questions on the sticky notes at their desks.

6. Do the demonstration again. This time tell students that you will be focusing the rays of light onto the paper. Invite them to make guesses about what will happen.

7. Finally, focus the rays of the light into a smaller and smaller dot on the paper. Ask students to make careful observations because things will start to happen very fast.

8. Focus the light tightly enough so that smoke begins to rise from the paper that is being heated by the focused rays of the sunlight. If necessary, repeat the demonstration so that students have the opportunity to make their observations one more time. (Make sure to tell students that this demonstration should be conducted only by an adult.)

9. When students have completed their observations, ask students to complete **Beyond the Data** at the end of the lab sheet. Tell students they can do the questions with their partner, but remind them that they each have to submit a lab.

10. **SEARCHLIGHT:** Rotate through the groups listening carefully to the conversation, making mental notes about what students understood and didn't understand. Use the information to shape the debriefing so that it (1) underscores students' new understanding of the transformation of light to heat, and (2) clarifies any misconceptions. If there are students who already seem to understand that light energy can be changed into heat energy, invite them to explore more about the sun's energy at the web sites listed above in "Teacher Information."

11. Answer any questions students may yet have about the demonstration.

Products and Assignments

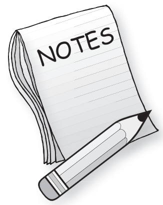
Focusing Attention on Sunlight

Extension Activities

N/A

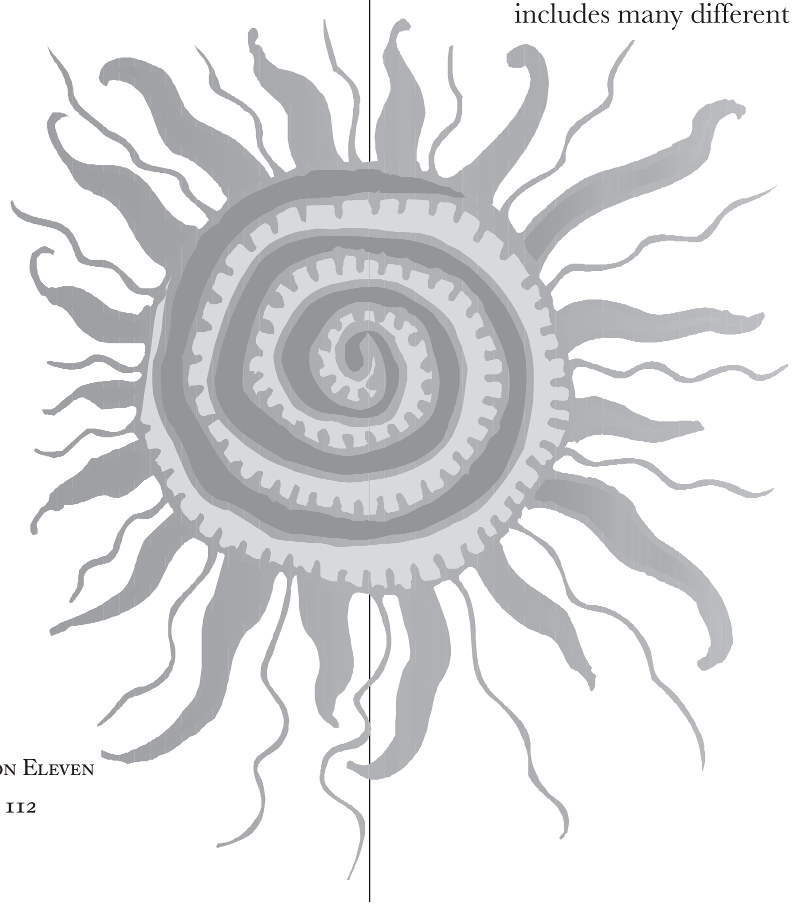
Post Assessment

N/A



Debriefing and Reflection Opportunities (5 minutes)

1. Explain to students that they have observed how powerful just a few rays of the sun can be. Engage them in a discussion about what they saw.
    - What did you see?
    - What is the sun's energy?
    - How do you think the sun's light affects earth?
    - If the sun is this powerful, how might it affect our weather?
    - Which of your questions have yet to be answered?
2. Emphasize that students saw a small model of the interaction between the sun and earth. Light energy comes from the sun. It is absorbed by all surfaces on earth and transformed or changed into heat energy. The earth's surfaces release some of the heat into the air nearby, warming the air, our atmosphere. Sun's light is what causes all of the effects just mentioned: the heating of the earth's surface, the release of some of the heat, and the warming of the atmosphere.
3. Share with students that they will be looking more closely at this interaction among the sun, air, land and water over the next six weeks. Close by saying that in the next session they will explore the effect of sunlight on land, which includes many different kinds of surfaces.



Name:____ **Date:**________________________

FOCUSING ATTENTION ON SUNLIGHT

Background Information

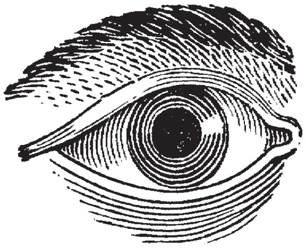
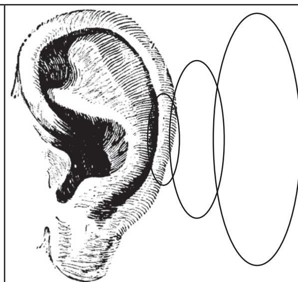
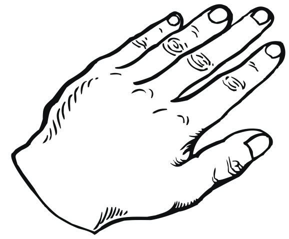
We see the sun in the sky almost everyday. Because it is such a regular object in the sky, we probably don't take the time to stop and think about sunlight and how it affects our earth and our weather. In this experiment, you will have a chance to focus your think about the effects of sunlight on objects.

You will be making some guesses about what will happen in this experiment and making observations. Space is provided on the lab sheet for you to explain what you think will happen in this experiment.

You will also have the opportunity to record your observations. Do you remember that observations are made with our eyes (sight), ears (sound), nose (smell), and fingers (touch)? In the Data Charts below, you will see that there are four columns, one for each sense that you may use to make your observations. When you make your guesses and observations, make sure that you use the correct column.

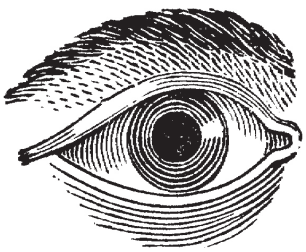
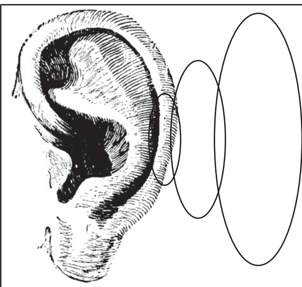
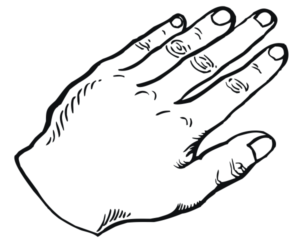
Name:____ **Date:**______________________

Predictions: What will unfocused sunlight do to paper?

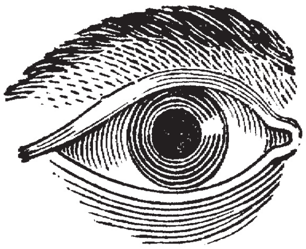
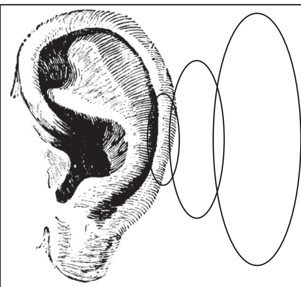
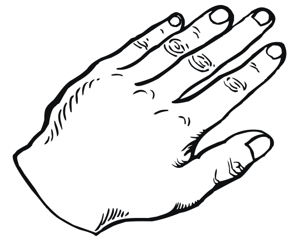
Name:____ **Date:**________________________

Observations: What does unfocused sunlight do to paper?

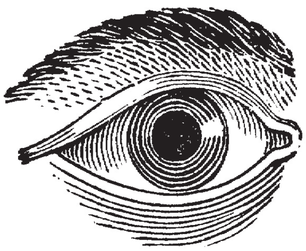
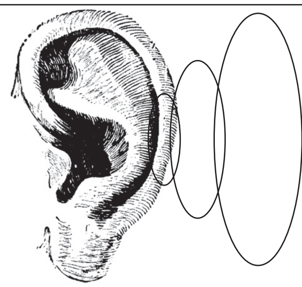
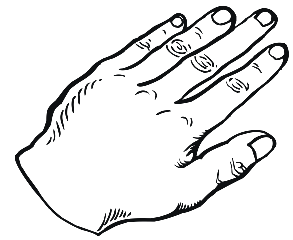
Name:____________________________________ **Date:**____________________

Observations: What does focused sunlight do to paper?

Name:____ **Date:**__________________________

Observations: What does focused sunlight do to paper?

Name:____ **Date:**____________________

Beyond the Data

1. In what ways were your predictions accurate?

2. Review your observation charts. Which sense did you use the most to make your observations? The least?

3. What is so important about the sun?

4. How might the power of the sun influence our weather?

5. What questions do you still have?

RUBRIC FOR ASSESSING ANSWERS TO THE GUIDING QUESTIONS:
What happens when sunlight shines on objects?

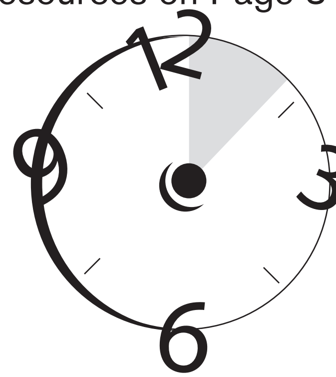
Novice	Intermediate	Advanced	Expert
• Objects get brighter when the sun shines on them. • Objects grow when the sun shines on them.	Objects get warm when the sun shines on them.	Sunlight is absorbed by objects, and they get warm.	Sunlight is absorbed by objects and causes them to heat up. In turn, this heat warms the object and air nearby.

Wind

Core/AID

Time Allocation: 1 hour, 10 minutes

Required Materials and Resources on Page 311



Lesson Overview

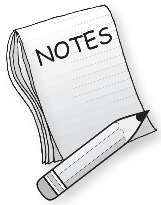
In this lesson, the teacher will develop students' understanding of the principle: The darker substances (e.g., dark soil, asphalt roadways, forests) absorb more sunlight than lighter substances (e.g., snow, glacier ice) and, as a result, release more heat than the lighter surfaces. Students will participate in a simple experiment—involving black and white paper—that will provide them with the opportunity to construct their own understanding of the absorption rates of different colored surfaces. The black paper represents the darker surfaces on earth, while the white paper represents the lighter surfaces. This session also provides an alternate experiment for students who may already be familiar with the absorption rates of different land surfaces and need increasing levels of challenge (AID).

Guiding Questions:

- Do all surfaces absorb the same amount of sunlight?
- Do all surfaces release (give off) the same amount of heat?
- What happens to earth's temperature when heat, created by sunlight, gets trapped in our atmosphere? (AID)

BIG IDEA

Unequal Heating of Earth's Surface



Content Goals

Universal Themes

- Interaction
- Balance

Principles and Generalizations

- The earth's darker surfaces (e.g., dark soil, asphalt roadways, forests), absorb more sunlight (light energy) than lighter surfaces (e.g., snow, glacier ice) and, as a result, release more heat than the lighter surfaces.
- When heat is trapped in our atmosphere, earth gets warmer. This is called the Enhanced Greenhouse Effect or global warming. (AID)

Concepts

- Light energy
- Absorb
- Dark surfaces/substances
- Light surfaces/substances
- Glacial ice
- Release
- Heat
- Trapped (AID)
- Greenhouse effect (AID)
- Enhanced Greenhouse Effect (AID)
- Cause
- Model

Teacher Information

- Land surfaces on earth absorb sunlight differently.
- Darker surfaces absorb more sunlight than do lighter ones.
- Dark surfaces on earth include forests, asphalt roadways and dark-colored soil.
- Lighter surfaces include fresh snow, sand, and glacial ice.
  o Glacial ice begins as fresh snow.
  o Air then infiltrates the fresh snow.

o Snowflakes become smaller, thicker, and rounder.
o Air is forced out.
o Snow is re-crystallized into a much denser mass of small grains called firn.
o Once the thickness of the ice and snow exceeds 50 meters, firn fuses into a solid mass of interlocking ice crystals to form glacial ice.
o Glacial ice absorbs more sunlight than does fresh snow.

Skills

- Read a thermometer
- Graph
- Understand cause and effect

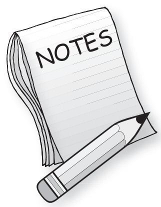
Materials and Resources

For all students:

1. A sunny window and/or
2. A sunny location outdoors for students
3. 12 pieces of black construction paper, 5.5" X 8" (6-8 1/2" x 11 pieces of paper cut in half)
4. 12 pieces of white construction paper, 5.5" X 8" (6-8 1/2" x 11 pieces of paper cut in half)
5. 24 thermometers
6. A clock/watch with a minute hand
7. Student Lab Sheets
8. Sticky notes
9. Pens/pencils

For students needing more challenge, these additional resources will be required:

1. 2 jars, one with a lid and one without
2. 2 balls of clay
3. 2 thermometers that students can anchor into the clay that they placed at the bottom of each jar.
4. A short reading on the greenhouse effect. A web page article about the greenhouse effect available at: www.windows.ucar.edu . Once there, click on their search option and type in "greenhouse." The search will bring up the greenhouse effect article, available in three levels of reading difficulty.



5. Student Lab Sheet, **The Greenhouse Effect**

Preparation Activities

1. Make sure it is sunny outside or that students have sunny windows in which to work.
2. Cut the construction paper in half. Ensure that there is a black and white piece of paper for each pair of students.
3. Locate the thermometers and arrange all lab materials so that students can easily locate and collect them.
4. Print enough copies of the lab sheets, **Black and White**.
5. If it is probable that some students will be familiar with the absorption rates of substances, have ready the materials for the AID component to this session that are listed above, as well as enough copies of their lab sheet, **The Greenhouse Effect** and the web article by the same name.

Introductory Activities (5 minutes)

Convene a whole class meeting. Remind students that they have been studying about weather, which is the study of the interactions among the sun, land, air and water. Explain that today they will look at how sunlight is absorbed by earth's surfaces. Ask the guiding questions so that students have a focus for their work: Do all substances absorb (take in) the same amount of heat? Do all substances release (give off) the same amount of heat?

Pre-assessment (5 minutes)

Ask students what happens when sunlight shines on dark and light substances. Use the rubric that is included with this unit to ascertain students' knowledge level. If some students seem to understand differing absorption rates, arrange them into a group (Group 2). They will work on the Greenhouse Effect experiment that is included.

Teaching and Learning Activities (30 minutes)

1. Quickly review the experiment to make sure there are no misunderstandings. Explain that students will be scientists and record their observations on their science lab sheet. If needed, ask students to recall the protocol for making detailed observations.

2. If there is a Group 2, ask students to read through their article about the greenhouse effect, as well as their experiment.

3. Move students outside to a sunny location or to a station at a sunny window.

4. Glance at each group of students to make sure that each pair has their papers laid out correctly and that the thermometers are not yet placed on the papers. They should be kept out of the sunlight until you tell students to place them on the papers.

5. If there is a Group 2, make sure that they have the materials for their experiment properly arranged. Remind students that they can use the sticky notes to write down questions that they have related to the experiment.

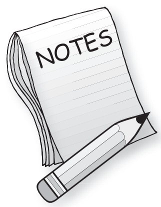
6. When students are ready, begin timing the one-minute intervals.

7. Keep students on track by keeping time.

8. Rotate through the groups to make sure that students are recording their data correctly.

9. Pay special attention to students who need more scaffolding. Use Socratic questioning to move each pair forward in their thinking. Ask questions that demand less inference to students who do not have as much experience with the topic (e.g., How is the black paper similar to asphalt roadways?) Ask questions that require more inference to the more sophisticated thinkers (e.g., How might the heat that is released from darker substances differ from the heat released from lighter substances?)

10. Bring students back inside or have them return to their desks. Provide each pair of students with enough time to complete their lab.



Products and Assignments

- **Black and White**
- **The Greenhouse Effect**

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (30 minutes)

1. Reconvene students and ask them to form small groups of four students. Have Group 2 students work as a small group. Ask Group 1 students to summarize how surfaces absorb sunlight differently. Ask Group 2 students to summarize what happens when sunlight is "trapped" in our atmosphere.
2. When students have had a chance to summarize their findings, provide students with the opportunity to share their findings with the entire class.
3. Then, engage students in a discussion of Group 1's summary statements. What was similar among the findings? What differences exist?
4. Emphasize with students that different substances do, indeed, absorb sunlight differently. The darker surfaces absorb more light than lighter surfaces. With respect to the earth, darker substances are forests, dark soils, and asphalt. Lighter substances include sand, fresh snow, glacial ice and ice caps.
5. Dark and light substances release different amounts of heat. Dark surfaces give off more heat because they have absorbed more sunlight. The heat, in turn, warms the nearby air, our atmosphere. The interaction of the sun, land, and air all contribute to weather.
6. Provide students in Group 2 with the opportunity to share their findings. Emphasize that our atmosphere is, indeed, fragile. Too much heat can build up in our atmosphere when it gets filled with man-made pollutants that prevent heat from escaping. When this happens, the temperatures are higher than normal. This can have harmful effects, such as the melting glaciers and ice caps, which, in turn, raise the sea level.

7. Review with students the connection between the absorption rates of dark and light substances and our weather. Daily temperatures are affected by the heat released by surfaces. Scientists are beginning to believe that our daily weather is warmer as a result of the Enhanced Greenhouse Effect, sometimes called Global Warming.

Name: ____ **Date:** ____________________

BLACK AND WHITE=DARK AND LIGHT SURFACES

Background

For the last couple of days we have been talking about what happens when sunlight falls upon objects. You've already noted that sunlight seems to increase the surface temperature of objects. But, there is a twist to this experiment. Today you will have a chance to see what happens when the rays of the sun fall upon different colored objects. Will the black paper absorb the sunlight in the same way that it is absorbed by the white paper?

Materials

To conduct this experiment, you will need the following materials for each pair of students:

- two pieces of paper, one black and one white
- two thermometers
- A lab sheet

Procedures:

1) Take your pieces of paper to a sunny window or place outside.
2) Make sure to place your papers out of the sunlight.
3) Put both thermometers in a shady place for a few minutes until they read approximately the same temperature.
4) While you are waiting, make predictions about what will happen when you place your thermometers on each piece of paper and expose them to the sunlight.
5) When your teacher says "begin," place your papers in the sunlight. Then, put one thermometer on the white paper and the other one on the black paper.
6) Take your first reading of each thermometer and place the temperature readings on your data chart.
7) Your teacher will prompt you to make your remaining readings. You will take one reading each minute for the next nine minutes.
8) After each reading, you can talk about your observations with your partner. Place your observations in your data sheet. While you can talk with your partner about your experiment and your observations, you will each be asked to turn in a lab sheet.

Name: ______________________________ **Date:** ____________________

My prediction about what will happen to the temperatures on the white and black sheets of paper.

____

____

____

____

____

____

____

____

Name: ____ Date: ____________________

Data Table

Observation #	Temperature Reading On The White Paper	Temperature Reading On The Black Paper	Observations
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Name: ____ **Date:** ____________________

Beyond the Data

1. What information did you use to make your prediction?

2. What did you notice about the surface temperature of the white paper? The black paper?

3. How do you explain the fact that one piece of paper had a higher surface temperature?

4. Think about what you know about the light paper and the dark paper. What conclusions can you draw about the absorption rates of the different surfaces of earth (e.g., soil, forests, asphalt surfaces, sand, ice, glacial ice, and snow cover)?

Name: *CJ* Date: *11/3*

BLACK AND WHITE=DARK AND LIGHT SURFACES

Background

For the last couple of days we have been talking about what happens when sunlight falls upon objects. You've already noted that sunlight seems to increase the surface temperature of objects. But, there is a twist to this experiment. Today you will have a chance to see what happens when the rays of the sun fall upon different colored objects. Will the black paper absorb the sunlight in the same way that it is absorbed by the white paper?

Materials

To conduct this experiment, you will need the following materials for each pair of students:

- two pieces of paper, one black and one white
- two thermometers
- A lab sheet

Procedures:

1) Take your pieces of paper to a sunny window or place outside.
2) Make sure to place your papers out of the sunlight.
3) Put both thermometers in a shady place for a few minutes until they read approximately the same temperature.
4) While you are waiting, make predictions about what will happen when you place your thermometers on each piece of paper and expose them to the sunlight.
5) When your teacher says "begin," place your papers in the sunlight. Then, put one thermometer on the white paper and the other one on the black paper.
6) Take your first reading of each thermometer and place the temperature readings on your data chart.
7) Your teacher will prompt you to make your remaining readings. You will take one reading each minute for the next nine minutes.
8) After each reading, you can talk about your observations with your partner. Place your observations in your data sheet. While you can talk with your partner about your experiment and your observations, you will each be asked to turn in a lab sheet.

Name: *CJ* **Date:** *11/3*

My prediction about what will happen to the temperatures on the white and black sheets of paper.

I think that the white will absorb 3 degrees every 4 minutes

because white reflects heat. I think the black paper will

increase 5 degrees every 3 minutes because black absorbs heat

and does not reflect it.

Name: *CJ* ______________________ Date: *11/3* ______________

Data Table

Observation #	Temperature Jar 1	Temperature Jar 2	Observations
1	*74°F*	*79°F*	
2	*78°F*	*78°F*	
3	*79°F*	*80°F*	
4	*80°F*	*82°F*	
5	*80°F*	*83°F*	
6	*81°F*	*83°F*	
7	*81°F*	*84°F*	
8	*80°F*	*84°F*	
9	*81°F*	*86°F*	
10	*81°F*	*86°F*	

Name: *CJ* Date: *11/3*

Beyond the Data

1. What information did you use to make your prediction?
   I used my knowledge that dark colors absorb more heat. I know this because of an experiment that I did to prove this.

2. What did you notice about the surface temperature of the white paper? The black paper?
   They both get hotter, but the black paper gets hotter and faster.

3. How do you explain the fact that one piece of paper had a higher surface temperature?
   Dark colors (black) absorb more light energy than light colors. Therefore, the more light energy, the more heat energy (higher temperature.)

4. Think about what you know about the light paper and the dark paper. What conclusions can you draw about the absorption rates of the different surfaces of earth (e.g., soil, forests, asphalt surfaces, sand, ice, glacial ice, and snow cover)?
   Darker Earth surfaces like tar absorb more light than lighter Earth surfaces like snow.

Name: ____ **Date:** ____________________

THE GREENHOUSE EFFECT

Background

Global warming refers to an average increase in the earth's temperature. Scientists think that our earth's average temperature may actually be rising. In fact, they think earth has warmed by about one degree F over the past 100 years. A warmer earth may lead to changes in rainfall patterns and a rise in sea levels, among other things. Scientists think that the earth could be getting warmer on its own, but they think it is more likely that people and their activities on our planet are contributing to the rise in temperature.

If you would like to read more about the greenhouse effect, you can visit the following websites: www.soton.ac.uk/research (Once at this site, use the search option and type in "greenhouse") and www.epa.gov/globalwarming/kids

Materials

You can do a simple experiment with a lab partner that will help you understand the greenhouse effect. You will need the following materials for each pair of students:

- two jars, one with a lid and one without
- two thermometers
- two small balls of clay for anchoring the thermometers

Procedures:

1. Take your materials to a sunny window or place outside if the weather is sunny.
2. Place a small ball of clay in the bottom of each jar. Anchor a thermometer in the bottom of each jar.
3. Wait five minutes until both thermometers have come to about the same temperature.
4. While you are waiting, predict what will happen to the temperatures in each jar once you have placed the lid on one of them and waited for ten minutes.
5. Place the lid on one of the jars.
6. Every minute, for ten minutes, record the readings for both thermometers on the data chart below. Don't disturb the thermometers.

Name: ______________________________ **Date:** ____________________

My prediction about what will happen to the temperature in each jar once the lid is placed on one of the jars.

Name: ______________________________ **Date:** ____________________

Data Table

Observation #	Temperature Jar 1	Temperature Jar 2	Observations
1	*74°F*	*79°F*	
2	*78°F*	*78°F*	
3	*79°F*	*80°F*	
4	*80°F*	*82°F*	
5	*80°F*	*83°F*	
6	*81°F*	*83°F*	
7	*81°F*	*84°F*	
8	*80°F*	*84°F*	
9	*81°F*	*86°F*	
10	*81°F*	*86°F*	

Name: ______________________________ **Date:** ____________________

Beyond the Data

1. What information did you use to make your prediction?

2. How accurate as your prediction?

3. Why do you think the temperature rose in the jar with the lid?

4. What is a model?

5. How can this experiment be used as a model of the greenhouse effect on earth?

6. How do you think the greenhouse effect might influence our weather?

RUBRIC FOR ASSESSING ANSWERS TO THE GUIDING QUESTIONS:
What happens when sunlight shines on objects?

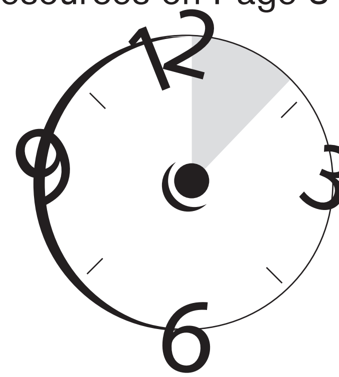
Novice	Intermediate	Advanced	Expert
If the sun hits the North Pole, the snow will melt and make it really hot. *or* The sun warms the surfaces and they sometimes change colors or shine. *or* Everything gets darker and colder. *or* It won't do anything to the different colors, but maybe fade them.	Sunlight bounces off objects and reflect into our eyes. Then we see it. *or* It heats up differently.	It is hotter on different colors, like pavement on a driveway is hotter than the grass. *or* Some colored surfaces will heat up faster.	Darker substances on earth absorb more sunlight. When the dark substances absorb lots of sunlight, they get hot, like asphalt in the summertime. Lighter substances don't absorb as much sunlight as the darker ones and so they aren't as warm as the darker ones.

Wind

Core

Time Allocation: 40 minutes

Required Materials and Resources on Page 311



Lesson Overview

In this lesson and Lesson 14, the teacher will develop students' understanding of the fact: There is a great deal more water on earth than there is land. This principle will eventually extend students' understanding about the unequal heating of earth's surfaces. Specifically, darker surfaces absorb and release more heat. Further water absorbs and releases heat more slowly than land does.

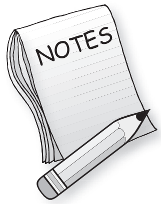
Students will learn about the skill of estimation. In small groups they will work through an estimation problem as a class. Then they will move on to their lab sheet and follow the instructions to estimate the amount of water and land on earth's surface. Finally, they will share their strategies and their estimations with the class.

Guiding Questions

- How can we make estimates of things that appear, at first, to be unknowable?
- What is the percentage of water and land on earth surface?
- How does the amount of water on the earth's surface affect our weather?

BIG IDEA

Estimating Land and Water on Earth



Content Goals

Universal Theme

Communication

Principles and Generalizations

- There is more water on earth than there is land.
- Reasonable estimates of very large quantities require careful, logical thinking.
- Percents and fractions represent part-to-whole relationships.

Concepts

- Estimation
- Reasonable
- Percent
- Fraction
- Part-to-whole relationships

Teacher Information

The earth's oceans and lakes make up 75% of the earth's surface.

Skills

- Estimate

Materials and Resources

1. Two, preferably three, flat maps of the world
2. Flip chart and markers
3. Enough copies of **Estimation: It's Easier Than You Think!** for each student in the class
4. Pencils
5. Sticky notes

Preparation Activities

1. Make enough copies of **Estimation: It's Easier Than You Think!** for students.
2. Make sure that you have at least one large, flat map of the world. Two or three maps would be ideal.

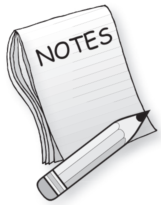
Note: Field trials with diverse classrooms indicate that this sequence of two lessons about the amount of water and land may not be necessary. Teachers reported that many students already knew that much of the earth was water, about 3/4 or 75%.

Introductory Activities (5 minutes)

- Divide students into small, heterogeneous groups of three students each. Ask students to generate a list of the things that have surprised them since they began their discussion about the weather. Provide students with time to share their thinking with the class. Students' responses will vary.
- Explain that students are in for another surprise. They will spend time talking about a very important fact about weather. Explain that it is something that they probably all know about but have not, until now, connected with the weather. It is that the earth is covered mostly by water. If this is so, how might the idea of these big, vast oceans be connected to weather? Ask students to talk for a minute among the members of their groups to come up with a possible connection.
- Elicit responses from the groups and record their answers on flip chart paper.
- Hang the flip chart paper containing students' ideas and indicate to students that they will return to these ideas over the next two days. Explain that before we address this important question, we need to talk about how we estimate, a very important skill that meteorologists and other scientists use.
- Ask students about estimation. When do you use estimation? Listen to students and ask: What are the steps you think about when you estimate? Listen and diagnose students' current levels of understanding about this thinking skill. Explain that they will have an opportunity to sharpen their estimating skill in this unit about the surface of earth.
- Remind students to keep Guiding Question # 3 in mind: How does the amount of water on the earth's surface affect our weather? It is their job today to come up with an answer to this question. Also remind students about the sticky notes on their desks that they can use any time to write down questions about any aspect of the lesson and/or weather.

Pre-assessment (2 minutes)

Ask students if anyone has thinking protocol for estimating that they would like to share. It is unlikely that anyone will know of protocol.



Teaching and Learning Activities (25 minutes)

1. Read with students the first paragraph in the **Estimation Lab**.

2. Explain that they will be working through an example of an estimation problem.

3. Alert students that, at the outset, it will sound impossible to solve. Remind students not to be set back by it. Instead, use the “thinking steps” to work through it.

4. Go over the example, “How much water will you drink in a lifetime.”

5. Ask students to apply the protocol to another problem: How tall is our flag pole?
   a. Find the unknown: the height of the flag pole
   b. Identify what I know about the unknown; how can I break it into smaller, more knowable parts? It can be considered as high as X number of people, x number of yard sticks, etc.
   c. Line of reasoning:
   o The flag pole is about 10 yard sticks high. Each yard stick is 3 feet.
   o 10 X 3 feet = 30 feet. The flag pole is about 30 feet high.
   o The flag pole is about 5 men high. Each man is about 6 feet tall
   o 5 men X 6 feet =30 feet. The flag pole is about 30 feet high.
   d. Check the answer to make sure it is reasonable. Ask students how they could check the reasonableness of this answer.

6. Invite students to talk among the members of the group and write down any questions they have on sticky notes.

7. Take time to answer any student questions.

8. Ask student to move on to their lab sheet and to follow the instructions. Students will be working to estimate the amount of water and land on earth’s surface.

9. Rotate through the group and pay special attention to the students who need more scaffolding. You might have to provide hints and suggestions to students who have trouble breaking the maps down into smaller, more workable sections (six – nine sections will probably be ideal). You might also have to help students develop a line of reasoning once they have estimates for each of the smaller portions of the map. This is, they will need to think about making an overall estimate from the six-nine estimates that they gained by breaking the map down into smaller, more manageable sections.

10. Make sure that students do not have estimates that are unreasonable.

Products and Assignments

Estimation: It's Easier Than You Think!

Extension Activities

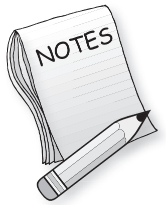
Invite students to make their own estimation problems

Post Assessment

N/A

Debriefing and Reflection Opportunities (8 minutes)

1. Spend time on this section of the lesson. Make sure that students understand the thinking process that is the foundation for estimation. Explain that we can all be better thinkers if we understand how thinking skills are done.
2. Equally important, make sure that students have generated a reasonable estimate of the amount of water and land on earth's surface.
   - Ask students to explain out loud the thinking steps involved with estimation.
   - Ask if students checked their answer to make sure it was reasonable.
   - Ask: Which strategy did you use to tell if your answer was reasonable?
   - Listen to students' responses to check the "reasonableness" of students' strategies.
   - Talk about the slight variations in students' estimates. Is it OK to have slightly different estimates? Why or why not?



3. Ask students to clean up, store their work, and be prepared for the next session in which they will make a visual representation of their answer.

Name: ____ **Date:** ____________________

ESTIMATION: IT'S EASIER THAN YOU THINK!

Background

Estimating is a thinking process that we use to make skillful and reasonable judgments about questions that, at first, seem unknowable. It involves five stages: (1) figuring out the different unknowns in the problem, (2) thinking or writing down what you already know about the unknowns, (3) developing an accurate chain of reasoning, (4) using the reasoning to generate your estimate, and (5) checking your answer to make sure it is sensible.

For example, you might want to estimate how much water you will drink in a lifetime. Your **first** step will be to figure out the different "unknown" parts of the question. In this example, there are two unknowns. The first one is how much you drink and the other is how long you will live. **Second**, write down what you already know about each of the unknown parts of the problem: how much you drink and how long you will live. In problems that seem unknowable, it is advisable to break the unknown parts into smaller, "knowable units." For example, if you think about what you drink in one day, rather than in a lifetime, the problem will be easy to solve.

"On average, I drink 3 glasses of milk (8 oz), 1 glass of juice (8 oz), some milk on my cereal (1/2 of a cup), and 1 can of soda (8 oz)."

So, write down: On average, I drink about 44 oz of fluid a day.

Now address the other unknown part of the estimation problem: how long you will live. We can tap into what is generally known about the human life span to come up with a number here. Many scientists believe that people live, on average, about 75 years. **Third**, create a line of reasoning with your information to help you solve the problem. "I will have to multiply what I drink in one day times 365 (days in a year) times 75 (the average number of years I will live)."

Fourth, using your line of reasoning, generate the answer to the problem:

44 oz X 365 X 75= 1,204,500 oz

To make it easier to understand the answer, one could convert it to 8 oz cups or gallons.
Cups in a lifetime: 150,562.5
Gallons in a lifetime: 18,820.3

Fifth, check whether your answer seems reasonable. "If I continue to drink about the same amount liquid each day as I do now, and I live to an average age, I think my estimate is pretty reasonable."

To summarize, estimation is a core thinking skill that is used is science, mathematics and many other areas of intellectual activity to solve seemingly unknowable problems. Used correctly, estimation can help people make reasoned and sound decisions and avoid guessing. Those skilled at estimation structure and sequence their thoughts

Name: ____ **Date:** ____________________

ESTIMATION: IT'S EASIER THAN YOU THINK!

In a thinking protocol that includes five stages:

1. Find the unknown (s) in the problem;
2. Identify what you do know about the unknowns, which usually involves breaking down the larger "unknown" into smaller, more knowable units;
3. Develop a line of reasoning;
4. Generate an answer based on the line of reasoning;
5. Check the answer to make sure it is sensible.

Name: ____ **Date:** ____________________

WHAT PERCENT/FRACTION OF THE EARTH'S SURFACE IS WATER AND LAND?

At first, this problem appears unknowable. The earth's surface is just too big to make an estimate of the amount of water and land it contains. Some might give up and say that they will need to use reference books to arrive at an answer. You think, however, that you might be able to estimate an answer to the problem by using the five steps in the estimation thinking protocol.

1. What appears hard or unknowable in this problem?

2. Using the map of the earth, how might we break the problem down into smaller, more "knowable parts?"

3. What line of reasoning will you use to develop an estimate of the proportion of water and land on earth?

4. Using your line of reasoning, develop an estimate.

   Percent/Fraction of water on earth's surface:

   Percent/Fraction of land on earth's surface:

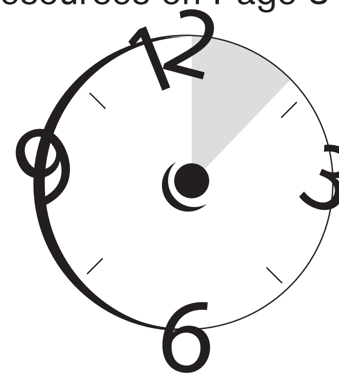
5. How might you check your estimate to make sure it is sensible?

Wind

Core/AID

Time Allocation: 40 minutes

Required Materials and Resources on Page 311



Lesson Overview

In this session students will be making a visual representation of their estimate about the amount of water and land on earth. This session, like the one preceding it, addresses Principle # 10: There is a great deal more water on earth than there is land. In order to construct their own meaning of what a percentage or fraction means, they will construct a pie chart of the surface of earth using 100 one inch squares of blue and brown construction paper.

Guiding Questions:

- What percent of the earth's surface is covered by water? By land?
- How can these numbers be represented?
- What are the available sources of water on earth? (AID)
- How much of the earth's water is available for drinking? (AID)

BIG IDEA

Using Pie Charts to Represent Information

Content Goals

Universal Theme

Communication

Principles and Generalizations

- There is more water on earth than there is land.
- Graphs, such as line graphs and pie charts, illustrate relationships between/among numbers.

Concepts

- Estimation
- Percent
- Fraction
- Graphs
- Pie chart
- Line graphs

Teacher Information

- The earth's oceans and lakes make up 75% of the earth's surface.
- Over 97% of the earth's water is found in the oceans as salt water. (AID)
- Two percent of earth's water is stored as fresh water in glaciers, ice caps, and snowy mountain caps. (AID)
- Only 1% of the earth's water is available for us to drink. (AID)

Skills

Represent numbers in graph form

Materials and Resources

For all students:

1. Two, preferably three, flat maps of the world
2. Flip chart and markers
3. Large sheets of white paper, enough for two - three pieces for each group of three students
4. Blue construction paper sheets, cut into one inch squares, 100 for each group

5. Brown construction paper sheets cut into one inch squares, 100 for each group
6. Pencils
7. Glue sticks – enough so that each group of students can have two sticks, three would be ideal
8. Sticky notes
9. Examples of pie charts containing information that students will find interesting. It is best to have pie charts that represent the well-known percents or fractions, such as 1/2 (50%, 1/4 (25%), and 3/4 (75%). *USA Today* always contains multiple charts and graphs about interesting topics.

For students working on the fresh water assignment (AID):

1. Ample copies of "The Water Cycle" available at the following website: http://earthobservatory.nasa.gov/Library/Water/
2. Large pieces of paper for students to make a pie chart of the available water on earth
3. Different colored markers

Preparation Activities

1. Make sure that you have at least one large, flat map of the world, two or three maps would be ideal.
2. Place at each table two-three large pieces of white paper and a pencil.
3. Place 100 one inch squares of blue construction paper and 100 one inch squares of brown paper at each table.
4. Make sure there are two glue sticks at each table; three would be ideal.
5. Have some additional examples of pie chart graphs ready to show students.
6. Make sure that the flip chart paper—that contains students' original thinking about the relationship between the amount of water on earth and weather—is visible.
7. Place all the materials for students working on the water source assignment together so that students will be able to access them easily (AID).

Introductory Activities (5 minutes)

- Request that students collect their work from Lesson 11 and ask them to convene into the same groups from that lesson. To prompt students' thinking, ask students—in their small groups—to recall their estimates of the amount of land and water on the earth. Make sure the estimates are reasonable.
- Then ask: "What are these?" as you hold up different pie chart graphs. Do pictures help us to communicate information more clearly to others? Listen to students' responses. Meteorologists, and others, use pictures to help people understand their work. Remind students of the many charts and graphs in the local newspaper that they learned about earlier. "These examples are pie charts, particular kinds of charts that show how a whole can be divided into parts to explain an idea."
- Explain that today students will be creating another kind of graph, called a pie chart, to make a visual representation of their estimate of water and land on earth's surface.

Pre-assessment

If some students already know the meaning of a fraction and percent and that 3/4 of the earth is covered with water, invite these students to work on the activities described in the AID section of this unit.

Teaching and Learning Activities (25 minutes)

1. Ask each group of students to place one of the large pieces of white paper at the center of their tables.

2. Next, demonstrate how students should draw a large circle on the paper with the pencil that is at their table.

3. Invite students to imagine that the lightly-drawn circle represents the whole of the earth. Tell them to look at their estimate from yesterday. Think about the whole of earth as 100%. If that is so, then we can use fraction or percent to represent the amount of land and water making up the "whole" of earth.

4. Tell the students that they will be selecting a total of 100 small blue and brown paper squares to represent their estimate.

5. Ask: How many brown pieces will you select to represent your estimate? How many blue ones will you need to illustrate your estimate? For example, if they believe that one-half of the earth is covered by land and one half by water, then they will select 50 pieces of blue and 50 pieces of brown paper, and so forth. If they believe that the parts are 3/4 and 1/4, they will select 75 pieces and 25 pieces, respectively.

6. Ask students to place and paste their colored pieces of paper in the circle. They may have to tear some of the pieces so that the edges fit within the circle.

7. Rotate from group to group, providing students with hints and questions that forward their estimates and progress.

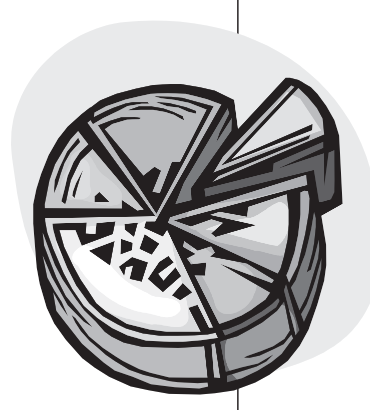
8. Invite students to hang their pie charts when they are done.

(AID)

9. If students already know the answer to the session's question and can represent their data in a pie chart, ask them to read a very short selection, "The Water Cycle," which contains information, in percentages, about the availability and distribution of fresh water.

10. Upon completion of their reading, ask students to make a pie chart showing the source and amount of water that is available in the world.

11. You might have to show students that there are two columns on the chart. One represents the "Percent of total water," and the other represents "Percent of Fresh Water." Students should use the first column for their data.



12. You might also want to limit the number of water sources because some of them are too small to show on a pie chart. Thus, the following list of sources would be more than adequate for students to understand that there is a very limited amount of available fresh water. Oceans and bays (96%); ice caps, glaciers, and permanent snow (1.5%), groundwater (1.5%); lakes and rivers (0.5%); and other (0.5%).

Products and Assignments

- Completed visual representations of land and water
- Pie charts that represent the estimates of global water distribution (AID)

Extension Activities

Students can use the Internet to explore any of the following topics:

- Availability of fresh water
- Water pollution
- Desalination of water

Post Assessment

Make sure that the pie charts represent the estimates accurately.

Debriefing and Reflection Opportunities (10 minutes)

1. In this debriefing, the teacher wants to reinforce three important points with students:
   - Estimation is an important skill used by all people, including scientists.
   - Estimation involves a series of thinking steps that will help to ensure that estimates are reasonable: find the unknown; identify what one does know about the unknown, usually by breaking it into smaller, more knowable pieces; establish a line of reasoning; check the answer for reasonableness.
   - There is a great deal more water on earth than land.
2. Make sure to bring students back to the last guiding question in this module: How does the amount of water on the earth's surface affect our weather? Return to the flip chart paper that includes students' thinking about the connection between the large amount of water on earth and weather. Query students to see if anyone has thought more about this question. Listen to students' thinking and share that they will be looking more closely at the connection between the large amount of water on earth and the weather in the sessions to come.

Name: ____ **Date:** ____________________

WHAT PERCENT/FRACTION OF THE EARTH'S SURFACE IS WATER AND LAND?

At first, this problem appears unknowable. The earth's surface is just too big to make an estimate of the amount of water and land it contains. Some might give up and say that they will need to use reference books to arrive at an answer. You think, however, that you might be able to estimate an answer to the problem by using the five steps in the estimation thinking protocol.

1. What appears unknowable in this problem?

2. Using the map of the earth, how might we break the problem down into smaller, more "knowable parts?"

3. What line of reasoning will you use to develop an estimate of the proportion of water and land on earth?

4. Using your line of reasoning, develop an estimate.

   Percent/Fraction of water on earth's surface:

   Percent/Fraction of land on earth's surface:

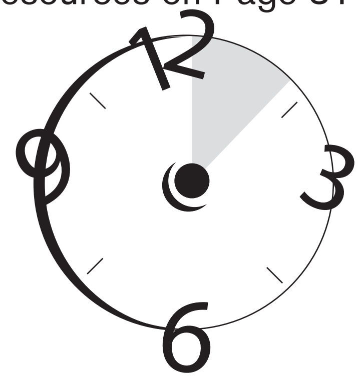
5. How might you check your estimate to make sure it is sensible?

Wind

Core/AID

Time Allocation: 48 minutes

Required Materials and Resources on Page 311



Lesson Overview

Students have spent time learning about the interaction of the sun on land surfaces. Most recently, they have learned that earth is about 75% water. In this session, students will learn about the different absorption rates of land and water. Specifically, water gains and loses heat more slowly than does land. Students will see this important principle at work in a demonstration. They will use graphing to see the different rates of warming and cooling in water and soil. At the end of this demonstration, students will be invited to think about how this difference in absorption rate affects weather.

Guiding Questions

- Do water and land absorb the sunlight in the same way?
- Why is it always cooler at the beach in summer?
- Why do shoreline towns usually receive less snow than inland towns?

BIG IDEA

Absorption Rates of Land and Water

Content Goals

Universal Themes

- Interaction
- Cause and effect

Principles and Generalizations

- Water gains and loses heat more slowly than land.
- Due to the unequal heating of land and water, shoreline areas that border large bodies of water will always be warmer in the winter and cooler in the summer than inland areas.
- Interactions among sunlight, land, air, and water cause local weather.

Concepts

- Gains
- Loses
- Unequal heating
- Interactions

Teacher Information

N/A

Skills

- Observe
- Graph
- Understand cause and effect
- Compare and contrast

Materials and Resources

1. Two plastic cups for each pair of students
2. One-half cup of water for each pair of cups that has been colored with tea bags
3. One-half cup of soil
4. Two thermometers for each pair of students
5. A gallon container

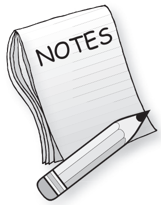
6. Copies of the sheet, **Land and Water Lab**
7. Modeling clay
8. An overhead of the graph from **Land and Water Lab** that students will use to record their data.
9. Two different colored markers or pencils for each pair of students.
10. The daily temperatures from two cities, one that is inland and another that is on the coastline.

Preparation Activities

1. Gather dark-colored dirt from outside, enough to fill the cups for students
2. Fill a gallon container with water. Place 4-5 tea bags in the water the day before the experiment is to be done with students. Allow the tea bags to steep in the water so that the water becomes dark, like the soil you have gathered.
3. Label each pair of cups. Label the one filled with soil, "land." Label the one filled with water, "oceans and lakes."
4. Fill the labeled cups and place them on trays. Attach a ball of clay to the inside of each cup. The clay ball should be large enough to support the weight of the thermometer. Attach the thermometer to the clay ball so that the bulb is about 1/2 inch below the surface in each cup. Put the cups in a cool place overnight.
5. Check the forecast for the next day. It will be best if there is sun in the forecast.
6. Make enough copies of the sheet for each student in the class, **Land and Water Lab**.
7. Just before the session with students, bring out the trays and keep them in a shady, cool place until students are ready to go outside or to a sunny station near a window.

Introductory Activities (3 minutes)

Convene a whole class meeting and arrange students into groups of two. Ask students to close their eyes and think about a hot summer afternoon when they are at a lake or the ocean. The temperature is well up into the 90's. They are walking on the sand. How do their feet feel? They are so hot, that they jump into the water. How do their feet feel now? Tell students that today they will be exploring why the lakes and oceans stay cooler than land. Their job during today's experiment is to learn



why water and land have different temperatures. In addition, their job is to begin thinking about the guiding question: What effect do the different temperatures of land and water have on our weather?

Pre-assessment and AID

If you believe that you have students who already understand that water and land absorb and release heat differently, invite them to prove the principle. They might like to select several cities in different locations (i.e., along the shore and inland) and track the temperatures over the course several days. Ask students to write up their findings and provide an explanation about their findings.

Teaching and Learning Activities (40 minutes)

1. Go over the lab sheet with students to make sure that they understand the directions.

2. On the overhead projector, show students a copy of the graph that they will be completing in the day's experiment.

3. Remind students that a graph has an X and a Y axis. For this experiment, they will see that temperature will be recorded on the X axis and time will be recorded on the Y axis.

4. Explain to students that they will be keeping track of two objects during the experiment. Thus, they will have two lines on their graph when they have finished. One line will represent the temperature of the "land" over time, while the other will represent the temperature of the "oceans and lakes."

5. Remind them to make a key in an open space on the graph that indicates which line color represents which sample.

6. Tell students that you will be the time keeper. They will take readings from their thermometers every 2 minutes and recording the data on their graph.

7. Explain to students that they will be recording the temperature of their "land" and "water" in the sun first and then in the shade. They will record the temperatures of each cup for 15 minutes in the sun and then move them to a shady location for another 15 minutes to record the temperatures.

8. Reconvene students back in the classroom when they have completed the experiment. Arrange them in groups of four. Tell them to take a quick glance at their data. Which warmed more quickly? Which took the longest to lose its heat?

9. Show them the weather map with the data from coastal cities and inland cities. Based upon what they have just learned, ask them to explain the differences in the temperatures of the two cities.

Products and Assignments

Ask students to complete their "Beyond the Data" questions on the lab sheet for homework.

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (5 minutes)

1. Begin by reminding students that here are many factors that affect our weather. It is a result of the complex interaction among the sun air, land, and water. All these components interact with each other to form a system, which, in turn, creates local weather. If you like, use the concept map from the first lesson to trace the interactions.
2. Explain that in this last lesson they observed that land and water absorb and release heat differently. Water absorbs and releases heat more slowly. That is why it is cooler along the beaches and lakes in the summer. Water does not warm as quickly as land and moderates the land temperature. Furthermore, the water releases heat more slowly so it stays warmer in the winter than does the nearby land. It keeps the land warmer in the winter. Thus, when inland areas get snow, places near the shore might get rain because the temperature is slightly warmer. Because so much of the earth is covered by water, the moderating effect of water is felt in many places because they are close to large bodies of water.

Name: ____ **Date:** ____________________

Land and Water Lab

Background

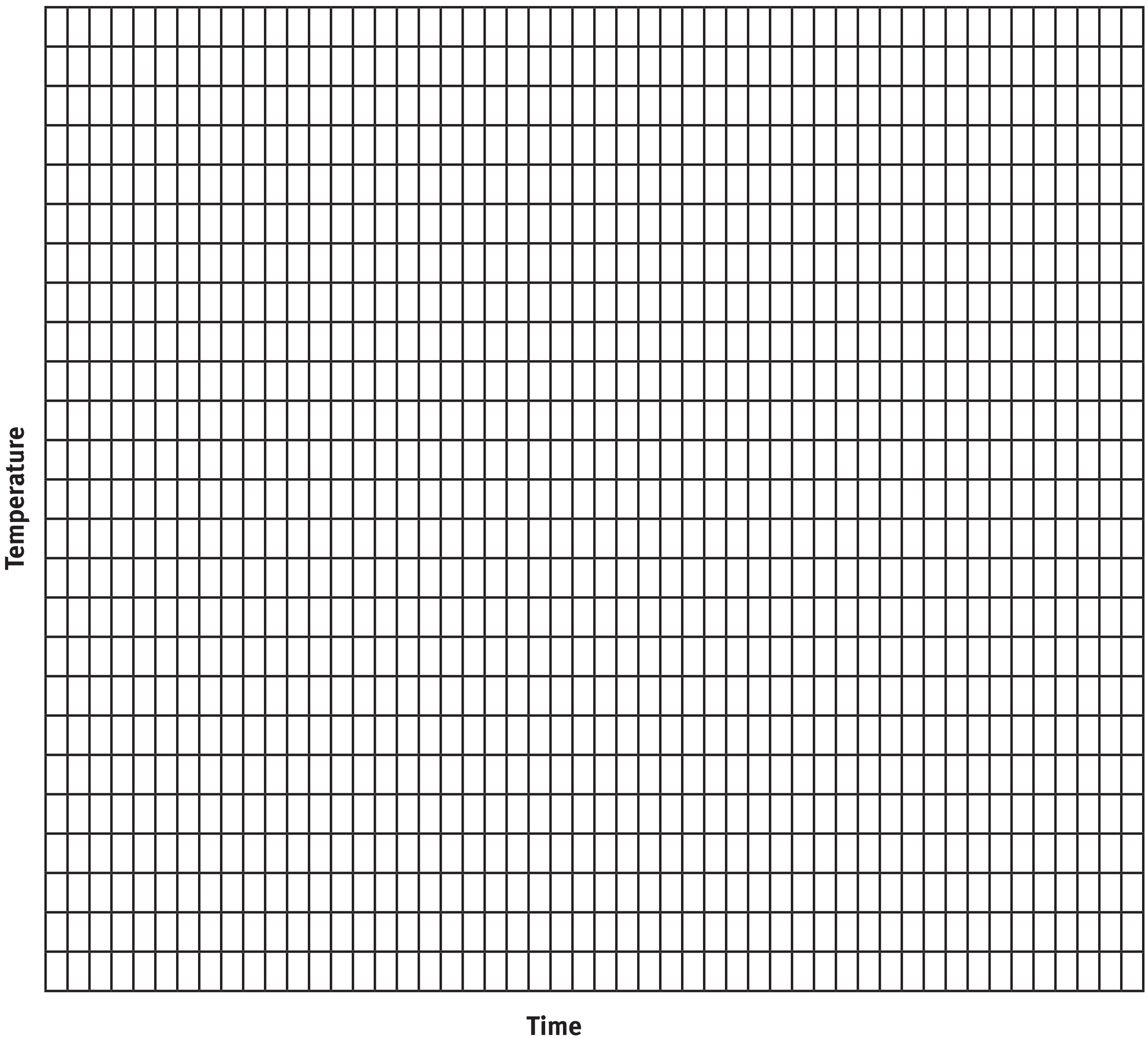
You have recently learned that there is a great deal more water on the surface of earth than there is land. Do you think that the large amount of water on earth's surface affects our weather? In this next experiment, you will see that sunlight affects land and water differently. You will also have the chance to hypothesize how the different absorption rates of land and water influence our weather.

Procedures

1) Listen to your teacher who will explain how you will use the graph that is attached to your lab sheet.
2) When your teacher tells you, gather your two cups that are labeled "land" and "oceans and lakes." Be careful to hold them as steady as you can so that you do not spill the water or dislodge the thermometers.
3) Go with your teacher outside to a place in the sun or move them to a sunny window location.
4) Your teacher will tell you when to begin recording the temperature on each of your thermometers. Make sure to read both thermometers and record the temperature of each in a different color on your graph
5) Your teacher will tell you when to make your observations.
6) When your teacher tells you to move your cups out of the sun, carefully move them to a shady location.
7) Continue to make your recordings at the designated times.
8) When you have finished your observations, complete "Beyond the Data" that is attached to this lab. You can talk over the answers to the questions with your partner, but you will each be responsible for handing in a completed lab sheet

Name: ______________________________ **Date:** ____________________

Land and Water Lab



Name: ______________________________ **Date:** ______________

Beyond the Data

1. Look at the data for land and water. Which earth features warmed more quickly?

2. How much warmer did one get over the other?

3. Which feature cooled more quickly?

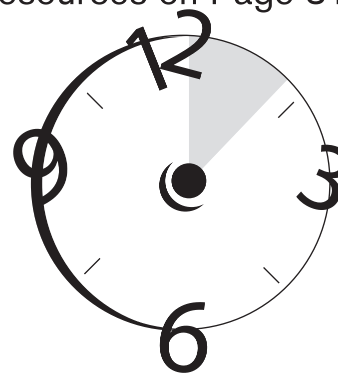
4. Think back to the hot summer day at the beach that we talked about at the beginning of the lesson. Why is land near the ocean cooler than land that is inland?

Wind

Core

Time Allocation: 40 minutes

Required Materials and Resources on Page 311



Lesson Overview

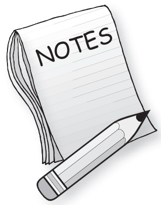
In this lesson, the teacher will develop students' understanding of the principle: Warm air rises. Students will construct their knowledge of this invisible and abstract phenomenon from a demonstration involving heated air. Through a subsequent discussion, students will come to see that warm air in the atmosphere behaves in the same way, but on a much larger scale.

Guiding Questions

- What happens when air is warmed?

BIG IDEA

Warm Air Rises



Content Goals

Universal Themes

- Interaction
- Cause and effect

Principles and Generalizations

- When air is warmed, it gets lighter and rises.

Concepts

- Lighter
- Rises
- Air movement

Teacher Information

The fastest surface wind recorded: 231 miles per hour
http://www.mountwashington.org/observatory/index.html
Place: Mt Washington, New Hampshire
Date: April 12, 1934

Windiest place: Gale winds reaching 200 miles an hour
Place: Commonwealth Bay, Antarctica

Fastest tornado winds: 286 miles an hour
Place: Wichita Falls, Texas
Date: April 2, 1958

Hurricane with the highest wind gusts: 175-180 miles per hour
Place: Central Keys and lower southwest Florida coast
Date: August 29, September 13, 1960

Skills

- Actively observe
- Understand cause and effect

Wind

Materials and Resources

1. Talcum powder
2. A cloth
3. A lamp, with a bare bulb, that is connected to an outlet
4. A copy of Christina Rossetti's "Who Has Seen the Wind," available at either web site below

http://www.recmusic.org/lieder/r/rossetti/wind.html

5. Graphic organizers, **Observation Sheet**, enough for students who might benefit by having the sheet in front of them
6. **Cause and Effect Graphic Organizer: Wind**

Preparation Activities

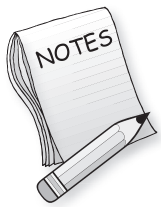
1. Sprinkle a little of the talcum powder on the cloth
2. Make enough copies of the graphic organizer, **Cause and Effect: Wind**
3. Make enough copies of the graphic organizer, **Observation**
4. Print a copy of "Who Has Seen the Wind?"

Introductory Activities (3 minutes)

- Begin this session by reading aloud "Who Has Seen the Wind?" by Christina Rossetti. Ask students:
  - o Have they seen the wind?
  - o How do they observe the wind if they can't see it? What other senses so they use?
  - o What is wind?
  - o What causes winds to be very strong sometimes and gentle at other times?
- Share with students that over the next few sessions they will be exploring what causes local winds, an important feature of our daily weather. In today's session, they will learn about hot air and how it behaves in a demonstration. In the next two sessions, they will be exploring how cool air behaves in relation to the warm air.

Pre-assessment

N/A



Teaching and Learning Activities (40 minutes)

1. Assign students to pairs heterogeneously.

2. Explain to students that they will be observing a demonstration. Their job is to make careful observations with all their senses. If they like, they can use the observation sheets that are on their desks to assist them record their observations.

3. Begin with the lamp off. Shake some of the powder off the cloth above the bulb. Let students make their observations.

4. Turn the lamp on and let it warm up so that it is hot.

5. Shake the cloth again. Students should be able to observe some of the particles being pushed upward in the air that is warmed above the bulb.

6. In a think-pair-share, ask students to dialogue about what has happened to the warmed air. They should all be able to explain that the warm air rose.

7. Solicit student responses. If necessary, use Socratic questioning to assist students' understanding that air gets heated, expands (the molecules push further apart), becomes lighter, and rises.

8. Ask students to take out their cause and effect graphic organizer, which they have used before. Invite them to complete the organizer with their partner.

9. Engage all students in a discussion of their cause and effect statements.

Products and Assignments

- **Cause and Effect Graphic Organizer: Wind**
- **Observation Sheets**, if used

Extension Activities

N/A

Post Assessment
N/A

Debriefing and Reflection Opportunities (5 minutes)
Provide students with the "big picture" in this module. They have been studying about the unequal heating of earth. They have looked at a small-scale demonstration that revealed the behavior of warm air. Specifically, it rises. Air in our much larger atmosphere behaves the same way. When the sun heats the earth, air that is next to the heated surfaces is warmed. This warm air is lighter than other air that has not been heated. The warmed air rises. Share that tomorrow they will be looking at how cool air behaves.

Reminder: Now would be a good time to check on students' **Weather Logs**.

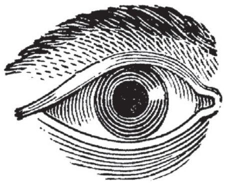
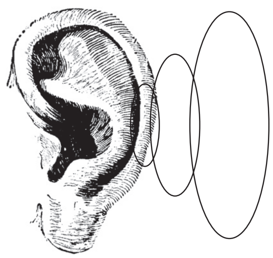
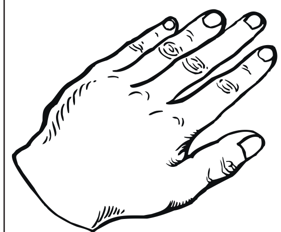
Name: ____ **Date:** ____________________

Cause and Effect Graphic Organizer: Wind

CAUSE	EFFECT
(When…..)	(these events or conditions happen…)
Examples:	
• When warm air rises…	•
• When cool air rushes in to take the place of warm air	•
• When the temperature between the warm air and the cool air is large…	•

Name: ______________________________________ **Date:** ____________________

Observations

Name: ____ **Date:** ____________________

Predictions and Observations Sheet

Background

Have you ever looked out on a cold, still winter morning and noticed smoke coming out of a chimney? If you observe carefully, you will see that the smoke goes straight up. The smoke is rising because the smoky air has been heated. It rises like a hot air balloon.

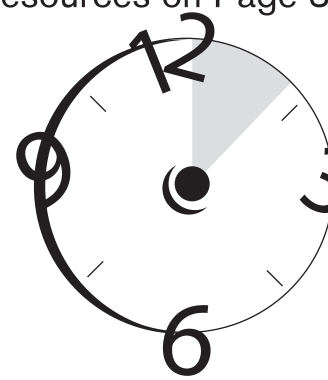
In this observation, you will have another chance to think about how heated air behaves. When you have made your observations, we will talk about why warm air behaves the way it does. We will also talk about how heated air behaves in our atmosphere.

Wind

Core

Time Allocation: 50 minutes

Required Materials and Resources on Page 311



Lesson Overview

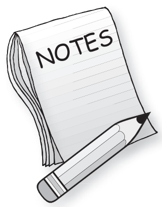
In the next two lessons, the teacher will develop students' understanding of the principle: Cool air sinks. Students will construct their knowledge of this invisible and abstract phenomenon from two demonstrations. In the first demonstration, students will observe how warm water behaves in cool water and vice versa. Once they see this interaction in a water medium, they will observe a second demonstration in the next lesson involving air. As a final step, and through a subsequent discussion, students will come to see that air in the atmosphere behaves the same way, but on a much larger scale.

Guiding Questions

- How does cool air behave?

BIG IDEA

Cool Air Sinks



Content Goals

Universal Themes
- Interaction
- Cause and effect

Principles and Generalizations
- Cool air sinks.

Concepts
- Dense
- Sinks

Teacher Information

The fastest surface wind recorded: 231 miles per hour
Place: Mt Washington, New Hampshire
Date: April 12, 1934
http://www.mountwashington.org/observatory/index.html
Windiest place: Gale winds reaching 200 miles an hour
Place: Commonwealth Bay, Antarctica

Fastest tornado winds: 286 miles an hour
Place: Wichita Falls, Texas
Date: April 2, 1958

Hurricane with the highest wind gusts: 175-180 miles per hour
Place: Central Keys and lower southwest Florida coast
Date: August 29, September 13, 1960

Skills
- Predict
- Actively observe
- Understand cause and effect

Wind

Materials and Resources

1. Red food coloring
2. Blue food coloring
3. Small bottles (2)
4. Large, clear containers (2)
5. **Predictions and Observation Sheet -** one copy for each student in the class.
6. **Observation Sheet -** copies for students who might benefit by having the sheet in front of them

Preparation Activities

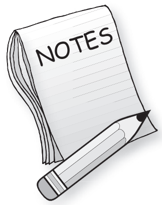
1. Fill one of the large clear containers with hot water and the other with cold water.
2. Fill one of the smaller bottles with hot water.
3. Fill the other bottle with cold water.
4. Note: Do these preparations just before class so that the water in the bottles holds its temperature.
5. Make enough copies of the **Predictions and Observation Sheet** for each student.

Introductory Activities (5 minutes)

- Begin this session engaging students in a whole class discussion about the last session. What did you learn about the behavior of warm air? How does what you learned relate to our atmosphere? Our weather? Listen to make sure students understand that air, when it is warmed by the sun, rises up into the atmosphere.
- Explain that over the next two sessions, they will be looking at the behavior of cool air. Because air is so hard to see, the first demonstration they will observe involves cool and warm water. Once they see how cool and warm water behave, they will see another demonstration in which they will observe the behavior of cool air.

Pre-assessment

N/A



Teaching and Learning Activities (40 minutes)

1. Students can work in heterogeneous pairs, once again. They may stay with their partner from the last session or provide them with the opportunity to switch partners.

2. Explain that students will be observing another demonstration. Their job is to make careful observations with all their senses. If they like, they can use the **Observation Sheets** that are on their desks to assist them record their observations.

3. Begin by explaining that one bottle is filled with hot water. To make sure they can identify it as the "hot" bottle, you are going to add some red food coloring to it. Add the blue food coloring to bottle containing the cold water for the same reason.

4. Then, explain to students that you are going to immerse the blue bottle into the container of hot water. You will hold your finger over the top at first, but then you will slowly remove your finger. When you remove your finger, students will have to pay very careful attention to observe what happens to the blue water.

5. Then, you will do the same thing with the red bottle. Students will have to pay close attention to observe what happens to the red colored water when it is immersed into the cold water.

6. Before you actually do the demonstration, invite students to predict what will happen to the blue and red water once you remove your finger. Students can use the places provided on their **Predictions and Observation Sheet** to write down their predictions.

7. When students have recorded their predictions, invite a few students to share. Acknowledge their thinking; respond with Socratic questioning if you think it will help to scaffold students' thinking.

8. Then, immerse the red and blue bottles, in turn.

9. Provide students with enough time to make their observations.

10. Reconvene the class. Invite students into a discussion of what happened to the red water and the blue water. Using questioning, if necessary, move the discussion so that students come to understand that cold water is denser—or heavier—than hot water. That's why the blue water sank to the bottom of the container filled with hot water. Likewise, the red water floated on the surface of the cold water. Hot water is lighter than cold water, and so it rises to the top of the container.

11. Query students about the following question: How do they think hot and cold air behave? Might it behave the same? Why or why not? Acknowledge students' responses. Lead them to understand that cold and warm air behave in a very similar fashion to the water they just observed. Air is much like water. Although we can't see air, it flows all around us like water would were we in an ocean or lake.

12. Share with students that they will see one more demonstration about the behavior of cool air in the next session.

Products and Assignments

My Predictions and Observation Sheet

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (5 minutes)

Remind students that they will continue their exploration of the behavior of cool air in the next session.

Name: ______________________________ **Date:** ____________________

PREDICTIONS AND OBSERVATION SHEET

Cold Air Sinks-1

Background Information

Have you ever noticed open freezer cases in the grocery store, the kind that sit on the floor and that have no door on the top of the free standing case? And if so, have you ever wondered why the owners haven't bothered to put a sliding glass top on this freezer chest? The answer lies in understanding cold air.

In the next two demonstrations, you will be exploring how cold water behaves. When you have finished, you will probably be able to answer the question about the freezer chest in the grocery store.

Name: ______________________________ **Date:** ____________________

PREDICTIONS

1. What do you think will happen to the red, hot water inside the bottle when it leaks out into the container filled with cold water?

2. What do you think will happen to the blue, cold water inside the bottle when it leaks out into the container filled with hot water?

Name: ____________________________ **Date:** ____________________

OBSERVATIONS

1. Describe what happened when the red, hot water leaked out into the container filled with cold water.

2. Describe what happened when the blue, cold water leaked into the container filled with hot water

Name: ______________________________ **Date:** ________________

Beyond the Data

1. In what ways were your predictions accurate?

2) See if you can explain what happened in the two demonstrations

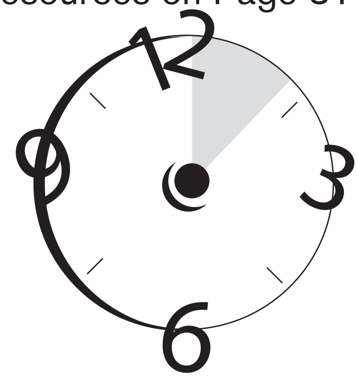
3) What questions do you still have?

Wind

Core

Time Allocation: 40 minutes

Required Materials and Resources on Page 311



Lesson Overview

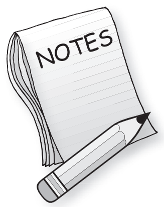
In this last lesson of the module, the teacher will further develop students' understanding of the principle: Cool air sinks. Students will construct their knowledge of this invisible and abstract phenomenon from a second demonstration involving cold air. As a final step, and through a whole class discussion, students will come to understand that air in the atmosphere behaves the same way as it did in the demonstration, but on a much larger scale.

Guiding Questions

- How does cool air behave?
- What takes the place of warm air that has risen?
- What is local wind?
- When does air move fastest?

BIG IDEA

Cool Air Sinks II



Content Goals

Universal Themes

- Interaction
- Cause and effect

Principles and Generalizations

- When air is cool, it sinks.
- When warm air rises, cool air rushes in to take its place.
- When cool air rushes in to take the place of the warm air, local wind is created.
- The greater the difference between the warm and cool air, the more quickly the air will move.

Concepts

- Dense
- Air movement

Teacher Information

The fastest surface wind recorded: 231 miles per hour
Place: Mt Washington, New Hampshire
Date: April 12, 1934

Windiest place: Gale winds reaching 200 miles an hour
Place: Commonwealth Bay, Antarctica

Fastest tornado winds: 286 miles an hour
Place: Wichita Falls, Texas
Date: April 2, 1958

Hurricane with the highest wind gusts: 175-180 miles per hour
Place: Central Keys and lower southwest Florida coast
Date: August 29, September 13, 1960

Wind

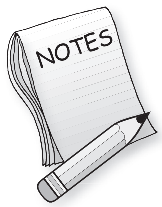
Skills
- Predict
- Observe
- Understand cause and effect

Materials and Resources
1. Small ice chest about the size used for a 6-pack of soda
2. Ample ice to fill the chest
3. Incense stick, lit and smoldering
4. **Cause and Effect Graphic Organizer**
5. **My Predictions and Observation Sheet**
6. **Observation Sheet**

Preparation Activities
1. Fill the ice chest with ice.
2. Place the lid on the chest to keep the cold air from escaping.
3. Place the chest in a place where all students can see it. Have it sit on the edge of a table, if possible.
4. Try to place the chest where there are no drafts. If necessary, place an oak tag screen around the small chest.
5. Get the incense ready to light.
6. Copy the black line masters

Introductory Activities (5 minutes)
- Engage students in a brief discussion of their learning from the last session. Specifically, you want to activate their learning about the behavior of cold water from the previous demonstration. They should recall that cold water sank in the last demonstration.
- Them, explain to students that they will watch a final demonstration today that focuses on the behavior of cold air. Ask: How many think that cold air will behave the same way that cold water did? Invite students to defend their thinking.

Pre-assessment
N/A



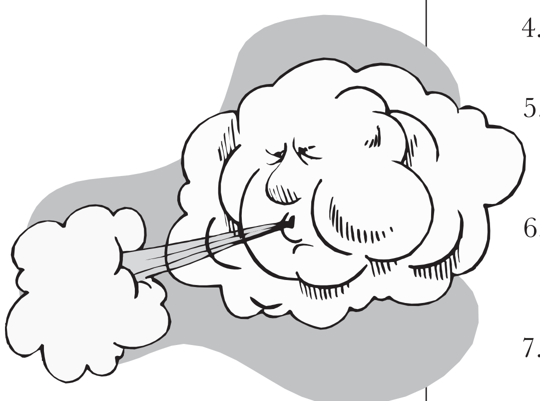
Teaching and Learning Activities (25 minutes)

1. Students can work in heterogeneous pairs once again. They may stay with their partner from the last session or provide them with the opportunity to switch partners.

2. Explain to students that they will be observing another demonstration. Their job is to make careful predictions and observations.

3. Move to the chest and light the incense. Blow out the flame so that the incense stick is smoldering.

4. Then, tell students to focus on the smoke.



5. Remove the lid. If necessary, tip the cooler slightly so students can see better.

6. Place the incense just below the lid. The cold air will "fall" over the edge of the chest and should carry the smoke down with it.

7. Provide students with time to make their observations.

8. Repeat the demonstration, if necessary.

9. Then, engage student pairs in a discussion about what they observed.

10. After a few moments, reconvene the whole class. Using Socratic questioning, move the discussion so that students understand that cold air sinks.

11. With that understanding in place, frame the next question: How do cold and warm air interact?

12. Acknowledge all responses. Working from students' conceptions about the interaction, share the fact that cool air comes in to take the place of the warm air that rises. The unheated, or cool air, sinks and rushes in to take the place of the warm air.

13. This movement of air is wind. Wind is measured in speed and direction. The speed is how fast the air is moving. The direction refers to the direction from which the wind is coming.

14. Share the fact that wind can move very fast. Explain that the greater the temperature difference between the warm and cool air, the faster the air movement will be. You can tell students about Mount Washington holding the record for the highest wind speed ever recorded on earth.

15. Ask students to take out their cause and effect graphic organizer, which they have used before. Invite them to complete the organizer with their partner.

16. Ask pairs to share their completed cause and effect statements.

17. Share with students that wind is based on a cause and effect relationship. Rising air causes cool air to rush in underneath; cool air rushing in helps to push warm air aloft in the atmosphere,

Products and Assignments

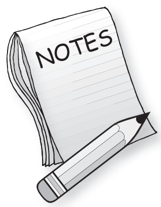
- **Predictions and Observation Sheet**
- **Cause and Effect Graphic Organizer**

Extension Activities

N/A

Post Assessment

N/A



Debriefing and Reflection Opportunities (10-15 minutes)

1. Provide students with the “big picture” in this module. They have been studying about the unequal heating of earth. In the last three sessions, they have looked at three, small-scale demonstrations that focus on the behavior of warm and cool air. Air in our much larger atmosphere behaves the same way. When the sun heats the earth, air that is next to the heated surfaces is warmed. This warm air is lighter than other air that has not been heated. The warmed air rises. Cold air sinks and rushes in to take the place of warm air.
2. In this concluding session on wind, show students the concept map for the unit. Trace with them their new understandings:
   • Sunlight shines on objects;
   • Sunlight warms all substances differently;
   • Substances release heat energy into the air nearby;
   • Warm air rises, cool air sinks;
   • When cool air rushes in to take the place of warm air, wind is created;
   • Wind influences weather.
3. Remind students that weather is a system. It is the result of the complex interaction among the sun, air, land, and water. In today’s lesson they looked at air movement, which is called wind. Wind is based on a cause and effect relationship between warm air and cool air. Wind speed and direction are key features of our daily weather. They have been recording these indicators since the beginning of the unit.
4. Emphasize that students have now studied three key elements that interact in the weather system: the sun, air and land. In the next couple of weeks, they will be studying water and the water cycle.
5. Explain that in the next session, students will have the opportunity to put together al that they have learned about the unequal heating of earth in an assignment called **Tiny Tornadoes.**

Reminder: Now would be a good time to check on students’ **Weather Logs**.

Name: ____ **Date:** ____________________

PREDICTIONS AND OBSERVATION SHEET

Cold Air Sinks-2

Background

Have you ever noticed open freezer cases in the grocery store, the kind that sit on the floor and that have no door on the top of the free standing case? And if so, have you ever wondered why the owners haven't bothered to put a sliding glass top on this freezer chest? The answer lies in understanding cold air.

In the next two demonstrations, you will be exploring how cold water behaves. When you have finished you will probably be able to answer the question about the freezer chest in the grocery store.

Name: ______________________________ **Date:** ____________________

PREDICTIONS

1. What do you think will happen when your teacher takes the lid off the small ice chest?.

Name: ______________________________ **Date:** ____________________

OBSERVATION

1. Describe what happened when your teacher took the lid off the chest

Name: ______________________________ **Date:** ____________________

Beyond the Data

1. In what ways were your predictions accurate?

2) See if you can explain what happened in the two demonstrations

3) What questions do you still have?

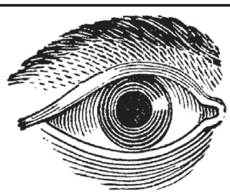
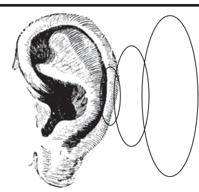
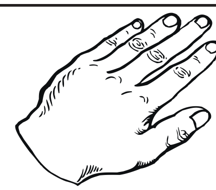
Name: ______________________________ **Date:** ____________________

Cause and Effect Graphic Organizer: Wind

CAUSE	EFFECT
(When…..)	(these events or conditions happen…)
Examples:	
• When warm air rises…	•
• When cool air rushes in to take the place of warm air	•
• When the temperature between the warm air and the cool air is large…	•

Name: ____ **Date:** ____________________

Observations

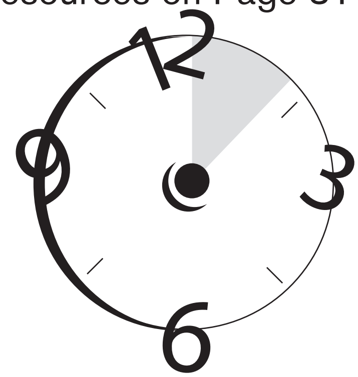
			

Wind

Core

Time Allocation: 40 minutes

Required Materials and Resources on Page 311



Lesson Overview

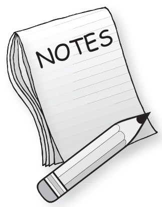
In this session, students will be working on the performance assessment, Tiny Tornadoes.

Guiding Questions

- What causes local wind?

BIG IDEA

Tiny Tornados



Content Goals

Universal Theme

Cycle

Principles and Generalizations

- When sunlight is absorbed by the earth, it is transformed into heat energy.
- Darker surfaces on earth absorb more sunlight than lighter surfaces and, as a result, release (give off) more heat into the nearby atmosphere than do lighter surfaces.
- When air is warmed, it gets lighter and rises.
- When warm air rises, cool air rushes in to take its place.
- When cool air rushes in to take the place of the warm air, local wind is created.

Concepts

- Sunlight
- Absorbed
- Transformed
- Heat energy
- Darker surfaces
- Lighter surfaces
- Lighter
- Rises
- Local winds
- Air movement

Teacher Information

N/A

Skills

- Explain
- Draw conclusions

Materials and Resources
The black line master, **Tiny Tornado** and **Rubric: The Tiny Tornado**

Preparation Activities
Copy **Tiny Tornado** so each student can have one.

Introductory Activities
N/A

Pre-assessment
N/A

Teaching and Learning Activities (40 minutes)
1. Explain to students that they will be working on an assignment that will require them to use all that they have learned about the unequal heating of earth.

2. Read through the assignment, **Tiny Tornados**, with them.

3. Make sure students understand what is expected in the assignment.

4. Invite students to work in pairs or small groups, but remind them that each person is responsible for handing in a completed assignment.

5. It will be important to compare individual student answers to the pre-assessment narrative that each completed at the outset of this module. Make sure to assess growth using the rubric that accompanies **Tiny Tornado**.

Products and Assignments

Tiny Tornado assignment.

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities

N/A

Name: ____ **Date:** ____________________

The Tiny Tornado

Two friends just came into school. They were arguing over something they had both witnessed the day before. Here is their story:

"Antonia and I were walking home from school and, as usual, we passed the park. It was a very warm afternoon, and the asphalt streets were really hot. You could see the heat shimmering off the black surfaces. As we got closer to the park and the shade provided by its tall trees, we saw something funny happen. We saw a bunch of papers and leaves get picked up and whirled around. It looked like a little tornado moving about in the sunlight.

Antonia said the whirling papers were a result of the cars whizzing by. I don't believe her. I think it looked more like a little tornado. Cars don't cause tiny tornados!

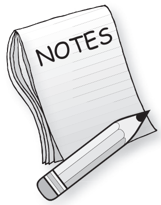
Can you help them by explaining what caused the papers to whirl around?

The Tiny Tornado

Cory
The suns light energy shines down on the black asphalt and because darker colors absorb the suns light energy better than lighter colors so the asphalt heated up and the hot air rises and the cold air from the shadow of the trees rushes in to take the hot airs place but there is a difference between the cold and hot airs temperature and that creates a stronger wind when the cold air rushes in but the cold air collides with the hot air and travels up with it still trying to turn so the cold air spirals up the hot air to make a little tornado that sucked up the leaves.

The Tiny Tornado

Heather, Carly and Laura
Because of the shade from the tall trees in the park, the air and ground underneath the trees was a lot cooler than the air otherwise. The story tells us that the day the two kids witnessed the tiny tornado was VERY hot. The black tar was scorching to the touch! The light tar was scorching to the touch. The light energy from the sun turns into heat energy. Heat energy heats the air to make it hot air. The hot air rises and mixes with the cool air made cool by the tree's shade. We all know that the mixture of hot and cool air creates winds. We think that when the temperature difference is large enough, a tiny tornado can be formed and not because of cars whizzing by.



The Tiny Tornado

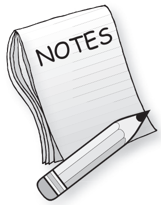
Dillon and Jonas

The sun's light rays are absorbed by the Black asphalt because darker colors absorb more light energy than light colors creating heat making the air hot so it rises up making the cold air rush in from the shade so there is moving air to lift up the paper.

The Tiny Tornado

Katherine

The sun's strong light rays hit the black asphalt which absorbs light better converting the light into heat. That day it happened to become very hot near the ground and very cold in the shade. The warm air rose while the cold air sunk and rushed to take the warm air's place. Since the bigger the temperature difference the faster the air moves they had a strong wind. All around there were shades so there was a lot of cold air coming from everywhere. The winds collided spinning. The spinning winds picked up objects finishing the tiny tornado.



Rubric: The Tiny Tornado

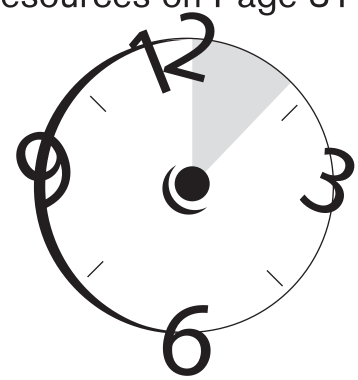
Novice	Intermediate	Advanced	Expert
The wind is just blowing all around in the city. It is made by the cars and the warm air.	The whirling top is caused by the wind. Wind is caused by the meeting of warm air and cool air.	The tiny tornado was caused by the heat in the city. Cool air came rushing in take the place of warm air that rose up in the air.	You really did see a tiny tornado. The heat, released from the asphalt streets, warmed the air nearby. The warm air rose and cooler air, probably from under the shady trees, rushed in to take its place. When the cool air rushed in, it picked up the papers and leaves in its path.

Water Cycle

Core

Time Allocation: 35 minutes

Required Materials and Resources on Page 311



Module Overview

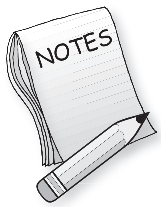
This is the last module in this weather unit, and it is designed to help students develop an understanding of one of the most important components of our weather system, the water cycle. The module will begin with an introduction to the concept of cycles and then will move through he phases of the water cycle: evaporation, condensation, and precipitation.

Learning activities are constructivist in nature; by completing science labs and participating in demonstrations, students will construct their own knowledge about the movement of water through our atmosphere. This module presents many opportunities for extensions and ascending intellectual demand (AID).

Throughout the lesson, students are reminded about the driving force for our weather, the sun, and frequently revisit the concept map for the unit, so that they understand how this field of knowledge is structured and that our weather is a complex system.

BIG IDEA

Going in Circles



Lesson Overview

This is an introductory session about the water cycle. Students will work in small groups to develop an understanding of the word cycle. They will be introduced to the notion that water is always in a state of motion as it moves through the earth and atmosphere. The water cycle is the continuous process by which water moves through the living and non-living parts of our earth. It moves from bodies of water, land, and living things on earth's surface to the atmosphere and back to earth's surface. Students will be reminded that the sun is the source of energy that drives the water cycle.

Guiding Questions

- What is a cycle?
- How does water move through the atmosphere?
- Why does water move through the atmosphere?
- Why is water an important resource?

Content Goals

Universal Theme

Cycle

Principles and Generalizations

- The sun moves water in a cycle through the living and non-living parts of earth.
- The rates of evaporation and precipitation balance each other.
- The sun, land, air and water interact in a system to create our weather.

Concepts

- Cycle
- Water cycle
- Living
- Non-living
- Balance
- System

Water
Cycle

Teacher Information

- For millions of years, the same amount of water has existed on earth.
- A cycle has no beginning and no end.
- Increasing demands on water, a finite resource, have led meteorologists and other scientists to focus on the exchange of water among the oceans, the atmosphere, and the surfaces of earth.
- The unending circulation is called the water cycle.
- The water cycle is a gigantic and intricate system powered by energy from the sun.
- The atmosphere is a connecting link between the oceans and lakes and the continents.
- Water from lakes, rivers, oceans, earth's surfaces, and living things evaporates into the atmosphere.
- Complex processes cause clouds to form.
- Clouds release precipitation.
- The precipitation that falls into the oceans or ground has ended one "turn" of the cycle and is ready to begin another by evaporating again.

Skills

- Understand cause and effect

Materials and Resources

1. Flip chart and paper
2. Markers
3. Sheets of paper on the center of clustered desks in the classroom
4. An index card, one for each student in the class.
5. Pencils
6. A large diagram of the water cycle or smaller copies for students

http://www.epa.gov/region7/kids/drnk_b.htm – a very simple, animated diagram of the water cycle

http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Watercycle.shtml -This site hosts a picture of the water cycle, as well as activities related to it. One activity contains a play that students can read.

http://www.windows.ucar.edu/cgi-bin/tour_def?link=/earth/Water/water_cycle.html&sw=false&cd=false&fr=f&edu=high - This site contains three versions of the water cycle: Beginning, intermediate, and advanced.

http://wwwga.usgs.gov/edu/watercyclegraphic.html -This site contains a detailed picture of the water cycle, perhaps appropriate for sophisticated learners.

7. Bicycle wheel in a large cardboard box placed behind the flip chart easel

Preparation Activities

1. Download pictures of the water cycle from any of the websites above.
2. Place copies of the water cycle pictures at students' desks.
3. Place the boxed bicycle wheel behind the flip chart.
4. Place several blank sheets of paper and a note cards on students' desks.

Introductory Activities (5 minutes)

Convene a class meeting. Tell students that before they get underway with some experiments about weather, that they will be focusing for a few moments on a single term, cycle. With great respect for the term, explain how is important to understand a concept because the water cycle is at the heart of all our weather. (Generate anticipation and excitement for what you will be talking about by explaining that you have brought a special object with you to help them understand the notion of cycle. The object is contained in the box behind the flip chart).

Pre-assessment

N/A

Teaching and Learning Activities (25 minutes)

1. Assign students to four small groups. While they are moving to their groups, move to the flip chart easel.

2. Then, ask them to brainstorm, among the members of their small group, examples of cycles in their lives and to write their answers on the paper at their desks (e.g., the school calendar, students' daily school schedule, night and day, life cycles, the rock cycle, economic cycles, blood flow through our body).

3. If necessary, prompt students: Every minute of every hour of every day and so on for the duration of their lives, their heart pulses, pumping blood throughout their body at the rate of about once per second.

4. Every twenty-four hours or so, the earth spins on its axis, driving the recurring habits of their lives—and those of all other living things.

5. Every year at about this time, much of the country marches into autumn.

6. Ask each group to share. Ask those listening to cross off their list the cycles that have been mentioned by other groups and to share only those things that have not been mentioned. List all examples on the flip chart paper.

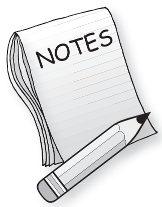
7. Next, ask each group to assign a recorder for the next question: What makes a cycle a cycle? Give students time to talk with each other and write down the thinking of the group. Ask for responses. Listen and ask appropriate follow up questions until students understand that cyclical events (1) repeat themselves over time and (2) have no beginning or ending point.

8. Finally, ask students to talk in their small groups to answer the following question: How might water behave in a cyclical fashion in our atmosphere?

9. Ask for a representative from each group to share the thinking of the group. Make notes about the thinking of the class. Use the information you collect about students' current level of understanding to tailor your instruction for the upcoming sessions on the water cycle. Identify where you will need to spend more/less time: evaporation, condensation, and or precipitation.

10. Transition to the diagram of the water cycle and bicycle wheel. Show and explain the diagram first. Identify what components students identified correctly and which components they might have overlooked.

11. Tell students not to worry if they don't understand all aspects of the water cycle. They will by the end of the unit.



12. Then, create anticipation by asking students what they think is in the box, rattling it, etc.) Take it out of the box and spin the wheel. Ask them how this might symbolize the water cycle. Listen carefully for the accurate connection between the spinning bicycle wheel and the water cycle (repeated and continual motion; no beginning and no end).

13. Explain that the same amount of water has been in our atmosphere and on our earth for millions of years.

14. It is in a state of balance between water and evaporated water in our atmosphere. In many ways, the balance between liquid water and evaporated water is like the balance of a bicycle. When everything is "balanced," our environment functions efficiently and productively. When it is off balance, atmospheric conditions can be unpredictable and affect human lives.

15. The amount of water in our world is finite; we can't make more if we use too much.

16. Tell students that they are well on their way to understanding the water cycle, which is a critical component of our weather system.

Products and Assignments

N/A

Extension Activities

Students interested in cycles can learn more at the following web sites:

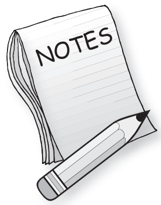
1. http://www.exploratorium.edu/ This is a site at the Exploratorium, located in San Francisco. It explores natural cycles.

2. http://www.standards.dfes.gov.uk/schemes2/secondary_music/mus04/04q1?view=get This unit develops pupils' ability to identify and create music based on cyclic patterns. During this unit pupils are introduced to the concept that some music is conceived structurally in cyclical rather than linear terms. Pupils listen to music originating from Java, Africa and India. They perform and compose group pieces using cyclical models. This unit is expected to take 5-14 hours.

3. http://www.standards.dfee.gov.uk/local/secondary/pdf/mus4.pdf This site explores cycles in music. It requires some advanced knowledge of music.

Students interested in the balance of the water cycle can research any of the following phenomenon which occur when the balance is disturbed is some way.

- **Air pollution:** Polluted air can change precipitation (rainfall) http://news.bbc.co.uk/1/hi/sci/tech/672802.stm
- http://www-ramanathan.ucsd.edu/VRpdfFiles/QuestSDUnionTribVRapr032002.pdf
- **Acid rain:** Sulphur dioxide in the air comes down as acid rain.
- http://www.ec.gc.ca/acidrain/kids.html -A basic introduction to acid rain
- http://www.swlauriersb.qc.ca/english/edservices/pedresources/webquest/rainwq.htm -This is an entire web quest about acid rain. It contains many ideas for extensions related to this environmental issue.
- **Transpiration:** Destroyed plant life causes diminished transpiration.
- http://www.windows.ucar.edu/tour/link=/earth/Water/transpiration.html&edu=high This website has information about transpiration at three different reading levels: beginning, intermediate, and advanced.
- **Water Table:** Ditching and draining may affect the water table.
- http://www.sd5.k12.mt.us/glaciereft/aquw3-8.htm This site contains two simple experiments that students, grades 3-8, can perform.
- http://md.water.usgs.gov/faq/#groundwatermain Frequently asked questions about ground water
- **Clear Cutting:** Clear-cutting often results in: (1) the elimination of the native forest ecosystem, causing vastly reduced habitat for wildlife; (2) increased erosion, with attendant stream silting and nutrient loss from the soil; (3) impairment of recreational values because of loss of wildlife viewing and other experiences associated with forests; and (4) susceptibility of the forest to insect damage, diseases, acid rain, and blown-down trees. http://www.nrdc.org/land/forests/fcut.asp This research shows the location and extent of clear cutting in New England.
- **Available drinking water:** Polluted ground water causes a shortage of drinking water. http://www.epa.gov/safewater/dwh/contams.html This site answers frequently asked questions about water, sources of water, and water pollution.



Post Assessment

N/A

Debriefing and Reflection Opportunities (5 minutes)

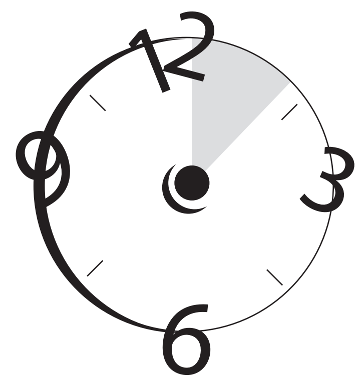
1. Move to the concept map of the weather unit. Trace what students already know about the weather system:
   • The sun is the source of energy that heats land and water
   • Land and water are heated unequally.
   • Warm air rises, cool air sinks.
   • When cool air rushes in to take the place of cool air, wind is formed.
2. Explain that the final element that contributes to the weather system is the water cycle. They have learned today that there are three phases to the water cycle: evaporation, condensation, and precipitation. Wind is responsible for carrying water through our atmosphere: as far as the North Pole and back, out to the edge of space, and above the highest thunderheads.
3. Share with students that the water cycle is one of the most exciting and dynamic aspects of the weather system. They will deepen their understanding of this important component of the weather system in the sessions to come.
4. Invite each student to write down on a card that is in the center of the table their name and (1) one thing that they already knew about the water cycle and (2) one question they still have about it. Ask students to hand the cards to you. Use the cards to learn more about students' prior knowledge about the water cycle.


Weather
is driven by
Sun's light energy
differently absorb the
which is absorbed by the
because
using
Earth's Surface
which consists of
Land
Oceans & Lakes
has
contain
Soil
Snow
Water
such as
such as
Dark surfaces
and
Light surfaces
which affects
such as
such as
which undergoes
Forests
Glacial ice
release
Evaporation
Heat
produces
which warms nearby
Water vapor
increases
moves
which can be cooled to produce
Air
rises in the
Condensation
Atmosphere
on
which forms
to be replaced by
Dust
Liquid water
can be cooled until
Freezing
to form
to produce
in the form of
Cooler air
which results in
Clouds
Hail
Snow
Sleet
produce
Wind
Dew
Fog
Precipitation
in the form of
Rain
Run off Water
Ground Water

Water Cycle

Core/AID

Time Allocation: 1 hour, 30 minutes – 2 hours
(2-3 Sessions)
Required Materials and Resources on Page 311



Lesson Overview

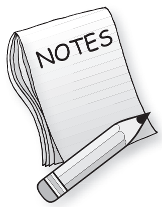
This is the first session about the water cycle, and it will focus on evaporation. By observing two experiments, students will see that the sun heats earth's surfaces and causes water to enter the atmosphere as water vapor. Students who already understand the process of evaporation will have the opportunity to design their own experiment about this process (AID).

Guiding Questions

- How does water enter our atmosphere?
- What is water vapor?

BIG IDEA

It's A Gas



Content Goals

Universal Theme

- Cycle
- Cause and effect

Principles and Generalizations

- When water is heated by the sun, tiny particles of water, called water vapor, "jump" or escape (evaporate) into the atmosphere in gas form.

Concepts

- Water vapor
- Evaporation
- Gas

Teacher Information

- Water vapor is an odorless, colorless gas.
- Although most of the water in the atmosphere evaporates from the surface of the oceans, some evaporates from rivers, streams, wet soil, and plants.

Skills

- Understand cause and effect
- Observe

Materials and Resources

1. A spoon or eye dropper
2. A small amount of water
3. An overhead projector

Experiment 1: **It's A Gas I**

4. Measuring cup
5. Water
6. Two drinking glasses
7. Two elastic bands

Experiment 2: **It's A Gas II**

8. Measuring cup
9. Water
10. One drinking glass
11. A saucer

Experiment 3 (AID): **It's A Gas III**

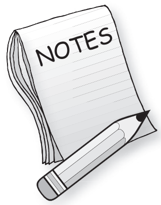
12. Water
13. Access to windy location, hair dryer or any other source of air movement
14. Small dishes that are the same size, paper towels, two articles of clothing. These are some of the materials students will probably identify for their experiment. You might want to have other things handy, such as cardboard that can be made into fans, etc.

Preparation Activities

1. Gather all the materials together for the two whole-class experiments and place them on a table where all students will be able to see.
2. Make enough copies of the worksheet: **It's a Gas I and II** for students as appropriate.
3. Turn on the overhead projector so that the surface warms up.
4. If you believe that you will have a small number of students who already understand evaporation, make enough copies of **It's a Gas III**. Also, make sure that the materials for this experiment are accessible to students.

Introductory Activities (5 minutes)

- Convene the class. Tell them that today they will begin exploring the water cycle. Their exploration will begin with evaporation, one phase of the water cycle. Ask students if they can actually see water evaporate? Listen for the answers. Students should be able to verbalize that the process is invisible to the naked eye. Then ask: If you can't see water evaporate, how do we know evaporation happens? What evidence do we have that this process is occurring all around us every day? Listen to students' responses. Place a drop or two of water on the warmed overhead surface. Ask students to predict what will happen to the water. Why did the water evaporate? Where did it go?



- **SEARCHLIGHT:** Make a mental note of the students who already seem to have an understanding of the evaporation process.

Pre-assessment
Some students may already understand the evaporation process. Invite these students to work on a parallel experiment, **It's A Gas III:** Design an experiment to show that warm water evaporates faster than unheated water

Teaching and Learning Activities (35-65 minutes)
1. Assign students to dyads. Assign the dyads to two or three groups. One group will complete and observe Experiment 1 over the next two days. The other group will complete and observe Experiment 2 for the same time period. The third group will be designing and conducting their own experiment about evaporation.

2. Tell students that the two experiments are models, small scale likenesses, of the evaporation processes that are continually happening on earth. In experiment I, **Evaporation and Heat**, students will be observing what happens to moisture when it is exposed to the sun (heat). In experiment II, **Evaporation and Surface Area**, students will be looking at the effect of surface area on evaporation. In experiment III, **Evaporation and Wind**, students will be looking at the effect of wind on evaporation.

3. Ask students to review their lab sheet with their partner. Have them discuss any questions with each other.

4. Explain to students that they will be making observations today and over the next two days. Each day they will be responsible for completing observations on their assigned experiment. (As long as it is sunny across the next two days, students should see evidence of evaporation, namely water should be disappearing)

Products and Assignments
Completed lab sheets for experiments I, II, and III.

Extension Activities
N/A

Post Assessment
N/A

Debriefing and Reflection Opportunities (25 minutes)

1. When students have made their observations on the second day, ask them to complete "Beyond the Data." Then, convene the class. Ask each group to prepare a two-minute summary of their findings, and to make a list of the new questions students generated.
2. Conclude the lesson with your own summary, if necessary: Wind, increased surface area, and warmth made water evaporate more quickly. Water on earth evaporates more quickly in locations that are hotter and have stronger winds. In addition, puddles evaporate more quickly than do larger bodies of water. Evaporation is one phase of the cycle in which water moves through the atmosphere.
3. Using a flip chart paper, make a list of the new questions students posed. Review the questions and, if possible, develop simple extension activities around their questions. These extensions can be offered as anchor activities throughout the school day.
4. Close by focusing student's attention on the water cycle graphic. Point out that they have explored the process of evaporation and will be moving on to look at condensation the next session.

Name: ____ **Date:** ____________________

It's a Gas 1: Evaporation and Heat

Background

Water is always on the move in our atmosphere. You learned yesterday that water moved in a cycle: evaporation, condensation, and precipitation. The water cycle is an important part of our weather system.

Even though you can't see it, the air has water in it. People think that a puddle has disappeared. In fact, it hasn't disappeared at all! Very small bits of water have actually entered the air from the surface of the puddle. These tiny bits of water are called water vapor. The reason you can't see them is because the water particles in the air are so small. They are invisible to the naked eye.

Evaporation occurs from every surface on earth. The sun is constantly 0 earth. When it does so, it warms oceans, lakes, rivers, streams, even soil that is wet from a rainstorm. The evaporated water enters our atmosphere as water vapor, a colorless gas.

Over the next two days you will have the opportunity to make observations about an experiment in which water will be evaporating. It will be your job to make observations about your experiment each day. At the end of the three days, you will have a chance to share your observations and conclusions with the class. You will work on your observations with a partner, but you will each be responsible for handing in your lab sheet and questions.

Materials you will need:

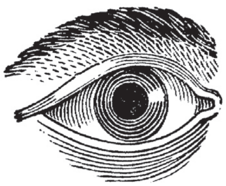
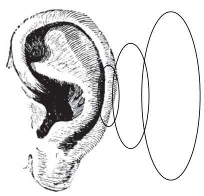
- one measuring cup
- two clear, plastic drinking glasses
- two elastic bands
- two labels

Procedures:

1. Label one plastic glass "Sun."
2. Label the other "Shade"
3. Measure out 1/2 cup of water into the measuring cup.
4. Pour the water into one of the glasses.
5. Measure out another 1/2 cup of water in the cap.
6. Pour it into the remaining empty glass.
7. Carefully slip an elastic band around each plastic cup and slide the elastic so that it marks the level of the water.
8. Place on plastic cup in a sunny location and the other in a shady location

Name: ______________________________ **Date:** ____________________

Observations

Sense	Day One	Day Two
	• • • • • •	• • • • • •
	• • • • • •	• • • • • •
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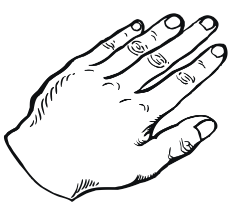	• • • • • •	• • • • • •

Name: ______________________ **Date:** ______________

Beyond the Data

1) Review your observations. What changes did you note across the two days in the water in the plastic cups?

___

___

___

In your own words, what caused the change to happen?

___

___

___

2) Explain how your experiment is a model for the process of evaporation on earth?

___

___

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3) What new questions do you have?

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___

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Name: ____ **Date:** ____________________

It's a Gas 2: Evaporation and Surface Area

Background

Water is always on the move in our atmosphere. You learned yesterday that water moved in a cycle: evaporation, condensation, and precipitation. The water cycle is an important part of our weather system.

Even though you can't see it, the air has water in it. People think that a puddle has disappeared. In fact, it hasn't disappeared at all! Very small bits of water have actually entered the air from the surface of the puddle. These tiny bits of water are called water vapor. The reason you can't see them is because the water particles in the air are so small. They are invisible to the naked eye.

Evaporation occurs from every surface on earth. The sun is constantly warming earth. When it does so, it warms oceans, lakes, rivers, streams, even soil that is wet from a rainstorm. The evaporated water enters our atmosphere as water vapor, a colorless gas.

Over the next two days you will have the opportunity to make observations about an experiment in which water will be evaporating. It will be your job to make observations about your experiment each day. At the end of the two days, you will have a chance to share your observations and conclusions with the class. You will work on your observations with a partner, but you will each be responsible for handing in your lab sheet and questions.

Materials you will need:

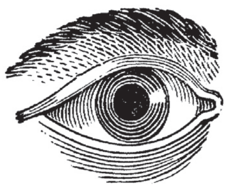
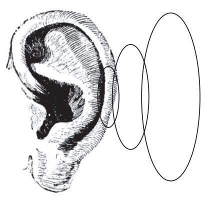
- one measuring cup
- one clear plastic drinking glass
- one plastic saucer

Procedures:

1. Measure out 1/2 cup of water into the measuring cup.
2. Pour the water into one of the containers.
3. Measure out another 1/2 cup of water in the cap.
4. Pour it into the remaining empty container.
5. Place both containers in sunny location

Name: ____________________ **Date:** ____________

Observations

Sense	Day One	Day Two
	• • • • • •	• • • • • •
	• • • • • •	• • • • • •
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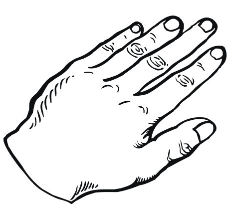	• • • • • •	• • • • • •

Name: ______________________________ **Date:** ______________

Beyond the Data

1. Using the measuring cup, measure the water that remains in one of the containers. Record your measurement below. Then, measure the remaining water on the other container. What do you note?

____
____
____

In your own words, what caused there to be a difference in the amount of remaining water?

____
____
____

2. Explain how your experiment is a model for the process of evaporation on earth.

____
____
____

3) What new questions do you have?

____
____
____

Name: ________________________________ **Date:** ____________________

It's a Gas 3: Evaporation and Wind

Background

Water is always on the move in our atmosphere. You learned yesterday that water moved in a cycle: evaporation, condensation, and precipitation. The water cycle is an important part of our weather system.

Even though you can't see it, the air has water in it. People think that a puddle has disappeared. In fact, it hasn't disappeared at all! Very small bits of water have actually entered the air from the surface of the puddle. These tiny bits of water are called water vapor. The reason you can't see them is because the water particles in the air are so small. They are invisible to the naked eye.

Evaporation occurs from every surface on earth. The sun is constantly warming earth. When it does so, it warms oceans, lakes, rivers, streams, even soil that is wet from a rainstorm. The evaporated water enters our atmosphere as water vapor, a colorless gas.

Over the next two days you will have the opportunity to design an experiment. Your task will be to design an experiment that looks at the effect of wind on evaporation. At the end of the two days, you will have a chance to share your observations and conclusions with the class. You will work on your experiment with the group, but you will each be responsible for handing in your lab report. The next page contains definitions of the sections of a lab report. The pages after the definitions are provided to help you develop your lab report.

It's a Gas III: The Contents of a Lab Report

1. Your **hypothesis** (What results you think you will get as a result of your experiment).
2. The **materials** you will use (The things you will need to perform your experiment)
3. **Procedures** (Steps that will be followed in the experiment)
4. **Observations** (What you actually saw in the experiment)
5. **Data** (Any measurements made during the experiment, such as weights, amounts, time, etc)
6. **Analysis of data** (Presentation of the data in charts, tables, graphs or drawings)
7. **Conclusions** (Summary statements about the results; did the data support your hypothesis, significance of the findings?)

Name: ______________________________ **Date:** ______________

It's a Gas III

1. Your hypothesis:

2. The materials you will use:

3. The procedures you will follow:

4. Your observations:

5. Data:

6. Analysis of data:

7. Your conclusions:

Name: ______________________________ **Date:** ________________

Beyond the Data

4) What does your data indicate about the effect of wind on evaporation?

____

____

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____

5) Explain how your experiment is a model for the process of evaporation on earth.

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6) What new questions do you have?

____

____

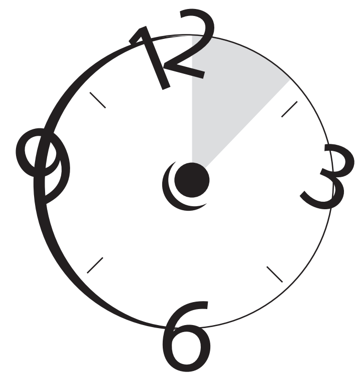
____

Water Cycle

Core

Time Allocation: 40 minutes

Required Materials and Resources on Page 311



Lesson Overview

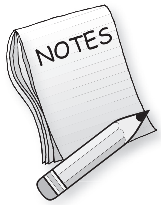
This lesson is the first of two lessons about condensation. In this first lesson, students will be provided with two short, small-scale experiments to conduct. Working in pairs, students will be asked to explain what is happening in each. This lesson will serve as a foundation to the next lesson in which students will be looking at condensation in our atmosphere, a much larger-scale process which forms clouds.

Guiding Questions

- What causes water vapor to condense back into liquid form?

BIG IDEA

Condensation



Content Goals

Universal Themes

- Cycle
- Cause and effect

Principles and Generalizations

When water vapor cools, it condenses back into liquid water.

Concepts

- Condense
- Condensation

Teacher Information

- Condensation occurs when water vapor changes to a liquid.
- The result of atmospheric condensation may be dew, fog, or clouds.
- Condensation occurs when two conditions are met: when sufficient water vapor is in the air and when there is a surface on which the water vapor can condense.

Skills

- Understand cause and effect
- Observe

Materials and Resources

1. Ice cubes
2. A pitcher of ice-cold water
3. Plastic cups, two for each pair of students in the class
4. Ample food coloring so that a small drop can be added to each plastic cup
5. Copies of, **Weather Detectives: Visible and Invisible Water**
6. A picture of a detective, such as Dick Tracey or some other well-known figure

Preparation Activities

1. Arrange the materials so that students can gather them easily.
2. Place three-four ice cubes in enough plastic cups so that each pair of students has one.
3. Keep the food coloring so that you can place drops in students' cups

Introductory Activities (5 minutes)

- Convene a class meeting and arrange students into pairs. Ask students what a detective is and entertain responses. If there is time, ask students who some contemporary detectives are.
- Explain to students that they will be spending some time being detectives today. Tell them that scientists are like detectives in that they are always hunting down clues about how and why things occur and work in the world around us. Today, they will be looking so they can explain how water appears and disappears. Their job will be to figure out where water is coming from in two experiments that they will be conducting.

Pre-assessment

N/A

Teaching and Learning Activities (20 minutes)

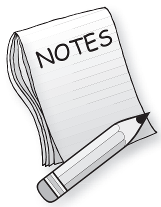
1. Ask one member of each pair to gather the resources they will need for their experiments: one plastic cup with ice, an empty plastic cup, and two copies of **Weather Detectives: Visible and Invisible Water**

2. Ask students to reading through their lab materials.

3. While students are reading their lab, place water in each plastic cup containing ice. Then, add enough food coloring to the cup so that the water is no longer clear.

4. Students should begin with Experiment 2 first in order to make some initial observations about the cup containing ice and colored water.

5. Then, they could turn their attention to Experiment 1.



Products and Assignments

Completed labs

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (15 minutes)

1. Reconvene students as a whole class. Discuss with students the answers to the questions in "Beyond the Data."
2. **Question 1**
   Students' responses will vary. Some students may think that the "steam" that appears on the cup is saliva; others might think it is spit. Using Socratic questioning, help students to understand that our breath, which is warm air, contains water vapor that we can't see, unless it comes in contact with colder air. Remind students about what happens to their breath on a cold day. In this case of the plastic cup, water vapor from their breath came in contact with the cold cup and the invisible droplets of water condensed on the surface of the cup.
3. **Question 2**
   Once again, student responses will vary because students may hold misconceptions. Some might think that the water on the outside of the cup "seeped" through the walls of the cup or sweated through the walls. Others might think that coldness comes through the walls and produces water. Finally, some might think that air turns into a liquid on the outside of the cup. Students may hold these misconceptions because they are confused by our everyday language—we talk about glasses "sweating." Also, humans sweat from the inside, and students may be transferring this understanding to the current example.
4. Make sure students' misconceptions are dispelled. The water on the outside of the cup is liquid that has condensed from water vapor in the air that comes in contact with the cold surface of the cup's exterior walls. It is difficult for students to think about invisible water in the air.

5. **Question 3**
   Ask students why these experiments are small scale models. Answers will vary. Students should be able to explain that the condensation in the two experiments occurred in very small-size locations, the cups.
6. Ask students to think-pair-share: How might the two experiments be small models of what happens in our atmosphere? Ask students to share. Discuss responses with students. They should understand:
   - That air in the atmosphere gets warmed.
   - That water evaporates and enters the atmosphere as water vapor.
   - Warm air rises and cools.

   If necessary, refer to the concept map of the unit and point out what is happening in the atmosphere.
7. They should be able to make the connection between the cooling of the air as it rises into the atmosphere and the cooling that they have just observed in the two experiments. Students may yet need to understand that the cooling of air causes clouds to form in our atmosphere. Tell students that they will be learning about clouds and how they form in the next session.

Name: ____ **Date:** ____________________

Condensation: Weather Detectives Visible and Invisible

Background

You learned that water moved in a cycle: evaporation, condensation, and precipitation. You also learned that water disappears into the air when it evaporates. Believe it or not, as water moves through the water cycle, it becomes visible again during condensation. In the two experiments that follow, you will have the opportunity to explain how water becomes visible once more.

Condensation occurs when invisible particles of water vapor become liquid once again. It happens when warm air, holding water vapor, cools on tiny particles of dust or smoke or on blades of grass (dew) or cold windows (frost).

Look closely at what is happening in the two experiments contained in this lab. You have all the equipment you need. Be a detective and scientist. Use your thinking and power of observation to see if you can figure out what is happening.

You can talk with your partner about all your observations, but each person will be required to hand in a completed lab.

Materials you will need:

- One plastic cup filled with ice and colored water
- One empty plastic cup

Procedures:

Experiment 2

1. Make careful observations about the cup containing the colored water. What is inside the plastic cup? Is there anything that you can see on the surface of the water? Is there anything on the outside of the plastic cup? Place your observation on the sheet that is provided.

Experiment 1

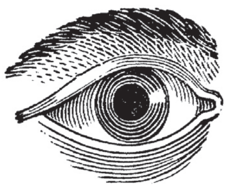
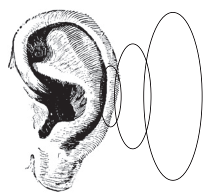
2. One person should pick up the cup and hold it close to his or her mouth. He or she should then breathe out deeply onto the outside of the plastic cup.
3. Discuss what you observe. Repeat the process, if necessary, two or three times.
4. Record your observations on the sheet provided.
5. Turn to "Beyond the Data." Answer question number 1.

Experiment 2

6. Turn your attention back to experiment 2.
7. Make close observations about the cup once gain. Pay special attention to the outside of the cup. Has anything changed since you make your initial observations?
8. Record your observations on the sheet that is provided.
9. Turn to "Beyond the Data." Answer question 2.

Name: ____ **Date:** ______________________

Observations

Sense	Experiment One	Experiment Two: Pre	Experiment Two: Post
	• • • • • •	• • • • • •	• • • • • •
	• • • • • •	• • • • • •	• • • • • •
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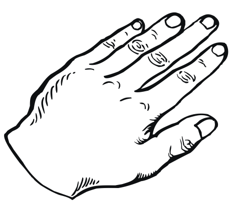	• • • • • •	• • • • • •	• • • • • •

Name: ________________________________ **Date:** ____________________

Beyond the Data

1) Review your observations. How do you explain what you saw happening on the outside of the empty plastic cup?

____

____

____

2) Review your observations, pre and post, of the plastic cup filled with colored water and ice. Explain what was happening on the outside of the cup.

____

____

____

3) Explain how your experiments are models for the process of condensation in earth's atmosphere.

____

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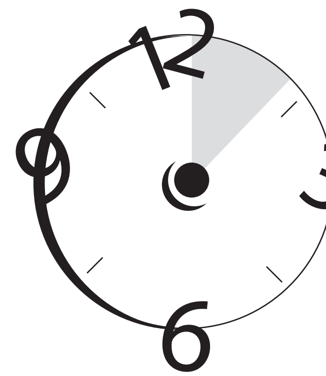
Water Cycle

Core

Time Allocation: 45 minutes

Required Materials and Resources on Page 311



Lesson Overview

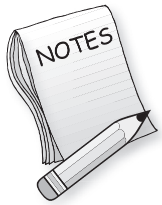
Different types of clouds will be the focus for this session. Students will learn about the three, general types of clouds and what each type can signal for upcoming weather.

Guiding Questions

- How do clouds form?
- Why do clouds look different?
- How can clouds be used to forecast the weather?

BIG IDEA

Condensation and Cloud Formation



Content Goals

Universal Themes

- Cycle
- Cause and effect

Principles and Generalizations

- Wind carries water vapor throughout the earth's atmosphere.
- When warm air containing water vapor rises, the air cools which causes the water vapor to condense in the atmosphere above the earth to form clouds.
- Meteorologists classify clouds according their shape and their altitude.
- The altitude and shape of clouds reflect atmospheric conditions and can predict local weather.

Concepts

- Condense
- Cloud
- Shape
- Altitude
- High clouds
- Middle clouds
- Low clouds
- Cloud cover
- Cloudless
- Clear
- Partly sunny
- Cloudy

Teacher Information

- Clouds tell the story about rising air.
- Clouds are made of the same substances: water and ice
- Air can be lifted to its condensation level in four ways. Convection currents raise air or thermals that may become cumulus or cumulonimbus. Frontal systems can also create clouds. Advancing cold air can push under

warm air or warm air can slide over cold air to form clouds. Converging air masses can push air upward to form a cloud. Clouds can also form when a moving air mass is lifted over a hill, mountain, or ridge.

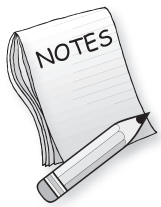
- Before the 1800's, there were no names for the different types of clouds.
- In 1803, Luke Howard, an English scientist, named different types of clouds.
- Howard's classification system is still used today.
- Clouds are usually white, gray, or dark gray/black.
- Thicker clouds—the ones with the most rain and snow—are darker because they block out most of the sunlight.
- The color of the clouds comes from the way sunlight hits the water droplets that compose them.
- Clouds change continually; they can change from one form to another.
- One indicator of weather is the amount of cloud cover in the sky.
  - o Weather is "cloudless" when there are no clouds at all.
  - o "Clear" weather occurs when clouds cover less than 3/10 of the sky.
  - o "Partly sunny" refers to occasions when the sky is 3/10-7/10 covered by clouds.
  - o "Cloudy" or overcast refers to days when more than 7/10 of the sky is covered by clouds.
- Cloud cover can modify the daily temperature range. At night clouds trap heat while during the day, clouds can reduce the high temperature.

Skills

- Understand cause and effect
- Observe
- Classify

Materials and Resources

1. Sufficient copies of the **Cloud Watcher's Key** and **Cloud Observer Guide**
2. Images from http://www.australiasevereweather.com/techniques/simple/clouds.htm
3. Student's **Weather Log**
4. *Cloud Dance* by Thomas Locker or a variety of pictures of different cloud types



5. Paper
6. A variety of cloud pictures available from any of these websites:
    - http://vortex.plymouth.edu/clouds.html Contains many pictures of all different types of clouds taken in New Hampshire. Also contains time lapse photography of could movement across the sky.
    - http://asd-www.larc.nasa.gov/SCOOL/cldchart.html This web page, by NASA, contains many photographs of different types of clouds, as well as a cloud photo gallery created by fourth grade students in Virginia.
    - http://www.usatoday.com/weather/wcloud0.htm This web site, prepared by USA Today contains a simple display of cloud types and accompanying cloud pictures. Equally important the site is filled with information about a variety of weather phenomenon: storms and fronts, climate and change, clouds and fog, El Nina and La Nina, Winds and the jet stream, ozone, floods and droughts, among others.

Preparation Activities

1. Visit the websites above to make sure that you can access pictures of the different types of clouds. Use Google to search for cloud images with the website's special "image search" command.
2. Copy the Cloud Observers' Guide for students. Make sure each student has one.
3. Provide paper at the center of students' desk clusters
4. Place two note cards at each desk cluster for the debriefing activity

Introductory Activities (5 minutes)

- Convene a whole class meeting. Explain to students that they will be learning about clouds in the next session and how they can be used to help us predict upcoming weather. For hundreds of years, sailors and farmers have learned to read the sky and make fairly accurate weather forecasts. It wasn't until 200 years ago that clouds were actually named and classified by Luke Howard, an English chemist.
- Invite students to think about their work on condensation in the last session. Remind them that they observed two small-scale experiments about condensation. Explain that condensation also occurs on a much larger scale in earth's atmosphere when warm air, containing water vapor rises. As it rises, the air in the atmosphere gets colder. At a certain point,

the water vapor turns back to liquid water. The result is clouds that come in many shapes and sizes.

- Ask students, in their groups, to listen or observe carefully the different types of clouds that they will see. Read *Cloud Dance* or show students different pictures of cloud types.
- Ask students to describe what they have seen or observed. Listen to their responses. Tell them that they are well on their way to understanding how to categorize cloud types.

Pre-assessment

N/A

Teaching and Learning Activities (25 minutes)

1. Ask students to refer to their **Cloud Watcher's Key** to help them understand the way clouds are classified.

2. Explain to students that clouds are classified in two ways: altitude and shape.

3. With respect to altitude, clouds can be classified into three different types: high, middle and low-level clouds.

4. High level clouds are called cirrus; middle level is called "alto" clouds; low-level clouds are called stratus.

5. Each of the three basic types of clouds can be used to predict the upcoming weather. Go over the **Cloud Classification and Meaning Chart** with students.

6. Explain to students how to observe the clouds in the sky and make a determination about the extent of cloud cover.

7. Have students take out their **Weather Logs.** Have students share some of the kinds of clouds they have observed and any observations they have made about the weather and cloud cover patterns (e.g., temperatures are usually lower when there is greater cloud cover).

Products and Assignments

Students will keep track of cloud types and cloud cover in their weather logs.

Extension Activities

1. Rainbows – http://eo.ucar.edu/rainbows/
2. Luke Howard
   - http://www.islandnet.com/~see/weather/history/howard.htm
   - http://www.weathernotebook.org/howard/ This website contains some copies of original sketches by Howard
3. Atmospheric optics
   - http://www.sundog.clara.co.uk/atoptics/phenom.htm Rainbows, halos, glories, coronas, and many more
   - http://cimss.ssec.wisc.edu/wxwise/class/optics.html Sophisticated scientific explanations of atmospheric optics
   - http://www.funet.fi/pub/astro/html/eng/amateurs/atmosphere/meteoptic/links.html Links to atmospheric optics
   - http://mintaka.sdsu.edu/GF/glossary.html A glossary of terms related to atmospheric optics
4. How much does a cloud weigh?
   - http://www.wsi.com/corporate/newsroom/newsletter/md2/CloudWeight.html
5. Cloud Forests
   - http://news.nationalgeographic.com/news/2001/08/0813_cloudforest.html

Post Assessment

N/A

Debriefing and Reflection Opportunities (15 minutes)

1. Divide students into three groups, once for each cloud type. Ask students to (1) summarize what they have learned about each cloud type, (2) list one question they have about clouds and write it on a note card. Provide students with the opportunity to share their summaries. Ask students to read their question and to turn in their card at the end of the session. Use the question cards to jump-start discussions throughout the remaining weeks.

Misconception alert: Some students may believe that clouds form over the sea and lakes, where they get "filled" with water. These students see the water cycle only in terms of liquid water—they see no phase change. These students may need to revisit boiling water to see that water becomes a gas when it is heated.

2. Students have other misconceptions about the formation of clouds:
   - Clouds come from someplace else in the sky.
   - Clouds are formed by boiling vapors
   - Clouds are made at night and may be made of snow, heat, fog and cold.
   - Clouds are mostly smoke, made of cotton or wool.
   - Clouds are sponges that hold water.
   - Clouds are dust particles.
3. Students with these misconceptions may have made art or science projects that contain "clouds" made from cotton or wool. They may have seen demonstrations with a tea kettle and heard that the steam is water vapor, when in fact it is condensation.
4. Other common misconceptions about clouds:
   - Clouds move when we move. In actuality, clouds move when the wind in the upper atmosphere blows them.
   - Clouds always mean rain. In actuality, clouds are necessary for rain, but are not sufficient predictors of rain.

Name: ______________________________ **Date:** ____________________

Cloud Observer's Guide

Background

We haven't always known about clouds. A long time ago, people believed that clouds sprang up from vapor given off by objects in the ground. The vapor particles joined together and rose up from the ground in little heaps. It seems almost impossible that people ever believed that clouds formed this way!

Today, we know a lot more about clouds, such as how they are formed and what they signal about upcoming weather. We know more because meteorologists have studied and observed them for many years. Meteorologists have learned that clouds can tell us a great deal about what is happening in the atmosphere and even give us clues about the upcoming weather.

But, how can you observe something that you cannot reach out to touch or feel? We can learn a great deal about clouds by just using our eyes and observing certain cloud attributes, such as shape and height in the sky. There are three important questions that we can ask ourselves to learn about clouds and what they mean:

1. What is the **shape** of the cloud or clouds?
    - Wispy and feathery (High clouds)
    - Bands or layers of clouds gradually spreading over the sky; thickening (Middle clouds)
    - Flat layers of low, gray clouds (Low clouds)
    - Puffy, white, no towering tops, form during the day, cauliflower-like (Low clouds, called fair weather clouds)
    - Towering, very large, sometimes a flattened top, can have a gray-black color (Vertical clouds, called thunderheads)

2. How **high** in the sky are the clouds?
    - High (H)
    - Middle (M)
    - Low (L)

3. How much of the sky is covered by clouds:
    - Cloudless
    - Partly cloudy
    - Completely overcast

You will use these three questions to help you collect weather information. Each day you will be recording the shape of the clouds, whether they are high-, middle-, or low-level clouds, and the amount of cloud cover. You will place your observations in your Weather Log. Your teacher will give you one page from your Weather Log, and will give you some practice observing clouds.

In this weather unit, you will learn to read the "signs" that clouds give us and really amaze your friends and family with your predictions!

Cloud Watcher's Key

Print a key to cloud types at one of the following sites:

http://eo.ucar.edu/webweather/cloud3.html or
http://www.wildwildweather.com/clouds/cloud_types.gif

Cloud Family	***Altitude***	***Type***	***Characteristics***	***Meaning***
High Clouds: Cirrus	20,000-70,000 ft Higher than Mount Everest; form at altitudes where commercial jet liners travel	Cirrus Cirrostratus Cirrocumulus	Made of ice crystals Light and feathery looking Can produce a halo around the sun or moon.	Generally not precipitation makers; can signal an approaching storm, especially if clouds begin to thicken up and become lower in altitude; sun or moon rings mean rain or snow coming soon.
Middle Clouds: Altocumulus Altostratus	6,500-20,000 ft	Altostratus Altocumulus	Mid-level sheet-like clouds; cover all or large potions of the sky; composed of liquid water droplets during the summer, liquid droplet-ice mix during the winter. Mid-level patchy clouds; generally composed of water rather than ice crystals.	May produce light precipitation as snow or rain. May produce showers or sprinkles.
Low Clouds: Stratus	6,500 feet	Stratus Stratocumulus Nimbostratus	Low, uniform layer of clouds; usually composed of liquid droplets, but can hold ice crystals during the winter. Low-level sheets of puffy gray clouds Low-level, dark gray clouds	Light drizzle that may last for a while Chief rain makers
Vertically Developed Clouds				
		Cumulus	Made from water vapor held inside warm air that is rising to great heights Big, puffy shapes Base is usually flat Sometimes described as having a cauliflower-like structure.	Associated with fair weather; increase in cumulus clouds throughout the afternoon as ground heating intensifies.
		Cumulonimbus	Dark, dense, billowing, towering clouds; tops can spread out in the shape of an anvil.	Associated with a storm containing lightening and thunder, gusty winds, even hail.

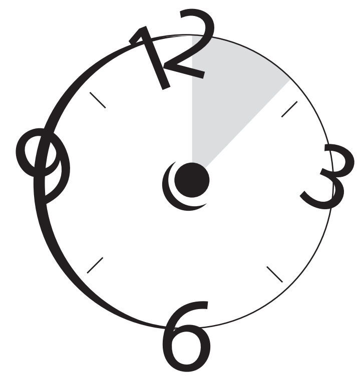
The more cloud types present in the sky, the greater the chance or rain or snow.
Precipitation is most likely to occur when clouds at different levels move from different directions,

Water Cycle

Core

Time Allocation: 1 hour, 30 minutes

Required Materials and Resources on Page 311



Lesson Overview

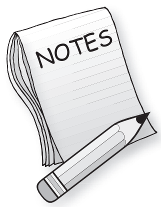
At the outset of this session on precipitation, students will be provided with the opportunity to examine mini-rainfalls in two demonstrations. With an understanding of precipitation as a backdrop, they will be provided with a chart to understand the "atmospheric anatomy" that leads to different forms of precipitation: snow, rain, sleet, freezing rain, and hail. At the conclusion of this session, students will have the opportunity to compare the rainfall amounts, as recorded in their weather logs, with the average rainfall for this time of year.

Guiding Questions

- In general, how does precipitation form?
- How are snow, rain, sleet, and hail formed?
- How do students' current rainfall amounts compare/contract to the reported rainfall amounts? Average rainfall amounts?

BIG IDEA

Precipitation



Content Goals

Universal Themes
- Cycles
- Cause and effect

Principles and Generalizations
- When the drops of water that form clouds are too heavy to float in the clouds, they coalesce and fall to the ground as precipitation.
- Atmospheric conditions near the surface of earth determine the form that precipitation will take: rain, sleet, snow, and hail.

Concepts
- Coalesce
- Precipitation
- Rain
- Atmospheric layers
- Sleet
- Freezing rain
- Hail
- Snow

Teacher Information

Rainfall

http://hi.water.usgs.gov/recent/waialeale.html This site contains information about rainfall on Mt. Waialeale, the location of the highest recorded rainfall amount, as well as a photo of the rain gauge at the summit.

Skills
- Observe
- Understand cause and effect

Materials and Resources
1. Sufficient small plastic cups for each cluster of desks in the room
2. Hot water

3. Plastic wrap squares to cover the small bowls
4. Elastic bands to secure the plastic wrap
5. Three ice cubes for each bowl
6. Sheets of wax paper 8 X 11
7. A bottle with a sprayer attached
8. Toothpicks for each group of students
9. Daily weather maps—with recent rainfall amounts—for each group of students
10. Copies of **Atmospheric Anatomy** for each student

Preparation Activities

1. Prepare the hot water and pour it into the bowls, leaving about one inch at the top of each bowl.
2. Place the plastic wrap securely over the top of each bowl and secure with an elastic band.
3. Place three ice cubes on the top of each bowl just before the beginning of this session. Make sure there is enough time for water droplets to be condensing and dropping from the inside of the plastic wrap back into the water in the bowl.
4. Place a sheet of wax paper, toothpicks, and a weather map at each desk cluster.
5. Put water into the spray bottle.

Introductory Activities (10 minutes)

- With students sitting at desk clusters, convene a whole class meeting. Ask students to brainstorm in their groups why clouds don't fall down. Ask each group to share the responses and to listen to the thinking of each group, in turn. Tell listening groups to eliminate any response that have been named by other groups.
- **SEARCHLIGHT:** Listen carefully to group responses. Most groups will probably say that clouds don't fall down because the warm air keeps pushing them up even though gravity tries to pull them down. Some students may surprise you and explain that sometimes clouds do fall down to earth.

- Explain to students that in this session they will be learning about the times that clouds do fall down to earth. Sometimes tiny droplets of water vapor in certain kinds of clouds (i.e., nimbostratus and cumulonimbus) clump together and fall to earth as precipitation (rain, sleet, snow, or hail).

Pre-assessment

Be listening intently to the discussions that occur during the introduction. If there are students who understand how: (1) droplets of water coalesce and (2) different types of precipitation are formed, invite these students to complete the AID activity below.

Teaching and Learning Activities (70 minutes)

1. Ask students, in their groups, to observe what is going on in the small bowl that has been placed at their tables.

2. **SEARCHLIGHT:** Rotate from group to group, making notes about students' observations and/or misconceptions.

3. Ask students to share their observations. Students should be aware that they were observing a mini-shower: Water evaporated from the surface of the water, condensed on the underneath side of the plastic wrap, and fell back to the surface of the water when the droplets were too heavy to adhere to the plastic wrap.

4. Ask students to explain what caused the water to fall back into the bowl. Students should explain that the water drops got so heavy that they fell down.

5. Explain to students that their bowl is a small model of what happens in the atmosphere. The same process happens inside certain clouds. Tiny droplets of water form around a speck of dust, pollen, or soot. (These are just like the particles that they sometimes see in the air in a shaft of sunlight streaming though a window.)

6. Then little drops of water begin to collide with each other and form bigger drops of water.

7. At this time, ask each group to find the wax paper sheet that is at their desks. Ask them to take it out and find the toothpicks that are at their desks. Rotate to each group and spray a fine mist of water onto the wax paper. Using their toothpicks, ask students to: (1) move the water droplets around on the wax paper, and (2) make observations regarding what happens to the droplets. Students should report that the little droplets formed bigger ones. This is called *coalescence*.

8. Explain students that the same process happens to tiny droplets in clouds. They collide with each other, get bigger, and finally become so heavy that they fall to earth as rain.

9. Great temperature variations occur in mid-latitudes that make forecasting different forms of precipitation difficult. These various layers in the atmosphere with their different temperatures make winter storm predictions hard for meteorologists.

10. Ask students to take out the chart that shows how the different forms of precipitation form, Atmospheric Anatomy.

11. Show students how rain and snow form. Snow forms when the temperature stays cold all the way from the clouds to the earth. Remind students about William Bentley, who photographed over 2,000 different snowflakes.

12. Sleet starts out as snow, but encounters a layer of warm air on the way to the ground, which causes the flakes to turn to rain. Further on its way to earth, the raindrops encounter a thick layer of freezing air, which turns the raindrops back to ice pellets.

13. Freezing rain follows the same pathway as sleet, except that it moves through a very shallow layer of cold air. The raindrops don't have a chance to turn to ice pellets. Instead they become super cooled and when they hit the frozen ground, they turn to ice on contact, leaving a coating of ice on the earth.

14. Hail is formed differently in the upper portions of cumulonimbus clouds during thunderstorms. Super cooled water droplets form around a particle. Then, the particle is lifted repeatedly in updrafts of moist air within the high cumulonimbus cloud. Each time this happens, a thin coating of ice is added to the ice droplet. Tell students that the next time they see hail, try to collect some to put into the freezer. If they can save some hailstones, they can cut them in half to reveal different layers of ice. Some people have reported as many as 25 layers of ice in a single hailstone.

15. Ask students to take out their weather logs and review their recorded rainfall amounts for the last week/two weeks. Using the newspaper weather map, ask each group of students to compare their recorded amounts to the newspaper recording. Are the amounts similar? Different? If they are different, ask students to explain why the differences might exist.

16. Provide students with time to share their findings and discuss hypotheses regarding any differences.

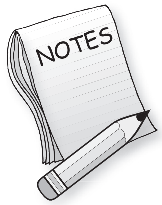
Products and Assignments

Weather logs containing precipitation amounts

Extension Activities

1. Cloud seeding
   - http://www.usatoday.com/weather/research/wmodify.htm
2. Droughts
   - http://www.drought.noaa.gov/ This is NOAA's drought information center. It is a roundup of the various NOAA websites and information on drought and climate conditions. Some external links are included.
   - Violent weather is usually accompanied by heavy precipitation:
3. Hurricanes
   - http://www.nhc.noaa.gov/
   - This is the web site of the National Hurricane Center, and it contains a wide variety of information about these storms.
   - http://www.fema.gov/kids/hurr.htm
   - This is a special website for students that contains a great deal of information about hurricanes.

4. Tornados
   - http://www.tornadoproject.com/
   - This website is managed by a small company that gathers, compiles, and makes tornado information available to weather enthusiasts and the meteorological community.
   - http://www.usatoday.com/weather/resources/basics/twist0.htm This is USA Today's home page about tornadoes.
   - http://www.chaseday.com/tornadoes.htm This site contains 32 pictures of different tornadoes, which can vary in size, shape and color.
   - http://www.fema.gov/kids/tornado.htm A special website about tornadoes for students.
5. Floods
   - http://www.pbs.org/wgbh/nova/flood/ PBS's home page about floods
   - http://www.noaa.gov/floods.html This is the web page about floods that is produced by the National Oceanic and Atmospheric Administration (NOAA).
6. Thunderstorms
   - http://www.nssl.noaa.gov/edu/storm/ Questions and answers about thunderstorms
   - http://www.usatoday.com/weather/resources/basics/thunderstorms.htm USA Today's web page about thunderstorms
7. Other noteworthy sites related to precipitation
   - http://www.fs.fed.us/land/wfas/rain.gif This site provides up-to-date information about precipitation falling across the United States.
   - http://www.cpc.noaa.gov/products/analysis_monitoring/regional_monitoring/cltrain.gif This site provides weekly precipitation totals for the previous week.
   - http://www.wtnh.com/Global/link.asp?L=46075 News Channel 8 is the only station in the state with an educationally-based weather network that serves dozens of schools across Connecticut. SchoolNET 8 allows students to access live weather data and utilize the information in daily science lessons. It also provides News Channel 8 viewers with LIVE, accurate weather information gathered from the schools' weather stations.
   - http://vp.accuweather.com/vantagepoint/wx/fore_precip?type=amounts&day=1 This site provides information about expected precipitation amounts by city. It also contains a link that will allow students to compare the expected precipitation for a given area to regional averages for the same time of year.

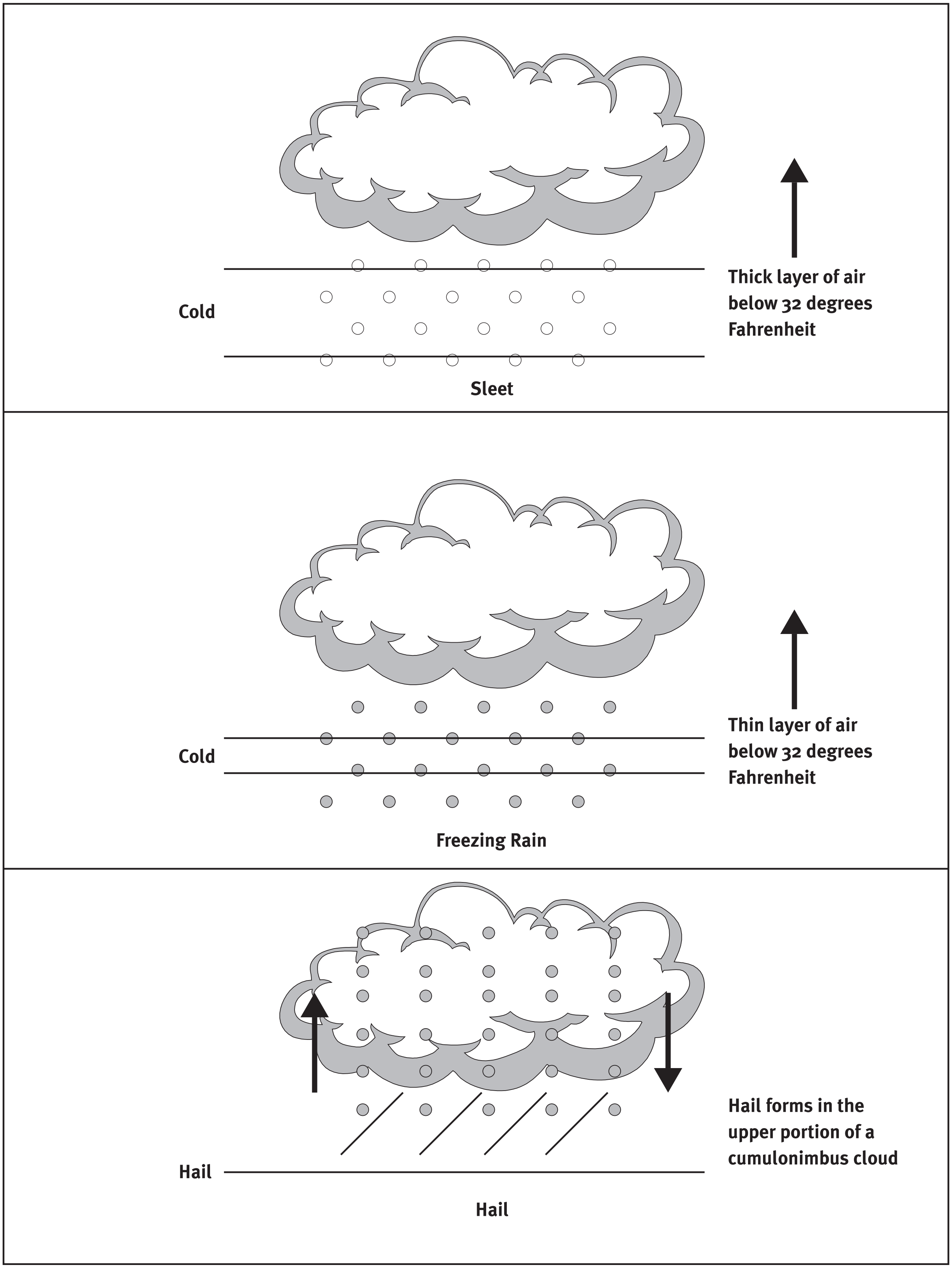


Post Assessment

N/A

Debriefing and Reflection Opportunities (10 minutes)

1. Assign each group a form of precipitation: rain, hail, sleet, snow and freezing rain. Ask students to work in small groups to make a quick summary of how the form of precipitation occurs in the atmosphere.
2. Misconception Alerts:
   Students have a variety of misconceptions about why precipitation falls to earth:
   • Rain falls out of the sky when the clouds evaporate.
   • Rain comes from holes in the sky.
   • Rain comes from clouds sweating.
   • Rain happens when clouds melt.
3. Make sure that students understand that water droplets coalesce. When they get too heavy to remain up in the sky, they fall as precipitation.
4. Many students have misconceptions about why we get precipitation:
   • Rain occurs because we need it.
   • Rain occurs because clouds get scrambled.
   • Rain occurs when clouds are shaken by the wind.
   • Rain occurs because clouds collide with one another.
   • Rain occurs when clouds get to heavy to stay up in the sky.
5. Make sure that students understand that it rains (snows) whether we need it or not. It occurs when water droplets coalesce and are too heavy to stay aloft.

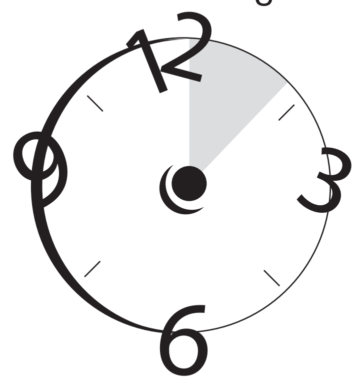

Cold
Thick layer of air below 32 degrees Fahrenheit
Sleet
Cold
Thin layer of air below 32 degrees Fahrenheit
Freezing Rain
Hail
Hail forms in the upper portion of a cumulonimbus cloud
Hail

Water Cycle

Core

Time Allocation: 38 minutes

Required Materials and Resources on Page 311



Lesson Overview

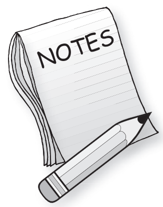
This session focuses on another aspect of the water cycle: ground water. Ground water refers to water that penetrates earth's surface and travels through dirt and rocks as it makes its way into wells, springs, and aquifers. Students will observe a demonstration (small models of different types of soil) and make inferences to learn how ground water travels through the earth's crust. In addition, there is an extension activity related to aquifers, which are underground wells.

Guiding Questions

- What happens to water, ice or snow that is absorbed once it hits earth?
- How can rocks and earth transmit water?
- Does ground water stay underground forever?

BIG IDEA

Ground Water—
P is for Permeability



Content Goals

Universal Theme(s)

- Cycle
- Cause and effect

Principles and Generalizations

- The sun causes water to move through our atmosphere in a never-ending cycle.
- Precipitation absorbed by the earth becomes either ground water or run-off water.
- Run-off water stays on earth's surface and flows into streams, brooks, rivers, lakes or oceans, thereby completing one turn of the water cycle.
- Ground water is absorbed by earth and passes through rocks at different rates into ordinary wells, springs, and aquifers. The rate at which water can pass through spaces between earth's rocks is called permeability.
- The permeability of a material increases with the size of the space between the rocks.
- Gravity pulls water in aquifers great distances.
- Pressure causes some water in aquifers to return to the surface, in springs and geysers, where one turn of the water cycle is completed.
- The amount of water removed by wells and springs must be equal to the amount returned to the ground. If more water is used than is returned, the water table will drop.

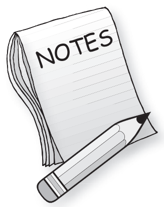
Concepts

- Ground water
- Permeability
- Aquifer
- Gravity
- Water table

Teacher Information

- When any form of precipitation falls, some runs off and some enters the earth through pores in the soil.

- Ground water is water that is absorbed by earth and passes through rocks at different rates. The rate at which water can pass through spaces between earth's rocks is called permeability.
- The permeability of a material increases with the size of the space between the rocks.
- If a great deal of rain falls, the upper layers of the soil will not be able to hold or absorb all the water.
- Water that can't be absorbed continues downward until it reaches an impermeable material, such as shale and clay.
- Water then begins to fill the porous spaces above the impervious material. The surface of this layer of ground water is called the water table.
- The water table can be at the surface or many hundreds of meters under the ground. In places such as swamps, and marshes, the water table is at the surface.
- In meadows and farmland, it is likely to be within several meters of the surface.
- In deserts, the water table may be hundreds of meters below the surface of the earth.
- We dig wells into the ground to reach water that is not at the surface. These wells are called ordinary wells.
- On hillsides, ground water may flow out in naturally occurring springs, called hillside springs, common in mountainous regions.
- Aquifers, sometimes many meters under the earth's surface, are permeable materials, such as gravels and sandstones that contain and carry ground water. Ground water is "sandwiched between impermeable rock layers. To see a cross section of an aquifer go to the following website: http://water.tamu.edu/aquifers.html
- Aquifers can be very large. (See the map of the Ogallala Aquifer that follows)
- Ground water contained in aquifers may be under pressure.
- Water contained in dipping aquifers is pushed along by the weight of the water behind it. It is also pulled by gravity.
- Ground water resurfaces through cracks in the top layer of impermeable rock. The waters that emerge through these cracks are called fissure springs or artesian wells.



Go to the following website to see a cross section of an artesian well:
http://ga.water.usgs.gov/edu/gwartesian.html

Below is a map of the Ogallala aquifer
http://hpwd.com/the_ogallala.asp

Skills

- Observe
- Understand cause and effect

Materials and Resources

1. The following for each group of 3-4 students:
   - 3 clear soda bottles, cut in half, with the top half inverted into the bottom half, such that the bottleneck drains into the lower portion of the bottle.
   - 2 cups of large-size gravel (permeable)
   - 2 cups of small pebbles (permeable)
   - 2 cups of clay or similar substance that is difficult for water to pass through (impermeable)
2. Water
3. A sponge

4. The diagram of the water cycle from Lesson 1 in this curriculum unit. It can be accessed at any of the following websites:

   http://www.epa.gov/safewater/kids/cycle.html A very simple, animated diagram of the water cycle

   http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Watercycle.shtml -This site hosts a picture of the water cycle, as well as activities related to it. One activity contains a play that students can read.

   http://www.windows.ucar.edu/cgi-bin/tour_def?link=/earth/Water/water_cycle.html&sw=false&cd=false&fr=f&edu=high - This site contains three versions of the water cycle: Beginning, intermediate, and advanced.

   http://wwwga.usgs.gov/edu/watercyclegraphic.html -This site contains a detailed picture of the water cycle, perhaps appropriate for sophisticated learners.

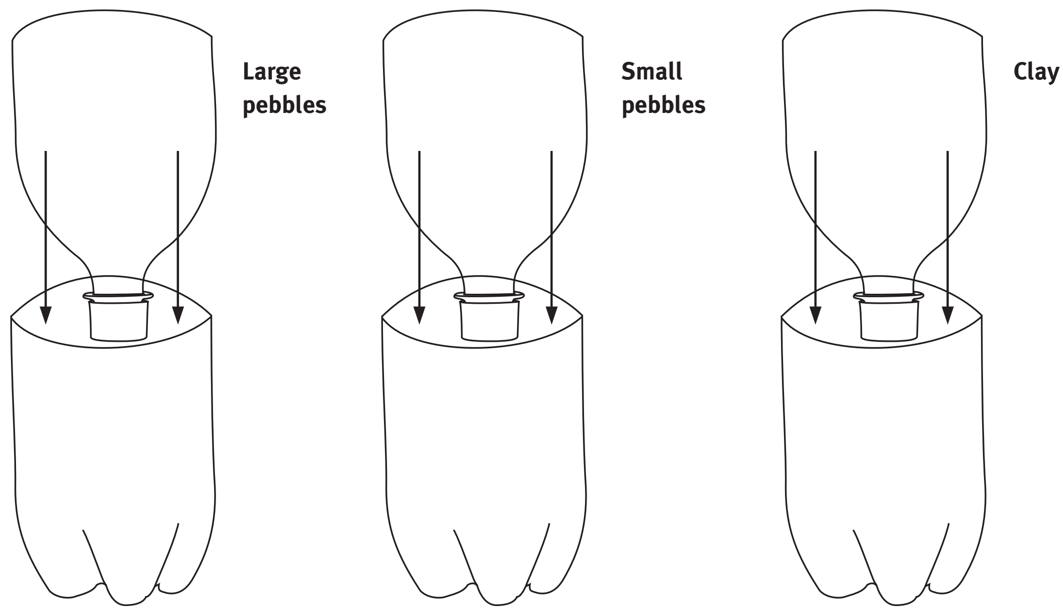
5. A picture of an aquifer. You can use the Ogallala aquifer map above, or use maps and pictures at websites below:
   http://water.tamu.edu/aquifers.html
   www.sepa.org.uk/groundwater/principles.htm
   www.ispe.arizona.edu/pubs/cap/aquifer.html

6. Enough copies of **P is for Permeability** for each student.

Preparation Activities

1. Collect the clear soda bottles for the demonstration or ask students to bring bottles from home.
2. Cut each in half according to the diagram below. It is advisable that the teacher complete this activity.
3. Fill the bottom of one bottle bottom with large-sized gravel.
4. Fill another with small pebbles.
5. Fill the remaining bottle half with clay or a clay-like substance.
6. Label the bottles, respectively: large rocks, small rocks, and clay.
7. Collect enough paper cups so that each group will have 3 cups.

8. Water, enough to fill the 3 small paper cups for each group.
9. Place copies of **P is for Permeability** in a folder.



Introductory Activities (5 minutes)

- Convene students in small groups. Explain to them that they are about to explore one phase of the water cycle: ground water. Invite students to share, in their small groups, where water goes once it comes to earth as precipitation and filters through soil. Remind students that ground water is different from run-off water, a topic that they just finished studying. Run-off water includes all the water that falls on the earth and moves downhill, on the surface of earth, due to the pull of gravity. Ground water refers to water that enters pores in the soil.
- This will be a good place for you to note students' prior knowledge and any misconceptions. Among other misconceptions, students may:
  - o Think that all water runs off into streams, brooks and rivers.
  - o Truly be puzzled by the question and not have thought about the fact that water percolates through rocks and soil into underground lakes, called aquifers, wells or springs.
  - o Believe that flooding only occurs along rivers when snow melts

in the spring or after a heavy rainfall. They may not understand flooding as a phenomenon that occurs when there is more water than the ground or rivers can accommodate.

- Note students who have a great deal of prior knowledge and any misconceptions students may verbalize. If misconceptions are present, make a note to address then at critical points in the lesson.
- Next, invite students to share their thinking about:
  - How does ground water travel through rocks and earth?
  - What is an aquifer? Spring? Ordinary well?
  - Where are aquifers located?
  - Why are aquifers important?

Pre-assessment

N/A

Teaching and Learning Activities (25 minutes)

1. Assign students to four small groups. Students may be grouped heterogeneously. Or, if large differences exist among students with respect to prior knowledge or learning rate, teachers may elect to group students by either critical difference.

2. Ask one member of each group to collect all the materials for his or her respective group. These materials include a set of three bottles filled with the three different substances, three cups of water, and a lab sheet for each student.

3. Make it clear to students that each group will complete the lab collectively, but that each group member is responsible for completing a lab sheet.

4. Go over the **P is for Permeability** lab sheet. Make sure students know what they should be looking for and what observations and inferences they are expected to make.

5. Allow students time to complete the activity and the lab sheet.

6. Rotate from group to group. Observe students and listen carefully to their

thinking in each group. Students should conclude that: (1) water moves more easily (quickly) through porous or permeable substances rather than substances that are dense and less porous, (2) water moves down due to gravity, (3) at some point, water stops moving, and (4) the water table is the surface of the water as it begins to collect at the bottom of their models.

7. In their experimental model, the water table will occur when the water reaches the bottom of the bottle and begins collecting. In the larger model of earth, this level occurs when water reaches bedrock and can go no further. As pores in the rocks and soil fill up, they become saturated and the water level rises. This level is called the water table. Be listening for students' observations and questions. Scaffold learning when necessary.

8. When students have completed their lab, reconvene them. Invite discussion about their models and how they are similar to earth. Explain that some places under the earth's crust contain large lakes that are called aquifers. Some aquifers are very large and have been collecting for thousands of years. One is called the Ogallala Aquifer which stretches beneath the plains states from South Dakota to Texas. It is huge. Show students the map of the Ogallala Aquifer, above, as well as cross-sections of aquifers. On the cross section, point out:
   - The impermeable layers above and below the aquifer
   - How the aquifer goes downhill
   - Fissures that allow some water to resurface as springs

9. Water in the Ogallala Aquifer originally came from precipitation that fell from as far away as the Rockies! Ask students to discuss the following question in their small group:
   - Ask what they suspect is happening to Ogallala Aquifer? Is its water supply increasing? Staying the same? Decreasing? Ask students to explain their answers to each other.
   - Guide students' thinking if necessary. Remind them that a large portion of the plain states is used for agriculture. Therefore, a great deal of water is required to irrigate crops. Water for irrigation comes from diverting rivers and taking water from ordinary wells.
   - Ask one member of each group to share the group's thinking with the class. Acknowledge their responses, asking questions to probe their thinking.

- Share with students that the supply of water in Ogallala Aquifer is actually depleting. It is being pumped out to help irrigate crops. Currently, more water is being pumped out than is being replenished by rainfall.
- Ask students to consider, in their small groups, what might be some things that will happen as a result of this depletion. Listen and acknowledge students' responses.
- Share with students that depletion of water from our aquifers is a serious problem. As the water table drops, wells and springs may go dry. Invite students into a discussion about what happens when wells go dry.
- Suggest that each of us has a special responsibility to conserve water. Ask students to share a strategy they have used, or their family has used, to conserve water.
- Explain to students that there are special scientists, called hydrologists, who work to keep us supplied with the water that we need. They help us to dig wells in the right places, help farmers locate enough water, tell us when we have to draw upon other sources of water, and help us to keep our water clean. They also help us to conserve our water supply because we cannot make more water on our planet.

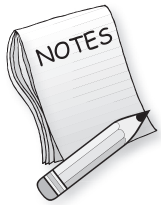
Products

Students' lab sheets **P is for Permeability**

Extension Activities

Note students who show special interest in the work of hydrologists or the Ogallala Aquifer. Invite them to visit the websites below that provide additional information about the Ogallala Aquifer.

- http://ga.water.usgs.gov/edu/earthgwaquifer.html This site contains an explanation about aquifers for students.
- http://www.npwd.org/Ogallala.htm This site contains information about the Ogallala Aquifer. It is one of the largest aquifers in the central United States.
- http://octopus.gma.org/katahdin/aquifer.html This site contains a one-page description of aquifers and easy-to-understand illustrations.



Debriefing and Reflection Opportunities (8 minutes)

1. When students have finished, you may invite all students share their findings. Students should:
   - Understand that the water cycle is not necessarily complete when rain hits the ground or snow melts. Some water travels underground and this water is called groundwater.
   - Comprehend that some rocks/materials are more permeable than others.
   - Recognize that permeability determines the rate at which water flows through materials. In general, water flows more quickly through materials that have larger "pieces" (grain size) because there is more space between the individual pieces for the water to flow. Sand and gravel are permeable; clay is less permeable (impermeable). (If students still have difficulty understanding the porousness of different earth materials, show them a sponge. Liken the different size holes in the sponge to the "holes" between the different earth substances. Water will flow more easily through materials that are more porous, or contain larger holes.
   - Understand that at some point, water stops flowing and begins to saturate the soil.
   - Recognize that when large bodies of this water form underground, they are called aquifers.
   - Know that aquifers, filled with fresh water, provide people with fresh water.
   - Realize that fresh water is an exhaustible resource.
   - Know that ground water emerges from underground when we use our wells, when it burst to the surface in geysers, or springs.
   - Appreciate that hydrologists help people to solve water issues.

2. **SEARCHLIGHT:** Look for students who: (1) have questions about the lab or (2) appear to be curious about the topic. Invite these students to have a conversation with you about the possibility of a follow-up to the lab experience. They may have questions they want to research or may be interested in pursuing any of the related topics below.
   - Droughts
     http://www.drought.unl.edu/kids/impacts/affects.htm
     http://www.state.nj.us/drbc/drought/kids_droughtinfo.htm

- Groundwater pollution
  http://www.groundwater.org/au/rechargereport/rr_kids_1003.pdf
- Geysers
  http://www.yellowstonekoa.com/kids.html
  http://www.infoplease.com/ipa/A0001803.html
- Fumaroles
  http://volcanoes.usgs.gov/Products/Pglossary/fumarole.html
  http://pubs.usgs.gov/gip/volc/geysers.html
- Hot springs
  http://www.yellowstonepark.com/things
- Other aquifers
  http://www.northern.edu/natsource/EARTH/Aquife1.htm
  http://aquat1.ifas.ufl.edu/guide/aquifers.html

3. Using the water cycle diagram from lesson 1 in this module, point out that they have been exploring an "invisible" aspect related to precipitation. Specifically, they have been learning about what happens to the precipitation once it falls to earth. Point out what happens to ground water. One turn of the cycle is completed when
   - Precipitation falls back into oceans and lakes.
   - Ground water travels underground into aquifers and reemerges at the surface in artesian wells, geysers, or springs.

Name: ______________________________ **Date:** ____________________

P is for Permeability

Background

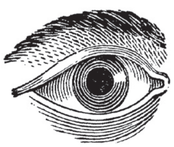
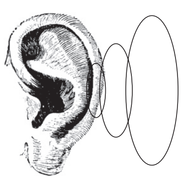
Water is always on the move even after precipitation penetrates the earth's surface. Even though this part of the water cycle can't be seen, we can make models to learn about how water travels through rocks and stones.

In this demonstration, you will have the opportunity to make observations about the speed and movement of water in different kinds of rocks and related materials. Your teacher will use three different bottles, each containing different substances to represent the different kinds of rocks that make up earth. One bottle contains medium-sized pebbles. Another contains sand, and the final bottle contains clay. The rate of water movement through each substance is called the permeability of the material.

Your teacher will be pouring the same amount of water through each bottle. Use your powers of observation to determine the permeability of each material.

Name: ______________________________ **Date:** ____________________

Observations

Sense	Bottle One: Pebbles	Bottle Two: Sand	Bottle Three: Clay
	• • • • • •	• • • • • •	• • • • • •
	• • • • • •	• • • • • •	• • • • • •
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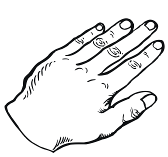
	• • • • • •	• • • • • •	• • • • • •

Name: ______________________ **Date:** ______________

Beyond the Data

1) Review your observations. Which substance is most permeable? Why?

2) Which substance is least permeable? Why?

3) In this model of earth, water has collected at the bottom of each container. Where does water collect when it has trickled down through the layers of rock deep within earth?

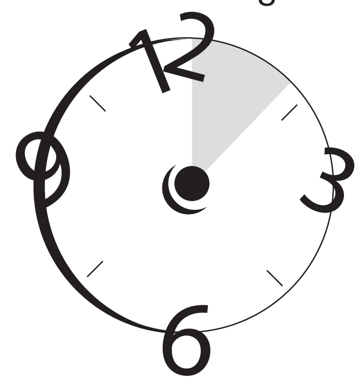
4) What new questions do you have?

Water Cycle

Core

Time Allocation: 1 hour, 15 minutes

Required Materials and Resources on Page 311



Lesson Overview

This session focuses on a final aspect of the water cycle: what happens to precipitation once it comes back to earth. Precipitation that returns to earth can be categorized as run-off water or ground water. Run-off refers to water which travels over the surface of earth into brooks, streams, rivers, and eventually into lakes and oceans. Ground water refers to water that penetrates earth's surface and travels through dirt and rocks as it makes its way into underground wells and aquifers.

In this lesson, students will perform a lab that focuses on run-off water and soil erosion. They will be asked to apply their learning to the larger context of earth.

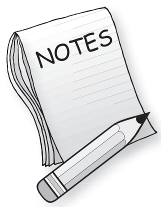
In the final lesson about ground water, students will observe a demonstration (small models of different types of soil) and make inferences to learn how ground water travels through the earth's crust. In addition, there is extension activity related to aquifers, which are underground wells.

Guiding Questions

- Where does precipitation go?
- What is run-off water?
- Where do rivers begin and end?
- How does run-off water erode the earth?

BIG IDEA

Run-off Water



Content Goals

Universal Theme(s)

- Cycle
- Cause and effect

Principles and Generalizations

- The sun causes water to move through our atmosphere in a never-ending cycle.
- Precipitation that falls on the earth can become ground water or run-off water.
- Gravity pulls run-off water over the earth into streams, brooks, rivers, lakes and eventually oceans, thereby completing one turn of the water cycle.
- Running water (e.g., streams, brooks, and rivers) is very powerful and erodes—or wears away—soil and changes the earth.

Concepts

- Run-off water
- Gravity
- Erosion
- Meander
- Mouth

Teacher Information

N/A

Skills

- Observe
- Understand cause and effect

Materials and Resources

1. Cherry, Lynne (2002). *A River Ran Wild.* Voyager Books. (ISBN # 0152163727). This book is the true story of the history, pollution and clean-up of the Nashua River.

2. Pictures of brooks, streams, and rivers. Many are available at the following web sites:
   http://absolutestockphoto.com/albums/userpics/10020/normal_Absolute_20_5257.jpg
   http://www.newenglandforestry.org/projects/images/stjohnriver.jpg
   http://facweb.bhc.edu/academics/science/harwoodr/GEOL101/study/Images/D011-080.jpg
3. Access to a computer, preferably one that can be connected to a projector so that all students can see.

Preparation Activities

1. Copy **River System Worksheet** for each student. Place a copy of the worksheet on each student's desk.
2. Visit the following two sites that contain information about river formation and an animation that allows students to trace the course of a river from beginning to end:

   http://www.hgfl.org - Put "rivers and bridges" into the search bar; then click on the title "Rivers and Bridges," the first activity. Next, click on start activity, and then click on rivers. Be sure you have your sound turned on, as there are sound effects to go along with the activity.

   http://www.woodlands-junior.kent.sch.uk/Homework/Grivers.html#3

Introductory Activities (10 minutes)

- Convene students in a large group. Invite students into a discussion in which they consider the question: Where does water go after it falls to the earth as ice, rain, snow or hail? Acknowledge all responses and, using questioning, move the discussion so that students begin to understand that the water cycle is not over when precipitation falls to the ground. Once precipitation falls to earth, it starts moving as run-off water or ground water. Explain to students that the water moves because it is responding to the force of gravity. If this abstract notion needs to be made more concrete for students, ask them to think about what happened to water the last time it rained hard. In which direction did the water go? (It was pulled by gravity.)

- Run-off water includes surface streams, brooks, rivers, and storm drains. Share with students that in the next two sessions, they will be exploring how rivers form and the effect of erosion, which is caused by any moving water.
- Note students who have a great deal of prior knowledge and students who verbalize any misconceptions. Students who demonstrate prior knowledge now or throughout the unit can be invited to investigate any of the related topics identified at the end of this lesson.
- If misconceptions are present, make a note to address then at critical points in the lesson. One of the most common misconceptions students at this age hold is that rivers always run north and south or "downhill." On the contrary, rivers flow with gravity, unless they have been modified by humans in some way. Rivers that flow from south to north include for example, the Ob in Russia and the Mackenzie in Canada. Another common misunderstanding is that all rocks are heavy. Many small rocks are picked up by swift flowing water, and this sediment features in this lesson on run-off precipitation.

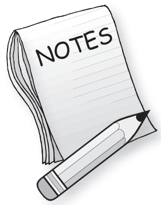
Pre-assessment (15 minutes)

- Complete a K-W-L with students as a large group. Note responses on a large class chart. Invite students to generate what they know about run-off water, e.g., brooks, streams and rivers. Note students' prior knowledge and use it as starting point (s) for these lessons.
- Keep the chart in sight and have students add new information as they proceed through these next couple of lessons on run-off water.

Teaching and Learning Activities (40 minutes)

1. Begin by reminding students about the context for this discussion, which is the water cycle, and that they are learning about one phase of the cycle: what happens to water once it falls as precipitation.
2. Explain that rivers are made up of run-off water and that all rivers are formed in basically the same way.
3. Share with students that they are about to see an animation about run-off precipitation and how it forms streams and rivers.

4. Point out the **River System Worksheet** that you passed out earlier. Go over the directions to make sure students understand what to do.
5. Share the River System animation.
6. At the conclusion of the animation, provide students with time to work with a partner to share their thoughts and questions on each phase of the animation.
7. Reconvene students as a large group and debrief them on their partner discussions. Using Socratic questioning, lead students to understand that:
   - Precipitation falls onto the earth
   - Some of the precipitation flows over the land and droplets combine to form small little rivulets that move with gravity and go downhill (Source)
   - The water in these little streams usually flows fast and is shallow.
   - Water in the little streams is powerful.
   - As it moves quickly in the little streams, it picks up dirt and pieces of rock. This is called erosion (rapids).
   - Streams often contain waterfalls and "plunge pools."
   - Streams don't go in straight lines.
   - Instead they follow the land that is softest and often create "meanders."
   - Water flows more slowly on the inside of each curve (where dirt and pebbles are deposited) and faster on the outside of the curves (where erosion occurs).
   - Water changes the land.
   - The shape of rivers changes over time
   - The river finally empties into a larger river or into the ocean.
   - When a river enters into a lake or an ocean, the emptying point is called the mouth of a river (river mouth).
   - Once the water has emptied into a lake or an ocean, one turn of the water cycle is complete.



Products and Assignments

Students' **River System Worksheets**

Extension Activities

For students who demonstrate prior knowledge and/interest in any of the subjects in this lesson, the following topics will support exploration of this phase of the water cycle in more depth. The websites following each topic may prove helpful in their exploration.

a. Physical characteristics that affect run-off (e.g., land use, vegetation, soil type, drainage area, elevation, slope of the land) http://www.shodor.org/master/environmental/water/runoff/RunoffApplication.html
b. Urban development and flooding http://webquest.sdsu.edu; http://weathereye.kgan.com/cadet/flood/index.html
c. Rivers of the world http://webquest.sdsu.edu ; http://www.factmonster.com/ipka/A0001779.html ; http://www.rev.net/~aloe/river/
d. Man-made features on rivers: canals, dams, reservoirs, weirs and locks http://www.answers.com/topic/canal-lock ; http://sciencebulletins.amnh.org/biobulletin/story1203.html
e. Acid rain http://webquest.sdsu.edu; http://epa.gov/acidrain/
f. Watersheds http://www.epa.gov/surf/
g. Melting glaciers http://sciencebulletins.amnh.org/earth/f/glaciers.2005 0331/essays/55_1.php
h. Waterfalls-Ask students to draw a picture of a waterfall and show how it works
i. Conduct an analysis of water usage in their own homes
j. Create a poster to convince others of the importance of water conservation issues.
k. Read *A River Ran Wild* by Lynn Cherry. Choose a local river or creek. Trace the history of it. Conduct simple science experiments to determine the health of the water.

Debriefing and Reflection Opportunities (10 minutes)

1. Reconvene students into a large group. In a discussion format review the major principles that guided this lesson:
2. The sun causes water to move through our atmosphere in a never-ending cycle.
3. Precipitation that falls on the earth can become ground water or run-off water.

4. Gravity pulls run-off water over the earth into streams, brooks, rivers, lakes and eventually oceans, thereby completing one turn of the water cycle.
5. Running water (e.g., streams, brooks, and rivers) is very powerful and erodes—or wears away—soil and changes the earth.

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River System Worksheet

You are about to see a computer animation about rivers. The animation explains how precipitation that falls to earth becomes a small stream and then a larger river. Your job is to think about each of the twelve phrases of this animation. You can see the twelve phases listed on this worksheet. You will also see a space after each point. Use this space to write down any thoughts or questions that come to mind.

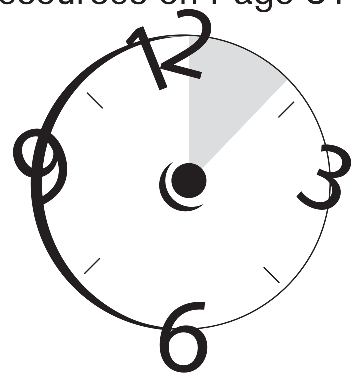
Phase Number	Phase Name	Thoughts or Questions
1	Source	
2	Stream	
3	Rapids	
4	Waterfall	
5	Meander	
6	Confluence	
7	Tributary	
8	Flood Plain	
9	Ox-bow Lake	
10	Coastal Flood Plane	
11	Estuary	
12	River Mouth	

Water Cycle

Core

Time Allocation: 1 hour, 20 minutes

Required Materials and Resources on Page 311



Lesson Overview

This session includes a performance assessment for the water cycle module. Using a plastic jar, students are asked to create a small model of the water cycle and explain how their choice of materials will support and sustain the model. A scoring rubric is provided.

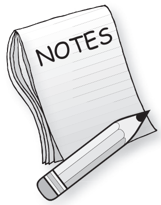
An optional extension is included in this performance assessment. If time is available, students can observe their model in operation over five days. A worksheet is provided so that students can document their observations. Furthermore, a reflection sheet is included to "jump start" students' thinking about their observations.

Guiding Question

- How and why does water move through the living and non-living parts of earth?

BIG IDEA

Water Cycle Assessment



Content Goals

Universal Themes

- Cycle
- Cause and effect

Principles and Generalizations

- The sun moves water in a cycle through the living and non-living parts of earth.
- When water is heated by the sun, tiny particles of water, called water vapor, escape into the atmosphere.
- Water vapor cools as it rises in the atmosphere and condenses back into liquid water to form clouds.
- When drops of water inside a cloud bump into each other, they clump together (coalesce).
- When drops of water become heavy enough, the air can no longer hold them up and they fall as precipitation (rain).
- Precipitation falls on every surface of earth to complete one turn of the water cycle.
- Ground water is absorbed by earth and passes through rocks at different rates into ordinary wells, springs, and aquifers. The rate at which water can pass through spaces between earth's rocks is called permeability.
- Gravity pulls run-off water over the earth into streams, brooks, rivers, lakes and eventually oceans, thereby completing one turn of the water cycle.

Concepts

- Energy source
- Water cycle
- Evaporation
- Condensation
- Precipitation
- Weather system

Teacher Information
N/A

Skills
- Understand cause and effect

Materials and Resources
1. Clean, clear, plastic jars with a lid (one for each student). This can be peanut butter, pickle, mayonnaise, or any other type of plastic jar. Tell students that you need each of them to bring one in to class. Gather extras for students who may not be able to provide them.
2. Duct tape
3. Labels, enough for each student in the class
4. Markers
5. Model building materials, such as:
   - Sand
   - Pebbles
   - Water
   - Dirt
   - Etc.
6. Concept map for the weather unit

Preparation Activities
1. Several days ahead of time, explain to students that they will need to bring in a clear, clean plastic jars as described in the material section above.
2. Collect several jars for students who may not be able to provide them.
3. Gather the water cycle materials that students will use to create their water cycle models.
4. Copy the worksheet, **Water Cycle Models** for each student.
5. Copy the weather unit concept map for each student.

Introductory Activities (5 minutes)
Convene students as a whole group. Explain that in this last session about the water cycle, they will be creating their own models of a water cycle. In addition, they will have the opportunity to sharing, in writing, an explanation about how their model will support all phases of the water cycle: evaporation, condensation, and precipitation.

Pre-assessment

N/A

Teaching and Learning Activities (60 minutes)

1. Invite students to work in heterogeneous pairs. Ask them to take with them their worksheet, **Water Cycle Models** and their two plastic jars.

2. Ask students to read through the instruction sheet and discuss the procedures with their partners.

3. Provide time for students to ask questions. Review the questions that students will need to address in the assessment.

4. Share the rubric with students. Invite questions and solicit student input for the rubric.

5. Make adjustments accordingly.

6. Post the rubric and provide students with copies for self-evaluation purposes.

7. Tell students that they may work together as partners to discuss all aspects of the assignment, but each student is required to turn in a water cycle model.

8. While students work, rotate from pair to pair using Post-Its to make notes about student understandings, misunderstandings, and sticking points. Use the Post-It notes to help you structure the debriefing at the end of this unit as well as the debriefing the entire curriculum unit that will occur shortly.

Products and Assignments

Assessment: **Water Cycle Models**

Extension Activities

N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (15 minutes)

1. Upon completion of the assessment, debrief with students about the water cycle in two stages. In the first stage, focus solely on what the water cycle is and how it works. Use the concept map to trace with your finger the working of the water cycle. Use your Post-It notes to remind you to address any existing student misconceptions about the water cycle.
2. In the second phase of the debriefing, "zoom out" and discuss with students how the water cycle functions as an essential component of the weather system. Ask students to explain their understanding with any or all of these questions:
   - Where does the water cycle "fit" in the weather system?
   - What would happen if it did not exist? (Accept reasonable answers.)
   - How does it affect the other components: air and land masses? (It provides essential moisture to crops, forests, etc; replenishes ground water reserves; provides all animals with water without which they would die.)
   - How do other components, such as wind, affect it? (Wind carries water and water vapor to every place in our enormous atmosphere.) The sun? (The sun is the energy source for both (1) local winds and (2) the water cycle.)
3. Emphasize the nature of a system. A system is composed of components that perform a function. Remind students of the Rube Goldberg machine, if necessary. The components influence one another in unique ways.

Water Cycle Models

You have learned that water moves continually throughout our planet in the water cycle. In this assignment, you will be creating a model that will demonstrate the water cycle at work.

You have been asked to bring from home a clean, clear, plastic jar with a lid. You will be given a variety of materials to create your model. You do not have to use all of them, only those that—in combination—will best illustrate the water cycle at work: energy source, evaporation, condensation, and precipitation. You can put other things into your model, provided that you check with your teacher first.

Arrange all your items in the bottom of your jar. Place the lid on your jar. Then using a label provided by your teacher, write your name and place the label on your model.

When you have completed your model, decide where to put your model for the next five days or so. Place your model where you think it will work best. Then, complete the worksheet below in which you will explain your model. Use separate paper for your answers.

(Optional)
Each day, make observations using the observation sheet that is provided. Make any special notes that you think are important.

At the end of five days, look at your prediction and daily observations. Draw conclusions about your water cycle model. What worked the way you thought it would? What was a surprise? How do you explain the surprises?

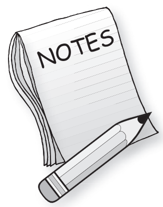
Water Cycle Models

Name______________________________ Date______________

	Explanation
The Water Cycle	Define water cycle.
Energy source	What is the energy source for your water cycle model?
Evaporation	What is evaporation? What will you see as evidence of evaporation?

Condensation	What is condensation? Where will you see evidence of it? Will condensation occur all the time? At some times more than others?
Precipitation	What will you see in your model that will lead you to believe that precipitation is occurring? What will happen after precipitation occurs?
Model	In what ways is your model like the water cycle that operates continually in earth's atmosphere?
Other (Specify)	

	Day 1	Day 2	Day 3	Day 4	Day 5
Energy source					
Evaporation					
Condensation					
Precipitation					
Other (Specify)					



Conclusions About Water Cycle Model

My Energy Source

Evaporation

Condensation

Precipitation

Water Cycle and Explanation Rubric

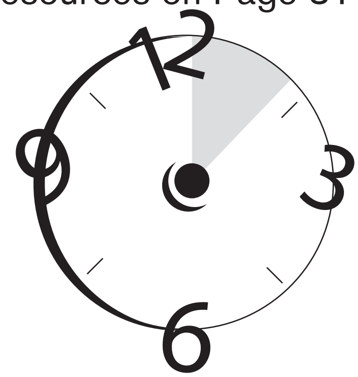
Concept	Novice	Intermediate	Advanced	Expert
Water Cycle	Little information is provided about the water cycle.	Several concepts are listed (e.g., energy source, evaporation, condensation, precipitation); some explanation is provided.	All the concepts are mentioned; a reasonably accurate explanation of the water cycle is provided.	All the concepts are listed; a comprehensive definition is provided; the explanation is clear, accurate, and comprehensive.
Energy Source	There is no mention of an energy source for the water cycle.	There is general reference to the sun.	The sun is listed as the source of energy for the water cycle; some description is provided about sunlight and how it is absorbed differently by the surfaces of earth.	A great deal of explanation about the sun as the source for the water cycle is provided; cause and effect relationships are readily apparent and accurately described.
Evaporation	The entry does not explain evaporation.	A definition of evaporation is provided.	A clear definition of evaporation is provided; some cause and effect relationships are explained (e.g., sunlight heats the surfaces of objects and cause droplets of water to enter invisibly into the atmosphere).	A clear definition of evaporation is provided; the cause and effect relationships are explained; variables that affect the evaporation process are clearly explained (e.g., heat, surface area, and wind).
Condensation	The entry does not explain condensation.	A general definition of condensation is provided.	A clear definition of condensation is provided; there is some specific information about how condensation occurs in the atmosphere to form clouds.	A clear definition of condensation is provided; a comprehensive and accurate explanation is provided about how water droplets coalesce to form a variety of clouds at different levels in the atmosphere; fog and dew may be mentioned.
Precipitation	The entry does not explain precipitation.	A general definition of precipitation is provided.	A clear definition of precipitation is provided; some forms of precipitation are mentioned, as well as how these forms are created in the atmosphere (e.g., rain, snow, sleet, hail freezing rain).	A clear definition of precipitation is provided; all forms of precipitation are described, as well as how the various forms are created in the atmosphere; the explanation includes information about how the precipitation completes one "turn" of the water cycle. It: (1) enters oceans, lakes or rivers, (2) runs off the surfaces of earth and into bodies of water, or (3) enters the ground and becomes ground water.

Unit Debriefing

Core

Time Allocation: 40 minutes

Require Materials and Resources on Page 311



Lesson Overview

In this last session of the unit, students will be reviewing the concept map that has guided their investigation in this weather unit. As written, this unit debriefing is constructed so that students play a large role in the debriefing process. They will work in small groups to synthesize the important concepts and principles for each of the four modules in this unit: geography, predicting weather, wind, and the water cycle. To be expected, student involvement requires time.

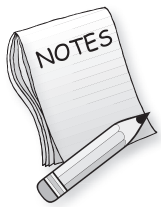
If time is not available, this debriefing can be conducted by the teacher. Instead of breaking students into small groups, the teacher can highlight and underscore the important concepts and principles in each module.

Guiding Questions

- What is the relationship between geography and weather (Module 1)?
- How are the key features of weather (i.e., temperature, wind direction, wind speed, cloud type, cloud cover, and precipitation) used to make weather predictions (Module 2)?
- How are local winds formed (Module 3)?
- How does the water cycle work (Module 4)? If the water cycle is covered in an earlier grade, this question can be eliminated. Teachers may keep the question in the unit if they want students to review the role of the rain cycle in the weather system.
- How do the sun, wind, water, air and land work as a system to create local weather?

BIG IDEA

What have we learned about the different ways weather affects our lives?



Content Goals

Universal Themes
All themes in unit

Principles and Generalizations
All principles and generalizations in unit

Concepts
All concepts in unit

Teacher Information
N/A

Skills
All skills in unit

Materials and Resources

1. Concept map for the weather unit
2. Plain paper
3. Flip chart paper
4. Markers
5. 3 X 5 note cards

Preparation Activities

1. Make enough copies of the concept map for each student in the class.
2. Print out the guiding questions for this lesson on the note cards, one to a card.

Introductory Activities (5 minutes)
Explain to students that in this last session of the weather unit they will be reviewing and reflecting on everything they have learned. Their job today will be two-fold. First, each student will work in a small group to develop an answer to a question. Students will present their answers to the class. Each student's second job is to listen carefully to all the presentations so that everyone knows the answers.

Unit Debriefing

Pre-assessment

N/A

Teaching and Learning Activities (30 minutes)

1. Arrange students into five groups, one group for each question.

2. Give each group a question to answer.

3. Invite students to use the concept map to help them explain their answer.

4. Provide students about 15 minutes to complete their answers. Tell students they can use paper and markers if they wish to illustrate an answer to their question.

5. Provide each group with two-three minutes to explain their answer to the class.

6. Use the remaining time to highlight the concepts and the relationships on the concept map that: (1) students had questions about or (2) you sense are unclear to students.

Products and Assignments

Students' explanations

Extension Activities

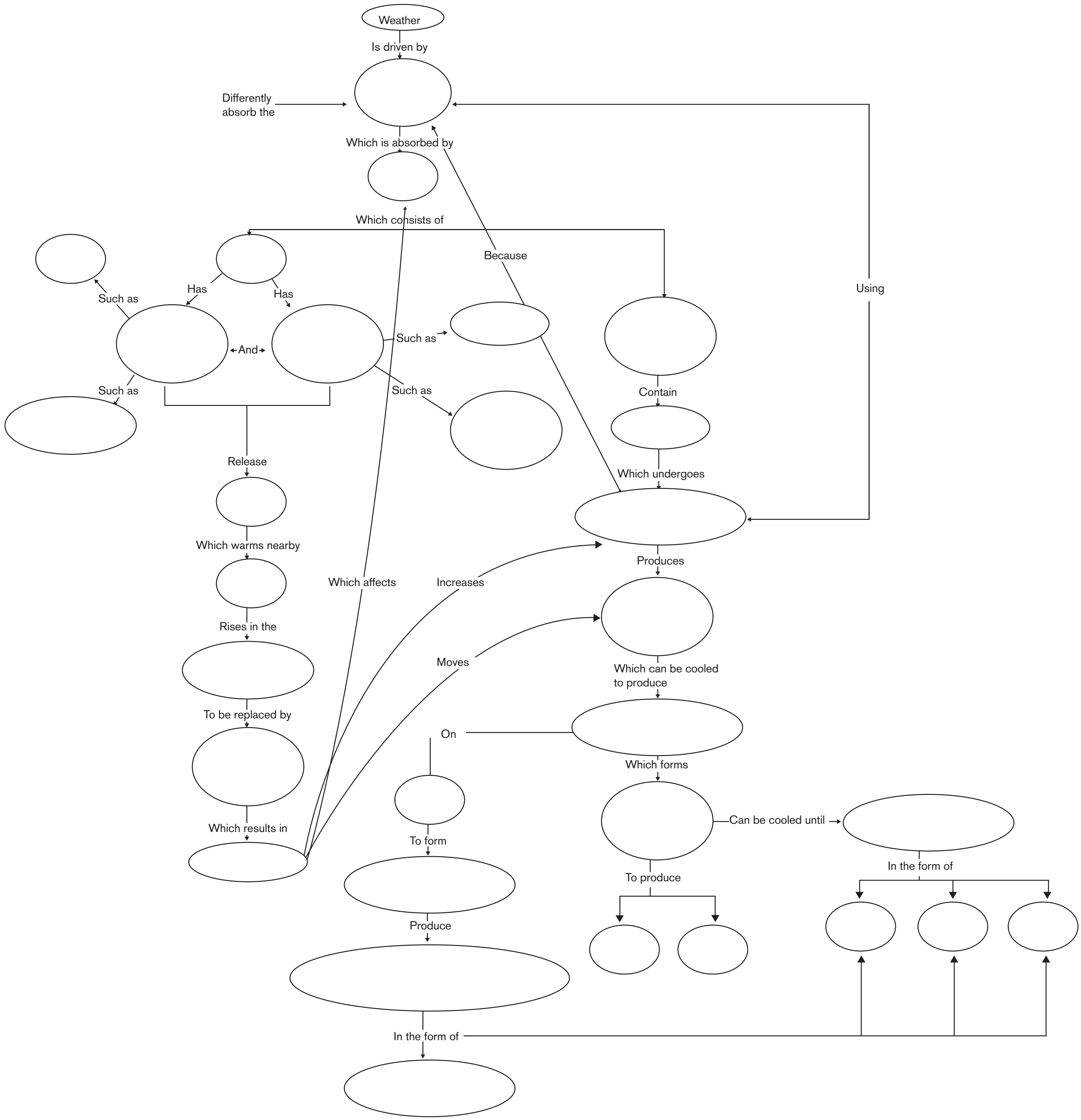
N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (5 minutes)

Allow time for any further comments or questions from students.


Weather
Is driven by
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Which undergoes
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Which affects
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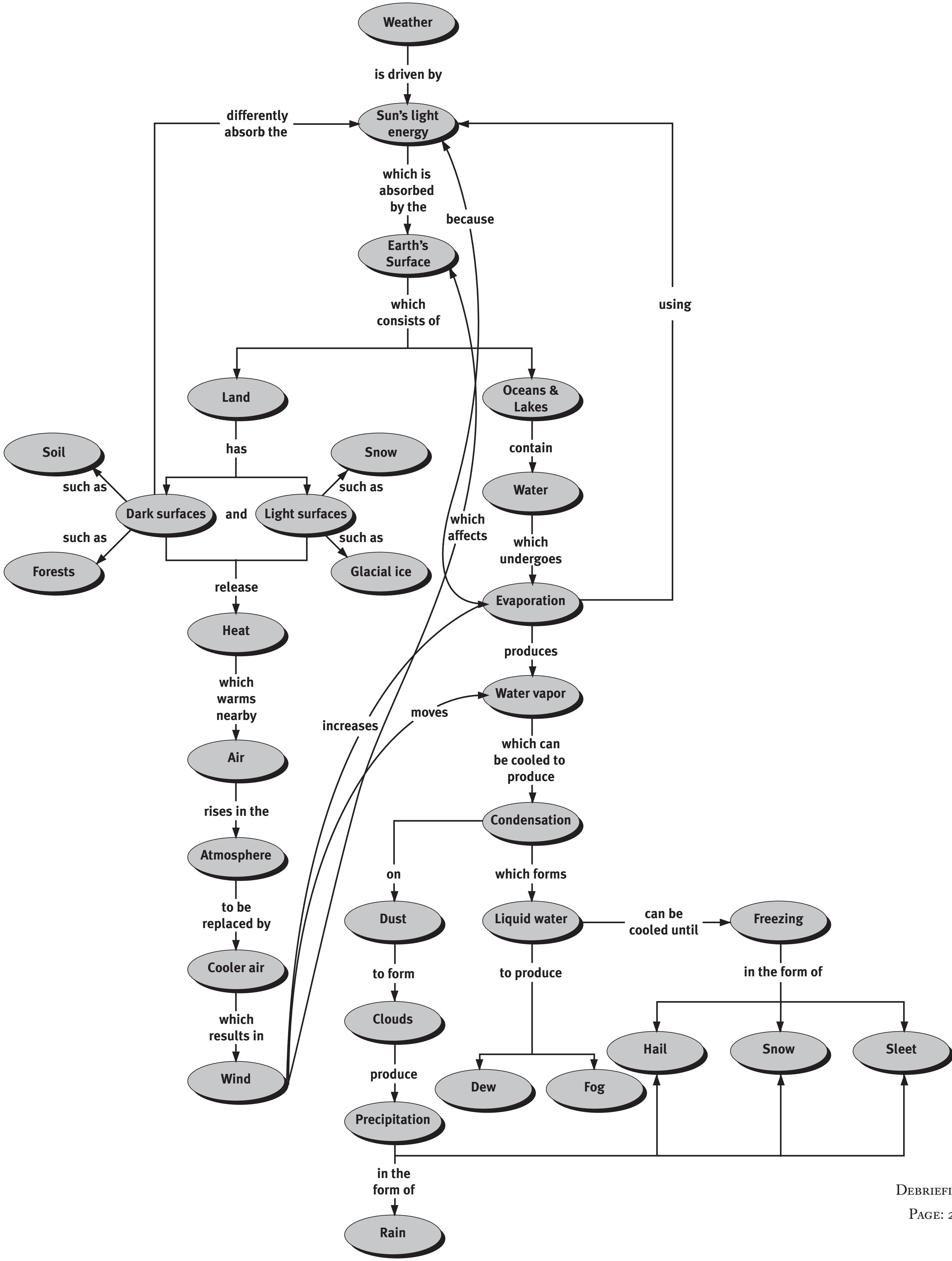
Weather
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Sun's light energy
differently absorb the
which is absorbed by the
because
Earth's Surface
using
which consists of
Land
Oceans & Lakes
has
contain
Soil
Snow
such as
Dark surfaces
and
Light surfaces
such as
Forests
Glacial ice
Water
which affects
which undergoes
release
Evaporation
Heat
produces
which warms nearby
Water vapor
moves
increases
Air
which can be cooled to produce
rises in the
Condensation
Atmosphere
on
which forms
to be replaced by
Dust
Liquid water
can be cooled until
Freezing
Cooler air
to form
to produce
in the form of
which results in
Clouds
Hail
Snow
Sleet
Wind
produce
Dew
Fog
Precipitation
in the form of
Rain

“Curriculum Map”

Author: Jeanne Purcell
Curriculum Map: Weather: The Never-Ending Story
Grade Level: 6

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
Introduction lesson: The sun, land, air and water interact to create our local weather.	CORE 35 minutes	• Parts of a weather system interact and influence one another.	• Sun • Land • Air • Water • Interact • System		• System	• What is weather? • How is weather like a system? • What is interaction? • What effect does weather have on our daily lives?
1. Geography influences local weather.	CORE 40 minutes	• Altitude (elevation) and latitude influence local temperatures. • Local weather is usually warmer in places that are closer to the equator than places that are closer to the North and South Pole. • Local weather is cooler in places that are higher in altitude than places that are closer to sea level.	• Geography • Temperature • Equator • Latitude • Elevation • Altitude • Sea level • North Pole • South Pole • Cause • Effect	• Find latitude. • Determine altitude • Identify cause and effect	• Location	• What is the relationship between the daily temperature of a place and its nearness to the equator? • What is the relationship between the daily temperature of a place and how high it is above sea level? • What is a cause and effect relationship?
2. Geography influences local weather.	CORE 1 hour, 20 minutes, plus time each day in an anchor activity for students to record and graph temperature data from two locations	• Local temperatures that are recorded over time reveal trends that enable meteorologists to draw conclusions and make predictions about local weather patterns.	• Newspaper weather map • Line graph • X axis • Y axis • Ordered pair • Trend	• Read a newspaper weather map • Gather world-wide temperature information from the Internet • Chart ordered pairs of numbers to create a line graph • Interpret a line graph	• Location	• How do you read temperature information from a newspaper weather map? • How do you find information about temperature from the Internet? • How do you construct and read a line graph? • What is the relationship between the daily temperature of a place and its nearness to the equator? • What is the relationship between the daily temperature of a place and how high it is above sea level?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
3. Meteorologists use their senses in order to make observations that help them learn about local weather.	PRACTICE/CORE 45 minutes	Detailed, careful observations lead to accurate weather predictions.	• Meteorologist • Observation • Senses • Accurate	• Observe	• Prediction	• What is observation? • Who makes observations? • How do we use our senses to learn about the weather?
4. A Beaufort scale estimates wind speed.	PRACTICE/CORE 1 hour, 20 minutes	• Wind speed and wind direction predict local weather. • When winds change direction and speed, it means a change in the weather will usually occur.	• Wind speed • Wind direction • Beaufort scale	• Estimate wind speed with a Beaufort scale • Determine wind direction • Observe	• Evidence • Explanation • Change • Measurement	• How can we measure wind? • How can we determine the direction of the wind? • What changes in the weather are associated with changes in the wind speed and direction?
5. The altitude and shape of clouds determine how they are classified by type: low. middle and high.	CORE/PRACTICE/ IDENTITY 40 minutes	• Data about cloud type and the amount of cloud cover predict local weather.	• Cloud • Altitude • Shape • Low clouds • Middle clouds • High clouds • Cloud cover • Cloudless • Partly cloudy • Overcast	• Observe • Classify cloud types • Estimate cloud cover	• Evidence • Explanation • Change • Measurement	• What are the attributes of clouds that meteorologists use in order to study them? • How do meteorologists determine the amount of cloud cover? • What do clouds and cloud cover indicate about the current weather conditions? Future weather conditions? • Would you like to be a meteorologist?
6. Precipitation falls in different forms: rain, snow, sleet, hail, and freezing rain.	PRACTICE/CORE 40 minutes	• Precipitation can be measured with a rain gauge. • Over time, precipitation patterns help to predict weather.	• Precipitation • Rain • Snow • Sleet • Hail • Freezing rain • Rain gauge • Measurement	• Observe • Read a rain gauge	• Evidence • Explanation • Change • Measurement	• How can meteorologists determine the amount of precipitation that falls?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
7. Air has properties: density, pressure, and temperature.	CORE 35-40 minutes	• Air causes pressure. • The pressure of air, or atmosphere, is equal to the weight of the air directly above that point on the earth. • There are many "cells" of air on earth at any given time, each with different pressure. • Air "cells" move from one place to another across the globe. • When air cells move and bump into each other, they interact to help create local weather.	• Air pressure	• Observe • Understand cause and effect	• Interaction • Cause and effect	• Does air cause pressure?
8. As cells move in the atmosphere, air pressure rises or falls in any given location over time.	CORE 40 minutes	• Air/gas has properties: mass or weight, temperature and density. • Our atmosphere contains many different, very large "cells" of air that have different pressure readings that move around the globe. • Lighter air is warmer and/or more humid. • Heavier air is cooler and/or drier. • A falling barometer (decreasing air pressure) generally means warmer, moist air and/or precipitation. • A rising barometer increasing air pressure) generally means cooler and/or drier weather. • Changing barometric pressure readings may indicate weather changes.	• Barometer	• Observe • Understand cause and effect	• Interaction • Cause and effect	• What is a barometer? • What can air pressure tell us about current and future weather conditions?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
9. Weather data can be recorded and studied.	PRACTICE/CORE 1 hour, 20 minutes, plus on-going time at an anchor station each day (10 minutes) for students to record weather observations in their individual Weather Logs	• Weather predictions are based on trends and patterns that emerge from past data.	• Trend • Pattern	• Observe • Read a thermometer • Read a rain gauge • Use a Beaufort scale • Determine wind direction • Record data • Make predictions	• Evidence • Explanation • Change • Measurement	• How do meteorologists systematically collect information about key weather features? • How do meteorologists communicate their findings?
10. The sun makes air move through our atmosphere to create local wind.	CORE 50 minutes	• The sun releases light energy.	• Sun • Star • Light energy • Energy • Air • Land • Atmosphere • Weather • Interact • System • Local wind	• See relationships: land, air, water, and sunlight • Understand cause and effect	• System • Cause and effect	• What is the sun? • What is the most important thing about the sun?
11. When sunlight is absorbed by the earth, it is transformed into heat energy which causes changes to earth's surfaces.	CORE/AID 40 minutes		• Light energy • Heat • Absorption • Transformed • Heat energy	• Observe • Understand cause and effect	• Interaction • Cause and effect	• What is the energy from the sun? • How powerful is energy from the sun? • What happens when sunlight falls on objects?
12. The earth's darker surfaces (e.g. dark soil, asphalt roadways, forests) absorb more sunlight (light energy) than lighter surfaces (e.g. snow, glacier ice), and as a result, release more heat than the lighter surfaces.	CORE/AID 1 hour, 10 minutes	• When heat gets trapped in our atmosphere, earth gets warmer. This effect is called the enhanced Greenhouse Effect or Global Warming (AID)	• Light energy • Absorb • Dark surfaces/ substances • Light surfaces/ substances • Glacial ice • Release • Heat • Trapped (AID) • Greenhouse Effect (AID) • Enhanced Greenhouse Effect (AID) • Cause • Model	• Read a thermometer • Graph • Understand cause and effect	• Interaction • Balance	• Do all surfaces absorb the same amount of sunlight? • Do all surfaces release (give off) the same amount of heat? • What happens to earth's temperature when heat, created by sunlight, gets trapped in our atmosphere (AID)?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
13. There is more water on earth than there is land.	CORE 40 minutes	• Reasonable estimates of very large quantities require careful, logical thinking. • Percents and fractions represent part-to-whole relationships.	• Estimation • Reasonable • Percent • Fraction • Part-to-whole relationships	• Estimate	• Communication	• How can we make estimates of things that appear, at first, to be unknowable? • What is the percentage of water and land on earth's surface? • How does the amount of water on earth's surface affect our weather?
14. There is more water on earth than there is land.	CORE/AID 40 minutes	• Graphs, such as line graphs and pie charts, illustrate relationships between/among numbers.	• Estimation • Percent • Fraction • Graphs • Pie Chart • Line graphs	• Represent • Numbers in graph form	• Communication	• What percent of the earth's surface is covered by water? By land? • How can these numbers be represented? • What are the available sources of water on earth? (AID) • How much of the earth's water is available for drinking? (AID)
15. Water gains and loses heat more slowly than land.	CORE/AID 48 minutes	• Due to the unequal heating of land and water, shoreline areas that border large bodies of water will always be warmer in the winter and cooler in the summer than inland areas. • Interactions among sun light, land, air, and water cause local weather.	• Gains • Loses • Unequal heating • Interactions	• Observe • Graph • Understand cause and effect • Compare and contrast	• Interaction • Cause and effect	• Do water and land absorb the sunlight in the same way? • Why is it always cooler at the beach in summer? • Why do shoreline towns usually receive less snow than inland towns?
16. When air is warmed, it gets lighter and rises.	CORE 40 minutes	• When air is warmed, it gets lighter and rises.	• Lighter • Rises • Air movement	• Actively observe • Understand cause and effect	• Interaction • Cause and effect	• What happens when air is warmed?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
17. Cool air sinks.	CORE 50 minutes		• Dense • Sinks	• Predict • Actively observe • Understand cause and effect	• Interaction • Cause and effect	• How does cool air behave?
18. When air is cool, it sinks.	CORE 40 minutes	• When warm air rises, cool air rushes in to take its place. • When cool air rushes in to take the place of the warm air, local wind is created. • The greater the difference between the warm and cool air, the quicker the air will move.	• Dense • Air movement	• Predict • Observe • Understand cause and effect	• Interaction • Cause and effect	• How does cool air behave? • What take the place of warm air that has risen? • What is local wind? • When does air move fastest?
19. When sunlight is absorbed by the earth, it is transformed into heat energy.	CORE 40 minutes Formative Assessment on Module 3	• Darker surfaces on earth absorb more sunlight than lighter surfaces and, as a result, release (give off) more heat into the nearby atmosphere than do lighter surfaces. • When air is warmed, it gets lighter and rises. • When warm air rises, cool air rushes in to take its place. • When cool air rushes in to take the place of the warm air, local wind is created.	• Sunlight • Absorbed • Transformed • Heat energy • Darker surfaces • Lighter surfaces • Lighter • Rises • Local winds • Air movement	• Explain • Draw conclusions	• Cycle	• What causes local wind?
20. The sun moves water in a cycle through the living and non-living parts of earth	• CORE • 35 minutes	• The rates of evaporation and precipitation balance each other. • The sun, land, air and water interact in a system to create our weather.	• Cycle • Water cycle • Living • Non-living • Balance • System	• Understand cause and effect	• Cycle	• What is a cycle? • How does water move through the atmosphere? • Why does water move through the atmosphere? • Why is water an important resource?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
21. When water is heated by the sun, tiny particles of water, called water vapor, “jump” or escape (evaporate) into the atmosphere in gas form.	CORE/AID 1 hour, 30 minutes – 2 hours		• Water vapor • Evaporation • Gas	• Understand cause and effect • Observe	• Cycle • Cause and effect	• How does water enter our atmosphere? • What is water vapor?
22. When water vapor cools, it condenses back into liquid water.	CORE 40 minutes		• Condense • Condensation	• Understand cause and effect • Observe	• Cycle • Cause and effect	• What causes water vapor to condense back into liquid form?
23. Wind carries water vapor throughout earth’s atmosphere.	CORE 45 minutes	• When warm air containing water vapor rises, the air cools which causes the water vapor to condense in the atmosphere to form clouds. • Meteorologists classify clouds according their shape and their altitude. • The altitude and shape of clouds reflect atmospheric conditions and can predict local weather.	• Condense • Cloud • Shape • Altitude • High clouds • Middle clouds • Low clouds • Cloud cover • Cloudless • Clear • Partly sunny • Cloudy	• Understand cause and effect • Observe • Classify	• Cycle • Cause and effect	• How do clouds form? • Why do clouds look different? • How can clouds be used to forecast the weather?
24. When the drops of water that form clouds are too heavy to float in the clouds, they coalesce and fall to the ground as precipitation.	CORE 1 hour, 30 minutes	• Atmospheric conditions near the surface of earth determine the form that precipitation will take: rain, sleet, snow, freezing rain, and hail.	• Coalesce • Precipitation • Rain • Atmospheric layers • Sleet • Freezing rain • Hail • Snow	• Observe • Understand cause and effect	• Cycle • Cause and effect	• In general, how does precipitation form? • How are snow, rain, sleet, and hail formed? • How do students’ current rainfall amounts compare/contract to the reported rainfall amounts? Average rainfall amounts?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
25. Precipitation absorbed by the earth becomes either ground water or run-off water.	38 minutes CORE	• The sun causes water to move through our atmosphere in a never-ending cycle. • Run-off water stays on earth's surface and flows into streams, brooks, rivers, lakes or oceans, thereby completing one turn of the water cycle. • Ground water is absorbed by earth and passes through rocks at different rates into ordinary wells, springs, and aquifers. The rate at which water can pass through spaces between earth's rocks is called permeability. • The permeability of a material increases with the size of the space between the rocks. • Gravity pulls water in aquifers great distances. • Pressure causes some water in aquifers to return to the surface, in springs and geysers, where one turn of the water cycle is completed. • The amount of water removed by wells and springs must be equal to the amount returned to the ground. If more water is used than is returned, the water table will drop.	• Ground water • Permeability • Aquifer • Gravity • Water table	• Observe • Understand cause and effect	• Cycle • Cause and effect	• What happens to water, ice or snow that is absorbed once it hits earth? • How can rocks and earth transmit water? • Does ground water stay underground forever?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
26. Precipitation that falls on the earth can become ground water or run-off water.	CORE 1 hour, 15 minutes	• The sun causes water to move through our atmosphere in a never-ending cycle. • Gravity pulls run-off water over the earth into streams, brooks, rivers, lakes and eventually oceans, thereby completing one turn of the water cycle. • Running water (e.g., streams, brooks, and rivers) is very powerful and erodes—or wears away—soil and changes the earth.	• Run-off water • Gravity • Erosion • Meander • Mouth	• Observe • Understand cause and effect	• Cycle • Cause and effect	• Where does precipitation go? • What is run-off water? • Where do rivers begin and end? • How does run-off water erode the earth?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
27. The sun moves water in a cycle through the living and non-living parts of earth.	CORE 1 hour, 20 minutes	• When water is heated by the sun, tiny particles of water, called water vapor escape into the atmosphere. • Water vapor cools as it rises in the atmosphere and condenses back into liquid water to form clouds. • When drops of water inside a cloud bump into each other, they clump together (coalesce). • When drops of water become heavy enough, the air can no longer hold them up and they fall as precipitation (rain). • Precipitation falls on every surface of earth to complete one turn of the water cycle. • Ground water is absorbed by earth and passes through rocks at different rates into ordinary wells, springs, and aquifers. The rate at which water can pass through spaces between earth's rocks is called permeability. • Gravity pulls run-off water over the earth into streams, brooks, rivers, lakes and eventually oceans, thereby completing one turn of the water cycle.	• Energy source • Water cycle • Evaporation • Condensation • Precipitation • Weather system	• Understand cause and effect	• Cycle • Cause and effect	• How and why does water move through the living and non-living parts of earth?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
Unit Debriefing	CORE 40 minutes	All principles and generalizations in unit	All concepts in unit	All skills in unit	All themes in unit	• What is the relationship between geography and weather (Module 1)? • How are the key features of weather (i.e., temperature, wind direction, wind speed, cloud type, cloud cover, and precipitation) used to make weather predictions (Module 2)? • How are local winds formed (Module 3)? • How does the water cycle work (Module 4)? If the water cycle is covered in an earlier grade, this question can be eliminated. Teachers may keep the question in the unit if they want students to review the role of the rain cycle in the weather system. • How do the sun, wind, water, air and land work as a system to create local weather?
GT Lesson When warm air rises and cool air sinks, local winds are produced.	CORE 45 minutes	• Geography creates local winds. • The unequal heating and cooling of water and land creates sea and land breezes. • The unequal heating and cooling of mountain slopes and valleys creates mountain and valley breezes. • Winds affect air temperature. Weather is the interaction among geography, the unequal heating of the earth, and the water cycle.	• Local wind • Sea breeze • Land breeze • Valley breeze • Mountain breeze • Interaction • Weather	• Observe • Understand cause and effect	• Interaction • Cause and effect	• What causes local winds? • How are local winds influenced by geography? • Wind affects air temperature, one of the major features of our weather.

“Materials Chart”

Lesson	Primary Materials	Books	Additional Materials (Supplied by Teacher or Students)
Introduction	Flip chart paper, markers,	Picture book of Rube Goldberg machines or download pictures of them from Internet	Internet access, pictures of the weather from www.google.com, 6-10 new articles about the weather
1	Globe, two flat world maps that show mountains (see lesson for world maps that can be downloaded from Internet), sticky notes for each cluster of desks		Internet access, pictures of vacation spots in the mountains and at resorts in the Pacific and Caribbean
2	Globe, two flat maps of the world that show mountains, 3-4 pieces of blank paper for each cluster of desks, 2 different colored overhead markers, colored pencils or markers for students		Internet access
3	Paper at each cluster of desks for students to use for brainstorming, pens and pencils, flip chart, marker		
4	One 8" circle template, one 5" circle template, sheets of light-colored oak tag sheets of a colored piece of construction paper, rulers scissors, markers in different colors, paper fastener (enough copies of the above for each student), compass, chalk		Internet access, pictures of different effects of wind at: http://sln.fi.edu/tfi/units/energy/gallery.html
5	Blank pieces of paper on students' desks		Internet access, pictures of different kinds of clouds – these can be found in many science books or they can be download from sites noted in lesson 5
6	Seven labels, waterproof markers, 6-7 rulers that are calibrated to eighths of an inch, duct tape, one cup of water		Seven clear, clean plastic soda bottles, cut in half, one *Zip-lock* baggie for each group of students
7	A scale that measure weight to the nearest hundredth of a gram, the following for each group of 3-4 students: 1 clear, small plastic vial with a lid (about the size of a prescription bottle), water to fill each vial 1/2 full, a small balloon		An *Alka-Seltzer* table for each group of 3-4 students

Lesson	Primary Materials	Books	Additional Materials (Supplied by Teacher or Students)
8	The Pressure's On: The Latex Balloon – each student will need the following materials: a wide-mouthed jar, a balloon with the neck cut off, a rubber band, a cardboard strip, 10 cm x 25 cm, a small, wooden shish kebob stick, about 12-15 cm, making or duct tape, scissors, metric rulers The Pressure's On: The Glass Tube – each student will need the following materials: a glass beaker or jar, with a 3-4" mouth, a ruler, centimeters preferable, tape, 6-8" of plastic tubing, 1/4 inch diameter, a stick of chewing gum, water		
9	As many air thermometers as there are groups of students, same number of broom handles to be used as posts on which the thermometers will be mounted, duct tape, six rulers calibrated to eighths of an inch, note cards in different colors (a different color for each weather observation team), push pins or tacks		A place outside the school building that is in the shade for most of the day, safe for students, yet not protected from the natural elements (e.g., wind, rain) for setting up a weather station, stones to prop up the rain gauges from each group, sledge hammer
10	Flip chart and paper, markers, sheets of paper on the center of clustered desks, pictures of wind, pictures of water: oceans, lakes, rivers, rain, snow, ice	*The Important Book* by Margaret Wise Brown	Internet access
11	A magnifying glass, a piece of paper, a sunny window or a sunny location outdoors for students, sticky notes on each table so that each student can have 4-5 notes		

Lesson	Primary Materials	Books	Additional Materials (Supplied by Teacher or Students)
12	A sunny window and/or a sunny location outdoors for students, 12 pieces of black construction paper 5.5" x 8" (6-8 1/2" x 11 pieces of paper cut in half), 12 pieces of white construction paper 5.5" x 8", 24 thermometers, a clock/watch with a minute hand, sticky notes, pens/ pencils, For students who need more challenge, these additional resources will be required: 2 jars, one with a lid, one without, 2 balls of clay, 2 thermometers that students can anchor in the clay that they placed at the bottom of each jar		Internet access, for students who need more challenge: s short reading on the greenhouse effect: www.windows.ucar.edu
13	Two, preferably three, flat maps of the world, flip chart and markers, pencils, sticky notes		
14	For all students: Two, preferably three, flat maps of the world, flip chart and markers, large sheets of white paper, enough for 2-3 pieces for each group of three students, blue construction paper, cut into 1" squares, 100 for each group, brown construction paper, cut into 1" squares, 100 for each group, pencils, glue sticks, enough for each group to have 2-3, sticky notes For students working on the fresh water assignment (AID): ample copies of "The Water Cycle' available at http://earthobservatory.nasa.gov/ Library/Water/ , different colored markers, large pieces of paper for students to make pie charts		Examples of pie charts containing information that students will find interesting. *USA Today* often has charts and graphs on interesting topics, Internet access
15	Two plastic cups for each pair of students, 1/2 cup of water for each pair of cups that has been colored with tea bags, 1/2 cup of soil, 2 thermometers for each pair of students, a gallon container, modeling clay, two different colored markers or pencils for each pair of students		An overhead of the graph from the **Land and Water Lab,** daily temperature from two cities, one that is inland and another that is on the coastline

Lesson	Primary Materialsv	Books	Additional Materials (Supplied by Teacher or Students)
16	Talcum powder, cloth	Copy of poem, "Who Has Seen the Wind" by Christina Rossetti (see website in lesson)	Lamp with a bare bulb, Internet access
17	Two small bottles, two large, clear containers		Red food coloring, blue food coloring
18			Small ice chest about the size used for a 6-pack of soda, ample ice to fill the chest, incense stick. Lit and smoldering
19	Black line master **Tiny Tornado** for each student (included in lesson)		
G/T lesson	Sheets of 8 1/2 x 11" paper		Styrofoam pans (2), enough sand to fill one pan, enough ice to fill other pan, cardboard windscreen folded in three places to wrap around pans when they are placed together side-by-side, stick of incense, extinguished and smoking
20	Flip chart and paper, markers, sheets of paper on the enter of clustered desks in the classroom, one index card for each student, pencils, large diagram of the water cycle or smaller copies for students		Internet access – see websites in lesson for diagrams of water cycle; Bicycle wheel in a large cardboard box placed behind easel
21	Spoon or eye dropper, small amount of water Experiment 1: It's a Gas I – measuring cup, water, 2 drinking glasses, 2 elastic bands Experiment 2: It's a Gas II – measuring cup, water, 1 drinking glass, a saucer Experiment 2: It's a Gas III (AID) – water, access to windy location or hair dryer, small dishes that are the same size, paper towels. 2 articles of clothing		Overhead projector
22	Plastic cups, two for each pair of students in the class, Ice cubes,		Ice cubes, pitcher of ice-cold water, ample food coloring so that a small drop can be added to each plastic cup, picture of a well known detective, such as Dick Tracey
23		*Cloud Dance* by Thomas Locker or pictures of various cloud types	Internet access, cloud images from this website: http://www.australiasevereweather.com/techniques/simple/clouds.htm

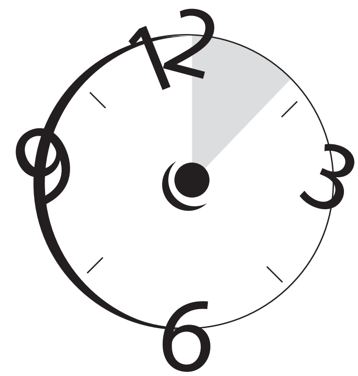
Lesson	Primary Materials	Books	Additional Materials (Supplied by Teacher or Students)
24	Sufficient small plastic cups for each cluster of desks in the room, hot water, elastic bands to secure plastic wrap,		Plastic wrap squares to cover the small bowls, 3 ice cubes for each bowl, 8 x 11 sheets of wax paper, bottle with a sprayer attached, toothpicks for each group of students, daily weather maps with recent rainfall amounts for each group of students
25	Water, sponge, diagram of water cycle (see lesson 25 for various websites)		The following for each group of 3-4 students: 3 clear soda bottles, cut in half with top half inverted into the bottom half, such that the bottleneck drains into the lower portion of the bottle, 2 cups of large-size gravel (permeable), 2 cups of small pebbles (permeable), 2 cups of clay or similar substance that is difficult for water to pass through (impermeable)
26		*A River Ran Wild* by Lynne Cherry	Internet access, pictures of brooks, streams, and rivers – see websites in lesson 26
27	Duct tape, labels for each student, markers, and model building materials such as: sand, pebbles, water, dirt, etc. Concept map for weather unit		Clean, clear plastic jars with a lid (one for each student)
Unit Debriefing	Concept map for weather unit, plain paper, flip chart paper, markers, 3 x 5 note cards		
G/T Lesson	Sheets of 8 1/2" x 11" paper		Styrofoam pans (2), enough sand to fill one pan, enough ice to fill the other pan, cardboard windscreen folded in three places to wrap around pans when they are placed together side-by-side, stick of incense, extinguished and smoking.

Wind

Core

Time Allocation: 45 minutes

Required Materials and Resources on Page 311



Session Overview

This lesson for G/T students builds on their understanding of the behavior of warm and cool air and should be offered after the lessons in Module 3 are completed. In this demonstration, students will observe that local winds are produced when cool air rushes in to fill the space left by warm air that has risen. In addition, they will learn that local winds are more pronounced in some geographic areas: shoreline communities and mountain and valley communities.

With respect to the shoreline communities, students already know that water heats up and releases heat more slowly than does land. During the daytime, warm air over land rises. When this happens, cooler air from the ocean or lake rushes in to fill the space left by the rising warm air. When cool air rushes in, it is called a sea breeze. Just the reverse happens at night. Warm air over the ocean or lake rises. Cool air from the land moves toward the water to produce a land breeze.

BIG IDEA

Land/Sea and Mountain/ Valley Breezes

In a similar fashion, geography produces local winds in mountainous communities. During the daytime, the Sun heats the valley floor. Warm air rises up the sides of the mountain slopes producing a valley breeze. At night, the mountains cool faster than the valleys. The cool air from the mountain peaks sinks into the valleys creating a mountain breeze.

This demonstrations requires the use of a microwave oven to heat sand and a smoldering piece of incense. It requires the oversight of an adult.

Guiding Questions

- What causes local winds?
- How are local winds influenced by geography?

Content Goals

Representative Topic

N/A

Principles and Generalizations

- Geography affects how **local** winds are formed.
- When warm air rises and cool air sinks, local winds are produced
- The unequal heating and cooling of water and land creates **sea** and **land breezes**.
- The unequal heating and cooling of mountain slopes and valleys creates **mountain** and **valley breezes**.
- Winds affect air temperature
- **Weather** is the **interaction** among geography, the unequal heating of Earth, and the water cycle

Concepts

- Local wind
- Sea breeze
- Land breeze
- Valley breeze

- Mountain breeze
- Interaction
- Weather

Related Information

- Winds are named for the direction from which they blow.
- A sea breeze moderates land temperatures.
- Sea breezes generally begin about noontime and reach their greatest intensity in the mid-afternoon.
- The intensity of land and sea breezes depend upon the location and time of year.
- Tropical areas, with intense solar heating experience more frequent and stronger sea breezes than do mid-latitude locations.
- Valley breezes form during the day when air, along mountain slopes, is heated more intensely than air at the same elevation over the valley floor.
- Mountain breezes are formed when cooler air along the mountain slopes descends into the valley.
- The coldest pockets of air are usually found in the valley.
- Crop damage in the fall is most likely to happen to crops in the lowest part of mountain valleys.

Skills

- Observation
- Cause and effect

Materials and Resources

1. 2 styrofoam pans, similar to the kinds used for packaging meats or restaurant leftovers
2. Enough sand to fill one of the pans
3. Enough ice to fill the other pan
4. A cardboard windscreen, folded in three places, to wrap around the pans when they are placed together side-by-side.
5. A stick of incense lit, extinguished, and smoking
6. Sheets of 81/2 X 11 paper

Preparation Activities

1. Just before you are ready to do the demonstration with students, warm the sand in a microwave until it is very warm to the touch
2. Fill the other pan with the ice.
3. Position the pans side by side and place the wind screen around three sides of the pans in order to eliminate any wind disturbances.
4. Make enough copies of **Local Winds** for each student in class.
5. Some sheets of blank paper at students' desks

Introductory Activities (3 minutes)

Convene students and arrange them into groups of two. Tell students to imagine themselves on a beach next to an ocean or lake. It is a very hot day, and it is early afternoon. The sun is beating down, and the sand is very hot on your feet. Your face is cool though. What is it that is cooling you? Tell students that wind from the water is cooling them and it is an example of local wind. Their job is to learn as much as they can about local winds, a very important feature of weather. Wind is moving air.

Preassessment

N/A

Teaching and Learning Activities (20 minutes)

1. Explain to students that there are two types of winds: local and global.
2. Both kinds of wind are caused by something students have already learned about: the unequal heating of land and water.
3. Remind students that they discovered that: (1) water gains and loses heat more slowly than land does, and (2) dark surfaces on Earth absorb more sunlight and give off more heat than do lighter surfaces.
4. Local winds move relatively short distances and can blow from any direction.
5. Global winds are part of a large pattern of air circulation that moves across the Earth.
6. Go over the lab sheet with students to make sure that they understand the directions.
7. Complete the first demonstration with the heated sand and ice cubes to model the effect of a sea breeze.

8. Hold the smoking incense over the join between the pans. Hold it long enough so that students see the smoke traveling toward the hot sand the way it does on a beach on a summer afternoon.
9. Repeat the demonstration. Allow the sand to cool, and fill the other container with very warm water to model the effect of a land breeze. Hold the incense the same way and allow students to observe the smoke traveling toward the warm water the way a land breeze does in the night time.
10. At the conclusion of the demonstration, ask students to think about mountain and valley temperatures. How might the local winds in this type of geography be similar to the local winds that are produced at shoreline communities?

Products and Assignments

Completed lab sheet, **Local Winds**

Extension Activities

- Wind farms and wind turbines
- Local winds: Chinook winds
- Local winds: Katabatic winds
- Local winds: Santa Ana winds
- Global winds: Coriolis effect
- Global winds: Jet stream

Post-Assessment

N/A

Debriefing and Reflection Opportunities (15 minutes)

Reconvene students and arrange them into groups of 4 so that two pairs of lab partners form each group. Invite students to brainstorm how local winds influence weather for 2-3 minutes. At the conclusion of the brainstorming, engage the class in a discussion of their responses. Using Socratic questioning, help students clarify their thinking so that they understand that local winds affect the temperature of a place.

WEATHER: THE NEVER-ENDING STORY

Name: ________________________________ **Date:** ____________________

Local Winds Demonstration

Background

You have learned a great deal about the conditions that affect our daily weather. In the past, you learned that water warms and releases its heat more slowly than land does. Just recently, you learned that warm air rises and cool air sinks. If we think about our earth and land surfaces releasing heat into the air, some places will have air temperatures that are higher than others.

Today, you will be drawing on all that you have learned to understand how local winds are created and affect our weather. Wind is the movement of air. It is caused by the unequal heating of the surfaces on Earth: water and land, as well as dark and light land surfaces. The warmer surfaces release more heat causing the air nearby to warm. This warm air rises and cool air rushes in to fill the space left by the warm air. This movement of air is called wind.

There are two types of winds: local and global. Local winds move short distances and can blow from any direction. There are many different kinds of local winds: mountain and valley breezes, land and sea breezes, Chinook winds, Santa Ana winds, just to name a few. Global winds, on the other hand, are part of a much larger pattern of circulation that moves across Earth. Global winds travel longer distances than local winds do, and they tend to travel in more predictable directions than local winds.

By the end of today's session, you will see—once again—that weather results from the interaction of a number of important components: the Sun, air, land and water.

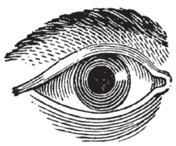
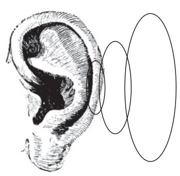
Think of this demonstration as a model. A model is a small-scale representation of something. Meteorologists use models to study many aspects of weather because weather is too complex and too big to observe in its natural state. To better understand the complex interactions that constitute weather, meteorologists use models.

Procedures:

1. Put your name at the top of your lab sheet.
2. Your teacher will be conducting a demonstration that you will watch with a partner.
3. Record your observations. You can talk to your partner about what you see. In addition, you can talk over the answers to the questions in "Beyond the Data" with your partner.
4. Each student is responsible for handing in his or her own lab sheet.
5. Your teacher will tell you when to make your observations.

Name: ______________________________ **Date:** ____________________

Observations

Sense	Experiment One	Experiment Two: Pre	Experiment Two: Post
	• • • • • •	• • • • • •	• • • • • •
	• • • • • •	• • • • • •	• • • • • •
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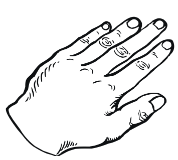	• • • • • •	• • • • • •	• • • • • •

WEATHER: THE NEVER-ENDING STORY

Name: ______________________ **Date:** ______________

Beyond the Data

1. Describe what happened to the “smoke” during the first demonstration.

2. Why do you think the smoke moved the way it did?

3. Describe what happened to the smoke during the second demonstration.

4. Why did the smoke move in a different direction during the second demonstration?

5. Think back to the hot summer day at the beach that we talked about at the beginning of this lesson. Then, think about the model that you have just seen. How does geography influence local wind patterns?

6. Talk with your partner about the following: How does air—moving air—influence our weather? Summarize your thinking below.

RUBRIC: What Are Local Winds and How Do They Affect Temperature?

Novice	Intermediate	Advanced	Expert
• Local winds just blow around. • They are not big, just average winds.	• Local winds are moving air. • They don't move very far. They just stay around in one place. • They make breezes.	• Local winds are moving air. • They happen when cool air rushes under warm air that has risen. • They aren't big; they affect one or two small areas • Local winds can affect the temperature of a place.	• Local winds affect a small area and happen when some places are warmer than others. • When cool air rushes under warm air that has risen, we get wind. • Some kinds of geography encourage local winds, like mountains and valleys and large bodies of water. • Local winds affect temperature because the bring in cooler air.