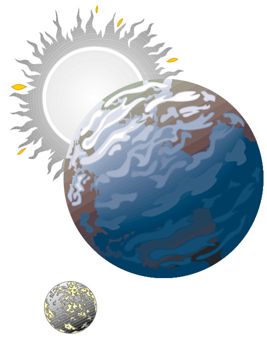
Earth/Space Science

Course No. 2001310

Bureau of Instructional Support and Community Services
Division of Public Schools and Community Education
Florida Department of Education

Reprinted 2000

This product was developed by Leon County Schools, Exceptional Student Education Department, through the Curriculum Improvement Project, funded by the State of Florida, Department of Education, Division of Public Schools and Community Education, Bureau of Instructional Support and Community Services, through federal assistance under the Individuals with Disabilities Education Act (IDEA), Part B.



Earth/Space Science

Course No. 2001310

revised by
Missy Atkinson

edited by
Missy Atkinson
Sue Fresen

graphics by
Rachel McAllister

page layout by
Blanche Blank

Curriculum Improvement Project
IDEA, Part B, Special Project

LEON COUNTY SCHOOLS

Exceptional Student Education

Curriculum Improvement Project
Sue Fresen, Project Manager

Leon County Exceptional Student Education (ESE)
Ward Spisso, Director of Exceptional Education and Student Services
Diane Johnson, Director of the Florida Diagnostic and Learning Resources System (FDLRS)/Miccosukee Associate Center

School Board of Leon County
Tom Young, Chair
Joy Bowen
J. Scott Dailey
Maggie Lewis
Fred Varn

Superintendent of Leon County Schools
William J. Montford

Table of Contents

Acknowledgments

The staff of the Curriculum Improvement Project wishes to express appreciation to the content revisor and reviewers for their assistance in the revision of *Earth/Space Science* from original material by content, instructional, and graphic design specialists from Broward and Leon county school districts.

Content Revisor

Missy Atkinson
Technology Coordinator
Godby High School
Tallahassee, FL

Copy Editor

Deborah Shepard
English Teacher
Lincoln High School
Tallahassee, FL

Review Team

Greg Danner
Science Teacher
School of Arts and Sciences
Tallahassee, FL

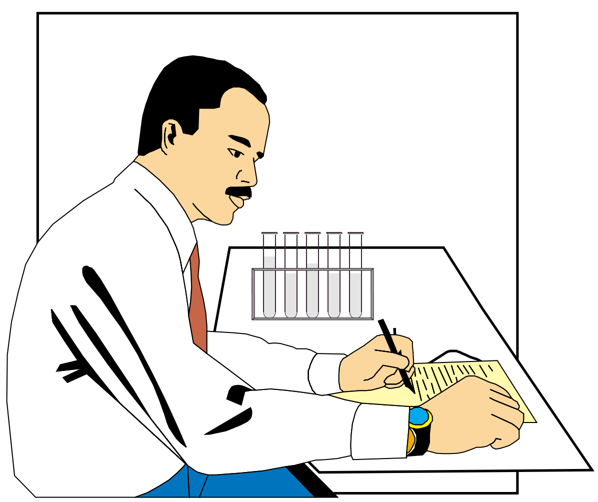
Steve Fannin
Science Teacher
Lincoln High School
Tallahassee, FL

Sue Gauding
ESE Teacher
Godby High School
Tallahassee, FL

Production Staff

Sue Fresen, Project Manager
Blanche Blank, Text Design Specialist
Rachel McAllister, Graphic Design Specialist
Curriculum Improvement Project
Tallahassee, FL

Unit 1: Introduction to the Scientific Processes



Vocabulary

Study the **scientific method** *vocabulary words and definitions below.*

conclusion ..... an explanation of a problem based on observations and collected data

control group ..... the part of the experiment without a variable factor; allows the results of experiment to be compared

controlled experiment ..... an experiment in which all the factors are the same except for the one being tested

data ..... scientific facts that are collected, usually in the form of numbers

experiment ..... a way to test a hypothesis or try out an answer to a question

experimental group ..... part of the experiment that contains the variable factor

fact ..... an idea that has been proven by experiments

hypothesis ..... an idea or statement that attempts to explain the relationship of observed factors; an educated guess

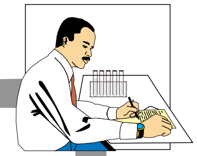
laboratory ..... a place equipped and used for experimental study, research, analysis, testing, or preparation in any branch of science

observation .... noticing something, using one's senses (sight, smell, touch, hearing, or taste)

scientific method .... the steps scientists use to solve problems

theory .... a hypothesis that has withstood the test of time

variable factor .... the factor being tested in an experiment

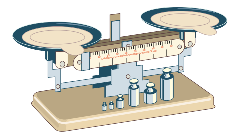


Vocabulary

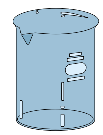
Study the **scientific apparatus** *vocabulary words and definitions below.*

apparatus .... the equipment or tools needed for a specific task, as in biology or chemistry

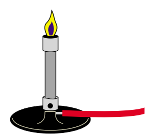
balance .... used to measure the mass of an object



beaker .... a glass container which is used in scientific experiments

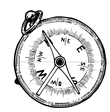


Bunsen burner ....



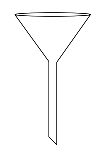
gas burner used to heat chemicals or apparatus

compass .... used to determine direction

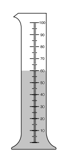


eyedropper .... a glass dropper used to dispense small amounts of liquids

funnel .... used to pour liquids into containers

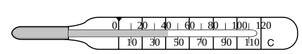


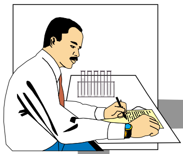
graduated cylinder ....



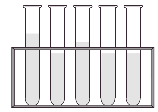
used to measure the volume of a liquid

thermometer .... instrument used to measure temperature





test tube .... multiple-purpose glass container that can be heated



tongs .... a tool with two connected curved arms, used to grasp and lift hot apparatus or chemicals

Introduction

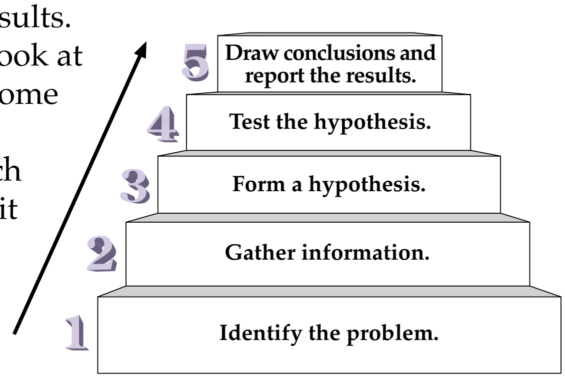
Many of us have had unanswered questions about our environment—why…? how…? when…? Some of us have gone to find answers. Most of us, however, must depend on more qualified individuals for answers. Most often, those qualified individuals are scientists—investigators in the field of science. They specialize in finding answers in an efficient and organized manner.

To investigate efficiently and in an organized way, scientists must use a certain method. This method is called the **scientific method**—a way of solving problems using specific steps. Scientists must also be careful to follow safety rules as they are conducting **experiments** in the **laboratory**. Following laboratory rules protects the results of experiments and also protects scientists from accidents.

Steps of the Scientific Method

Have you ever observed something in nature and wondered what it is and how it works? If so, you have that in common with scientists. Scientists wonder about nature. They ask questions and design experiments to find the answers to their questions.

Whenever scientists have questions or problems, they use a certain method called the *scientific method* to find answers. It is a way of solving problems using five specific steps—identifying the problem, gathering information, forming a **hypothesis**, testing the hypothesis, and drawing **conclusions** and reporting the results. The method allows scientists to look at a specific problem and develop some solutions. Using the scientific method, scientists can look at each possible solution to determine if it is correct.



Step 1: Identify the problem

The first step is to identify the problem and develop a question about it. The study of a problem always begins with a question. Scientists must know exactly what the question is so that they can decide how they want to go about finding an answer to it.

In a study about the origins of coquina, a stone made of broken shell and bone found in Florida, scientists had only one question: How did coquina stone made from organisms that lived in the ocean come to be found miles away far from the beaches and sea?

Step 2: Gather information

Then information is collected about the question. **Observations** are made and recorded. Careful observations are important in gathering information. Scientists observe everything they can about a scientific problem. Scientists, studying various stones in areas it seemed they could not have formed, used many ways of collecting information to learn when and where the stone formed.

There are various ways to collect information. Some of the ways are listed below.

Ways to Collect Information

- reading about what other scientists have done on the subject
- using the senses (sight, hearing, smell, touch, or taste) to make observations
- using scientific equipment, such as a telescope

Confirmed observations can become scientific **facts**. A fact is an idea that has been proven by experiments. Observations and facts are then recorded. This recorded information becomes **data**. Scientific facts, often in the form of numbers, are called data. Scientists must use logical reasoning to interpret their data.

Step 3: Form a hypothesis

Looking at the data gathered, scientists make a guess and suggest what may be the answer to the problem. This guess, which is based on observations, is called a *hypothesis*. A hypothesis is an idea or statement that explains the relationship of observed facts to each other. It is a tool for further study of the problem. A good hypothesis must include specific explanatory information so that it can be tested.

The idea that ocean levels change was a good hypothesis for several reasons. It explained why coquina rocks were found in dry areas as well as under the sea. It predicted that the level of the ocean would not remain constant over long periods of time and could change by either spreading or receding. Very importantly, this hypothesis could be tested.

A Good Hypothesis

- explains how observed facts relate to each other
- predicts new facts
- lends itself to testing; a hypothesis that cannot be tested is of no value

Step 4: Test the hypothesis

Scientists who proposed that the ocean levels could change would not have had a useful hypothesis if they had not found a way to test it. The test of their hypothesis was as important as the hypothesis itself.

Experimentation is the scientific testing of a hypothesis. It must be done in a careful manner. Scientists must repeat experiments many times before they accept the results. They must also test important factors under different conditions.

An experiment consists of two groups—the **experimental group** (which contains the variable being tested) and the **control group** (without the variable). The factor being tested in the experiment is the **variable factor**. A **controlled experiment** is one in which all the factors are the same except for the one being tested.

Scientists must carefully design their experiments to eliminate the possibility of bias (making their results fit their hypothesis). This is why several scientists will work together or simultaneously on the same experiment to ensure accurate results. The experiment must also be repeated many times achieving the same results in order for conclusions to be made. A single result does not imply any conclusion.

During and after experimentation, scientists must make careful and complete observations. Accurate records of the results must be made in the form of charts, graphs, or tables. Scientists use these charts, graphs, and tables to analyze their data—to look for similarities and differences between the results. These analyses are used to help draw conclusions about their hypothesis.

Scientists developed ways to test their hypothesis that ocean levels change over time. They took precise measurements of the ocean levels.

Step 5: Draw conclusions and report the results

After the experiments are completed, conclusions are drawn. Scientists use the conclusions to reevaluate their hypothesis. They must decide if the conclusions confirm or contradict their hypothesis. An experiment does not always confirm a hypothesis. It may show the hypothesis as being partially or totally wrong. If the hypothesis is wrong, the scientist must go back and study the data and facts. The facts would be interpreted a different way, and the scientist would develop a new hypothesis to be tested. Even if an experiment supports a hypothesis, the experiment may need to be repeated many times before a hypothesis can be confirmed.

Scientists who studied the question of how and where coquina stones formed learned a great deal. After years of measuring, their conclusions stated that oceans could change and the coquina that was found on dry land could have formed in the ocean.

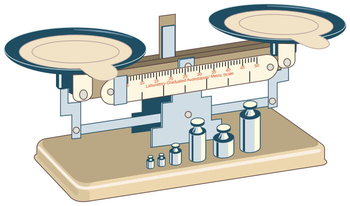
Many scientific discoveries have been made by mistakes or by forming the wrong hypothesis. Penicillin was discovered as a mold that killed all of a researcher's bacteria. Scientists often ask other scientists from different disciplines to review their research and make suggestions for refining their hypothesis or in figuring out why their hypothesis was not supported. Different conclusions may be reached by different teams of scientists working on the same problem. This difference of opinion helps the scientists reach a better understanding of the problem.

When a hypothesis has withstood the test of time, it is called a **theory**. An accepted theory, however, may change as new discoveries in science are made.

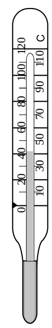
It is important to write down the results of experimentation and make them available for other scientists to use. The results may then be used to continue experimentation—to go on and make more new discoveries.

The Scientific Laboratory

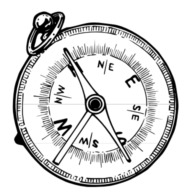
Scientists are required to conduct their experiments in a very careful and precise manner. Exact measurements must be made and recorded. Making these exact measurements requires very specific equipment or scientific **apparatus**. Therefore, scientific laboratories are equipped with special apparatus for measuring and handling materials. Apparatus such as **thermometers**, scales, and **graduated cylinders** are used for measuring. Other apparatus such as **beakers**, **tongs**, **test tubes**, **funnels**, and **eyedroppers** are used for handling materials. Study the pictures of the apparatus below and learn to identify each piece by name and function.



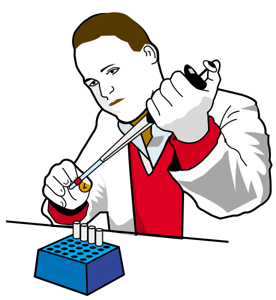
balance



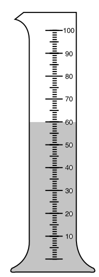
thermometer



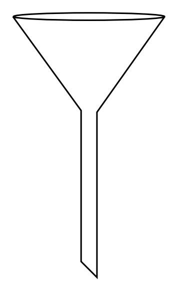
compass



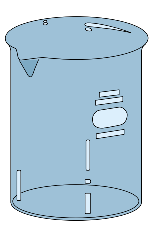
pipet



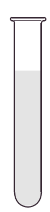
graduated cylinder



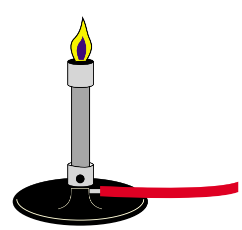
funnel



beaker



test tube

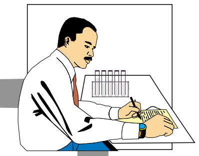


Bunsen burner

Computers and Science

Computers have become very important in scientific studies. Some experiments are performed entirely by the computer. Scientists can develop computer models or simulations to test collected data or a hypothesis. These computer simulations allow scientists to perform complicated mathematical computations more quickly and reliably. Supercomputers can perform billions of calculations per second to help solve complicated problems. Simulations are also used when the experiment may be very dangerous. Computer models help scientists refine their hypothesis and determine the type of information to be collected. Computers have helped speed up the scientific process and allow scientists to simulate past events (like the creation of the universe) or dangerous processes.

Computers also allow scientists to share information and collaborate with others doing similar research. They also allow teams of scientists from different disciplines to review or duplicate research even if they are not on the same continent. The Internet was originally developed by the Department of Defense as a means of sharing and transmitting this research data quickly. Now we use the Internet to research current scientific discoveries, to ask scientists questions about their research, or to collect data for laboratory experiments or simulations. The Internet has helped share current information among the scientific community. It is a great resource for up-to-date information. As with all other resources, however, information from the Internet must be carefully reviewed to determine accuracy and reliability.



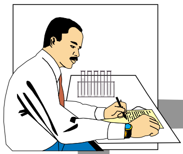
Laboratory Safety Rules

The school science laboratory can and should be a safe place in which to explore interesting and challenging activities. There is, however, one factor that is most important—that is *safety*!

The following rules and procedures should be followed at *all* times in order to make the science laboratory a safe place.

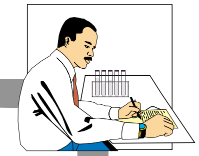
Safety Guidelines

1. Read and follow all directions while working in the laboratory.
2. Wear protective gear, such as aprons, at all times. Wear goggles when working with dangerous or hot chemicals, or any time your teacher instructs you to do so.
3. NEVER taste or directly inhale chemicals. Test the smell of a substance by wafting or fanning some of the odor to your nose with your hand. Your teacher can show you how.
4. DO NOT bring food or drink into the lab.
5. Wash hands thoroughly after each lab.
6. DO NOT rub eyes or put hands in mouth.
7. Dress in a way that helps you work safely and efficiently in the lab. Tie your hair back. Wear cotton—it doesn't catch fire as easily as nylon or polyester. Always keep your shoes on while in the lab. Roll up long or loose sleeves.
8. DO NOT look directly down into the mouth of a filled test tube. DO NOT point the mouth of a filled test tube at another student. Liquid can splash into eyes.
9. DO NOT perform any experiments unless the instructor is in the room.
10. Report ALL minor and major accidents to your instructor. Remain calm and do not alarm others by shouting or running.
11. Know the location of the safety shower, eye wash, and fire blanket. Know how to use these important pieces of safety equipment.
12. Turn off gas burners and the gas outlets when no one is using them. NEVER leave a lit burner unattended.
13. Use tongs or gloves to handle hot objects.
14. DO NOT look directly at the sun, with or without equipment, as it may damage your eyes.
15. Keep lab tables clean and neat to prevent accidents. Wipe all areas at the end of the lab.
16. MAKE SAFETY A HABIT!



Summary

The sharing of scientific information requires that scientists be able to obtain and report their findings in an efficient and consistent manner. When answering questions, scientists use the five steps of the scientific method—(1) identifying the problem, (2) gathering information on the problem, (3) forming a hypothesis, (4) testing the hypothesis (experiment), and (5) drawing conclusions and reporting the results. Scientists must also have very specific equipment or apparatus to make accurate measurements and to handle materials properly. Just as scientists have specific rules and procedures for operating in the laboratory, we too must follow safety rules to make our experiences in the science laboratory safe and rewarding.



Practice

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

__________ 1. An experiment may have only one variable factor.

__________ 2. Experiments always prove the hypothesis to be true.

__________ 3. A good hypothesis can be tested.

__________ 4. A hypothesis attempts to explain the relationship among observed facts.

__________ 5. A fact is an idea that has been proven by experiments.

__________ 6. Careful observation is an important step in scientific study.

__________ 7. Data is usually in the form of numbers.

__________ 8. Logical reasoning has no part in a scientific experiment.

__________ 9. If you get positive results from your experiment the first time, it is okay to stop and report your results.

__________ 10. It is best to keep the results of your experiment a secret so that no one may steal your ideas.

__________ 11. Observation is done solely with the eyes.

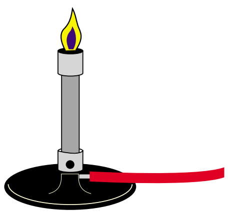
__________ 12. A theory can be disproved if new discoveries are made.

__________ 13. The experiment is the last step of the scientific method.

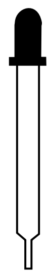
Practice

Use the list below to label the **apparatus**. *Write the term on the line provided.*

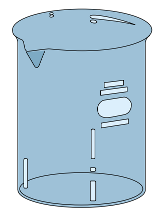
balance	**compass**	**graduated cylinder**
beaker	**eyedropper**	**thermometer**
Bunsen burner	**funnel**	**test tube**



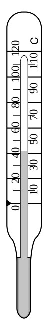
1. ____________________



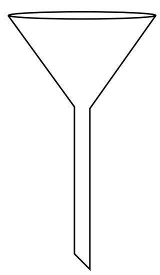
2. ____________________



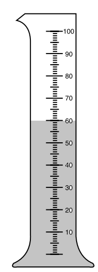
3. ____________________



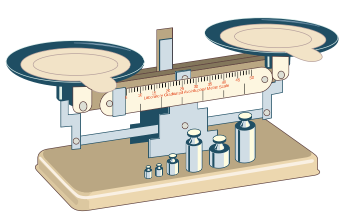
4. ____________________



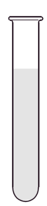
5. ____________________



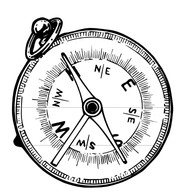
6. ____________________



7. ____________________



8. ____________________



9. ____________________

Practice

Circle the letter of the correct answer.

1. A __________ is an instrument used to measure temperature.
   a. balance
   b. thermometer
   c. compass
   d. funnel

2. A(n) __________ is used to dispense small amounts of liquid.
   a. eyedropper
   b. graduated cylinder
   c. beaker
   d. test tube

3. A(n) __________ is a gas burner used to heat chemicals or apparatus.
   a. beaker
   b. compass
   c. eyedropper
   d. Bunsen burner

4. A __________ is used to pour liquids into containers.
   a. beaker
   b. graduated cylinder
   c. funnel
   d. test tube

5. A __________ is used to determine which direction you are facing.
   a. thermometer
   b. balance
   c. compass
   d. graduated cylinder

6. A ____________ is a multiple-purpose glass container that can be heated.

   a. graduated cylinder
   b. beaker
   c. funnel
   d. test tube

7. A glass jar which is used in scientific experiments is called a(n) ____________ .

   a. beaker
   b. test tube
   c. graduated cylinder
   d. eyedropper

8. A(n) ____________ is used to measure the mass of an object.

   a. thermometer
   b. compass
   c. apparatus
   d. balance

9. A ____________ is used to measure the volume of a liquid.

   a. beaker
   b. funnel
   c. graduated cylinder
   d. test tube

10. Scientific ____________ is used in the science laboratory.

    a. compass
    b. apparatus
    c. funnel
    d. eyedropper

Practice

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

_________ 1. If there is something you do not understand about the lab assignment, you should ask your teacher.

_________ 2. It is only necessary for the teacher to know where the safety equipment is and how to use it.

_________ 3. It is a good idea to bring a lunch along and to eat while working on lab activities.

_________ 4. Use tongs or gloves to handle hot equipment.

_________ 5. It is important to use good housekeeping habits in the laboratory.

_________ 6. Report all accidents to the teacher—no matter how minor.

_________ 7. Do not wear loose or baggy clothes in the lab.

_________ 8. Safety glasses must be worn when working with dangerous or hot chemicals.

_________ 9. It is important to put your nose directly over a container and breathe deeply to smell a substance in the laboratory.

_________ 10. Open test tubes should never be pointed at yourself or at others.

Practice

Find all the **hazards** *in the science lab pictured below. List them on the lines below. Be prepared to discuss them in class.*

Practice

List the locations and uses of the **safety equipment** *below.*

Equipment	Location	Use
safety shower		
eye wash		
fire extinguisher		
fire blanket		
sand		
goggles		
lap aprons		
container—broken glass		

Practice

Use the list below to write the correct term for each definition on the line provided.

Bunsen burner	**eyedropper**	**observation**
conclusion	**graduated cylinder**	**thermometer**
control group	**hypothesis**	**variable factor**
experiment		

________________________ 1. the factor being tested in an experiment

________________________ 2. an instrument used to measure temperature

________________________ 3. the part of the experiment without a variable factor

________________________ 4. an idea or statement that attempts to explain the relationship of observed factors; an educated guess

________________________ 5. used to dispense small amounts of liquid

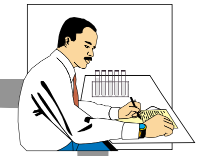
________________________ 6. a way to test a hypothesis or try out an answer to a question

________________________ 7. to notice something using one's senses (sight, smell, touch, hearing, or taste)

________________________ 8. used to measure the volume of a liquid

________________________ 9. an explanation of a problem based on observations and collected data

________________________ 10. a gas burner used to heat chemicals or apparatus



Practice

Use the list below to write the correct term for each definition on the line provided.

apparatus	**data**	**scientific method**
balance	**experimental group**	**test tube**
beaker	**fact**	**theory**
controlled experiment		

________________________ 1. an idea that has been proven by experiments

________________________ 2. scientific facts that are collected, usually in the form of numbers

________________________ 3. a hypothesis that has withstood the test of time

________________________ 4. a multiple-purpose glass container that can be heated

________________________ 5. the steps scientists use to solve problems

________________________ 6. an experiment in which all the factors are the same except for the one being tested

________________________ 7. part of the experiment that contains the variable factor

________________________ 8. the equipment or tools needed for a specific task, as in biology or chemistry

________________________ 9. a glass container which is used in scientific experiments

________________________ 10. an instrument used to measure the mass of an object

Practice

Circle the letter next to the **scientific method** *term that correctly completes each statement below.*

1. The factor being tested in an experiment is the ____________ .
   a. variable
   b. hypothesis
   c. observation
   d. control

2. The part of the experiment without a variable factor is the ____________ .
   a. observation
   b. control group
   c. experiment
   d. hypothesis

3. An idea or statement that attempts to explain the relationship of observed factors to each other is a(n) ____________ .
   a. hypothesis
   b. observation
   c. fact
   d. conclusion

4. A way to test a hypothesis or try out an answer to a question is a(n) ____________ .
   a. fact
   b. experiment
   c. observation
   d. data

5. To notice something using one's sight, smell, touch, hearing, or taste is a(n) ____________ .
   a. observation
   b. act
   c. theory
   d. data

6. An explanation of a problem based on observations and collected data is a __________ .

   a. fact
   b. theory
   c. data
   d. conclusion

7. An idea that has been proven by experiments is a __________ .

   a. fact
   b. theory
   c. controlled experiment
   d. data

8. Scientific facts that are collected, usually in the form of numbers, are called __________ .

   a. data
   b. scientific method
   c. controlled experiment
   d. theory

9. A hypothesis that has withstood the test of time is a(n) __________ .

   a. theory
   b. controlled experiment
   c. scientific method
   d. observation

10. The steps scientists use to solve problems are known as the __________ .

    a. theory
    b. controlled experiment
    c. scientific method
    d. data

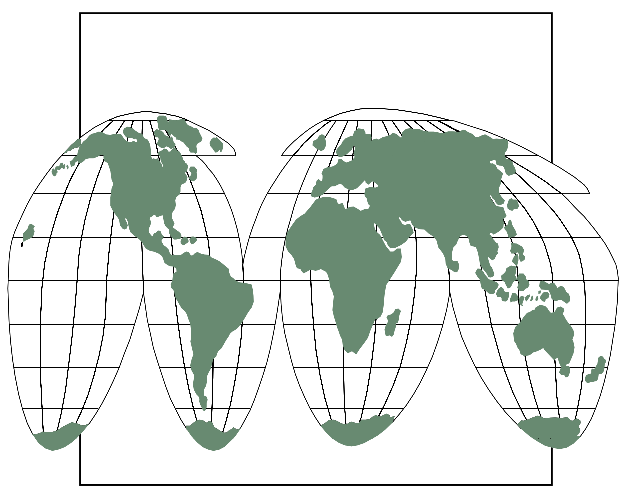
11. An experiment in which all the factors are the same except for the one being tested is a(n) ____________ .

    a. experimental group
    b. controlled experiment
    c. theory
    d. scientific method

12. The part of the experiment that contains the variable factor is the ____________ .

    a. controlled experiment
    b. scientific method
    c. theory
    d. experimental group

Unit 2: Map Reading



Vocabulary

Study the vocabulary words and definitions below.

contour interval .... the difference in elevation between two contour lines

contour lines .... lines that pass through points on a map with the same elevation

elevation .... the height above sea level

equal-area projection map .... a map that shows areas that are positioned correctly but whose shapes are distorted

equator .... imaginary line halfway between the poles; it divides north and south latitude and represents 0° (zero degree) latitude

globe .... a spherical or round model of Earth

International Date Line .... the imaginary line at 180° longitude where east and west longitude meet; at this point, one date changes to the next

isobars .... lines on a weather map that represent areas of equal barometric pressure

isotherms. .... lines on a weather map that represent areas of equal temperature

latitude .... measure of a distance north and south from the equator

legend .... explanation of the symbols used on a map

longitude .... measure of a distance east or west from the prime meridian

map .... a drawing or model of the surface of Earth showing lines of longitude and latitude and positions of physical features of the land

map projection .... a flat drawing of Earth

Mercator projection map .... a map on which both lines of longitude and latitude are parallel; it is good for navigation but gives a distorted view of the polar areas

meridians .... lines on a map that run from the north pole to the south pole that measure longitude

meteorologist .... scientist who studies and predicts the weather

parallels .... lines on a map that circle the globe in an east-west direction; these lines are used to measure latitude

polar projection .... a map that gives an accurate view of the polar regions but a distorted view of the areas near the equator

prime meridian .... an imaginary line that runs through Greenwich, England, that divides east and west longitude; it represents 0° longitude

relief .... the difference in elevation between the high and low points of a land surface

scale .... the comparison of the distance on the map to the actual distance on Earth's surface

time zones .... the 24 longitudinal divisions of Earth that represent the 24 hours of the day; each is 15° of longitude

topographic map .... a flat map of Earth that shows the surface features of the land

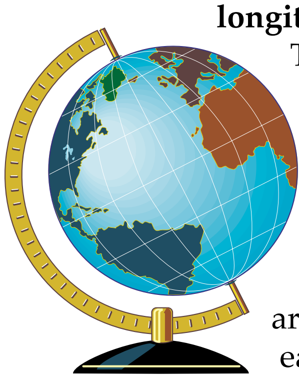
Introduction

Maps have been in existence for a very long time—for as long as human beings have wanted to go somewhere. There is evidence that prehistoric people drew maps on the walls of their caves to locate good hunting grounds or other shelters. Maps are used every day. They are now even computerized for use in large transportation systems. Eventually, this computerization will create maps for use in our cars.

Learning how to read maps, what symbols are used, and how to draw a map are important life skills. The use of three basic types of maps—road maps, **topographic map**s, and weather maps—is essential in the study of Earth/space science.

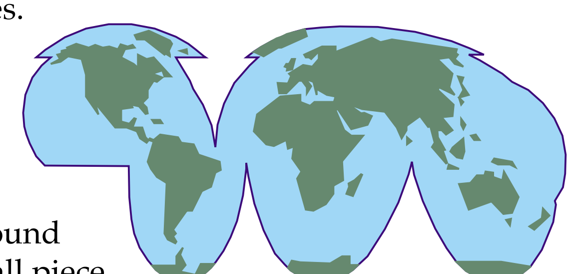
Maps

A map is a drawing or model of Earth's surface which shows lines of **longitude** and **latitude**, and positions of physical features. There are different types of maps which show different features of Earth.

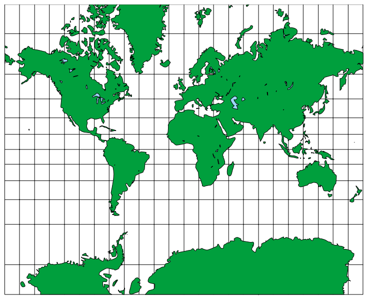


A **globe** is a spherical model of Earth. Because its shape is similar to the shape of Earth, it is very accurate. Places on a globe closely correspond to the actual places where they are located on Earth. Globes are not as convenient as maps because they are not easily carried or stored.

A **map projection** is a drawing of Earth's curved surface on a flat piece of paper. A map is much more practical than a globe because it can be put in textbooks; hung on walls; and projected on television, radar screens, and computer screens. However, a map projection also has disadvantages. When a round surface is projected on a flat surface, the shape and size of land masses and oceans are distorted.



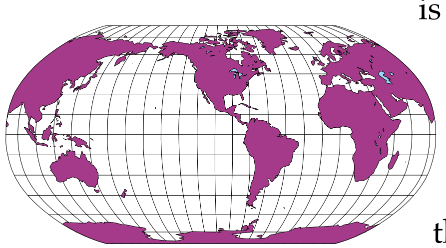
To show how a map distorts a round surface, flatten a large and a small piece of an orange skin. The larger the piece, the more it must be torn to become flat. This is true with the earth's surface also—the larger the area being shown on the map, the greater the distortion will be of that area.



On a **Mercator projection map** both the lines of latitude and longitude are straight and parallel. To understand how a Mercator projection is made, wrap a piece of paper around the **equator** of a globe and form a cylinder. Imagine the surface of the globe transferred to the paper. This gives us a map that is fairly accurate near the equator, but the land masses and oceans near the poles are greatly distorted and appear to be much larger than they really are in that area.

A **polar projection** is formed by placing a flat piece of paper on either of the poles of a globe. The longitude lines point outward like spokes of a wheel, and the latitude lines form a series of circles that get larger as they move away from the poles. This type of map provides a good picture of the polar areas, but the areas along the equator are distorted.

Another type of projection can be found on an **equal-area projection map**. It shows areas positioned correctly, but shapes may be distorted. This map is circular, with the lines of longitude meeting at the poles and the lines of latitude being equal distances apart and curving slightly.

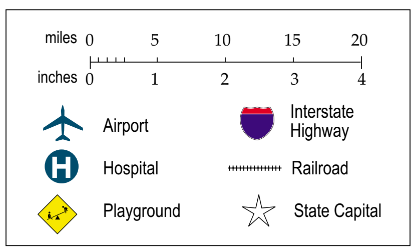


Some map projections are more accurate than others. Mercator projections produce maps that are distorted near the poles. Longitude lines are spread apart on the map to make them parallel. Polar maps, however, give an accurate view of the polar regions. Equal-area maps are useful because the land masses are located at the proper longitude and latitude.

Maps are used for different reasons. Some maps are used to show the following:

- amount of yearly rainfall
- political boundaries of cities, states, and countries
- climatic regions
- barometric pressure
- population
- vegetation of an area
- soil types
- topographic features
- elevation
- weather

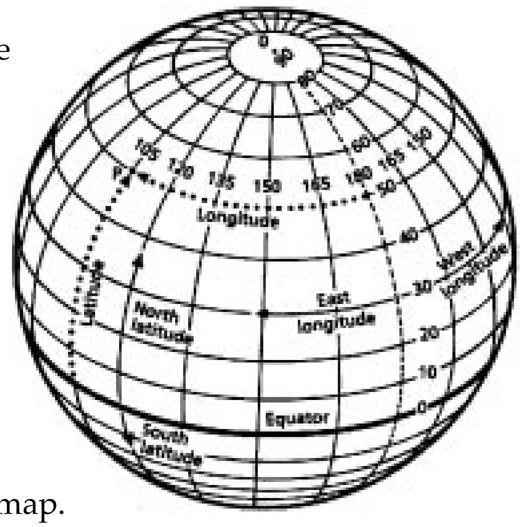
Every map has a **legend** that explains the symbols used on the map. It is usually located in a box in a lower corner of the map. The legend also shows the **scale** of the map. The scale of the map compares the distance on the map to the actual distance on Earth's surface.



Longitude and Latitude

Maps and globes have lines drawn on them in two directions. Lines that run from the north pole to the south pole are called **meridians**. The **prime meridian** is the imaginary line that runs through Greenwich, England. The measure of distance east and west of the prime meridian is called *longitude.* Lines of longitude that are west of Greenwich are called *west longitude*, and those east of Greenwich are called *east longitude*.

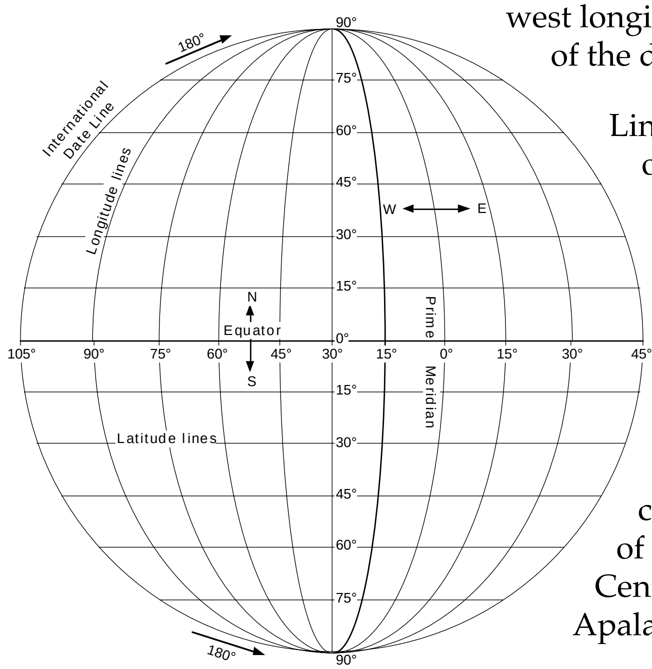
Lines that circle the globe in an east-west direction are called **parallels**. The longest of these is the equator, which is located halfway between the poles. On both sides of the equator, parallel circles (circles that are an equal distance apart) are drawn. These parallels, or circles, get smaller as they near the poles. Parallels measure the distance north and south of the equator, which is called *latitude*.



The equator is labeled 0° latitude. Since the distance from the equator to the poles is one-fourth of the distance around Earth, both poles are labeled 90° latitude. Parallels of latitude that are north of the equator are called *north latitudes*, and those south of the equator are called *south latitudes*.

Latitude and longitude are used to locate places on a map. The parallels and meridians intersect each other to form a grid or network of lines on the map. Any place on the surface of Earth can be located by giving the coordinates of the lines of latitude and longitude that cross at that point. Since distances in a circle are measured in degrees, longitude and latitude are also measured in degrees.

The prime meridian is labeled 0° longitude. Half the distance of a circle is 180°; therefore, the meridian that is halfway around the globe from the prime meridian is labeled 180° longitude. This is called the **International Date Line**. This is the place where one date changes to the next. Here longitude changes from west to east or east to west depending on the direction of travel. The International Date Line also works much like the prime meridian but in reverse. Longitudes to the east of the date line are west longitude. Longitudes to the west of the date line are east longitude.



Lines of longitude and the time of day are closely related. Just as the day is divided into 24 hours, lines of longitude that are 15° apart form 24 divisions of Earth. These divisions are called **time zones**, and there is one for each hour of the day. Four of these time zones divide the contiguous United States. Two of these in Florida—Eastern and Central—are separated by the Apalachicola River.

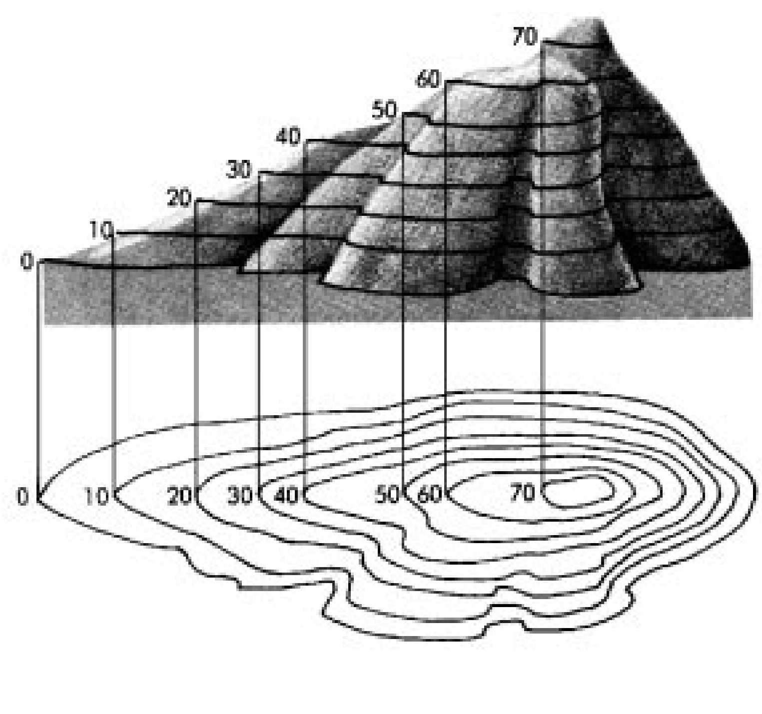
Topographic Maps

A *topographic map* is a line-and-symbol representation of natural and selected man-made features of a part of Earth's surface. These features are plotted to scale. Topographic maps show landscape features such as hills, mountains, plains, lakes, and rivers. They also show some features placed on Earth by people such as railroads, cities, dams, and roads.

Topographic maps show the shape and **elevation**, or height of surface features above sea level, of the land. In order to represent elevation on a flat map, **contour lines** are used. Contour lines are drawn to join points of equal elevation. These lines are then numbered to represent the number of feet above or below sea level of the land at that point. The difference in elevation between two contour lines is called the **contour interval**.

Topographic maps have many uses as basic tools for planning recreational sites, airports, highways, and construction of all types.

The difference in elevation between the high and low points of the land's surface is called the **relief** of the map. A map with high relief represents a lot of variation in elevation and usually indicates a very hilly or mountainous area. On the other hand, an area with low relief may be found along the coast or in the plains, where the land is generally flat.

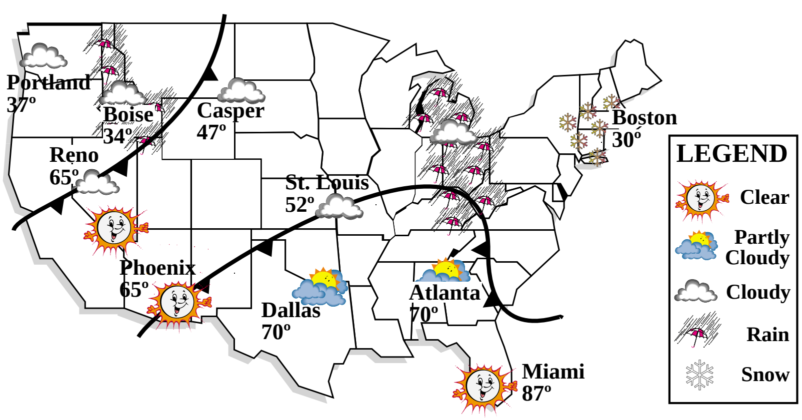


When using contour lines, the following rules apply:

- Contour lines close to form irregular ovals or circles around hills, lakes, or basins.
- Each line represents the same height above sea level all along its course.
- When contour lines cross a stream, they form a V that points upstream.
- Contour lines do not stop in the middle of the map; they either close or go to the edge of the map.
- Contour lines do not cross other contour lines that represent a different elevation.

Weather Maps

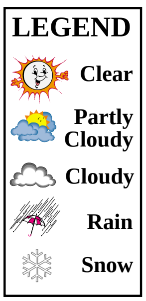
Meteorologists are scientists who study and predict the weather. They gather information about the weather from many sources, such as weather satellites, barometers, and thermometers and from observations of weather currently happening in different parts of the country. Meteorologists take this information and put it on a map, using various symbols.



Weather maps show different kinds of weather information. Places with the same barometric pressure are connected by lines called **isobars**. They show the size and position of high- and low-pressure systems. Lines that connect points of equal temperature are called **isotherms**. Weather maps may also show the direction and speed of the wind and types of precipitation, such as rain, drizzle, and snow.

Weather satellites send us pictures that show cloud covers and movement. They can also help meteorologists predict where pressure systems are moving, as well as the movement of tropical storms and hurricanes.

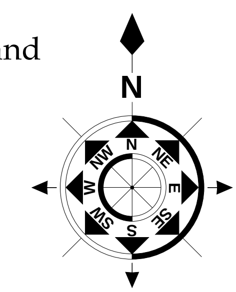
From the information gathered and represented on weather maps, meteorologists can then predict the weather for the next few days. Weather predictions are usually about 75 percent to 85 percent accurate. Due to rapidly changing conditions, it is impossible to be correct 100 percent of the time.



As with other types of maps, weather maps also have a legend which tells what the symbols on the map represent. The symbols used by the National Weather Service are standard—always the same. This makes it easier to track and predict weather conditions. For example, hurricanes are tracked by plotting the latitude and longitude of the storm. This is done every few hours. Despite this, it is still difficult to predict the course of hurricanes, since they often change directions suddenly. When tracking weather on television or in the newspaper, though, you should check the map legend because smaller, independent sources may use different symbols from those of the National Weather Service.

Summary

Different types of maps show different features of Earth and have different uses. Each type has advantages and disadvantages. Legends and scales help us interpret maps. Parallels and meridians are imaginary lines that measure distances in degrees of latitude and longitude. Special maps, such as topographic and weather maps, give special types of information.



Practice

Use a **Florida map** *to answer the following using short answers.*

1. Find the scale on the map. How many miles does one inch represent?

2. Find the legend on the map. Draw three of the symbols used on the lines below. Identify what each represents.

Symbol	**Represents**
______________________	______________________
______________________	______________________
______________________	______________________

3. Find the distance in miles between the following cities.

Cities	Distance
1. Fort Lauderdale—Miami	
2. Miami—West Palm Beach	
3. Fort Lauderdale—Orlando	
4. Daytona—Jacksonville	
5. Jacksonville—Miami	
6. Fort Myers—Fort Lauderdale	
7. Tampa—Sarasota	
8. Miami—Key West	
9. Gainesville—Ocala	
10. Tallahassee—Jacksonville	

4. In what counties are the Everglades? ____________________________

____

5. Name the large lake near the Everglades. ________________________

____

6. What swamp is near Jacksonville? ______________________________

7. Name three rivers near the city in which you live. _______________

____

8. Name two islands that are part of Florida. _______________________

____

9. What is the capital of Florida? __________________________________

10. Name two cities in Florida that each of these major highways connect.

I–10 __________________________ and ___________________________

I–75 __________________________ and ___________________________

A1A __________________________ and ___________________________

Practice

Use a **city map** *to locate the following information. Write the name of the* **street** *or* **highway** *and the* **map coordinates** *in the spaces below.*

Find	Street Name	Grid #
a major highway or interstate that goes through a city		
a street that runs east and west		
an avenue that runs north and south		
a boulevard		
city hall		
courthouse		
post office		
library		
a police station		
a hospital		
a bus depot		
your favorite restaurant		
a hotel		
a tourist attraction		
a park		
a school		

Practice

Answer the following using short answers.

1. What is a map? ____

   ____

2. What is a globe? ____

   ____

3. Why is a globe a more accurate representation of Earth than a map?

   ____

   ____

4. What is a map projection? ____________________________________

   ____

   ____

5. Name three ways map projections can be used that globes cannot be used.

   ____

   ____

   ____

6. What is the main disadvantage of a map projection? ____________

   ____

   ____

Practice

Match each phrase to the correct type of **map projection** *that it describes. Write the letter on the line provided. The letters will be used more than once.*

______ 1. areas positioned correctly, shapes distorted

______ 2. made by wrapping paper around equator in cylinder

______ 3. made by placing flat piece of paper on poles

______ 4. both lines of latitude and longitude are parallel

______ 5. longitude lines point out like spokes on a wheel

______ 6. accurate near the equator, distorted at poles

______ 7. accurate near poles, distorted near equator

______ 8. lines of longitude meet at both poles

______ 9. good for navigation purposes

______ 10. good for showing exact location of land masses

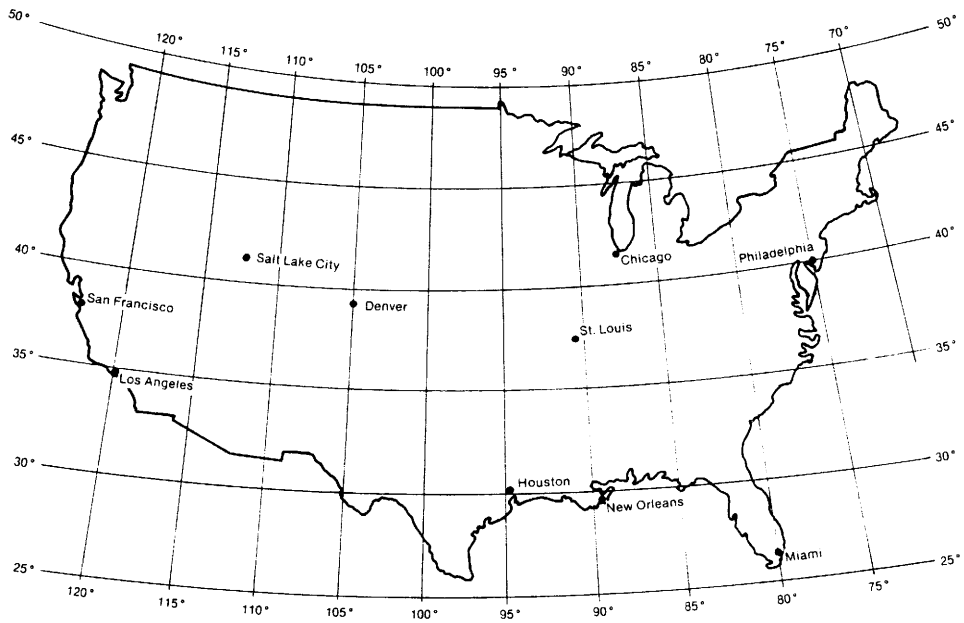
A. Mercator projection

B. polar projection

C. equal-area projection

Practice

Use the **United States map** *below to complete the chart. Give the* **latitude** *or* **longitude lines** *of each city. If the city falls between latitude or longitude lines,* **estimate** *the correct position. There are 5° between the lines. For example, San Francisco is about halfway between 35° and 40° latitude; its latitude would be 38° and its longitude 122°.*



City	Latitude	Longitude
1. San Francisco	38° N	122° W
2. Los Angeles		
3. Salt Lake City		
4. Denver		
5. Chicago		
6. St. Louis		
7. Houston		
8. New Orleans		
9. Philadelphia		
10. Miami		

Practice

Label the **world map** *on the next page with the following terms. Then answer the questions below.*

Africa	**Australia**	**International Date Line**
Antarctica	**equator**	**North America**
Arctic Ocean	**Europe**	**Pacific Ocean**
Asia	**Greenland**	**prime meridian**
Atlantic Ocean	**Gulf of Mexico**	**South America**

1. What continent lies between 20° and 60° north latitude and between 160° and 50° west longitude?

    ____

2. What continent lies between the equator and 40° south latitude and between 110° and 160° east longitude?

    ____

3. What continent lies between 20° north latitude and 60° south latitude and between 90° and 30° west longitude?

    ____

4. What continent lies between 40° south latitude and 40° north latitude and between 20° west longitude and 50° east longitude?

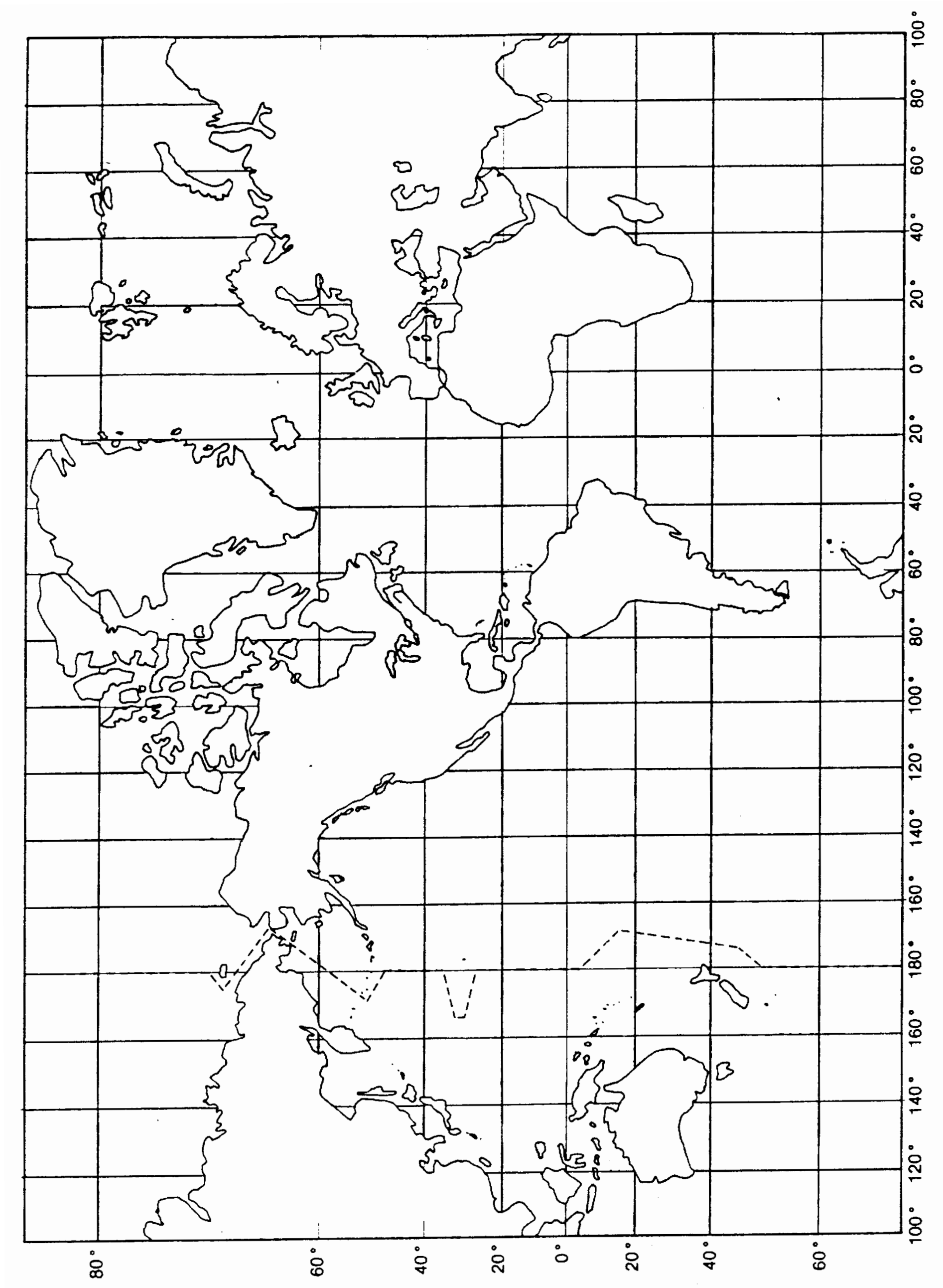
    ____

5. What continent lies between 30° and 70° north latitude and between 20° west longitude and 40° east longitude?

    ____

Practice

Use the **world map** *below to complete the practice on the previous page.*



Practice

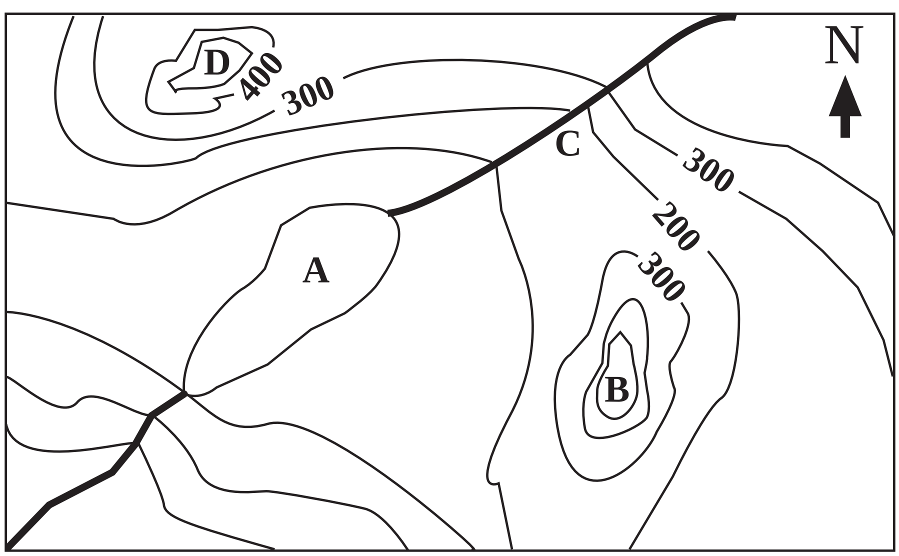
Match each definition with the correct term. Write the letter on the line provided.

______	1.	lines that run from the north pole to the south pole	A.	0° latitude
______	2.	the imaginary line that runs through Greenwich, England	B.	0° longitude
______	3.	lines that circle the globe in an east-west direction	C.	90° latitude
______	4.	the parallel that is located halfway between the two poles	D.	180° longitude
______	5.	the measure of a distance north and south of the equator	E.	degrees
______	6.	the measure of a distance east and west of the prime meridian	F.	equator
______	7.	longitude is measured in this unit	G.	International Date Line
______	8.	the meridian that is halfway around Earth from the prime meridian	H.	latitude
______	9.	the 24 longitudinal divisions of Earth that are 15° wide and that correspond to the 24 hours of the day	I.	longitude
______	10.	latitude of the equator	J.	meridians
______	11.	latitude of the poles	K.	parallels
______	12.	longitude of Greenwich, England	L.	prime meridian
______	13.	longitude of the International Date Line	M.	time zones

Practice

Use the **contour map** *below to answer the following questions.*

1. What type of landform is A? ______________________
2. What type of landform is C? ______________________
3. In which direction is C flowing? ______________________
4. What type of landform is B and D? ______________________
5. What is the elevation of B? ______________________
6. What is the elevation of D? ______________________
7. What is the contour interval of this map? ______________________
8. What is the length of the lake in this map? (Hint: use a ruler and the scale of the map.) ______________________

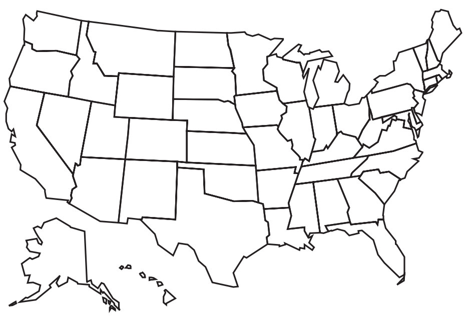


Scale: 1 cm = 100 meters

Practice

Bring in the **weather map** *from the local newspaper or the Internet. Draw the* **weather conditions** *on the maps below for four consecutive days. Try to* **predict** *what the weather map will look like for the next day based on your other maps. Make a* **legend** *at the bottom of the page for the weather maps.*

Date:



Date:

Date:

Date:

Date:

Legend

Practice

Answer the following using short answers.

1. What is a topographic map? ______________________________

____

2. What are four landscape features that topographic maps show?

____

____

3. What four features placed on Earth by people do topographic maps show?

____

____

4. What term describes the height of features above or below sea level?

____

5. How is elevation shown on a flat map? ______________________

6. What is a contour interval? ______________________________

____

7. On a map, what is relief? ________________________________

8. What landscape features are found on a map with high relief? _____

____

9. What type of land is represented on a map with low relief? _______

____

Practice

Use the list below to write the correct term for each definition on the line provided.

elevation	**legend**	**polar projection**
equator	**map**	**relief**
International Date Line	**Mercator projection map**	**time zone**
isobars	**meteorologist**	

_____________________________ 1. the 24 longitudinal divisions of Earth that represent the 24 hours of the day; each is 15° of longitude

_____________________________ 2. the difference in elevation between the high and low points of a land surface

_____________________________ 3. a drawing or model of the surface of Earth showing lines of longitude and latitude and positions of physical features of the land

_____________________________ 4. explanation of map symbols

_____________________________ 5. lines on a weather map that represent areas of equal barometric pressure

_____________________________ 6. a map that gives an accurate view of the polar regions but a distorted view of the areas near the equator

_____________________________ 7. scientist who predicts the weather

_____________________________ 8. a map on which both lines of longitude and latitude are parallel

_____________________________ 9. the imaginary line at 180° longitude where east and west longitude meet

____________________________ 10. imaginary line halfway between the poles that represents 0° latitude

____________________________ 11. the height above sea level

Practice

Use the list below to write the correct term for each definition on the line provided.

contour interval	**isotherms**	**parallels**
contour lines	**longitude**	**prime meridian**
equal-area projection map	**map projection**	**topographical map**
globe	**meridians**	

______________________________ 1. a flat drawing of Earth

______________________________ 2. the difference in elevation between two contour lines

______________________________ 3. lines on a map that run from the north pole to the south pole that measure longitude

______________________________ 4. lines that pass through points on a map with the same elevation

______________________________ 5. east-west lines on a map that circle the globe and measure latitude

______________________________ 6. a map that shows areas that are positioned correctly but whose shapes are distorted

______________________________ 7. an imaginary line that runs through Greenwich, England, that divides east and west longitude

______________________________ 8. a spherical model of Earth

______________________________ 9. a flat map of Earth that shows the surface features of the land

______________________________ 10. lines on a weather map that represent areas of equal temperature

______________________________ 11. measure of a distance east or west from the prime meridian

Practice

Circle the letter of the correct answer.

1. ____________ are lines that pass through points on a map with the same elevation.

   a. Contour lines
   b. Isobars
   c. Scales
   d. Equators

2. The ____________ is an imaginary line that is halfway between the poles; it divides north and south latitude and represents 0° latitude.

   a. International Date Line
   b. globe
   c. equator
   d. isotherm

3. ____________ are lines on a weather map that represent areas of equal temperature.

   a. Latitude
   b. Isotherms
   c. Isobars
   d. Longitude

4. A ____________ is an explanation of the symbols used on a map.

   a. legend
   b. map
   c. Mercator projection map
   d. map projection

5. A ____________ is a map on which both lines of longitude and latitude are parallel; it is good for navigation but gives a distorted view of the polar areas.

   a. meteorologist
   b. meridian
   c. Mercator projection map
   d. polar projection

6. ____________ are lines on a map that circle the globe in an east-west direction; these lines are used to measure latitude.

   a. Scales
   b. Elevation
   c. Polar projections
   d. Parallels

7. ____________ is the difference in elevation between the high and low points of a land surface.

   a. Time zone
   b. Prime meridian
   c. Scale
   d. Relief

8. A ____________ is a flat map of Earth that shows the surface features of the land.

   a. topographic map
   b. time zone
   c. relief
   d. scale

9. ____________ is the difference in elevation between two contour lines.

   a. Equator
   b. Equal-area projection map
   c. Polar projection
   d. Contour interval

10. A(n) ____________ is a spherical model of Earth.

   a. International Date Line
   b. equator
   c. legend
   d. globe

11. The ____________ is an imaginary line at 180° longitude where east and west longitude meet; at this point, one date changes to the next.

   a. legend
   b. latitude
   c. equator
   d. International Date Line

12. A ____________ is a drawing or model of the surface of Earth showing lines of longitude and latitude and positions of physical features of the land.

   a. meteorologist
   b. meridian
   c. map projection
   d. map

13. A flat drawing of Earth is a ____________ .

   a. parallel
   b. meteorologist
   c. Mercator projection map
   d. map projection

14. A ____________ is a map that gives an accurate view of the polar regions but a distorted view of the areas near the equator.

   a. scale
   b. polar projection
   c. relief
   d. prime meridian

15. The ____________ is an imaginary line that runs through Greenwich, England, that divides east and west longitude; it represents 0° longitude.

   a. prime meridian
   b. scale
   c. equator
   d. time zone

16. The 24 longitudinal divisions of Earth represent the 24 hours of the day; each is 15° and is called a ____________ .

    a. prime meridian
    b. scale
    c. topographic map
    d. time zone

17. A(n) ____________ is a map that shows areas that are positioned correctly but whose shapes are distorted.

    a. equator
    b. International Date Line
    c. globe
    d. equal-area projection map

18. The height above sea level is called ____________ .

    a. elevation
    b. equator
    c. International Date Line
    d. globe

19. ____________ is a measure of the distance north and south from the equator.

    a. Map projection
    b. Map
    c. Legend
    d. Latitude

20. ____________ are lines on a weather map that represent areas of equal barometric pressure.

    a. Isobars
    b. Longitudes
    c. Latitudes
    d. Isotherms

21. ____________ is the measure of a distance east or west from the prime meridian.

a. Latitude
b. Mercator projection map
c. Map
d. Longitude

22. Scientists who study and predict the weather are called ___________ .

a. astronauts
b. geologists
c. meteorologists
d. biologists

23. ____________ are lines on a map that run from the north pole to the south pole that measure longitude.

a. Polar projections
b. Meridians
c. Parallels
d. Meteorologists

24. A ____________ is the comparison of the distance on the map to the actual distance on Earth's surface.

a. topographic map
b. time zone
c. relief
d. scale

Unit 3: The Universe and Solar System

Vocabulary

Study the vocabulary words and definitions below.

asteroids .... fragments of rock and metal that orbit the sun; many are in a belt between Mars and Jupiter

comet .... a mass of dust and ice with a bright gaseous tail that orbits the sun

constellation .... a small number of stars that appears to form a shape or image

elliptical galaxies .... galaxies that have a very bright center that contain very little dust and gas and are spherical to disklike in shape

galaxy .... millions or billions of stars in a system

meteors .... fragments of rocky material from space that burn as they fall through Earth's atmosphere; also known as meteoroids

nebula .... a cloud of interstellar gas and dust (*pl.* nebulae)

orbit .... (noun) the path of an object revolving around another object; (verb) to revolve in a path around another object

planets .... bodies that revolve around a sun and reflect its light

satellite .... an object that revolves around a larger object

solar system .... the sun and all the planets, their moons, asteroids, meteors, and comets; all objects that move around the sun

spiral galaxies .... disk-shaped galaxies that have a center of bright stars and flattened arms that swirl around the center, and look like a pinwheel; the solar system is part of a spiral galaxy

stars .... hot, bright bodies of gas constantly exploding in space

stellar equilibrium....................... the balance between forces in a star including nuclear fusion, gravity, and the explosive force of the star

theory .... a hypothesis that has withstood the test of time

universe .... all bodies in space and all space between these bodies—all matter and all energy

Introduction

As early humans began to study the sky, they believed Earth to be the center of the **universe**. Their observations were based solely upon the motion of the sun, moon, **planets**, and **stars** that their eyes could see—not an actual, scaled model. In time, the astronomers were able to develop more realistic models of our **solar system** with the sun as the center of the universe. Today, we know that even this model has changed. With new technologies, today's scientists are able to learn even more about space, enabling us to understand our world and even worlds beyond our own.

Origin of the Universe

Scientists have offered many **theories**, or educated guesses, on how the universe began. The theory that most scientists accept today is called the *Big Bang* theory.

According to this theory, all of the matter and energy found in the universe was once packed together in a single body. Between 15 and 20 billion years ago there was a huge explosion, and matter and energy spread outward in all directions. As the material cooled, gas formed and collected into expanding clouds. As the clouds moved away from the center of the explosion, they cooled and condensed to form galaxies. These galaxies continued to move away from each other and are still moving today. Within these galaxies today, stars form and die while the entire universe continues to expand.

Origin of the Solar System

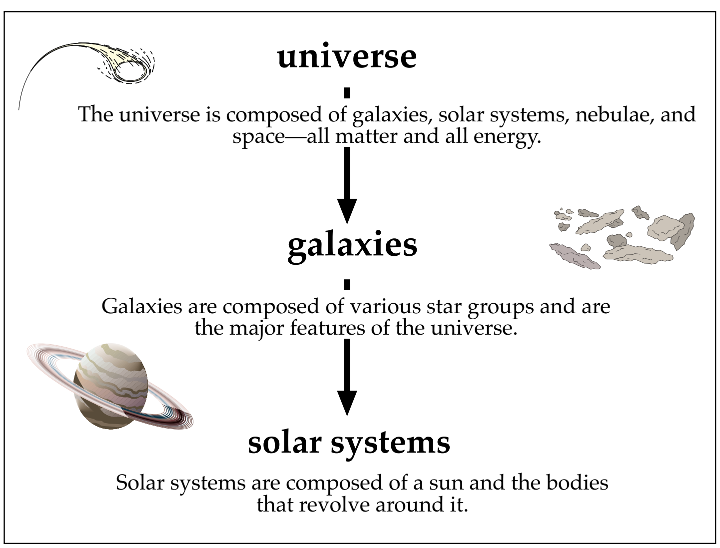
There are also many theories of how the solar system began. The force of gravity once pulled the solar system together. Scientists think that about five million years ago, gravity pulled together a large cloud of dust and gas. According to the *Dust Cloud* theory, also known as the nebular theory, a slowly rotating cloud of dust and gas—a **nebula**—formed in one of the spiral arms of our **galaxy**, the Milky Way. As the cloud shrank, its center became so dense and hot that a star, the sun, was formed. Smaller fragments of remaining material began to **orbit** the sun. In time, gravity pulled these small bits of gas and dust together. These small bits then combined to make a few larger masses. These masses formed the planets and their **satellites**. When the sun began to shine, the remaining gas and dust were driven back into space, and only the material that had condensed into solid bodies remained.

Another theory suggests that a star larger than the sun came very close to the sun. The closeness of the larger star caused explosions on the sun. The gases from these explosions condensed into particles which formed the planets.

The Universe

The *universe* is a system that contains many smaller parts. Galaxies, solar systems, nebulae, and space—all matter and energy—are the components that make up the universe.

Galaxies like our Milky Way are composed of various star groups and are the major features of the universe. Within galaxies, there are many different types of stars. Some of these stars are orbited by *satellites*. These star groups are called *solar systems*. Our sun is an example of a star with orbiting satellites. Only about one percent of all matter in the universe is found in galaxies.

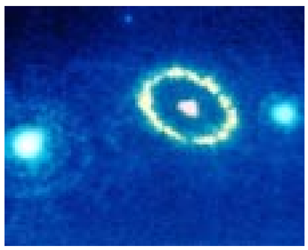


The other 99 percent of matter in the universe is in *space*. Some matter is composed of nebulae, or dust and gas clouds, that are difficult to see without special instruments. The rest is called *dark matter* because we cannot see or detect it.

Measuring Distances in the Solar System

Distances within the solar system are commonly given in AUs. AU stands for Astronomical Unit, the average distance between the sun and Earth. One AU equals 93 million miles or 150 million kilometers. The planet Mercury is .3 AUs from the sun and Earth is one AU from the sun.

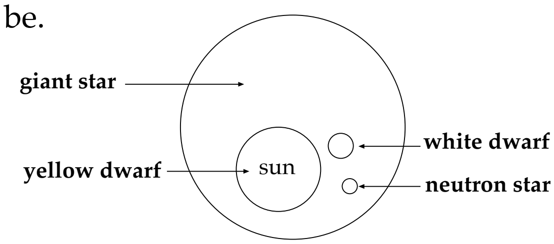
The Stars, Planets, and Heavenly Bodies



In the universe, there are many groups of billions of stars called galaxies. Galaxies are classified according to their shape. One kind of galaxy is a **spiral galaxy**. It is disk-shaped and looks like a pinwheel with large arms that unwind from the center. Earth's galaxy, the Milky Way, is a spiral galaxy. Another common galaxy is an **elliptical galaxy**, which looks spherical to flattened or disklike in shape. They have no arms and very little dust and gas.

Stars

Stars differ in size, brightness, and temperature. Our sun is average in size for a star. Stars come in a variety of sizes and colors. They range from blue to red, from less than half the size of our sun to over 20 times the sun's size. The size and temperature of a star depends on how much gas and dust collects as the star forms. The color of the star depends on the surface temperature of the star. The more mass a star starts out with, the brighter and hotter it will be.



Sizes of Stars

Earth's sun is a medium-sized star and is called a *yellow dwarf*. There are many explosions on the surface of the star as the star uses its nuclear fuel. This nuclear activity, fusion, produces all the star's light and heat.

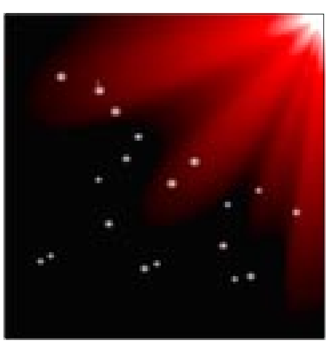
Fusion is the joining of atoms to form new atoms. In a young star, such as our sun, four atoms of hydrogen join to form one atom of helium. This process releases the heat and light of the sun. As stars age, they use all their hydrogen. At this point, their fuel becomes the helium they produced earlier.

Medium-sized stars (such as our sun) use their fuel (helium) until they reach the red giant phase. In red giants, the outer layers expand, the core contracts, and helium atoms in the core fuse to form carbon. Once the carbon core is stabilized, the end is near. The star will shed its outer layers as a gaseous cloud called a planetary nebula. The star continues cooling and shrinking until it has become a white dwarf. The star then radiates its remaining heat into the coldness of space. In the end, it will be a cold dark mass sometimes referred to as a black dwarf. Our sun is expected to produce life-sustaining levels of light energy for about another five billion years.

Stars that are five or more times as massive as our sun follow a slightly different path. When they use up their hydrogen, they eventually grow into a red supergiant (i.e., a very big red giant) and begin to shrink, growing hotter and denser. When the core becomes essentially just iron, the star has nothing left to fuse. In less than a second, the star begins the final phase of its collapse. The core temperature rises to over 100 billion degrees as the iron atoms are crushed together. In one of the most spectacular events in the universe, the explosive shock of the collapsing core propels the material away from the star in a tremendous explosion called a supernova. The exploded material moves off into space possibly colliding with other cosmic debris to form new stars, planets, or moons.

If the core remains intact after the supernova, it is called a neutron star. However, if the original star was very massive (15 or more times the mass of our sun), a black hole might form. A black hole produces no light (hence it is *black*), but it is extremely massive. Black holes have so much gravity, even light falls into them.

Stars maintain a balance between the great forces that produce radiation and fuel their nuclear fusion. This balance is called **stellar equilibrium**. As large stars grow older, they use up their remaining fuel, and this balance is thrown off, creating great explosions called supernovas and collapsing with great changes of gravity into neutron stars or black holes. In these changes, matter is neither created nor destroyed; it changes form and the remaining star particles and gases can now form new stars in the universe.

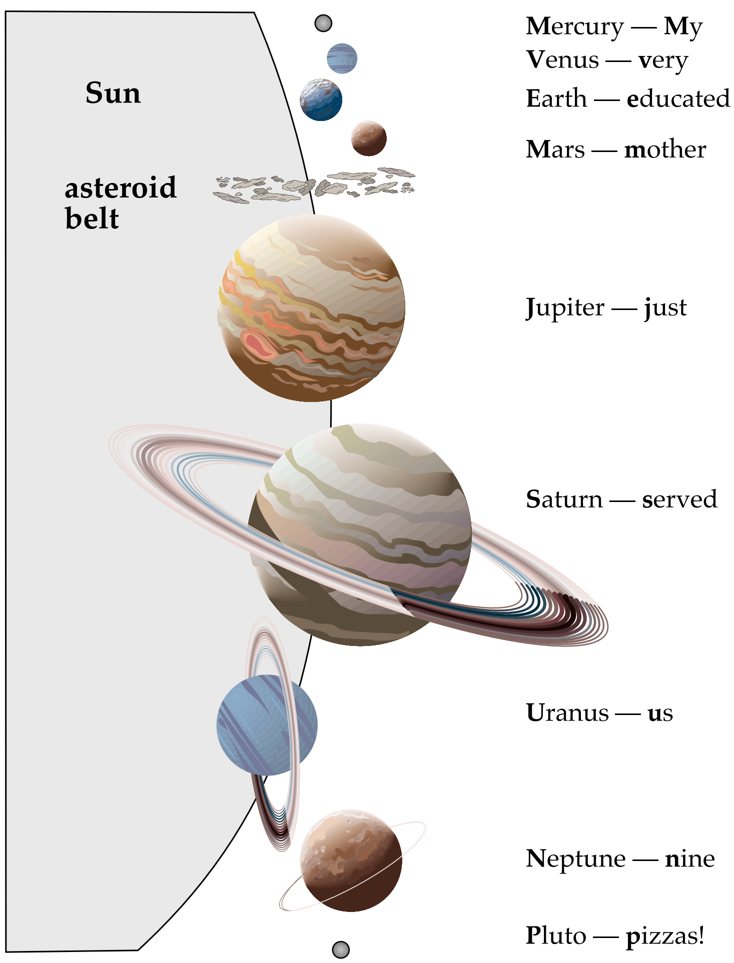

the Great Bear

When people look at the universe, they often see smaller groups of stars called **constellations**.

Constellations look like pictures or shapes. The Big Dipper and Little Dipper are constellations. The planets, sun, and moon all follow paths within a narrow belt across the sky. There are 12 constellations that appear in this belt. These constellations are called the signs of the Zodiac. The names of the signs of the Zodiac are Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn, Aquarius, and Pisces.

Orbiting the sun are the nine planets of the solar system. *Planets* do not burn like stars but reflect the light of the sun. It is easy to remember the names of the planets in their order from the sun.

Just remember this sentence: My very educated mother just served us nine pizzas!



My **v**ery **e**ducated **m**other **j**ust **s**erved **u**s **n**ine **p**izzas!

Moons are satellites that orbit the planets. Some planets have no moons, and some have many moons. Earth has one moon. The moon accompanies Earth on its annual journey around the sun.

Masses of dust and ice with a gaseous tail, called **comets**, also revolve around the sun. Halley's Comet is the most well-known comet. It is seen from Earth every 76 years. Halley's Comet was last seen in 1986. It will not be seen again until the year 2062.

Meteors are small pieces of rocky material that sometimes enter Earth's atmosphere. When a meteor enters Earth's atmosphere, it begins to burn. This is called a *shooting star*, but it is not really a star. The rocky fragments of a meteor that hit the surface of Earth are called *meteorites*.

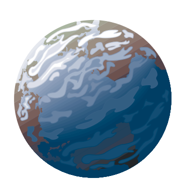
Asteroids are pieces of rock and metal that orbit the sun. Many are located in a belt between the planets Mars and Jupiter. These fragments of matter are similar to that from which planets were formed. They may be a broken-up planet or trapped debris. Asteroids range in size from tiny particles, too small to be seen, to masses 1,000 kilometers in diameter.

Planets

Our solar system consists of nine planets, their satellites, and many other small bodies such as asteroids, comets, and meteoroids. The planets in order from the sun are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.

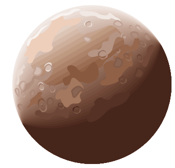
Mercury. Mercury is the planet closest to the sun. It rotates very slowly. The side facing the sun is very hot, while the side away from the sun is very cold. The spacecraft *Mariner 10* visited Mercury in 1974. It discovered a barren world with many craters. The craters have remained unchanged for billions of years because Mercury has no atmosphere or weather.

Venus. Venus is sometimes called Earth's *sister planet* because it is very similar in size, mass, and density. The atmosphere of Venus is very different from that of Earth. Venus' atmosphere is composed of carbon dioxide. It also has thick clouds of sulfuric acid. These clouds trap heat and create a greenhouse effect, causing extremely high surface temperatures. Venus is also covered by craters, but there is evidence that oceans once existed.

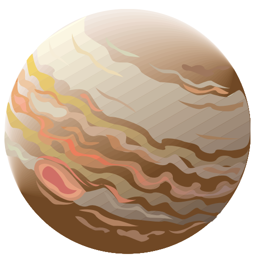

Earth

Earth. Earth is the third planet from the sun and is a bit larger than Venus. So far as we know, Earth is the only home of life in the solar system. It has one large moon but there are larger moons in the solar system. There are three main zones of Earth: the atmosphere; the hydrosphere (the world's water);

and the lithosphere (the solid body of the world). Earth's solid body is divided into three regions: the core; the mantle; and the crust, the outermost layer of Earth and the one to which all human activity is confined.

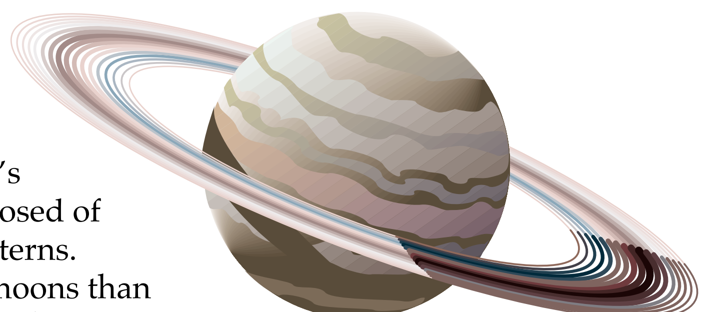

Mars

Mars. Mars was examined by the *Viking* spacecraft in 1976 and revisited by the Mars *Pathfinder* in July of 1997. Its red soil, suspended by windstorms, gives it the name the *red planet*. Many large volcanoes and craters dot the surface of Mars, indicating that the planet was once very active. The solar system's largest known volcano, Mons Olympus, is found here. Mars also has large ice caps. The ice does not melt because the temperature of Mars is well below freezing. Mars has two small moons—Phobos and Deimos.

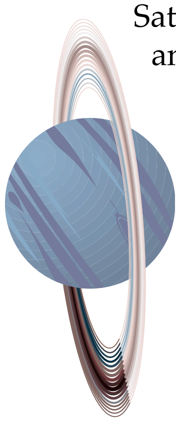

Jupiter

Jupiter. The largest planet in the solar system is the *gas giant*, Jupiter. Huge storm clouds cover the planet, including the giant red spot which is thought to be like a hurricane three times as large as Earth. In 1979, the *Voyager* spacecraft discovered a thin ring circling the planet. At least 16 moons are known to orbit Jupiter. The first four were discovered by Galileo Galilei in 1610.

Saturn. Saturn is very similar to Jupiter. It also has a dense atmosphere, storms, and rings. Saturn's rings, however, are composed of ice and form intricate patterns. Saturn has more moons than any other planet. There are at least 17, but there may be as many as 23 orbiting Saturn.


Saturn

Uranus. Uranus is also a *gas giant* like Jupiter and Saturn. The clouds that cover Uranus give it its characteristic greenish-blue color. Uranus also has a ring system, but the rings encircle the planet from top to bottom. This is because Uranus' axis is tilted at nearly a 90° angle, so it appears to have been knocked on its side. Fifteen moons orbit the planet.


Uranus

Neptune. Neptune is considered Uranus' twin. It is about the same size and has a greenish-blue color. Two thin rings encircle the planet, and it has two moons.

Pluto. The most distant planet in our solar system is Pluto. It was the last planet discovered, and due to its great distance from Earth its one moon was not discovered until 1978. Pluto is the smallest planet and may be composed entirely of frozen methane and ice.

The planets orbit around the sun in our solar system just as the moon orbits Earth. What holds the planets in this orbit? Gravity does. It is the universal force of attraction between all objects that tends to pull them toward one another just as objects are pulled towards Earth's surface. Sir Isaac Newton proposed his law of gravity in 1687. Newton's law stated that every particle in the universe attracts every other particle with a force that is proportional to the masses and inversely proportional to the square of the distance between the objects. The force of attraction between any two objects depends upon their masses and the distance between them.

Using Newton's law of gravitation, both the French astronomer Urbain Leverrier and the British mathematician John Couch Adams predicted the existence of a new planet that was causing the orbit of Uranus to be different than expected from Newton's law. Neptune was discovered in 1846 by German astronomer Johann Galle in an orbit close to its predicted position.

Summary

The nine planets—along with comets, meteoroids, asteroids, and other celestial objects—make up Earth's vast neighborhood. The planets and other heavenly bodies have at least one thing in common. They all share gravitational forces with the sun, forming a large system—the solar system. With the help of space probes, cameras, and other data-gathering equipment placed above Earth's atmosphere, scientists are able to find out more and more about our celestial neighborhood. These scientific studies are making our world seem smaller than we once imagined it to be and the universe more accessible.

Lab Activity: Dimensions of the Solar System

Purpose

Construct a model to show the relative distance from the sun to the planets.

Materials

- adding machine tape
- metric ruler
- string

Dimensions of the Solar System		
Planet	**Distance from the Sun**	
	Millions of Km	**Cm***
Mercury	58	
Venus	108	
Earth	150	3
Mars	228	
Jupiter	778	
Saturn	1427	
Uranus	2870	
Neptune	4486	
Pluto	5900	

*scale 1 cm = 50 million km

Procedure

1. Obtain a length of adding machine tape approximately 150 cm long.

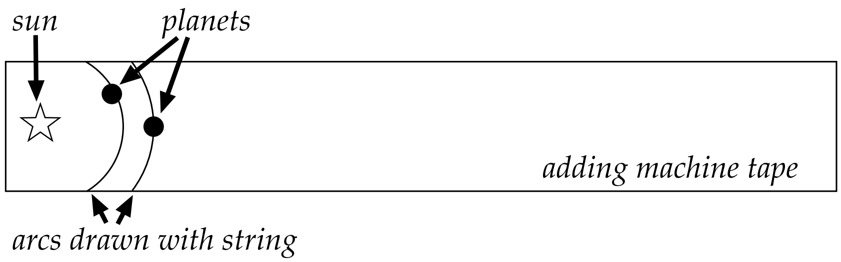
2. Using the chart above, calculate the distance in cm from the sun for each planet using the scale 1 cm = 50 million km.

Example: Earth $$150 \cancel{\text{million km}} \times \frac{1 \text{ cm}}{50 \cancel{\text{million km}}} = \frac{150 \text{ cm}}{50} = 3 \text{ cm}$$

3. Find the spot one centimeter above one edge of your tape. Draw a small star there to represent the sun. (See diagram below.)

4. To plot each planet, measure the distance from the sun and place a mark at the appropriate distance for each planet.

5. Use the string to draw arcs to represent the orbits of the planets.



6. Label the planets.

7. Draw dotted lines between Mars and Jupiter to represent the asteroid belt.

8. All of the planets through Saturn are easily visible to the naked eye. Name them.

____

____

____

9. Each of the planets between Earth and the sun are seen as the "morning star" or the "evening star." Name them.

____

____

10. What might be the possible origin of the asteroids?

____

____

____

____

11. Where are the largest planets located?

____

____

____

____

12. Where are the smallest planets located?

____

____

____

____

Practice

Answer the following using complete sentences.

1. What is the name of the most commonly accepted theory on how the universe began?

2. When do scientists think that the universe was created?

3. Before the Big Bang, where was most of the matter and energy found in the universe?

4. How did this big explosion affect the matter and energy that was already present in the universe?

5. According to the Big Bang theory, how were the galaxies formed?

6. What continues to happen to the stars in these galaxies today?

____

____

7. What is a slowly rotating cloud of dust and gas called?

____

8. What theory states that the shrinking of a large cloud of dust formed the solar system?

____

____

____

____

9. Describe another theory of how the planets were formed.

____

____

____

____

____

10. What are the four components that make up the universe?

____

____

____

____

Practice

Write a paragraph about the following.

1. The origin of the universe according to the Big Bang theory:

____

____

____

____

____

____

____

____

2. The origin of the solar system according to the nebular theory, also known as the Dust Cloud theory:

____

____

____

____

____

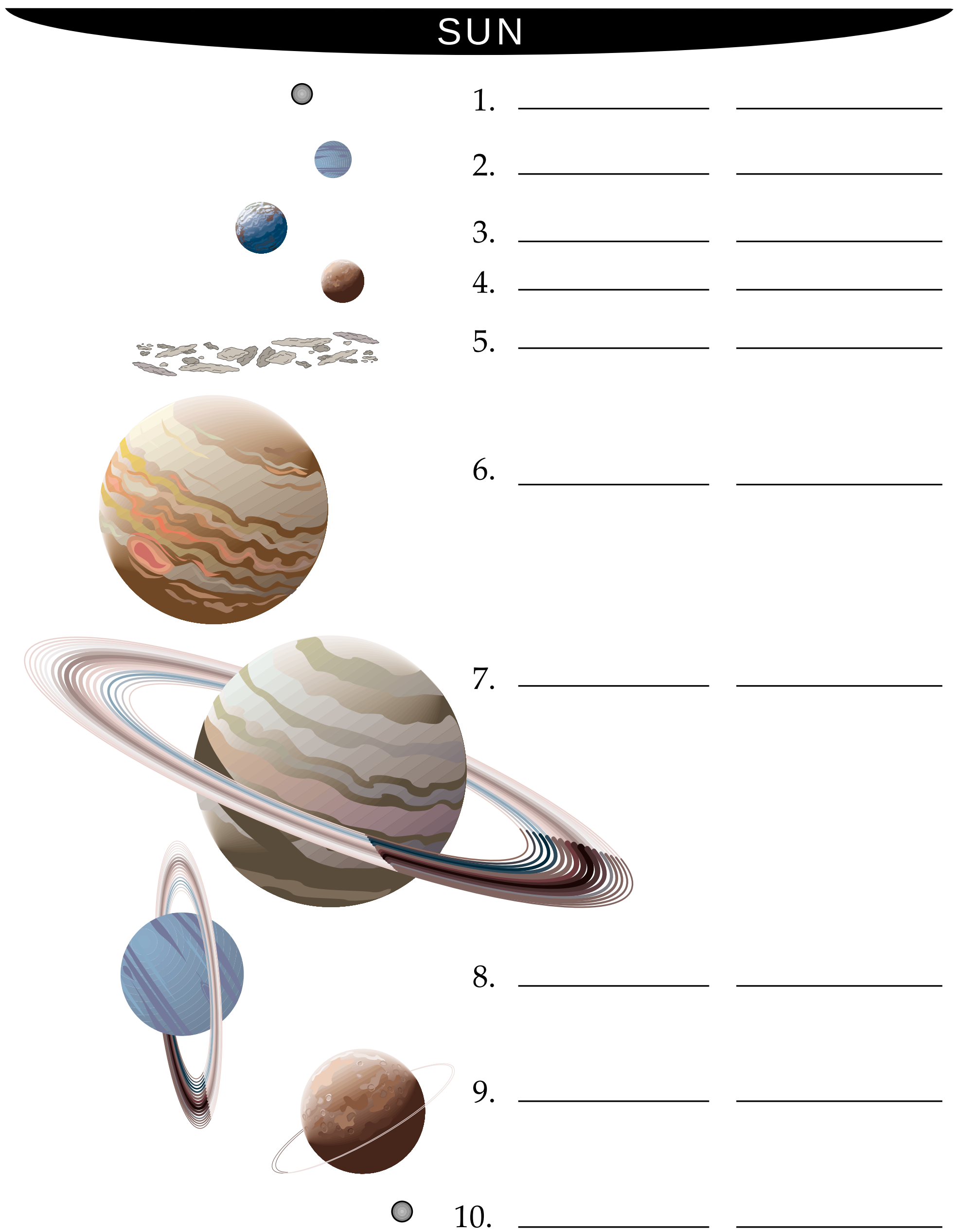
____

____

____

Practice

Label each **heavenly body** *illustrated below and give one characteristic.*



1. ______________ ______________
2. ______________ ______________
3. ______________ ______________
4. ______________ ______________
5. ______________ ______________
6. ______________ ______________
7. ______________ ______________
8. ______________ ______________
9. ______________ ______________
10. ______________ ______________

Practice

Use the list below to write the correct term for each definition on the line provided.

asteroids	**galaxy**	**planets**	**stars**
comet	**meteors**	**satellite**	**stellar equilibrium**
constellation	**nebula**	**solar system**	**theory**
elliptical galaxies	**orbit**	**spiral galaxies**	**universe**

______________________ 1. a mass of dust and ice with a bright gaseous tail that orbits the sun

______________________ 2. bodies that revolve around a sun and reflect its light

______________________ 3. hot, bright bodies of gas constantly exploding in space

______________________ 4. fragments of rocky material from space that burn as they fall through Earth's atmosphere

______________________ 5. millions or billions of stars in a system

______________________ 6. galaxies that have a very bright center that contain very little dust and gas

______________________ 7. galaxies that have a center of bright stars and flattened arms that swirl around the center, and look like a pinwheel

______________________ 8. a small number of stars that appears to form a shape or image

______________________ 9. an object that revolves around a larger object

______________________ 10. the path of an object revolving around another object

_______________________ 11. a cloud of interstellar gas or dust

_______________________ 12. the sun and all the planets, their moons, asteroids, meteors, and comets; all objects that move around the sun

_______________________ 13. a hypothesis that has withstood the test of time

_______________________ 14. all bodies in space and all space between these bodies—all matter and all energy

_______________________ 15. fragments of rock and metal that orbit the sun; many are in a belt located between Mars and Jupiter

_______________________ 16. the balance between the forces in a star

Practice

Circle the letter of the correct answer.

1. A ____________ is a mass of dust and ice with a bright gaseous tail that orbits the sun.

   a. planet
   b. meteor
   c. star
   d. comet

2. ____________ are bodies that revolve around a sun and reflect its light.

   a. Galaxies
   b. Stars
   c. Meteors
   d. Planets

3. ____________ are hot, bright bodies of gas constantly exploding in space.

   a. Meteors
   b. Elliptical galaxies
   c. Galaxies
   d. Stars

4. ____________ are fragments of rocky material from space that enter Earth's atmosphere and burn as they fall.

   a. Spiral galaxies
   b. Meteors
   c. Elliptical galaxies
   d. Galaxies

5. A ____________ is millions or billions of stars in a system.

   a. constellation
   b. galaxy
   c. meteor
   d. planet

6. ____________ galaxies are oval-shaped galaxies which are smooth in appearance and have few clouds of dust and gas.

   a. Constellation
   b. Spiral
   c. Elliptical
   d. Comet

7. ____________ galaxies are galaxies that are disc-shaped.

   a. Spiral
   b. Star
   c. Nebula
   d. Elliptical

8. A ____________ is a small number of stars that appears to form a shape or image.

   a. comet
   b. constellation
   c. galaxy
   d. meteor

9. A principle based on facts which has withstood the test of time is a ____________ .

   a. satellite
   b. planet
   c. solar system
   d. theory

10. All bodies in space and all space between these bodies, and all energy and all matter, compose the ____________ .

    a. elliptical galaxy
    b. solar system
    c. spiral galaxy
    d. universe

11. The sun and all the planets, their moons, asteroids, meteors, and comets and all objects that move around the sun compose the ____________ .

    a. solar system
    b. elliptical galaxy
    c. universe
    d. spiral galaxy

12. A ____________ is a cloud of interstellar gas and/or dust.

    a. satellite
    b. nebula
    c. planet
    d. solar system

13. ____________ are fragments of rock and metal that orbit the sun, many of which are located between Mars and Jupiter.

    a. Galaxies
    b. Satellites
    c. Meteors
    d. Asteroids

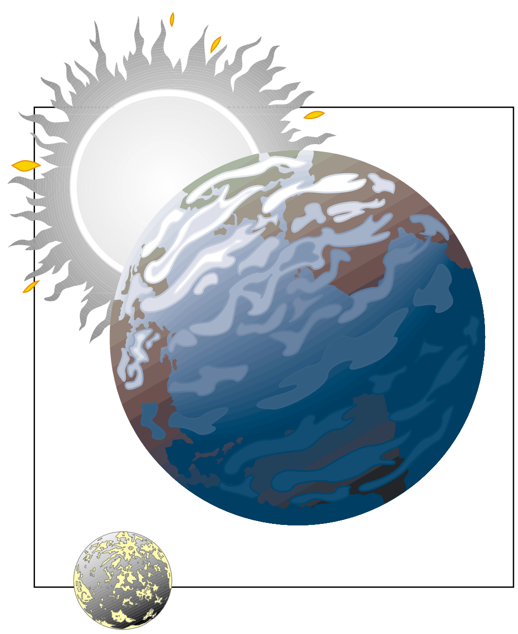
14. A ____________ is an object that revolves around a larger object.

    a. satellite
    b. galaxy
    c. constellation
    d. comet

15. The moon and planets revolve or ____________ around the sun.

    a. asteroid
    b. comet
    c. solar system
    d. orbit

Unit 4: The Earth, the Moon, and the Sun



Vocabulary

Study the vocabulary words and definitions below.

corona .... the low-density cloud of gases surrounding the sun

craters .... holes or bowl-shaped depressions on a moon or planet

ebb tide .... the movement of a tidal current away from the shore

elliptical .... oval-shaped

equinox .... either of the two times of the year when the number of hours of daylight and darkness are the same in both hemispheres; marks the first day of spring and fall; means *equal night*

flood tide .... the tidal current associated with the increase in the height of the tide

highland areas .... areas on the moon which are high mountain ranges and large craters; appear light in color

lunar eclipse .... an event which occurs when Earth blocks the light as it moves between the sun and the moon

lunar month .... the measure of time it takes for the moon to pass from one new moon to the next (29½ days)

maria (MAR-ee-uh)...................... lunar seas or plains on the moon which appear dark

meteors .... fragments of rocky material from space that burn as they fall through Earth's atmosphere; also known as meteoroids

moon phase .... the changing appearance of the moon which depends on the moon's position relative to the sun

neap tide .... tide occurring at the first and third quarters of the moon when the sun, Earth, and moon form a right angle; produces tides in a medium range

orbit .... (noun) the path of an object revolving around another object; (verb) to revolve in an orbit around another object

partial eclipse .... an event which occurs when part of the sun is blocked out by the moon

penumbra .... part of a shadow cast by an object in which light from the source is only partly blocked

revolve .... to move around another heavenly body
Examples: the moon revolves around Earth; planets revolve around the sun

rotate .... to spin on an axis
Example: Earth rotates, causing day and night

seasons .... the four divisions of the year characterized by differences in weather and the number of hours of daylight

solar eclipse .... an event which occurs when the moon passes between Earth and the sun

solstice .... either of the two times a year when the sun is at its greatest apparent distance north or south of the equator; marks the first day of *summer* and *winter*

spring tide .... tide that occurs when the sun, moon, and Earth are in a straight line

tide .... the rise and fall of the oceans caused by the gravitational attraction between the sun, Earth, and moon

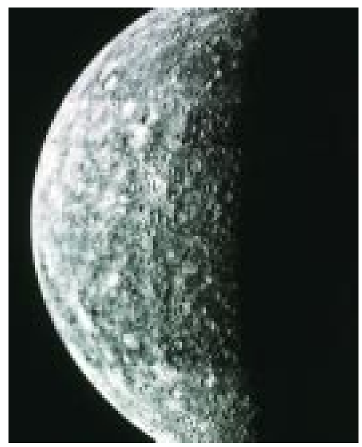
total eclipse .... an event which occurs when the sun is completely blocked out by the moon

umbra .... the part of a shadow cast by an object in which light from the source is completely blocked

Introduction

Through scientific study and space exploration, we have learned that Earth exists as a part of a larger system called the solar system. Within our solar system, the moon and Earth have a very important relationship. The relationship between sun, Earth, and moon affects many of the everyday occurrences that we take for granted—the **tides**, the amount of solar energy, the length of our days and nights, and the **seasons**. Learning about this relationship helps us to understand the why of these daily occurrences and to understand our need for future exploration of the world beyond our Earth.

The Relationship of the Earth and the Moon



Earth has one moon. The moon **revolves** around Earth about once a month. The moon also turns, or **rotates**, on its axis one time per month. Because of this, we only see one side of the moon. The moon does not give off light of its own. It reflects the light of the sun.

Earth has a blanket of air surrounding it called an *atmosphere*. The moon does not have an atmosphere because it does not have a strong enough gravitational force to hold a blanket of air around it. Since there is no atmosphere on the moon, there is no water. Without an atmosphere and water, the moon is unable to support life.

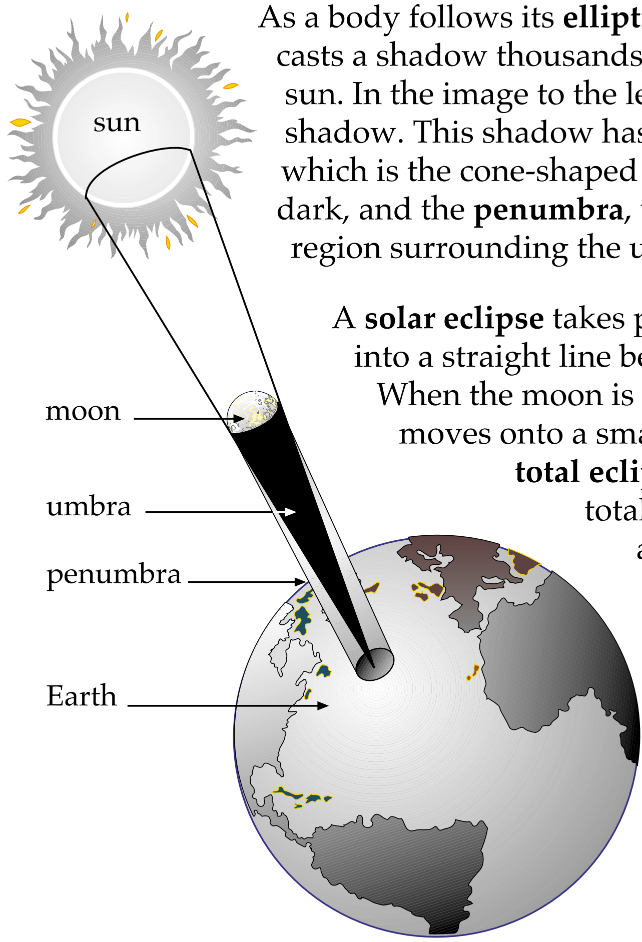
Earth is the third planet from the sun. Earth's atmosphere is different from the other planets. It contains oxygen and water vapor and thus can support life. The atmosphere also protects Earth from extremes in temperatures. Without an atmosphere, the moon is subjected to very high and low temperatures. The dark side of the moon may get as cold as –175° Celsius, and the lighted side may reach temperatures of 130° Celsius.

When viewed from Earth, the surface of the moon has light and dark areas, which sometimes combine to look like a man's face.
The light-colored areas are **highland areas**. The highland areas have mountains that are much higher than any found on Earth. The parts of the

moon that appear dark are called **maria**. *Mare* (singular for maria) is the Latin word for *seas*. The maria are flat areas that look like seas, except that they do not have any water in them.

The surface of the moon also has many bowl-like depressions called **craters**. Craters vary in diameter from a few inches to over 500 miles. Most of the craters were produced long ago by the impact of **meteors**. In contrast, Earth has only about a dozen well-known craters. Although many meteors travel towards Earth, most of those meteors burn up in Earth's atmosphere. The moon, on the other hand, has no atmosphere to affect the meteors' impacts. Additional craters may have been on Earth in early geologic history, but these have been destroyed by erosion.

Solar Eclipse



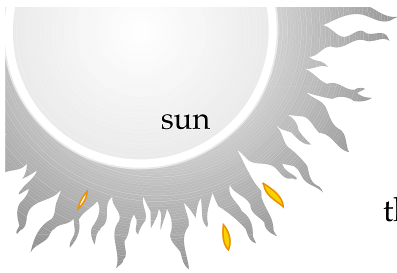
Solar Eclipse

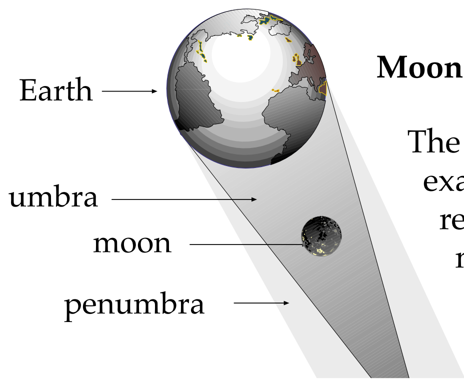
As a body follows its **elliptical** orbit around the sun, it casts a shadow thousands of miles long away from the sun. In the image to the left, the moon is casting a shadow. This shadow has two parts—the **umbra**, which is the cone-shaped inner part that is completely dark, and the **penumbra**, which is the partly shaded region surrounding the umbra.

A **solar eclipse** takes place when the moon passes into a straight line between the sun and Earth. When the moon is in this position, its shadow moves onto a small area of Earth. During a **total eclipse** of the sun, the moon totally blocks out the sun and, for a short time, becomes dark. Only a halo of light from the sun's rim, called a **corona**, can be seen. Other parts of Earth that fall in the penumbra experience a **partial eclipse**, where only part of the sun is blocked by the moon. A partial eclipse is seen by many more people than a total eclipse.

Lunar Eclipse

When the moon moves into Earth's shadow, we have a **lunar eclipse**. During a lunar eclipse, hardly any sunlight reaches the moon and, consequently, it looks very dim. A lunar eclipse will last about three or four hours. It is longer than a solar eclipse because Earth's shadow is very wide, and it takes a long time to pass through it. A lunar eclipse can be seen from more areas of Earth than a solar eclipse. Also, there are many more lunar eclipses than solar eclipses.



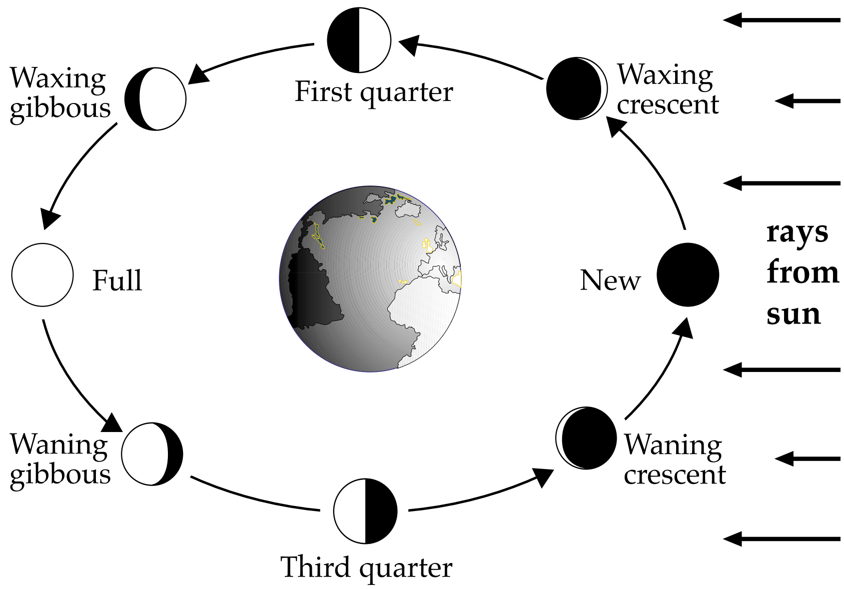


Lunar Eclipse

Moon Phases

The moon moves around Earth in exactly the same way that the planets revolve around the sun. It takes the moon $27\frac{1}{3}$ days to make one trip around Earth. The moon also rotates or spins on its axis one time as it revolves around Earth. While the moon is moving around Earth, Earth is also moving around the sun. Therefore, it takes about two more days for the moon to return to its original position in relation to the sun and Earth. It takes a total of $29\frac{1}{2}$ days for the moon to pass from one new moon to the next new moon. This period of time is called a **lunar month**.

As the moon **orbits** Earth, sometimes the side that is lighted by the sun is facing Earth, and at other times part or all of the lighted side is facing away from Earth. The different portions of the lighted side of the moon that are visible as the moon revolves around Earth are known as **moon phases**.



The circle shows the phases of the moon as seen from Earth.

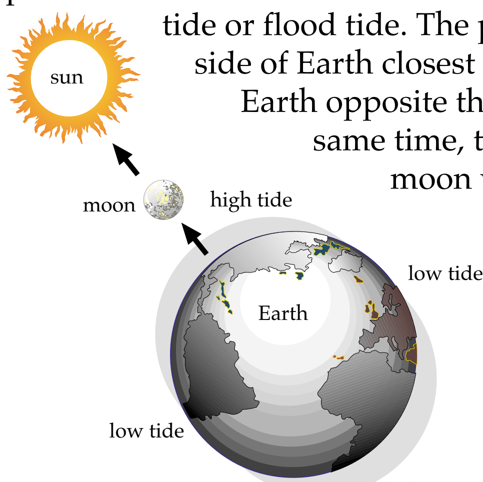
- New Moon—when the moon is in between Earth and the sun, the unlighted side of the moon is facing Earth and cannot be seen
- Crescent Moon—just before and after the new moon; only a slice of the lighted side is seen
- Quarter Moon—halfway between the new moon and full moon; half the moon is dark and half is lighted
- Gibbous Moon—just before and just after a full moon; over half of the moon is lighted; it appears lopsided
- Full Moon—when the moon is on the opposite side of Earth from the sun; the entire lighted side is touching Earth

Tides

If you have gone to a beach and stayed a few hours, you probably have noticed that the ocean water does not stay at the same level. The water level of the ocean rises and falls at regular time periods. At certain times of the day the water is higher than at other times. This regular rise and fall of the ocean water is called *tides*.

Tides are the movements of the ocean water caused by the gravitational attraction among the sun, Earth, and moon. Both the moon and sun affect the tides, but the moon's effect is greater than the sun's effect because it is so much closer.

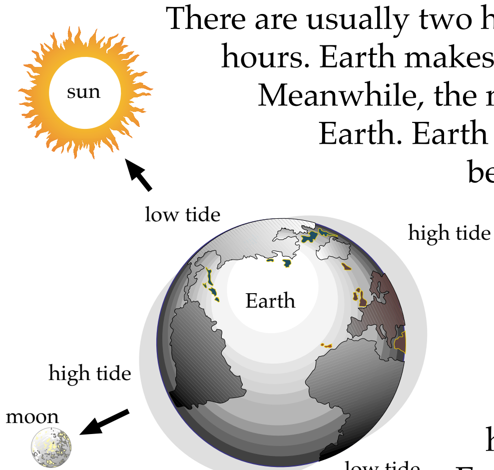
There are high tides and low tides. Tides do not change suddenly. High tides move in slowly. When the water reaches its highest level, it is called *high tide* or **flood tide**. Then, it slowly moves out until it reaches its lowest point called *low tide* or **ebb tide**. A low tide or ebb always follows a high tide or flood tide. The pull of the moon draws the water to the side of Earth closest to the moon and pushes it to the side of Earth opposite the moon. This causes high tides. At the same time, the side of Earth at 90° angles from the moon will have low tides.



Spring Tide

Most shorelines have four tides every day. There are two high tides and two low tides. There are about six hours and 12 minutes between a high tide and a low tide. Twice every month the sun, moon, and Earth are all in a straight line. The combined gravitational pull of the sun and moon causes higher than average high tides and lower than average low tides. These are called **spring tides**. Spring tides occur during a full moon and a new moon.

The moon, Earth, and sun are also at right angles (90°) twice a month. During this time, the gravity forces work against each other creating **neap tides**. During neap tides, the high tides are lower than normal and the low tides are higher than normal. Therefore, the difference between high and low tides is less during a neap tide. Neap tides occur during the first and third quarter of the moon's phase.



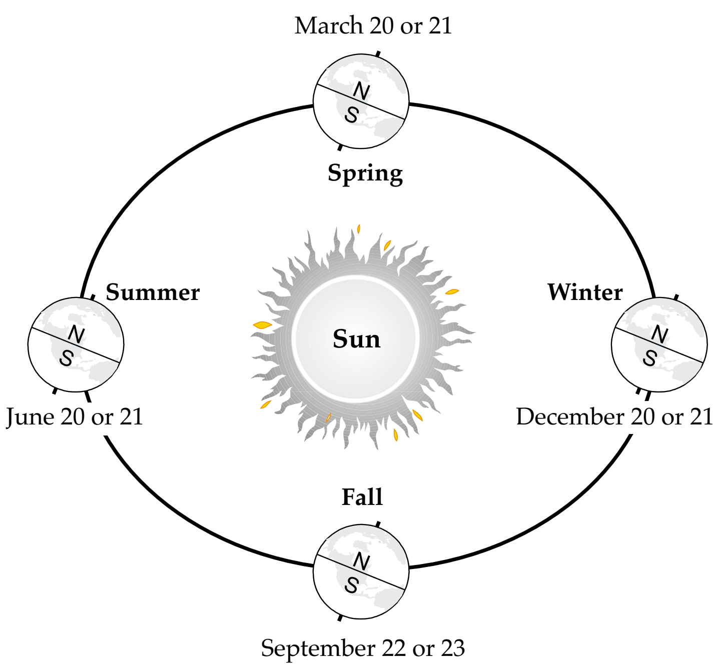
Neap Tide

There are usually two high tides and two low tides every 24 hours. Earth makes one turn on its axis in 24 hours. Meanwhile, the moon is also moving in its orbit around Earth. Earth must rotate 24 hours and 50 minutes before the moon returns to the same position overhead. The moon, then, has also moved. This results in the tides being 50 minutes later each day. For example, if it is high tide at 9:00 a.m. on Monday, the high tide will be at 9:50 a.m. on Tuesday. Low tides and high tides are about six hours apart. As Earth rotates, different locations on Earth pass through high and low tides.

Most locations in Florida experience two high tides and two low tides during a 24-hour period. This is called a semidiurnal tide. The heights of the high tides and low tides are about the same. Some places only experience a single high tide and a single low tide a day due to their location. This is a diurnal tide. Other places may experience mixed tides with varying heights of high and low tides during a 24-hour period.

Seasons

The *seasons* are the four divisions of the year characterized by differences in temperature, weather, and the number of hours of daylight. Seasons are caused by the tilt of Earth on its axis. Earth's tilt causes the duration of daylight hours to vary and the angle at which the sun's rays strike a given location to change as Earth makes its yearly revolution around the sun.



Summer begins on June 21 or 22 in the Northern Hemisphere. During summer, the Northern Hemisphere is tilted toward the sun, and thus receives more direct rays. At the same time, the Southern Hemisphere is pointed away from the sun and receives the indirect rays of the sun. Therefore, it is winter in the Southern Hemisphere and summer in the Northern Hemisphere.

Winter begins on December 21 or 22 in the Northern Hemisphere, when it is tilted away from the sun. At the same time, the Southern Hemisphere is tilted towards the sun and is having summer.

Two times a year neither pole leans towards the sun. During these times Earth is in such a position in its orbit that its axis is neither tilted toward nor away from the sun. The vertical rays of the sun strike the equator. On these two days, called the *spring* or *fall* **equinox**, daylight and night hours are the same in both hemispheres. Day and night are 12 hours long everywhere on Earth.

On March 20 or 21, the spring equinox begins in the Northern Hemisphere. September 22 or 23, the fall equinox, is the beginning of fall. Again, the seasons are opposite in the Southern Hemisphere.

As the seasons change, the number of hours of daylight and darkness also changes. The first day of summer, June 21 or 22, has the greatest number of daylight hours and is called the *summer* **solstice**. The sun is the farthest north of the equator on this day because the north pole is tilted most directly toward the sun.

After the summer solstice, daylight hours begin to decrease in the Northern Hemisphere until the winter solstice. Three months after the summer solstice comes the fall equinox. At that time, September 22 or 23, daylight and darkness are equal. Fall begins in the Northern Hemisphere, and spring begins in the Southern Hemisphere.

Daylight hours continue to decrease above the equator and increase below the equator until December 21 or 22, the winter solstice. The solstice has the least amount of daylight of the year and marks the beginning of winter in the Northern Hemisphere. At this time, the sun is the farthest south of the equator.

After the winter solstice, days continue to grow longer in the Northern Hemisphere until the summer solstice. Three months after the winter solstice comes the spring equinox. On that day, then, Earth's axis leans neither toward nor away from the sun, and day and night are equal in both hemispheres. March 20 or 21 is the beginning of spring north of the equator and the beginning of fall in the Southern Hemisphere.

After the spring equinox, daylight hours continue to increase in the Northern Hemisphere until the summer solstice—the longest day. At this time, the cycle of the seasons begins again.

At the equator, the number of hours of daylight is always the same as the number of hours of darkness. As you move towards the poles, the hours become more uneven. The tilt of Earth on its axis causes the polar areas to have uneven hours of daylight and darkness. The poles have 24 hours of daylight in summer and 24 hours of darkness during the winter.

Summary

Our moon is very different from Earth. While the moon rotates on its axis and revolves around Earth, Earth revolves around the sun. These three heavenly bodies create different shadows as they change positions. At certain times these shadows result in eclipses—lunar, solar, or total. As the moon rotates and revolves, different portions of the lighted side are visible from Earth. As a result, the moon appears to change its shape, or go through phases. The moon's gravitational pull on Earth (as well as the sun's) causes our changing ocean tides.

Practice

Answer the following using complete sentences.

1. What are two conditions of Earth that allow it to support life?

 ____

 ____

 ____

2. Is there life on the moon? ____________________________________

 Why or why not? ____

 ____

 ____

 ____

3. Why doesn't the moon have an atmosphere?

 ____

 ____

 ____

4. Why does the moon have much hotter and much colder temperatures than Earth?

 ____

 ____

 ____

 ____

5. Why do we sometimes see a man's face in the moon?

____

____

6. The word mare means sea in Latin, but how do the maria on the moon differ from the seas on Earth?

____

____

____

7. Describe the highland areas on the moon.

____

____

8. What are the bowl-like depressions on the moon? What caused them?

____

____

9. How large are the craters on the moon?

____

____

10. Why are the moon's craters so well preserved?

____

____

____

Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

corona	**partial**	**shadows**	**three or four hours**
lunar	**partial eclipse**	**solar**	**total**
lunar eclipse	**penumbra**	**solar eclipse**	**umbra**

1. Eclipses are caused by the ______________________ cast by either moon or Earth as they pass by one another.

2. The part of a shadow that is cone-shaped and completely dark is the ______________________ .

3. The outer, partly shaded part of a shadow is called the ______________________ .

4. A ______________________ takes place when the moon passes in a straight line between the sun and Earth.

5. During a ______________________ eclipse of the sun, the moon totally blocks out the sun, and for a short time it becomes dark.

6. A halo of light from the sun's rim, called the ______________________ , can be seen around the edges of the moon during a total eclipse.

7. A ______________________ eclipse can be seen by more people than a ______________________ eclipse.

8. A ________________________ occurs when only part of the moon passes in front of the sun.

9. When the moon moves into Earth's shadow, we have a ________________________ .

10. During a lunar eclipse, hardly any sunlight reaches the moon, and it looks very dim for about ________________________ .

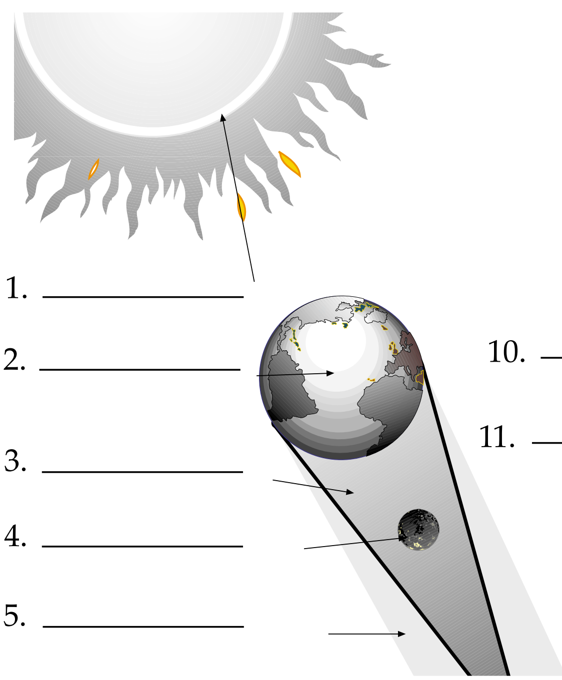
11. There are more ________________________ eclipses than ________________________ eclipses.

12. A ________________________ eclipse can be seen from more areas of Earth than a solar eclipse.

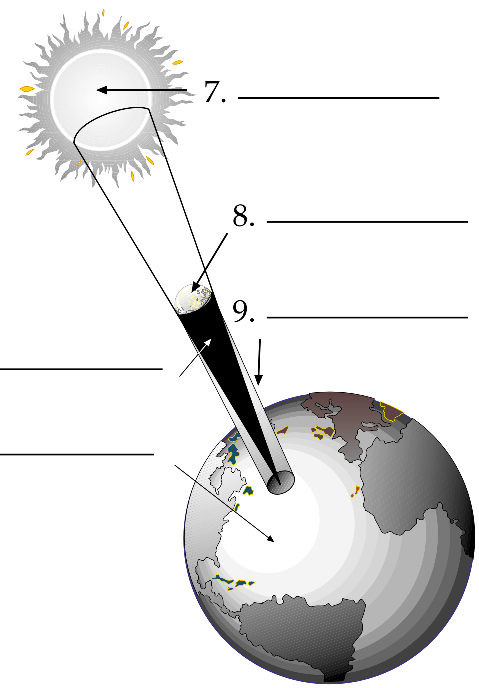
Practice

Identify the two **eclipses** *shown in the diagrams below. Use the list below to label the parts of each. (One or more words will be used more than once.) Write the correct term on the line provided.*

Earth	**solar**
lunar	**sun**
moon	**umbra**
penumbra	



1. ______________
2. ______________
3. ______________
4. ______________
5. ______________



7. ______________
8. ______________
9. ______________
10. ______________
11. ______________

6. ______________ eclipse

12. ______________ eclipse

Practice

Answer the following questions using the **weather section** *of your* **local newspaper** *or the* **Internet***; then do the activity that follows.*

1. What time will the moon rise today? ____________________________

2. What time will the moon set today? _____________________________

3. On what date this month is there a full moon ? __________________

4. On what date this month is there a new moon? __________________

5. Go outside and observe the moon tonight after it rises. (Check the time in the newspaper.)

6. Fill out the information on the chart below, noting the date and time of your observation. Draw the shape of the moon that you saw. Use a compass or stationary landmark to determine the location of the moon.

7. Record the same information on the same night of the week for the next three weeks and record your findings.

8. Did your results correspond with the information the newspaper gave?

   Explain. ____

   ____

Date	Time	Shape	Location

Practice

Match each definition with the correct term. Write the letter on the line provided.

______ 1. the time that it takes the moon to make one trip around Earth

______ 2. the amount of time that it takes the moon to go through its phases from one new moon to the next new moon

______ 3. the measure of time it takes the moon to go through its phases

______ 4. the different portions of the lighted side of the moon that we see as it revolves around Earth

______ 5. the number of times the moon rotates during one revolution around Earth

______ 6. where the light of the moon comes from

A. one

B. lunar month

C. $29\frac{1}{2}$ days

D. $27\frac{1}{3}$ days

E. phases

F. the sun

Practice

Match each definition with the correct term. Write the letter on the line provided.

______ 1. phase when the moon is between Earth and the sun; it cannot be seen because the dark side is facing Earth

______ 2. phase when the moon is on the opposite side of Earth from the sun; we see the entire lighted side

______ 3. phase just before and after the new moon; only a slice of the lighted side is seen

______ 4. phase when the moon is halfway between the new moon and full moon; we see one-half of the light side and one-half of the dark side

______ 5. phase just before and after the full moon; looks lopsided

______ 6. the path that the moon takes around Earth

A. crescent moon

B. full moon

C. gibbous moon

D. new moon

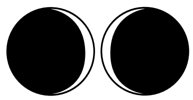
E. orbit

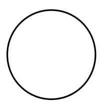
F. quarter moon

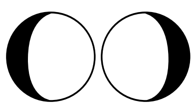
Practice

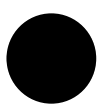
Name each **phase** *of the moon that is shown below. In the column on the right, tell where the moon is in* **relation** *to Earth and sun at each phase.*

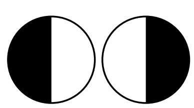
Phase **Position**

1.  ____________ ____________

2.  ____________ ____________

3.  ____________ ____________

4.  ____________ ____________

5.  ____________ ____________

Practice

Use the information about the **high** *and* **low tides** *of a specific location from the* **local newspaper** *or* **Internet** *to fill out the chart below for three consecutive days. Record the* **high** *and* **low tides** *for each date. Be sure to use the* **same** *location each time!*

Date	High (a.m.)	Low (a.m.)	High (p.m.)	Low (p.m.)

Use the **local newspaper** *to answer the following using short answers.*

1. When is the next first-quarter moon? ____________________________
2. When is the next full moon? ____________________________________
3. When is the next third- or last-quarter moon? ___________________
4. When is the next new moon? ____________________________________
5. On what dates would you expect to find a spring tide?

   ____

6. On what dates would you expect to find a neap tide?

   ____

7. How much later is the evening high tide than the morning high tide on your first day of observation?

____

8. How much later is the morning high tide the second day than the first day?

____

9. Do the high and low tides occur at the same time on all the Florida beaches?

____

How do you know? ________________________________

____

____

____

10. Name two reasons why you might want to know when the tides will be high and low.

____

____

____

____

____

____

____

____

Practice

Answer the following using complete sentences.

1. Define tides. ____

____

____

____

2. How many high tides are there normally in a 24-hour period? _____

   How many low tides? ______________________________________

3. Does the sun or moon have a greater gravitational pull on our ocean waters?

____

   Why? ____

____

____

____

4. What kind of tides do we have when the sun, Earth, and moon are all in a straight line?

____

5. When do spring tides occur? ______________________________

____

6. When do neap tides occur? ______________________________

____

7. Describe the ocean water level during a spring tide.

8. How are the sun, moon, and Earth lined up during a neap tide?

9. Do the sun and moon's gravitational forces work together or against each other during a neap tide?

10. During which type of tide is the difference between high and low tide the greatest?

11. If there is a high tide at 10:00 p.m. one night, at what time will the high tide be the next night?

12. Why are the high tides and the low tides a few minutes later each day?

Practice

Answer the following using complete sentences.

1. In what three ways do the seasons differ from each other? ________

   ____

2. What causes Earth to have seasons? ____________________________

   ____

3. Which way is Earth tilted when the Northern Hemisphere is having summer?

   ____

4. Which way is Earth tilted when the Northern Hemisphere is having winter?

   ____

   ____

   ____

5. Do both hemispheres have the same seasons at the same time? ____

   Why or why not? ____

   ____

   ____

6. When are the sun's rays pointed directly over the equator instead of at one of the poles?

   ____

   ____

7. What is it called when the sun is farthest north of the equator?

____

8. What else happens at this point mentioned in question 7? ________

____

9. What is it called when the number of hours of daylight and darkness are the same?

____

10. The equinox also marks the first day of what two seasons? _______

____

11. Where on Earth are the length of the days and nights always the same?

____

12. What parts of Earth have 24 hours of daylight in the summer and 24 hours of darkness in the winter?

____

____

13. What seasons begin on the following dates in the Northern Hemisphere?

June 21 or 22: ______________________________________

December 21 or 22: __________________________________

March 20 or 21: _____________________________________

September 22 or 23: _________________________________

Practice

Use the list below to write the correct term for each definition on the line provided.

craters	**lunar month**	**phases**	**solar eclipse**
elliptical orbit	**maria**	**revolve**	**solstice**
equinox	**neap tide**	**rotate**	**spring tide**
highland areas	**orbit**	**seasons**	**tides**
lunar eclipse			

________________________ 1. holes or bowl-shaped depressions on a moon or planet

________________________ 2. positions of the sun that mark the first day of summer and winter

________________________ 3. the divisions of the year characterized by differences in weather and hours of daylight

________________________ 4. either of the two times of the year when the number of hours of daylight and night are equal in both hemispheres

________________________ 5. tide occurring at the first and third quarters of the moon when the sun, Earth, and moon form a right angle; produces tides in a medium range

________________________ 6. to move around another heavenly body (examples: moon around Earth; planets around sun)

________________________ 7. the measure of time it takes for the moon to pass from one new moon to the next (29½ days)

________________________ 8. the path of an object revolving around another object

__________________________ 9. an event which occurs when Earth blocks the light as it moves between the sun and the moon

__________________________ 10. the changing appearance of the moon which depends on the moon's position relative to the sun

__________________________ 11. the spinning movement of a body on its axis

__________________________ 12. lunar seas or plains on the moon which appear dark

__________________________ 13. the rise and fall of the oceans caused by the gravitational attraction between sun, Earth, and moon

__________________________ 14. tide that occurs when the sun, moon, and Earth are in a straight line; causes unusually high and low tides

__________________________ 15. an event which occurs when the moon passes between Earth and the sun

__________________________ 16. areas on the moon which are high mountain ranges and large craters; appear light in color

__________________________ 17. an oval-shaped path of one object that revolves around another object

Practice

Circle the letter of the correct answer.

1. The path of an object revolving around another object is a(n) ____________ .

   a. eclipse
   b. atmosphere
   c. rotation
   d. orbit

2. An oval-shaped path of one object that revolves around another object is a(n) ____________ orbit.

   a. elliptical
   b. revolution
   c. eclipse
   d. rotation

3. Earth ____________ or spins on its axis, causing day and night.

   a. rotates
   b. revolves
   c. orbits
   d. craters

4. The rise and fall of the oceans caused by the gravitational attraction between sun, Earth, and moon is a(n) ____________ .

   a. eclipse
   b. crater
   c. tide
   d. highland

5. Either of the two times of the year when the number of hours of daylight and darkness are the same in both hemispheres is called a(n) ____________ .

   a. continental climate
   b. ozone
   c. equinox
   d. marine climate

6. The __________ is either of the two times a year when the sun is at its greatest distance north or south of the equator; it marks the first day of summer and winter.

   a. tropical zone
   b. polar zone
   c. temperate zone
   d. solstice

7. An event which occurs when the moon passes between Earth and the sun is a(n) __________ .

   a. atmosphere
   b. lunar eclipse
   c. solar eclipse
   d. highland

8. An event which occurs when Earth blocks the light as it moves between the sun and the moon is a(n) __________ .

   a. atmosphere
   b. solar eclipse
   c. highland
   d. lunar eclipse

9. The light areas on the moon which are mountain ranges and large craters are called __________ .

   a. orbits
   b. maria
   c. highland areas
   d. revolutions

10. The dark areas on the moon which are the lunar seas or plains are called __________ .

   a. highlands
   b. craters
   c. revolutions
   d. maria

11. The holes or bowl-shaped depressions on a moon or planet are ____________ .

a. moon phases
b. maria
c. highlands
d. craters

12. The four divisions of the year characterized by differences in weather and the number of hours of daylight are called ____________ .

a. temperate zones
b. polar zones
c. marine climates
d. seasons

13. The moon ____________ around Earth.

a. revolves
b. rotates
c. marie
d. craters

14. The tide that occurs when the sun, moon, and Earth are in a straight line is called a(n) ____________ .

a. ebb tide
b. flood tide
c. spring tide
d. neap tide

15. The tide that occurs at the first and third quarters of the moon, when sun, Earth, and moon form a right angle, is called a(n) ______________________ .

a. ebb tide
b. flood tide
c. spring tide
d. neap tide

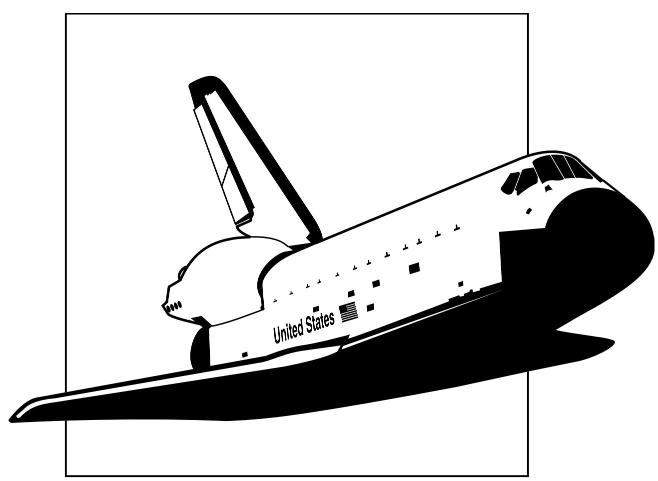
16. The changing appearance of the moon which depends on the moon's position relative to the sun is the ____________ .

   a. lunar month
   b. moon phase
   c. partial eclipse
   d. penumbra

17. The measure of time it takes for the moon to pass from one new moon to the next (29½ days) is a ____________ .

   a. highland
   b. revolution
   c. lunar month
   d. moon phase

Unit 5: Space Exploration



Vocabulary

Study the vocabulary words and definitions below.

artificial .... manmade

astronaut .... a person who flies in a rocket or space shuttle

astronomer .... one who studies astronomy or makes observations of celestial phenomena

astronomy .... the science of celestial bodies and their properties

communication satellite .... a satellite that receives, amplifies, and relays signals

cosmic ray .... ray of very short wavelength and great power that hits Earth from beyond its atmosphere

detector .... device for indicating the presence of a certain substance

lunar .... of or relating to the moon; designed for use on the moon

NASA .... the abbreviation for the National Aeronautics and Space Administration

orbiter .... a spacecraft designed to orbit a celestial body without landing on its surface

payload .... the load carried by a spacecraft

satellite .... an object that revolves around a larger object

space probes .... rocket-launched vehicles that carry instruments, cameras, and other data-gathering equipment for deep-space measurements

space shuttle .... a reusable spacecraft that carries astronauts into space and returns them to Earth

space stations .... living quarters in space, equipped with all the necessary instruments to work and live

telecommunication .... communication over a distance

telescope .... instrument for making distant objects appear larger and therefore nearer; may use lenses, mirrors, or an antenna

transmitter .... instrument that sends signals from one place to another

weather satellites .... satellites that continuously monitor weather conditions

Introduction

As early as 500 B.C., **astronomy**—the science or study of celestial bodies and their properties—was practiced by scholars. Pythagoras (500 B.C.), a Greek philosopher and mathematician, was observing Earth's shadow on the moon when he concluded that Earth must be a sphere. Around 200 B.C., Eratosthenes (3rd century B.C.), a Greek **astronomer**, actually computed Earth's size while demonstrating its curvature. Until the invention of the **telescope** by a later astronomer, these scholars used crude instrumentation to seek the answers about Earth and beyond. Today's technology and sophisticated instrumentation has allowed us to go far beyond the early astronomers in the study of our celestial neighborhood.

Origins of Astronomy

Earth

Humankind has always been interested in the skies or *heavens*. Many early civilizations (including the Egyptians and Babylonians) recorded their observations and ideas on astronomy. The early Greeks are credited with many discoveries. Aristotle, a Greek who lived about 500 B.C., believed that everything in the sky revolved around Earth. The Greeks proposed the first models of the universe. In one of these first models, Ptolemy (2nd century A.D.) also supported the view that Earth was the stationary center of the universe—a view popular at that time.

The Polish astronomer Nicholas Copernicus (1473–1543) was one of the first to challenge that view. He proposed that Earth was a planet, like the other five known planets, and that it revolved around the sun—the center of the universe. Later astronomers, such as Tycho Brahe, collected data to attempt to disprove his controversial theory. Ironically, in the early 1600s a German astronomer, Johannes Kepler (1571-1630) used this data to support the Copernican theory. Kepler proposed three laws that described the movement of the planets.

Probably the most well known of early astronomers is the Italian astronomer Galileo Galilei (1564-1642). He is considered the *father of modern astronomy*. Galileo built his own telescopes and made many astronomical observations. He discovered the first four moons of Jupiter, the relief of our moon, and sunspots. Galileo was another scientist who was persecuted for his views and was sentenced to house arrest for the last 10 years of his life.

Even before Galileo first pointed his telescope skyward, people were interested in the movements of the sun, moon, and stars. The moon is perhaps the most studied celestial object. The first astronomical phenomenon to be understood was the cycle of the moon. Today we know that cycle as the phases of the moon. The early Greek scholars realized that eclipses were simply the obscuring of the sun as the moon passes directly between Earth and the sun.

Today we are able to gather information about the solar system through the use of **space probes**. Space probes are rocket-launched vehicles that carry instruments and equipment used to gather and record data in deep space. These probes have a radio system to send pictures and information to Earth. The *Pioneer*, *Mariner*, and *Viking* were our earliest probes. *Voyager II* has visited Jupiter, Saturn, Uranus, and is continuing on past Neptune and beyond. Information from probes increases our knowledge of space.

space probe taking pictures of the coast of Florida

Gathering Information about Earth and Space

Artificial satellites and unmanned rockets have been used to pave the way for our travel into space. Unmanned rockets are powered by controls from stations on Earth. The direction, location, and speed of the rockets are controlled by using special computer or radio signals. A number of artificial **satellites** have been launched into space. Many of them receive and send radio and television signals which have improved worldwide communications.

The first **telecommunication** satellite launched in 1960 was called the *Echo I*. It was a plastic balloon with a thin aluminum coating. This coating was much like a mirror—it reflected light and radio waves. The *Echo I* was used to relay or reflect telegrams, telephone calls, and pictures back to Earth—crossing oceans and continents. Television pictures are relayed the same way. (The prefix *tele-* means *at or from a distance*.)

astronaut walking in space

Space flights have been made safer because of the information gathered by these satellites and rockets. The *Mercury* space capsule provided scientists with data and experience in space flight itself. The *Gemini* space capsules provided **astronauts** with experience in controlling spacecrafts and working in space. Vehicles docked in space while the astronauts walked in space. The three **lunar** probes—*Ranger*, *Lunar Orbiter*, and *Surveyor*—took pictures of the moon that helped scientists choose a spot for the *Apollo* moon landing. The *Surveyor* probe actually landed on the moon, giving scientists an abundance of valuable information.

astronauts in the space shuttle

In the 18th century, scientists used hot-air balloons to measure weather conditions. Today, we have more than 8,000 weather stations around the world that make observations about our weather conditions. Reports are made by airplane pilots, ships at sea, and radar stations. Satellites are also used to monitor our weather. They are able to observe Earth's oceans and other areas where there are no weather stations. The **weather satellites** send back pictures that show how weather changes from hour to hour. These pictures help us to follow large weather patterns, and they improve the accuracy of our weather predictions. Television stations show daily satellite pictures of weather patterns.

Communication satellites are now used by many nations. The Intelsat—the world's largest satellite system—has 102 member nations and 250 ground stations. This satellite system provides a 240 channel link between the United States and Europe. The Intelsat system was used by the United States to relay the landing of *Apollo 11* on the moon. It is also used for the transmission of telephone, educational, medical, and other types of communication. More and more satellites are being placed in orbit as we expand our use of telecommunications (cell phones, beepers, satellite television, and the Internet). Many companies and agencies now have their own satellites, and personal satellites are not far off in the future.

Global Positioning Systems (GPS) are space-based radio positioning systems that provide 24 hour three-dimensional position, velocity, and time information to users anywhere on or near the surface of Earth. These measurements are used for critical navigation applications. The NAVSTAR system, operated by the United States Department of Defense, is the first GPS system available for nonmilitary uses. GPS is currently available in some cars and for marine navigation systems. GPS is also used to measure the movements of Earth's crust, to track the weather, and to help locate earthquakes.

satellite

By combining GPS with computer mapping techniques, we will be better able to identify and manage our natural resources. Intelligent vehicle location and navigation systems will let us find more efficient routes to our destinations, saving millions of dollars in gasoline costs and also preventing the cause of tons of air pollutants. Travel aboard ships and aircraft will be safer in all weather conditions.

Sources Used to Collect Information

The collection of information about Earth and space requires the use of some very specialized equipment. The satellites used for information collection often have much of this specialized equipment built into them. The weather satellites that send information to Earth about the weather can take pictures of cloud covers. Hurricanes can be tracked, allowing enough time to give hurricane warnings. Temperature **detectors** help us learn how temperature changes at different heights in the atmosphere. **Cosmic ray** detectors gather information about cosmic radiation, which is harmful to people. To collect scientific data, microphones are mounted on the satellite to record the sound of meteors hitting the satellite. These recordings give scientists information for improving satellites and increasing knowledge of meteors.

In the development of the space program for the United States, the National Aeronautics and Space Administration (**NASA**) agency has used manned space travel to gather information about Earth and space. The early missions of the *Apollo* spacecraft provided data and practice for landing on the moon. Subsequent landings on the moon provided over 2,000 samples of moon rock for study. Television cameras aboard today's spacecraft send pictures of the moon, Earth, and other planets back to scientists on Earth. Radio **transmitters** are used to send information to receiving stations on the ground. Antennas detect all kinds of radiation around the spacecraft.

space shuttle

The spacecraft itself is valuable for data collection. A reusable spacecraft designed to transport astronauts, materials, and satellites to and from space—called the **space shuttle**—acts as a taxi and helps to speed up technological research and improvements. Animals are sent into space to test how the effects of a flight could affect a person's breathing, heart action, muscle tension, body temperature, and other physiological functions. The shuttle carries such **payload** as communication satellites, telescopes, special scientific experiments, and scientific equipment to be placed in orbit. After each mission is completed, the main portion of the

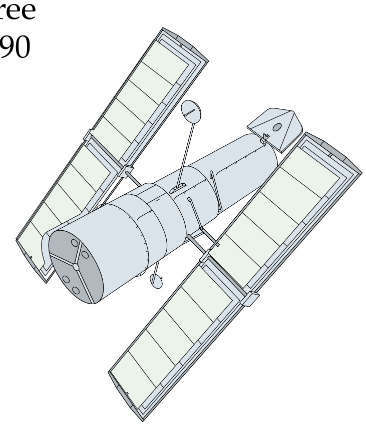
space shuttle

four-element shuttle system—the **orbiter**—glides back to Earth and lands like an airplane.

The United States and Russia have also launched **space stations**—space vehicles with living quarters, work space, and all of the equipment and systems necessary for astronauts to work and live. The space stations carry telescopes, cameras, computers, and anything needed for research projects. Future space stations may become factories or power stations for our future energy needs.

Back on Earth, all telescopes are used to concentrate information signals received from space. Some telescopes use mirrors or lenses to concentrate light waves to view images of planetary objects. Other telescopes, called *radio telescopes*, use large reflecting dishes and antennas to receive radio waves. From the ground, scientists are forced to study Earth and space more indirectly through telescopes or planetary probes that gather important information about other planets and send this information back to Earth.

The Hubble Space Telescope is designed to see 10 times more clearly into space than other Earth-based telescopes; it can see objects one-billionth as bright as the human eye can see. The Hubble telescope circles Earth every 97 minutes, 370 miles (595 kilometers) above the atmosphere. It was designed to last 15 years, with servicing every three years, the 43-foot Hubble was put into orbit in 1990 and began transmitting data back to Earth. An international project, the telescope contains equipment developed by the European Space Agency and a variety of United States institutions.



Hubble Telescope

The Hubble telescope's primary mirror (the benchmark by which telescopes are measured) is relatively small at 94.5 inches wide (2.4 meters). The mirror had a flaw which was corrected in 1993, and the Hubble has performed remarkably well since then.

The telescope is so sensitive that it can detect the equivalent of a flashlight beam from 250,000 miles away—the distance from Earth to the moon. Since the telescope is located beyond Earth's atmosphere, the telescope can receive ultraviolet and infrared light that doesn't reach Earth's surface.

The Hubble Space Telescope can be pointed anywhere in space except close to the sun, moon, or Earth's lighted side as the light is simply too bright for its sensitive instruments. Two antennas send out data and receive instructions from the ground via NASA's Tracking and Data Relay Satellite System. A receiving antenna is located in White Sands, New Mexico. The scientific data is then transmitted to other sites. The Hubble telescope has already given scientists new glimpses into the universe from discovering new galaxies to witnessing the formation of a black hole. It will be a useful tool for future scientific discoveries.

NASA Research

astronaut

Although many of us are unaware of them, the NASA space program has far-reaching effects that touch our daily lives. Technologies developed for the space program have been transferred to uses that are quite different from their original applications. These transferals have had an impact on many areas of life.

In the area of space research, NASA's technologies have created safer space travel for astronauts, provided more accurate information about the solar system, and improved command missions where unmanned satellites can probe space and gather important information. Any dangerous effects of space travel on astronauts are outweighed by the information that NASA is able to gather and put to use. This includes the remote possibility of finding homes for people on other planets.

Communication is another area in which the transferal of technologies has benefitted our everyday lives. Worldwide communications (television and radio) have been greatly improved and continue to improve daily. Our accuracy in forecasting the weather has increased. There are improved warning systems for dangerous storms.

These technologies have improved our military capabilities. While research has provided us with better defenses against foreign invasion, it has also created a nuclear power race among the more powerful countries.

The many research projects must be funded in some way. Funds for science research come from federal government agencies, industry, and private foundations. Many taxpayers object to the expenditure of the billions of tax dollars that are necessary to complete the research projects. It is difficult, however, to dispute the technological advances that have been made in the United States since our decision to explore that great space beyond our Earth.

Summary

People have been interested in studying the sky and celestial bodies since the earliest times. Observations have been recorded since 500 B.C. Our ideas about the universe changed as discoveries were made by scientists such as Copernicus and Galileo. Today, through research conducted by NASA using sophisticated technology, scientists can gather firsthand information. Astronauts travel safely in space shuttles and collect data from space stations. More distant parts of the universe can be studied with probes and satellites. The technological advances in communication and other areas have benefited us in many ways.

Practice

Use library **reference materials** *to answer the following.*

1. What were the major accomplishments of the following astronomers?

   Pythagoras (500 B.C.): ____

   ____

   ____

   Ptolemy (2nd century A.D.): ____________________________________

   ____

   ____

   Copernicus (1473-1563): _______________________________________

   ____

   ____

   Kepler (1571-1630): ____

   ____

   ____

   Galileo (1564-1642): ____

   ____

   ____

2. Name four instruments that are used to collect information about space.

3. Name the first communication satellite and describe its function.

Practice

Write **True** *if the sentence is correct. Write* **False** *if the sentence is* not *correct.*

__________ 1. Galileo was a Greek philosopher who believed that Earth was the stationary center of the universe.

__________ 2. The Polish astronomer Nicholas Corpernicus proposed that Earth was a planet and that it revolved around the sun.

__________ 3. Eratosthenes, a Greek astronomer, computed the size of Earth.

__________ 4. Pythagoras, an Italian astronomer, built his own telescopes.

__________ 5. Galileo discovered the first four moons of Jupiter.

__________ 6. Johannes Kepler supported the Copernican theory and developed his own laws of planetary motion.

__________ 7. The first astronomical phenomenon to be understood was the cycle of Earth.

__________ 8. A lunar probe is special instrumentation designed to be launched into space to gather information about the moon.

__________ 9. An eclipse is the obscuring of the sun as the moon passes directly between Earth and the sun.

__________ 10. The *Apollo* and the *Gemini* were probes sent into space to make direct observations of our solar system.

__________ 11. The only way to study the moon is indirectly by instrumentation.

Practice

Match each definition with the correct term. Write the letter on the line provided.

______ 1. a spacecraft designed to orbit a celestial body without landing on its surface

______ 2. communication over a distance

______ 3. a satellite that receives, amplifies, and relays signals

______ 4. rockets that carry cameras and other instruments to study space

______ 5. one who studies astronomy or makes observations of celestial phenomena

______ 6. device for indicating the presence of a certain substance

______ 7. a reusable spacecraft that carries astronauts into space and returns them to Earth

A. astronomer

B. communication satellite

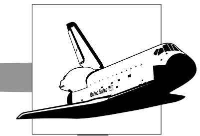
C. detector

D. orbiter

E. space probes

F. space shuttle

G. telecommunication



Practice

Match each definition with the correct term. Write the letter on the line provided.

______ 1. instrument for making distant objects appear larger and therefore nearer; may use lenses, mirrors, or an antenna

______ 2. satellites that continuously monitor weather conditions

______ 3. a person who flies in a rocket or space shuttle

______ 4. living quarters in space, equipped with all the necessary instruments to work and live

______ 5. manmade

______ 6. the load carried by a spacecraft

______ 7. the abbreviation for the National Aeronautics and Space Administration

______ 8. rays of very short wavelength and great power that hit Earth from beyond its atmosphere

A. artificial

B. astronaut

C. cosmic rays

D. NASA

E. payload

F. space stations

G. telescope

H. weather satellite

Practice

Use the list below to complete the following statements.

detectors	**planetary probes**	**telescopes**
funds	**satellite system**	**transmitters**
NASA	**space stations**	**weather satellites**
orbiter	**taxpayers**	**weather stations**

1. ____________________ are built into satellites to learn how temperature changes at different heights.

2. Today, there are more than 8,000 ____________________ around the world that make observations about our weather conditions.

3. ____________________ would send back pictures that show weather changes from hour to hour.

4. The Intelsat is the world's largest ____________________ , and it has 102 member nations.

5. ____________________ are used to send information to receiving stations on the ground.

6. After completing a mission, the main portion of the four-element shuttle system, the ____________________ , glides back to Earth and lands.

7. In the development of the space program for the United States, ____________________ uses manned space travel to gather information about Earth and space.

8. __________________________ carry telescopes, cameras, computers, and anything needed for research projects.

9. On Earth, __________________________ are used to concentrate information signals received from space.

10. From the ground, scientists are forced to study Earth and space more indirectly through telescopes or __________________________ that gather important information about other planets and send this information back to Earth.

11. Many __________________________ object to spending billions of tax dollars to complete research projects, but the technological advances in communication and other areas have benefitted us in many ways.

12. __________________________ for science research come from federal government agencies, industry, and private foundations.

Practice

Use the list below to write the correct term for each definition on the line provided.

artificial	**detector**	**space shuttle**
astronaut	**NASA**	**space stations**
communication satellite	**satellite**	**telecommunication**
cosmic rays	**space probes**	**transmitter**

________________________ 1. a satellite that receives, amplifies, and relays signals

________________________ 2. man-made

________________________ 3. a person who flies in a rocket or space shuttle

________________________ 4. rays of very short wavelength and great power that hit Earth from beyond its atmosphere

________________________ 5. communication over a distance

________________________ 6. instrument that sends signals from one place to another

________________________ 7. device for indicating the presence of a certain substance

________________________ 8. a reusable spacecraft that carries astronauts into space and safely returns them to Earth

________________________ 9. living quarters in space, equipped with all the necessary instruments to work and live

________________________ 10. an object that revolves around a larger object

_______________________ 11. rockets that carry cameras and other instruments to study space

_______________________ 12. the abbreviation for the National Aeronautics and Space Administration

Lab Activity

Purpose	Materials
Use the Internet to research a mission to explore space.	• reference material • Internet access

Use the list of **Internet sites** *below and other* **reference materials** *to complete this activity.*

Internet Sites:

NASA Shuttle Web
http://shuttle.nasa.gov/index.html/

The Space Experience - a guide to past and future space missions
http://www.geocites.com/CapeCanaveral/Hangar/5816/

Kennedy Space Center
http://www.ksc.nasa.gov/

NASA Web Site
http://www.nasa.gov/

NASA On-Line Resources for Educators
http://www.hg.nasa.gov/office/codef/education/online/html

NASA Classroom of the Future
http://www.cotf.edu/

NASA Observatorium
http://observe.ivv.nasa.gov/nasa/core.shtml

NASA Observatorium Human Spaceflight
http://observe.ivv.nasa.gov/nasa/spacefly/spacefly_index.shtml

Project Gemini
http://www.ksp.nasa.gov/history/gemini/gemini.html

Project Mercury
http://www.ksp.nasa.gov/history/mercury/mercury.html

Eye on the Universe - A Hubble Mission
http://www.thetech.org/hyper/hubble/

Hitchhiker's Guide to Hubble
http://www.discovery.com/area/specials/hubble/hubble1.html

Star Journey from National Geographic
http://www.nationalgeographic.com/features/97/stars/

Space Telescope Science Institute
http://www.stsci.edu/

Satellite Passes - shows positions of current satellites and orbiters over the United States)
http://www.bester.com/satpasses.html

GOES Project Science
http://climate.gsfc.nasa.gov/~chesters/goesproject.html

The Satellite Site - What is a satellite? Build one on the Internet.
http://www.thetech.org/hyper/satellite/

1. Name of the space mission or satellite: ____________________

2. Date of mission: ____________________________________

3. Major purpose: ____________________________________

4. Scientific discoveries made by exploration: ________________

   ____

   ____

5. Why was this mission helpful to the exploration of space and future discoveries?

   ____

   ____

   ____

Practice

Circle the letter of the correct answer.

1. An object that revolves around a larger object is a __________ .
   a. space shuttle
   b. space station
   c. transmitter
   d. satellite

2. The abbreviation for the National Aeronautics and Space Administration is __________ .
   a. NASA
   b. NAAA
   c. NATA
   d. ASA

3. Rocket-launched vehicles that carry instruments, cameras, and other data-gathering equipment for deep-space measurements are called __________ .
   a. space probes
   b. space shuttles
   c. detectors
   d. cosmic rays

4. __________ are living quarters in space, equipped with all the necessary instruments to work and live.
   a. Space shuttles
   b. Satellites
   c. Space probes
   d. Space stations

5. A __________ is a reusable spacecraft that carries astronauts into space and returns them to Earth.
   a. satellite
   b. space probe
   c. space shuttle
   d. space station

6. __________ is communication over a distance.

   a. Telecommunication
   b. NASA
   c. Astronaut
   d. Cosmic rays

7. A person who flies in a rocket or space shuttle is a(n) __________ .

   a. satellite
   b. cosmic ray
   c. astronaut
   d. detector

8. __________ are rays of very short wavelength and great power that hit Earth from beyond its atmosphere.

   a. Transmitters
   b. Detectors
   c. Cosmic rays
   d. Shuttles

9. __________ means manmade.

   a. Telecommunication
   b. Detector
   c. Cosmic rays
   d. Artificial

10. A __________ is a device for indicating the presence of a certain substance.

    a. space probe
    b. telecommunication
    c. transmitter
    d. detector

11. A __________ is an instrument that sends signals from one place to another.

    a. transmitter
    b. detector
    c. cosmic ray
    d. satellite

12. A(n) ____________ is a spacecraft designed to orbit a celestial body without landing on its surface.

    a. orbiter
    b. transmitter
    c. satellite
    d. space probe

13. The load that is carried by a spacecraft is called the ____________ .

    a. orbiter
    b. payload
    c. space shuttle
    d. satellite

14. An instrument that concentrates signals from space for viewing objects is a ____________ .

    a. transmitter
    b. space probe
    c. satellite
    d. telescope

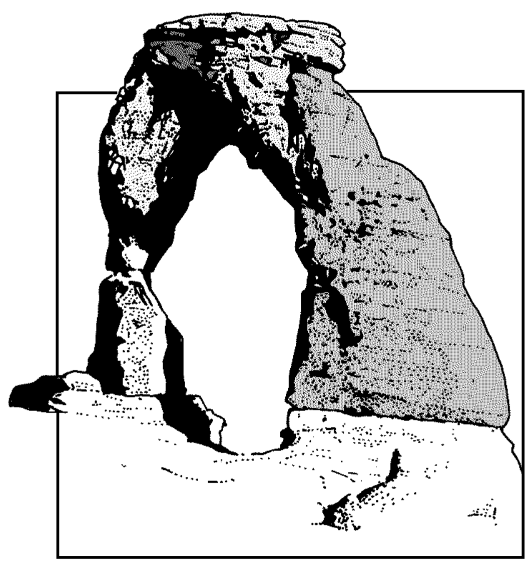
15. One who studies astronomy or makes observations of celestial phenomena is a(n) ____________ .

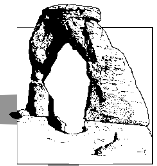
    a. astronaut
    b. detector
    c. astronomer
    d. transmitter

16. The science of celestial bodies and their properties is called ____________ .

    a. geology
    b. astronomy
    c. astrology
    d. biology

Unit 6: Rocks and Minerals





Vocabulary

Study the vocabulary words and definitions below.

cleavage .... the tendency of a mineral to break along a smooth or flat surface

conglomerates .... rocks composed of rounded fragments varying from small pebbles to large boulders in a cement

crystal .... a solid shape in which the atoms are arranged in a definite pattern forming flat faces

extrusive .... igneous rocks that cool on Earth's surface

fracture .... the tendency of a mineral to break along a jagged, uneven, or curved surface

fragmental rocks .... the first group of the formation of sedimentary rocks made from pieces or fragments of rocks

gems .... rare, precious, or semiprecious minerals

igneous rock .... a rock formed after magma has cooled

inorganic .... materials that do not contain carbon and have never lived

intrusive .... igneous rocks that cool below Earth’s surface

lava .... melted rock (magma) on the surface of Earth

luster .... the reflecting qualities of a material; its shine or surface appearance

magma .... melted (hot liquid) rock found inside Earth

metallic minerals .... minerals that have a shiny appearance and are good conductors of heat and electricity

metals .... minerals that conduct heat and electricity; have shine

metamorphic rock .... an igneous or sedimentary rock that has been changed by heat and pressure

mineral .... an inorganic substance with a definite chemical formula and specific shape

mineralogist .... a scientist who studies and identifies minerals

Mohs’ scale .... a scale used to test the hardness of a mineral

nonmetallic minerals .... minerals without metal, with no shine

nonmetals .... minerals that do not conduct heat or electricity; have no shine

ore .... a rock or mineral from which metals and nonmetals can be removed in usable amounts

organic... materials formed from the remains of plants and animals

rock .... a solid material made of one or more minerals

rock cycle .... continuous change of rocks from one form to another

sediment .... small pieces of rock

sedimentary rock .... rock made up of several layers of sediment cemented together

specific gravity .... the ratio or relationship between the mass of the mineral and the mass of an equal volume of water

Introduction

Rocks and **minerals** form the basis of the soil that we walk upon. The study of their formations and their properties enable us to identify common rocks and minerals found in our environment.

As a result of physical and chemical processes, Earth's materials constantly change. Heat and pressure cause rocks to change from one form to another in a continuing cycle. The forces acting on Earth create many landforms and rock structures, which affect the topography of an area. Florida's most common rock is limestone. Reefs, caves, and sinkholes are features of our state's unique environment.

Properties of Minerals

Most of the solid part of Earth's crust consists of *minerals*. The most common minerals are formed from eight common elements. Minerals have five special characteristics, which are described below.

Mineral Characteristics

1. A mineral occurs naturally in Earth; it is not manufactured.
   Iron is a mineral because it is a naturally occurring substance found on Earth. Steel, however, is manufactured, so it is not a mineral.

2. Minerals are **inorganic**. They are not made from things that are living or were once living.
   Coal is *not* a mineral because it is **organic** and is composed of the remains of plants and animals.
   Quartz is a mineral because it is inorganic and is composed of the nonliving substances of iron and oxygen.

3. Minerals are always found as solids in Earth.

4. Minerals always have a definite chemical composition. They have the same kinds of atoms in the same proportions in every sample.

5. There is a definite geometrical arrangement or orderly pattern of atoms in most minerals. This orderly arrangement forms **crystals**.

Minerals from which **metals** or **nonmetals** can be removed in large enough amounts to be usable are called **ores**. Metals are minerals that can conduct heat and electricity and have a shine to them. Gold, silver, aluminum, and copper are examples of metals. Nonmetals are not shiny and do not conduct heat and electricity well. Nonmetals are often gases or soft solids. Some examples of nonmetals found in ores are sulfur, phosphorus, oxygen, and nitrogen.

Gems are rare minerals that are beautiful, long-lasting, and durable. Precious gems are very rare, beautiful, and valuable. These include diamonds and emeralds. Gems are usually cut into specific shapes. Other gems such as opals, turquoise, and topaz are semiprecious.

The shape of gems is a product of their structure. That is, a diamond is shaped a certain way because of the way its atoms are assembled. When two or more atoms are brought close enough together, an attractive force between the electrons of the atoms and/or the nucleus of the other atoms can result. If this force is strong enough to keep the atoms together, a chemical bond is said to be formed. Crystals are formed when atoms combine by sharing electrons in regular patterns as a substance (usually a liquid) is cooled. All rocks and minerals are formed from atoms sharing bonds with other atoms. This bonding or sharing of electrons produces a new chemical substance with different physical properties. For example, diamond and coal are composed of carbon atoms, but they have different physical properties resulting from the different type of bonds between the atoms.

Mineral Identification

Mineralogists are scientists who study and identify minerals. Some minerals can be recognized by their appearance. However, because so many minerals look alike, tests have been developed to help identify minerals. Knowing the properties of minerals makes it easier to identify them.

gems are rare minerals

Physical Properties

Many minerals can be identified by their physical properties, such as color, texture, hardness, or **luster**. Other minerals must be tested with chemicals to determine their identity. Below are some tests that can be performed to identify minerals by their physical properties.

Luster. Luster is usually determined by deciding whether the mineral is shiny (reflects light) or not. A **metallic mineral** (such as the metals silver or gold) is shiny and is said to have a metallic luster. Minerals that do not shine like a metal are said to have a nonmetallic luster. These **nonmetallic minerals** may look dull, pearly, glassy, silky, or transparent (light can pass through).

Color. The color of a mineral is one of the first physical properties to be observed. However, color can be used in determining only a few minerals—those which are always the same color. The mineral gold, which is a metallic yellow, is an example. Other minerals are turquoise (blue-green), sulfur (yellow), hematite (dark red), and azurite (deep blue). The color of many other minerals can change because of impurities in them. Also, several minerals can have the same color. Calcite, talc, and halite are all white, for example. So, to be sure, other tests are needed to identify minerals.

Shape. Many minerals can be identified by whether they have a crystal form. A crystal form is a regular, geometric pattern that creates flat faces. The different crystal forms also aid in identifying minerals. Crystalline form is not natural for all minerals. That is one reason to use other methods of identification.

Cleavage. The way a mineral breaks is described as either **cleavage** or **fracture**. Minerals cleave if they break along a smooth, flat plane. Some rocks cleave in only one direction, such as mica, which splits into thin sheets. Other rocks will show perfect cleavage in several directions. Feldspar splits in different directions, but nearly always at right angles.

A gentle tap of a hammer on the mineral will make it cleave or split. Some minerals do not split in a definite direction. When the break causes an irregular surface, it is called a *fracture*. The surface may be rough and curved with thin, jagged points. Quartz is a mineral that does not break in any certain pattern.

Streak. A streak test reveals the true color of the mineral. A streak is the color of the powdered mineral. You may have done something similar to a streak test if you used a soft stone to write on the sidewalk. To find the streak color, rub the unknown mineral on a hard, rough, white surface (like the unglazed side of a bathroom tile or a streak plate). It may leave a streak of color. The color of the streak is used to identify the mineral.

The color made by the streak test is always the same, but it may not be the same color as the larger piece of the mineral. Some minerals, however, streak the same color as they appear. For example, talc is white and its streak is white. The streaks of some minerals are different from their appearance. Hematite, for example, may be red or black, while the powder from the streak test is always cherry red. Also, the mineral iron pyrite is yellow, but it has a greenish-black streak.

Of course, for a mineral to leave a powder on the streak test, it must be softer than the streak plate. This is why minerals harder than a porcelain tile (measuring more than five on the **Mohs' Scale** of Hardness) will not leave a streak.

Specific Gravity. **Specific gravity** is useful in recognizing heavy minerals and many jewels. The specific gravity of a mineral is its weight compared to an equal volume of water. For example, if a mineral weighs four times as much as an equal volume of water, its specific gravity is four.

Minerals which contain metals are usually dense. The density, or *heft*, is judged rather than actually measuring specific gravity.

A diamond is the hardest mineral.

Hardness. Hardness is one of the properties most useful in identifying a mineral. Hardness is a mineral's resistance to being scratched. In other words, "What can it scratch?" or "What can scratch it?" We test a mineral against other minerals. The harder mineral will always scratch a softer mineral.

A German mineralogist named Friedrich Mohs (1773-1839) worked out a scale of hardness. This scale—called *Mohs' scale*—is used to identify a mineral's hardness. Ten minerals whose hardness is known are arranged in the order of their increasing hardness. Each mineral is given a number from one to 10. Talc is the softest mineral, so it is given the number one. Diamond is the hardest mineral, so it is given the number 10.

A mineral will scratch any mineral with a lower number. If two minerals do not scratch each other, they have the same hardness. Diamonds will scratch all other minerals, and talc can be scratched by most other minerals.

Mohs' Scale of Hardness

Hardness		**Mineral**
softest	1	talc
	2	gypsum
	3	calcite
	4	fluorite
	5	apatite
	6	feldspar
	7	quartz
	8	topaz
	9	corundum
hardest	10	diamond

If you are on a field trip collecting minerals, you may not be able to find other minerals needed to use for the hardness test. In such a situation a field scale can be used. The hardness determinations are not as exact as those using the minerals on Mohs' scale of hardness minerals, but they will be close enough for field use.

Field Scale of Hardness

Hardness		**Test**
softest	1	soft and greasy feeling, scratched easily with fingers
	2	scratched by fingernail with a lot of pressure
	3	scratched by a copper penny
	4	scratched easily by a knife
	5	scratched by a knife using a lot of pressure
	6	scratched by a steel file
	7	can scratch a steel file or piece of glass
	8	can scratch quartz
	9	(no good field tests for hardness above #8)
hardest	10	

Acid Test. There are many chemicals that could be used as a mineral test. One test often used is the hydrochloric acid (HCl) test. When HCl is put on a mineral, bubbles may occur. If bubbles are given off, then calcite is present. Hydrochloric acid detects the presence of oxygen or carbon.

The color a flame turns when a small amount of the mineral is placed in it tells what metals are present. For example, copper turns the flame green.

Other Tests. In addition to those tests described above, the shape and size of the crystals found in a mineral can assist in determining its identity. Also, magnetic properties may be present. Minerals that contain iron or magnetite are attracted by a magnet. Still other minerals have unusual or unique characteristics: halite has a salty taste; sulfur a definite smell; and jade, when tapped, will have a bell-like ring.

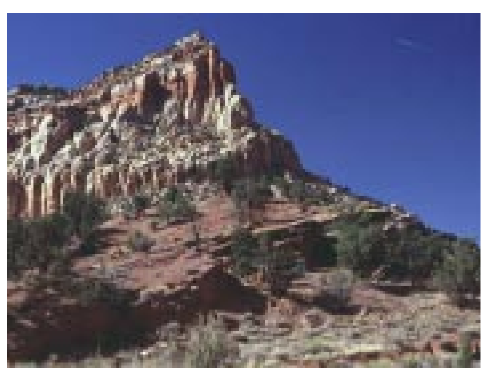
Mineral Identification	
Physical Properties	**Chemical Properties**
1. luster 2. color 3. shape 4. cleavage 5. streak 6. specific gravity 7. hardness	1. acid test 2. flame test

Major Types of Rocks

Rocks are composed of one or more minerals. About a dozen minerals are common rock-forming minerals. Elements such as oxygen, silicon, carbon, and sulfur combine with minerals to form many types of rocks. Rocks are classified into three groups, according to the way they were formed. These three groups of rocks are igneous, sedimentary, and metamorphic.

Igneous Rocks

The group of rocks known as igneous originate deep inside Earth. The word igneous means *fire-formed*. It is so hot in Earth's mantle that rocks and minerals melt and become liquid or molten material. This molten material inside Earth is called **magma**. **Igneous rocks** form when the magma cools and hardens.



igneous

Magma below the surface of Earth cools very slowly. The magma eventually becomes solid or crystallizes within Earth. These rocks would not be seen if not for erosion. Igneous rocks that are formed inside Earth are called **intrusive**. The crystals in intrusive igneous rock, such as granite, are large because the magma cooled slowly.

Granite is the most common igneous rock. Its large crystals tell us that it was formed by cooling slowly below Earth's surface. Granite makes up much of the continental crust. It is strong and can be polished. It is used in many buildings and monuments. Granite varies in color from a light gray to a pinkish color, depending on the proportion of each of the minerals (quartz, feldspar, and mica) present in the granite.

Sometimes the molten material, magma, is pushed from deep within Earth to the surface of Earth from volcanoes. On occasion, the molten materials break through the surface. If this molten material escapes from a volcano, it is called **lava**. Lava flows on the surface. Lava usually cools very quickly, forming small crystals. Sometimes it cools so quickly that no crystals are formed.

The volcanic rocks formed when lava cools on Earth's surface and becomes solid are called **extrusive**. Basalt is a common extrusive igneous rock with small crystals. Basalt is found in areas where there were ancient lava flows. It is plentiful in the Hawaiian Islands and makes up much of the ocean's crust. Obsidian is another extrusive rock that forms when magma cools so quickly that no crystals form. It is black and glassy in appearance. Another extrusive rock is pumice. It cools so quickly that it has no crystals and has holes made by the gases escaping from the lava. It is the only rock that floats.

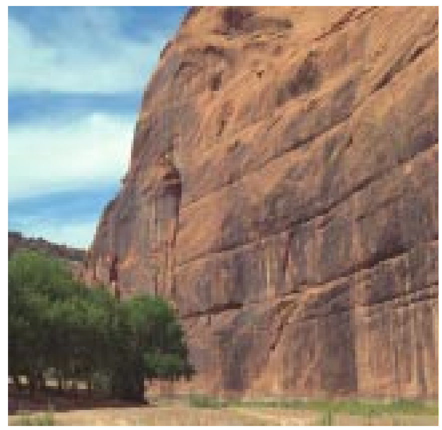
hardened lava

Sedimentary Rocks

The surface of Earth is always being broken into smaller and smaller pieces through a process called *weathering*. Broken pieces such as rocks, gravel, pebbles, sand, and clay are *rock fragment*s. Rock fragments ranging in size from large gravel to microscopic bits are moved from place to place by the agents of erosion: wind, water, gravity, and glaciers. Rock fragments will settle in one place and pile up. These rock fragments that pile up are known as **sediment**. Most sediment builds up under water. Sediment piles up in layers on top of layers and over time becomes cemented together.

Sediment can harden to form **sedimentary rocks**. Sedimentary rocks are formed in two ways: (1) When new sediment piles on top of old sediment, the pressure of the weight of the top layers will harden the layers below; and (2) dissolved minerals in the water can cement the sediment together. All sedimentary rocks are made of layers, with the oldest sediments on the bottom and the newest ones near the top.

Sedimentary rocks are divided into three groups according to where the sediments came from and how the rocks were formed. The first group of sedimentary rocks are made from pieces or fragments of rocks and are called **fragmental rocks**. Rocks formed from these deposits are called *clastic* sedimentary rocks. They are further classified by the size of the pieces of rock in them. Those made of small, sand-sized grains of rock are called *sandstones*. They become cemented together by minerals such as quartz that are dissolved in the water that flows over them. *Shale* is made from clay or mud, which has somewhat larger particles than sandstone. The particles in shale are flat and are easily broken apart into flat pieces. Some fragmental rocks have large pebbles mixed with mud and sand. They are called **conglomerates**.



sedimentary

A second type of sedimentary rock is called *organic*. Organic sedimentary rock forms when the remains of plants and animals harden into rock. For example, limestone is formed from the shells of sea animals. The coral reefs off the coast of Florida are made of limestone deposits. Coal is another organic rock formed from plants that lived millions of years ago.

The third type of sedimentary rock is *chemical*. Chemical sedimentary rocks are formed when water evaporates and leaves behind mineral deposits. Halite or rock salt is a chemical rock. Many chemical rocks are found near the Great Salt Lake in Utah.

Metamorphic Rocks

The word *metamorphic* comes from the Greek words meaning *change* and *form*. **Metamorphic rocks** are rocks that used to be a different kind and have changed over time. Metamorphic rocks are formed deep within Earth where the temperature is high and the pressure is great. Rocks are changed by heat, pressure, and chemical action.

metamorphic

Heat alone can change one kind of rock into another kind of rock. This heat is supplied by magma. Heat and pressure together can change rocks, too. Rocks can also be changed by chemical actions. Magma contains chemicals that can cause changes in the rocks it touches. The new rocks are harder and may look different, and the minerals in these rocks may change.

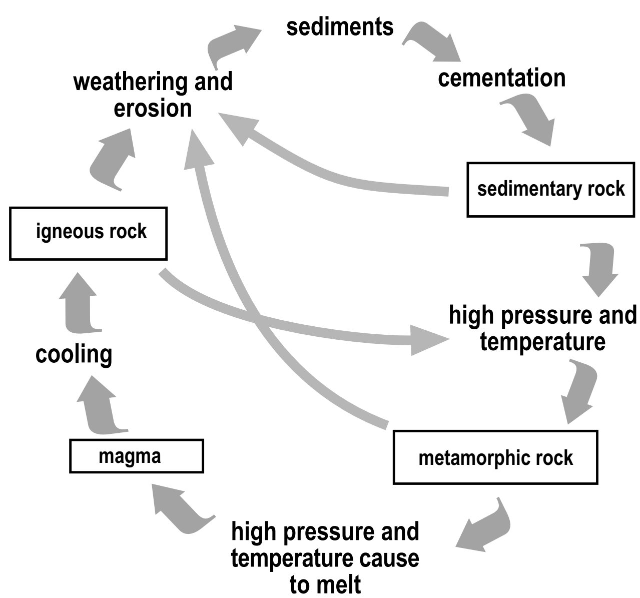
Igneous rocks and sedimentary rocks can change to form metamorphic rocks. Sedimentary rocks such as limestone, which is fairly light and grainy and can be rubbed to a smooth finish, may change into marble, which is heavy and can be polished into a glass-like luster. Shale, which feels like hard mud and crumbles under pressure, may change to slate, which is very hard, fine-grained, and brittle. Sandstone is a soft rock that is easily broken. It may change into quartzite, which is finer grained, harder, has a glass-like luster, and is not easily broken.

Granite is an igneous rock with a mixture of large and small crystals found in several colors. It may change into gneiss (pronounced *nice*), which is streaked and composed of very small crystals of many colors.

The Rock Cycle

The continuous changing of rocks from one form to another is called the **rock cycle**. Igneous rocks are the ancestor of all rocks. Wind and water caused some of the igneous rock to be broken down to eventually form sedimentary rock. Some of the igneous and sedimentary rocks became buried deep in Earth. The high temperature and pressure caused them to be changed into metamorphic rocks. Eventually the metamorphic rocks will be exposed to the surface of Earth again and be broken down into sediments by wind and water. All three types of rocks may become buried so deeply that they become a liquid, and magma will be formed again. When the magma cools, it will form igneous rock, and the cycle will repeat again and again.

The Rock Cycle



Major Florida Rock Formations

Limestone is by far the most abundant rock formation in Florida. It lies under the land in all of the state. Limestone is a sedimentary rock composed of calcium carbonate ($CaCO_3$). Florida limestones range from hard and compact to soft and chalky. They range in color from white or light gray to a light grayish brown. Limestone may be easily identified by applying a drop of hydrochloric acid, which causes the calcite particles to bubble.

Limestone in the state is divided into several types. Key Largo limestone is found in the Florida Keys and contains fossil corals. Another type of limestone is oolite. Oolites are small rounded grains which look like fish eggs. These grains are formed by the deposition of layers of calcite around tiny particles, such as sand grains or shell fragments. It is found in several southern Florida counties.

Another type of Florida limestone is coquina. Coquina limestone is composed of shells and quartz sand grains that have been cemented together. Coquina has long been used as a building stone in Florida and is used today in architecture because of its unusual beauty. As you would expect, coquina is rarely found far from the coast.

In many areas of north and central Florida, underground water dissolves the limestone and carries it away, forming underground caves and caverns. During periods of drought, the roofs of these underground structures sometimes cave in, forming sinkholes.

Florida produces millions of tons of limestone and other minerals each year. Limestone production is a major industry in Florida. Most of the limestone produced in the state is crushed for use in making roads and concrete. It is also used as a conditioner for soil in agriculture, riprap (broken stone for foundations), and building stone walls.

Dolomite, common clay, kaolin (china clay), fuller's earth, and quartz sand are other common Florida rocks. These valuable natural resources are important for the state's economy. (See chart below for information about the uses of these rocks.)

Rocks	Uses
limestone	roads, concrete, cement, fertilizer, soil conditioner
dolomite	agricultural lime, cut stone
common clay	roads, brick, cement
kaolin	ceramics, tile, rubber, plastics, paper, paint
fuller's earth	absorbent (kitty litter, oil dry), insecticides, soaps, plastics, paints

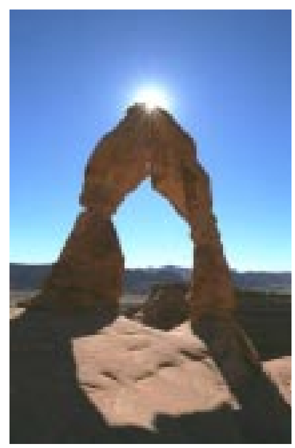
Summary

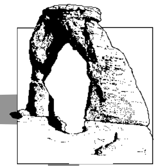
Earth's crust is composed of elements which combine to form minerals. Minerals have five essential characteristics: naturally formed, inorganic, solid, a definite chemical formula, and an orderly arrangement of atoms. Minerals are identified by their physical properties, including luster, color, shape, cleavage, streak, specific gravity, hardness, and certain other tests.

Rocks are composed of one or more minerals. The three major types of rocks are igneous, sedimentary, and metamorphic. Rocks are continually changing from one form to another through the rock cycle.

Florida's rock formations consist of mostly limestone. Key Largo, oolite, and coquina are three of the different types. Florida's other rock formations include dolomite, common clay, kaolin, fuller's earth, and quartz sand. These natural resources are important for the state's economy.

Interesting rock formations found in the United States.





Practice

Use the list below to write the correct term for each definition on the line provided.

aluminum	**inorganic**	**ores**
atoms	**metals**	**rocks**
copper	**minerals**	**silver**
definite	**naturally**	**solid**
gold		

1. Our soil is made of ____________________ and ____________________ .

2. Five essential characteristics that all minerals have are as follows:
   1) ____________________ formed; are
   2) ____________________ ; are
   3) ____________________ ;
   4) have a ____________________ composition; and
   5) most have a definite geometric arrangement of ____________________ .

3. Rocks or minerals from which we can remove usable amounts of metal are called ____________________ .

4. Minerals that conduct heat and electricity and have a shine to them are called ____________________ .

5. Four metals are ____________________ , ____________________ , ____________________ , and ____________________ .

Practice

Use the list below to write the correct term for each definition on the line provided.

diamonds	**nitrogen**	**phosphorus**
emeralds	**opals**	**sulfur**
gems	**oxygen**	**topaz**

1. Four nonmetals are ____________________ ,

   ____________________ , ____________________ ,

   and ____________________ .

2. Rare minerals that are beautiful, long-lasting, and durable are

   called ____________________ .

3. Two precious gems are ____________________ and

   ____________________ .

4. ____________________ and ____________________ are two

   semiprecious stones.

Lab Activity 1: Identifying Minerals—Luster

Purpose	**Materials**
Identify the luster of certain mineral samples.	• mineral samples

1. Observe each mineral and describe its luster.
2. When you have determined the luster, place a check in the appropriate space on the chart below.
3. When you have finished, return each mineral to its own box.

Metallic		Nonmetallic					
color		dull	pearly	glassy	silky	sparkling	other
A							
B							
C							
D							
E							
F							
G							

4. Why is this test useful? ______________________________________

____

____

Lab Activity 2: Identifying Minerals—Color, Shape, and Cleavage

Purpose	**Materials**
Identify the color, shape, and cleavage of certain mineral samples.	• mineral samples

1. Look at each sample mineral. (These samples have already been split.)

2. Determine the color of each sample. Record your observations in the chart.

3. Observe each mineral and try to describe its shape (square, rectangle, round, oval, diamond, no shape). When you have determined the shape, write your answer in the chart below.

4. Then, for each mineral, decide if it has any flat surfaces. If it does, write *flat*. If it does not, write *not flat*.

5. Use your answers from the chart below to answer the questions on the following page.

Sample	Color	Shape	Surface
A			
B			
C			
D			
E			
F			
G			

6. Which samples are the same color? ______________________________

____

7. Which samples do you think are the same mineral? _______________

____

Why? ____

8. Do you think color is an important clue in identifying these minerals? ______ Why or why not? ______________________________

____

9. Which samples have flat surfaces? _______________________________

____

10. Which samples do not have flat surfaces? _________________________

____

11. Which samples have cleavage? __________________________________

____

12. Which samples fracture? _______________________________________

____

13. Why is this test useful in identifying minerals? __________________

____

____

____

____

Practice

Below are 10 **descriptors for minerals**. *Each one is the result of a certain* **mineral test**. *Which test is it? Choose the test from the list, and write the name of the test next to the correct descriptor. One or more tests will be used more than once.*

Mineral Tests

cleavage	**hydrochloric acid**	**specific gravity**
color	**luster**	**streak**
hardness	**shape**	

1. soft ______________________________
2. dull ______________________________
3. geometric figure ______________________________
4. deep blue ______________________________
5. smooth, flat surface ______________________________
6. cherry red powder ______________________________
7. weight ______________________________
8. bubbles ______________________________
9. break ______________________________
10. shiny ______________________________

Lab Activity 3: Identifying Minerals—Hardness

Purpose

Identify the hardness of certain mineral samples.

Materials

- mineral samples
- hardness field scale

1. Label each sample with a different letter.
2. Using the hardness field scale on page 153, test sample A for each of the properties on the list.
3. After you have determined the mineral's hardness, record your answers below.
4. Repeat the procedure for each mineral sample.
5. What is the hardness number for mineral A? ______________
6. What is the hardness number for mineral B? ______________
7. What is the hardness number for mineral C? ______________
8. What is the hardness number for mineral D? ______________
9. What is the hardness number for mineral E? ______________
10. What is the hardness number for mineral F? ______________
11. What is the hardness number for mineral G? ______________

Lab Activity 4: Mineral Identification—Hydrochloric Acid Test

Purpose

Identify minerals using the hydrochloric acid test.

Materials

- mineral samples
- eyedropper
- hydrochloric acid

1. Take the mineral in sample A, and with an eyedropper, place a drop of hydrochloric acid (HCl) on it. *Caution:* Be very careful when using HCl—wear safety goggles and aprons. Clean up all spills immediately!

2. On the chart below, record what happens.

3. Repeat steps one and two with each sample.

Sample	Reaction with HCl	Calcite ?
A		
B		
C		
D		
E		
F		
G		

4. Why do you think this test is considered helpful in identifying minerals?

____

____

Lab Activity 5: Mineral Identification—Physical Properties

Purpose	**Materials**
Identify minerals using physical properties.	• mineral samples

1. Use the key below to identify mineral samples. For each sample, begin at 1. Either 1A or 1B will describe the mineral. Follow the directions given. Continue following directions until the mineral is identified.

2. Record the name of the mineral on the chart on the following page.

3. Start again with the next sample.

Dichotomous Key: Minerals

1.	A.	Metallic	Go to 2
	B.	Nonmetallic	Go to 3
2.	A.	Shiny gray color	Galena
	B.	Brassy yellow color	Pyrite
3.	A.	Scratches glass	Go to 4
	B.	Does not scratch glass	Go to 5
4.	A.	Cleavage	Feldspar
	B.	No cleavage	Quartz
5.	A.	Earthy, dull appearance/no cleavage	Go to 6
	B.	Cleavage/shiny appearance	Go to 7
6.	A.	Yellow color	Sulfur
	B.	Red to brown streak	Hematite
7.	A.	Cubic cleavage/salty taste	Halite
	B.	Crystal shape/double image when placed on printed page	Calcite

Mineral		Mineral	
A		E	
B		F	
C		G	
D		H	

Lab Activity 6: Forming Crystals

Purpose	**Materials**
Observe the formation of crystals.	• water • 2 shallow, ovenproof glass dishes • salt • sugar

1. Boil a small amount of water.
2. Stir in as much salt or sugar as will dissolve. Stop adding salt or sugar when it starts settling on the bottom without dissolving.
3. Label two shallow, ovenproof glass dishes A and B.
4. Divide the solution into the dishes.
5. Slowly heat the dish labeled A over a flame until the water is evaporated. (Be careful to watch so it does not burn.)
6. Set aside dish B for several days, then check it for crystals.
7. Describe the crystals in dish A. ______________________________

    ____

    ____

    ____

8. How did the crystals form in dish A? ________________________

    ____

    ____

    ____

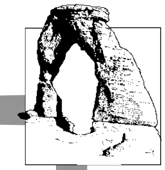
9. Describe the crystals in dish B.

10. How did these crystals form?

11. What is your conclusion about the formation of the crystals?

12. Which dish is most like extrusive rocks?

13. Which dish is most like intrusive rocks?



Practice

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct. In each* **false** *statement,* **circle** *the word or words that make the statement* false.

__________ 1. Color is a property of minerals.

__________ 2. Texture is how a mineral shines.

__________ 3. Streak is a property of minerals.

__________ 4. All minerals streak the same color.

__________ 5. All minerals have the same density.

__________ 6. Some minerals are softer than others.

__________ 7. A mineral has cleavage when it breaks along rough surfaces.

__________ 8. Most minerals have crystals.

__________ 9. Some minerals are shiny.

__________ 10. A mineral fractures when it breaks along flat surfaces.

__________ 11. Talc is the hardest mineral.

__________ 12. Diamond is the softest mineral.

__________ 13. The ability of a magnet to attract a mineral can help identify it.

__________ 14. All samples of a mineral will be the same color.

__________ 15. Some minerals fizz or bubble when acid is dropped on them.

Practice

Match each description with the correct name of the **mineral identification test**. *Write the letter on the line provided.*

_______ 1. the way a mineral reflects light; it may have a metallic, glassy, pearly, greasy, silky, or brilliant appearance

_______ 2. the color of a mineral in its powdered form; shown by rubbing the mineral across a piece of unglazed porcelain

_______ 3. a mineral's resistance to being scratched; it is measured on a scale from one to 10

_______ 4. when a mineral breaks along a smooth or flat surface

_______ 5. when a mineral breaks along an uneven or curved surface

_______ 6. the comparison of the weight of the mineral with an equal amount of water

_______ 7. atoms arranged to form flat faces

_______ 8. can be attracted by a magnet

_______ 9. the mineral will bubble or fizz when acid is dropped on it

_______ 10. the color of flame given off by a mineral gives its identity

_______ 11. scale used to measure the hardness of a mineral

_______ 12. one of the first observable properties

A. acid test

B. cleavage

C. color

D. crystals

E. flame test

F. fracture

G. hardness

H. luster

I. magnetic properties

J. Mohs' scale

K. specific gravity

L. streak

Lab Activity 7: Forming Sediments

Purpose	Materials
Use laboratory materials to form sediments.	• large container • sodium carbonate • calcium carbonate • water • 2 test tubes

1. Dissolve about 1 gram of sodium carbonate in 10 milliliters of water in a test tube.

2. In a second test tube, dissolve about 1 gram of calcium carbonate in 10 milliliters of water. (Both of these solutions should be clear and colorless.)

3. Pour the contents of these two test tubes into the same larger container.

4. What happened? ____

   ____

   ____

   ____

5. After a few minutes, what forms in the bottom of the container?

   ____

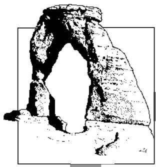
   ____

6. How could this be similar to the way sediment forms in the water?

   ____

   ____

   ____



Lab Activity 8: Form Sedimentary Rocks from Other Rocks

Purpose	**Materials**
Form sedimentary rocks from other rocks.	• large jar • mixture of sedimentary particles • paper cups • plaster of Paris

Part 1

1. Mix some soil, sand, and pebbles in a jar.
2. Add water and stir or shake this mixture well. Watch how the particles settle.
3. Which one settled first? ______________________________
4. Why do you think it settled first? ______________________________

   ____
5. Does it settle in layers? ______________________________

Part 2

1. Pour the mixture above into a paper cup.
2. Very carefully, pour the water out of the paper cup, leaving a mixture of sand, soil, and pebbles.
3. Mix a small amount of plaster of Paris in another paper cup. The plaster should be thin and watery.
4. Pour plaster of Paris into the first cup with the sand, soil, and pebble mixture.
5. Set aside to dry.

6. The next day, if the plaster of Paris is dry, tear away the paper cup.

7. Describe what you see when you tear away the paper cup.

Lab Activity 9: Rock Types

Purpose	**Materials**
Identify rock types by their physical characteristics.	• rock samples • magnifying glass

Rock	Color	Fragments Present	Describe Layers	Describe Crystals Present	Color Bands	Texture	Rock Type
A							
B							
C							
D							
E							
F							
G							

1. Choose a rock sample and examine it carefully.
2. Record the physical characteristics in the chart above.
3. Compare the characteristics with rock characteristics described in the unit.
4. Determine the type of rock, and record it in the chart above. Write **I** for Igneous, **M** for Metamorphic, and **S** for sedimentary.
5. Repeat for each sample.

6. List three characteristics used to identify igneous rocks.

____

____

____

7. List three characteristics used to identify sedimentary rocks.

____

____

____

8. List three characteristics used to identify metamorphic rocks.

____

____

____

9. What type of rock is the easiest to identify? ____________________

   Why? ____

____

____

10. Does color aid in the identification of rock types? ______________

   Explain. ______________________________________

____

____

____

Practice

Use the drawing of the **rock cycle** *on page 160 to answer the following by writing* **yes** *or* **no**.

> **The Rock Cycle**
>
> A rock may change in many different ways. A rock may even repeat the changes over and over again. This is known as the rock cycle. Follow the arrows in the diagram on page 160 to see how a rock of one kind can be changed into a rock of another kind.

1. Is there a specific place in the cycle where the rock cycle begins?

   ____

2. Do the changes in a rock's form take place in any special order?

   ____

3. The arrows show the paths a rock can take to change into another type of rock. Can the paths be traveled in all directions? __________
4. Can a sedimentary rock turn into either a metamorphic or igneous rock? ____
5. Can a metamorphic rock turn into either a sedimentary or an igneous rock? ____
6. Can an igneous rock turn into either a metamorphic or a sedimentary rock? ____
7. Can a rock change into another type of rock (igneous, metamorphic, sedimentary) in any order? ____

Answer the following using complete sentences.

8. What does the word cycle mean? ______________________________

____

____

9. Why do you think mineralogists call this a cycle? _______________

____

____

____

10. What takes place for an igneous rock to become a metamorphic rock?

____

____

____

____

____

11. What takes place for a sedimentary rock to become a metamorphic rock?

____

____

____

____

____

12. What takes place for an igneous rock to become a sedimentary rock?

13. What takes place for a metamorphic rock to become a sedimentary rock?

14. What takes place for a metamorphic rock to become an igneous rock?

15. What takes place for a sedimentary rock to become an igneous rock?

Practice

Answer the following using complete sentences.

1. What is the most abundant rock formation in Florida? ____________

2. What is the chemical name and formula for limestone? ____________

3. What are some uses of limestone? ____________

4. Name three different types of limestone. ____________

5. Which type of limestone is found on the coast of Florida? ____________

6. How is coquina limestone formed? ______________________________

____

____

7. What are three other important types of rocks found in Florida?

____

____

____

8. Why are these three important to the state? ______________________

____

____

____

9. How are the underground caves and caverns found in Central Florida formed?

____

____

____

____

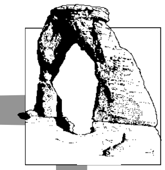
10. How does a sinkhole form? _____________________________________

____

____

____

____



Practice

Circle the letter of the correct answer.

1. __________ is not one of the three main types of rocks.
   a. sedimentary
   b. igneous
   c. metamorphic
   d. conglomerate

2. Igneous rock that cools inside Earth is called __________ .
   a. extrusive
   b. intrusive
   c. sedimentary
   d. metamorphic

3. Sedimentary rocks are the result of __________ .
   a. weathering
   b. fire
   c. heat
   d. pressure

4. The rock that floats is __________ .
   a. granite
   b. basalt
   c. halite
   d. pumice

5. The coral reefs off Florida's coast are made of __________ .
   a. sandstone
   b. limestone
   c. shale
   d. granite

6. Coal is a(n) __________ rock.
   a. chemical
   b. fragmental
   c. organic
   d. extrusive

7. Rocks that change in form are called __________ .

    a. igneous
    b. sedimentary
    c. metamorphic
    d. fragmental

8. __________ sedimentary rocks form when water evaporates and leaves behind a mineral deposit.

    a. Fragmental
    b. Organic
    c. Intrusive
    d. Chemical

9. Rocks made of large pebbles mixed with mud and sand are __________ .

    a. conglomerates
    b. sandstone
    c. limestone
    d. shale

10. Igneous rocks are also known as __________ .

    a. rocks that have changed in form
    b. fire-formed rocks
    c. rocks that result from weathering
    d. organic

11. Marble is a metamorphic rock that forms from __________ .

    a. shale
    b. limestone
    c. sandstone
    d. granite

12. __________ is not a metamorphic rock.

    a. marble
    b. gneiss
    c. slate
    d. granite

Practice

Use the list below to write the correct term for each definition on the line provided.

gems	**magma**	**ore**
igneous rock	**metamorphic rock**	**sediment**
inorganic	**mineral**	**sedimentary rock**
lava		

________________________ 1. does not contain carbon and has never lived

________________________ 2. a rock or mineral from which metals and nonmetals can be removed in usable amounts

________________________ 3. rare, precious, or semiprecious minerals

________________________ 4. an igneous or sedimentary rock that has been changed by heat and pressure

________________________ 5. an inorganic solid with a definite chemical formula and specific shape

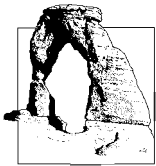
________________________ 6. small pieces of rock

________________________ 7. melted rock found inside Earth

________________________ 8. rock made up of several layers of sediment cemented together

________________________ 9. a rock formed after magma has cooled

________________________ 10. melted rock on the surface of Earth



Practice

Use the list below to write the correct term for each definition on the line provided.

cleavage	**luster**	**nonmetallic**
extrusive	**metallic**	**rock**
fracture	**mineralogist**	**rock cycle**
intrusive	**Mohs' scale**	

______________________________ 1. a scientist who studies and identifies minerals

______________________________ 2. continuous change of rocks from one form to another

______________________________ 3. the tendency of a mineral to break along a jagged, uneven, or curved surface

______________________________ 4. the tendency of a mineral to break along a smooth or flat surface

______________________________ 5. a solid material made of one or more minerals

______________________________ 6. igneous rocks that cool on Earth's surface

______________________________ 7. a scale used to test the hardness of a mineral

______________________________ 8. minerals without metal, with no shine

______________________________ 9. the reflecting qualities of a material

______________________________ 10. igneous rocks that cool below Earth's surface

______________________________ 11. has a shiny appearance

Practice

Circle the letter of the correct answer.

1. A rock formed after magma has cooled is ____________ .

   a. sedimentary rock
   b. sediment
   c. metamorphic rock
   d. igneous rock

2. The melted rock found inside Earth is ____________ .

   a. magma
   b. sediment
   c. metamorphic rock
   d. sedimentary rock

3. The melted rock on the surface of Earth is ____________ .

   a. lava
   b. sedimentary rock
   c. ore
   d. metamorphic rock

4. Small pieces of rock are ____________ .

   a. sedimentary rock
   b. ore
   c. metamorphic rock
   d. sediment

5. Rock made up of several layers of sediment cemented together is ____________ .

   a. ore
   b. metamorphic rock
   c. sedimentary rock
   d. inorganic

6. A rock changed by heat and pressure is ____________ .

   a. ore
   b. inorganic
   c. mineral
   d. metamorphic rock

7. A rock or mineral from which metals and nonmetals can be removed in usable amounts is a(n) ____________ .

   a. gem
   b. crystal
   c. mineral
   d. ore

8. An inorganic substance with a definite chemical formula and specific shape is a(n) ____________ .

   a. crystal
   b. inorganic
   c. mineral
   d. luster

9. Materials that do not contain carbon and have never lived are called ____________ .

   a. metallic minerals
   b. nonmetals
   c. crystals
   d. inorganic

10. Rare, precious, or semiprecious minerals are called ____________ .

   a. gems
   b. metallics
   c. crystals
   d. nonmetallics

11. The surface appearance of a material is called its ____________ .

   a. rock cycle
   b. lava
   c. fracture
   d. luster

12. Minerals that have a shine and are good conductors of heat and electricity are ____________ .

   a. rocks
   b. crystals
   c. nonmetallic
   d. metallic

13. Minerals without metal and that have no shine are __________ .

    a. rocks
    b. gems
    c. nonmetallic
    d. crystals

14. A scale used to test the hardness of a mineral is __________ .

    a. Mohs' scale
    b. nonmetallic
    c. metallic
    d. inorganic

15. The continuous change of rocks from one kind to another is a __________ .

    a. rock cycle
    b. metallic
    c. Mohs' scale
    d. nonmetallic

16. A solid material made of one or more minerals is a __________ .

    a. Mohs' scale
    b. nonmetallic mineral
    c. metallic mineral
    d. rock

17. The breakage of a mineral along a jagged, uneven, or curved surface is a(n) __________ .

    a. fracture
    b. cleavage
    c. nonmetallic
    d. organic

18. A scientist who studies and identifies minerals is a __________ .

    a. geologist
    b. biologist
    c. chemist
    d. mineralogist

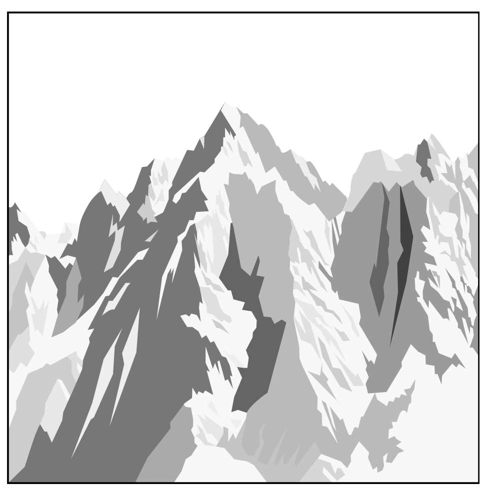
19. The tendency of a mineral to break along a smooth or flat surface is a(n) ____________ .

    a. organic
    b. fracture
    c. cleavage
    d. intrusive

20. Igneous rocks that cool on Earth's surface are called ___________ .

    a. nonmetals
    b. extrusive
    c. intrusive
    d. organic

Unit 7: Mountains



Vocabulary

Study the vocabulary words and definitions below.

dissected mountains .... mountains formed by the erosion of a plain or plateau

dome mountains .... mountains formed when rocks are pushed up by internal forces within Earth

fault-block mountains .... mountains formed by the movement of large amounts of rock along a crack in Earth's crust

folded mountains .... mountains formed as a result of the bending of rocks in Earth's crust

glacier .... large, moving mass of ice and snow

gorge .... a very steep valley between young mountains

hills .... landforms less than 600 meters high

mountain range .... a series of mountains parallel to each other

mountain system .... a group of mountain ranges

mountains .... landforms that are at least 600 meters high

plain .... a flat area of low elevation

plateau .... a flat area of land over 600 meters above sea level

relief .... the difference in elevation between the high and low points of a land surface

slope .... side of a mountain

summit .... top of a mountain

volcanic mountains .... mountains formed by volcanoes

weathering .... the breaking down of rocks and other particles by wind, water, and ice

Introduction

As we admire the landscapes of the planet Earth, we find that some of the most spectacular sceneries are the high peaks and the steep canyons of the landform that we call **mountains**. The majestic outlines of this landform never seem to change; however, we know that Earth's surface is constantly changing. Evidence of folding, faulting, or volcanism can be seen in mountains. Mountains can also be changed by erosion from wind, water, and ice.

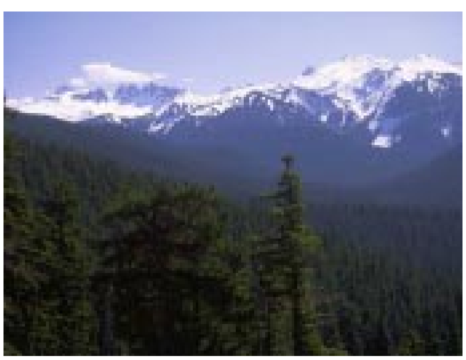
Mountains are indicators of the past or present changes of Earth's surface. Understanding the events that occur in the formation of mountains will help us to understand better the evolution of our planet Earth.

Mountains

Mountains are landforms that are at least 600 meters above the surrounding lands. Those less than 600 meters are called **hills**. This difference in height or elevation among landforms is called **relief**.

Some common features of mountains include the following: the **summit**, or the top of a mountain; the **slope**, or side of the mountain; and a very steep valley between young mountains, known as a **gorge**.

The Rocky Mountains and the Himalayan Mountains are examples of **mountain ranges**—a series of mountains parallel to each other. A group of mountain ranges is called a **mountain system**. For example, the mountain systems of the United States include the Rockies and the Appalachians.



mountain range

Mountain formations change over time. Different types of **weathering** such as wind, water, and ice will wear away mountains. For example, **glaciers**, large, moving masses of ice and snow, are found on some mountains. As a glacier moves through a mountain range, it will carve valleys and peaks, changing the surface of the mountains. The Matterhorn in Switzerland is an example of a peak formed by a glacier.

When a mountain is young, it is usually bigger than an older mountain. The valleys of young mountain ranges are steep and narrow. The valleys of old mountain ranges are wide. The Appalachian Mountain range is an example of an old mountain system; while the Rocky Mountains are an example of a young mountain system.

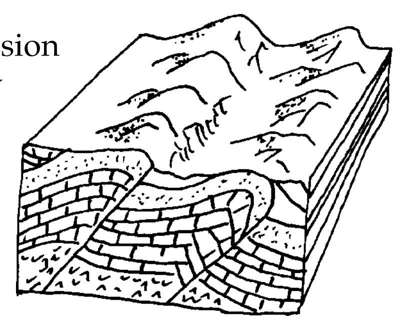
	Young Mountains	**Old Mountains**
size	larger	smaller
appearance	rugged	worn by erosion
valleys	steep and narrow	wide
example	Rocky Mountains	Appalachian Mountains

Types of Mountains

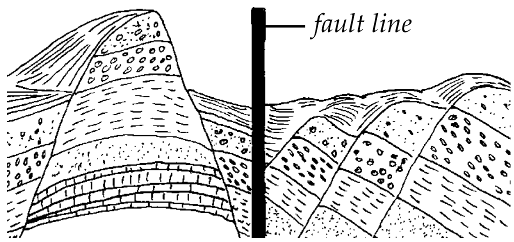
The world's largest mountain ranges are **folded mountains**—mountains formed as a result of the bending of rocks in Earth's crust. These include the Rocky and Appalachian mountains of the United States, the Himalayan Mountains in Asia, the Alps of Europe, and the South American Andes. These ranges were formed over millions of years.

During the formation, sediment is deposited in areas along continental margins where the crust sinks. As the sediments are buried deeper and deeper, the pressure on the sediments increases greatly. Since they are sinking deeper into Earth, their temperature increases. This increase in temperature and pressure causes the sediment to become folded, warped, and twisted. As this happens, the sediments are uplifted to form folded mountains.

Some folded mountains are formed by the collision of crustal plates. These collisions occurred very slowly over long periods of time as the continents moved to their current positions. The Himalayan Mountains were formed when India *crashed* into Asia and pushed up the tallest mountain range on the continents. In South America, the Andes Mountains were formed by the collision of the South American continental plate and the oceanic Pacific plate.

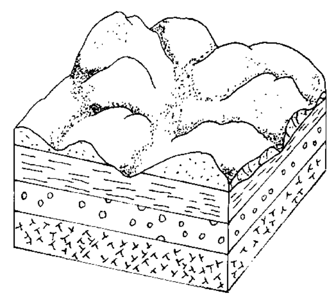


folded mountains



fault-block mountain

Fault-block mountains are formed by the movement of large amounts of rock along a crack in Earth's crust. Pressure within Earth can break apart Earth's crust. The rock that makes up Earth's crust will split. This breaking or splitting of the rocks is called a fault. The rising land between two faults can become a fault-block mountain. The Grand Tetons of Wyoming and the Sierra Nevada mountain range of California are examples of mountains formed by faulting.

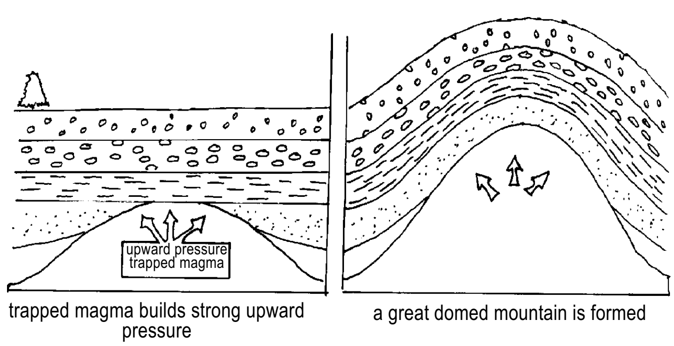


dissected mountain

The mountains in New Zealand are examples of **dissected mountains**. Dissected mountains are formed by the erosion of a **plain** or **plateau** usually by a river or stream. These mountains will eventually wear down to sea level.

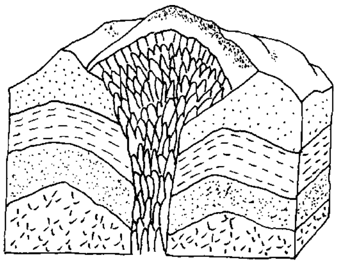
Another type of mountain is a **dome mountain**. These mountains are formed when the rocks are pushed up by internal forces within Earth, creating a dome-shaped mountain.

Magma under the surface of Earth has great pressure. If this magma is trapped, it builds up pressure. As it builds up pressure, it pushes upward, causing the layers of rock to rise. Even though these layers of rock are pushed upward, the magma cannot break the crust above it. The crust is then lifted and a dome mountain is formed.



dome mountain

Dome mountains are rounded. They are not as high as folded mountains or fault-block mountains. In the United States, dome mountains are found in the Black Hills of South Dakota and the Adirondacks in New York.



volcanic mountain

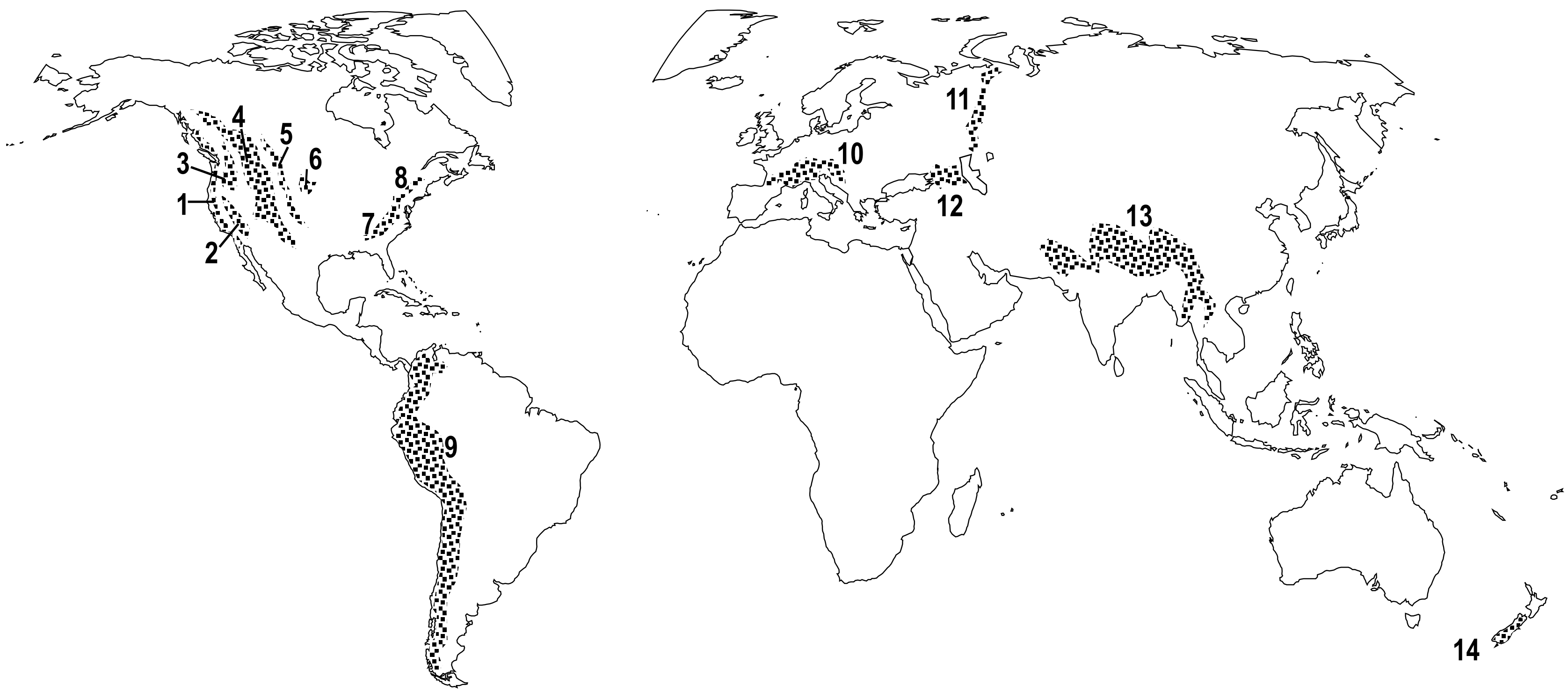
As the name suggests, **volcanic mountains** are formed by volcanoes. Lava and other igneous material from volcanoes have formed mountains in many different areas of the world. The Cascades of Washington (which includes Mount St. Helens) are volcanic mountains. Sometimes these mountains become active volcanoes and erupt like Mount St. Helens in 1980 and the Philippines' Mount Pinatubo volcano in 1991.

Types of Mountains	Examples
Folded	Rockies; Appalachians; Himalayas; Alps; Andes
Fault-Block	Sierra Nevada; Grand Tetons
Dissected	New Zealand
Dome	Adirondacks; Black Hills
Volcanic	Cascades

Ages of Mountain Ranges

Range	Continent	Age (in years)	Type
Cascades	North America	1,000,000	volcanic
Himalayas	Asia	25,000,000	folded
Alps	Europe	40,000,000	folded
Andes	South America	70,000,000	folded
Rockies	North America	70,000,000	folded
Coast Ranges/Sierra Nevadas	North America	135,000,000	fault-block
Juras	Europe	135,000,000	folded
Caucasus	Eurasia	225,000,000	folded
Urals	Eurasia	225,000,000	folded
Appalachians	North America	225,000,000	folded
Green Mountains (Vermont)	North America	500,000,000	dome
Adirondack Mountains	North America	2,500,000,000	dome

Study the map of the mountain ranges on the next page.



1. Pacific Coastal Range
2. Sierra Nevada
3. Cascades
4. Rockies
5. Grand Tetons
6. Black Hills
7. Appalachians
8. Adirondacks
9. Andes
10. Alps
11. Urals
12. Caucasus
13. Himalayas
14. Southern Alps or New Zealand

Summary

Mountains are landforms at least 600 meters above the surrounding land. Mountain features include the summit, slopes, and gorges. A series of mountains is a mountain range, and a group of ranges is a mountain system. Mountain formations change over time by weathering. Types of mountains include folded, fault-block, dissected, dome, and volcanic mountains.

Practice

Use the list below to complete the following statements.

Adirondacks	**dome mountains**	**Mount St. Helens**
bending	**erosion**	**New Zealand**
Black Hills	**Grand Tetons of Wyoming**	**volcanoes**
dome		

1. Magma pushes rock layers up to form ________________________ .
2. Dome mountains are found in the ________________________ of South Dakota and the ________________________ in New York.
3. ________________________ mountains are not as high as folded or fault-block mountains.
4. Dissected mountains are formed by ________________________ .
5. Volcanic mountains are formed by ________________________ .
6. An example of dissected mountains can be found in ________________________ .
7. ________________________ is an example of a volcanic mountain.
8. An example of fault-block mountains in the western United States is ________________________ .
9. Folded mountains are formed by the ________________________ of rocks in Earth's crust.

Practice

Use the list below to complete the following statements.

Alps	**Matterhorn**	**warp**
faulting	**narrow**	**water**
fold	**Rockies**	**wide**
glaciers	**steep**	**wind**
ice	**twist**	

1. The Sierra Nevada Mountains were formed as a result of ________________________ .

2. ________________________ , ________________________ , and ________________________ weather a mountain.

3. The valleys of young mountain ranges are usually ________________________ and ________________________ .

4. The valleys of old mountain ranges are usually __________________ .

5. The __________________ is an example of a peak formed by a glacier.

6. The surface of a mountain can be carved and changed by ________________________ .

7. As sediment sinks, temperature and pressure increase, causing the sediment to ________________________ , ________________________ , and ________________________ .

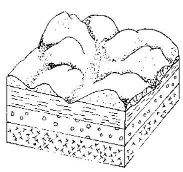
8. The ________________________ and the ________________________ are two examples of folded mountains.

Practice

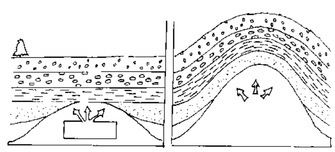
Match the **mountains** *below with the correct* **mountain type**. *Write the letter on the line provided.*

______	1. Sierra Nevada	A.	dissected
______	2. New Zealand	B.	dome
______	3. Mount St. Helens	C.	fault block
______	4. Appalachian	D.	folded
______	5. Black Hills	E.	volcanic

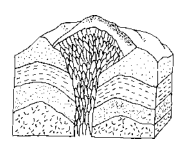
Identify the **mountains** *below with the correct* **mountain type**. *Write the type on the line provided.*



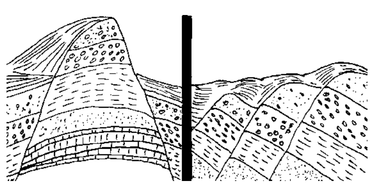
6. ______________



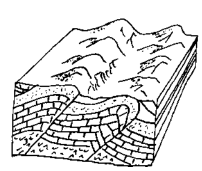
7. ______________



8. ______________



9. ______________



10. ______________

Practice

Answer the following using complete sentences.

1. What is the difference between a hill and a mountain?

____

____

____

____

2. Explain why older mountains are smaller than younger mountains.

____

____

____

____

3. Explain how any two of the four types of mountains are formed.

____

____

____

____

____

____

____

____

Practice

Use the list below to write the correct term for each definition on the line provided.

dissected mountains	**hills**	**relief**
dome mountains	**mountains**	**slope**
fault-block mountains	**mountain range**	**summit**
folded mountains	**mountain system**	**volcanic mountains**
glacier	**plain**	**weathering**
gorge	**plateau**	

_______________________ 1. a flat area of low elevation

_______________________ 2. a flat area of land over 600 meters above sea level

_______________________ 3. a group of mountain ranges

_______________________ 4. mountains formed by volcanoes

_______________________ 5. mountains formed by the erosion of a plain or plateau

_______________________ 6. mountains resulting from rocks being pushed up by internal forces within Earth

_______________________ 7. mountains formed from the bending of rocks in Earth's crust

_______________________ 8. top of a mountain

_______________________ 9. the difference in elevation between the high and low points of a land surface

_______________________ 10. a series of mountains parallel to each other

_______________________ 11. side of a mountain

_______________________ 12. landforms that are at least 600 meters high

_________________________ 13. landforms less than 600 meters high

_________________________ 14. a very steep valley between young mountains

_________________________ 15. mountains formed by the movement of large amounts of rock along a crack in Earth's crust

_________________________ 16. large, moving mass of ice and snow

_________________________ 17. the breaking down of rocks and other particles by wind, water, and ice

Practice

Circle the letter of the correct answer.

1. Landforms that are at least 600 meters high are called ____________ .

   a. reliefs
   b. slopes
   c. hills
   d. mountains

2. Landforms less than 600 meters high are called ____________ .

   a. hills
   b. slopes
   c. gorges
   d. reliefs

3. The ____________ is the top of a mountain.

   a. summit
   b. relief
   c. mountain range
   d. gorge

4. The side of a mountain is its ____________ .

   a. relief
   b. mountain range
   c. gorge
   d. slope

5. The difference in elevation between the high and low points of a land surface is called ____________ .

   a. mountain rings
   b. gorge
   c. relief
   d. slope

6. A very steep valley between young mountains is a ____________ .

   a. mountain range
   b. glacier
   c. mountain system
   d. gorge

7. A series of mountains parallel to each other is a ____________ .

   a. volcanic mountain
   b. fault-block mountain
   c. mountain system
   d. mountain range

8. A group of mountain ranges is a ____________ .

   a. structural mountain
   b. dissected mountain
   c. mountain system
   d. plain

9. ____________ are mountains formed by the erosion of a plain or plateau.

   a. Plateaus
   b. Plains
   c. Fault-block mountains
   d. Dissected mountains

10. Mountains formed from rocks pushed up by internal forces within Earth are ____________ .

    a. dissected mountains
    b. plateaus
    c. volcanic mountains
    d. dome mountains

11. Mountains formed by volcanoes are ____________ .

    a. volcanic mountains
    b. dissected mountains
    c. dome mountains
    d. fault-block mountains

12. A __________ is a flat area with low elevation.

   a. glacier
   b. plain
   c. summit
   d. gorge

13. A __________ is a flat area of land over 600 meters above sea level.

   a. glacier
   b. plain
   c. plateau
   d. gorge

14. __________ are the result of the bending of rocks in Earth's crust.

   a. Dissected mountains
   b. Dome mountains
   c. Fault-block mountains
   d. Folded mountains

15. __________ is the breaking down of rocks and other particles by wind, water, and ice.

   a. Relief
   b. Weathering
   c. Gorge
   d. Slope

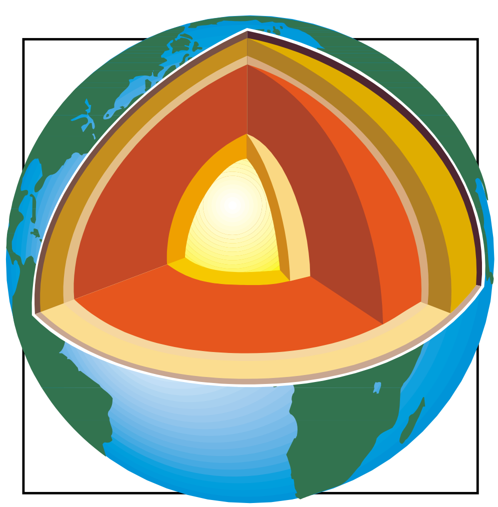
16. A ____________________ is a large, moving mass of ice and snow.

   a. summit
   b. plateau
   c. slope
   d. glacier

17. Mountains formed by the movement of large amounts of rock along a crack in Earth's crust are called ____________________ .

   a. folded mountains
   b. volcanic mountains
   c. dome mountains
   d. fault-block mountains

Unit 8: Plate Tectonics



Vocabulary

Study the vocabulary words and definitions below.

abyssal plains .... large, flat regions deep on the ocean floor

canyons .... deep V-shaped valleys found along the continental slope

continental drift .... a hypothesis suggesting that the continents have moved and been in different positions through geologic time

continental shelf .... relatively flat part of the continent that is covered by seawater; lies between the coast and the continental slope

continental slope .... the steeply dipping surface between the outer edge of the continental shelf and the ocean basin proper

continents .... the seven major landmasses found on the surface of Earth

convection currents .... the circular movements of heat through liquids or gases

core .... the innermost layer of Earth which has two parts—the *outer* portion which is liquid and the *inner* portion which is solid

crust .... the outer layer of Earth

earthquake .... a sudden movement of Earth's crust

epicenter .... the point on the surface of Earth directly above the focus of an earthquake

fault .... a break in Earth's surface along which movement has occurred

focus .... the true center of an earthquake below Earth's surface

guyots (GEE-oze)......................... underwater volcanic mountains with flat tops

lava .... melted rock (magma) that comes to the surface of Earth

lithosphere .... the rigid outer layer of Earth, including the crust and upper mantle

magma .... melted (hot liquid) rock found inside Earth

mantle .... the molten layer of Earth below the crust

mid-ocean ridge .... mountain chain that rises from the ocean basins

Pangaea (pan-JEE-uh).................. the large landmass that broke up and drifted to form our present day continents

plates .... pieces of Earth's crust that move about on the mantle

plate tectonics .... theory stating that crustal plates on the surface of Earth are continuously moving due to convection currents

Richter scale .... scale used to describe the strength of an earthquake

rift .... a wide valley that separates two parallel chains of underwater mountains

Ring of Fire .... major earthquake zone that forms a ring around the Pacific Ocean; includes the western coasts of North America and South America and the eastern coast of Asia

seamounts .... underwater cone-shaped volcanic mountains

seismic waves .... waves by which energy moves away from the focus of an earthquake in all directions from the center

seismograph .... an instrument used to measure earthquake activity

seismologist .... a person who studies earthquakes

trenches .... long, narrow cracks in the ocean floor that are the deepest parts of the ocean

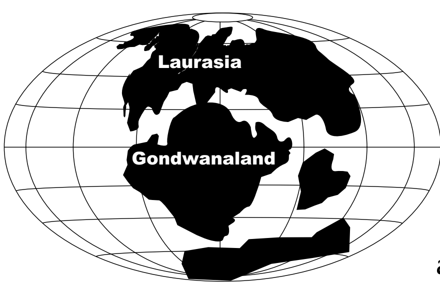
volcano .... a vent in Earth's crust through which hot, liquid rock erupts or oozes; a mountain formed of lava

Introduction

Earth's **crust** is subject to strong forces within and on the surface of Earth. Some of these forces are pushing, pulling, pressure from within, and sliding movements. When these stresses are released, violent events often occur. **Earthquakes** and **volcanoes** are some of the results. Although Earth's crust was once thought to be stationary, we now know that it is in constant motion. This movement results in new formations on Earth's surface, including hot springs, **lava** flows, and fractured valley walls. Understanding **continental drift** and **plate tectonics**, and their theoretical effects on topography, may help us solve the mystery behind the features we see on the surface of Earth.

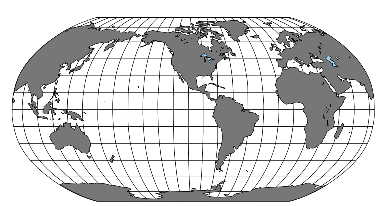
Continental Drift

The surface of Earth has seven major landmasses called **continents**. People have believed throughout history that the location of the continents was fixed. As world maps were improved, many noted that the shapes of the continents seemed to fit together like pieces of a jigsaw puzzle. This idea seemed foolish because no one understood how continents could move.



In 1912, the German meteorologist Alfred Wegener described his hypothesis of *continental drift*. He suggested that at one time all of the continents were one large landmass called **Pangaea**. Wegener believed that this giant landmass split apart and broke into two large landmasses he called *Laurasia* and *Gondwanaland*. These landmasses then broke apart and, over time, *drifted* across the ocean floor until they reached their present positions.

This hypothesis was based on several kinds of evidence. One was how the coastlines of the continents seemed to *fit* like pieces of a jigsaw puzzle. Wegener also noted that similar rock structures and fossils were found in neighboring continents across the ocean. Similarities in ancient climate were indicators, as well. His hypothesis was rejected at first, because there was no explanation for the movement of the continents.



the continents today

Further evidence in support of Wegener's hypothesis continued to be discovered. Glacial deposits and erosional scratches caused by glaciers were found in both South America and Africa. A 200-million-year-old reptile fossil was found in Antarctica that matched ones found in India and South Africa. Since Alfred Wegener's death, the theory has been generally accepted because more evidence has been found.

Earth scientists now realize that the positions of the continents are not permanent. Continents gradually move over the surface of the globe. During the 1950s and 1960s, new developments led to a broader theory known as *plate tectonics*.

Plate Tectonics

New discoveries showed that the sea floor seemed to be cracked and spreading apart. This discovery led to the theory of **plates** and plate movement. This most recent theory is called the *theory of plate tectonics*, which suggests that Earth is separated into large sections called plates—nine large ones and several smaller ones. The large plates include both continental and oceanic crust.

These plates may have separated because of **convection currents**. Convection currents transfer heat through liquids or gases. The heated material rises, and the cooler material takes its place. The difference in temperatures of the gases and liquids under Earth's crust caused movement of the plates. The plates floated on an ocean of liquid rock and gases. As the plates separated, they moved at different speeds and in different directions. Today, the plates are still moving. Scientists have measured plate movement using lasers. The plates are drifting about one to 10 centimeters a year depending on the location.

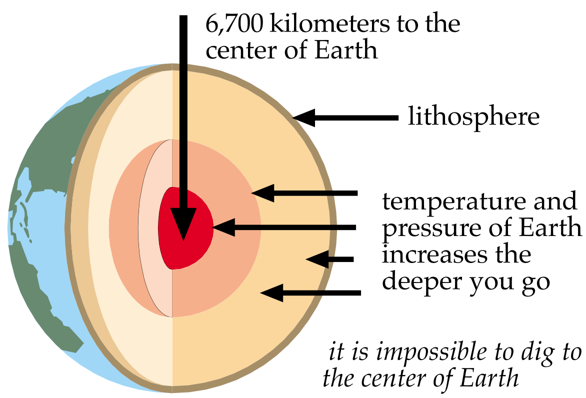
Plates may move apart (form divergent boundaries), move together (form convergent boundaries), or slide past one another (transform boundaries). These movements help explain some of the topographic features we see as well as earthquakes and volcanoes. Changes are always taking place along the edges of the plates. Divergent boundaries, plates moving away from each other, create **mid-ocean ridges** and **rift** valleys. The Mid-Atlantic Ridge, the Rift Valley in Africa, and the Red Sea are examples of divergent boundaries. Convergent boundaries, plates moving toward or underneath one another, form mountain ranges, **trenches** and volcanic island arcs. Subduction occurs when one plate is forced underneath another plate forming a trench. Many examples of these features can be found in the Pacific Ocean. Transform boundaries result from the sliding of plates along their edges. The San Andreas **fault** in California is an example of this type of boundary.

Volcanoes and earthquakes are often found in areas where the plates are sliding past each other, running into each other, or moving apart. Movement of the San Andreas fault caused the San Francisco earthquakes of 1906 and 1989.

Scientists continue to test theories about Earth's crust. Their tests and studies will lead to a better understanding of the structure of Earth.

Lithosphere

There are three major layers of Earth. They are the crust, mantle, and **core**. Each of these layers is made up of different materials. The **lithosphere** is the rigid outer layer of Earth, which includes the crust and the very top of the **mantle**. To get an idea of the lithosphere, think about digging straight down into Earth. You would pass through several different solid layers and would have to dig down about 6,700 kilometers before you would reach the center of Earth. Only about the first 100 kilometers would be the lithosphere.

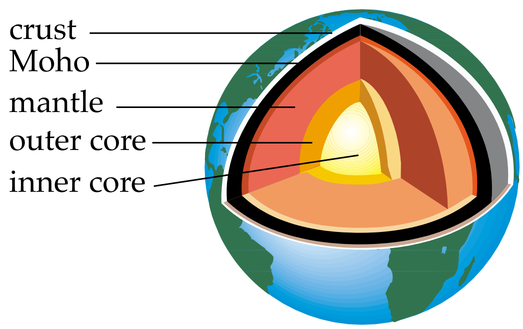


Of course, it is impossible to dig to the center of Earth. Scientists have had to use indirect means to learn about the inside of Earth. Indirect means are ways of finding out about Earth without actually touching or seeing the rocks.

Scientists have learned Earth is not the same composition all the way to the center. Scientists draw conclusions from earthquake and volcanic information recorded by instruments. This is how the depth and the temperature of Earth is estimated. Scientists have also found that the temperature and the pressure in Earth increases the deeper you go.

The ground you stand on is called the soil. The soil is a very thin layer, about six meters deep. Underneath the soil is *bedrock*, which contains minerals, rocks of various kinds, and ores. Together, soil and bedrock act like the skin of Earth. This skin is called Earth's *crust*. The crust is hard and thin. It can be as thick as 67 kilometers and as thin as eight kilometers in some spots. The crust is thickest under the continents and thinnest under the oceans.

On the diagram below of Earth's lithosphere, there is a very dark line labeled *Moho*. This is short for Mohorovicic discontinuity, the boundary between Earth's crust and mantle. It is named after Andrija Mohorovicic (1857-1936), a Yugoslav geologist. The Moho averages about three miles under the ocean basin floors and 25 miles under the continents. The Moho is not a layer, but a boundary line between the crust and the mantle.



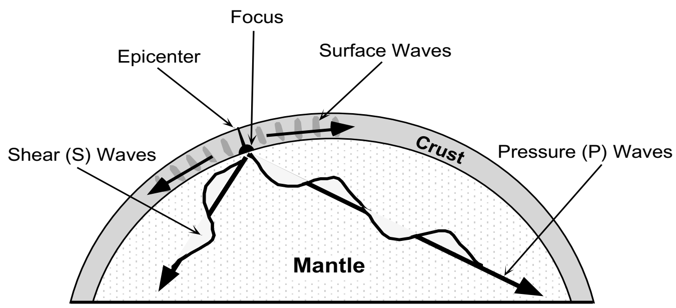
Below the crust is a layer of rock which is heavier and contains more iron than the rock found in the crust. This layer is called the *mantle*. The mantle is between 2,800 and 3,000 kilometers thick. The rock in the mantle seems to be able to flow and move about like a fluid.

The third layer of Earth, the core, is beneath the mantle and has two parts. The *outer core* is about 2,000 kilometers thick. The outer core contains melted iron and nickel. At the center of Earth is the *inner core*. It is 2,800 kilometers in diameter at the thickest point. From where the inner core begins to the very center of Earth is about 1,400 kilometers. Scientists believe the inner core is solid and contains iron mixed with some nickel and cobalt.

Earthquakes

An *earthquake* is the shaking of Earth's crust caused by plates moving inside Earth. Earth's crust is not one big piece. It is really several plates which float on the liquid, molten part of the mantle. As the plates drift or move, their edges may rub and grind against each other. This grinding, along with an upward push of the rock layers, causes earthquakes.

Earthquakes occur along a *fault*, which is a break or crack in Earth's crust. As Earth's crust bends on both sides of a fault, pressure builds up. When the rocks cannot stand the pressure anymore, they break. *Faulting* can be caused either by an uplifting that causes the surface to break or by horizontal forces that rip the crust apart. The zone inside Earth where the actual movement in the rocks occurs is called the **focus**. The place on the crust of Earth's surface directly above the focus is called the **epicenter**.



During an earthquake, energy moves away from the focus in all directions releasing energy in the form of **seismic waves**. These waves are felt as the shocks of an earthquake.

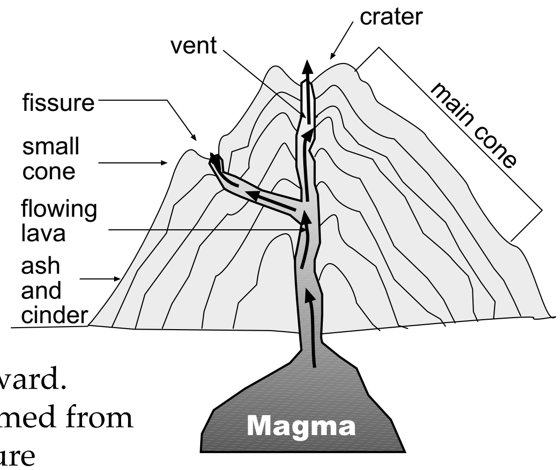
Scientists called **seismologists** study the inner structure of Earth and the changing surface of Earth in an effort to predict future earthquakes. A **seismograph** is an instrument used to measure the force of an earthquake. Some earthquakes are so slight that they go unnoticed. Other earthquakes are so powerful that the tremors cause rockslides, buildings to fall, the ground to open up, fires and explosions from broken electric and gas lines, and floodwaters released from collapsing dams.

When an earthquake is recorded, it is given a number on the **Richter scale**. The Richter scale uses numbers from one to 10 to measure the relative strength of an earthquake. The largest earthquakes ever recorded have Richter magnitudes near 8.6. The energy released from these great shock waves is about the same as one billion tons of TNT (an ingredient in explosives). Earthquakes with a magnitude less than 2.5 are not normally felt by humans.

earthquake damage

In 1906, an earthquake with a Richter scale rating of 8.25 nearly destroyed the city of San Francisco. An earthquake with a magnitude of 8.4–8.6 occurred in Alaska and lasted three–four minutes. In 1989, another major earthquake occurred in San Francisco. It measured 7.1 on the Richter scale and caused major destruction.

Volcanoes



A *volcano* is an opening in Earth's surface through which melted rock, called **magma**, erupts from inside Earth. Magma beneath the surface of Earth builds up great pressure. Scientists believe that it collects in pockets and builds up pressure. This pressure forces the magma upward. Sometimes dome mountains are formed from the pressure. Other times, the pressure becomes so great that the magma is pushed out onto the surface of Earth. When this happens, it is called an eruption. Once the magma flows out of the opening of the volcano, it is called *lava*. A hill or mountain builds up as the lava cools. This is how volcanic mountains are formed.

Volcanoes can also form in the oceans. The **Ring of Fire** is an area in the Pacific Ocean where many of the world's active volcanoes are found. Sometimes the tops of volcanoes stick out above the surface of the ocean forming islands. The Hawaiian Islands are really the tops of volcanoes.

Volcanoes affect Earth in many ways. They are responsible for changing the surface of Earth by building volcanic mountains. The lava and ash from volcanic eruptions form fertile land that can be farmed. Scientists study volcanoes to learn more about the interior of Earth.

a quiet volcano

Volcanic mountains are sometimes quiet. A quiet volcano is one where the lava oozes out and spreads over the land. Quiet volcanoes have gently sloping sides. They do not explode.

an active volcano

Explosive volcanoes are ones where the magma blasts to the surface. For the magma to come to the surface with such force, it must be held underground for a long time. The pressure builds up and becomes so great that the magma is pushed out of Earth explosively. With the magma comes rocks, cinders, ash, dust, steam, and poisonous gases. The dust and ash can cause breathing problems in humans and can even cause changes in the weather. Volcanoes can destroy property and lives. Some volcanic eruptions have triggered large earthquakes.

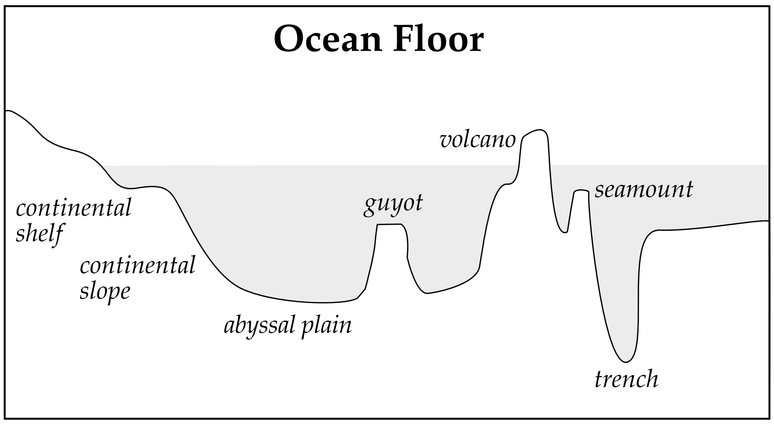
Some volcanoes are dormant, which means that they have erupted in human history but not within the past 50 years or so. They are inactive but may erupt at any time. Other volcanoes are active, like Kilauea in Hawaii, which has erupted more than 50 times in recorded history. Mount St. Helens on the Pacific Coast of the United States is an active volcano which erupted in 1980.

The Ocean Floor

Earth's ocean floor has been studied for more than 100 years. In the 1950s and 1960s, scientists invented new instruments, such as the precision depth recorder, to more accurately study and map the ocean floors. Using these instruments, scientists discovered that the land areas of the ocean floor had many of the same features as the continents.

The area where the land and the ocean water meet is called the *shoreline*. Beyond the shoreline the ocean floor begins to slope gently downward. This is called the **continental shelf**. The width of the continental shelf varies from 200 to 1200 kilometers. At the edge of the continental shelf, the ocean floor drops off at a very steep angle for four or five kilometers. This marks the boundary between the crust of the continent and the crust of the ocean basin. It is called the **continental slope**. Deep V-shaped valleys called **canyons** are found along the continental slope. Some of these underwater canyons are deeper than any found on the surface of Earth.

The ocean basin, or floor, begins at the bottom of the continental slope. There are plains on the ocean basin that are larger and flatter than any found on Earth's surface. They are called **abyssal plains**. The deepest parts of the ocean floor are long, narrow cracks called *trenches*, which cut into the abyssal plain. Most of these trenches are found in the Pacific Ocean. The Marianas Trench in the Pacific Ocean is the deepest spot on Earth. It is over 11,000 meters deep.



Many volcanic peaks rise from the plain. Some peaks rise above sea level to form islands like the Hawaiian Islands. Many old volcanic islands are now underwater. Underwater cone-shaped volcanic mountains are called **seamounts**. Seamounts with flat tops are called **guyots**.

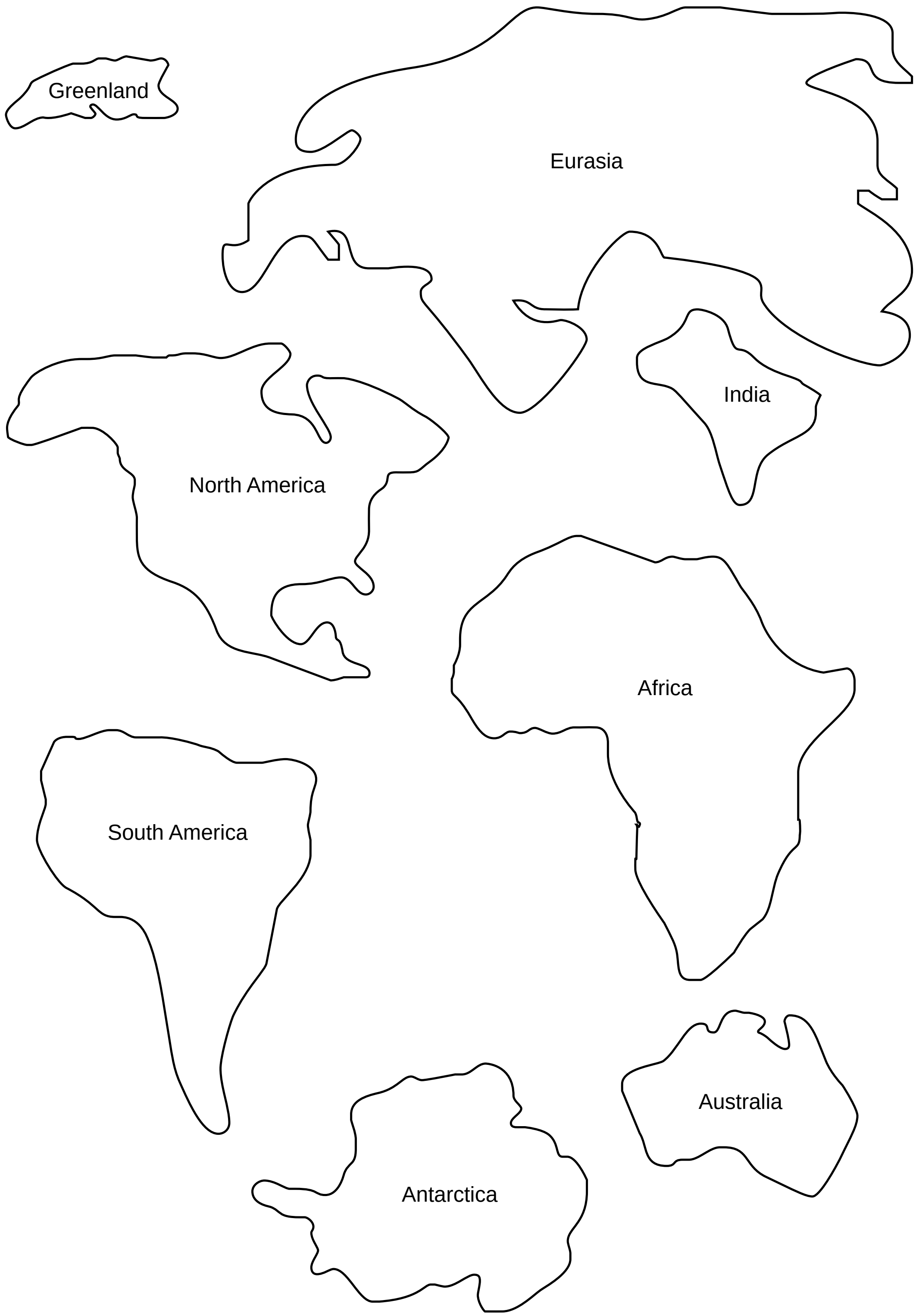
Some of the highest mountain ranges on Earth are located under the ocean. These underwater mountain chains, rising from the plain, are called *mid-ocean ridges*. On the floor of the Atlantic Ocean are underwater mountains named the Mid-Atlantic Ridge. The Mid-Atlantic Ridge is the longest fracture on Earth. It runs around the world from the North Atlantic to the South Atlantic, into the Indian Ocean, across the Pacific, and northward to the Atlantic. This mountain chain is about 65,000 kilometers long. Underwater ridges vary greatly in size and shape. Many ridges in the Pacific Ocean are flat-topped mountains. The Mid-Atlantic Ridge is really two parallel chains of mountains separated by a wide valley called a *rift*.

Important differences between the continents and the seafloor have been noted, too. The ocean basins have many more volcanoes and earthquakes than the continents. The rocks found there differ from the rocks found on Earth's surface. Ocean basins are made of basalt; continents are made of granite. In addition, the crust of Earth is much thinner on the ocean floor than on the surface of Earth.

Summary

Scientists have collected evidence to show that Earth's continents were once one large landmass. Over time the continents separated and drifted to their present locations. By the 1960s, a theory known as plate tectonics suggested that Earth is separated into plates. These plates are still moving, and this movement helps explain volcanoes and earthquakes. The ocean floor has many of the same features as the continents, including mountains and earthquakes, even though there are important differences.

The lithosphere, or solid part of Earth, has three major layers—crust, mantle, and core. The plates of Earth's crust move. This movement along a fault in the crust may cause earthquakes. The pressure beneath the surface of Earth may cause molten rock to flow from an opening in Earth's crust and form a volcano.


Greenland
Eurasia
North America
India
Africa
South America
Australia
Antarctica

Practice

Write **True** *if the sentence is correct. Write* **False** *if the sentence is* not *correct.*

__________ 1. The continental drift theory is a more recent theory than that of plate tectonics.

__________ 2. The San Andreas fault in California is really a boundary between two plates.

__________ 3. Both the theory of continental drift and plate tectonics believe that all of the landmasses on Earth were once part of one big landmass.

__________ 4. The single landmass that contained all the other land masses was called Laurasia.

__________ 5. Pangaea broke apart to form Gondwanaland and Laurasia.

__________ 6. According to the plate tectonics theory, the continents floated on the water to get to their present places on Earth.

__________ 7. There are 10 major landmasses that make up the surface of Earth.

__________ 8. Plates are no longer moving today.

__________ 9. Alfred Wegener suggested the theory of plate tectonics.

__________ 10. The shapes of the continents seem to fit together like pieces of a jigsaw puzzle.

__________ 11. Convection currents are caused by differences in the temperatures of gases and liquids under Earth's crust.

Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

core	**inner**	**mantle**	**outer**
crust	**instruments**	**Moho**	**rock**
indirect	**lithosphere**		

1. The solid part of Earth is called the ____________________ .

2. The three layers of Earth are ____________________ ,
   ____________________ , and ____________________ .

3. Scientists draw conclusions from the information recorded by
   ____________________ .

4. When you find out about something without seeing or touching it, you have discovered it by ____________________ means .

5. The ____________________ contains soil and bedrock.

6. The ____________________ is the boundary line between the crust and the mantle.

7. The layer below the crust is called the ____________________ .

8. The mantle is made up of ____________________ core.

9. Under the mantle is the ____________________ core.

10. The center of Earth is called the ____________________ .

11. The ________________________ core is the layer of melted material.

12. The thinnest layer is the ________________________ .

13. The thickest layer is the ________________________ .

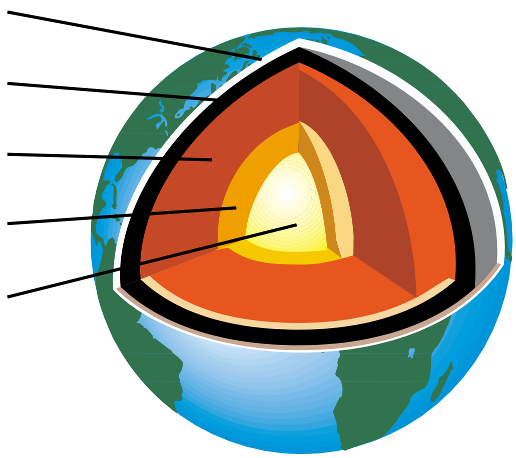
14. The hottest layer with the greatest pressure is the ________________________ core.

15. The coolest layer is the ________________________ .

Practice

Look at the diagram below. On the lines, write the names of the **parts of Earth**.

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________



Complete the following chart.

Layers	Thickness	Material
crust		
mantle		
outer core		
inner core		

Lab Activity 2: Earthquakes

Purpose	Materials
Make a seismic-risk map of the United States.	• map of United States • colored pencils • pencil

1. Choose a color to represent each of the risk zones in the legend of the map on page 239.

2. Color the squares of the map legend to match the color chosen for each zone.

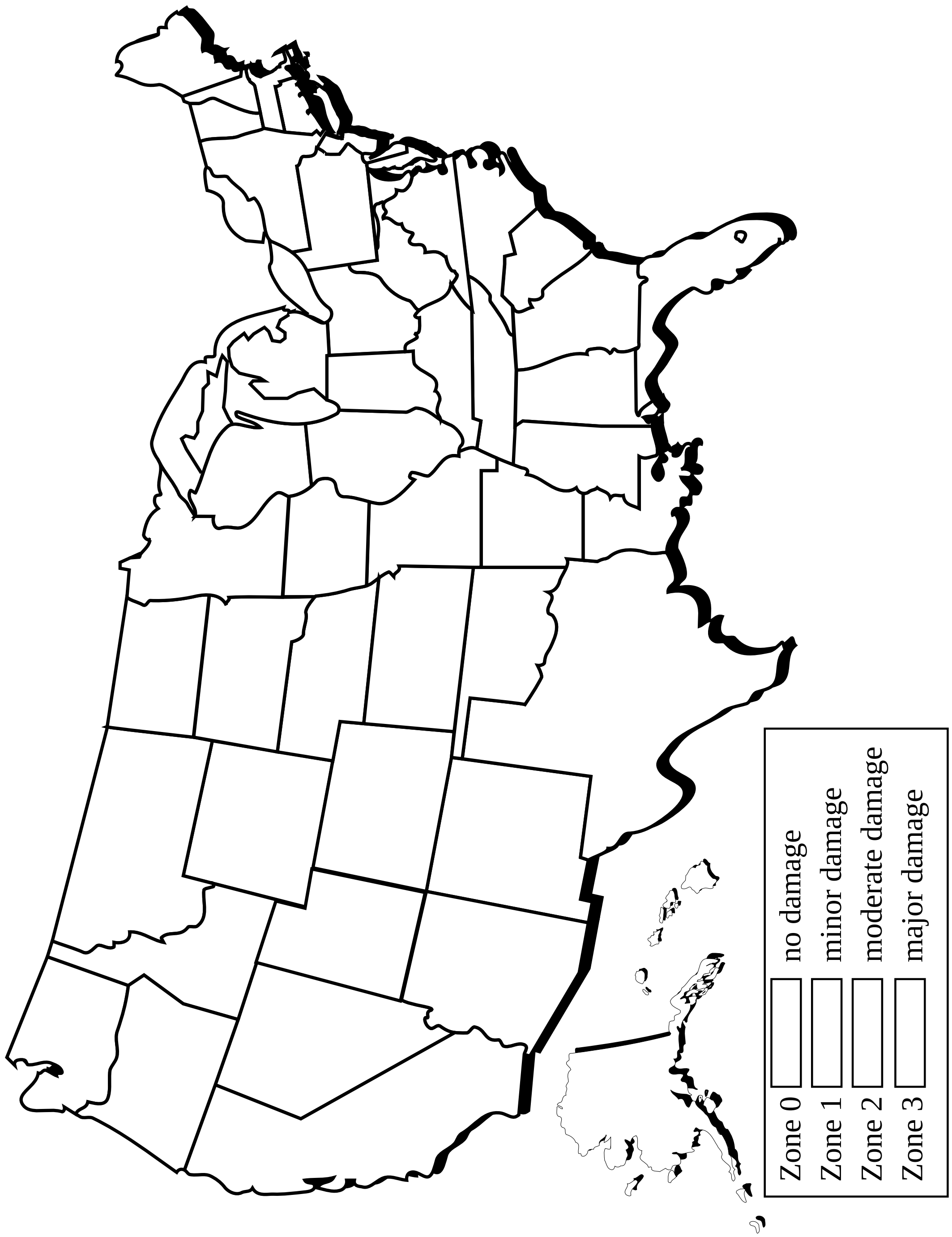
3. Plot the data from the chart on page 238 on the map. Place one dot in the state for each recorded earthquake. Place two dots in the state for each high-intensity earthquake.

4. Since California has such a large number of earthquakes, simply write the number of earthquakes on the state. In parentheses, write the number of high-intensity earthquakes.

5. Color each state according to the legend on page 239. Example: California will be colored for Zone 3.

Earthquake Locations

State	Damaging earthquakes recorded	State	Damaging earthquakes recorded
Alabama	2	Montana	10 (3 high intensity)
Alaska	12 (2 high intensity)	Nebraska	3
Arizona	4	Nevada	12 (3 high intensity)
Arkansas	3	New Hampshire	0
California	over 150 (8 high intensity)	New Jersey	2 (1 high intensity)
Colorado	1	New Mexico	5
Connecticut	2	New York	5 (1 high intensity)
Delaware	0	North Carolina	2
Florida	1	North Dakota	0
Georgia	1	Ohio	6 (1 high intensity)
Hawaii	12 (2 high intensity)	Oklahoma	2
Idaho	4	Oregon	1
Illinois	10	Pennsylvania	1
Indiana	3	Rhode Island	0
Iowa	0	South Carolina	6 (1 high intensity
Kansas	2	South Dakota	1
Kentucky	5	Tennessee	7
Louisiana	1	Texas	3 (1 high intensity)
Maine	4	Utah	9 (2 high intensity)
Maryland	0	Vermont	0
Massachusetts	4 (1 high intensity)	Virginia	5
Michigan	1	Washington	11 (2 high intensity)
Minnesota	0	West Virginia	1
Mississippi	1	Wisconsin	1
Missouri	9 (2 high intensity)	Wyoming	3


Zone 0 no damage
Zone 1 minor damage
Zone 2 moderate damage
Zone 3 major damage

Practice

Using the information gathered from **Lab 2**, *answer the following using short answers.*

1. In what states have damaging earthquakes occurred?

 ____

 ____

2. In what region have damaging earthquakes been concentrated?

 ____

3. What does a concentration of damaging earthquakes indicate about the underlying rock structure of the area?

 ____

 ____

4. Based on this map, in which states might future earthquakes occur?

 ____

 ____

5. In which state is the earthquake risk highest? ____________________

 ____

6. Could you be sure that an earthquake could not occur in any area?

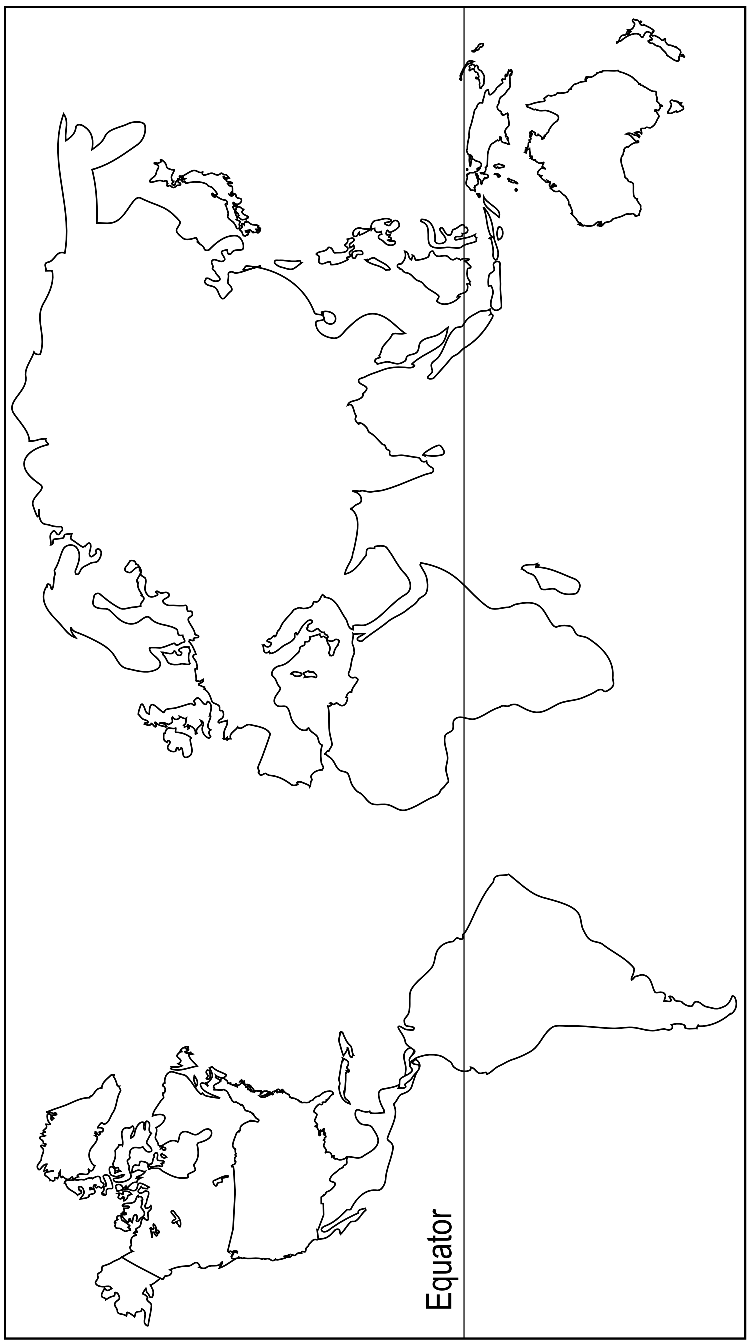
 ____

 Why? ____

 ____

Practice

Use a reference book or the Internet to locate the **active volcanoes** *found on Earth. Mark their approximate location by placing a dot on the map below. Use a marking pen to trace the* **Ring of Fire** *on the map. (If using the Internet, try http://www.neic.cr.usgs.gov/current_seismicity.html.)*



Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

blasts	**inactive**	**poisonous**
erupt	**lava**	**Ring of Fire**
gentle	**magma**	**rocks**
Hawaiian	**mountains**	

1. Melted rock beneath the surface of Earth is called ______________ .

2. Melted rock that comes to the surface of Earth is called

   ______________________ .

3. When a volcano erupts, ______________________ comes out of it as well as ______________________ gases.

4. Quiet volcanoes have sides with ______________________ slopes.

5. Quiet volcanoes do not ______________________ .

6. Many of the world's active volcanoes are found in the

   _________________ in the Pacific Ocean.

7. Cooled lava collects over time to build ______________________ .

8. Magma ______________________ out from an explosive volcano.

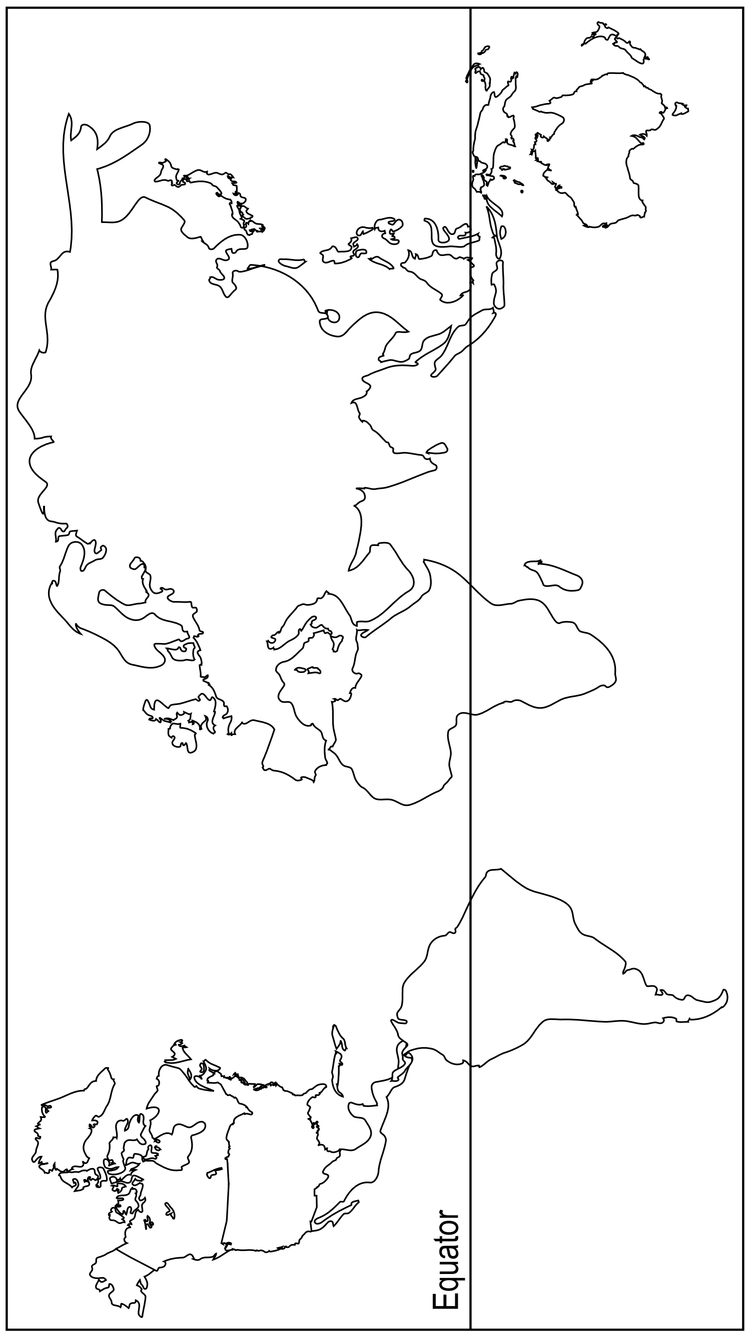
9. Dormant volcanoes are usually ______________________ .

10. Dormant volcanoes can ______________________ at any time.

11. The ______________________ Islands are the tops of volcanoes.

Practice

Use reference materials to locate the **mid-ocean ridges**. *Use small triangles to represent peaks to draw the mid-ocean ridge on the map below.*



Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

11,000	**earthquakes**	**mid-ocean ridges**	**slope**
abyssal plains	**Indian**	**Pacific**	**thinner**
Atlantic	**instruments**	**rift**	**trenches**
basin	**Marianas Trench**	**shelf**	**volcanoes**
canyons	**Mid-Atlantic Ridge**	**shoreline**	

1. The ocean basins have more ____________________ and ____________________ than the continents.

2. The steep drop-off at the edge of the continental shelf is the ____________________ .

3. ____________________ are deep V-shaped valleys found along the continental slope.

4. Plains found on the ocean floor are flatter and larger than those found on land. They are known as ____________________ .

5. Many ridges in the ____________________ Ocean are flat-topped mountains.

6. Another name for the ocean floor at a depth of more than 4,000 meters is the ____________________ .

7. The Mid-Atlantic Ridge is really two parallel chains of mountains separated by a valley called a ____________________ .

8. The ____________________ is the area where the water and the land meet.

9. In the late 1950s and 1960s scientists invented new ____________________ that let them study and map the ocean floor.

10. The area beyond the shoreline where the ocean slopes gradually downward is called the ____________________ .

11. The deepest parts of the ocean floor are long, narrow cracks called ____________________ .

12. Mountain chains found under the sea are known as ____________________ .

13. The longest mountain range in the world is the ____________________ . It is found in the ________________ , ____________________ , and ____________________ oceans.

14. The crust of Earth is ____________________ on the ocean floor than on the surface of Earth.

15. The ____________________ is the deepest place on Earth. It is over ____________________ meters deep.

Practice

Use the list below to write the correct term for each definition on the line provided.

abyssal plains	**continental slope**	**plates**
canyons	**convection currents**	**plate tectonics**
continents	**guyots**	**rift**
continental drift	**mid-ocean ridges**	**seamounts**
continental shelf	**Pangaea**	**trenches**

______________________ 1. pieces of Earth's crust that move about on the mantle

______________________ 2. mountain chains found under the surface of the ocean

______________________ 3. the seven major landmasses found on the surface of Earth

______________________ 4. relatively flat part of the continent that is covered by seawater and lies between the coast and the continental slope

______________________ 5. large, flat regions deep on the ocean floor

______________________ 6. deep V-shaped valleys found along the continental slope

______________________ 7. the steep drop-off at the edge of the continental shelf and the ocean basin proper

______________________ 8. the circular movements of heat through liquids or gases

______________________ 9. the large landmass that broke up and drifted to form our present day continents

______________________ 10. a wide valley that separates two parallel chains of underwater mountains

______________________ 11. long, narrow cracks in the ocean floor that are the deepest parts of the ocean

______________________ 12. a hypothesis suggesting that the continents have moved in different positions through geologic time

______________________ 13. theory stating that crustal plates on the surface of Earth are continuously moving due to convection currents

______________________ 14. underwater cone-shaped volcanic mountains

______________________ 15. underwater volcanic mountains with flat tops

Practice

Use the list below to write the correct term for each definition on the line provided.

core	**fault**	**magma**	**seismic waves**
crust	**focus**	**mantle**	**seismograph**
earthquake	**lava**	**Richter scale**	**seismologist**
epicenter	**lithosphere**	**Ring of Fire**	**volcano**

________________________ 1. a sudden movement of Earth's crust

________________________ 2. scale used to describe the strength of an earthquake

________________________ 3. instrument used to measure earthquake activity

________________________ 4. the true center of an earthquake below Earth's surface

________________________ 5. a vent in Earth's crust through which hot, liquid rock erupts or oozes

________________________ 6. the point on the surface of Earth directly above the focus of an earthquake

________________________ 7. waves by which energy moves away from the focus of an earthquake in all directions from the center

________________________ 8. hot, liquid rock found inside Earth

________________________ 9. the molten layer of Earth below the crust

____________________ 10. a crack in Earth's crust

____________________ 11. magma that comes to the surface of Earth

____________________ 12. major earthquake zone that forms a ring around the Pacific Ocean

____________________ 13. the outer layer of Earth

____________________ 14. the innermost layer of Earth which has two parts

____________________ 15. a person who studies earthquakes

____________________ 16. the rigid outer layer of Earth, including the crust and upper mantle

Practice

Circle the letter of the correct answer.

1. Deep V-shaped valleys found along the continental slope are ____________ .

    a. trenches
    b. rifts
    c. canyons
    d. plates

2. A wide valley that separates two parallel chains of underwater mountains is a ____________ .

    a. basin
    b. canyon
    c. plain
    d. rift

3. Long, narrow cracks in the ocean floor that are the deepest parts of the ocean are ____________ .

    a. trenches
    b. faults
    c. mountains
    d. mantles

4. The relatively flat part of the continent that is covered by seawater and lies between the coast and the continental slope is the ____________ .

    a. mantle
    b. continental shelf
    c. abyssal plain
    d. trench

5. A large, flat region deep on the ocean floor is a(n) ____________ .

    a. basin
    b. abyssal plain
    c. mid-ocean ridge
    d. convection current

6. A mountain chain found under the surface of the ocean is the ____________ .

   a. mid-ocean ridge
   b. convection current
   c. continent
   d. basin

7. The ____________ is the steeply dipping surface between the outer edge of the continental shelf and the ocean basin proper.

   a. basin
   b. abyssal plain
   c. Pangaea
   d. continental slope

8. The ____________ are the seven major landmasses found on the surface of Earth.

   a. continents
   b. plates
   c. trenches
   d. convection currents

9. ____________ are pieces of Earth's crust that move about on the surface of Earth.

   a. Rifts
   b. Trenches
   c. Basins
   d. Plates

10. ____________ is the large landmass that broke up and drifted to form our present day continents.

   a. Pangaea
   b. Shoreline
   c. Abyssal plain
   d. Rift

11. ____________ are the circular movements of heat through liquids and gases.

    a. Plates
    b. Trenches
    c. Mid-ocean ridges
    d. Convection currents

12. A sudden movement of Earth's crust is a(n) ____________ .

    a. volcano
    b. mantle
    c. core
    d. earthquake

13. The instrument used to measure earthquake activity is a(n) ____________ .

    a. epicenter
    b. seismograph
    c. volcano
    d. Richter scale

14. A vent in Earth's crust through which hot, liquid rock erupts or oozes is a ____________ .

    a. volcano
    b. rift
    c. mantle
    d. mountain

15. A crack in Earth's surface is a ____________ .

    a. mountain
    b. rift
    c. trench
    d. fault

16. A person who studies earthquakes is a(n) ____________ .

    a. seismograph
    b. seismologist
    c. Richter scale
    d. epicenter

17. The innermost layer of Earth which has two parts; the outer portion which is liquid and the inner portion which is solid is the ____________ .

    a. focus
    b. magma
    c. crust
    d. core

18. Magma that comes to the surface of Earth is called ____________ .

    a. mantle
    b. core
    c. crust
    d. lava

19. An area where many of the world's active volcanoes are found is called the ____________ .

    a. Ring of Fire
    b. fault
    c. core
    d. epicenter

20. The outer layer of Earth is called the ____________ .

    a. mantle
    b. crust
    c. core
    d. fault

21. The ____________ is the molten layer of Earth below the crust.

    a. magma
    b. core
    c. crust
    d. mantle

22. The point on the surface of Earth directly above the focus of an earthquake is the ____________ .

    a. epicenter
    b. core
    c. crust
    d. mantle

23. The ____________ is used to describe the strength of an earthquake.

a. Richter scale
b. seismograph
c. lava
d. seismologist

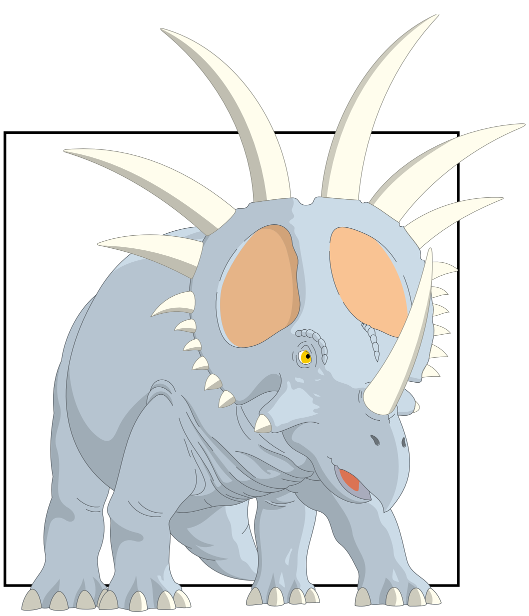
24. ____________ are waves by which energy moves away from the focus of an earthquake in all directions from the center.

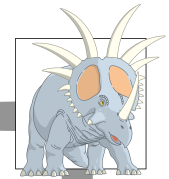
a. Earthquakes
b. Epicenters
c. Seismic waves
d. Volcanos

25. The true center of an earthquake below Earth's surface is the ____________ .

a. core
b. fault
c. mantle
d. focus

Unit 9: Geologic History and Fossils





Vocabulary

Study the vocabulary words and definitions below.

absolute dates .... dates that tell how many years have passed since an event took place

brachiopods .... small, clam-like marine invertebrates

carbon-14 .... radioactive form of carbon found in living things which is used to determine the age of materials

cast .... a mold that has the same shape as the original fossil and has been filled with hardened sediment

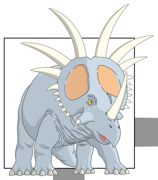
Cenozoic .... the most recent geologic era of Earth; the Age of Mammals

epoch .... subdivision of a period of time in the geologic time scale

era .... the largest division of geologic time

extinct .... no longer living on Earth

fossils .... remains and imprints of life forms that once lived on Earth



geologic time scale .... the division of Earth into periods of time; the sequence of eras, periods, and epochs

geologists .... scientists who study the origin, history, and structure of Earth and the processes which form and change its surface

half-life .... the time it takes one-half of the atoms of a radioactive sample to decay

index fossils .... fossils that identify the age of the rock in which they occur; also called guide fossils
Example: The trilobite is an index fossil for the middle Cambrian Period.

law of superposition .... principle stating that sedimentary rocks are formed with the oldest layers on the bottom and the youngest on top

Mesozoic .... the geologic era of Earth from 225 million years ago to 65 million year ago; the Age of Reptiles

mold .... the empty cavity of a fossil left in a rock after the original organism has decayed

paleontologist .... scientist who studies fossils

Paleozoic .... the geologic era of Earth from 600 million years ago to 225 million years ago, known for presence of invertebrates, amphibians, and fish; the Age of Invertebrates

period .... subdivision of an era in the geologic time scale

petrification .... process by which the remains of plants or animals are replaced by stone

Proterozoic .... the first geologic era of Earth, beginning about 3,000 million years ago and lasting until 600 million years ago; the Age of Rocks

radioactive decay .... process used to determine the age of rocks based on the rate at which the radioactive materials in them decay

rate of erosion .... time it takes for land to weather away

rate of sedimentation .... amount of sediment deposited over time

relative dates .... dates that place events in order of when they took place

revolutions .... major changes in Earth's crust due to volcanic activity and crustal movement that marked the end of eras

trace fossils .... imprints from the activities of animals
Example: footprints

trilobites .... small marine invertebrates believed to be the early ancestors of the horseshoe crab

Introduction

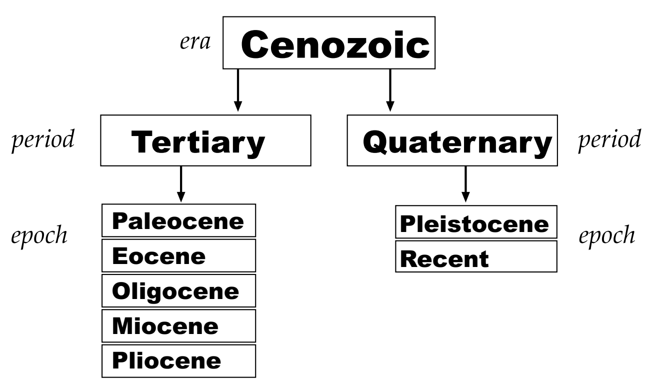
The sequence of Earth's history or geologic time covers such a large expanse of time that scientists have divided it into smaller units. **Eras**, **periods**, and **epochs**—the subdivisions of geologic time—are markers of the major changes in Earth's crust.

Changes in and on Earth's crust have caused many organisms to change or evolve over time. The study of the age of rocks, rock layers, and **fossils** is the scientists' way of solving the mystery of the earliest life form and the age of Earth.

Divisions of Geologic Time

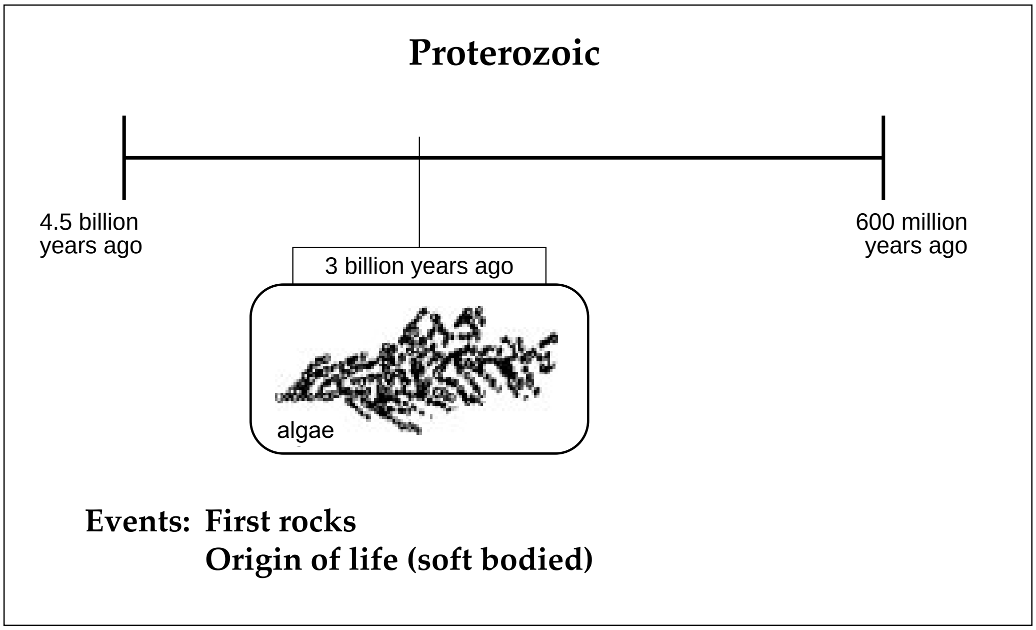
Geologists are scientists who study the origin, history, and structure of Earth, and the processes which change its surface. Geologists believe Earth to be about 4.5 billion years old. In order to study the events that happened on Earth more accurately, Earth is divided into periods of time, creating a **geologic time scale**. The largest divisions of geologic time are called *eras*. The length of an era is measured between major changes in Earth's crust called **revolutions**. Revolutions consist of violent volcanic activity and crustal movements causing major changes in Earth's surface. There are four major eras. From oldest to most recent, they are the **Proterozoic**, the **Paleozoic**, the **Mesozoic**, and the **Cenozoic**.

Enough is known about the three most recent eras to further break them down into smaller divisions called *periods*. The Paleozoic has seven, the Mesozoic has three, and the Cenozoic has two—thus far. Minor revolutions, such as climatic changes and the presence of fossils, mark the beginning and end of periods. Periods are usually named for the locations where these changes were discovered. For example, the Devonian Period was named after Devon, England.



Proterozoic Era

The first geologic era of Earth is called the Proterozoic. This era covers almost 90 percent of the age of Earth. It began with the formation of Earth and lasted until about 600 million years ago. Proterozoic time was marked by episodes of mountain building and the formation of the first rocks on Earth. The first living things developed during this era. They were simple, single-celled microorganisms such as protozoans and bacteria. Later, after the oceans formed, algae and simple invertebrates such as sponges and marine worms appeared. Since all of these life forms were soft bodied, they left very little fossil evidence.



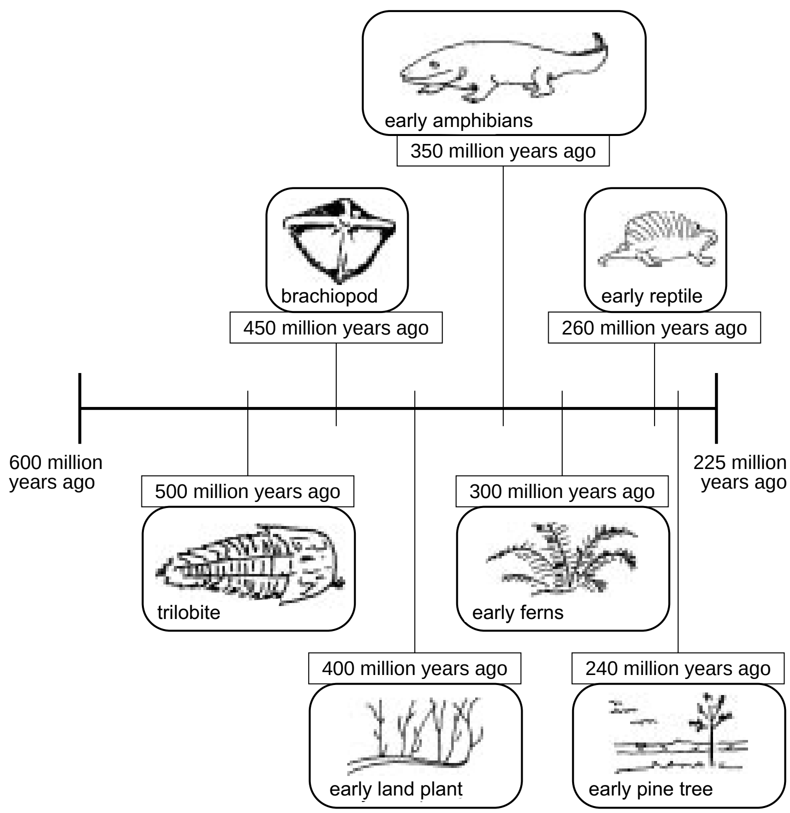
Paleozoic Era

An abundance of fossils marked the beginning of the Paleozoic era, which means *ancient life*. The Paleozoic Era began 600 million years ago and lasted until 225 million years ago. It is subdivided into six periods: the Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, and the Permian.

The Paleozoic Era began with the appearance of a large number of small marine invertebrates such as **trilobites**, believed to be ancestors of horseshoe crabs. There were also **brachiopods**, which were clam-like organisms. In later periods, land plants and animals developed. Vertebrate animals such as fish, amphibians, and reptiles appeared by the end of the Paleozoic Era. Thick forests of ferns and conifers (cone-bearing trees) appeared. During the second half of the Paleozoic Era, a variety of natural resources began forming. Fossil fuels, such as coal, oil, and natural gas, are found in rocks from the Paleozoic Era. During this period, geologists believe that the land portion of Earth was one huge continent now called *Pangaea*.

Pangaea

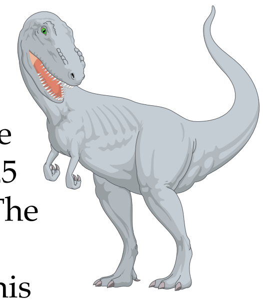
Paleozoic



Events: One land mass (Pangaea)
Coal and oil deposits

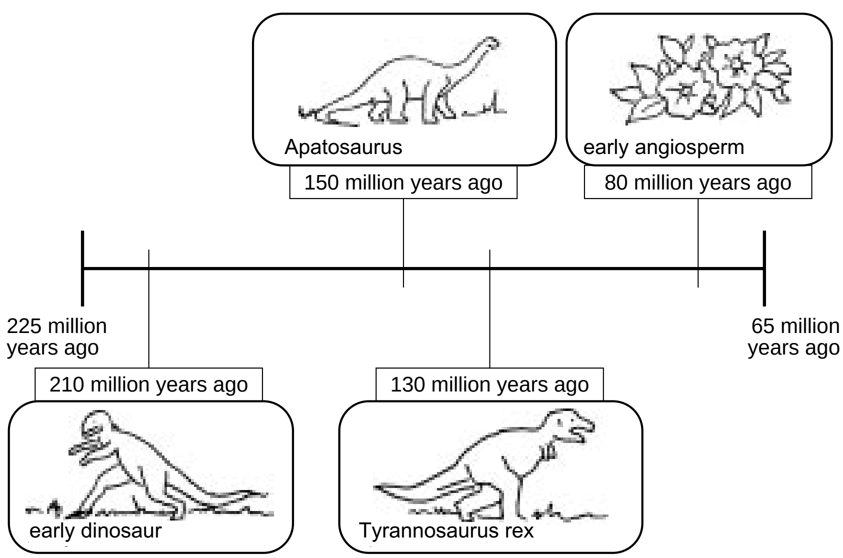
End of Paleozoic: Breakup of Pangaea

Mesozoic Era



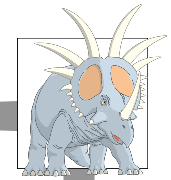
The breaking apart of Pangaea into separate continents marked the end of the Paleozoic and the beginning of the Mesozoic Era, which means *middle life*. This era began 225 million years ago and lasted until 65 million years ago. The Mesozoic Era is divided into three periods: the Triassic, Jurassic, and Cretaceous. The climate was mild during this era. Dinosaurs and other reptiles were the dominant form of life, which gave this era the name *Age of Reptiles*. Mammals and birds made their first appearance on Earth, as did flowering plants. Major geological changes occurred on Earth during this era. Most of our major mountain ranges were formed due to the movements of crustal plates. Towards the end of this era, the climate began to change as the warm tropical climate was replaced by colder temperatures. By the end of this era, the great dinosaurs had become **extinct**, or no longer living on Earth, possibly because of their inability to adapt to the climatic changes. Others have suggested that a large meteorite collided with Earth. This impact might have caused the climate changes and the extinction of the dinosaurs.

Mesozoic



Events: Age of Reptiles
Appearance of mammals and birds
Mountains formed

End of Mesozoic: Climate changes

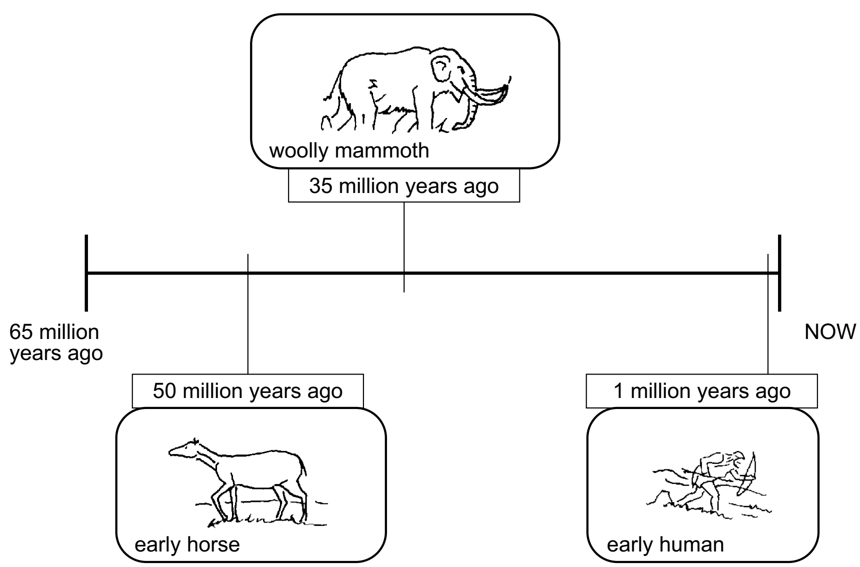


Cenozoic Era

We are now in the last era, the Cenozoic Era, which began 65 million years ago. This era is commonly called the *Age of Mammals*. Because of excellent fossil records, more information is known about this era than any other era. Therefore, the Cenozoic Era's two periods, the Tertiary and Quaternary, are subdivided into smaller units called *epochs*. The Tertiary period has five epochs: the Paleocene, Eocene, Oligocene, Miocene, and Pliocene. The most recent period, the Quaternary Period, is divided into the Pleistocene and Recent Epochs. (See page 261.)

The climate late in the Cenozoic Era, in the Quaternary period, became much colder than during the Mesozoic Era. Several Ice Ages took place. Different types of large mammals that were adapted to the colder temperatures, such as the woolly mammoth, appeared. Angiosperms became the dominant plant forms because they could tolerate the colder climate. The landforms that we find today developed during this era. Humans appeared on Earth near the beginning of the last period of this era, which was between 500,000 and 1,000,000 years ago.

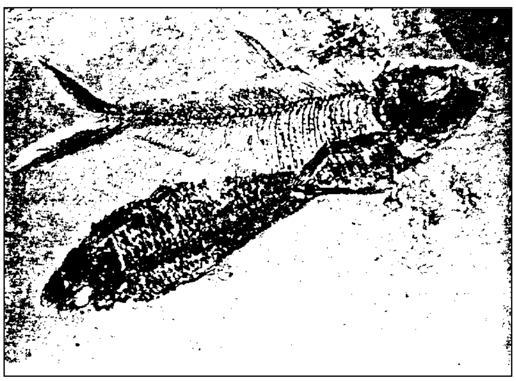
Cenozoic



Events: Ice Ages
Early humans appeared

Fossil Formation

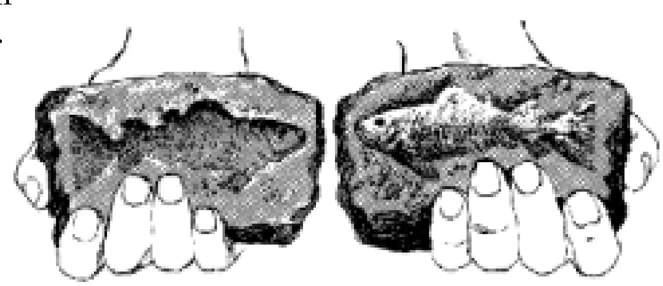
Fossils are the remains or traces of prehistoric plants and animals preserved in rock. Scientists who look for and study fossils to learn about Earth's history are called **paleontologists**. Because most dead organisms are eaten or *decay*, only about one percent of past life is left to become fossils. There are different types of fossils. Sometimes remains, or actual parts of the organism, will be found. Other times only evidence, such as a fossil footprint or imprint of the organism, will be discovered.



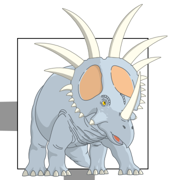
fish fossils

Most fossils are found in *sedimentary rock*. Organisms that lived near water were more often preserved than those that lived in drier regions. When the organism died, it must have been covered with sediment very quickly to prevent it from decaying or being eaten by other organisms. The *sediments* hardened, and the organism was preserved between the rock layers. Sometimes when an organism is buried in sedimentary rock, its soft parts decay, and the hard parts are dissolved, leaving only an impression. When this happens, a cavity called a **mold** forms in the rock in the exact shape of the organism that died. If this cavity becomes filled with sediments that harden, a **cast** of the original organism forms. This is a fossil.

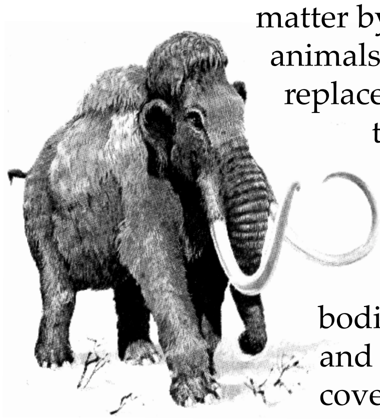
Many ancient organisms left impressions in sediments that eventually hardened into rock and were preserved. Fossils formed in this way are called *imprints*. The activities of these animals left footprints, tracks, and burrows which formed fossil imprints called **trace fossils**. The trace fossils of dinosaurs and other animals that are *extinct* left important clues for scientists that led them to other discoveries about the animals.



imprint of a fossil



The remains of some ancient fossils have been preserved through **petrification**. Petrification is the gradual replacement of the organic matter by a stonelike substance. As ancient plants and animals decayed, the organic matter in their bodies was replaced by minerals. The minerals then hardened in the same shape or form of the organism that died.



Ice, tar, or resin would sometimes preserve the entire plant or animal. Entire animal bodies were buried and frozen in large masses of ice and snow. When animals fell into tar pits, they were covered with tar and thus preserved. Many large animals, including the saber-toothed tiger and wooly mammoth, have been found in the La Brea Tar Pits in California. The sticky resin of pine trees preserved entire insects that became imbedded in the resin. After thousands of years, the resin was hardened, forming *amber*. The preservation of entire animals or plants in these ways gave scientists a great amount of information about these animals and their time periods.

Evidence of Earth's History from Fossils

The study of fossils is important to scientists because it gives them many clues as to how living things changed throughout geologic time. Divisions of geologic time are based on the appearance and disappearance of fossils.

Fossils used to divide geologic time into units are called **index fossils** or guide fossils. Index fossils identify the age of the rock in which they occur. These are fossils of plants and animals which only lived for a short period of time but were found in many areas of Earth. It can be determined that these fossils, although found in different areas, must have formed at the same time. Other fossils are the remains and imprints of species that lived over long periods of time, but only in certain areas. The disappearance of these fossils may indicate climatic or other changes which caused the extinction of the species.

By studying fossils, scientists have also learned how the surface of Earth has changed over time. For instance, fossils can help determine if and when an area was covered with water. If fossils of marine animals are found on land, scientists can assume that the land was once covered with water. Also, fossils found in layers of sedimentary rock, such as those found in the Grand Canyon, provide clues to the past climate of the area.

Fossils are also important tools for determining the age of sediments. Since fossils contain organic material, their age can be determined by the **half-life** of the **carbon-14** in them. Once the age of the fossil is determined, the age of the sediments will be approximately the same age as the fossil. However, if a fossil is found in a cave or canyon, it can only be assumed that the age of the rock is older than that of the fossil.

bee fossils

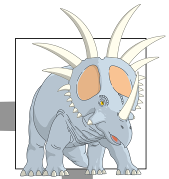
Ways to Determine the Age of Earth

Geologists have tried to measure geologic time using several methods. Since they are dealing with such a long period of time, it is very difficult to determine the exact dates when events occurred. Geologists use both relative and **absolute dates** when measuring geologic time. Absolute dates tell us how many years have passed since an event took place. **Relative dates** place events in historical order by comparing them with other happenings that took place, but they do not tell us how many years ago the events occurred. Several methods have been used to measure geologic time. They include 1) studying **rates of sedimentation**, 2) studying **rates of erosion**, 3) studying **radioactive decay**, and 4) studying evidence of fossils.

Methods for Measuring Geologic Time

- studying rates of sedimentation
- studying rates of erosion
- studying radioactive decay
- studying evidence of fossils

Scientists have studied the rate of sedimentation, or the amount of sediment deposited over time, to determine geologic time. Most sedimentary rocks are laid down in layers with the oldest layers on the bottom and younger layers near the top. This is called the **law of**



superposition. The sedimentary rock layers of the Grand Canyon are an excellent example of this law. Sedimentary rocks only give clues to relative ages of rocks rather than giving absolute dates.

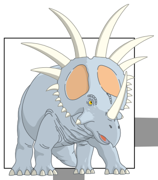
At one time, scientists believed that geologic time could be measured by the *rate of erosion*. They assumed that the rate of erosion throughout time had always been the same. Their estimates were not accurate because the rate of erosion varies with the hardness and thickness of the rock and with the amount of precipitation that fell.

In the late 1800s, the work of Antoine Henri Becquerel and Marie and Pierre Curie led to the discovery of radioactive elements. They found that certain elements, such as uranium, were radioactive and gave off invisible energy waves. These radioactive elements would decay or break apart at a constant rate called a *half-life*, which is the time it takes one-half of the atoms of a sample of the material to decay. The half-life of radioactive elements varies for each element. By determining the half-life of radioactive elements found in rocks, scientists could accurately determine the age of the rocks. Radioactive carbon, called *carbon-14*, can be used to tell the age of materials that were once living.

All living things take in a certain amount of carbon-14 from the plants they eat. When they die, the carbon-14 that is already present in their bodies begins to decay. The age of bones, shells, wood, and other remains of plants and animals can be determined by measuring the amount of carbon-14 found.

Summary

Earth's history is outlined in the geologic time scale. The largest subdivisions are called eras. Each era is divided into periods and the periods into smaller units called epochs. You are living in the Recent Epoch of the Quaternary Period of the Cenozoic Era. Ways to measure geologic time include studying rates of sedimentation, rates of erosion, radioactive decay, and evidence of fossils.

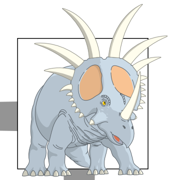


Lab Activity 1: Part 1—Geologic History

Purpose	**Materials**
Create a timeline showing selected ages and events in geologic history.	• meter stick • 5 meters of adding machine tape • pencil or markers • scissors

1. Using a scale of 1 millimeter equals 1 million years (1mm = 1,000,000 years), convert each of the ages given below to its equivalent distance in millimeters. Write the correct number of millimeters on each line.

Age	Time	No. of Millimeters
Proterozoic Era Begins	4.5 billion years	4,500 mm
Paleozoic Era Begins		
Cambrian Period begins	570 million years	570 mm
Ordovician Period begins (first vertebrates)	500 million years	______
Silurian Period begins (first land plants)	430 million years	______
Devonian Period begins (first amphibians)	395 million years	______
Mississippian Period begins	345 million years	______
Pennsylvanian Period begins	325 million years	______
Permian Period begins (first reptiles)	280 million years	______
Mesozoic Era Begins		
Triassic Period begins (first dinosaurs)	225 million years	______
First mammals	200 million years	______
Jurassic Period begins (first birds)	190 million years	______
Cretaceous Period begins	136 million years	______
Cenozoic Era Begins		
Tertiary Period		
Paleocene begins epoch	65 million years	______
Eocene epoch begins	54 million years	______
Oligocene epoch begins	38 million years	______
Miocene epoch begins	26 million years	______
Pliocene epoch begins	7 million years	______
Quaternary Period		
Pleistocene epoch begins	2.5 million years	______
Earliest humans	2 million years	______



Lab Activity 1: Part 2—Geologic History

1. Cut a piece of adding machine tape 5 meters long. Draw a line along the tape from one end to the other. Label one end *Today*. Beginning at the *Today* line, measure and mark off the position on the tape that represents each age or event listed below.

2. Locate the following ages and events on the timeline. Write them in the appropriate places.

Late Paleozoic Era	**Pangaea begins to break up**
Early Mesozoic Era	**Dinosaurs and other reptiles are the dominant form of life**
Triassic Period	**Fish, amphibians, and reptiles appeared**
Cretaceous Period	**Fossil fuels begin to form**
Oligocene epoch	**Great volcanic activity**
Pleistocene epoch	**The Great Ice Age**

Refer to the **timeline** *to answer the following using complete sentences.*

3. How does the length of time that humans have existed on Earth compare with the duration of geologic time?

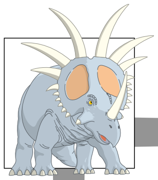
____

____

4. By looking at the timeline, what can be determined about the rate at which ages and events have occurred on Earth?

____

____



5. Explain why it would not be possible to represent the length of a person's lifetime on your timeline.

____

____

____

____

____

6. Name an event or a form of life from each era below.

   Paleozoic: ____

   ____

   Proterozoic: ____

   ____

   Cenozoic: ____

   ____

   Mesozoic: ____

   ____

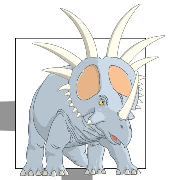
7. List the four major divisions of geologic time from oldest (earliest) to youngest (oldest).

____

____

____

____



Practice

Answer the following using short answers.

1. Name the four eras in Earth's history.

____

____

____

____

2. Do all of the eras cover the same amount of time? ________________

   Why or why not? ______________________________________

____

____

____

3. Why isn't the Proterozoic Era divided into periods?

____

____

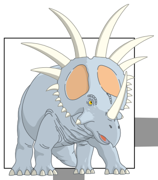
____

4. Why is the most recent era the only one that has periods further subdivided into epochs?

____

____

____



5. Which era covered the most amount of time in the history of Earth?

____

____

6. What are periods named after? ________________________________

____

____

7. When did Pangaea start to break apart?

____

____

8. Name the periods of the Paleozoic Era.

____

____

____

____

____

____

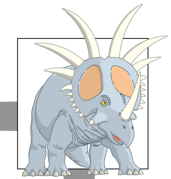
____

9. Name the three periods of the Mesozoic Era from the most recent to the oldest.

____

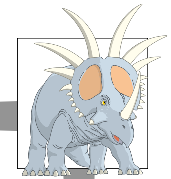
____

____



10. Name the periods and epochs of the Cenozoic Era from the most recent to the oldest.

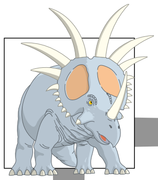
Periods:	**Epochs:**
____________________	____________________ ____________________
____________________	____________________ ____________________ ____________________ ____________________ ____________________



Practice

Fill in the chart below with the **eras**, **periods**, *and* **epochs** *that make up the geologic time scale. List* **plant** *and* **animal life forms** *that lived in each era.*

Era	Period	Epoch	Life Forms
________ present to 65 million years ago			
________ 65 to 225 million years ago			
________ 225 to 600 million years ago			
________ 600 million to 3,000 million years ago			



Practice

Use the list below to complete the following statements.

amber	**extinct**	**mold**	**remains**
carbon-14	**fossils**	**paleontologists**	**sedimentary**
cast	**imprint**	**petrification**	**trace**
climatic	**index**		

1. The remains or traces of prehistoric plants and animals that are preserved in rock are called ____________________ .

2. ____________________ are scientists who look for and study fossils.

3. The actual parts of an ancient organism that are preserved are called ____________________ .

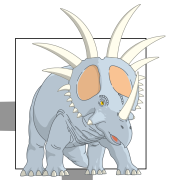
4. When evidence such as a footprint is found, it is called a(n) ____________________ .

5. Most fossils are found in ____________________ rock.

6. A cavity that forms in a rock that is the exact shape of the organism that died is called a ____________________ .

7. When the cavity of a mold fills with sediment and hardens, a(n) ____________________ of the original organism forms.

8. Fossil imprints are also called ____________________ fossils.



9. Animal species that no longer live on Earth are said to be
   ____________________ .

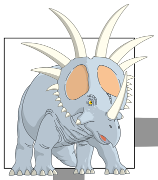
10. Sometimes the remains of an animal are replaced by stone through a process called ____________________ .

11. Insects are sometimes preserved in the resin of trees that hardens to form a substance known as ____________________ .

12. Fossils that identify the age of the rock in which they occur are called ____________________ fossils.

13. The age of fossils can be determined by the radioactive half-life of ____________________ .

14. The disappearance of a group of fossils may indicate a ____________________ change.



Lab Activity 2: Making Fossils

Purpose

Discover how fossils are made.

Materials

- clay
- plaster of Paris
- dark pencil
- knife
- assorted objects
- petrified wood or object preserved in acrylic
- leaf
- tray or aluminum pan

A: Mold

1. Put clay in aluminum tray.
2. Smooth the surface of the clay.
3. Press a small object into the surface of the clay.
4. Remove object gently.
5. Set impression aside.

B: Cast

1. Mold a cube from the clay.
2. Cut the cube in half.
3. Press a small object into one half of the clay.
4. Place a pencil closely against the object to provide a tunnel for the plaster.
5. Firmly press the other half of the clay on top of the object and pencil.
6. Separate the two halves of the mold and carefully remove the object and pencil.

7. Fit the two halves of the clay securely together and place in tray with pencil hole on top.

8. Pour thick plaster of Paris (the consistency of pudding) into opening.

9. Allow to dry overnight.

10. When dry, carefully pry mold apart and break off pencil-shaped protrusion.

C: Imprint

1. Place a leaf on a sheet of paper.

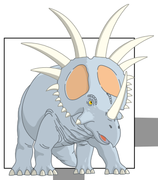
2. Rub a soft pencil over the leaf to completely coat it. (May use carbon paper.)

3. Carefully pick up leaf and place on clean sheet of paper, carbon side down, and press firmly.

4. Remove leaf from paper and discard.

5. Compare the following types of fossils.

	Mold	**Cast**	**Carbonization**	**Preservation** (petrification/amber)
Original material still present?				
Shows external structure?				
Original material must have contained hard parts (shells, bones, etc.)?				



6. Are molds and casts actual remains? ____________________

   Explain. ____________________

7. How does petrification occur? ____________________

8. How do casts and preserved organisms differ? ____________________

Practice

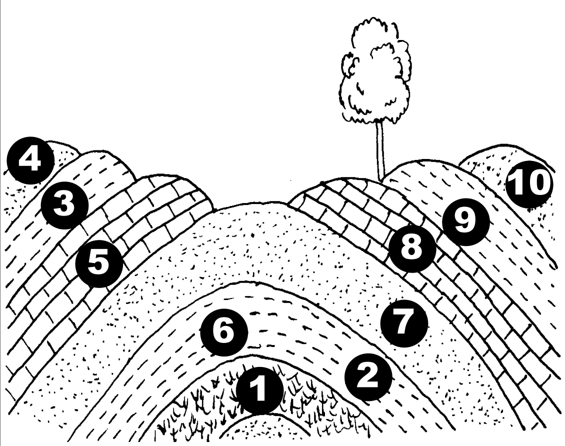
Read the information below and follow the directions.

Scientists use sedimentary rock layers to determine geologic time.

- Sedimentary rocks are laid down in layers. The oldest layers are on the bottom and youngest layers are near the top.
- Erosion can alter the surface of layers.
- Magma can invade layers. The magma is younger than the layer it invades.

1. Observe the diagrams of sedimentary rock layers on the following pages. Using the background information above, list the rock layers by number from oldest to the youngest. Some numbers may appear on the same line.

2. Write a brief history of the area, include faulting, uplifting, and erosion, on the lines provided.

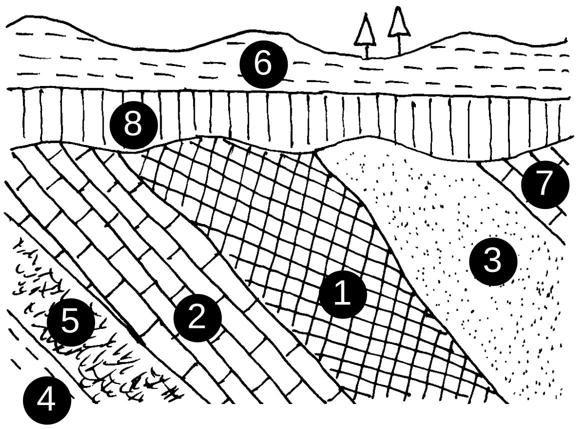


Relative Ages of Rock Layers

____
(youngest)
____
____
____
____
____
(oldest)

Geologic History: ____

____

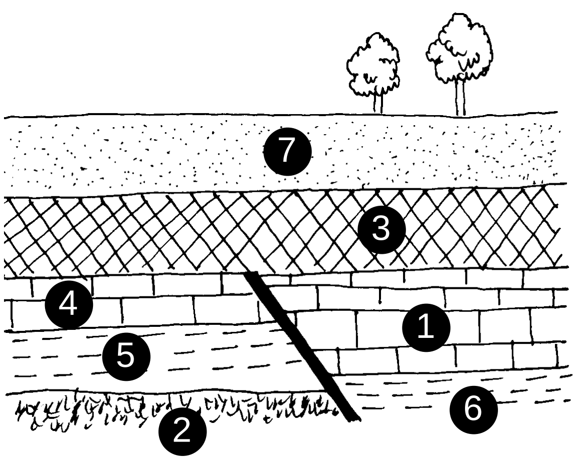


Relative Ages of Rock Layers

____
(youngest)
____
____
____
____
____
(oldest)

Geologic History: ____

____

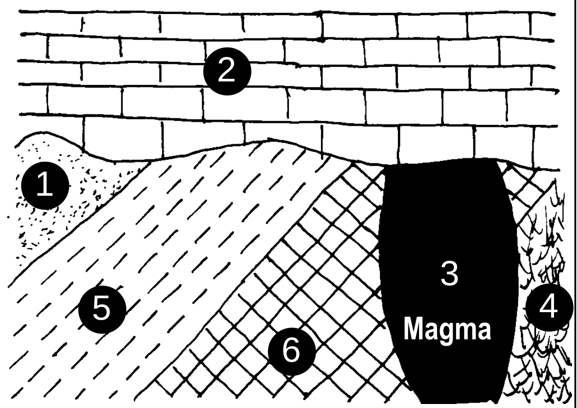


Relative Ages of Rock Layers

____
(youngest)
____
____
____
____
____
(oldest)

Geologic History: ____

____

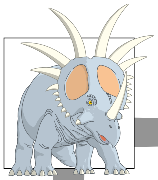


Relative Ages of Rock Layers

____
(youngest)
____
____
____
____
____
(oldest)

Geologic History: ____

____



Practice

Answer the following using complete sentences.

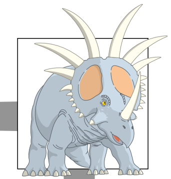
1. What is the difference between absolute dates and relative dates?

2. What does the law of superposition tell us about the age of sedimentary rocks?

3. Do the clues from sedimentary rocks help determine absolute or relative dates?

4. Is the rate of erosion an accurate way to learn the age of rocks?

   Why or why not?



5. What is the most accurate way to determine the age of rocks?

____

____

6. What is a half-life? ____

____

____

____

7. What is carbon-14? ____

____

____

____

8. What radioactive element can be used to determine the age of anything that is living or has once lived?

____

9. What are fossils? ____

____

____

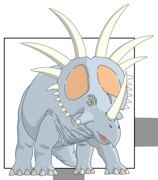
10. Name four methods used to determine the age of Earth.

____

____

____

____



Practice

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

__________ 1. It is very easy to determine exact dates in geologic history.

__________ 2. Relative dates tell how many years have passed since an event took place.

__________ 3. Geologists use both relative dates and absolute dates to measure geologic time.

__________ 4. The law of superposition states that sedimentary rocks are laid down with the oldest rocks in the bottom layer and the newest rocks in the upper layers.

__________ 5. Sedimentary rocks give clues as to the absolute dates of rocks.

__________ 6. Geologic time can be accurately measured by the rate of erosion.

__________ 7. The rate of erosion of rocks varies with the hardness and thickness of the rock.

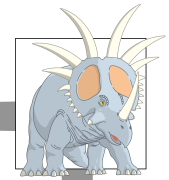
__________ 8. Antoine Henri Becquerel and Marie and Pierre Curie did work that led to the discovery of radioactivity.

__________ 9. Radioactive elements decay at a constant rate called the half-life.

__________ 10. Carbon-14 is used to tell the age of materials that have never lived.

__________ 11. Carbon-14 is a method of determining the age of materials.

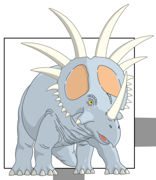
__________ 12. The discovery of fossils was not of much help to scientists in dating geologic time.



_________ 13. The half-life of an element is the amount of time it takes a sample to totally decay.

_________ 14. The age of fossils can be determined by measuring the amount of carbon-14 found.

_________ 15. Fossils are usually found in igneous rock.



Practice

Use the list below to write the correct term for each definition on the line provided.

Cenozoic	**Mesozoic**	**rate of erosion**
epoch	**Paleozoic**	**rate of sedimentation**
era	**period**	**relative dates**
fossils	**Proterozoic**	**revolutions**
geologists	**radioactive decay**	

________________________ 1. recent life; also called the Age of Mammals; started about 65 million years ago

________________________ 2. middle life; also called the Age of Reptiles; started about 225 million years ago

________________________ 3. Age of Rocks; started about 3,000 million years ago

________________________ 4. remains and imprints of life forms that once lived on Earth

________________________ 5. used to determine the age of rocks

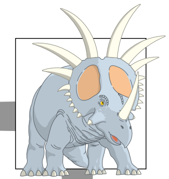
________________________ 6. time it takes for land to weather away

________________________ 7. subdivision of a period of time in the geologic time scale

________________________ 8. subdivision of an era in the geologic time scale

________________________ 9. ancient life; also called the Age of Invertebrates; started about 600 million years ago

________________________ 10. the largest division of geologic time

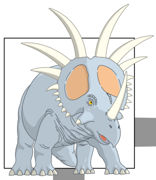


_______________________ 11. major changes in Earth's crust due to volcanic activity and crustal movement that marked the end of eras

_______________________ 12. dates that place events in order of when they took place

_______________________ 13. amount of sediment deposited over time

_______________________ 14. scientists who study the origin, history, and structure of Earth and the processes which form and change its surface



Practice

Use the list below to write the correct term for each definition on the line provided.

absolute dates	**geologic time scale**	**paleontologists**
brachiopods	**half-life**	**petrification**
carbon-14	**index fossils**	**trace fossils**
cast	**law of superposition**	**trilobites**
extinct	**mold**	

______________________ 1. imprints from the activities of fossils

______________________ 2. dates that tell how many years have passed since an event took place

______________________ 3. small marine invertebrates that are clam-like organisms

______________________ 4. radioactive form of carbon found in living things which is used to determine the age of materials

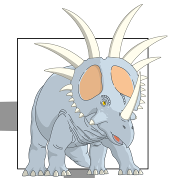
______________________ 5. no longer living on Earth

______________________ 6. the division of Earth into periods of time; the sequence of eras, periods, and epochs

______________________ 7. the time it takes one-half of the atoms of a radioactive sample to decay

______________________ 8. principle stating that sedimentary rocks are formed with the oldest layers on the bottom and the youngest on top

______________________ 9. small marine invertebrates believed to be the early ancestors of the horseshoe crab



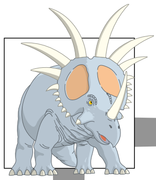
______________________ 10. a mold that has the same shape as the original fossil and has been filled with hardened sediment

______________________ 11. scientists who study fossils

______________________ 12. the empty cavity of a fossil left in a rock after the original organism has disappeared

______________________ 13. the process by which remains of plants or animals been replaced by stone

______________________ 14. fossils that identify the age of the rock in which they occur; also called guide fossils



Practice

Circle the letter of the correct answer.

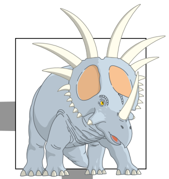
1. The largest division of the geologic time scale is a(n) __________ .
   a. epoch
   b. period
   c. era
   d. half-life

2. The subdivision of an era in the geologic time scale is a(n) __________ .
   a. period
   b. era
   c. half-life
   d. revolution

3. The subdivision of a period of time in the geologic time scale is a(n) __________ .
   a. epoch
   b. period
   c. era
   d. half-life

4. The __________ Era is the most recent geologic era of Earth and is called the Age of Mammals.
   a. Proterozoic
   b. Mesozoic
   c. Paleozoic
   d. Cenozoic

5. The geologic __________ era of Earth is called the Age of Reptiles and started about 225 million years ago.
   a. Mesozoic
   b. Proterozoic
   c. Cenozoic
   d. Paleozoic



6. The ____________ Era of Earth is called the Age of Invertebrates and started about 600 million years ago.

   a. Paleozoic
   b. Cenozoic
   c. Mesozoic
   d. Proterozoic

7. The ____________ Era, also called the Age of Rocks, is considered to be the first geologic era of Earth.

   a. Paleozoic
   b. Cenozoic
   c. Mesozoic
   d. Proterozoic

8. The process used to determine the age of rocks by the rate at which the radioactive materials in them decay is ____________ .

   a. absolute dates
   b. rate of sedimentation
   c. rate of erosion
   d. radioactive decay

9. The remains and imprints of life forms that once lived on Earth are ____________ .

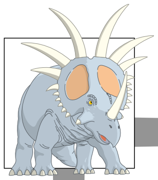
   a. brachiopods
   b. epochs
   c. fossils
   d. relative dates

10. The ____________ is the time it takes for land to weather away.

    a. law of superposition
    b. rate of sedimentation
    c. geologic time scale
    d. rate of erosion

11. The ____________ is the amount of sediment deposited over time.

    a. law of superposition
    b. rate of sedimentation
    c. rate of erosion
    d. geologic time scale



12. The scientists who study Earth and the processes which form and change Earth are __________ .

    a. brachiopods
    b. trilobites
    c. geologists
    d. revolutions

13. __________ tell how many years have passed since an event took place.

    a. Eras
    b. Periods
    c. Geologic time scales
    d. Absolute dates

14. __________ are small, clam-like organisms.

    a. Brachiopods
    b. Trilobites
    c. Geologists
    d. Fossils

15. The radioactive form of carbon found in living things which is used to determine the age of materials is __________ .

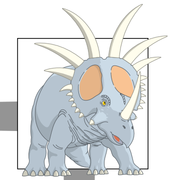
    a. half-life
    b. carbon-14
    c. epoch
    d. era

16. __________ means no longer living on Earth.

    a. Extinct
    b. Fossils
    c. Carbon-14
    d. Mesozoic

17. The time it takes one-half of the atoms of a radioactive sample to decay is its __________ .

    a. era
    b. period
    c. epoch
    d. half-life



18. The principle stating that sedimentary rocks are formed with the oldest layers on the bottom and the youngest on top is called the __________ .

    a. geologic time scale
    b. law of superposition
    c. rate of erosion
    d. rate of sedimentation

19. Major changes in Earth's crust due to volcanic activity and crustal movement that marked the end of eras are called __________ .

    a. absolute dates
    b. brachiopods
    c. revolutions
    d. periods

20. The division of Earth into periods of time is the __________ .

    a. law of superposition
    b. geologic time scale
    c. absolute date
    d. rate of erosion

21. __________ places events in order of when they took place.

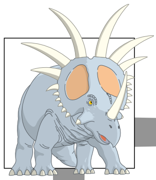
    a. Eras
    b. Epochs
    c. Relative dating
    d. Geologic time scale

22. Small marine invertebrates believed to be the early ancestors of the horseshoe crab are __________ .

    a. fossils
    b. periods
    c. brachiopods
    d. trilobites

23. The process by which the remains of plants or animals have been replaced by stone is __________ .

    a. petrification
    b. organism
    c. decay
    d. imprinting



24. A mold that has the same shape as the original fossil and has been filled with hardened sediment is called a(n) ____________ .

    a. cast
    b. amber
    c. decay
    d. sediment

25. Scientists who study fossils are called ____________ .

    a. paleontologists
    b. biologists
    c. geologists
    d. organisms

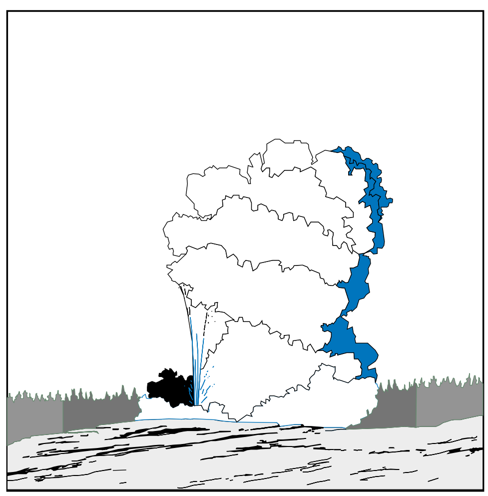
26. Fossils of organisms that identify the age of the rock in which they occur are ____________ .

    a. trace fossils
    b. index fossils
    c. amber
    d. remains

27. The empty cavity of a fossil left in a rock after the original organism has decayed is a(n) ____________ .

    a. fossil
    b. cast
    c. imprint
    d. mold

Unit 10: The Water Cycle



Practice

Study the vocabulary words and definitions below.

aquifer .... layer of rock found underground that is filled with water

artesian well .... a well in which water naturally rises above the level at which it was initially found

clouds .... condensed water vapor in the atmosphere

condensation .... the changing of a gas into a liquid

dew point .... the temperature at which water vapor condenses

evaporation .... the changing of a liquid into a gas by the escaping of atoms or molecules into the atmosphere

geyser .... a fountain of hot water erupting periodically from the ground

groundwater .... underground water that supplies wells and springs

hard water .... water that contains large amounts of dissolved minerals (magnesium and calcium carbonate)

hydrologic cycle .... the movement of water from the oceans and freshwater sources to the land and air and then back to the oceans; also called the *water cycle*

hydrosphere .... all of Earth's water

nitrates .... pollutants from fertilizers or waste products of animals that seep into the water

phosphates .... pollutants from detergents or fertilizers that seep into water

pollutant .... substance that causes harm to the environment

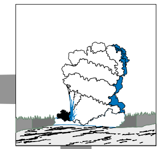
pollution .... the contamination of the environment with waste

precipitation .... moisture that falls to Earth as rain, hail, sleet, or snow

runoff .... excess rainwater that drains into lakes and other bodies of water

saltwater intrusion .... when salt water moves into the bodies of fresh water

saturated .... a condition in which a substance can hold no more water



sinkhole .... a depression in a region where soluble rock has been removed by groundwater

soft water .... water that does not contain dissolved minerals

spring .... a flow of groundwater that emerges naturally at the ground surface

transpiration .... the process by which water evaporates from the leaves of plants

water cycle .... the movement of water from the oceans and freshwater sources to the land and air and then back to the oceans; also called the *hydrologic cycle*

water table .... the upper level of the saturated zone of groundwater

water vapor .... water in a gaseous state

Introduction

More than 70 percent of planet Earth's surface is covered by water. This 70 percent of the surface includes oceans, lakes, rivers, and other bodies of water. Water circulates among these sources in a cycle powered by the sun. This **water cycle** is essential to all life.

In Florida, water is of extreme importance, with 90 percent of the population living less than one hour away from the coast. The linkage of our freshwater system to our coastal waters by caves, tunnels, lakes, rivers, and swamps makes Florida home to many unique environments.

The Water Cycle

The **hydrosphere** is all of Earth's water. The oceans contain over 95 percent of Earth's water supply; however, its water is salty and cannot be used directly by people on Earth to drink and grow food. Earth's usable freshwater supplies are found in moving water such as rivers, streams, and **springs**, and in standing water in ponds, lakes, and wetlands. Much of our freshwater supply is frozen in polar ice caps and glaciers.

Water moves from the oceans and freshwater sources to the land and air and then back to the oceans in a continuous cycle called the *water cycle* or **hydrologic cycle**. The water cycle provides fresh, usable water to lands all over the world—even to areas where there are no bodies of fresh water nearby. The water cycle changes salty, unusable ocean water into fresh, usable water.

The water cycle has three main steps. However, the cycle is continuous—there is no beginning or end.

The first step involves the **evaporation** of water into the air. Evaporation is a process in which water changes from its liquid state to a gaseous state called **water vapor**. Most of this occurs when the sun heats the water in oceans, lakes, and other bodies of water, causing evaporation. Plants also give off water vapor from their leaves in a process called **transpiration**. Animals, too, give off water vapor as part of respiration.

In the second step of the water cycle, the water changes back into a liquid during a process called **condensation**. This occurs because water vapor cools as it rises in the atmosphere. The temperature at which water condenses is called the **dew point**. At the dew point, water condenses into tiny droplets that may form dew or **clouds**. The water that evaporates from the ocean condenses as fresh water because the salts do not evaporate.

The third and last step of the water cycle is **precipitation**. This is when the fresh water returns to Earth as rain, snow, sleet, hail, fog, or dew. Some of the water that returns to Earth will wash into the oceans, lakes, and rivers. This water is called **runoff**. The rest of the water soaks into the ground and becomes **groundwater**. Eventually, the groundwater will return to the ocean through underground channels, where it will continue in the water cycle.

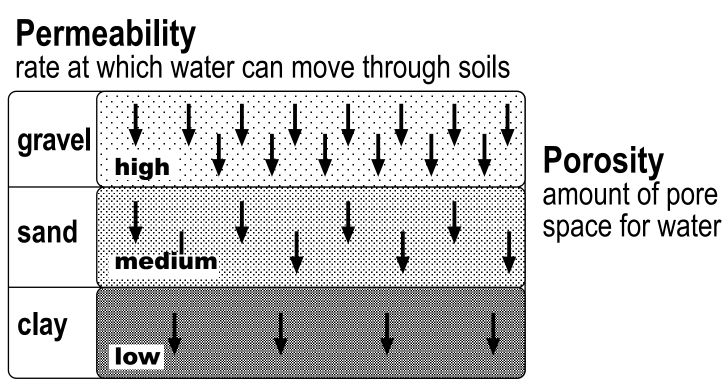
water cycle

Seawater

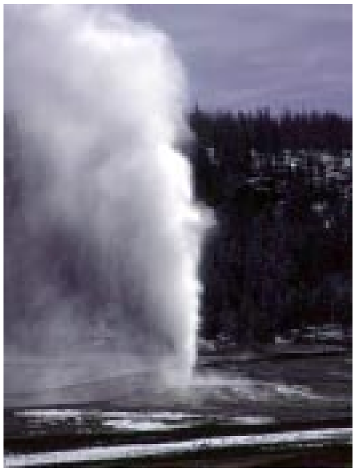
Seawater is not pure water. It contains salts and other chemical compounds. All of the salts in ocean water were carried from the land to the sea by rivers or runoff. The salinity is the amount of dissolved substances in seawater. Most seawater has a salinity of about 3.5 percent or 35 parts per thousand. Salinity of seawater increases as water is evaporated by the sun because the salts are left behind. As ice forms, salinity also increases as only the water freezes leaving the salts in the water below. Salinity of seawater decreases when the amount of water is increased by precipitation or runoff.

Groundwater

Water that soaks into the ground is called *groundwater*. Different types of rocks and soil hold different amounts of groundwater. Ground that has many pores or spaces between the soil particles can hold a lot of groundwater. When all of the pores and spaces are filled with water and the ground has all the water that it can hold, it is said to be **saturated**. The upper level of the saturated zone of groundwater is called the **water table**. When you dig a well to get water, you must dig below the level of the water table to get water to flow up through the well.



Underground water moves from high ground to lower ground. It moves more slowly underground because of friction between the rocks and the water. The larger the spaces between the rocks, the faster the water can move. **Aquifers** are layers of rock found underground that have large pores and through which water can easily move. Most aquifers are made of sand, gravel, sandstone, or limestone. Most of the time you must use a pump to get the water from an aquifer. However, sometimes when a well is dug, there is enough pressure to cause the water to flow to the surface on its own. This natural upward flow of water forms an **artesian well**.



a geyser

When water reaches the surface under pressure and flows out of natural openings in the rock, a *spring* is formed. **Geysers** are springs in which the water that flows out is hot. Usually, it takes time for the pressure and steam to build. That is why geysers flow in spurts rather than continuously. Old Faithful in Yellowstone National Park is a geyser that erupts about every hour.

Groundwater dissolves certain types of minerals, such as limestone, and carries them away, leaving hollow chambers or underground caves and caverns. Occasionally, during dry periods when the level of the groundwater is very low, the roofs of these caves may collapse, forming **sinkholes**. When the water table returns to its normal level, the sinkholes fill with water and become lakes or ponds.

Rainwater that does not contain any dissolved minerals is called **soft water**. When the rainwater filters through the ground, it dissolves calcium carbonate from limestone and becomes **hard water**.

Florida's Freshwater Systems

Florida has over 30,000 bodies of fresh water, which makes the state an excellent area for fishing and outdoor recreation. These bodies of water include lakes, rivers, ponds, canals, and swamps, the navigation of which is controlled by the United States Army Corps of Engineers.

Florida has thousands of lakes, including Lake Okeechobee—its largest and most famous. Lake Okeechobee is a large, natural lake in the heart of south-central Florida. The Okeechobee Waterway is a navigation channel which connects the Atlantic Ocean and the Gulf of Mexico.

Florida has many swamps, marshes, and other wetlands due to its humid climate and low elevation. The Everglades (also known as the River of Grass), which lies directly south of Lake Okeechobee, is the largest marsh. It is a combination of sawgrass and water. A well-known swamp is the Okefenokee swamp found along the Suwannee River in northern Florida. Because of the unstable nature of the swamp's soil, Native Americans gave it a name meaning *Land of the Trembling Earth*.

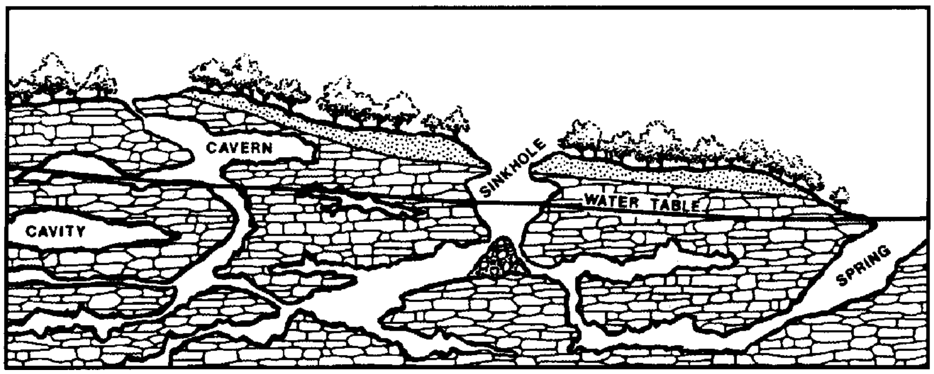
Florida has a number of rivers in its freshwater system. The St. Johns River begins in a swampy area just west of Ft. Pierce and flows in a northerly direction about 300 miles to Mayport, north of Jacksonville. It is the largest river system located entirely in the state. The St. Johns River receives part of its water flow from underground water seepage, including a large number of perennial springs. The southwest region of Florida has a system of four major rivers that all have their origin in the Green Swamp. These include the Hillsborough, Withlacoochee, Oklawaha, and Peace rivers. The Suwannee River, which flows out of the Okefenokee Swamp in northern Florida, was made famous by Stephen Foster's song "Old Folks at Home."

A major river system in northern Florida is the Apalachicola-Chattahoochee-Flint. It drains areas in Alabama, Tennessee, and Georgia, and adds their runoff to the Florida system. The Apalachicola river system is important economically because its estuary (the place where river and the Gulf of Mexico meet) is a major source of shellfish, oysters, shrimp, and crabs.

Because of Florida's low elevation, there exists a very delicate environment. Its freshwater systems are constantly monitored by the United States Army Corp of Engineers, and many of its lakes and canals are controlled by its five water management districts. The level of Lake Okeechobee is of extreme importance. In flood conditions, water is released from the lake to flow through canals and out to the ocean.

Times of drought are equally dangerous. When there is not enough rainfall, the aquifer beneath the land becomes dangerously low, allowing for **saltwater intrusion**. This is when salt water moves into the freshwater aquifer. This can contaminate our water supply reducing the amount of fresh water available.

Sinkholes are formed when the rock layers are dissolved by groundwater or the water table drops abruptly. In both cases, the underlying rock cannot support the surface rock and soil. The underground layers collapse, forming a sinkhole. They can occur unexpectedly and *swallow* houses, roads, and other buildings. Sinkholes, such as Big Dismal Sink in Leon County and Riverview Sink in Hillsborough County, are common in parts of Florida. Recent sinkholes have occurred in central Florida in Winter Park, Gainesville, and Chiefland. In January 1999 a sinkhole occurred in the northbound lane of I-95 in Palm Beach County.



sinkhole

Other factors that affect Florida's freshwater systems are **pollutants**. **Phosphates**, found in detergents and fertilizers, and **nitrates** from animal wastes and fertilizers, are two major causes of water **pollution** in Florida. These pollutants kill fish and plant life and make water unsafe for drinking. Current environmental safeguards are helping to protect our limited water supply.

Summary

Earth's water moves in a continuous hydrologic cycle through evaporation, condensation, and precipitation. Seawater makes up over 95 percent of the hydrosphere. Through evaporation in the water cycle, salt water is changed to fresh water. Groundwater is held in rocks, soil, and aquifers. The action of water may form springs, geysers, caves, and sinkholes. Florida has many freshwater bodies that provide recreation and food. We must protect our delicately balanced water resources.

Lab Activity 1: Part 1—The Hydrologic Cycle

Purpose
Demonstrate evaporation, a part of the hydrologic cycle.

Materials
- beaker, jar, or aluminum can
- crushed ice
- food coloring
- salt

1. Fill a container (beaker, jar, or aluminum can) with crushed ice.
2. Add a little salt. (Salt will make the temperature very low.)
3. Put some food coloring on the ice and mix it.
4. Let stand.
5. What do you see on the outside of the container? ________________
6. Where did this come from? ________________________________
7. Did it come from the water inside the container? ________________
8. How can you tell? ____

____

____

____

____

____

____

____

Lab Activity 1: Part 2—The Hydrologic Cycle

Purpose

Demonstrate condensation, a part of the hydrologic cycle.

Materials

- large, flat dish
- medium heat-resistant container
- boiling water
- crushed ice
- hot plate

1. Fill a heat-resistant container half full of boiling water.
2. Place crushed ice in a flat dish larger than the container used in step one.
3. Put the dish with crushed ice on top of the container filled with boiling water.
4. What happens to some of the boiling water? ____________________

   ____

5. What do you see on the bottom of the dish that contains crushed ice?

   ____

6. Where do you think this came from? __________________________

   ____

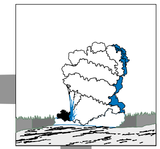
7. Why do you think the water droplets form on the bottom of the dish?

   ____

   ____

   ____

   ____



Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

air	**hydrosphere**	**polar ice caps**	**springs**
condensation	**lakes**	**ponds**	**streams**
evaporation	**land**	**precipitation**	**water cycle**
hydrologic cycle	**oceans**	**rivers**	**wetlands**

1. The movement of water in a cycle from the ocean and the land to the air and back again is called the ____________________ .

2. All of Earth's water is called the ____________________ .

3. Over 95 percent of Earth's water supply is found in the ____________________ .

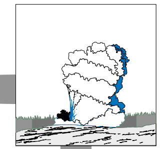
4. Earth's usable freshwater water supplies are found in ____________________ , ____________________ , ____________________ , ____________________ , ____________________ , and ____________________ .

5. Much of our freshwater supply is unavailable to us because it is frozen in ____________________ .

6. In the water cycle, water moves from the ____________________ and the ____________________ to the ____________________ and back to the ____________________ .

7. The ________________________ changes salty ocean water into fresh water.

8. Three steps of the water cycle are ________________________ , ________________________ , and ________________________ .



Practice

Use the list below to complete the following statements.

animals	**fog**	**rain**	**snow**
clouds	**groundwater**	**runoff**	**transpiration**
condensation	**hail**	**sleet**	**water vapor**
dew			

1. Water in its gaseous state is called ________________________ .

2. Plants give off water vapor from their leaves in a process called ________________________ .

3. ________________________ give off water vapor when they breathe.

4. The changing of a gas into a liquid is ________________________ .

5. Water vapor condenses into tiny droplets that form ________________________ or dew

6. The six forms of precipitation are ________________________ , ________________________ , ________________________ , ________________________ , ________________________ , and ________________________ .

7. Rainwater that runs into lakes, streams, and the ocean is called ________________________ .

8. Water that soaks into the ground after a rain is ________________________ .

Practice

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

__________ 1. The water cycle is also called the hydrologic cycle.

__________ 2. Most of the water found on Earth is fresh water.

__________ 3. The water cycle has a beginning and an end.

__________ 4. The water frozen in polar ice caps is salt water.

__________ 5. The water cycle has three main steps.

__________ 6. Evaporation is the process in which water changes to water vapor.

__________ 7. Plants and animals give off water vapor.

__________ 8. Transpiration is the second step in the water cycle.

__________ 9. Precipitation is moisture that falls to Earth as rain, hail, sleet, or snow.

__________ 10. Clouds form when water evaporates.

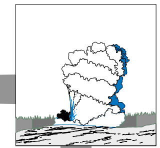
__________ 11. Water that soaks into the ground is called runoff water.

__________ 12. All of Earth's water is called the hydrosphere.

__________ 13. Groundwater stays there forever and is no longer part of the water cycle.

__________ 14. The water cycle makes it possible for areas with no nearby bodies of fresh water to have a supply of fresh water.

__________ 15. The water that evaporates from the ocean takes the salt with it as a gas.



Lab Activity 2: Seawater

Purpose	**Materials**
Show what happens to the salt and minerals that rivers deposit into the oceans. Demonstrate how the salinity of the water can change.	• 50 mL tap water • 5 mL salt **or** 50 mL of seawater • flat dish

1. Get 50 mL of seawater or pour 50 mL of tap water into a tumbler and stir 5 mL of salt into the tumbler of tap water. Keep stirring until the salt is dissolved.

2. Pour water into a flat dish.

3. Put the dish into a sunny or warm place. Leave it until all the water has evaporated.

4. What is left in the dish? ______________________________

5. Taste some of what is left. Do you think the ocean is getting saltier all the time? Why?

   ____

   ____

   ____

6. What happens to the water when the sun warms the ocean?

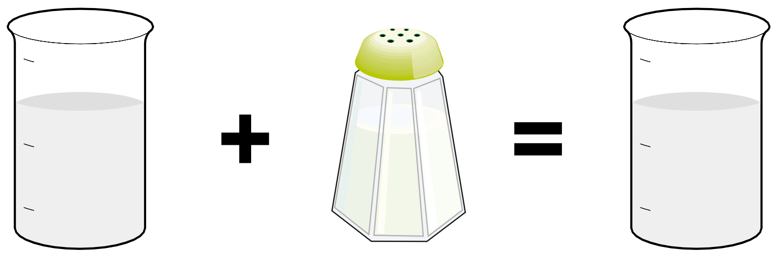
   ____

7. What is left behind when water evaporates from the ocean? ______

   ____

Practice

Answer each question below using complete sentences.



96.5 grams pure H_20 + 3.5 grams solid salts = 100 grams seawater

salt =

67.0%	sodium chloride	$NaCl$
14.6%	magnesium chloride	$MgCl_2$
11.3%	sodium sulfate	Na_2SO_4
2.2%	potassium chloride	KCl
3.5%	calcium chloride	$CaCl_2$
1.1%	miscellaneous	

1. What percent of the ocean's water is pure water? ____________________

____

2. What percent of the ocean's water is solid salt? ____________________

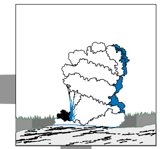
____

3. What salts are found in the ocean's water? ____________________

____

____

____



Lab Activity 3: Porosity of Aquifers

Purpose

Observe what takes place in aquifers composed of different materials.

Materials

- beaker
- 200 mL graduated cylinder
- marking pen
- funnel
- filter paper
- gravel
- clay
- sand
- mud

1. Obtain a beaker, graduated cylinder, and marking pen.
2. Measure 100 mL of water in cylinder; pour water into an empty beaker. Use a pen to draw a line around water level. Pour water into sink.
3. Fill beaker with soil sample to line.
4. Fill cylinder with 100 mL of water. Slowly pour water to fill line. Determine how much water was used and record in chart below.
5. Dump water and sample in trash can—not sink.
6. Repeat for all four samples.
7. Rank the samples from 1-4 from the greatest amount of space to the least. Record the numerals in the chart below.

	Rock	**Sand**	**Mud**	**Clay**
Amount of Water				

Remember: The amount of water held in the sample is equal to the amount of pore space or porosity of your sample.

8. What type of material would hold the most groundwater?

    ____

9. What type of material would hold the least groundwater?

    ____

10. How does the amount of porosity relate to the size of the particles?

    ____

    ____

    ____

    ____

11. Which materials would make a good aquifer? ____________

    Why? ________________________________

    ____

    ____

    ____

    ____

    ____

    ____

    ____

Lab Activity 4: Water Movement (Permeability)

Purpose

Demonstrate the movement of water through soil samples.

Materials

- beaker
- funnel
- filter paper
- graduated cylinder
- soil samples
- marking pen

1. Obtain a beaker, funnel, and filter paper.
2. Fill graduated cylinder with 50 mL of water. Pour into beaker. Use marking pen to draw line at water level.
3. Fold filter paper into cone. Tear off small piece at end to just hold sample in funnel.
4. Fill funnel half full with sample. Pack it down loosely.
5. Pour water through funnel until beaker is filled to 50 mL mark. Time it. Record how long this takes in chart below.
6. Dump soil sample in trash can, and pour water down drain in sink.
7. Repeat using other samples.
8. Rank the materials from slowest to fastest. Record them on the chart below.

	Rock	**Sand**	**Mud**	**Clay**
Time to Filter 50 mL				

Remember: How fast the water moves through the sample is related to the amount of oxygen that flows through the sample.

9. Which material dries out most quickly? ____________________

10. Which material dries out most slowly? ____________________

11. How does particle size relate to the speed with which the water flows through the samples?

    ____

    ____

    ____

12. Would clay make a good aquifer? ____________________

    Why or why not? ________________________________

    ____

    ____

13. What materials would hold groundwater above them? __________

    ____

14. What material would make the best aquifer? ______________

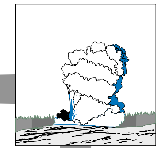
    Why? ____

    ____

    ____

    ____

    ____



Practice

Use the list below to complete the following statements.

aquifer	**geysers**	**Old Faithful**	**sinkhole**
artesian well	**groundwater**	**ponds**	**soft water**
calcium carbonate	**hard**	**resistance**	**spring**
caverns	**lakes**	**saturated**	**water table**
caves	**limestone**		

1. Water that soaks into the ground is called ____________________ .

2. The ground is ____________________ when it has as much water as it can hold.

3. The level below which all the pores of the ground are saturated forms the ____________________ .

4. Water moves more slowly underground than above ground because of the ____________________ between the rocks and the water.

5. Layers of rock found underground that have large pores through which water can easily move form a(n) ____________________ .

6. Sometimes pressure in an aquifer is great enough so that the water will flow to the surface on its own when a well is dug. This upward flow of water forms a(n) ____________________ .

7. A ____________________ forms when water under pressure reaches the surface through a natural opening in Earth.

8. Springs that have hot water spouting out of them at intervals are ____________________ .

9. ____________________ is a famous geyser in Yellowstone National Park that erupts about once every hour.

10. Groundwater dissolves ____________________ and carries it away, leaving ____________________ and ____________________ underground.

11. When the roof of an underground cave or cavern collapses, a ____________________ is formed.

12. Rainwater that falls and does not have any dissolved minerals in it is called ____________________ .

13. When rainwater filters through the ground, it dissolves ____________________ and becomes ____________________ water.

14. Sinkholes that fill with water become ____________________ or ____________________ .

Practice

Write **True** *if the statement is correct. Write* **False** *of the statement is* not *correct.*

__________ 1. All rocks found underground hold the same amount of water.

__________ 2. The rocks beneath the ground have small spaces called pores between them.

__________ 3. The spaces between the rocks underground can hold water.

__________ 4. Groundwater moves faster than water moving on the surface of Earth.

__________ 5. You must dig a well deep enough so that it goes below the water table if you hope to have water flow up into it.

__________ 6. Water always flows out of a well under its own pressure.

__________ 7. The larger the spaces between the rocks, the more slowly the water moves underground.

__________ 8. Most aquifers are made of mud and clay and other closely packed rock and soil.

__________ 9. Water that comes to the surface in the form of a spring flows from a natural opening in the rocks.

__________ 10. Old Faithful is a spring.

__________ 11. Hot water flows constantly from Old Faithful.

__________ 12. Groundwater dissolves minerals like limestone and carries them away, leaving caves and caverns underground.

__________ 13. A sinkhole is an underground cave that fills with water.

__________ 14. Rainwater is hard water.

__________ 15. Hard water contains dissolved minerals.

Practice

Use the list below to complete the following statements.

30,000	**Okefenokee**
Atlantic Ocean	**"Old Folks at Home"**
Everglades	**phosphates**
Green Swamp	**saltwater intrusion**
Gulf of Mexico	**sawgrass**
Lake Okeechobee	**St. Johns River**
Land of the Trembling Earth	**Suwannee**
nitrates	**swamps**
northerly	**U. S. Army Corps of Engineers**

1. Florida has over ________________________ bodies of fresh water.

2. Navigation of Florida's fresh water is controlled by the ________________________ .

3. Florida's largest lake is ________________________ .

4. Lake Okeechobee is connected by a waterway to both the ________________________ and the ________________________ .

5. Because of its low elevation, plentiful rainfall, and humid climate, Florida has many ________________________ and marshes.

6. Florida's largest marsh is the ________________________ , located just south of Lake Okeechobee.

7. The Everglades is a combination of ________________________ and water.

8. The ______________________ Swamp is found along the Suwannee River.

9. *Okefenokee* is a Native American name which means ______________________ .

10. The largest river system located entirely in Florida is the ______________________ .

11. The St. Johns River begins near Ft. Pierce and flows about 300 miles in a ______________________ direction to Mayport.

12. The ______________________ River which flows out of the Okefenokee Swamp was made famous by Stephen Foster's song, ______________________ .

13. The Hillsborough, Withlacoochee, Oklawaha, and Peace rivers all flow out of the ______________________ .

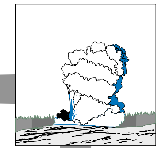
14. When rainfall is low, there is a danger that salt water will fill up the freshwater aquifer, causing ______________________ .

15. ______________________ and ______________________ that are dumped into the freshwater systems of Florida are a major cause of water pollution.

Practice

Use reference materials or the Internet to locate and label the following **freshwater systems** *on the map of Florida below.*

Apalachicola River	**Peace River**
Everglades	**St. Johns River**
Hillsborough River	**Suwannee River**
Lake Okeechobee	**Withlacoochee River**
Okefenokee Swamp	



Practice

Use the list below to write the correct term for each definition on the line provided.

aquifer	**groundwater**	**precipitation**
condensation	**hydrologic cycle**	**transpiration**
dew point	**pollution**	**water vapor**
evaporation		

______________________________ 1. underground water that supplies wells and springs

______________________________ 2. contamination of the environment with waste

______________________________ 3. the temperature at which water vapor condenses

______________________________ 4. water in a gaseous state

______________________________ 5. rock layer filled with water

______________________________ 6. the changing of a liquid to a gas

______________________________ 7. the changing of a gas to a liquid

______________________________ 8. rain, snow, sleet, or hail

______________________________ 9. process of water evaporating from the leaves of plants

______________________________ 10. the movement of water from the oceans and freshwater sources to the land and air and then back to the oceans; also called the water cycle

Practice

Use the list below to write the correct term for each definition on the line provided.

clouds	**nitrates**	**runoff**	**soft water**
geyser	**phosphates**	**saturation**	**water cycle**
hard water	**pollutant**		

__________________________ 1. a fountain of hot water erupting periodically

__________________________ 2. substance that causes harm to the environment

__________________________ 3. the water entering a river or stream after a rainfall

__________________________ 4. water that contains large amounts of dissolved minerals (magnesium and calcium carbonate)

__________________________ 5. condensed water vapor

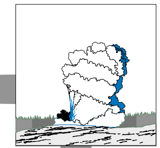
__________________________ 6. water that does not contain dissolved minerals

__________________________ 7. pollutants often found in soap detergents or fertilizers that seep into water

__________________________ 8. pollutants from fertilizers or waste products of animals that seep into water

__________________________ 9. a condition in which a substance cannot hold any more water

__________________________ 10. the movement of water from the oceans and freshwater sources to the land and air and then back to the oceans; also called hydrologic cycle



Practice

Circle the letter of the correct answer.

1. __________ is the changing of a liquid to a gas.
   a. Evaporation
   b. Precipitation
   c. Saturation
   d. Transpiration

2. __________ is the changing of a gas to a liquid.
   a. Evaporation
   b. Condensation
   c. Saturation
   d. Precipitation

3. Rain, snow, sleet, and hail are forms of __________ .
   a. groundwater
   b. condensation
   c. transpiration
   d. precipitation

4. A rock layer filled with water is a(n) __________ .
   a. aquifer
   b. groundwater
   c. water cycle
   d. sinkhole

5. __________ are condensed water vapor.
   a. Clouds
   b. Pollutants
   c. Springs
   d. Phosphates

6. __________ is underground water that supplies wells and springs.
   a. Pollution
   b. Condensation
   c. Hydrologic cycle
   d. Groundwater

7. The contamination of the environment with waste is called __________ .

   a. pollution
   b. runoff
   c. transpiration
   d. groundwater

8. The temperature at which water vapor condenses is the __________ .

   a. aquifer
   b. dew point
   c. runoff
   d. water cycle

9. Water in a gaseous state is __________ .

   a. groundwater
   b. hard water
   c. soft water
   d. water vapor

10. All of Earth's water is called the __________ .

    a. water cycle
    b. hydrologic cycle
    c. dew point
    d. hydrosphere

11. A formation of hot water erupting periodically from the ground is called a(n) __________ .

    a. water cycle
    b. artesian well
    c. aquifer
    d. geyser

12. The water entering a river or stream during and after a rainfall is __________ .

    a. soft water
    b. runoff
    c. hard water
    d. condensation

13. A depression in a region where soluble rock has been removed by groundwater is called a ____________ .

    a. swamp
    b. hydrologic cycle
    c. runoff
    d. sinkhole

14. Water that contains large amounts of magnesium and calcium carbonate is ____________ .

    a. soft water
    b. saltwater intrusion
    c. transpiration
    d. hard water

15. Rainwater that does not contain dissolved minerals is ____________ .

    a. saltwater intrusion
    b. transpiration
    c. soft water
    d. hard water

16. The process by which water evaporates from the leaves of plants is called ____________ .

    a. condensation
    b. transpiration
    c. evaporation
    d. precipitation

17. Among pollutants often found in soap detergents or fertilizers are ________________________ .

    a. phosphates
    b. aquifers
    c. nitrates
    d. runoffs

18. __________ are pollutants from fertilizers or the waste product of animals that seep into the water.

a. Phosphates
b. Runoffs
c. Nitrates
d. Water vapors

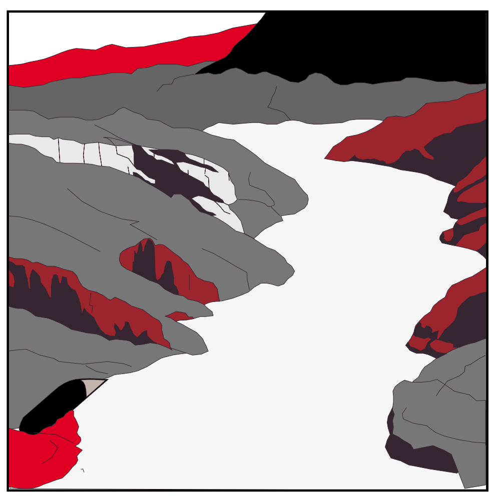
19. __________ occurs when salt water moves into the freshwater aquifer.

a. Condensation
b. Evaporation
c. Pollution
d. Saltwater intrusion

20. Another name for the water cycle is the __________ cycle.

a. hydrologic
b. hydrosphere
c. condensation
d. evaporation

Unit 11: Rivers



Vocabulary

Study the vocabulary words and definitions below.

channel .... a waterway formed by runoff on steep surfaces of mountains

delta .... large amounts of sediment deposited at the mouth of a large river

deposition .... sediment deposited in new locations by running water

floodplains .... flat areas on both sides of a river where sediments have been deposited when the river overflows

load .... particles of soil and rock that a river carries

mature river.................................... a river with many tributaries where water flow may be both slow and fast and there are no rapids or waterfalls

meander .... a curve or loop-like bend in the course of river or stream (noun); to follow a winding course (verb)

mouth .... point where a river joins a larger body of water such as a lake or ocean

old river .... a slowly flowing river that has a wide floodplain and is curved and winding

oxbow lakes .... U-shaped lakes formed when a meander is cut off from the rest of the river

river .... a large flow of water formed when tributaries join

riverbanks .... the sides of a river

riverbed .... the bottom of a river channel

sediment .... pieces of rock and soil deposited by a river

source .... the beginning of a river

stream .... a body of water that flows in only one direction

tributaries .... smaller streams flowing into a larger stream or body of water

young river .... a river found in mountainous areas; its water flows very fast and often has rapids and waterfalls

Introduction

As water moves along the earth, it erodes or carves out pathways on the surface. These pathways form many of our **river** systems—with all of their parts that we know as **tributaries**, **meanders**, and **streams**. As with rocks, rivers have characteristics that help us to unravel more of the mysteries of Earth. The development of a river passes through several stages—young, mature, and old. The physical characteristics of a river are a good gauge to use in determining the age of an area. Understanding the characteristics of our rivers helps us to better understand the topography of our environment.

Development of Rivers

Most rivers have their **source**, or beginning, in the mountains. Water from rain and melting snow trickles downhill. At first, this water does not have a permanent path or **channel**. Eventually, enough trickles meet to cut a channel and a small *stream* is formed. River systems begin where runoff trickles downhill, following the same path over and over.

As a result of gravity, water moves downhill and gradually cuts a channel. The water flowing in the stream carves a V-shaped valley in the land. As water cuts deeper paths, it moves faster. Small streams meet to form *tributaries* which flow into a main river. The main river eventually empties into a large body of water, such as a lake or ocean. The place where the river joins a lake or ocean is called its **mouth**.

This network of streams and tributaries is called a *drainage system* because it drains an area of its runoff. Many drainage systems have a treelike pattern. Small currents and streams resemble small twigs and branches. Larger tributaries form the main branches, while the main river is the trunk.

All rivers are not the same age. You can tell the approximate age of a river by its characteristics. Some characteristics of a river at different stages are listed below.

A young river

- has a V-shaped valley
- is usually found in the mountains
- has very fast flowing water
- cuts downward, making a deep valley
- often has rapids and waterfalls
- erodes the land very quickly
- carries large particles as it erodes the land

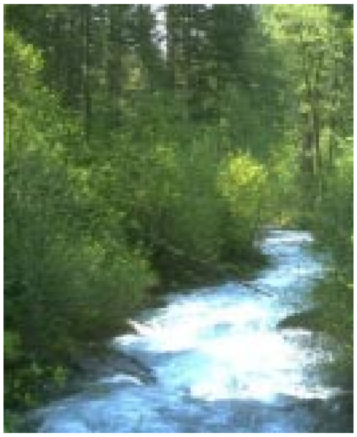
A mature river

- has been developing for thousands of years
- has formed a wider valley
- has valley walls that are farther from the river
- no longer has rapids or waterfalls
- has both slow and fast moving water in different areas
- has many tributaries
- develops a flat **floodplain** on both sides of the channel

An old river

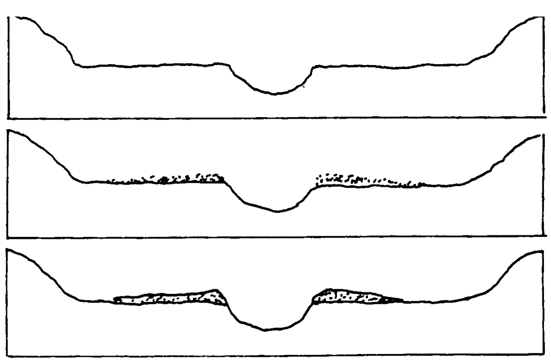
- has a floodplain several times wider than the channel
- has a valley floor that is flat and wide (U-shaped)
- is curved and winding with many loops called meanders
- has slower waters
- has a very wide floodplain
- carries small particles as it erodes the land

Erosion and Deposition



The fast flow of a young river carries large amounts of soil and rocks. Old rivers, on the other hand, move more slowly and carry smaller particles of soil and rock. The particles of soil and rock that a stream or river carries are called its **load**. Rivers deposit the soil and rock particles, or **deposition**, in new locations. Rivers that carry a lot of soil and rocks appear muddy.

Deltas are formed at the mouth of rivers that empty into quiet bodies of water. As the river flows into a lake or an ocean, it slows down. It cannot carry as much material at a slower speed, so it deposits much of the material. The fan-shaped deposition is largely fertile top soil. For this reason, deltas make fertile growing areas. The deposits build up above the river's water level and add land to a coastal area. The delta formed at the mouth of the Mississippi River, for example, extends the area hundreds of kilometers into the Gulf of Mexico. In this region, cotton and rice are grown.



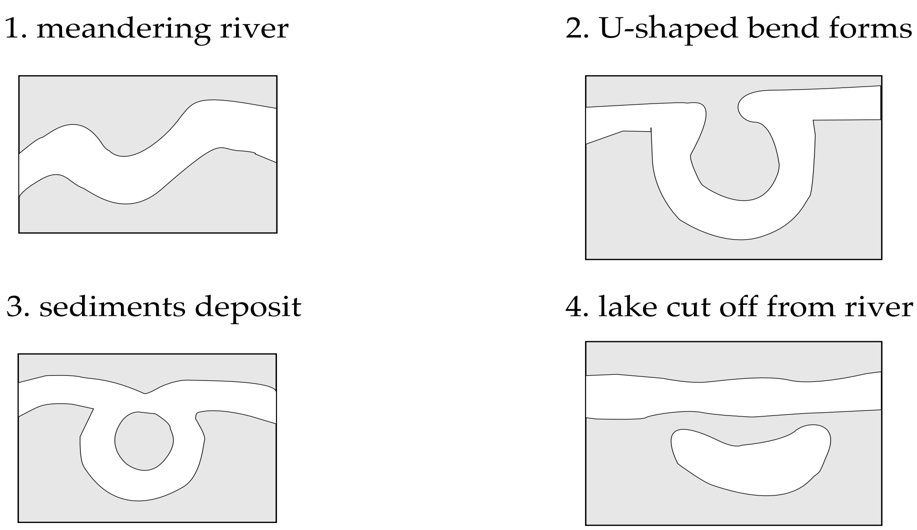
A river may deposit its load along the riverbank. Over time levees develop.

When a river's speed slows down, it can no longer carry as much of a load. Some of this material is then deposited on the bottom of the river channel, which is called the **riverbed**. These deposits are called **sediments**. Levees develop when sediments are deposited on the sides of the river or along the **riverbank**.

Floodplains are flat areas on both sides of the river. When a flood causes a river to overflow, it deposits sediments on the floodplains. These areas are very fertile and are often used for farming.

Rivers begin to *meander*, or wander, from side to side across the land. The movement creates curves or loop-like bends in the river known as *meanders*. The river usually erodes or cuts away the bank more when the river curves. The river flows faster on the outside of the curve and cuts away the bank. Sediments are deposited on the inside of the curve, where the river flows more slowly.

Sometimes U-shaped bends are formed as the river winds. Erosion and deposition along the bends can eventually cut part of the bend off from the rest of the river. When this happens, small lakes called **oxbow lakes** form. The diagram below shows the formation of an oxbow lake.



Summary

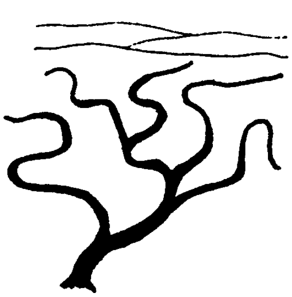
Most rivers are formed as precipitation moves downhill in small streams. The flowing water cuts a channel in the land. Streams flow together to form tributaries, which flow into the main river. At the mouth of the river, the water empties into a larger body of water. The age of a river can be determined by its physical characteristics. Rivers erode the land over which they flow. As rivers move they pick up soil and rocks and deposit the load in new locations. The deposition of soil and rock in the riverbed is called sediment. Along the riverbank, a levee may be formed from the deposition. At the mouth of the river a delta may build up over time, creating fertile growing areas. Rivers may meander across the land. The erosion and depositions in the river curves may result in an oxbow lake.

Practice

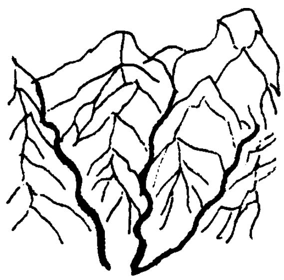
Label each of the drawings below. Use **young river**, **mature river**, *or* **old river**.

Characteristics of Rivers

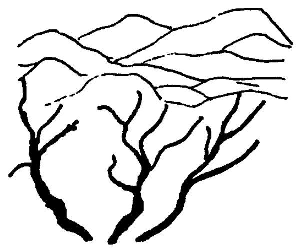
Surface relief



1. ____________________



2. ____________________



3. ____________________

Cross-section

4. ____________________

5. ____________________

6. ____________________

Practice

Use an **atlas** *of the United States to find the names of the* **major rivers** *that make up the* **Mississippi River System**. *Label the rivers on the map below that make up the Mississippi River System.*

The Mississippi River System

The Mississippi River is an example of an old river. Its source is Lake Itasca in Minnesota, and its mouth is in the Gulf of Mexico. The Mississippi River is the largest river in the United States. The small streams and tributaries that feed into the Mississippi River form a river system that has a treelike pattern.

Lab Activity 1: Researching a River

Purpose

To identify the major landmarks and features associated with a river system.

Materials

- reference materials
- maps
- Internet access

Use the list of Internet sites below and other reference materials to complete this activity.

Internet Sites:

Wild and Scenic Rivers
http://www.nps.gov/rivers/

Water Resources in the United States
http://water.usgs.gov/

Water Resources of Florida (main office in Tallahassee)
http://fl-water.usgs.gov/

Mississippi River Road Map
http://www.mississippi-river.com/

1. Name of river: ____

2. Source (beginning of river): __________________________________

3. Outlet (where the river flows to): ____________________________

4. Location of source (state, county, country, etc.): ______________

   ____

   ____

   ____

5. Describe the watershed of the river (flow pattern). Include states or areas the river flows through, including major cities or lakes:

____

____

____

____

6. Direction the river flows: ______________________________

7. Names of tributaries that join the river: ____________________

8. Names of any structures that affect the river's flow (dams, levees, etc.):

____

____

9. What is the condition of the water in the river? ______________

____

____

10. List any environmental concerns: _________________________

____

____

____

____

____

____

Practice

Use the list below to complete the following statements.

branches	**faster**	**Mississippi River**	**source**
channels	**fertile**	**mountains**	**tributaries**
decreases	**mature**	**mouth**	**young**
deltas	**meanders**		

1. Most rivers begin in the ______________________ .

2. Moving water cuts paths in the earth called

   ______________________ .

3. Small streams flow together to form ______________________ that flow into the main river.

4. As the water cuts deeper paths, the water begins to move

   ______________________ .

5. The place where a river joins a lake or ocean is called its

   ______________________ .

6. The place where a river begins is its ______________________ .

7. ______________________ are deposits of sediment that form at the mouth of a river.

8. As the water flows into a lake or ocean from a river, its speed

   ______________________ .

9. The ____________________ has a large delta that extends hundreds of kilometers into the Gulf of Mexico.

10. The soil found in deltas is very ____________________ .

11. A river system often resembles the ____________________ of a tree.

12. A ____________________ river has a deep V-shaped valley.

13. In a ____________________ river, waterfalls and rapids have disappeared and floodplains have developed.

14. An old river is curved and winding with many loops called ____________________ .

Lab Activity 2: Erosion and Deposition

Purpose

Demonstrate erosion and deposition.

Materials

- sand (enough to make a steep model of a mountain)
- deep pan (4' x 3')
- thin water hose or rubber tubing

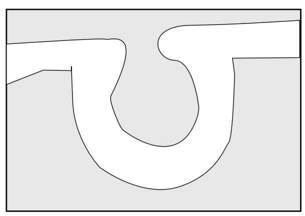
1. Place sand inside pan.
2. Pile up sand on one end of pan to make a model of a small mountain.
3. Take the hose and place it near the top of the sand mountain.
4. Slowly run a stream of water through the hose so the water flows down the mountain.
5. What happens when the stream of water runs down the mountain?

Practice

The four diagrams below show the stages of an **oxbow lake** *being formed by the* **erosion** *and* **deposition** *of a* **meandering river**. *Place the diagrams in correct order by numbering the boxes from 1 to 4. On the line following the box, write what is happening in each stage using the following phrases:*

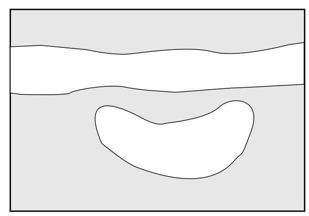
sediment deposits
U-shaped bend forms
meandering river
lake cut off from river

A.



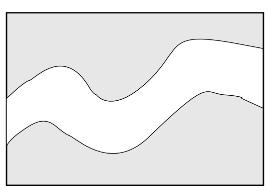
☐ ____________________

B.



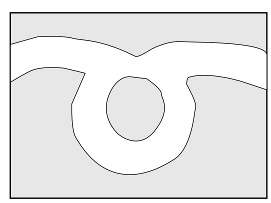
☐ ____________________

C.



☐ ____________________

D.



☐ ____________________

Practice

Use the list below to write the correct term for each definition on the line provided.

channel	**meanders**	**river**	**source**
delta	**mouth**	**riverbanks**	**stream**
deposition	**old river**	**riverbed**	**tributaries**
floodplains	**oxbow lakes**	**sediment**	**young river**
load			

______________________ 1. a body of water that flows in only one direction

______________________ 2. a large flow of water formed when tributaries join

______________________ 3. U-shaped lakes formed when a meander is cut off from the rest of the river

______________________ 4. loops formed by a winding river

______________________ 5. smaller streams flowing into larger streams or a body of water

______________________ 6. sides of the river

______________________ 7. sediment deposited by running water

______________________ 8. flat areas on both sides of where a river has once overflowed

______________________ 9. bottom of the river channel

______________________ 10. large amounts of sediment deposited at the mouth of a large river

______________________ 11. point where a river joins a larger body of water

____________________ 12. a slowly flowing river that has a wide floodplain and is curved and winding

____________________ 13. a river found in mountainous areas; its water flows very fast and often has rapids and waterfalls

____________________ 14. the beginning of a river

____________________ 15. particles of soil and rock that a river carries

____________________ 16. pieces of rock and soil deposited by a river

____________________ 17. a waterway formed by runoff on steep surfaces of mountains

Practice

Circle the letter of the correct answer.

1. A river found in mountainous areas and its water flows very quickly is a(n) ____________ .
   a. riverbed
   b. delta
   c. old river
   d. young river

2. A slowly flowing river that has a wide floodplain and is curved and winding is called a(n) ____________ .
   a. old river
   b. floodplain
   c. riverbed
   d. young river

3. The point where a river joins a larger body of water is called its ____________ .
   a. mouth
   b. riverbank
   c. channel
   d. delta

4. Large amounts of sediment deposited at the mouth of a large river form a ____________ .
   a. riverbank
   b. floodplain
   c. delta
   d. channel

5. The ____________ is the bottom of the river.
   a. riverbank
   b. floodplain
   c. riverbed
   d. mouth

6. The flat areas on both sides of where a river has once overflowed are called ____________ .

   a. riverbanks
   b. deltas
   c. floodplains
   d. meanders

7. ____________ are the sides of the river.

   a. Meanders
   b. Riverbanks
   c. Channels
   d. Floodplains

8. Sediment deposited in new locations by running water is called ____________ .

   a. deposition
   b. load
   c. floodplain
   d. source

9. A smaller stream that flows into a larger stream or body of water is a ____________ .

   a. meander
   b. tributary stream
   c. channel
   d. floodplain

10. Curves or loop-like bends formed in the course of a winding river are called ____________ .

    a. meanders
    b. tributary streams
    c. riverbanks
    d. floodplains

11. The beginning of a river is called its ____________ .

    a. source
    b. channel
    c. load
    d. delta

12. Particles of soil and rock that a river carries is its ____________ .

a. deposition
b. riverbed
c. load
d. delta

13. ____________ are pieces of rock and soil deposited by a river.

a. Sources
b. Channels
c. Loads
d. Sediments

14. A waterway formed from runoff on steep surfaces of mountains is a ____________ .

a. river
b. stream
c. source
d. channel

15. A body of water that flows in only one direction is a ____________ .

a. young river
b. stream
c. river
d. channel

16. A ____________ is a large flow of water formed when tributaries join.

a. river
b. stream
c. channel
d. tributary

17. U-shaped lakes that form when a meander is cut off from the rest of the river are called ____________ .

a. meanders
b. oxbow lakes
c. channels
d. floodplains

Unit 12: Glaciers

Vocabulary

Study the vocabulary words and definitions below.

abrading .... the scraping of the bedrock surface as ice moves over it

alpine glacier .... a glacier that forms high in the mountains and moves slowly down the mountain through the valley; also called *valley glacier*

cirque .... the bowl-shaped depression in which snow accumulates; when it overflows, a valley glacier begins

continental glaciers .... very large sheets of ice that form glaciers in the polar regions

drift .... name given to material deposited by glaciers

glacier .... a large mass of moving ice and snow

hanging valley .... small abandoned glacial valley suspended on the mountain above the main glacial valley

horns .... steep, three-sided mountain peaks formed by glaciers

ice age .... a period of time when large ice sheets covered much of the surface of Earth

icebergs .... huge chunks of floating ice that break apart from a glacier when it reaches the sea

interglacial ages .... the periods of time between the ice ages

kettle lakes .... lakes formed by the melting of a huge chunk of ice left behind by a glacier

meltwater .... water resulting from the melting of glacial snow and ice

moraines .... long, thin deposits of earth and stone that mark the sides and front of a glacier

outwash .... layered deposits of rock fragments dropped by glacial meltwater

piedmont glaciers .... glaciers which form at the foot of mountains

plucking .... combination of water freezing in the cracks of rocks and the glacier pulling the rocks along with it

striations .... scratches made by sharp-pointed rocks as a glacier moves over the land

till .... unlayered and unsorted rock material deposited directly by a glacier

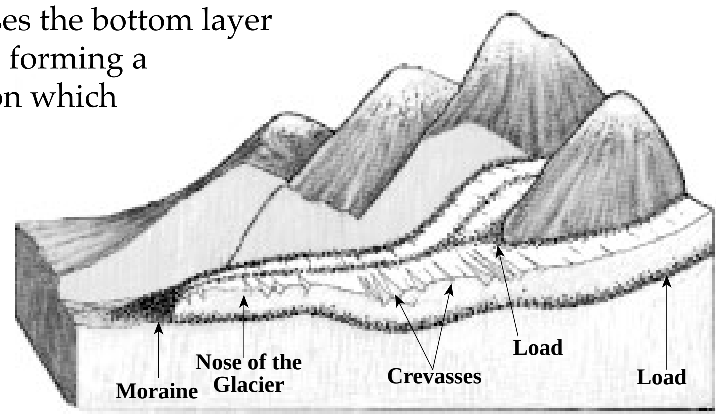
valley glacier .... a glacier that forms high in the mountains and moves slowly down the mountain through the valley; also called *alpine glacier*

Introduction

Many of our most beautiful hills and valleys are the result of years of erosion by ice and snow. During the time when the temperature of Earth was extremely low, massive amounts of snow and ice formed large **glaciers** which moved outward from the poles of Earth. The formation and movement of glaciers is important to the understanding of the **ice ages** and our rock formations as we know them today.

Glaciers

A *glacier* is a huge mass of moving ice and snow. It forms where more snow falls in the winter than melts during the summer. When the snow accumulation builds to about 60 meters, the weight of the snow causes the bottom layer to be squeezed together, forming a sheet of ice. If the land on which the glacier is formed is sloped, the glacier will move down the slope. If it is formed on flat land, it will spread out in all directions.



Types and Formation

There are three types of glaciers: piedmont, alpine, and continental. **Piedmont glaciers** form at the foot of some mountains. These glaciers spread out on the plains and join one another, making a continuous sheet of ice. A second type of glacier that forms high in the mountains is called an **alpine glacier**. Alpine glaciers are also called an **valley glacier**. They usually move downward through river valleys due to the pull of gravity.

The third type of glacier is the continental. **Continental glaciers** are very large sheets of ice that move outward in all directions from a central point. Unlike alpine glaciers, they are not confined to valleys, but cover large areas of land surfaces. They form in the polar regions and are sometimes called *polar ice caps*. The only continental glaciers existing today are found in Greenland and Antarctica.

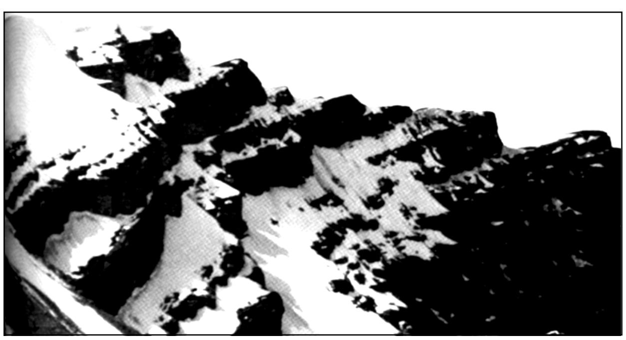
Types of Glaciers	
piedmont glaciers	form at the foot of some mountains
alpine glaciers	form high in the mountains
continental glaciers	very large sheets of ice that form in the polar regions and move outward in all directions from a central point

Erosion and Movement

Although their movement is not visible, most glaciers are thought to be moving or sliding along the ground. As glaciers move through an area, they completely change the surface of that area by erosion. Glaciers scrape away all loose particles of rock and pile them up in huge mounds, like a bulldozer at work. Glaciers erode by **abrading** and **plucking**.

Abrading is the scraping of the bedrock surface over which the ice moves. The results of this are similar to using a scouring pad on a soiled pot or pan. As the ice moves, it scrapes over rocks, scouring and polishing the surface of rocks beneath it.

Plucking combines freezing and pulling forces. The sun warms the rocks, ice melts and water runs into cracks in the rocks. When the water freezes again and expands, the rocks break. The rocks become part of the bottom of the moving glacier. In this way, the glacier lifts and carries rocks, sand, gravel, and even large boulders with it. Plucking adds to the scouring power of the glacier.

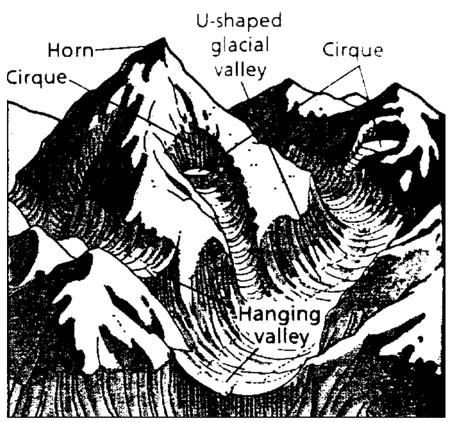


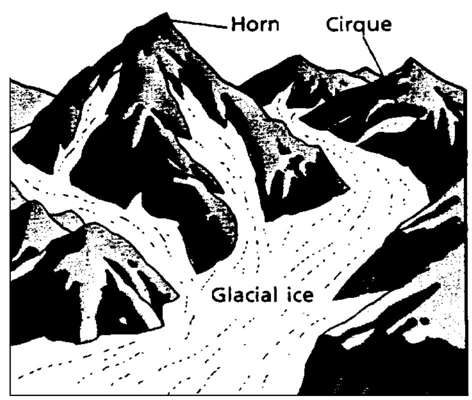
As glacial ice moves, sharp rocks make gouges and scratches called **striations** in the rock beneath it. Glaciers dig into soft rock more deeply than hard rock, leaving step-like irregularities in the land that they pass over.

Valley glaciers begin in a **cirque**, a bowl-shaped depression filled with ice and snow. The glacier that forms in a cirque may actually grow and extend to the mountain's summit. In some places, valley glaciers erode the cirques, forming three-sided peaks called **horns**. The Matterhorn in the Swiss Alps is an example of a horn.

When the cirque overflows, the glacier begins moving down the valley. As a glacier moves through narrow, V-shaped valleys once occupied by a stream or river, it widens, deepens, and straightens the valley. It changes the shape of the V-shaped valley to a U-shaped one.

Just as tributaries join to form rivers, small glaciers join to form larger glaciers. As the smaller glaciers melt and disappear, their valleys no longer erode. The valley of the main glacier continues to erode until it is much lower than the abandoned valley of the smaller glacier. The abandoned valley is left suspended on the mountain high above the main valley floor and is called a **hanging valley**. When the river again flows through the small valleys, waterfalls are created as the river plunges into the deeper valley. The waterfalls of Yosemite National Park in California spill from hanging valleys.





Deposits

Glaciers pick up and deposit rocks and debris as they travel. When a glacier begins to melt, it deposits the rocks it has been carrying. **Drift** is the name given to material deposited by glaciers. The material that the glacier drops first has not yet been sorted by the action of running water. It is a mixture of various sizes of boulders, rocks, sand, and clay called **till**. As the glacier continues to melt, running water called **meltwater** sorts the materials left behind according to size. The material deposited by meltwater is called **outwash**. In outwash, gravity sorts the rock fragments by size and weight. Heavier, larger fragments fall to the bottom.

The glacier may melt so rapidly at the front that it appears to be moving backwards, even though it is actually moving forward. That is, the glacier continues to grow and move forward. While this happens, the end of the glacier farthest from where it forms will melt so that the glacier covers less surface. When this happens, the glacier is said to be retreating. As the glacier recedes, mounds of till are left behind. Long, thin **moraines** are deposits of earth and stone that mark the edges of a glacier. Scientists search for moraines to find the location of glaciers that melted long ago.

Some valley and continental glaciers reach the sea. When this happens, they form cliffs of ice and snow that sometimes break off into the sea and drift. These huge pieces of floating ice are called **icebergs**.

Lakes are also created by glaciers. Sometimes huge blocks of glacial ice covered with sediment are left behind. As this glacial ice melts, it makes a depression in the ground that fills with water and forms **kettle lakes**. Most of Minnesota's lakes were formed in this way. The Great Lakes were also formed by glaciers, but in another way. They formed when the glacial till piled up in low-lying river channels, damming the water in the area. The land areas filled with water, and the Great Lakes were formed.

Today, glaciers can still be seen at high altitudes. Alaska has many glaciers—16 in Glacier Bay alone! In the ice fields of Alberta, Canada, visitors can walk onto glaciers. Scientists continue to study these existing glacier formations and their activities.

Ice Ages

Earth passes through periods of time in which the average temperatures everywhere on the surface of Earth become much lower. During these periods, large continental sheets of ice spread out from the poles. The period of time when this occurs is known as an *ice age*.

During an ice age, some water from the oceans forms glaciers and the sea level drops. Areas of the world that were previously covered by water become land masses. During the last ice age, Great Britain was connected to Europe by dry land.

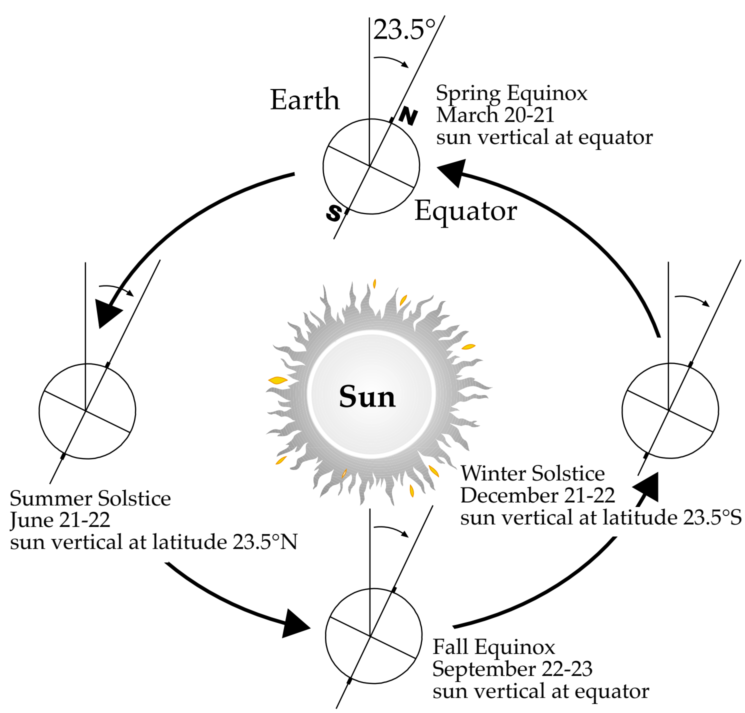
The periods of time between ice ages are called **interglacial ages**. During interglacial ages, the ice melts and the water level of the oceans rises, covering low-lying land areas. Each ice age period has been separated by long periods when the climate was as warm as or warmer than it is today.

Most of the glacial periods occurred during a division of the geologic calendar called the Pleistocene Epoch. From field investigations of deposits, geologists have found evidence that at least three other ice ages have occurred on Earth. There may have been more, but only three are confirmed. The earliest one took place about 600 million years ago, and the second occurred only 200 million years ago.

The most recent ice age in the Pleistocene Epoch is of greatest interest to us. It began about eight million years ago, and the last ice sheet retreated only about 7,000 years ago. We are now in an interglacial period, but scientists predict we will enter into another ice age in a few thousand years.

There is no clear explanation as to what causes the temperature changes that lead to ice ages; however, several theories have been suggested. Some recent theories include the following:

1. The tilt of Earth can vary over thousands of years from 22° to 25°. Its present angle is 23½°. When the tilt is 25°, the poles receive more sunlight, making the poles warmer, which causes the ice to melt. As the ice melts, the oceans rise and landforms sink. When the tilt is at 22°, the poles receive less sunlight, making the poles colder. This causes glaciers to grow and oceans to recede.



2. Every 100,000 years Earth's orbit around the sun changes from an oval to almost a circle. This causes the sun to be farther away during fall, winter, and spring, making these seasons colder. When the decreased tilt and the more circular orbit happen at the same time, an ice age may begin.

3. The amount of energy put out by the sun varies. When the energy from the sun decreases, Earth cools and an ice age begins.

Summary

Piedmont, continental, and alpine or valley glaciers are three types of glaciers. As glaciers move, they completely change the surface of the land by erosion and deposition, forming horns, lakes, hanging valleys, and moraines. Earth has experienced glacial periods known as ice ages. The most recent occurred during the Pleistocene Epoch.

Lab Activity: Erosion by Glaciers

Purpose	**Materials**
Observe how glaciers erode Earth's surface.	• freezer tray with sand • gravel • one-half block of frozen ice • ruler • bucket

1. Arrange the sand and gravel in the freezer pan.
2. Place the ice block at one end of the tray.
3. Allow it to melt for an hour or two.
4. Refreeze the tray.
5. Repeat step 3.
6. Refreeze the tray.
7. Repeat step 3.
8. Allow the block of ice to completely melt.
9. Record observations made of the changes in the sand and gravel.

   First melt: ____

   ____

   Second melt: ____

   ____

   Complete melt: ____

   ____

Practice

Use the list below to complete the following statements.

60 meters	**glacier**	**icebergs**	**U**
abrading	**horns**	**kettle lakes**	**V**
cirques			

1. A glacier begins to move when snow accumulation builds to about

   ____________________ .

2. A huge mass of moving ice and snow is called a

   ____________________ .

3. Many mountains have three-sided peaks formed by glaciers called

   ____________________ .

4. Lakes formed from huge pieces of ice covered with sediment that were left behind by a glacier are called ____________________ .

5. Valley glaciers begin when bowl-like depressions called ____________________ overflow with ice and snow.

6. Glaciers change ____________________-shaped valleys formed by rivers into ____________________-shaped valleys.

7. ____________________ is the scraping of the bedrock surface as ice moves over it.

8. Huge pieces of glaciers that break off and drift in the ocean are called

   ____________________ .

Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

alpine	**Greenland**	**piedmont**	**valley**
Antarctica	**hanging valleys**	**plucking**	**waterfalls**
continental	**moraines**	**striations**	
drift	**outwash**	**till**	

1. The first material a glacier drops as it begins to melt is called

   __________________________ .

2. A combination of freezing and pulling forces is called

   __________________________ .

3. The only two continental glaciers that exist today are found in

   __________________________ and __________________________ .

4. When the valley of a main glacier continues to erode and abandoned valleys are left suspended high above the main valley floor, __________________________ are formed that often have beautiful __________________________ .

5. The three main types of glaciers are __________________________ or __________________________ , __________________________ , and __________________________ .

6. Gouges or scratches in the rock beneath the glacier made by sharp rocks being pulled along by the glacier are called

   __________________________ .

7. Material deposited by glaciers is called ____________________ .

8. The first deposits that are sorted are known as ______________ .

9. Sorted glacial deposits from meltwater are called

   ________________ .

10. ____________________ are deposits that mark the edge of a

    glacier.

Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

8 million	**22°**	**colder**	**interglacial**
20 million	**23½°**	**glaciers**	**lower**
600 million	**25°**	**Great Britain**	**rises**
7000	**circle**	**ice age**	**three**

1. A period of time when the average temperatures everywhere on Earth become lower and large continental sheets of ice spread out from the poles is called a(n) ____________________ .

2. Warm periods between ice ages are called ____________________ ages.

3. During interglacial ages, the water level of the ocean ____________________ due to the melting of the ____________________ .

4. It is believed that Earth has passed through ____________________ ice ages.

5. The first ice age began ____________________ years ago, the second began ____________________ years ago, and the most recent one began ____________________ years ago.

6. The great ice sheets from the last ice age retreated only about ____________________ years ago.

7. The present angle of the tilt of Earth on its axis is

    ______________________ .

8. The tilt of Earth varies from ______________________ to

    ______________________ .

9. When Earth is tilted at ______________________ , the poles get less sunlight, making them ______________________ .

10. When the tilt is ______________________ , the poles are warmer.

11. During ice ages, the water level of the oceans becomes

    ______________________ .

12. Every 100,000 years, Earth's orbit becomes almost a(n)

    ______________________ .

13. We are now in a(n) ______________________ age.

14. During the last ice age, ______________________ was connected to Europe by dry land.

Practice

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

__________ 1. We are presently in an ice age.

__________ 2. Earth has gone through three ice ages.

__________ 3. A period of time when the average temperatures on Earth become lower and glaciers form is known as an interglacial age.

__________ 4. The first ice age began about 600 million years ago.

__________ 5. The number of years between ice ages is constant.

__________ 6. The water level of the oceans rises during interglacial ages.

__________ 7. Scientists know exactly what causes ice ages.

__________ 8. The last great sheets of ice from the last ice age disappeared only about 7,000 years ago.

__________ 9. Scientists predict another ice age will occur in a few thousand years.

__________ 10. One theory of why we have ice ages is that the amount of energy we receive from the sun varies.

Practice

Answer the following using complete sentences.

1. Why could the change in the tilt of Earth cause temperatures on Earth to change?

2. Why would Earth's orbit becoming circular cause a change in temperature?

3. Why would the amount of energy Earth gets from the sun affect the temperature of Earth?

Practice

Use the list below to write the correct term for each definition on the line provided.

abrading	**horns**	**piedmont glaciers**
cirque	**ice age**	**plucking**
continental glaciers	**icebergs**	**striations**
drift	**interglacial ages**	**till**
glacier	**kettle lakes**	**valley glaciers**
hanging valley	**moraines**	**valley or alpine glaciers**

______________________________ 1. small abandoned glacial valley suspended on the mountain high above the main glacial valley

______________________________ 2. unsorted and unlayered rock material and other matter deposited directly by a glacier

______________________________ 3. huge chunks of floating ice that break apart from a glacier when it reaches the sea

______________________________ 4. lakes formed by the melting of a huge chunk of ice left behind by a glacier

______________________________ 5. steep three-sided peaks formed by glaciers

______________________________ 6. combination of freezing and pulling forces

______________________________ 7. a period of time when large ice sheets covered much of the surface of Earth

______________________________ 8. glaciers which form at the foot of mountains

______________________________ 9. name given to material deposited by glaciers

__________________________ 10. long, thin deposits of rock material that mark the edges of a glacier

__________________________ 11. the periods of time between the ice ages

__________________________ 12. glaciers that move very slowly down the mountain through a valley

__________________________ 13. a large mass of moving ice and snow

__________________________ 14. the scraping of the bedrock surface as ice moves over it

__________________________ 15. the bowl-shaped hollow in which snow accumulates

__________________________ 16. scratches made by sharp-pointed rocks

__________________________ 17. another name for alpine glaciers

__________________________ 18. glaciers formed in the polar regions, some of which are very large sheets of ice

Practice

Circle the letter of the correct answer.

1. A large mass of moving ice and snow is a(n) __________ .

   a. iceberg
   b. moraine
   c. glacier
   d. cirque

2. Glaciers that move very slowly down the mountain through a valley are called __________ .

   a. continental glaciers
   b. valley glaciers
   c. icebergs
   d. piedmont glaciers

3. Glaciers formed in the polar regions by very large sheets of ice are __________ .

   a. horns
   b. alpine glaciers
   c. piedmont glaciers
   d. continental glaciers

4. The name given to material deposited by glaciers is __________ .

   a. cirque
   b. abrading
   c. drift
   d. horns

5. Glaciers which form at the foot of mountains are __________ .

   a. continental glaciers
   b. valley glaciers
   c. piedmont glaciers
   d. alpine glaciers

6. ____________ is the combination of freezing and pulling forces in a glacier.

   a. Cirque
   b. Plucking
   c. Abrading
   d. Striation

7. ____________ is the scraping of the bedrock surface as the ice moves over it.

   a. Striation
   b. Abrading
   c. Plucking
   d. Moraine

8. ____________ are steep three-sided mountain peaks formed by glaciers.

   a. Horns
   b. Striations
   c. Moraines
   d. Icebergs

9. The bowl-shaped hollow in which snow accumulates is called a(n) ____________ .

   a. striation
   b. cirque
   c. horn
   d. iceberg

10. ____________ are scratches made by sharp-pointed rocks as a glacier moves over the land.

    a. Glaciers
    b. Kettle lakes
    c. Striations
    d. Horns

11. Long, thin mounds of rock material that mark the sides and front of a glacier are __________ .

    a. moraines
    b. cirques
    c. striations
    d. horns

12. __________ is the unlayered and unsorted rock material and other matter deposited by a glacier.

    a. Moraine
    b. Cirque
    c. Till
    d. Outwash

13. The valley of a tributary that meets the main valley from a considerable height above the main valley is called a __________ valley.

    a. striation
    b. kettle
    c. cirque
    d. hanging

14. Layered deposits of rock fragments dropped by glacial meltwater are called __________ .

    a. till
    b. outwash
    c. moraine
    d. horns

15. A period of time when large ice sheets covered much of the surface of Earth is called a(n) __________ age.

    a. hanging
    b. terminal
    c. glacier
    d. ice

16. __________ lakes are formed by the melting of a huge chunk of ice left behind by a glacier.

   a. Striation
   b. Iceberg
   c. Ground moraine
   d. Kettle

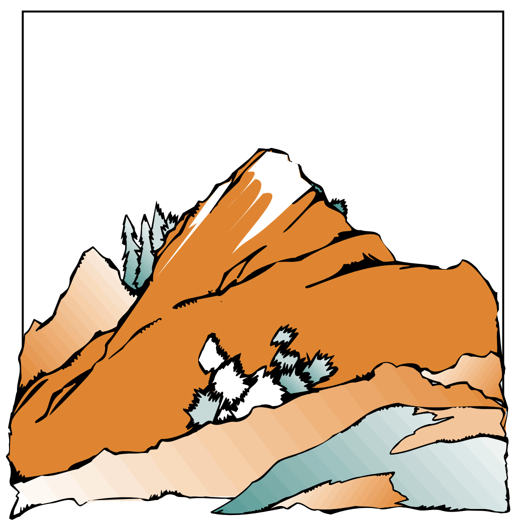
17. __________ are periods of time between ice ages.

   a. Interglacial ages
   b. Ancient ages
   c. Prehistoric ages
   d. Alpine ages

18. Huge chunks of floating ice that break apart from a glacier when it reaches the sea are called __________ .

   a. striations
   b. icebergs
   c. glaciers
   d. moraines

Unit 13: Weathering and Erosion



Vocabulary

Study the vocabulary words and definitions below.

caverns .... underground caves formed by running water dissolving limestone over a period of time

chemical weathering .... the change in mineral composition or chemical makeup of a rock by chemical means; also called "decomposition"

clay .... a mineral found in large quantities in the soil; a common soil type found in Florida

dunes .... hills of sand deposited by the wind

erosion .... the movement of weathered rocks and soil from one place to another by wind, water, ice, or gravity

glacier .... a large, moving mass of ice and snow

gravel .... large pieces of rock and mineral in soil

gravity .... the force of attraction between all objects in the universe; an agent of erosion

humus .... the dark-colored material left in soil by the decaying of plants and animals

loam .... type of soil made of sand, silt, and clay

loess .... pieces of silt and clay deposited by wind

mechanical weathering .... the breakdown of rocks into smaller particles by physical means

organic .... material formed from the remains of plants and animals

runoff .... water that flows over Earth's surface

sand .... small particles of rock found in soil

silt .... soil particles that are smaller than sand but larger than clay

soil .... a combination of small pieces of rock and organic material combined with air and water

topsoil .... the upper layer of soil that contains a lot of humus

weathering .... the breaking down of rocks and other materials by chemical or physical means

Introduction

Glaciers, water, wind, and **gravity**—all are forces responsible for **weathering** and **erosion**. Changes resulting from these forces determine the shape of Earth's surface. They create our mountains, valleys, sand **dunes**, and deserts. They determine the type of **soil** that is formed in a particular area. Learning about weathering and erosion gives us clues to understanding our Earth.

Weathering

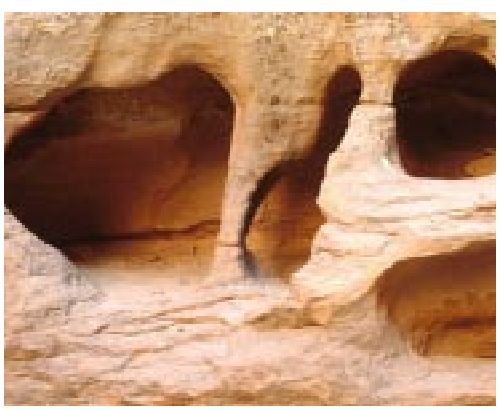
Weathering is a slow process that breaks down substances and materials exposed to the atmosphere. Some examples of weathering are peeling paint, rust, and rock fragments. Rocks on Earth's surface are broken down by two types of weathering—mechanical and chemical.

the effects of weathering

Mechanical Weathering

In **mechanical weathering**, rocks are broken down into smaller fragments. As weathering progresses, the rock fragments become smoother and more rounded. The agents of mechanical weathering are temperature, water, plants, and wind.

Changes in temperature can cause rocks to expand and contract. This can cause particles of rock on the surface to flake off.



weathering caused by water

Water expands as it freezes. If water seeps into cracks in a rock and the temperature falls below freezing, the resulting ice expands in the crack. Eventually this expansion will break the rock into smaller pieces. Plants can also enlarge cracks in rocks as their roots expand and grow into the rock. Small rock particles can be carried by the wind. These windblown particles create a *sand blasting* effect on soft rocks, abrading or wearing away rocks. Many rock formations in desert regions are the result of this abrasion. Landslides are often caused by mechanical weathering.


weathering caused by wind

Chemical Weathering

Chemical weathering causes changes in the mineral composition or chemical makeup of the rock. Chemical weathering is sometimes called *decomposition*. The agents of this type of weathering are water, oxygen, and acids. For instance, water can dissolve rocks. These dissolved rocks can form other deposits, such as **clay**, or formations such as stalactites and stalagmites. Another form of chemical weathering involves oxygen. Oxygen in the atmosphere can chemically combine with other compounds. The resulting *rust* is darker and chemically different than the original material.

Acids and other chemicals can also cause changes in rocks. Carbon dioxide can dissolve in water, making it carbonated. This carbonated water can dissolve limestone and feldspar. In addition, acid rain can corrode the surface of rocks. Some plants are capable of growing on rocks. They produce weak acids to *soften* the rock's surface so their roots can attach. Lichens are examples of plants that produce acids and cover rock surfaces.


effects of erosion

Erosion

The surface of Earth is continually being built up and worn down. The breaking down of rocks and other materials by chemical or physical means is called *weathering*. *Erosion* is the movement of these weathered rocks and soil from one place to another. The four main types of erosion are water, wind, ice, and gravity.

Water Erosion

Of all the forces that cause erosion, water is the most important. Water is responsible for changing much of Earth's surface. Below are several ways in which water can erode the surface of Earth:

How Liquid Water Erodes Earth's Surface

1. Rivers are important because they affect large areas. Heavy rains and large amounts of melting snow cause **runoff** water to carry away sediment. The sediment goes into rivers where more material eroded from other areas is carried. Rivers then empty into other rivers, lakes, or oceans. Water carries materials as it moves. Rivers slow down where they empty into large bodies of water. The slowing of the current at the river's mouth causes moving **sand** and other particles to stop moving and fall to the bottom of the stream. The sediment builds up and forms a delta—a wedge-shaped area of sand at the mouth of a river. As more sediment is added to the delta, the path of the river will change.

2. Fast-moving water in rivers also wears away the banks, creating canyons and carrying rocks and soil downstream to new locations. The Grand Canyon, formed by the Colorado River, is an example of erosion caused by a fast-moving stream.

3. **Caverns** are caves formed by underground running water dissolving limestone and carrying it away. The Carlsbad Caverns in New Mexico and the Linville Caverns in North Carolina were formed by this type of erosion.

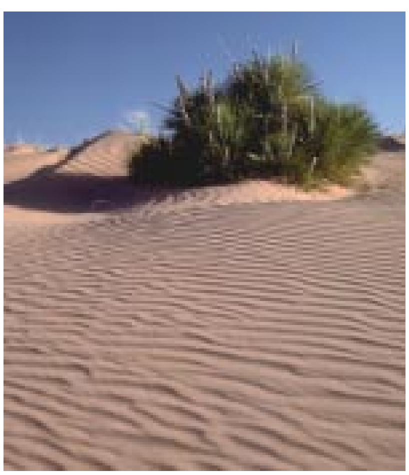
4. When the roof of an underground cave formed by erosion sinks or collapses, a *sinkhole* is formed. Central Florida has many sinkholes.

The amount of erosion is determined by several factors. The type of minerals that make up rocks and soil determines how quickly it will erode. Rocks with holes in them or with large spaces between them will soak up the running water, whereas rocks with no openings cause rapid *runoff*. The slope of a surface also determines the amount of erosion. A steep hill will cause more erosion than a gently sloping hill. The amount and type of plants grown in an area also affect the rate of erosion. An area with many plants will erode less quickly than an area with few or no plants. This is why picking sea grasses along sand dunes is often prohibited.

Wind Erosion

Wind erosion occurs mainly in areas where there is very little moisture. Because of this, there are few plants to hold the soil in place. Wind picks up and carries small bits of sand and dust. Wind erosion occurs in deserts, along the beach, and by rivers in dry regions.

Loose particles carried by the wind act like sandpaper, wearing down rocks into flat, sharp forms. Wind erosion depends on the speed of the wind, the length of time that it blows, and the size of the particles being carried. Sand is the heaviest type of particle carried by the wind. It is carried close to the ground and is the first to be deposited by the wind. **Silt** is finer than sand and is carried farther before it is deposited. Dust is the lightest material carried by the wind. It gets into the high air currents and can be carried for hundreds of miles.



When the wind dies down, the materials it has been carrying are deposited. Hills of sand called *sand dunes* are the most common type of wind deposit. They are formed near rocks and bushes and where the wind slows down in desert areas and along shorelines. **Loess** is another type of wind deposit formed of angular pieces of silt and clay that tend to pack together into a dense mass. Loess deposits are usually light in color and may be several meters thick. They form fertile soil. The hilltops and valleys of the Mississippi River are formed from deposits of loess. The presence of grass and shrubs helps to control wind erosion. Roots hold soil and other particles in place.

Ice Erosion

Ice erosion is caused by large sheets of moving ice known as *glaciers*. Glaciers form in areas where winter snowfall is greater than summer melting. The snow piles up, putting pressure on the snow at the bottom. The snow at the bottom of the pile eventually packs tightly and turns into ice. As the ice continues to build up, the pressure causes it to move. As the glacier moves, it tears rocks and soil from the ground similar to the effect of dragging a heavy rake across an unpaved driveway. The glacier also acts like a bulldozer. The front of the glacier piles up material called *till*. When the glacier melts and retreats, it leaves behind the material it was carrying.

Mountain shapes can be changed by glaciers. Glaciers have eroded mountain tops into peaks, such as the Matterhorn in Switzerland, and formed hanging valleys with beautiful waterfalls like those in Yosemite National Park in California. Glaciers can also form lakes. The Great Lakes were formed by glaciers deepening river valleys and damming them to form lakes.

Gravitational Erosion

The gravitational pull of Earth also causes erosion. Sometimes the movement of rocks and soil down a hillside, due to the pull of *gravity*, is very slow. Soil and rock particles may be pulled down a hillside so slowly that it is hardly noticeable. This slow movement which may not even be noticeable is called *slump*. Eventually, this material comes to rest at the bottom of the slope. At other times the combined forces of gravity, water, and steep slopes cause rapid movements. *Landslides* are rapid movements of large amounts of rock caused by excessive rains or earthquake activity. *Mudflows* are also rapid movements that occur after heavy rains. *Avalanches* happen when rapid melting of snow or earthquake activity occurs in heavy layers of snow. Gravitational erosion can cause major structural damage wiping out roads, houses, and sometimes entire towns.

Soil

Soil is a combination of weathered rock and **organic** material with air and water filling the spaces between the soil particles. The type of minerals and organic matter that are contained in the soil determine the type of soil. The organic material in soil, called **humus**, comes from the decaying or breaking down of dead plants and animals. Humus is dark-colored and found in the upper layer of soil called **topsoil**. The humus in the soil makes it fertile and good for growing plants.

Particles of soil vary in size. Large particles of rock and mineral found in the soil are called **gravel**. Weathering causes gravel to break down into smaller pieces called *sand*. Sand is further weathered to produce smaller particles called *silt*. *Clay* is the smallest particle in the soil. It is so small that it must be magnified to see. It packs very tightly to form large clumps so it may be impossible to see the individual particles. **Loam** is a type of soil that is a mixture of sand, silt, and clay. It holds a large amount of water which makes it very good for farming.

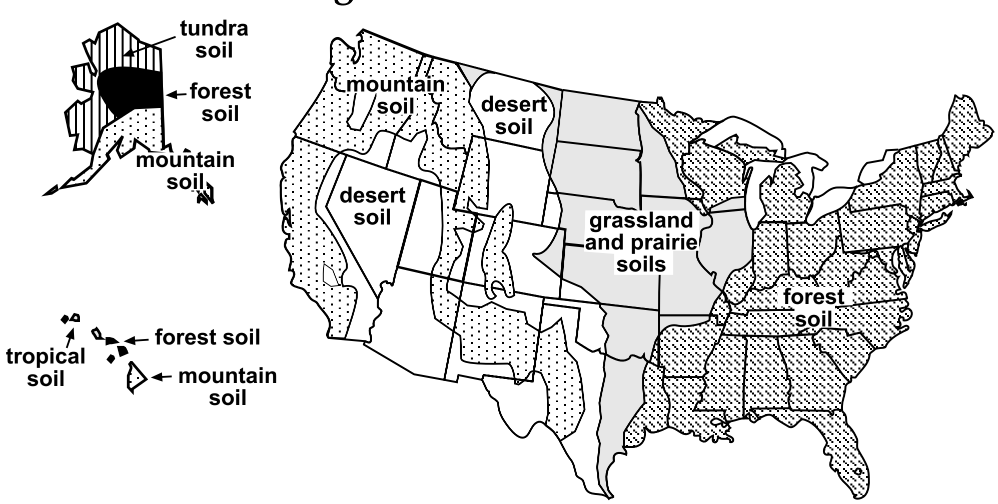
Soil Types and Regions

Soil is classified by its makeup and the region in which it forms. The chart below lists several factors that determine soil types.

Factors Which Determine Soil Types	
time	the amount of time the soil has had to form
climate	the average weather for that region
rocks	the type of rocks present in the area
Earth's surface	the shape of Earth's surface in the area

Forest Soil. The soil in the eastern part of the United States ranges from brownish-gray in the Northeast to a reddish color in the Southeast. Forest soil forms under tree cover, contains very little humus, and requires frequent fertilization because heavy rainfall causes the minerals in the soil to be washed away. The southeastern forest soil is slightly more fertile than northeastern forest soil due to the warmer southern climate, which causes organic matter to decay more quickly.

Soil Regions of the United States



Grasslands and Prairie Soils. The part of the United States from the eastern forest region to the Rocky Mountains has grasslands and prairies. The soil there is rich in humus and receives large amounts of rainfall, which makes it fertile and good for farming.

Desert Soil. The lack of rainfall in the desert regions of the western United States results in soil that is rich in minerals. However, the soil lacks humus due to the limited number of plants.

Mountain Soil. The soil found in the mountain ranges of the western United States, although rich in mineral ores, is dry and made up of pieces of rock. Therefore, it is not a good soil for growing crops.

Tundra Soil. The tundra region of the United States has thin soil. This, combined with the severely cold climate, allows only the growth of mosses and lichens. Alaska is the only region in the United States that has tundra soil.

Tropical Soil. Tropical soil is found in only one part of the United States, the very warm, humid climates of the Hawaiian rain forests. The tropical soil region has excessive rain and heat which causes organic matter to rapidly decay. A thick layer of humus does not form because heavy rain washes it away. However, the plentiful organic matter in this region quickly replaces the humus and minerals needed to keep the rain forests growing.

Soils contain different minerals and nutrients depending on their formation. Sometimes fertilizers are added to soil to enrich it for growing crops. Phosphate, nitrate, and other chemicals may be used in fertilizers. These substances, however, can act as pollutants when applied incorrectly. Organic fertilizers such as manure or compost may be used to increase organic material content. The risk of misuse with these appears to be less than with other fertilizers.

Summary

Mechanical and chemical weathering breaks down rocks and other materials exposed to the atmosphere. Temperature, water, plants, and wind are mechanical weathering agents. The agents of chemical weathering are water, oxygen, and acids. The process of erosion moves weathered materials from one place to another. The four main types of erosion are water, wind, ice, and gravity. Weathered rock becomes part of our soil. Soil types vary depending on the composition and other factors such as age and climate.

Lab Activity 1: Weathering

Purpose

Observe the effects of mechanical weathering.

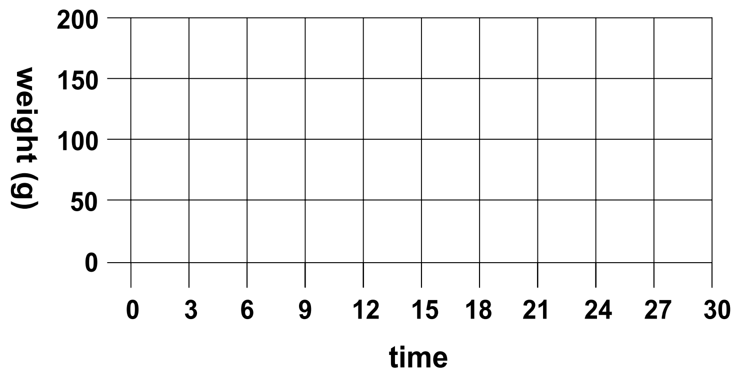
Materials

- plastic jar with screw-top lid
- pre-soaked marble chips
- balance
- piece of screen
- water

1. Measure out 100 grams of presoaked marble chips.
2. Place marble chips in jar. Fill halfway with water. Secure lid.
3. Shake jar for three minutes.
4. Strain out water using screen.
5. Weigh marble chips.
6. Repeat nine more times for a total of 30 minutes.
7. Record weight in chart below.

Time	Weight of Chips
0	100 g
3	
6	
9	
12	
15	
18	
21	
24	
27	
30	

8. Use the graph below to plot your data from the previous page.



9. Describe the changing appearance of the marble chips from the beginning to the end of the procedure.

____

____

____

10. What type of weathering does this represent? ______________

Why? ____

____

____

11. Why were the rock chips presoaked? ____________________

____

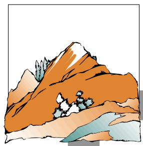
____

12. How did the mass of the rock chips change through time?

____

____

____



Lab Activity 2: Water Erosion

Purpose

Observe the effects of erosion by water.

Materials

- large baking pan
- soil
- pitcher
- water

1. Take the baking pan and fill it with soil.
2. Smooth the soil so that it is evenly spread.
3. Fill the pitcher with water.
4. Place the edge of the pan and soil on a book to raise one side of the pan.
5. Pour the water slowly over the soil at the higher end of the pan.
6. Record what happens on the lines below.

____

____

____

7. Pour the water more quickly.
8. Record what happens on the lines below.

____

____

____

9. Compare your observations.

Lab Activity 3: Wind Erosion

Purpose

Observe the effects of erosion by wind.

Materials

- small fan or blowdryer (on low)
- sand box (3′x 2′)

1. Put the sand in the box.
2. Smooth the sand so that the sand is evenly spread.
3. Turn the fan on.
4. Aim the fan at one end of the box.
5. Record what happens on the lines below.

____

____

____

____

6. Place a large rock or object in the center of the box.
7. Turn on the fan.
8. Record the results below.

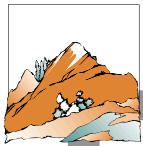
____

____

____

____

____



Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

abrasion	**gravity**	**temperature**
chemical	**ice**	**water**
decomposition	**mechanical**	**weathering**
erosion	**plants**	**wind**

1. The breaking down of rocks and other materials by physical or chemical means is called ______________________ .

2. The movement of weathered rocks and soil from one place to another is called ______________________ .

3. The two main types of weathering are ______________________ and ______________________ .

4. The agents of mechanical weathering are ______________________ , ______________________ , ______________________ , and wind.

5. Wind blown particles cause the weathering away of rock particles, or ______________________ .

6. Chemical weathering is also called ______________________ .

7. The four main types of mechanical erosion are

______________________, ______________________,

______________________ and ______________________ .

8. ______________________ is the most important type of erosion.

Practice

Use the list below to complete the following statements.

canyon	**landslides**	**sand**
caverns	**loess**	**sand dunes**
dust	**mudslides**	**silt**
glaciers	**runoff**	**wind**
gravity		

1. ____________________ water caused by heavy rains and melting snow carries soil away.

2. Fast-moving water in rivers forms a ____________________ as it erodes the banks of the river.

3. Caves found underground that are formed by running water dissolving limestone are called ____________________ .

4. The type of erosion that usually occurs in desert areas is ____________________ erosion.

5. Hills of sand deposited by the wind near rocks or bushes are called ____________________ .

6. A type of wind deposit formed by pieces of clay and silt is ____________________ .

7. Types of particles carried by wind are ____________________ , ____________________ , and ____________________ .

8. Large sheets of moving ice and snow that erode Earth's surface are known as ____________________ .

9. The type of erosion caused by the force that pulls objects towards the center of Earth is ____________________ .

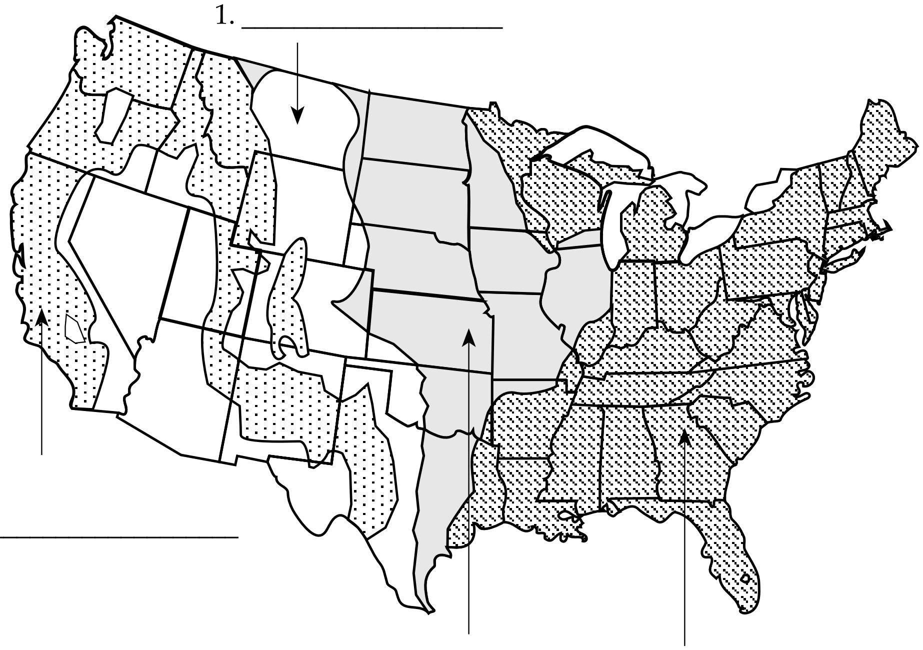
10. ____________________ and ____________________ are rapid forms of erosion caused by gravity, rain, and earthquakes.

Practice

Label the **soil regions** *on the map below as* **mountain**, **desert**, **forest**, *or* **grassland and prairie**.

Soil Regions of the United States

1. ____________________



2. ____________________

3. ____________________

4. ____________________

Practice

Write a description of the **type of soil** *found in each area.*

1. desert: ____

____

____

____

____

2. forest: ____

____

____

____

____

3. mountain: ____

____

____

____

4. grassland or prairie: ____

____

____

____

____

Practice

Use the list below to write the correct term for each definition on the line provided.

caverns	**gravel**	**loess**	**silt**
clay	**gravity**	**organic**	**soil**
dunes	**humus**	**runoff**	**topsoil**
erosion	**loam**	**sand**	**weathering**
glacier			

________________________ 1. water that flows over Earth's surface

________________________ 2. soil particles that are smaller than sand but larger than clay

________________________ 3. hills of sand deposited by wind

________________________ 4. small particles of rock found in soil

________________________ 5. a mineral found in large quantities in the soil; a common soil type found in Florida

________________________ 6. dark colored material left in soil by the decaying of plants and animals

________________________ 7. a combination of small pieces of rock and organic material combined with air and water

________________________ 8. the upper layer of soil that contains a lot of humus

________________________ 9. large pieces of rock and mineral in soil

________________________ 10. the breaking down of rocks and other materials by chemical or physical means

________________________ 11. a large, moving mass of ice and snow

____________________ 12. material formed from the remains of plants and animals

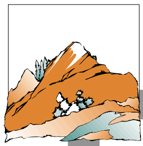
____________________ 13. pieces of silt and clay deposited by wind

____________________ 14. the movement of rocks and soil from one place to another by wind, water, ice, or gravity

____________________ 15. type of soil made of sand, silt, and clay

____________________ 16. the force of attraction between all objects in the universe

____________________ 17. underground caves formed by running water dissolving limestone over a period of time



Practice

Circle the letter of the correct answer

1. The movement of weathered rocks and soil from one place to another by wind, water, ice, or gravity is __________ .

   a. gravel
   b. humus
   c. erosion
   d. soil

2. Underground caves formed by running water dissolving limestone over a period of time are __________ .

   a. dunes
   b. caverns
   c. humus
   d. loam

3. A large, moving mass of ice and snow is called a __________ .

   a. dune
   b. cavern
   c. runoff
   d. glacier

4. Large pieces of rock and mineral in soil are __________ .

   a. clay
   b. silt
   c. gravel
   d. loam

5. A combination of small pieces of rock and organic material combined with air and water is __________ .

   a. sand
   b. humus
   c. clay
   d. soil

6. __________ is the dark-colored material left in soil by the decaying of plants and animals.

a. Clay
b. Silt
c. Humus
d. Loam

7. __________ is a mineral found in large quantities in the soil.

a. Gravel
b. Clay
c. Silt
d. Humus

8. The force of attraction between all objects in the universe is called __________ .

a. loess
b. gravity
c. runoff
d. weathering

9. __________ is the small particles of rock found in the soil.

a. Silt
b. Clay
c. Gravel
d. Sand

10. Hills of sand deposited by wind are called __________ .

a. dunes
b. sand
c. clay
d. silt

11. __________ is a type of soil made of sand, silt, and clay.

a. Loam
b. Humus
c. Loess
d. Topsoil

12. Pieces of silt and clay deposited by wind are called __________ .

    a. soil
    b. loess
    c. humus
    d. gravel

13. Material formed from the remains of plants and animals is called __________ .

    a. organic
    b. loam
    c. sand
    d. silt

14. Water that flows over Earth's surface is called __________ .

    a. gravel
    b. silt
    c. clay
    d. runoff

15. Soil particles that are smaller than sand but larger than clay are called __________ .

    a. loam
    b. humus
    c. gravel
    d. silt

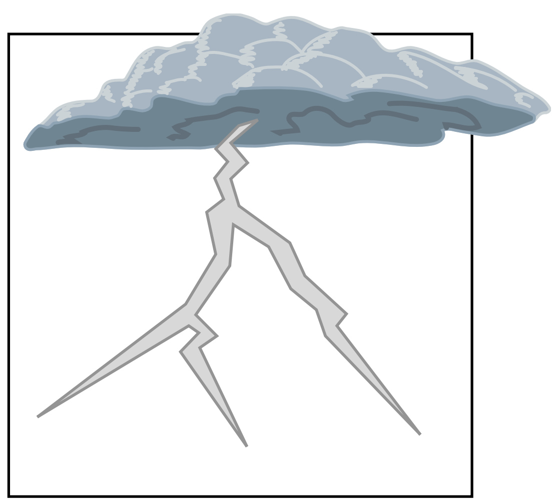
16. The upper layer of soil that contains a lot of humus is __________ .

    a. gravel
    b. silt
    c. topsoil
    d. clay

17. The breaking down of rocks and other materials by chemical or physical means is called __________ .

    a. runoff
    b. erosion
    c. weathering
    d. gravel

Unit 14: The Atmosphere and Weather



Vocabulary

Study the **atmosphere** *and* **climate** *vocabulary words and definitions below.*

atmosphere .... the mixture of gases surrounding Earth

climate .... the weather of an area over a long period of time

continental climate .... type of climate found where there are huge land masses

desert .... dry areas that receive less than 25 cm of rainfall per year

exosphere .... the upper part of the thermosphere; extends into interplanetary space

ionosphere .... the lower part of the thermosphere that contains electrically charged particles called ions

jet stream .... narrow layer of strong winds that blow from west to east just above the troposphere

marine climate .... type of climate found when an area is located near a large body of water

mesosphere .... the coldest layer of the atmosphere, just above the stratosphere

ozone .... type of oxygen with three oxygen atoms (O_3) found in the upper areas of the stratosphere

polar zone .... area of Earth that extends from the poles to 60° north and south latitude and has a very cold climate

stratosphere .... the layer of Earth's atmosphere above the troposphere; it contains the ozone layer

temperate zone .... the zone of moderate climate with distinct seasonal changes; located between 30° and 60° latitude

thermosphere .... the layer of the atmosphere above the mesosphere where the air is very thin and hot; includes the ionosphere and exosphere

tropical zone .... area of Earth that extends from 30° north latitude to 30° south latitude; above average temperatures and precipitation

troposphere .... the lowest layer of the atmosphere that contains most of Earth's weather

weather .... the day-to-day changes in temperature, humidity, wind, and air pressure

Vocabulary

Study the **solar radiation** *and* **air mass** *vocabulary words and definitions below.*

air masses .... large bodies of air having the same temperature and amount of moisture

barometer .... an instrument used to measure air pressure

cold front .... forms when a mass of cold air meets a mass of warm air and moves beneath it

conduction .... direct transfer of heat energy from one substance to another

convection .... transfer of heat energy by moving air or fluid

convection current .... the vertical movement of air or water caused by differences in temperature

currents .... vertical movements of air or water caused by the uneven heating of Earth

direct rays .... rays of the sun that hit Earth at a 90° angle; they create the greatest amount of heat

front .... the boundary formed when two different masses of air meet

high-pressure system .... system that brings cool, clear skies and dry weather

indirect rays .... rays of the sun that hit Earth at greater than 90°; they produce less heat

low-pressure system .... system that brings cloudy, rainy, and often stormy weather

occluded front .... forms when a cold front overtakes and merges with a warm front

radiation .... process by which the sun's rays reach Earth in the form of waves

stationary front .... forms when two unlike air masses face each other, but neither moves

warm front .... forms when a mass of warm air meets a mass of cold air and moves over it

wind .... horizontal movements of air caused by the uneven heating of Earth

Vocabulary

Study the **wind** *and* **current** *vocabulary terms and definitions below.*

anemometer .... an instrument used to measure wind speed

doldrums .... the area around the equator where air moves straight up and there is very little wind

horse latitudes .... area at about 30° north and south latitude where there is very little wind

land breeze .... cool air blowing from land to sea at night

monsoons .... winds that blow inland during summer bringing rainy weather and that blow out to sea in winter bringing dry weather

polar easterlies .... system of winds that blows cold air from the poles

prevailing westerlies .... wind system formed over large land areas that blows from the west to the east

sea breeze .... cool air that moves from sea to land during the day

trade winds .... system of winds found just north and south of the equator that blows toward the equator from the northeast and southeast

wind vane .... an instrument that tells from which direction the wind is coming

Vocabulary

Study the **storm** *and* **precipitation** *vocabulary terms and definitions below.*

anticyclone .... high-pressure system with winds moving clockwise

blizzard .... a severe snowstorm with high winds

cirrus .... very high, thin, feathery clouds made of ice crystals

cloud .... tiny droplets of water suspended in the air

cumulonimbus .... cumulus clouds that bring rain; also called thunderheads

cumulus .... puffy, white clouds with flat bottoms

cyclone .... a low-pressure system with winds moving in a counterclockwise direction

hurricane .... a large, powerful low-pressure storm system; a cyclone with sustained winds of 75 mph or more

lightning .... a sudden discharge of electricity from clouds

nimbostratus .... a dark, low-lying stratus cloud that contains rain

nimbus .... a cloud that causes rain to fall

precipitation .... moisture that falls to Earth as rain, hail, sleet, or snow

saturated .... a term used when the air has all the moisture it can hold

stratus .... smooth, layered clouds found low in the sky

thunder .... the sound made by lightning

tornado .... a violent, funnel-shaped windstorm

tropical depression .... a storm formed by a large, low-pressure system over water with winds less than 35 mph

tropical storm .... a storm formed when the winds of a tropical depression are between 35 and 74 mph

waterspout .... a tornado that forms over water

Introduction

Earth is enveloped in layers of gases called the **atmosphere**. These layers are responsible for Earth's **weather** and for protecting us from harmful rays of the sun. Weather affects us daily and is a determining factor in many of our decisions. Air pressure, temperature, winds, and humidity change constantly and can produce dangerous conditions like **hurricanes** and **tornadoes**. The day-to-day weather we experience makes up our **climate**. Some areas have a cold, polar climate while others have a hot and humid tropical climate. Climate and weather influence our daily lives. Studying Earth's weather and climate changes will help us to understand how to prepare for or prevent dangerous weather conditions and cope with our ever changing environment.

Atmosphere

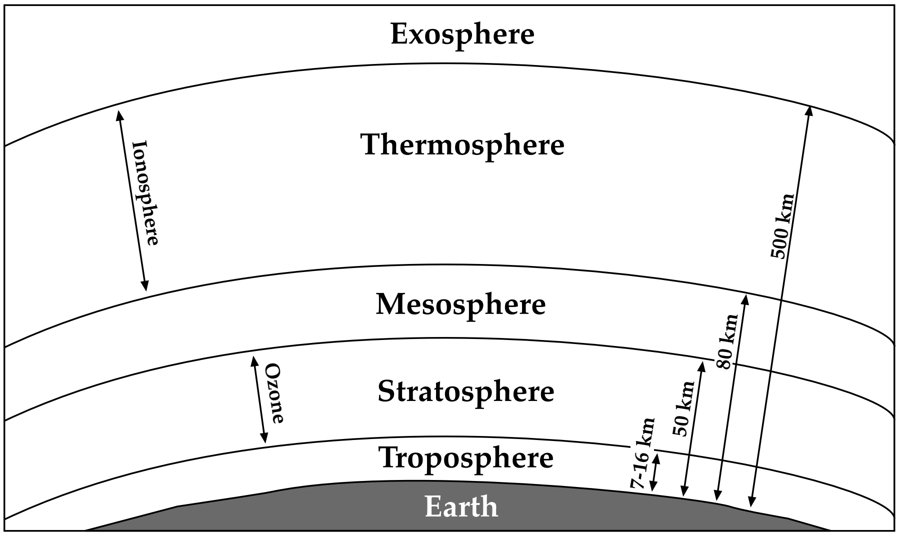
Earth is surrounded by a mixture of gases called the *atmosphere.* The atmosphere is divided into four layers, based on differences in temperature and gases present. The layer of the atmosphere closest to Earth is the **troposphere**. This is the layer in which we live, and it contains most of our weather. The troposphere extends upwards from the surface of Earth for about 10 kilometers. The temperature decreases farther up in the troposphere.

Earth

Just above the troposphere is a narrow layer of strong winds that blow from west to east called the **jet stream**. Planes flying eastward use the jet stream to increase their air speed.

The layer of air above the troposphere is the **stratosphere**. This layer extends to about 50 kilometers above Earth’s surface. The air in the lower areas of the stratosphere is very cold, but the air in the upper layers is about the same as it is at sea level.

This warmer temperature is due to the **ozone** present there. Ozone is a gas with three oxygen atoms (O_3), rather than two oxygen atoms (O_2) present in the air we breathe. Ozone absorbs the sun’s ultraviolet rays and heats up the atmosphere. It also shields Earth and keeps ultraviolet rays from reaching Earth's surface. Ultraviolet rays can cause blindness and skin cancer.



For these reasons, it is important that the ozone layer of Earth not be destroyed. Chemicals known as chlorofluorocarbons (CFCs) that are used in aerosol (spray) cans can destroy the ozone layer. Federal laws have been passed which regulate the use of aerosol cans.

Most of the ozone on Earth is in this layer of the stratosphere; however, some of it is found in lower layers. When **lightning** strikes, ozone is formed. You can smell the presence of ozone when lightning strikes. It has a clean, sharp smell.

lightning striking

Above the stratosphere lies the **mesosphere**, where the temperature is colder. It is, in fact, the coldest part of the atmosphere. This layer extends to about 80 kilometers above the Earth.

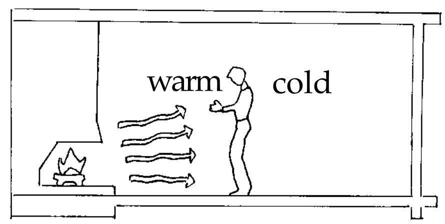
Beyond the mesosphere is the **thermosphere**, which is divided into two parts, the **ionosphere** and the **exosphere**. The ionosphere extends to about 500-700 kilometers. The exosphere is the last layer of the atmosphere and extends for thousands of kilometers upward into interplanetary space.

The thermosphere is very hot because of absorption of the sun's energy. The first part of the thermosphere, the ionosphere, is a layer of electrically charged particles. These particles are bombarded by energy from space. They become electrically-charged particles called *ions* and *free electrons*. These are useful for communication because they reflect radio waves.

The last layer of the thermosphere and atmosphere is the exosphere. Here, the atmosphere is very thin. In other words, atoms and ions are very far apart. Some gases escape into space.

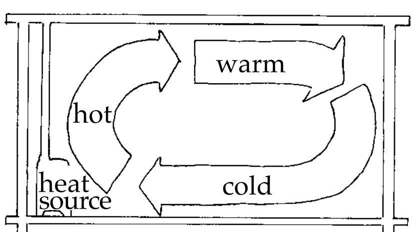
The Effect of Solar Radiation

Earth receives its heat from the sun. The sun's energy is spread through the atmosphere in three ways—**radiation**, **convection**, and **conduction**. Radiant energy from the sun reaches Earth in the form of waves by a process called *radiation*. These light waves are absorbed by Earth and returned to the atmosphere as heat. As air molecules absorb heat, they begin to move farther and farther apart. Warm air is therefore less dense, or lighter, and rises.



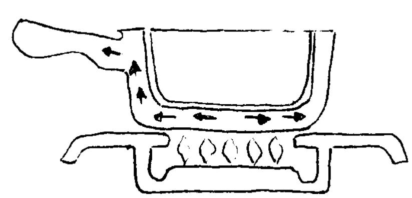
Radiation

Convection is the process through which heat is transferred by moving air or water. As the warm air rises, denser, heavier, and colder air moves in to replace it. This movement creates a **convection current**. Convection currents cause a constant exchange of air until the surface is evenly heated. Most of the heat in the atmosphere is transferred by convection currents.

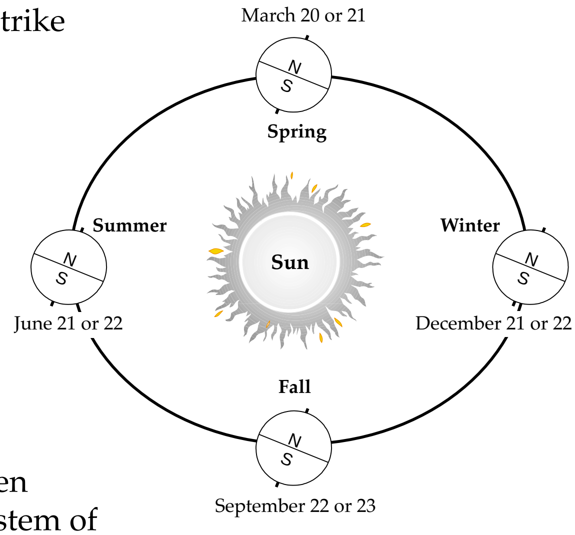


Convection

The direct transfer of heat energy through contact is called *conduction*. When cool air above Earth's surface comes into contact with the warm ground, the air is heated. Air temperatures closer to the ground are generally warmer than those higher up. Conduction plays only a minor role in heating the atmosphere because land and water are poor conductors of heat.


Conduction

The angle at which the sun's rays strike Earth varies because Earth is a sphere that rotates on its axis. The sun's rays produce the most heat when they strike Earth at a 90° angle. We call these rays **direct rays**. The area near the equator gets most of the direct rays of the sun. The rays that strike Earth on both sides of the equator hit at an angle that is greater than 90° and are called **indirect rays**. This creates an uneven heating of Earth which causes a system of air currents and winds to be formed. Vertical movements of air are called **currents**, and horizontal movements of air are called **wind**.



High and Low Air Pressure

L

low pressure

The uneven heating of Earth also causes changes in air pressure. When lighter, warm air rises, it creates an area of low pressure. The winds of a **low-pressure system** move upward, spiraling towards the system's center in a counterclockwise direction in the Northern Hemisphere and clockwise in the Southern Hemisphere. Low-pressure systems generally bring cloudy, rainy weather that is often accompanied by storms.

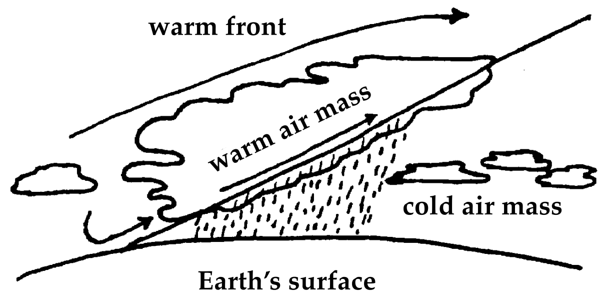
H

high pressure

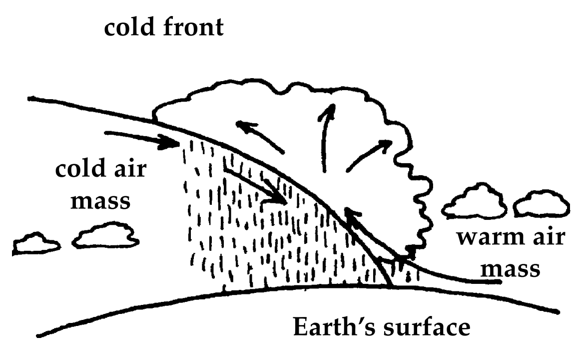
The heavier, cooler air in the upper atmosphere sinks, creating an area of high pressure. The winds of a **high-pressure system** move downward, spiraling outward in a clockwise direction in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. High-pressure systems bring cool, clear skies and dry weather. Differences between air pressure also cause winds. Air will move from an area of high pressure into an area of low pressure. The strength of the wind will depend on the amount of difference in pressure between the two systems. Air pressure systems cause changes in weather and are measured by a **barometer**.

Fronts

Large bodies of air having the same temperature and amount of moisture are called **air masses**. Some air masses form over continents and others form over the oceans. Those forming over the oceans have more moisture in them than the ones forming over land. When two different types of air masses meet, a boundary called a **front** forms. Fronts usually have stormy or unstable weather. There are four types of fronts: warm, cold, stationary, and occluded.



Warm Front. A **warm front** () forms when a mass of warm air meets a mass of cold air. The warm air gradually moves up and over the colder air causing **precipitation** and **clouds** ahead of the warm front. High **cirrus** clouds form and are followed by **stratus** clouds, causing the barometer to fall, and **nimbostratus** clouds producing rain or snow falls for a long period of time. A warm front is indicated by a line with half circles on it.



Cold Front. A **cold front** () forms when a cold air mass pushes a warm air mass in front of it. The cold air wedges under the warm air and lifts it up at a sharp angle, causing the formation of **cumulus** and **cumulonimbus** clouds, which produce thunderstorms and hard rains. Cold fronts generally move through an area quite rapidly, with cool, clear weather following. Cold fronts are indicated by a line with triangles facing the direction the front is moving.

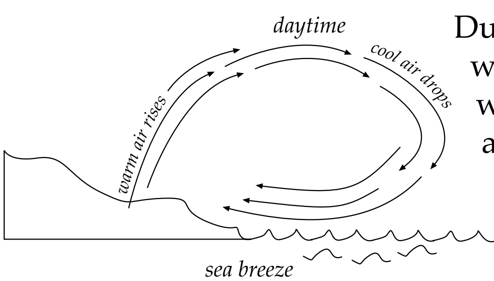
Stationary Front. A **stationary front** () forms when two unlike air masses face each other, but there is very little movement of air. The weather associated with a stationary front is similar to a warm front. Eventually one front or the other moves, forming either a warm or a cold front. The symbol for this front is a line with half circles on one side and triangles on the other.

Occluded Front. An **occluded front** () forms when a cold front overtakes and merges with a warm front. It is characterized by a combination of weather from both fronts. An occluded front is indicated by a line with alternating half circles and triangles on the same side of the line.

Winds

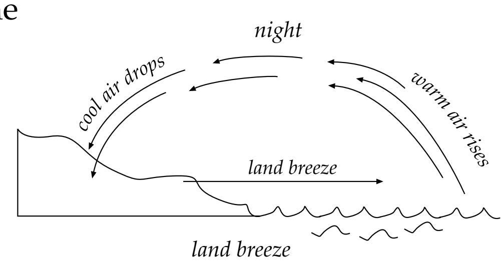
The differences in air pressure caused by the uneven heating of Earth by the sun result in winds. We use a **wind vane** to indicate the direction from which the wind is blowing. An **anemometer** is used to measure wind speed.

There are different types of wind systems. Local wind systems are caused by the specific conditions of a local area. The surface features of a particular area affect the amount of heat absorbed by the sun. Land absorbs the heat of the sun faster than water does, but it also loses heat faster than the water. This causes an uneven heating of the air and results in local winds. Winds are named for the direction from which they come.



During the day, land near a large body of water heats up faster than the water. The warm air above the land rises and the cool air from the body of water moving inland to replace it creates a **sea breeze**.

At night, the land cools faster than nearby bodies of water. Eventually air above the water will become warmer than that above the land and will rise, causing the cooler air from land to move in and replace it. This movement of air from land to sea is called a **land breeze**.



Wind Systems

The unequal heating and rotation of Earth also creates global wind systems, or belts. The air above the equator is warmer than the air above the polar regions. Warmer air rises and travels towards the poles where it cools and becomes heavier. This cool, heavy air then moves back towards the equator where it is again warmed and rises. This warming and cooling process combines with Earth's rotation to form convection currents that create global winds. There are several wind systems on Earth's surface. They are as follows:

Doldrums. The **doldrums** are a windless zone at the equator. The air seems to be motionless, but actually it is constantly being heated and forced straight up. This causes very little wind or no wind at all except during storms. In the days of sailing ships, many ships were caught in the doldrums and lost.

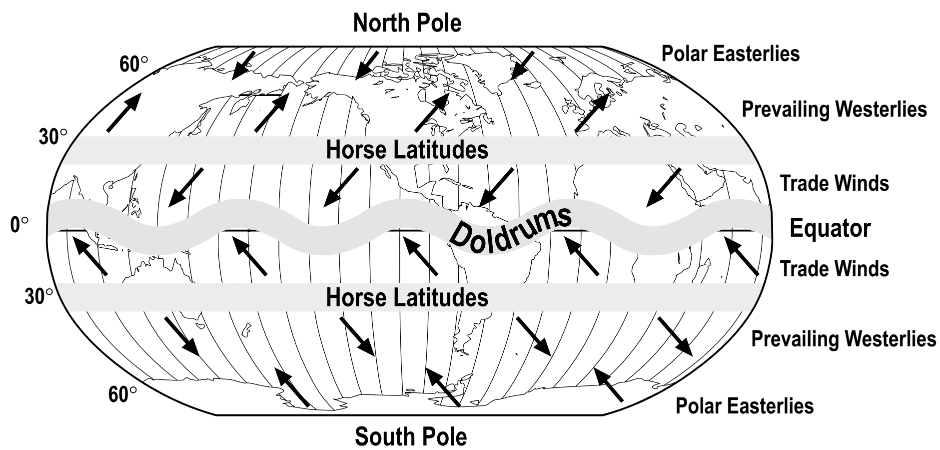
Trade Winds. The wind belt known for the **trade winds** is found just north and south of the equator. In these areas, wind is fairly constant. North of the equator the winds blow from the northeast, and south of the equator they blow from the southeast. Early sailors depended on these winds to get from one continent to another in order to trade, and called them trade winds.

Horse Latitudes. Just north and south of the trade winds at about 30° latitude are two narrow regions known as the **horse latitudes**. This is where the air moving from the equator cools and sinks. It is characterized by clear weather and very little rainfall. There is also very little wind in this area. If ships were caught in this region, they sometimes had to throw horses overboard when they were unable to feed them, giving the area its name.

Prevailing Westerlies. North and south of the horse latitudes are another wide belt of winds known as the **prevailing westerlies**, named for the direction from which they blow. These winds form in areas of Earth where there are large areas of land. The air over the land heats up and rises, then cools and sinks again, creating a wind belt.

Polar Easterlies. The belt known as the **polar easterlies** extends from 65° north and south latitude to the poles. These winds come from the east and blow cold winds away from the polar areas.

Sometimes winds that blow are seasonal. Winds that blow in one direction one season and in an opposite direction in another season are called **monsoons**. During a monsoon, the land becomes hotter than the water, causing winds that blow in from the ocean which bring warm, moist air, producing a rainy season during the summer. In the winter, the land cools more quickly, causing the winds to blow from the land to the oceans, which creates a dry season. A monsoon is actually a very large, long-lasting land and sea breeze.

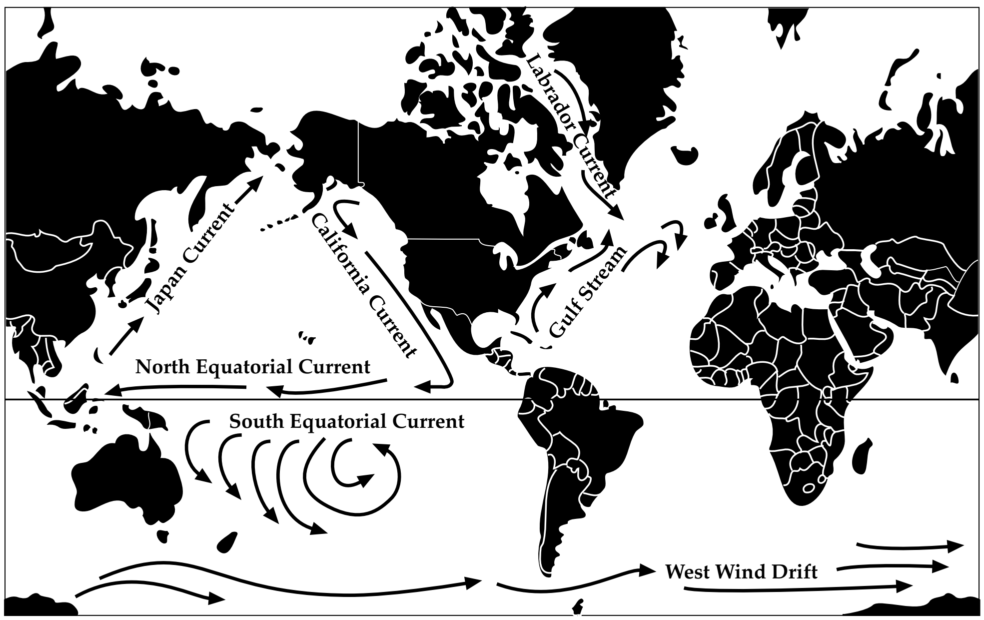


Wind Belts

Currents

A *current* is a moving, streaming, or plowing body of water or air. Ocean currents are sometimes called the *rivers of the ocean*. Like the rivers on the land, ocean currents flow in nearly the same direction.

The ocean has many currents. These currents are caused by the forces of the sun's heat, Earth's rotation, and the blowing winds.



Ocean Currents

Changes in the water temperature cause currents. Differences in water temperature start water movement called convection currents. Because the equator of Earth receives direct sun rays, the waters near the equator are warmer than the waters near the north or south pole. Warm water from the equator is pushed toward the poles by winds and Earth's rotation. This warm current transfers its warmth to the lands it flows by and to the cool waters around the poles. The colder water is heavier, so it sinks and moves back to the equator.

Ocean currents affect the climate of the continents they flow past. Currents that originate near the equator are warm. The warmth of these currents is transferred to the land and to the cool northern waters. The Gulf Stream is a warm current that helps moderate the winters of the British Isles and Norway and keeps them relatively warm for their latitudes. The Gulf

Stream warms our eastern coast of the United States. The Japan Current is also a warm current. It brings a mild climate to parts of British Columbia and Alaska.

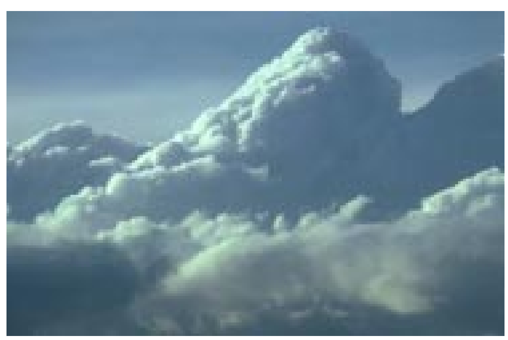
Alaskan waters are near the North Pole and nearer to either pole the water cools. Colder, heavier polar waters sink under warm currents and move back toward the equator. The California Current is a colder current that affects the western coast of the United States.

The dense fog of London is an example of the way currents affect the land masses. This heavy fog is caused when the warm, moist air from the Gulf Stream meets the colder air from the Labrador Current.

Storms

There are many different types of storms that occur on the surface of Earth. They range in severity from minor inconvenience to major disaster.

When two fronts collide, rainstorms and thunderstorms form. A *rainstorm* or steady rainfall that lasts for hours forms when a warm front meets a cold front. There is not usually much danger in a rainstorm except for flooding if the storm lasts long enough.

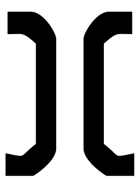


Thunderstorms form when a cold front meets a warm front. As warm air rises, it cools and condenses, forming *cumulonimbus* clouds. These clouds cause heavy rains along with **thunder** and lightning. During thunderstorms, electrical charges build up in the clouds. *Lightning* is the sudden discharge of electricity from the clouds. *Thunder* is the sound made by lightning. It is usually heard a few seconds after the lightning is seen because sound travels slower than light.

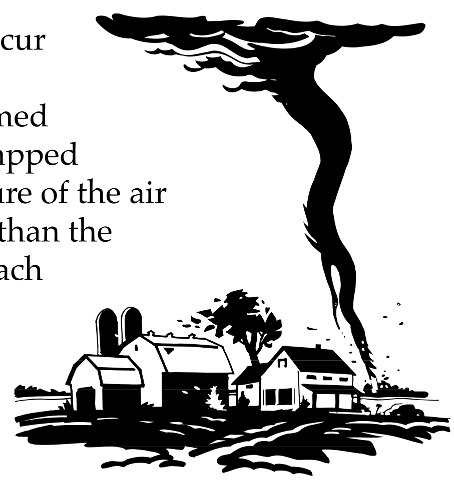
Blizzards occur during the winter months. Blizzards combine high winds, below freezing temperatures, and blowing powdery snow. Winds often range from 30 to 45 miles per hour (mph). These severe weather conditions can be dangerous to people and animals.

Low-pressure areas that contain warm air rising in a counterclockwise circular motion are called **cyclones**. The low-pressure areas usually cause rainy, stormy weather. High-pressure areas that have cool, dry air moving downward in a clockwise motion are called **anticyclones**. They bring clear, dry, fair weather. Cyclones and anticyclones move in opposite directions in the Southern Hemisphere. These systems can be either mild or severe.

A *hurricane* is a large, powerful cyclone. Hurricanes start out as low-pressure areas over the ocean in summer or early fall. As the system builds, it forms a spiral motion and contains a large amount of moisture. When wind speed is less than 35 mph, the storm is called a **tropical depression**. If the storm builds to a wind speed of 35 to 74 mph, it is called a **tropical storm**. When sustained winds reach 75 mph or more, a hurricane is born. Hurricane winds can reach over 200 mph; however, most of the damage from hurricanes comes from the flooding caused by the heavy rains associated with the storm.



A *tornado* is a violent, funnel-shaped windstorm that can occur along with thunderstorms or hurricanes. Tornadoes are formed when a mass of warm air is trapped between two masses of cold air. The pressure of the air in the center of the tornado is much lower than the surrounding air, causing winds that can reach 300 mph. The path of a tornado is much smaller than that of a hurricane, but because of its extremely high winds, it can do more damage to the area it strikes. A tornado that forms over the ocean is called a **waterspout**.



Safety Precautions

Storms can cause severe damage. Many safety precautions can be taken to prevent injury and lessen damage.

Rainstorms and thunderstorms rarely cause severe damage, with the exception of flooding. However, if lightning occurs, take the precautions listed on the following page:

Lightning Safety Precautions

1. Stay indoors.
2. Unplug electrical appliances to prevent damage.
3. If outdoors, stay away from tall objects like trees and towers. Also, avoid metal objects like golf clubs and aluminum baseball bats.

Getting struck by lightning can result in burns, loss of hearing, nervous system problems, and death. Lightning is a problem in Florida—especially during the summer and fall.

Hurricanes develop in tropical waters usually between June and November. These storms affect Florida and cause damage from wind and water. Hurricanes cause large-scale destruction and often leave areas without power and telephone service. Therefore, make sure that you have water, nonperishable food, candles, flashlights, a portable radio, batteries, and other items you may need.

A *hurricane watch* means that a hurricane may threaten within 24 hours. *Hurricane warnings* indicate that one is expected to strike within 24 hours. When a warning is issued, take the following precautions:

Hurricane Warning Safety Precautions

1. Leave low-lying areas.
2. Secure boats, outdoor objects, and windows.
3. Fill your car with gas.
4. Leave mobile homes for sturdier shelter.
5. Listen to weather service bulletins.
6. Leave your home for shelter, if advised by authorities.

After the hurricane has completely passed, stay away from heavily damaged areas, flooded areas, and loose wires, and cooperate with emergency officials. Do not mistake the *eye* of the hurricane for the *end*. The eye is a calm area at the center of a hurricane. After it passes, the storm will continue.

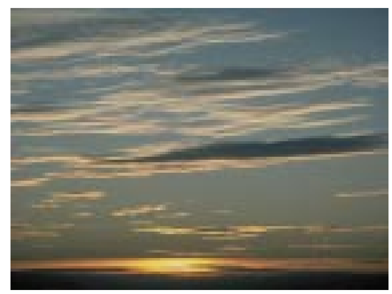
Tornadoes can be spawned by hurricanes or occur singly over land or water. Remain indoors or seek shelter in low-lying areas, if outdoors. If inside, open a window a few inches on the side of the house away from the storm, and take shelter in a small interior area like a hallway, closet, or bathroom.

Blizzards are not a common occurrence in Florida. But if you should be where they occur, it is important to stay indoors, if possible. Frostbite and disorientation are common problems. People in northern areas watch weather bulletins and stay close to home as a precaution.

Danger to human life can be lessened by taking appropriate precautions when warnings are issued. It is important to pay attention to signs of severe weather.

Clouds

Clouds are tiny droplets of water suspended in the air. Clouds form when the air becomes **saturated** (has all of the moisture that it can hold). The droplets of water cling to particles of dust, salt, smoke, or even volcanic ash found in the atmosphere and form clouds.



cirrus clouds

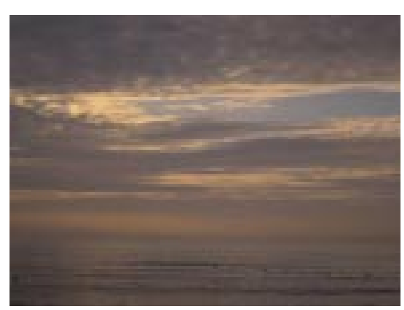
There are three basic types of clouds. They are classified according to their shape and the altitude at which they are formed. There are three basic types:

Cirrus. Cirrus clouds are thin, feathery clouds that form at very high altitudes. They are made of ice crystals and indicate that snow or rain may be coming in the next few hours.

cumulus clouds

Cumulus. Cumulus clouds are puffy with flat bottoms. They look like puffs of cotton in the sky. They form in the middle altitudes and usually indicate fair weather.

Stratus. Stratus clouds are the gray, smooth, layered clouds that lie low in the sky. They block out the sun and usually bring rain or drizzle. Stratus clouds that form close to the ground are called fog.



stratus clouds

Another term used to describe clouds is **nimbus**, which means *rain*. *Nimbostratus* clouds are low, black, layered clouds that cause long periods of rain. *Cumulonimbus* clouds are often called thunderheads because they are the clouds that cause thunderstorms.

Clouds shield against the heat of the sun. Since clouds are made of droplets of water, more light is reflected off them. As a result there are lower temperatures during the day than if there were no clouds. At night, clouds act as blankets that insulate Earth and keep it warmer. Heat waves radiated by the sun that enter the atmosphere are short waves. As they bounce off the surface of Earth, they become longer. These longer waves cannot pass through the cloud layer and therefore bounce back to Earth's surface, maintaining warmer nighttime temperatures than if there were no clouds. Clouds blanket Earth in much the same way a blanket keeps a person warm on a cool night. Cloud cover can keep crops from freezing when the temperatures unexpectedly drop below freezing.

Precipitation

When clouds form, water droplets may grow larger and larger until they are so heavy that they can no longer remain suspended in the air. Water falls to the ground in one or more forms called *precipitation*. There are several types of precipitation. The type of precipitation formed depends on the weather conditions and temperatures.

Rain is the most common type of precipitation. It forms when the temperature of air below the clouds is above freezing and droplets of water fall from the clouds. If the rain falls in very tiny drops, it is called *drizzle* or *mist*.

When the temperature in the clouds is below freezing and the temperature of the air below the clouds is also freezing, crystals of ice called *snowflakes* form. Each snowflake is unique, but all of them have six points.

Sleet forms when raindrops fall through a layer of air that is below freezing, causing the rain to freeze as it falls to Earth. Sleet also forms when snow melts on its way down and then freezes again; sleet will only fall in the winter. Freezing rain forms when conditions on the ground are cold enough to freeze the rain when it lands.

A damaging form of precipitation is *hail*. It can destroy entire crops as well as damage cars and other property. Hail or hailstones are chunks or balls of ice formed in cumulonimbus clouds. A hailstone is formed when a water droplet freezes on a small crystal of ice. Updrafts in the cloud toss the ice balls up in the cloud and then a layer of water freezes on the ice ball. This continues until the hailstone is finally heavy enough to fall to Earth. The average hailstone is about the size of a pea, but sometimes they can get as large as baseballs.

Climates

Weather encompasses the day-to-day changes in the temperature, humidity, wind, and air pressure. *Climate* is the average of conditions that make up an area's weather over a long period of time. Weather changes from day to day, whereas climate remains the same.

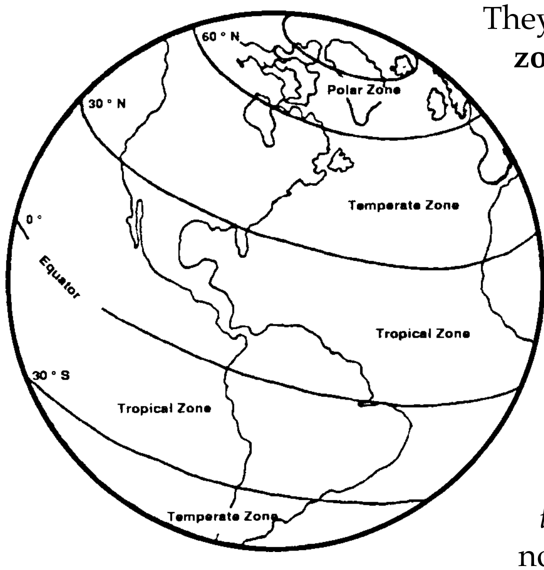
Factors Influencing Climate

An area's climate is influenced by many factors. Some of these include latitude, elevation, and nearness to a major body of water.

The latitude or distance north or south of the equator is a factor in determining the climate of an area. Areas near the equator receive the direct rays of the sun and have warm climates. Likewise, the areas farther from the equator get more indirect rays and are cooler, with the coldest areas being at the poles.

Elevation, or height above sea level, is also a factor in determining the climate of an area. The higher the elevation, the colder the climate. Even high mountains near the equator can have snow-capped peaks. Mountains near coastal regions are also important in forming **deserts**. When the moist winds from the ocean rise and meet the mountain range, they drop their moisture in the form of rain on the side of the mountains nearest the ocean or in the form of snow on the mountains. The air that passes to the other side of the mountains is now dry, and the climate on that side of the mountains will also be dry.

A major body of water near land may have a great influence on the climate. Land near large bodies of water may be humid or moist. Since large bodies of water heat up and cool off much more slowly than land, these areas do not have the extreme temperature changes of large land areas.



climate zones

There are three main climate zones on Earth. They are the **polar zone**, the **temperate zone**, and the **tropical zone**. The *polar* zone begins at each pole and extends to about 60° north or south latitude. Here, the average temperatures remain below freezing and there is little precipitation. Between 60° and 30° latitude on each hemisphere is a region called the *temperate* zone, which has a variance of temperatures and an average amount of precipitation. The *tropical* zone extends from about 30° north latitude to 30° south latitude. It has above-average temperatures and precipitation.

Within these zones there are other climatic types. *Deserts* are areas that receive less than 25 centimeters of rainfall a year. They are usually located along the western border of a large land mass with a range of coastal mountains.

Marine climates are found near large bodies of water. Temperatures in this type of climate do not vary much because the water cools off and heats up much more slowly than the land does. There is also less seasonal change in these areas.

Continental climates are found where there are huge land masses. They are greatly affected by air masses that move in from both polar and tropical regions. They have noticeable seasonal changes and severe temperature changes. Mountain regions located in continental areas also show distinct climatic changes. Higher up in the mountain regions, the climate becomes more like that found in the polar regions.

Summary

Heat and energy are transferred from the sun by Earth's atmosphere through convection, radiation, and conduction. Uneven heating of Earth causes changes in air pressure and air currents. These changes along with the Earth's rotation produce local wind systems and global wind systems.

Blowing winds, the sun's heat, and the Earth's rotation combine to create the oceans' many water currents.

Air masses of different types meet and form warm, cold, stationary, or occluded fronts. Colliding fronts cause many different types of storms. In the event of severe storms such as hurricanes and tornadoes, safety precautions should be used to prevent injury or property damage.

When moist air is cooled, water vapor condenses around tiny specks of dust, smoke, or salt to form droplets. Huge numbers of droplets form clouds. When these water droplets get too heavy, they fall to the ground in some form of precipitation—rain, sleet, hail, or snow. Three basic types of clouds insulate Earth and help shield it from the sun's heat.

Climate is the average weather of an area over a long period of time. Factors such as latitude, elevation, and nearness to water affect climate. Earth's atmosphere has four layers. Each layer has different temperatures and gases present.

Practice

Use the list below to complete the following statements.

10	**exosphere**	**oxygen**	**thermosphere**
aerosol cans	**ionosphere**	**ozone**	**troposphere**
atmosphere	**jet stream**	**skin cancer**	**ultraviolet rays**
blindness	**mesosphere**	**stratosphere**	

1. The blanket of air that surrounds Earth is the ________________________ .

2. The layer of the atmosphere closest to Earth that contains our weather is the ________________________ .

3. The troposphere extends for about ________________________ kilometers.

4. A narrow band of winds that blow from west to east, just above the troposphere, in which airplanes sometimes fly, is called the ________________________ .

5. The ________________________ is the layer above the troposphere.

6. The upper layer of the stratosphere is about the same temperature as Earth at sea level because of the presence of ________________________ .

7. Ozone heats the atmosphere by absorbing the sun's ________________________ .

8. Ultraviolet rays from the sun can cause ____________________ and ____________________ .

9. CFCs used in ____________________ destroy the ozone layer.

10. The coldest part of the atmosphere is the ____________________ .

11. Beyond the mesosphere is the ____________________ , which extends to 500-700 kilometers and is very hot.

12. Within the thermosphere, the part that contains electrically charged particles is called the ____________________ .

13. The last layer of the atmosphere extends for thousands of kilometers into space and is called the ____________________ .

14. Ozone is a gas that contains three atoms of ____________________ per molecule instead of two atoms, as does the gas that we breathe.

Practice

Complete the chart below. Beside each layer of the **atmosphere***, record the* **distance** *each extends into* **space***, and list the important* **characteristics** *of each.*

Layer	Distance	Characteristics
1. troposphere		
2. stratosphere		
3. mesosphere		
4. thermosphere		
a. ionosphere		
b. exosphere		

Practice

Answer the following using complete sentences.

1. How does ozone differ from the oxygen we breathe?

2. How does ozone smell?

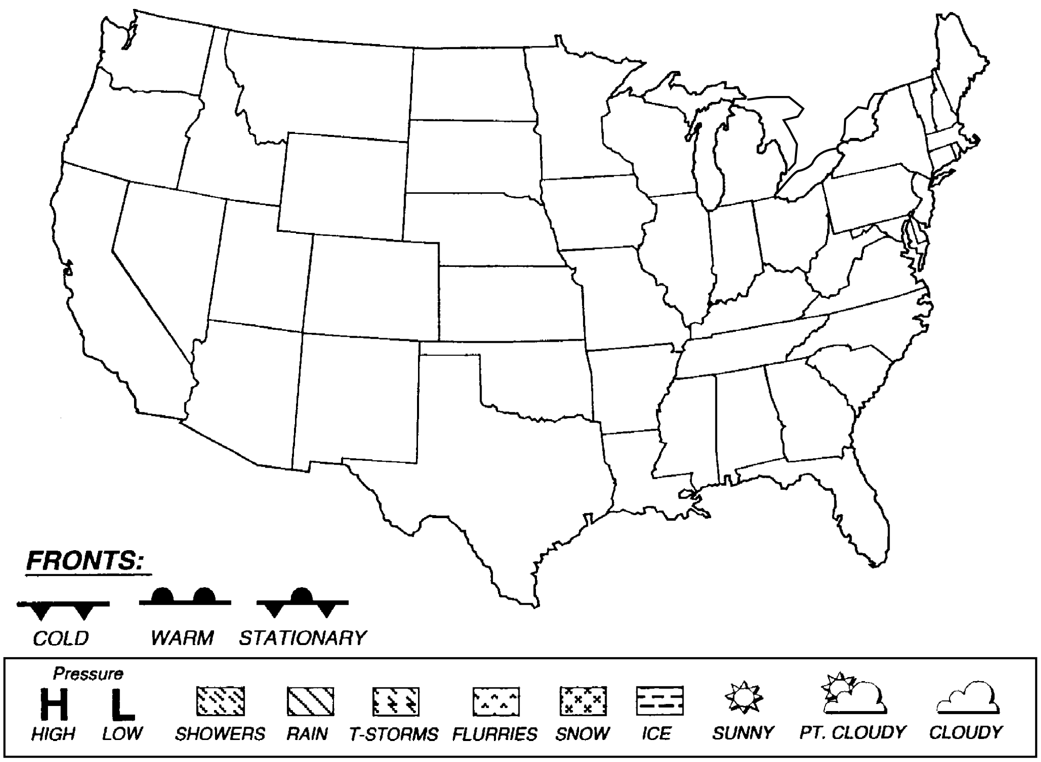
3. When can you smell ozone?

4. How does the ozone layer protect us?

5. What can be done to stop people from destroying the ozone layer?

Practice

Use data from the newspaper to construct a **weather map** *for a particular day. Use your knowledge of* **air masses** *to predict the weather for the* **southeast region**.



Practice

Use the list below to complete the following statements.

convection current	**heat**	**radiation**
counterclockwise	**indirect rays**	**sun**
currents	**low-pressure**	**wind**
direct rays		

1. Earth gets its heat from the ____________________ .

2. The process by which the sun's energy reaches Earth in the form of waves is called ____________________.

3. Light waves are absorbed by Earth and returned to the atmosphere as ____________________ .

4. A ____________________ is formed when warm air rises and cold air rushes in to take its place.

5. Rays of the sun that hit Earth at a 90° angle are called ____________________ .

6. Rays that strike Earth at an angle of greater than 90° are called ____________________ .

7. ____________________ are vertical movements of air.

8. Horizontal movements of air are called ____________________ .

9. Air that is heated is less dense; it rises and forms a

    _______________________ area.

10. The winds of a low-pressure area move _______________________

    in the Northern Hemisphere.

Practice

Use the list below to complete the following statements.

air mass	**high-**	**occluded**
barometer	**high pressure area**	**stationary**
cold	**low-**	**warm**
front		

1. Cloudy, rainy weather is caused by a ________________________ pressure system.

2. Cool air that is heavy sinks and creates a ________________________ .

3. Cool, clear skies with dry weather accompany a ________________________ pressure area.

4. A ________________________ is used to measure air pressure.

5. A large body of air having the same amount of moisture and temperature is called a(n) ________________________ .

6. A boundary called a ________________________ forms when two different types of air masses meet.

7. After a(n) ________________________ front, the weather is usually cool and clear.

8. A(n) ________________________ front forms when two fronts meet but neither moves for a period of time.

9. A(n) ________________________ front brings rain or snow that lasts for a long period of time.

10. When a cold front overtakes and merges with a warm front, a(n) ________________________ front forms.

Practice

Match the **front** *with the correct* **symbol***. Write the letter on line provided.*

______ 1. Warm Front

______ 2. Cold Front

______ 3. Occluded Front

______ 4. Stationary Front

A. 

B. 

C. 

D. 

Lab Activity 1: The Earth's Rotation Creates Winds and Currents

Purpose	Materials
Observe the effects of rotation on water.	• bowl • water • lazy Susan tray or rotating piano stool

1. Place a bowl of water on a lazy Susan tray or a rotating piano stool.

2. Gently spin in a counterclockwise direction.

3. Let the water become still.

4. Rotate in the opposite direction.

5. What did you see happen when the water was spun counterclockwise?

    ____

    ____

    ____

6. What did you see happen to the water when it was rotated in the opposite direction?

    ____

    ____

    ____

7. How did the water movement change? ____________________

    ____

    ____

Lab Activity 2: Water Currents

Purpose

Observe water currents that result from heating water.

Materials

- ice cubes
- rectangular pan
- water
- food coloring
- Bunsen burner

1. Place ice cubes in the center of a rectangular pan.
2. Fill pan with water.
3. Put an immersion heater just below the surface of the water on one side of the pan. (A Bunsen burner can be used. Make sure to heat one side of the pan, not the center.)
4. Add several drops of food coloring close to the heated side.
5. Continue to heat until you can see the movement of the color.
6. In what direction does the colored water move? ________________
7. Does the clear water move? ________________________________
8. Does the colored water stay at the top? ______________________
9. What climate zone does the ice represent? ____________________
10. What climate zone does the heater represent? _________________
11. Considering what you have observed, in what direction do you think the ocean currents should move?

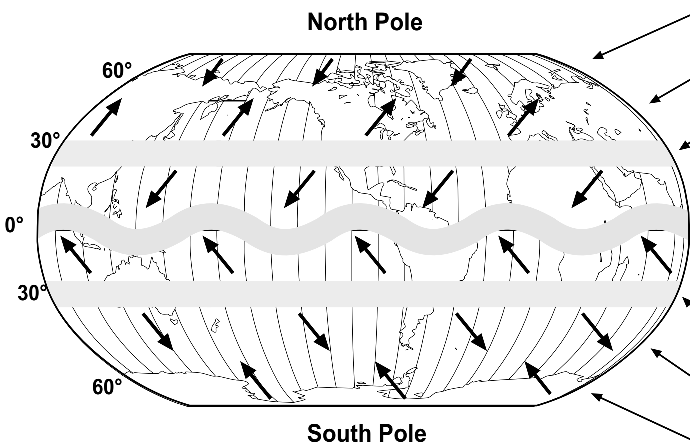
    ____

    ____

    ____

Practice

Label the **major wind systems** *on Earth. Write* **North**, **South**, **East**, *or* **West** *on each line in the chart to show the direction of the* **major air movements**. *The arrows indicate the direction of the movement.*



1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________

10.-15.

Wind		
Direction of movement for latitudes:	Northern Hemisphere	Southern Hemisphere
60° - 90°		
30° - 60°		
0° - 30°		

Practice

Match each definition with the correct term. Write the letter on the line provided.

______ 1. instrument used to indicate from which direction the wind is coming

______ 2. instrument used to measure the speed of the wind

______ 3. breeze formed when the air on land warms and rises and cooler wind from the ocean rushes in to replace it

______ 4. breeze that blows at night when cool air from the land moves out to sea replacing the warmer air found there

______ 5. system of wind found just north and south of the equator where there is a steady wind flow that early sailors depended on

______ 6. seasonal winds that bring rainy weather in the summer and dry weather in the winter

______ 7. area around the equator where there is little or no wind

______ 8. system of winds found in the areas of Earth where there are large land masses; these winds blow from the west

______ 9. narrow band near 30° latitude with very little wind

______ 10. system of winds that extends from the poles to 65° north and south latitude that blow cold winds from an easterly direction

A. anemometer

B. doldrums

C. horse latitudes

D. land breeze

E. monsoons

F. polar easterlies

G. prevailing westerlies

H. sea breeze

I. trade winds

J. wind vane

Practice

Use the **hurricane tracking map** *on the next page to* **plot** *the* **paths** *of hurricanes* **Bonnie** *and* **Andrew**. *Then answer the questions below with a short answer.*

Hurricane Bonnie			**Hurricane Andrew**		
Date	Position at 6:00 a.m.		Date	Position at 6:00 a.m.	
1998	Latitude	Longitude	1992	Latitude	Longitude
Aug. 22	21.8° N	68.7° W	Sept. 20	20.7° N	60.0° W
23	23.8° N	71.3° W	21	23.9° N	63.3° W
24	25.2° N	72.1° W	22	25.6° N	67.0° W
25	27.8° N	73.8° W	23	25.5° N	72.5° W
26	31.7° N	77.3° W	24	25.4° N	79.3° W
27	34.5° N	77.5° W	25	26.6° N	86.7° W
28	36.2° N	75.1° W	26	29.2° N	91.3° W
29	39.2° N	69.6° W	27	32.1° N	90.5° W
30	44.3° N	57.0° W	28	35.4° N	84.0° W

1. Where did Bonnie hit land? ______________________________

2. Where did Andrew hit land? ______________________________

3. In which general directions do hurricanes move? ______________

4. Where do most of the hurricanes form that affect Florida?

   ____

5. Which areas of the United States are most affected by hurricanes?

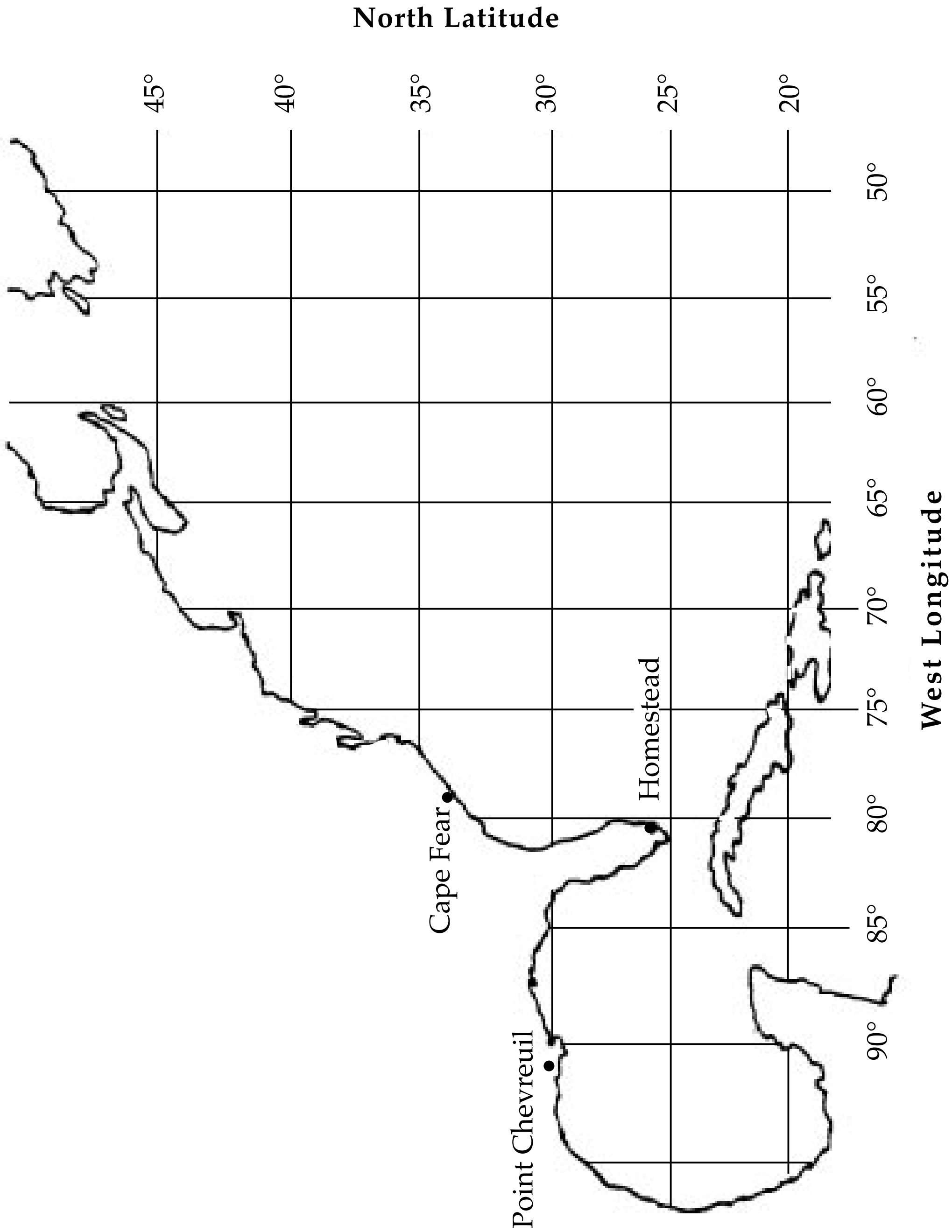
   ____

6. What causes the most damage from a hurricane, wind or water?

   ____

Practice

Use the information on the previous page to **plot** *the* **paths** *of* **hurricanes Bonnie** *and* **Andrew** *on the map below.*



Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

75	**cyclones**	**thunder**
200	**hurricane**	**tornado**
anticyclones	**lightning**	**tropical depression**
blizzard	**opposite**	**tropical storm**
cumulonimbus	**rainstorm**	**waterspout**

1. A storm formed when two fronts meet that causes steady rainfall lasting for hours is called a ______________________ .

2. A snowstorm with strong winds is called a ______________________ .

3. Thunderstorms are caused by the formation of ______________________ clouds.

4. A sudden discharge of electricity from the clouds is called ______________________ .

5. ______________________ is the sound made by lightning.

6. Low-pressure areas that contain warm air rising in a counterclockwise circular motion are called ______________________ .

7. High-pressure areas that have cool, dry air moving downward in a clockwise motion are called ______________________ .

8. High- and low-pressure systems move in ____________________ directions in the Southern Hemisphere.

9. A large powerful cyclone that begins as a low-pressure system over the ocean in summer or early fall is called a ____________________ .

10. A low-pressure system with winds less than 35 mph is called a(n) ____________________ .

11. A large, low-pressure system with winds from 35 to 74 mph is a ____________________ .

12. A hurricane is formed when sustained winds reach ____________________ mph. Hurricane winds can reach speeds of over ____________________ mph.

13. A violent, funnel-shaped windstorm with winds that reach 300 mph is a ____________________ .

14. A ____________________ is a tornado that forms over the ocean.

15. The path of a ____________________ is smaller than that of a ____________________ , but because of the high winds it can do more damage.

Practice

Answer the following using complete sentences.

1. What danger exists in thunderstorms? ____________________________

2. What should you do if you are caught outside during a thunderstorm?

3. What are three precautions to take in the event of a hurricane?

4. What is the difference between a hurricane watch and a hurricane warning?

5. Where should you seek shelter indoors during a tornado?

Practice

Match each description with the correct **type of cloud**. *Write the letter on the line provided.*

______ 1. thin, feathery clouds found at high altitudes		A. cirrus
______ 2. clouds that contain rain		B. cumulonimbus
______ 3. gray, smooth, layered clouds found low in the sky		C. cumulus
______ 4. clouds that cause thunderstorms		D. nimbostratus
______ 5. puffy clouds with flat bottoms found at middle altitudes		E. nimbus
______ 6. low-lying, black, layered clouds that bring long periods of rain		F. stratus

Label the three basic **types of clouds**:

7. ____________________

8. ____________________

9. ____________________

Practice

Complete the chart below for **five** *consecutive days.*

Cloud Observation Chart

Date and time of day	Direction of wind	Type of cloud observed	Description of clouds observed (puffy? wispy? dark? flat? etc.)	Weather conditions at the time
	north			
	east			
	south			
	west			
	north			
	east			
	south			
	west			
	north			
	east			
	south			
	west			
	north			
	east			
	south			
	west			
	north			
	east			
	south			
	west			

Practice

Match each definition with the correct term. Write the letter on the line provided.

______ 1. moisture that falls to Earth as rain, hail, sleet, or snow

______ 2. condensation on particles of dust, smoke, or salt

______ 3. temperature of the air below the clouds is above 32° F

______ 4. six-pointed crystals of ice that fall when the temperature of both the clouds and the land is below freezing

______ 5. rain that falls in very tiny droplets

______ 6. rain that freezes after it hits the ground

______ 7. snow melts and freezes again on its way down

______ 8. the most damaging form of precipitation

A. cloud

B. drizzle or mist

C. freezing rain

D. hailstones

E. precipitation

F. rain

G. sleet

H. snowflakes

Practice

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

________ 1. Water droplets must condense on particles such as dust or smoke in order to form clouds.

________ 2. Precipitation forms when water droplets become so heavy that they can no longer stay suspended in the air.

________ 3. Snow is the most common type of precipitation.

________ 4. Rain that forms very large droplets is called drizzle or mist.

________ 5. In order for snowflakes to form, both the temperature of the clouds and the temperature of the air must be below freezing.

________ 6. Snowflakes can have four, five, or six points.

________ 7. Sleet and freezing rain are the same thing.

________ 8. Sleet only falls in the winter.

________ 9. The form of precipitation that causes the most damage is sleet.

________ 10. Hailstones are formed in cumulonimbus clouds.

________ 11. Hailstones are usually the size of golf balls.

________ 12. Hailstones move up and down in the clouds several times, forming new layers of ice until they are finally heavy enough to fall.

________ 13. Snow that melts on its way down and refreezes is called sleet.

________ 14. The type of precipitation that falls is only determined by the temperature on the ground where it falls.

Practice

Answer the following using complete sentences.

1. What three factors influence the climate of an area? ______________

    ____

    ____

2. Why are areas near the equator warmer? ________________________

    ____

3. How do mountains near coastal regions help in the formation of deserts?

    ____

    ____

    ____

4. Describe the temperature and precipitation in each of the three major climate zones. Fill in the chart below.

Zone	Temperature	Precipitation

5. Describe the following climate types.

Desert: ____

____

____

____

____

____

Marine climate: ______________________________________

____

____

____

____

____

Continental climate: __________________________________

____

____

____

____

____

____

Practice

Use the list below to write the correct **atmosphere** *and* **climate** *term for each definition on the line provided. One or more terms will be used more than once.*

atmosphere	**jet stream**	**stratosphere**
climate	**marine climate**	**temperate zone**
continental climate	**mesosphere**	**thermosphere**
desert	**ozone**	**troposphere**
exosphere	**polar zone**	**weather**
ionosphere		

______________________ 1. type of climate found where there are huge land masses

______________________ 2. type of climate found when an area is located near a large body of water

______________________ 3. day-to-day changes in temperature, humidity, wind, and air pressure

______________________ 4. the blanket of air surrounding Earth

______________________ 5. the part of the thermosphere that contains electrically charged particles called ions

______________________ 6. the zone of moderate climate with distinct seasonal changes located between 30° and 60° latitude

______________________ 7. coldest layer of the atmosphere, just above the stratosphere

______________________ 8. dry areas that receive less than 25 cm of rainfall per year

______________________ 9. area of Earth that extends from the poles to 60° north and south latitude and has a very cold climate

______________________________ 10. the weather of an area over a long period of time

______________________________ 11. the layer of the atmosphere above the mesosphere where the air is very thin and hot

______________________________ 12. type of oxygen with three oxygen atoms (O_3) found in the upper areas of the stratosphere

______________________________ 13. the layer of air closest to Earth

______________________________ 14. the upper part of the thermosphere

______________________________ 15. the lowest layer of the atmosphere that contains most of our weather

______________________________ 16. the layer of Earth's atmosphere that contains ozone

______________________________ 17. narrow band of winds that blow from west to east just above the troposphere

Practice

Use the list below to write the correct **solar radiation** *and* **air mass** *term for each definition on the line provided.*

air masses	**currents**	**occluded front**
barometer	**direct rays**	**radiation**
cold front	**front**	**stationary front**
conduction	**high-pressure system**	**warm front**
convection	**indirect rays**	**wind**
convection current	**low-pressure system**	

______________________ 1. front that forms when two unlike air masses face each other, but neither moves

______________________ 2. process by which the sun's rays reach Earth in the form of waves

______________________ 3. front that forms when a cold front overtakes and merges with a warm front

______________________ 4. system that brings cloudy, rainy, and often stormy weather

______________________ 5. rays of the sun that hit Earth at greater than 90°; they produce less heat

______________________ 6. system that brings cool, clear skies and dry weather

______________________ 7. the boundary formed when two different masses of air meet

______________________ 8. rays of the sun that hit Earth at a 90° angle; they create the greatest amount of heat

______________________ 9. vertical movements of air or water caused by the uneven heating of Earth

______________________ 10. vertical movement of air or water caused by differences in temperature

______________________ 11. front formed when a mass of cold air meets a mass of warm air and moves beneath it

______________________ 12. an instrument used to measure air pressure

______________________ 13. large bodies of air having the same temperature and amount of moisture

______________________ 14. front that forms when a mass of warm air meets a mass of cold air and moves over it

______________________ 15. horizontal movements of air caused by the uneven heating of Earth

______________________ 16. direct transfer of heat energy from one substance to another

______________________ 17. transfer of heat energy by moving air or fluid

Practice

Use the list below to write the correct **wind** *and* **current** *term for each definition on the line provided.*

anemometer	**monsoons**	**sea breeze**
doldrums	**polar easterlies**	**trade winds**
horse latitudes	**prevailing westerlies**	**wind vane**
land breeze		

________________________ 1. an instrument used to measure wind speed

________________________ 2. area at about 30° north and south latitude where there is very little wind

________________________ 3. the area around the equator where air moves straight up and there is very little wind

________________________ 4. system of winds that blows cold air from the poles

________________________ 5. cool air that moves from sea to land during the day

________________________ 6. cool air blowing from land to sea at night

________________________ 7. system of winds found just north and south of the equator that blows toward the equator from the northeast and southeast

________________________ 8. winds that blow inland during summer bringing rainy weather and that blow out to sea in winter bringing dry weather

________________________ 9. an instrument that tells from which direction the wind is coming

________________________ 10. wind system formed over large land areas that blow from the west to the east

Practice

Use the list below to write the correct **storm** *and* **precipitation** *term for each definition on the line provided.*

anticyclone	**hurricane**	**stratus**
blizzard	**lightning**	**thunder**
cirrus	**nimbostratus**	**tornado**
cloud	**nimbus**	**tropical depression**
cumulonimbus	**precipitation**	**tropical storm**
cumulus	**saturated**	**waterspout**
cyclone		

________________________ 1. a large, powerful low-pressure storm system; a cyclone with sustained winds of 75 mph or more

________________________ 2. puffy, white clouds with flat bottoms

________________________ 3. high-pressure system with winds moving clockwise

________________________ 4. a cloud that causes rain to fall

________________________ 5. a sudden discharge of electricity from clouds

________________________ 6. a severe snowstorm with high winds

________________________ 7. a term used when the air has all the moisture it can hold

________________________ 8. tiny droplets of water suspended in the air

________________________ 9. very high, thin, feathery clouds made of ice crystals

________________________ 10. a low-pressure system with winds moving in a counterclockwise direction

____________________ 11. smooth, layered clouds found low in the sky

____________________ 12. a dark, low-lying stratus cloud that contains rain

____________________ 13. the sound made by lightning

____________________ 14. cumulus clouds that bring rain; also called thunderheads

____________________ 15. moisture that falls to Earth as rain, hail, sleet, or snow

____________________ 16. a tornado that forms over water

____________________ 17. a violent, funnel-shaped windstorm

____________________ 18. a storm formed when the winds of a tropical depression are between 35 and 74 mph

____________________ 19. a storm formed by a large, low-pressure system over water with winds less than 35 mph

Practice

Circle the letter of the **atmosphere** *and* **climate** *term that correctly completes each statement below.*

1. A dry area that receives less than 25 cm of rainfall per year is a(n) ____________ .

   a. equinox
   b. ozone
   c. polar zone
   d. desert

2. The upper part of the thermosphere is called the ____________ .

   a. ionosphere
   b. jet stream
   c. exosphere
   d. mesosphere

3. The coldest layer of the atmosphere, just above the stratosphere is called the ____________ .

   a. exosphere
   b. ozone
   c. polar zone
   d. mesosphere

4. The ____________ is the lower part of the thermosphere that contains electrically charged particles called ions.

   a. ozone
   b. mesosphere
   c. exosphere
   d. ionosphere

5. The ____________ is a layer of Earth's atmosphere above the troposphere; it contains the ozone layer.

   a. thermosphere
   b. temperate zone
   c. stratosphere
   d. tropical zone

6. The layer of the atmosphere above the mesosphere where the air is very thin and hot is called the __________ .

   a. tropical zone
   b. thermosphere
   c. ionosphere
   d. troposphere

7. The day-to-day changes in temperature, humidity, wind, and air pressure are called __________ .

   a. temperate zones
   b. tropical zones
   c. weather
   d. marine climates

8. The __________ is mixture of gases surrounding Earth.

   a. equinox
   b. polar zone
   c. tropical zone
   d. atmosphere

9. The __________ is a narrow layer of strong winds that blow from west to east just above the troposphere.

   a. mesosphere
   b. jet stream
   c. polar zone
   d. ozone

10. The weather of an area over a long period of time is called the __________ .

    a. climate
    b. seasons
    c. solstice
    d. tropical

11. The type of climate found when an area is located near a large body of water is called __________ .

    a. seasons
    b. continental climate
    c. tropical zone
    d. marine climate

12. The type of climate found where there are huge land masses is called ____________ .

    a. continental climate
    b. marine climate
    c. tropical zone
    d. seasons

13. The zone of moderate climate with distinct seasonal changes located between 30° and 60° latitude is a ____________ .

    a. polar zone
    b. temperate zone
    c. tropical zone
    d. solstice

14. The type of oxygen with three oxygen atoms (O_3) found in the upper areas of the stratosphere is called ____________ .

    a. ozone
    b. seasons
    c. climate
    d. solstice

15. The ____________ is the layer of air closest to Earth.

    a. troposphere
    b. temperate
    c. thermosphere
    d. mesosphere

16. The area of Earth that extends from the poles to 60° north and south latitude and has very cold climate is called the ____________ .

    a. temperate zone
    b. stratosphere
    c. tropical zone
    d. polar zone

17. The lowest layer of the atmosphere that contains most of our weather is called the ____________ .

    a. stratosphere
    b. polar zone
    c. troposphere
    d. temperate zone

Practice

Circle the letter next to the **solar radiation** *and* **air mass** *term that correctly completes each statement below.*

1. An instrument used to measure air pressure is a ____________ .
   a. barometer
   b. convection current
   c. direct ray
   d. current

2. The vertical movement of air or water caused by differences in temperature is a ____________ .
   a. current
   b. front
   c. direct ray
   d. convection current

3. Rays of the sun that hit Earth at a 90° angle are called ____________ .
   a. fronts
   b. indirect rays
   c. high-pressure systems
   d. direct rays

4. A system that brings cool, clear skies and dry weather is a(n) ____________ .
   a. low-pressure system
   b. indirect ray
   c. high-pressure system
   d. stationary front

5. A system that brings cloudy, rainy, and often stormy weather is a(n) ____________ .
   a. stationary front
   b. occluded front
   c. convection current
   d. low-pressure system

6. The process by which the sun's rays reach Earth in the form of waves is called ____________ .

   a. wind
   b. warm front
   c. radiation
   d. stationary front

7. Large bodies of air having the same temperature and amount of moisture are ____________ .

   a. currents
   b. convection currents
   c. warm fronts
   d. air masses

8. A front formed when a mass of cold air meets a mass of warm air and moves beneath it is a ____________ .

   a. cold front
   b. current
   c. front
   d. direct ray

9. Vertical movements of air caused by the uneven heating of the Earth are ____________ .

   a. fronts
   b. direct rays
   c. currents
   d. indirect rays

10. The boundary formed when two different masses of air meet is a(n) ____________ .

    a. occluded front
    b. low-pressure system
    c. high-pressure system
    d. front

11. The rays of the sun that hit Earth at more than 90° and produce less heat are called ____________ .

    a. radiation
    b. low-pressure systems
    c. occluded fronts
    d. indirect rays

12. A front that forms when a cold front overtakes and merges with a warm front is a(n) __________ .

    a. occluded front
    b. stationary front
    c. low-pressure system
    d. warm front

13. A front that forms when two unlike air masses face each other, but neither moves is a(n) __________ .

    a. warm front
    b. high-pressure system
    c. stationary front
    d. occluded front

14. The horizontal movements of air caused by the uneven heating of Earth are called __________ .

    a. stationary front
    b. radiation
    c. occluded front
    d. wind

15. A front that forms when a mass of warm air meets a mass of cold air and moves over it is a(n) __________ .

    a. occluded front
    b. warm front
    c. stationary front
    d. low-pressure system

16. The transfer of heat energy by moving air or fluid is __________ .

    a. convection
    b. current
    c. conduction
    d. radiation

17. The direct transfer of heat energy from one substance to another is __________ .

    a. radiation
    b. conduction
    c. current
    d. convection

Practice

Circle the letter next to the **wind** *and* **current** *term that correctly completes each statement below.*

1. A system of winds that blows cold air from the poles is called ____________ .

   a. sea breezes
   b. prevailing westerlies
   c. polar easterlies
   d. horse latitudes

2. Cool air blowing from land to sea at night is a ____________ .

   a. monsoon
   b. trade wind
   c. land breeze
   d. sea breeze

3. The area around the equator where air moves straight up and there is very little wind is called ____________ .

   a. monsoons
   b. doldrums
   c. land breezes
   d. horse latitudes

4. An instrument used to measure wind speed is a(n) ____________ .

   a. sea breeze
   b. land breeze
   c. anemometer
   d. wind vane

5. The area at about 30° north and south latitude where there is very little wind is the ____________ .

   a. horse latitudes
   b. monsoons
   c. prevailing westerlies
   d. trade winds

6. Winds that blow inland during summer bringing rainy weather and that blow out to sea in winter bringing dry weather are called ____________ .

   a. sea breezes
   b. monsoons
   c. polar easterlies
   d. trade winds

7. An instrument that tells from which direction the wind is coming is a(n) ____________ .

   a. anemometer
   b. land breeze
   c. monsoon
   d. wind vane

8. A wind system formed over large land areas that blows from the west to the east is the ____________ .

   a. polar easterlies
   b. monsoons
   c. trade winds
   d. prevailing westerlies

9. Cool air that moves from sea to land during the day is a ____________ .

   a. sea breeze
   b. land breeze
   c. doldrum
   d. trade wind

10. A system of winds just found north and south of the equator that blows toward the equator from the northeast and southeast is the ____________ .

    a. trade winds
    b. polar easterlies
    c. doldrums
    d. prevailing westerlies

Practice

Circle the letter next to the **storm** *and* **precipitation** *term that correctly completes each statement below.*

1. Tiny droplets of water suspended in the air are ______________ .
   a. clouds
   b. blizzards
   c. hurricanes
   d. cyclones

2. A high-pressure system with winds moving clockwise is a(n) ______________ .
   a. anticyclone
   b. cyclone
   c. tornado
   d. hurricane

3. ______________ clouds are clouds that bring rain—they are also called thunderheads.
   a. Cumulus
   b. Cumulonimbus
   c. Hurricanes
   d. Cyclones

4. Moisture that falls to Earth as rain, hail, sleet, or snow is ______________ .
   a. saturated
   b. thunder
   c. stratus
   d. precipitation

5. A sudden discharge of electricity from clouds is called ______________ .
   a. thunder
   b. precipitation
   c. waterspout
   d. lightning

6. A severe snowstorm with high winds is a ____________ .

   a. tornado
   b. blizzard
   c. cloud
   d. tropical depression

7. Any type of low-pressure system with winds moving in a counterclockwise direction is a ____________ .

   a. hurricane
   b. tropical storm
   c. tropical depression
   d. cyclone

8. Very high, thin, feathery clouds made of ice crystals are ____________ .

   a. cumulus
   b. stratus
   c. cirrus
   d. nimbostratus

9. Puffy, white clouds with flat bottoms are ____________ .

   a. cumulus
   b. stratus
   c. cirrus
   d. nimbostratus

10. A large, powerful low-pressure storm system is a ____________ .

    a. blizzard
    b. cyclone
    c. hurricane
    d. tornado

11. A storm formed when the winds of a tropical depression are between 35 and 74 mph is a ____________ .

    a. tornado
    b. tropical storm
    c. blizzard
    d. cyclone

12. The sound made by lightning is ____________ .

    a. cyclone
    b. tornado
    c. thunder
    d. nimbus

13. A dark, low-lying stratus cloud that contains rain is called ____________ .

    a. nimbostratus
    b. precipitation
    c. nimbus
    d. stratus

14. Smooth, layered clouds found low in the sky are called ____________ .

    a. tornados
    b. nimbus
    c. stratus
    d. cumulus

15. A cloud that causes rain to fall is called ____________ .

    a. precipitation
    b. stratus
    c. cirrus
    d. nimbus

16. A tornado that forms over water is a ____________ .

    a. tropical depression
    b. blizzard
    c. cyclone
    d. waterspout

17. A term used when the air has all the moisture it can hold is ____________ .

    a. stratus
    b. tornado
    c. thunder
    d. saturated

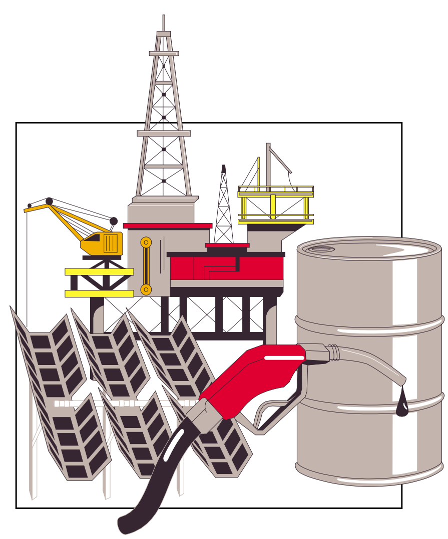
18. A storm formed by a large, low-pressure system over water with winds less than 35 mph is a ____________ .

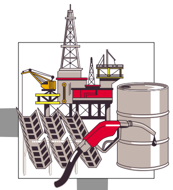
    a. tropical storm
    b. blizzard
    c. tropical depression
    d. tornado

19. A violent, funnel-shaped windstorm is a ____________ .

    a. hurricane
    b. tropical storm
    c. tornado
    d. cyclone

Unit 15: Energy Sources





Vocabulary

Study the vocabulary words and definitions below.

anthracite .... the final stage in the formation of coal; it is very hard and burns cleanly

biomass fuel .... a burnable fuel made from plant and animal material
Examples: wood and peat

bituminous .... the third stage in the formation of coal; it is soft and gives off a lot of heat when burned

coal .... fossil fuel that comes from plants that lived millions of years ago

conserve .... to save natural resources for the future

electricity .... the type of energy produced by using natural resources such as water, wind, and fossil fuels to power a generator

energy .... the ability to do work or move objects

fossil fuel .... fuel made from decayed plants and animals that lived millions of years ago preserved below Earth's crust
Examples: coal, oil, natural gas

geothermal energy .... energy produced by the heat from inside Earth's crust

hydroelectricity .... electricity produced by falling water

lignite .... the second stage in the formation of coal; it is moist and still has bits of woody tissue in it

methane .... natural gas used in stoves and for heating homes

natural gas .... a fossil fuel in its gaseous state found along with oil deposits

natural resources .... materials found on or inside Earth's crust that people can use

nonrenewable .... materials that are used up faster than they can be replaced in nature or can be used only once

nuclear energy .... energy produced by splitting the nucleus of the uranium atom

oil shale .... sedimentary rock with oil trapped between its layers

peat .... the first stage of the formation of coal; formed from decomposed plants

petroleum or **oil** .... liquid fossil fuel formed from plants and animals that lived in the sea

renewable .... materials that can be replaced in nature at a rate close to their rate of use or used over again

solar cells .... a device used to collect energy from the sun and transform it into electricity

solar collectors .... large panels that collect solar energy that will be used to heat water, etc.

solar energy .... energy from the sun

tidal power .... the energy from the two-way flow of the tides used to produce electricity

wind power .... energy of the wind used to create electricity

Introduction

It is a well known fact that nothing lasts forever. Our **energy** resources are no exception. We need energy to power our cars and factories, heat our schools and homes, refine metals, make steel, and to do many of the things that we take for granted. Because the price of **petroleum** or **oil** tends to increase and their supply is limited, we are trying to find other methods for producing energy. **Coal**, gas, oil, wind, water, the sun, the tides, and nuclear reactions are but a few of Earth's energy resources. Some are **renewable** and some are not. If we understand these resources, and whether they are renewable or **nonrenewable**, we can make informed decisions about producing and using energy.

Sources of Energy

Energy is the ability to do work. We get energy from our **natural resources**. Some energy is used directly, such as burning **natural gas** to cook. Many times we change a natural resource into another form of energy, such as **electricity**. Electricity is produced by a generator. A generator uses energy from coal, gas, oil, wind, uranium, steam, tides, or falling water to turn the blades of a large wheel called a *turbine*. The turbine turns the coils in the generator to produce electricity.

Our major sources of energy include the sun, moving water and wind, tides, **fossil fuels**, nuclear reactions, plant and animal materials, and heat inside Earth's crust.

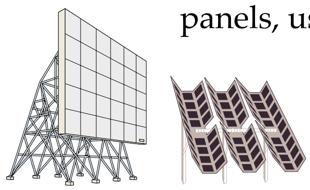
Types of Energy

Coal is one of the fossil fuels.

Some of the energy we use comes from natural resources which can be used over and over again, such as water and wind. Other resources, such as soil and forests, can be replaced within a relatively short period of time. These resources are said to be *renewable*; they can be replaced or used over again. Other resources, such as fossil fuels, are *nonrenewable*. Fossil fuels—oil, gas, and coal—take millions of years to form. They can be used up faster than they can be replaced in nature or used only once. We must **conserve** our use of nonrenewable resources so that they do not run out in the foreseeable future.

Renewable Resources

Solar Energy. Energy from the sun is called **solar energy**. Many homes and buildings are heated by using **solar collectors**. Solar collectors are panels, usually put on the roof of a house, to collect heat to use for hot water, cooking, washing, and heating swimming pools. Solar energy can also be converted to electricity through the use of **solar cells**. Using solar cells is expensive. They are not used very often, except in spacecrafts.



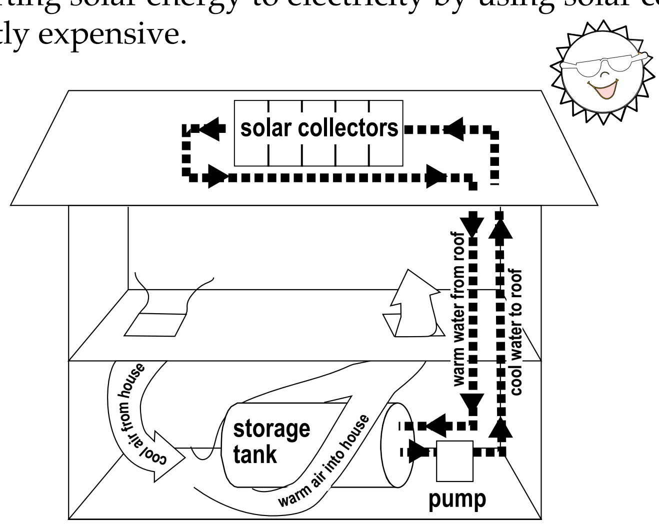
solar panels

The *advantages* of using solar energy include the following:

1. It is a renewable resource because there is a continuous supply of sunshine.
2. Solar energy does not pollute the atmosphere, land, or water.

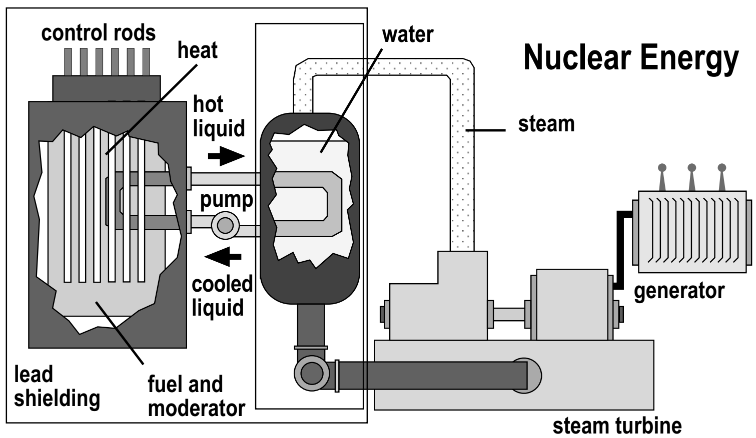
The *disadvantages* of solar energy include the following:

1. It cannot be collected at night.
2. It can only be used in areas that receive a lot of sunshine.
3. It is impractical for large buildings because too many solar panels would be required.
4. Converting solar energy to electricity by using solar cells is currently expensive.

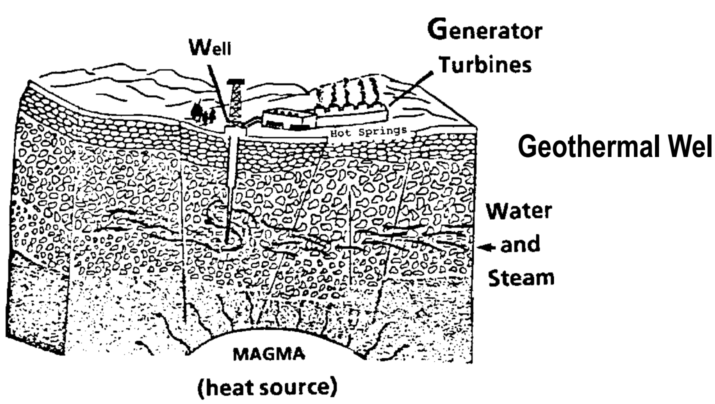


How Solar Energy Can Warm Our Homes

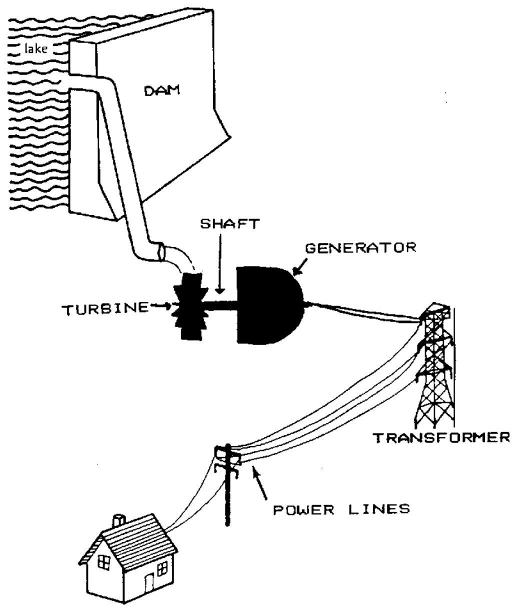
Nuclear Energy. **Nuclear energy** is produced by splitting the nucleus or center of the uranium atom. When the atom splits, a great deal of energy is released as heat. This heat energy is then used to turn water into steam. Then, the steam turns the turbines of generators that produce electricity. A major disadvantage of nuclear energy is that it produces radioactive wastes that can destroy cells and change or destroy genetic material. These wastes may leak from storage facilities. The leaked wastes may contaminate the soil or groundwater. In extreme instances, cores may *melt down*. That is, they may become so hot due to faulty power plant operation that they may melt through the floor and shielding.



Geothermal Energy. **Geothermal energy** uses the heat from inside Earth's crust. Wells are drilled into hot water deposits in Earth. The water then escapes to the surface as steam. The steam is then used to run generators to make electricity. Sometimes the hot water comes to the surface naturally in hot springs and geysers. In Iceland, most homes get their hot water from hot springs and geysers. Geothermal energy is renewable; however, even if all of the geothermal energy available were used, it could only provide a very small amount of the energy we need.



Water Power. Water is one of the major sources of electricity in the United States. Water power produces electricity called **hydroelectricity**. To harness the power of water, a dam is built on a river to control the flow of the water. The flow of the water turns the turbines of generators that produce electricity. Hydroelectric power has many advantages. It is renewable and relatively inexpensive, and does not pollute the atmosphere. One disadvantage is that many times rivers are not located where the power is needed.



Hydroelectric Power

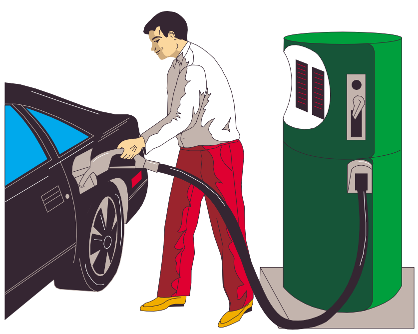
Wind Power. The energy of the wind, or **wind power**, can be turned into electrical energy through the use of windmills. Windmills can be used to pump water or grind grain. Prior to the industrial revolution of the 1800s, windmills were very common, but many have been replaced by electric and fossil fuel-operated motors. The recent energy shortages have brought about an increase in new, modern types of windmills that do not require fuels in order to perform the work desired. Because the wind is not predictable in most areas of the world, it is not a widely used resource. Wind is a renewable resource.

Tidal Power. The energy from the two-way flow of the tides through narrow passages can also be used to generate electricity. **Tidal power** is not a widely used source of energy because there are only a few areas in the world with usable tidal conditions. Tides are a renewable resource. Experimental tidal power plants have been built in Canada, near the Bay of Fundy, where the vertical difference in low and high tides is 13.6 meters (44.6 feet).

Biomass Fuels. **Biomass fuels** are combustible fuels made from plant and animal materials. Some plants can be converted into alcohol and burned for fuel. Wood can also be burned to create heat. Biomass fuels are a renewable resource. Burning garbage is being considered as an alternative to some biomass fuels.

Nonrenewable Resources

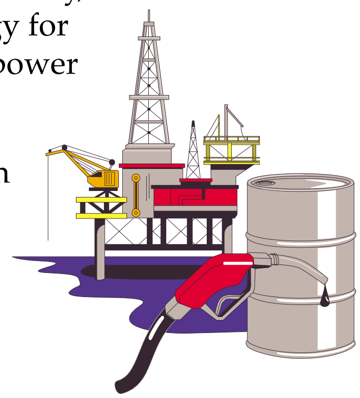
Fossil Fuels. Fossil fuels include coal, oil or petroleum, natural gas, and **oil shale**. Fossil fuels come from plants and animals that died millions of years ago and were preserved in Earth's crust. Over the years, these remains were chemically changed to produce our fossil fuels. Since millions of years are required to form deposits of fossil fuels, they are nonrenewable resources. These fuels are currently our most important source of energy for industry, transportation, and for use in our homes. Since they are nonrenewable, they must be conserved.



The largest deposits of coal and shale are found in North America. Because they are usually buried, it takes considerable effort (strip mining or shaft mining) to extract this fuel. New reserves of oil and gas are being discovered, but many environmental considerations must be weighed before drilling and recovery can begin.

Coal comes from plants that died millions of years ago. These dead plants are covered with more dead plants and turn into **peat**. Heat, pressure, and time eventually turn peat into different coal.

The next stage in coal formation is the production of **lignite** or brown coal. It contains bits of woody tissue but retains some moisture; therefore, it does not burn well. **Bituminous**, or soft coal, is the next stage in coal formation. Bituminous coal gives off a lot of heat when burned and is abundant. The last stage of coal formation is the production of **anthracite**. It is the hardest type of coal and burns the most cleanly, but it is very scarce. Coal is used to provide energy for trains and ships and for generating electricity in power plants and factories.



Petroleum or oil is a liquid fossil fuel formed from plants and animals that lived in shallow coastal waters. Oil is used as a lubricant and to make gasoline, plastics, synthetic fabrics, medicine, building materials, kerosene, wax, and asphalt.

Shale is a sedimentary rock that has oil trapped between its layers. It is plentiful, but it is difficult and expensive to remove the oil from the rock. However, shale oils may be used in the near future.

Natural gas is usually found along with oil. It is the only fossil fuel that can be used as it comes from Earth, without having to be processed first. **Methane** is the most common natural gas. It is used in gas stoves and to heat homes.

Fossil fuels have some *disadvantages*, however. They include the following:

Disadvantages of Fossil Fuels

1. Fossil fuels are nonrenewable (once used up they cannot be replaced).
2. Many fossil fuels contain traces of sulfur, which causes pollution when burned. If spilled or in contact with living organisms, many fossil fuels are extremely toxic and damaging.
3. It is expensive and often difficult to remove the fossil fuels from Earth's surface.

Use of Natural Resources

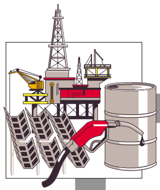
It is crucial that the use of natural resources be carefully planned and monitored. Fossil fuels and mineral supplies are continually decreasing, and the world's population continues to rise. Without safeguards and regulations, uncontrolled burning of wood and coal can pollute the air. Inorganic materials from industries and some pesticides can pollute our waters, and nuclear energy pollutants may become a danger to mankind.

Efforts at conservation include recycling and the use of alternative energy sources. Coal is more plentiful than petroleum, so the United States is using more coal for energy production every year. Minerals, such as aluminum, can be recycled. Some minerals are found in ocean water, and in the future, these may be used more extensively.

Some of Earth's energy resources are renewable; others are nonrenewable. Several nonrenewable energy sources are being rapidly exhausted. The wise use and conservation of natural resources is necessary to ensure that these resources remain available for future generations.

Summary

Our natural resources supply the energy needed to do work or move objects. Types of energy include solar energy, nuclear energy, geothermal energy, water power, wind power, tidal power, biomass fuel, and fossil fuels. Some of the sources of energy are renewable, and others are nonrenewable. Our natural resources must be conserved to safeguard the supply for our future.



Lab Activity: Solar Energy

Purpose

Determine what type of materials should be used to collect and store solar energy.

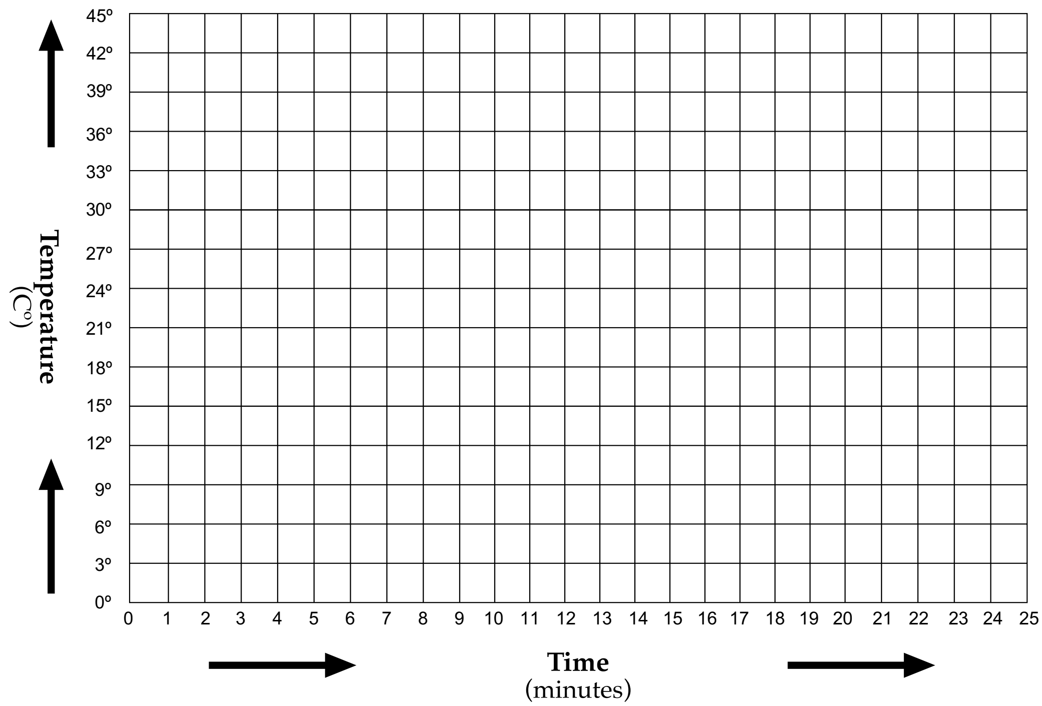
Materials

- 4 empty aluminum beverage cans, pop tops and labels removed
- 4 thermometers
- black paint
- silver or metallic paint
- 2 clear cellophane squares
- 2 rubber bands
- graph paper
- lamp
- red, blue, green, and black markers

1. Paint two of the cans black. Paint two with the metallic paint. Let dry.
2. Fill all 4 cans ⅓ full with water and insert thermometers into cans.
3. Cover 1 black can and 1 aluminum can with clear cellophane and secure with rubber bands.
4. Place all 4 cans equal distance from light source (10 to 20 centimeters from lamp with 100 watt bulb).
5. Use the graph on the next page to record the temperature in C° for each can. Take a measurement every minute for 25 minutes. Turn lamp off after 15 minutes.
6. Use the table below as a key to make a graph of the results.

Can	Color	Cellophane	Markers
A	aluminum	no	red
B	aluminum	yes	blue
C	black	no	green
D	black	yes	black

Temperature Graph



7. Place the cans in order from largest to smallest temperature changes.

8. Which can gained heat the fastest? ______________________________

9. Which can held heat the longest? ______________________________

10. Which can lost heat the fastest? ______________________________

11. Is there a relationship between fast "warmers" and fast "coolers"?

    ____

    If so, what is it? ____

    ____

12. Why do asphalt parking lots and streets become very hot on a sunny day while concrete sidewalks remain relatively cool?

13. How does the color of material affect the material's ability to absorb energy?

14. What materials would you use to make a solar collector?

15. What materials would you use to store solar energy?

Practice

Answer the following using complete sentences.

1. What is energy? ____________________

2. Where do we get most of our energy? ____________________

3. Name eight major sources of energy. ____________________

4. How is electricity produced from other energy sources?

5. List three renewable natural resources from which we can get energy.

6. List three nonrenewable natural resources from which we can get energy.

7. List two advantages of solar energy.

8. List three disadvantages of solar energy.

9. How is nuclear energy released to create electricity?

10. How can geothermal energy be used to produce electricity?

11. What is electricity produced from water called? ____________________

____

12. Name three advantages of water power. ____________________________

____

____

____

13. What is one disadvantage of hydroelectric power? _________________

____

____

14. For what purpose are windmills used? _____________________________

____

____

15. What is the main disadvantage of wind power? ____________________

____

____

____

16. Why is tidal power not a widely used resource? ____________________

____

____

____

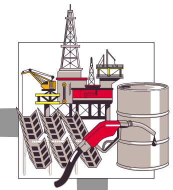
____

17. What is biomass fuel? ______

18. Name two ways biomass fuel can be used as energy sources.

19. What is our most important source of energy? ______

20. Name four types of fossil fuels. ______



Practice

Place an **R** *on the line if the natural resource listed is* **renewable**. *Place an* **N** *on the line if it is* **nonrenewable**.

__________ 1. fossil fuels

__________ 2. forests

__________ 3. gold and silver

__________ 4. cotton

__________ 5. nylon

__________ 6. diamonds, rubies, and emeralds

__________ 7. aluminum

__________ 8. paper

__________ 9. hydroelectricity

__________ 10. farmland used for grazing animals

__________ 11. plastic

__________ 12. minerals from Earth

__________ 13. plants

__________ 14. wind power

__________ 15. iron and steel

Name three **natural resources** *that can be* **recycled**, *or used over and over again.*

16. ____

17. ____

18. ____

Practice

Complete each statement below with the correct answer.

1. Fossil fuels come from ______________________________________

   ____ .

2. Petroleum is formed from ____________________________________

   ____ .

3. Six uses of petroleum are ___________________________________

   ____

   ____

   ____ .

4. Coal comes from ____

   ____

   ____ .

5. The first stage in the development of coal is ____________________

   ____

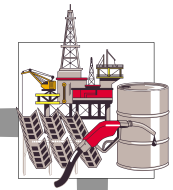
   ____ .

6. The second stage in the production of coal is the formation of

   ________________________________ , which does not burn well.

7. The type of coal that produces a lot of heat and is very abundant is

   called ____ .



8. The hardest type of coal is called ______________________________ .

9. Two uses of coal are ____

____

____

____

____ .

10. Natural gas is usually found ____________________________________

____

____ .

11. The type of natural gas we use in stoves and to heat our homes is

____ .

12. The type of fossil fuel that is the most difficult and expensive to

remove from Earth is ____ .

13. Shale is ____ .

14. Three disadvantages of fossil fuels are __________________________

____

____

____

____

____ .

Practice

Use the list below to write the correct term for each definition on the line provided.

anthracite	**fossil fuel**	**natural resources**
biomass fuel	**hydroelectricity**	**nonrenewable**
bituminous	**lignite**	**petroleum or oil**
conserve	**methane**	**renewable**

________________________ 1. liquid fossil fuel

________________________ 2. electricity produced by falling water

________________________ 3. natural gas used in gas stoves

________________________ 4. the second stage in the formation of coal; it is moist and still has bits of woody tissue in it

________________________ 5. resources found in Earth

________________________ 6. fuel made from decayed plants and animals preserved below Earth's crust

________________________ 7. materials that can be replaced in nature at a rate close to their rate of use or used over again

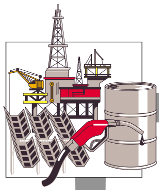
________________________ 8. materials that are used up faster than they can be replaced in nature or can be used only once

________________________ 9. soft coal that gives off a lot of heat when burned

________________________ 10. a burnable fuel made from plant and animal material

____________________________ 11. the final stage in the formation of coal; it is very hard and burns cleanly

____________________________ 12. to protect or preserve natural resources for the future



Practice

Use the list below to write the correct term for each definition on the line provided.

coal	**nuclear energy**	**solar collectors**
electricity	**oil shale**	**solar energy**
energy	**peat**	**tidal power**
geothermal energy	**solar cell**	**wind power**
natural gas		

_______________________ 1. energy produced by splitting the nucleus of the uranium atom

_______________________ 2. energy from the sun

_______________________ 3. energy produced by the heat from inside Earth's crust

_______________________ 4. fossil fuel that comes from plants that lived millions of years ago

_______________________ 5. the ability to do work or move objects

_______________________ 6. the type of energy produced by using natural resources such as water, wind, and fossil fuels to power a generator

_______________________ 7. a fossil fuel in its gaseous state found along with oil deposits

_______________________ 8. sedimentary rock with oil trapped between its layers

_______________________ 9. the first stage of the formation of coal; formed from decomposed plants

_______________________ 10. large panels that collect solar energy that will be used to heat water, etc.

_______________________ 11. a device used to collect energy from the sun and transform it into electricity

_______________________ 12. the energy from the two-way flow of the tides used to produce electricity

_______________________ 13. energy of the wind used to create electricity

Practice

Circle the letter of the correct answer.

1. Materials found on or inside Earth's crust that people can use are called __________ .

   a. renewable resources
   b. nonrenewable resources
   c. fossil fuels
   d. natural resources

2. Fuel made from decayed plants and animals that lived millions of years ago preserved below Earth's crust are __________ .

   a. fossil fuels
   b. nuclear energy
   c. renewable
   d. petroleums

3. __________ materials can be replaced or used again.

   a. Renewable
   b. Petroleum
   c. Methane
   d. Nonrenewable

4. __________ materials can be used up faster than they can be replaced in nature or used only once.

   a. Petroleum
   b. Methane
   c. Renewable
   d. Nonrenewable

5. A liquid fossil fuel formed from plants and animals that lived in shallow coastal waters is called __________ .

   a. methane
   b. hydrocarbon
   c. petroleum
   d. renewable

6. __________ is a fossil fuel in its gaseous state found along with oil deposits.

   a. Peat
   b. Bituminous
   c. Petroleum
   d. Natural gas

7. __________ is a natural gas used in home heating and gas stoves.

   a. Anthracite
   b. Bituminous
   c. Petroleum
   d. Methane

8. __________ is a fossil fuel that comes from plants that lived millions of years ago.

   a. Uranium
   b. Biomass fuel
   c. Coal
   d. Natural gas

9. __________ is the second stage in the formation of coal. It is moist and still has bits of woody tissue in it.

   a. Biomass fuel
   b. Methane
   c. Bituminous
   d. Lignite

10. __________ is soft coal that gives off a lot of heat when burned.

   a. Natural gas
   b. Oil shale
   c. Anthracite
   d. Bituminous

11. __________ is the final stage in the formation of coal. It is very hard and burns cleanly.

   a. Anthracite
   b. Methane
   c. Bituminous
   d. Lignite

12. To ____________ is to preserve natural resources for the future.

a. renew
b. energize
c. conserve
d. anthracite

13. ____________ is energy from the sun.

a. Geothermal energy
b. Nuclear energy
c. Wind power
d. Solar energy

14. ____________ is energy produced by splitting the nucleus of the uranium atom.

a. Geothermal energy
b. Nuclear energy
c. Wind power
d. Solar energy

15. ____________ is energy produced by the heat from inside Earth's crust.

a. Solar energy
b. Nuclear energy
c. Wind power
d. Geothermal energy

16. ____________ is an energy source made from plant and animal material.

a. Anthracite
b. Lignite
c. Coal
d. Biomass fuel

17. ____________ is the type of energy produced from natural resources such as water, wind, and fossil fuels by using a generator.

a. Solar energy
b. Hydroelectricity
c. Electricity
d. Nuclear energy

18. __________ is the ability to do work or move objects.

a. Energy
b. Geothermal energy
c. Solar energy
d. Nuclear energy

19. Electricity produced by falling water is called __________ .

a. geothermal energy
b. nuclear energy
c. hydroelectricity
d. methane

20. __________ is sedimentary rock with oil trapped between its layers.

a. Oil shale
b. Methane
c. Bituminous
d. Lignite

21. __________ is the first stage of the formation of coal and is formed from decomposed plants.

a. Peat
b. Lignite
c. Anthracite
d. Bituminous

22. Devices used to collect energy from the sun and transform it into electricity are __________ .

a. solar collectors
b. oil shale
c. peat
d. solar cells

23. Large panels that collect solar energy that will be used to heat water are __________ .

a. nuclear energy
b. solar collectors
c. tidal power
d. solar cells

24. The energy from the two-way flow of the tides used to produce electricity is ____________ .

    a. solar cells
    b. nuclear energy
    c. wind power
    d. tidal power

25. The energy of the wind used to create electricity is ____________ .

    a. tidal power
    b. wind power
    c. geothermal energy
    d. nuclear energy

Unit 16: Our Environment

Vocabulary

Study the vocabulary words and definitions below.

acid rain .... rain that contains sulfuric acid; forms as a result of the mixture of air pollutants with moisture in the atmosphere

conservation .... measures taken to save natural resources for future use

environment .... all of the things that make up your surroundings

fossil fuels .... fuels made from decayed plants and animals that lived millions of years ago preserved below Earth's crust
Examples: coal, oil, natural gas

hydrocarbons .... unburned particles of fuel that contain hydrogen and carbon; fossil fuels produce hydrocarbons

litter .... waste materials found along roadsides and other public places

nitrates .... pollutants found in fertilizers and detergents made of nitrogen compounds

pesticides .... chemicals used to kill insects

phosphates .... pollutants found in fertilizers and detergents made of phosphorus compounds

pollutants .... substances in the air, water, and land that are harmful to living things

pollution .... a change in the air, water, or land that is harmful or unpleasant to living things

recycling .... processing materials so they can be used again

smog .... a pollutant that contains nitrogen, sulfur, and hydrocarbons; creates a brown haze and unpleasant odor

temperature inversion .... occurs when a layer of cool air gets trapped under a layer of warm air and acts like a lid, keeping pollutants near the ground

thermal pollution .... the unnatural heating of waters

Introduction

Earth science combines several fields of science to study Earth and the space around it. Geologists study the surface and interior of Earth. Oceanographers study the ocean. Meteorologists study the weather, and astronomers study the universe. Land, water, air, and space are very closely related—what happens to one affects all of the others.

We must use what we know about Earth to improve and safeguard our living conditions, such as the exploration of land for building our homes, observation of air and ocean influences to predict floods and storms, and examination of photographs of geological structures from space to explore new sources of valuable metal deposits. We must depend on Earth science to help us find new resources and to help us to learn to protect and use our Earth wisely.

Protecting the Environment

The **environment** is very delicate. Special care must be taken of the environment if it is going to continue to provide an atmosphere that will support life and all of the natural resources people need to live. Some of these resources, such as minerals, ores, and **fossil fuels**, cannot be replaced. They are said to be nonrenewable. Others, such as the forests, soil, air, and water, can be replaced at a rate close to their rate of use and are renewable. People must learn to use resources wisely and conserve or preserve natural resources for future use.

Pollution is a change in the air, water, or land that can be harmful or unpleasant to living things and the environment. Pollution upsets the balance of nature, and if not controlled, causes severe environmental problems. These problems could eventually lead to the extinction of entire populations.

There are several measures society can take to help preserve the balance of nature. One way is to make people aware of the problems of pollution and the need for **conservation**. This can be accomplished through television and newspaper stories, local campaigns to clean up the environment, and education.

Society can help create laws to force large corporations and factories to stop polluting the environment and to stop overusing the natural resources. Laws are also important to keep individuals from burning trash, improperly dumping garbage, and littering. Regulations, such as those requiring licenses to hunt and fish, and placing limits on the numbers of animals killed, are also important.

Conducting scientific research to help keep nature in balance is another measure of preservation. Some of the projects scientists are working on to accomplish this include the following:

- finding new sources for food
- trying to learn how to control the weather so unusable land can be made usable
- looking for ways to get usable minerals and natural resources from the ocean
- trying to find easier and less expensive ways to get fresh water from ocean water
- trying to find less expensive and easier ways to get the oil out of shale
- looking for new sources of energy
- looking for new ways to stop and clean up the harmful effects of pollution
- exploring space to possibly find new resources, answers to problems on Earth, and perhaps a new place for people to live.

Air Pollution

Unwanted, harmful substances in the air are **pollutants**. Air can become polluted. The amount of air pollution varies depending on the conditions in a particular location. Air pollutants especially harmful to human health are **hydrocarbons**, sulfur oxides, particulates, carbon monoxide, and nitrogen oxides. What are these pollutants, and where do they come from?

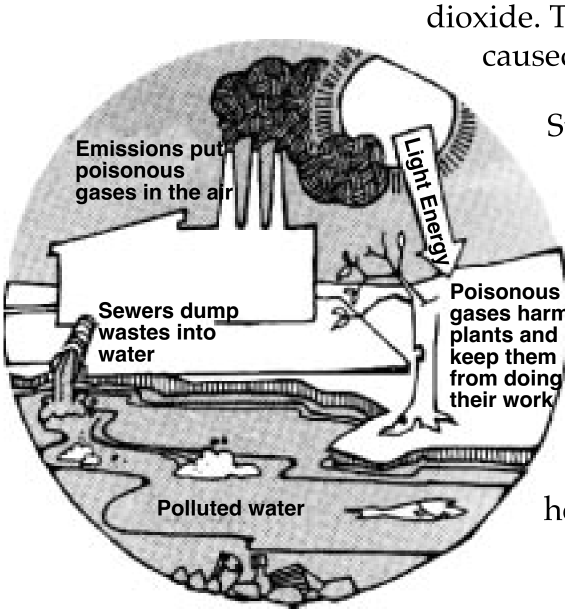
Hydrocarbons. Hydrocarbons are compounds of hydrogen and carbon. Hydrocarbons come from spilled or unburned particles of gasoline. Automobiles that do not have proper fuel settings or pollution control devices may produce hydrocarbons.

Carbon monoxide. Carbon monoxide is another dangerous gas produced by the incomplete burning of fuels. It is colorless and odorless. Its fumes can cause people to become very ill or die. The exhaust from automobiles, gas heaters, and charcoal grills produces carbon monoxide. Therefore, it is important not to operate a car or grill indoors because carbon monoxide poisoning could result.

Sulfur oxides. Fossil fuels, coal and oil, contain small amounts of sulfur. When the fuels are burned, the sulfur is released and combines with oxygen in the air to form sulfur oxides. Sulfur oxides irritate the eyes, nose, throat, and lungs. If sulfur oxides combine with moisture in the atmosphere, a powerful acid called "sulfuric acid" forms. This acid then falls to Earth in rain or snow. This sulfuric acid damages plant leaves, stains the paint on buildings, and causes lung damage.

When sulfuric acid combines with rain, **acid rain** is formed. Acid rain kills fish, damages crops, and pollutes our water supplies. In Florida, the natural limestone rock helps neutralize the sulfuric acid in groundwater so acid rain is not a serious problem. The northern United States is not as fortunate; there, rock is granite and does not buffer the sulfuric acid as limestone does.

Nitrogen oxides. At very high temperatures, nitrogen and oxygen gases in the atmosphere react with each other and form nitric oxide. This gas forms in car engines and comes out of exhaust pipes. Nitric oxide then reacts with oxygen in the air and forms another compound, nitrogen dioxide. The brown haze over many cities is caused by nitrogen dioxide.



Sunlight causes a chemical reaction between nitrogen oxide, sulfur oxide, and hydrocarbon gases. This reaction produces a fog-like pollutant called **smog**. Smog got its name from the words smoke and fog. Most smog seems to come from the burning of fossil fuels. Smog usually occurs in areas with a lot of industry or heavy traffic. Smog creates an unpleasant odor, a brown haze in the air, and causes the burning of eyes and inflammation of the lungs.

The condition of the air is dependent on other factors besides pollutants. The amount of pollution in an area also depends on geographical features in the area. Very windy areas seldom have much pollution because the wind carries the pollutants away. On the other hand, areas in valleys or with mountains on one side are more likely to have pollution problems because the pollution cannot escape. Weather conditions also have an effect on pollution. Moisture dissolves some pollutants in the air; however, as that moisture becomes a form of *precipitation*, it can pollute the land and waters instead.

Sometimes air pollution is made worse when a layer of cool air gets trapped under a layer of warm air. The warm air acts like a lid and keeps the pollutants near the ground. This effect is called a **temperature inversion** and can create dangerously high levels of pollution. When this occurs, people have to be warned to stay indoors until the weather clears.

Particulates. Particulates are tiny particles of dust, soot, ash, and oil. Burning diesel fuels, coal, oil, and wood gives off particulates. People may experience chest pains or coughing as a result. Particulates can cause lung diseases such as bronchitis, asthma, emphysema, and cancer.

Controlling Air Pollution

Efforts have been made to control air pollution. Laws were passed requiring that unleaded gas be used in new cars in an effort to stop one type of air pollution. Some other important solutions to the problem include the following:

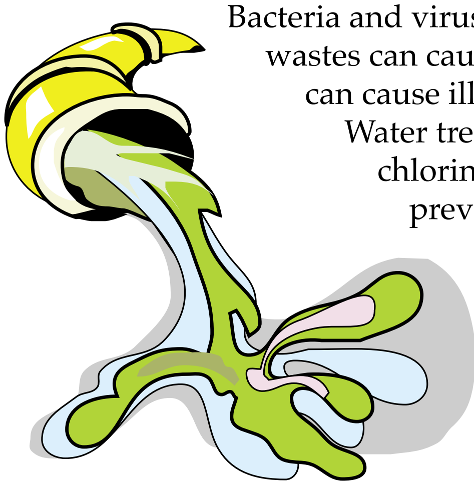
- Laws have been passed, such as the 1970 Clean Air Act, that require industry not exceed safe levels of pollutants. This law is scheduled to be reviewed every five years.
- Warning systems have been installed in areas with high pollution rates.
- More greenery has been planted in cities to reduce the amount of carbon dioxide and increase the amount of oxygen.

- Pollution control devices have been installed on cars.
- Laws have been passed to prohibit the burning of garbage and leaves in residential and other restricted areas.

Every individual can do his or her part to help reduce air pollution. Actions such as car pooling, using public transportation, and making sure our cars are in proper working order can help solve the problem of air pollution.

Water Pollution

Water is one of our most important natural resources. We use fresh water to drink, grow food, produce energy, and manufacture products for transportation and recreation. Both the water on the surface of Earth and the groundwater beneath Earth's surface need to be kept free from pollution. As with air, there are many ways that water can be polluted.



Bacteria and viruses from untreated sewage and animal wastes can cause pollution of the water supplies. This can cause illness and diseases such as typhoid. Water treatment plants and the addition of chlorine to the water are common methods of preventing this type of pollution.

Water can also be polluted by chemicals from industrial plants, sewage systems, mines, and households. **Phosphates** and **nitrates** found in fertilizers, detergents, and cleaning supplies cause algae and pond weeds in lakes to multiply very rapidly, using up all of the available nutrients. When large numbers of these plants die, bacteria that decompose them exhaust the oxygen supply. Many other organisms, such as fish, will then die because of a lack of oxygen. **Pesticides** and other poisonous chemicals pollute waters, killing plant life and fish.

The unnatural heating of waters is called **thermal pollution**. Electric power plants that use both fossil fuels and nuclear fuels produce a lot of heat. Power plants use water to condense steam. When the water is returned to the lakes and rivers, it is warmer than before. This upsets the balance of nature. Some organisms cannot live at these higher temperatures. Thermal pollution also disrupts the breeding cycles of some fish. Some people argue that thermal pollution can be beneficial in winter—providing refuge from the cold for manatees, for instance. Manatees congregate in the winter near power plants, such as St. Marks and Crystal River, to take advantage of the warmer waters.

Too much sediment buildup in waterways can create pollution problems. Sand and soil settle to the bottom of rivers and lakes, gradually filling them. These sediments cover up the food supply of fish, causing them to die. Sediment buildup also smothers nonmoving organisms such as oysters and clams and clogs animals' gills, suffocating them. Dredging may then be necessary to open the waterway. Disturbing the bottom by dredging causes other problems such as destroying the nutrients in the sediments and altering the water flow.

Another pollution concern for all bodies of water is the oil spill. Major spills result from tanker collisions in the oceans. These oil spills from tankers spoil our beaches, pollute our ocean water, and cause birds and fish to die. Many cleaning methods are used to remove the oil.

Some of these methods create other types of pollution, however. Burning the oil releases hydrocarbons into the atmosphere. Adding chemicals to breakdown oil introduces other substances into an already stressed environment. Scraping up or collecting oily debris contributes to the problem of waste disposal and scarce landfills. The benefits of cleaning methods must be considered along with their risks and disadvantages.

Cleaning Up an Oil-Tainted Shore

Rocky beaches

1. Heaviest concentrations of oil are removed with pumps, vacuum trucks, and skimmer boats (in shallows near the shore).

2. Workers using buckets, scoops, and absorbents, which attract oil but not water, remove as much crude as possible.

3. High-pressure hoses wash oil back into the water where the oil is trapped by oil booms and vacuumed into trucks.

4. Chemical dispersants are applied where wave action can quickly disperse crude oil.

Sandy beaches

1. Workers collect oil with scoops, shovels, rakes, etc.

2. Heavy equipment is used to push oily sand into wave zones for natural cleansing action.

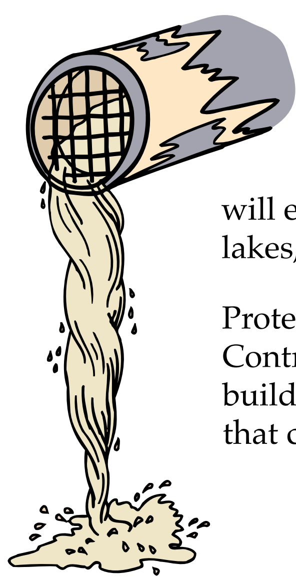
3. Tractors with raking equipment are used to separate tar balls and clumps of oily sand from the beach.

Muddy shoreline

1. Mud flats and beaches are very sensitive environments, easily damaged by people and equipment.

2. Low-pressure washing with hoses may be used to push oil into open water for skimming.

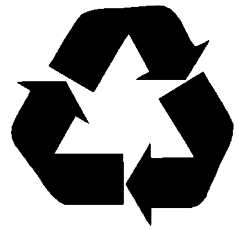
3. Oil-fouled plants are cut and removed if animal life is endangered.



One of the main forms of pollution of groundwater comes from the dumping of chemical wastes—especially radioactive wastes. When it rains, some of the dangerous chemicals seep down into the water table. These chemicals will eventually be pumped up into wells or enter streams, lakes, or oceans as part of the groundwater.

Protective measures must be taken to keep water pure. Controlling chemical use by farmers and industry and building waste treatment plants are examples of things that can be done to help reduce water pollution.

Land Resources



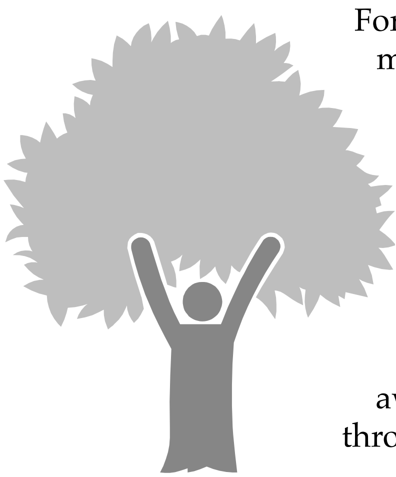
recycle

Natural resources found on land must also be conserved and protected from pollution. One of the most noticeable forms of pollution on land is **litter**. To help control litter, laws can be passed to place fines on littering. **Recycling**, which refers to processing materials so they can be used again, can also help to solve the litter problem. Glass bottles, aluminum cans, plastic, and paper are common forms of litter and can all be recycled.

Wastes in landfills, dumps, and septic tanks can cause pollution, if not disposed of properly. The creation of waste management companies and urban sewage treatment plants has helped to eliminate some pollution from these sources.

Chemicals from industry, buried radioactive wastes, and pesticides pollute the land when they enter the soil. Plants grown in this soil may contain these dangerous chemicals. These chemicals are then passed on to people and animals who eat the plants.

Land resources must not only be protected from pollution, they must also be conserved so that there are enough resources for future generations. Crops must be rotated and fertilizers added to keep farm land productive. Some land that is unsuitable for farming because it is too hilly can be terraced or contoured. Land too dry to grow crops can be irrigated in order to become productive. Land used for grazing must be carefully controlled to allow the vegetation to grow back before it is used again.



Forests are another valuable land resource. Trees must be replanted to replace the ones cut down. Since trees prevent erosion, foresters must be careful not to cut down too many trees in a particular place at any given time.

Practicing conservation and controlling pollution of natural resources will allow people to enjoy the gifts of nature for many years to come. It is important that we become aware of the destructive nature of items that we throw away every day. Some of these items require special disposal methods. Many communities have established hazardous-waste collection sites or other alternatives. Below is a chart of the toxic trash that should be separated from other trash.

Toxic Trash List

- **ammonia**
- **automotive fluids and body filler** for repairing auto body dents and holes
- **batteries** that are disposable or rechargeable (NiCad) batteries
- **caustic cleaners** such as oven cleaners and lye
- **cosmetics** such as fingernail polish and removers
- **electrical devices** with mercury switches
- **florescent light bulbs and their ballasts**
- **fuel** such as charcoal lighter
- **glue, rubber cement, and thinners**
- **herbicides** and their containers (don't rinse)
- **insect sprays, powders, strips, repellants, and their containers** (don't rinse)
- **liquid correction paper and thinner**
- **mothballs**
- **motor-oil cans** (don't rinse)
- **paint, polishers, dyes, and paint thinners** (give away what you don't use; latex paint can be dried out and disposed of in trash)
- **photographic chemicals**
- **pool chemicals**
- **solvents and spot removers**
- **spray cans**
- **wood preservatives** such as sanding sealer and water sealer
- **and anything labeled "dispose of carefully"**

Careers in Earth Science

There are a great number of career opportunities related to the field of Earth science. Some careers require a college degree, but others require vocational and on-the-job training instead. Listed below are brief descriptions of careers in Earth science and the amount of education needed.

Careers in Earth Science

Career	Description	Education
seismologist	scientist who studies earthquakes	college degree
geology technician	person who assists a geologist by recording data, assisting in the lab running equipment, and making maps	two-year degree
paleontologist	scientist who traces the development of Earth by studying fossils	geology degree plus a masters or doctorate in paleontology
air pollution inspector	Inspects factories, tests samples for pollution, and suggest ways to clean-up pollution	college degree
soil scientist	tests soil, determines what would best grow in it, and suggests ways to make it more productive	college degree
waste water plant operator	tests samples, records data, and runs tests on plant samples	trade school or community college
weather observer	records weather information and sends information to weather stations	1 or 2 years of trade school or community college
surveyor assistant	assists in taking measurements, land clearing, and collecting map data	high school plus on-the-job training
cartographer	draws maps	two years of technical training
coal inspector	inspects and reports on the quality of coal	high school plus on-the-job training

Summary

Protecting our environment and natural resources is extremely important for the future of Earth. Controlling pollution of air, land, and water is one part of the effort. Each of us has a responsibility as a caretaker of the environment. Many different kinds of scientists are working on solutions to today's problems.

Practice

Follow the steps below to conduct an **environmental survey** *of your neighborhood.*

Environmental Influences

Human beings are agents of change, and the rate at which they are changing the environment increases rapidly as their population increases. Only recently have people become aware of their impact on the atmosphere, water, and the crust of Earth.

1. Look over the survey on the next page. General categories for the ways people change the environment are listed on the left side of the page. Across the top are the various areas of the environment that may be affected by the processes and materials which people use.

2. Walk or ride through your neighborhood—at least a 10-block square—taking the survey with you.

3. Place a check in the last column to the right after each type of environmental influence found in your neighborhood. For example, if new houses are being built, put a check (√) after houses.

4. Find the area being influenced in the column headings at the top of the chart. Put an (**L**) in the left half of the box if the influence is large, or (**S**) in the left half of the box if the influence is small. In the right half of the box, put a (**+**) if the effect is good; put a (**-**) if the effect is bad.

KEY
(√) Influence found
(L) Large influence
(S) Small influence
(+) Good influence
(-) Bad influence

Ex.—Large, negative influence L –

Environmental Aspects

Environmental Influences	health	scenery	recreation	temperature	air	water	other	influence
Construction:								
houses								
roads								
shore structures								
commercial								
Traffic:								
streets								
highways								
Chemicals:								
fertilization								
weed control								
insect control								
Waste Disposal:								
litter								
dumps								
sewage								
Other:								

Practice

Answer the following using complete sentences.

1. List three ways in which road construction using concrete pavement changes the environment.

   ____
   ____
   ____

2. What other ways could people travel which would have fewer adverse effects on the environment?

   ____
   ____
   ____
   ____

3. How does an automobile affect the atmosphere? ____________

   ____
   ____
   ____
   ____

4. If there is smog in your community, what is its source? ________

   ____
   ____
   ____

5. What resources are used in local construction?

____

____

6. What resources are lost to humans when cities move into the surrounding countryside?

____

____

____

7. Describe some solutions to the problems above.

____

____

____

____

____

____

____

Write **True** *if the statement is correct. Write* **False** *if the statement is* not *correct.*

__________ 8. Human influence can be recognized on your local environment.

__________ 9. The chart on page 527 does not permit the estimation of a negative impact on an environment.

__________ 10. The public can suggest ways to improve and protect the environment.

Practice

Answer the following using complete sentences.

1. Name three ways society can help preserve the balance of nature.

   ____

   ____

   ____

2. Name five ways scientists are trying to maintain the balance of nature.

   ____

   ____

   ____

   ____

3. Name three ways laws can help stop the pollution and depletion of natural resources.

   ____

   ____

   ____

4. Name three ways people can be made aware of the problems of pollution and the necessity of conservation.

   ____

   ____

   ____

Lab Activity: Water Pollution

Purpose	Materials	
Create and clean up an oil spill.	• aluminum pie plate • new or used motor oil • pieces of nylon net • pieces of nylon stocking • pieces of cardboard • pieces of string • pieces of straw	• salad oil • plastic bowl • cotton balls • spoon • detergent • eyedropper

Thirty miles from the shore of Santa Barbara, an oil production platform pulled up a worn-out drill. Oil and gas began escaping into the water. Blow out! Before the leak could be stopped, 700,000 gallons of oil were released. What can be done to clean up the spill?

1. Obtain an aluminum pie plate or similar container. Pour about one inch of water in the plate.

2. Use an eyedropper to place 15 to 20 drops of salad oil on the surface of the water.

3. The problem you face is the same as that faced by the people of Santa Barbara. How can you clean up the oil with the tools at hand? Select any of the materials available and use them to clean up the oil slick. Use a watch with a second hand to determine the amount of time it takes you to clean up the spill. Use the Data Chart on the next page to record your results.

4. Repeat the simulation by adding salad oil to new water. Try at least three different techniques and materials and record the results.

5. Up to this point you have been using a light oil. Now perform the same procedures using a heavier oil—in this case, motor oil. Record your results in the Data Chart on the next page.

6. You have been very lucky. The weather during your oil recovery operations has been fair and calm. Many oil spills occur in stormy weather. To simulate rough weather, carefully make waves in your model ocean. You can make waves by *gently* blowing over the surface or moving a card through the water. Get new water and repeat two of the techniques with heavy oil and rough water. Record your data in the Data Chart below.

7. Select the method you feel works best and modify it as follows. After you have added 15 to 20 drops of heavy oil, add 5 to 10 drops of detergent. Stir the water to mix the oil and detergent. Then proceed to remove the oil and soap mixture with the technique you selected. Record your results in the Data Chart below.

8. Clean up your lab station. Place the used oil in the container provided by your teacher. Wash the equipment with detergent and store.

Data Chart

	Material	Time taken to clean spill	Estimate percent of oil cleaned up	Comments: (e.g., messy, left with oily straw)
Light Oil				
Heavy Oil				
Heavy oil and rough water				
Heavy oil plus detergent				

9. Which method most rapidly cleaned up the oil spill?

____

10. Which method was most effective with light oil? ________________

____

Was the same method most effective with heavy oil? ____________

If not, which method was most effective with the heavy oil?

____

11. The first activities following an oil spill involve attempts to contain the spill. Containment keeps the spill from spreading. Which of the materials provided helped to contain an oil spill?

____

____

Ocean spills are often contained by placing booms. A boom is a barrier or fence of some type. Floating logs, foam, and rubber tubes have been tried. Under what weather conditions would booms work best?

____

____

12. Most of the oil removal techniques which use the materials provided remove the oil by *absorption*. The oil is absorbed by other substances like straw, sawdust, etc. The oil-soaked material is then removed from the water. Which of the techniques removed oil by absorption?

____

____

Some people say that these techniques simply move the oil spill from the water to the land. What do you suppose they mean?

____

____

13. What effect did the detergent have on your oil spill? __________

____

____

____

Did the detergent make your cleanup technique more effective or less effective? Please explain.

____

____

____

14. Fire is another technique often used to remove oil spills. The oil spill is ignited and allowed to burn. Where does the oil from the water go when it is burned?

____

____

15. What factors affect the cleaning up of oil spills in the ocean?

____

____

____

____

16. Once the oil reaches the beach, other problems occur. What is one technique you might use to remove oil from beach sands?

____

____

____

Which animals are likely to be most affected by oil on the beach?

____

____

17. Who should be responsible for cleaning up the spills? ___________

____

____

18. Some bacteria will use oil as their only food source. Ocean scientists would like to be able to plant these bacteria in oil spills. For these bacteria to be successful in cleaning up spills, the bacteria have to pass several tests. Some of the tests are listed below.

Rank these **tests** *in* **order of importance** *from 1 to 5. In the blank next to the test, write in the order number. The most important test to consider would be number 1, etc.*

______ The cost of the bacteria.

______ The bacteria will eat the oil quickly.

______ The bacteria will eat the oil thoroughly.

______ The bacteria will produce no harmful by-products.

______ The bacteria will disappear when their job is done.

Practice

Use the list below to complete the following statements. One or more terms will be used more than once.

acid rain	**fog**	**pollutants**
automobile exhaust	**fossil fuels**	**smoke**
automobiles	**hydrocarbons**	**sulfuric acid**
carbon monoxide	**industry**	**sulfur oxides**
charcoal grills	**nitrogen oxides**	**temperature inversion**

1. ________________________ are substances in the air, land, and water that are harmful to living things.

2. Four types of air pollution are ________________________ , ________________________ , ________________________ , and ________________________ .

3. Unburned particles of fuel that contain hydrogen and carbon are called ________________________ .

4. Most hydrocarbons come from ________________________ that are not properly maintained.

5. The sulfur found in ________________________ is a major cause of pollution.

6. Sulfur combines with oxygen and moisture in the atmosphere to form ________________________ .

7. Sulfuric acid in the atmosphere combines with rain to form ________________________ .

8. Smog is a chemical reaction between ________________________ , ________________________ , and ________________________ .

9. The word smog came from combining the words ________________________ and ________________________ .

10. ________________________ is a dangerous gas produced by the incomplete burning of fuels.

11. ________________________ and ________________________ are two sources of carbon monoxide.

12. A ________________________ is a layer of cool air trapped under a layer of warm air that keeps pollutants near the ground.

13. The 1970 Clean Air Act has helped reduce the levels of pollutants produced by ________________________ .

Practice

Answer the following using complete sentences.

1. What are four uses for fresh water? ______________________________

____

____

____

2. Where do bacteria and viruses that pollute water come from?

____

____

3. How can bacteria and viruses be prevented from polluting our water supplies?

____

____

4. What effect do phosphates and nitrates have on our water supplies?

____

____

____

____

5. How is thermal pollution caused? ______________________________

____

____

6. How does thermal pollution affect the fish and other organisms?

____

____

____

7. How can sediment buildup cause pollution? ____________________

____

____

8. How do oil spills cause pollution? ______________________________

____

____

9. How can dumping chemical wastes pollute groundwater?

____

____

____

10. Name four ways that we can help prevent water pollution.

____

____

____

____

____

Practice

Answer the following using complete sentences.

1. What is one of the most noticeable forms of pollution of the land?

____

____

2. Name two ways littering can be controlled. ____________________

____

____

____

____

3. What is recycling? ___________________________________

____

____

4. Name at least three kinds of items that can be recycled. __________

____

____

5. How do chemicals from industry and radioactive wastes pollute the land?

____

____

____

6. What else must be done for land resources besides protecting them from pollution?

____

____

7. Name four ways land can be made more productive. __________

____

____

____

____

____

____

____

8. How can forest land be protected? _______________

____

____

____

____

____

____

____

____

Practice

Use your school library or the career information in your guidance center to find the following information about **three careers** *in* **Earth science** *that interest you.*

1. Give a detailed description of exactly what the worker does. Use a separate sheet of paper, if needed.

2. Does the career require you to live in a specific part of the country or world? (Example: An oceanographer must live near the ocean.)

3. How much does the job pay per year?

4. Is the job primarily in government, private industry, or a college or university?

5. What type of education or special training is necessary?

6. What special skills are necessary? (Example: the ability to draw for a career in map making).

Practice

Use the list below to write the correct term for each definition on the line provided.

acid precipitation	**litter**	**pollution**
conservation	**nitrates**	**recycling**
environment	**pesticides**	**smog**
fossil fuels	**phosphates**	**temperature inversion**
hydrocarbons	**pollutants**	**thermal pollution**

______________________ 1. measures taken to save natural resources for future use

______________________ 2. processing materials so they can be used again

______________________ 3. a pollutant that contains sulfur, nitrogen, and hydrocarbons; creates a brown haze and unpleasant odor

______________________ 4. rain or snow that contains sulfuric acid

______________________ 5. all of the things that make up your surroundings

______________________ 6. a change in the air, water, or land that is harmful or unpleasant to living things

______________________ 7. substances in the air, water, and land that are harmful to living things

______________________ 8. fuels made from decayed plants and animals that lived millions of years ago

______________________ 9. chemicals used to kill insects

______________________ 10. pollutants found in fertilizers and detergents made of phosphorus compounds

_________________________ 11. unburned particles of fuel that contain hydrogen and carbon

_________________________ 12. waste materials found along roadsides and other public places

_________________________ 13. the unnatural heating of waters

_________________________ 14. occurs when a layer of cool air gets trapped under a layer of warm air that acts like a lid, keeping pollutants near the ground

_________________________ 15. pollutants found in fertilizers and detergents made of nitrogen compounds

Practice

Circle the letter of the correct answer.

1. ____________ is a pollutant that contains nitrogen, sulfur, and hydrocarbons. It creates a brown haze and unpleasant odor.

   a. Smog
   b. Phosphate
   c. Pesticide
   d. Hydrocarbon

2. ____________ is a change in the air, water, or land that is harmful or unpleasant to living things.

   a. Acid rain
   b. Smog
   c. Pollution
   d. Littering

3. ____________ are chemicals used to kill insects.

   a. Hydrocarbons
   b. Phosphates
   c. Nitrates
   d. Pesticides

4. ____________ are pollutants found in fertilizers and detergents made of nitrogen compounds.

   a. Fossil fuels
   b. Hydrocarbons
   c. Nitrates
   d. Phosphates

5. ____________ are unburned particles of fuel that contain hydrogen and carbon.

   a. Fossil fuels
   b. Pesticides
   c. Hydrocarbons
   d. Nitrates

6. Taking measures to save natural resources for future use is called ____________ .

    a. recycling
    b. conservation
    c. temperature inversion
    d. thermal pollution

7. Rain that contains sulfuric acid is ____________ .

    a. smog
    b. acid rain
    c. thermal pollution
    d. litter

8. Your ____________ is all of the things that make up your surroundings.

    a. litter
    b. smog
    c. environment
    d. conservation

9. Fuels made from plants and animals that lived millions of years ago are ____________ .

    a. smog
    b. pesticides
    c. hydrocarbons
    d. fossil fuels

10. Waste materials dropped along roadsides and other public places are ____________ .

    a. pesticides
    b. litter
    c. nitrates
    d. phosphates

11. ____________ are pollutants found in fertilizers and detergents made of phosphorus compounds.

    a. Nitrates
    b. Fossil fuels
    c. Hydrocarbons
    d. Phosphates

12. ____________ are substances in the air, water, and land that are harmful to living things.

    a. Acid rain
    b. Fossil fuels
    c. Nitrates
    d. Pollutants

13. Processing used materials so they can be used again is called ____________ .

    a. recycling
    b. conservation
    c. littering
    d. temperature inversion

14. The unnatural heating of waters is ____________ .

    a. pollution
    b. recycling
    c. smog
    d. thermal pollution

15. ____________ occurs when a layer of cool air gets trapped under a layer of warm air that acts like a lid, keeping pollutants near the ground.

    a. Acid rain
    b. Littering
    c. Recycling
    d. Temperature inversion

Appendices

Index

M

N

O

P

R

S

T

U

V

W

Y

References

Alexander, Peter, et al. *Earth Science*. Morristown, NJ: Silver, Burdette, and Ginn, 1987.

Barnes-Svarsey, Patricia, ed. *The New York Public Library Science Desk Reference*. New York: Stonesong Press Incorporated and the New York Public Library, 1995.

Bledsoe, Lucy Jane. *General Science*. Paramus, NY: Globe Fearon Educational Publisher, 1994.

DiSpezio, Michael, et al. *Science Insights: Exploring Earth and Space*. New York: Addison-Wesley, 1996.

Florida Department of Education. *Florida Course Descriptions*. Tallahassee, FL: State of Florida, 1998.

Florida Department of Education. *Florida Curriculum Framework: Science*. Tallahassee, FL: State of Florida, 1996.

Fonk, Robert H. and Linda B. Knight. *Earth Science*. New York: Holt, Rinehart, and Winston, 1994.

Hesser, Date T. and Susan S. Leach. *Focus on Earth Science*. Columbus, OH: Merrill, 1989.

Namowitz, Samuel N. and Nancy E. Spaulding. *Earth Science*. Lexington, MA: D. C. Heath, 1994.

Otto, James H. and Albert Towle. *Modern Biology*. New York: Holt, Rinehart, and Winston, 1985.

Pasachoff, Jay M., Naomi and Timothy M. Cooney. *Earth Science*. Glenview, IL: Scott Foresman, 1986.

Ramsey, William L., et al. *Modern Earth Science*. New York: Holt, Rinehart, and Winston, 1998.

Stevenson, L. Harold and Bruce Wyman, eds. *The Facts on File Dictionary of Environmental Science*. New York: Facts on File, 1991.

Tarbuck, Edward J. and Frederick K. Litgens. *Earth Scienc*e. Columbus, OH: Merrill, 1985.

White, Jo Ann, ed. *The New American Desk Encyclopedia*. New York: Penguin Putnam, 1997.

Production Software

Adobe PageMaker 6.5. Mountain View, CA: Adobe Systems.

Adobe Photoshop 3.0. Mountain View, CA: Adobe Systems.

Macromedia Freehand 8.0. San Francisco: Macromedia.

Microsoft Word 5.0. Redmond, WA: Microsoft.