This course of study outlines the sequence of learning activities to help you develop competence in the subject area of Earth and Space Science. Your competence will be assessed as you complete the objective exam (SEC4 or SEC5) and a series of tasks for the performance exam (SEA4 or SEA5). This course of study may take up to sixteen weeks to complete depending on your educational background, your experience with the subject matter, and the time you are able to dedicate to your studies. Consult with your mentor if you wish to accelerate your progress through this course of study.

Introduction

Welcome to the exciting topic of Earth and Space Science! This topic involves the study of astronomy, geology, meteorology, and oceanography. As a science teacher, you will want to convey the exciting careers related to Earth science to your students and help them connect the concepts to their own lives.

Geology is the study of this amazing planet Earth. Although the Earth itself is not alive, there is moving magma beneath its surface, which sporadically makes its way to the surface. Due to the constraints of pressure and heat, rocks actually change from one form to another. Studying the soil and rocks in an area can provide clues to past events as well as information on the current condition of the land. Sedimentary rock, which can preserve fossil evidence, can be used to help scientists better understand the Earth's past.

Oceanography is the study of the properties of oceans. Currents, waves, and upwelling all have an effect on marine organisms, as well as organisms on land. The movement of the oceans also impacts the climate of the Earth, which in turn affects living organisms. Water density is affected by temperature and salinity. Denser water sinks, displacing other water masses. As an iceberg is created, the nearby water becomes more saline and dense.

Meteorology is the study of atmospheric conditions around the globe, and it is strongly influenced by oceanic conditions. Even though air is not particularly tangible, air masses can act independently from each other. A front represents air masses meeting, which cause changing weather patterns. Weather maps contain symbols to represent different conditions. Since weather is often discussed on a daily basis, having some knowledge in meteorology can help a person interpret weather information.

Astronomy is the study of the space beyond Earth. Scientists use various tools to analyze objects that are very far away. Galileo was able to make many conclusions based on observations he made with a simple telescope. Finding a model that fits the data is always the goal of science. As more is learned about other planets, the unique conditions for life on Earth are better appreciated.

The Earth and Space Science course of study covers a vast amount of material. The four main topics include geology, oceanography, meteorology, and astronomy. The topics are grouped into larger subjects with set activities to complete. Be sure to check your understanding after completing each subject. This practice will help you build on your knowledge. Your mind needs time to process the
material, so the best practice is to complete a few activities each day, with an occasional day off from studying for time to process the information. Model the behaviors you would want your students to practice when learning new material.

Typically, people who choose to teach science as a career have a natural curiosity about the world around them. You already have a base knowledge from your previous schooling, reading, watching television, and interacting with the world. While working through this document, connect your new knowledge with your current base. Sometimes new knowledge contradicts your current understanding. You will need to pay close attention during these times so that you can properly reframe your understanding. Your goal is to become the best teacher you can be. By improving your background in the Earth sciences, you can share the relationships among the science disciplines with your students.

Competencies

This course of study covers the following competencies:

Competency: AstronomyThe graduate has a broad understanding of the basic concepts of astronomy.

Competency: GeologyThe graduate has a broad understanding of the principles of geology.

Competency: MeteorologyThe graduate has a broad understanding of the concepts of meteorology.

Competency: OceanographyThe graduate has a broad understanding of the basic concepts of oceanography.

Required Learning Resources

CourseCompass: Earth Science includes the following e-text:


Textbook:


Other Resources:
GEODe DVD from Pearson

Starry Night DVD from Tangent Scientific

Science Methods LabPaq from Hands-On Labs

Optional:


WGU Statement of Teaching Dispositions

WGU supports the development and demonstration of professional teaching dispositions throughout the course of its Teachers College (TC) licensure programs. All TC students and faculty will demonstrate the following dispositions described in the Teachers College’s conceptual framework and code of ethics:

Competent and caring

Respectful and embracing of diversity

Reflective practitioners

Equitable and fair

Professional practice consistent with the belief that all students can learn

Collaborative professionals

Professional leaders and change agents

Please review the "Teacher’s College Code of Ethics" found in the WGU Student Handbook (http://kb.wgu.edu/article.asp?article=1489&p=3). Practice the dispositions above while working through this course of study. Reflect on your learning and believe that you will learn the material needed to pass your assessment(s). Care about your education by scheduling time each week to devote to your studies. Collaborate with other teachers by interacting in the message boards, and be a leader of change by making suggestions to improve this learning document.
Preparing for Success

To successfully complete SEA and SEC, you need the appropriate resources to help with your learning. You should also prepare a calendar to schedule times devoted to your studies. Share your calendar with family and friends so they are aware of your obligations.

Topics

Acquire Learning Resources

Arrange to obtain the learning resources listed in the "Required Learning Resources" section so there will be no delays in your studies. These items are essential for you, as this document will guide you in the use of these materials. Some of these items must be shipped to you, so be sure that your mailing address information is current. If you click on your name on your AAP, you can check your contact information.

Resources

Enroll in Earth Science (CourseCompass)
URL: http://www.coursecompass.com

CourseCompass is an online learning environment that includes geoscience animations, practice quizzes, and the following e-text:


This college-level Earth science text focuses on three important themes:

Earth as a system
People and the environment
Understanding Earth

Each section and chapter of the text has questions at the end. Use these questions to check your understanding as you progress through the material. Enroll in "Earth Science" through the "Learning Resources" tab of your AAP for this course of study. See your mentor for help if needed.
Optional:

You may wish to purchase a hard copy of the Earth Science textbook that otherwise comes free with your CourseCompass: Earth Science enrollment.

Note: The WGU Bookstore has this book available for immediate purchase and delivery. You may shop at other online bookstores, but be sure to order early and use the correct ISBN to get the correct edition.

Order the Oceanography Text


The Earth science text listed for this course of study does not cover oceanography in the detail needed for you to pass the assessments, so this Oceanography text is a necessary learning resource for this course of study. This book can also be used during the AMNH seminar "Ocean Systems." This text comes with a companion website.

Note: The WGU Bookstore has this available for immediate purchase and delivery. You may shop at other online bookstores, but be sure to order early and use the correct ISBN to get the correct edition.

Order the GEODe DVD

This resource includes the GEODe DVD, which is mailed to your home address. You enroll for this learning resource through the "Learning Resources" tab for SEA within your AAP. Your mentor will need to approve this learning resource. This resource is interactive and includes excellent animations, videos, illustrations, photographs, and narration for a clear and thorough review and tutorial of important geoscience facts and concepts.

Note: Please do not order this learning resource through WGU if you have purchased or will be purchasing Earth Science. This resource is included for free if you purchase a new copy of Earth Science.

Enroll in the Starry Night DVD

The Starry Night DVD resource is mailed from Tangent Scientific to your home address (so check that your mailing address from your AAP is current). You enroll for this learning resource through the "Learning Resources" tab located behind the Course of Study. Your mentor will need to approve this learning resource. Starry Night Pro allows you to view the sky from different places on Earth and at different times.

Science Methods LabPaq

URL: https://web5.wgu.edu/aap/content/LabPaq_sciencemethods.pdf
The Science Methods LabPaqself-contained laboratory kit includes a lab manual along with the science equipment, specimens, supplies, and chemicals necessary to complete college laboratory experiments at home. The experiments reinforce science content and teach laboratory techniques.

Note: This resource is only available to students in a program with a version of 200810 or newer. These programs include a required one-time lab fee payment.

This resource is ordered by submitting the LabPaq Liability Release Form available at the website listed above. Follow the directions at the top of the form to receive this resource. Fax, mail, or more preferably, attach this form to an email and send to Learning@wgu.edu. Your lab order will be processed and your materials will ship within five to seven business days.

Please check your package as soon as it arrives. If there are any missing or damaged items, you will need to notify the learning resources department right away. Two weeks after shipment, Hands-On Labs will be unable to make exchanges or supply replacements for items.

Obtain a Notebook
As you engage with the activities throughout this course of study, you will be answering questions, completing exercises, sketching out concepts, and so forth. You have the ability to take these notes online through the web-enabled course of study. A notebook or study journal (either paper or electronic) makes your learning more active. It also provides an excellent source of important materials to review prior to demonstrating your competence through the assessments. Buy a blank notebook for your Earth science studies. Write all your notes and diagrams in this notebook. This is for your use only. Writing and drawing help your mind process and remember information.

Participate in the Message Board
The message boards are an important part of the WGU experience. In the lower right-hand corner of the course of study screen there is a message board area. Throughout your studies, you will want to follow the questions, observations, and responses of the other students and the expert advice of the course mentor. If you have questions of your own, do not hesitate to use this resource to get those answered as you develop your competencies.

AMNH Seminars (Optional)
URLs:

AMNH Calendarhttp://www.amnh.org/learn/calendar

AMNH-WGU FAQhttps://web5.wgu.edu/aap/content/amnh%20wgu%20faq.pdf

The online seminars offered by the American Museum of Natural History (AMNH) use multimedia and discussions to connect teachers and future teachers from around the world to cutting-edge research, classroom resources, and each other. Participating in the seminars develops your understanding of the content, models an appropriate teaching technique, and exposes you to an array of resources that can be used in your classroom or to help with lesson planning. While this is an optional learning resource, we strongly encourage you to take advantage of this
opportunity. These seminars, which are typically around $400, are covered as part of your WGU tuition.

There are three seminars related to these assessments: "Earth Inside and Out," "The Ocean System," and "The Solar System." Each six-week seminar requires about 8 hours per week of your time. The seminars have definite start and stop times, so, review the AMNH Calendar to determine when the course is offered and consult your mentor to coordinate this seminar into your schedule. Discuss the AMNH-WGU FAQ with your mentor to better understand how to successfully use the AMNH course as a WGU learning resource.

Enroll in this resource from the "Learning Resources" tab. Once your mentor approves your enrollment, you will be sent a confirmation email. Please check your email regularly for a registration email directly from AMNH. This message will contain the information you will need to access this on-line seminar.
Introduction to Earth Science

In order to fully understand and appreciate Earth science, you need to understand the history, nature, and applications of Earth science. You will begin your study with an overview of how the practice of science is a human endeavor; how scientific knowledge is gathered; its evolving nature; scientific terms, including hypothesis and theory; the difference between science and technology and other fields; the difference between science and pseudoscience and how to analyze claims; and the importance of science literacy in society. After completing this section's activities, you will be able to do the following:

Discuss science subjects that span all science disciplines.

Properly use the Science Methods LabPaq.

Calculate the error involved with using various tools.

Topics

The Nature of Science

The National Science Teachers Association (NSTA) is an organization, based on membership, which holds conferences, publishes literature, and works with teachers from kindergarten through college in an attempt to improve science education. If you are not already a member, it is recommended that you become one. State and national standards in science are based on NSTA's positions. After completing this topic, you will be able to discuss science subjects that span all science disciplines. How is science different than other subjects? Science involves the use of tools to investigate the world. After completing this topic, you will also be familiar with the Science Methods LabPaq.

Resources

The Nature of Science

URLs:

The Nature of Sciencehttp://www.nsta.org/about/positions/natureofscience.aspx

History and Nature of Sciencehttp://www.nap.edu/openbook.php?record_id=4962&page=200

Science has unique attributes, and it is different from other subject areas. Read about the NSTA's position on the nature of science by following the first link above. In your lab notebook, write down a summary of the NSTA's position on the nature of science.

The National Science Education Standards (NSES) were produced by the National Research
Council. NSTA supports these standards and has been engaging in an effort to implement the standards across the country. View the NSES position on the history and nature of science at the second link above. In your lab notebook, write down a summary of how science is a human endeavor and how science distinguishes itself from other bodies of knowledge.

While investigating the world around them, scientists evaluate data and formulate reasonable explanations. Read the "What is Earth Science" section in chapter 1 of Earth Science. This will help you have a better understanding of what you will be learning about over the next few months. In your notebook, write down explanations of each of the following:

Hypothesis
Scientific inquiry
Theory

Add to your notes about how science is a human endeavor.

Earth Science, People, and the Environment
Read the section "Earth Science, People, and the Environment" in chapter 1 of Earth Science. As a teacher, you should relate information to your students' lives. This section will give you ideas on how to do this.

Scientific Inquiry
URL: http://www.nsta.org/about/positions/inquiry.aspx

There is a strong misconception that a single series of steps called "the scientific method" exists and is used by all scientists. In reality, scientists use many different strategies and methods to solve problems and add to the body of scientific knowledge. Follow the link above to learn about the NSTA's position on scientific inquiry. In your lab notebook, write down the NSTA's position on scientific inquiry after reviewing the website provided.

Read "The Nature of Scientific Inquiry" section in chapter 1 of Earth Science. Compare the definition of hypothesis and theory in this chapter with the definition you wrote in your notebook. Add to your notebook a description of scientific methods.

Introduction to the Science Methods LabPaq
You will be using the supplies within the LabPaq to apply your understanding of science concepts. Read pages 1-11 of the lab manual included with the LabPaq about using this kit, pages 12-16 about presenting lab information, and pages 17-29 about equipment and lab techniques. While completing the labs in subsequent activities, refer to these pages to learn the proper technique for using all the supplies.
**Scientific Writing**

Written records are a crucial part of the science discipline. They help scientists recall and share the details of their experiments. The style used in writing lab reports or scientific papers is different from less formal writing. Make sure you understand the difference between lab notes and a lab report. Pages 12-16 of the LabPaq lab manual review this information. The following are a few helpful hints on scientific writing style:

- Be clear, concise, and complete.
- Include enough detail that someone else with similar skills could duplicate the results.
- Use a standard format.
- Use passive voice (e.g., "The flask was filled" rather than "I filled the flask").
- Use the proper verb tense (e.g., results that are still true today should be in the present tense).
- Scientific names of species should be italicized.
- Data is plural for datum.
- Spectra is plural for spectrum.
- Species is singular and plural.
- Numbers greater than 10 or associated with measurements should be written as numerals.
- Numbers 10 or less or that begin a sentence should be spelled.
- Numbers associated with measurements should not start a sentence.
- Units for metric measurements should be abbreviated without periods (e.g., mm).

**Experiment 1: The Scientific Method**

Complete "Experiment 1: The Scientific Method" in the Science Methods LabPaq. After completing the lab, send your lab report to the course mentor to receive feedback.

**Introduction to Earth Science**

Read the remainder of chapter 1 of Earth Science that was not assigned in the previous activities.

**Check for Understanding of Chapter 1**

URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 1 of Earth Science.
Measurement

All measurements are estimates because all measurement tools have limitations. This is important to understand and is related to the topic of significant figures. After completing this topic, you will have practiced calculating the error for various measurement tools. Why is possible error important to consider in science experiments?

Resources

The Metric System
URLs:

Use of the Metric System http://www.nsta.org/about/positions/metric.aspx

Metric Mishap Caused Loss of NASA
Orbiter http://www.cnn.com/TECH/space/9909/30/mars.metric.02/

Review the first website listed above for a description of the NSTA position on the metric system. Units are crucial during science experiments. In the second website listed above, read how NASA lost a $125 million Mars orbiter because measurement units were not consistent. When writing down numbers, always include the units.

Temperature Scales
URL: http://cryo.gsfc.nasa.gov/introduction/temp_scales.html

The Fahrenheit, Celsius, and Kelvin temperature scales are used in the study of Earth science. Review the website listed above and appendix A in Earth Science for a review of these temperature scales.

Experiment 2: Measurement
Complete "Experiment 2: Measurement: Length, Mass, Volume, Density, and Time" in the Science Methods LabPaq. After completing the lab, send your lab report to the course mentor to receive feedback.

Note: Experiment 3 describes how to calculate percent error.

Experiment 3: Experimental Error and Uncertainty
Complete "Experiment 3: Experimental Errors and Uncertainty" in the Science Methods LabPaq. After completing the lab, send your lab report to the course mentor to receive feedback.
Composition of Earth Part 1

Earth is one of the four inner rocky planets in the solar system. Minerals are the building blocks of rocks. Minerals can be identified by their chemical and physical properties. The chemical structures of the molecules that make up a mineral determine its physical properties, such as how a mineral breaks apart. After completing this section's activities, you will be able to do the following:

Describe the layered structure of Earth.

Use latitude and longitude to find a point on Earth.

Identify minerals and rocks.

Topics

Makeup of the Earth

When people dig into the Earth to build structures, they are only scratching the surface of the Earth’s crust. What is underneath the crust people walk on?

Resources

Earth’s Internal Structure

In your notebook, draw a cross section of the Earth. Label and color code each layer. Add information to your drawings on the Earth's size, general composition, and layered structure. Also, include answers to the following questions:

If you were to dig a hole through the center of the Earth to the other side, how long would your tunnel be?

How many layers would you need to dig through?

What materials would you dig through?

Page 16 of Earth Science will help you with this.

Earth’s Grid System

Read appendix B of Earth Science, which describes Earth’s grid system. You should be able to locate a point on Earth using this system. Figure B.2 in appendix B shows how this is
done. There is a song that refers to the changes in attitudes of people in the lower latitudes. The lower the latitudinal number of your location, the closer you are to the equator and the warmer the climate. The equator has latitude of zero. Where is longitude zero?

**Minerals**

Identifying minerals is challenging, but with practice you will get better. With your new knowledge, you will be able to identify the rocks you pick up outside. Learning about the minerals that occur naturally in your local area will make it easier to identify rocks and minerals near your home. Test your knowledge: What mineral is black and shiny?

**Resources**

**What Is a Mineral?**
Read the beginning of chapter 2 ("Minerals: Building Blocks of Rocks") in Earth Science. After reading this section, write down a definition of mineral in your notebook. Review the next sections in this chapter on elements and bonds.

**Properties of Minerals**
URL: http://facweb.bhc.edu/academics/science/harwoodr/Geol101/Labs/Minerals/The goal of this activity is to help you understand the properties of minerals and how these properties can be used to identify minerals. At the completion of this activity you should be able to identify hand samples of common rock-forming and ore minerals by their properties (e.g., color, luster, streak, density, cleavage).

Read the section "Properties of Minerals" in Earth Science. Review figure 2.13, which shows the hardness scale, figure 2.15, which shows common cleavage directions, and figure 2.21, which shows common silicate minerals (note that there are two different feldspars mentioned in figure 2.21). Practice describing the minerals from these two figures.

Read the section "Mineral Groups" in chapter 2 of Earth Science with these specific minerals in mind, and add to your notes. Read through the mineral properties and identification website provided. Memorize the identification chart and without using any notes practice identifying samples using the links to specific minerals at the bottom of the website.

**Mineral Activity**
Streak Test http://www.minerals.net/resource/property/streak.htm
Hardness Test http://www.minerals.net/resource/property/hardness.htm
The Science Methods LabPaq contains 18 minerals and a list of 18 mineral names. Using what you have learned in the previous activity, match the 18 minerals with their appropriate name. Use the Streak Test and Hardness Test websites as necessary to help you better understand how to use these tests to identify minerals. Once you have identified the minerals, list two common uses of each mineral and send your results to the course mentor for feedback.

**Mineral Groups**
Over 90% of the Earth's crust is composed of silicate minerals. Temperature and pressure determine the type of specific minerals created. While reading, take notes on the conditions (temperature and pressure) in which the specific minerals were formed.
Check for Understanding of Chapter 2
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 2 of Earth Science.
Composition of Earth Part 2

When you are standing on a boulder or staring at a granite countertop, it might be difficult to imagine what conditions created these rocks. Varying degrees of temperature, pressure, and weathering are needed to change the form of rocks. What processes created the marble used as tile in a building, or the granite used for a countertop in a kitchen? After completing this section's activities, you will be able to do the following:

Describe the rock cycle.

Describe Earth's geological resources.

Topics

The Rock Cycle

When you are standing on a boulder or staring at a granite countertop, it might be difficult to imagine what conditions created these rocks. Varying degrees of temperature, pressure, and weathering are needed to change the form of rocks. What processes created the marble used as tile in a building or the granite used for a countertop in a kitchen?

Resources

Earth as a System
At the beginning of chapter 3 in Earth Science, read the section "Earth as a System: The Rock Cycle." In your notebook, explain the general details of the processes involved when one type of rock (igneous, metamorphic, or sedimentary) is transformed into any other.

Igneous Rocks
Read the section "Igneous Rocks: Formed by Fire" in chapter 3 of Earth Science. As you read this section, write down in your notebook how these rocks can be identified by their texture and composition. For example, granite has a course-grained texture. How is this related to its appearance, and where it was made? Figure 3.11 in this chapter shows six common igneous rocks that you should be able to identify.

Sedimentary Rocks
Read the section on sedimentary rocks in chapter 3 of Earth Science. Mechanical weathering creates the detrital group of sedimentary rocks, while chemical weathering creates the chemical group of sedimentary rocks (chapter 4 of Earth Science discusses weathering in more detail). As you read this section, write down in your notebook how these rocks can be identified by their texture and composition. The size of the sediment particles helps with sedimentary rocks' classification. For example, sandstone is made from sand sediment.
Metamorphic Rocks
Read the section on metamorphic rocks in chapter 3 of Earth Science. As you read this section, write down in your notebook how these rocks can be identified by their texture and composition. For example, slate is made from very fine grains, whereas marble is made from bigger grains. When looking at marble, you can typically see the grains, whereas in slate you cannot distinguish individual grains. Figure 3.31 shows five common metamorphic rocks that you should be able to identify.

Experiment 12: Crystal Growing and the Rock Cycle
Complete "Experiment 12: Crystal Growing and the Rock Cycle" in the Science Methods LabPaq. After completing the lab, send your lab report to the course mentor to receive feedback.

Check for Understanding of Chapter 3
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 3 of Earth Science.

Geological Resources
Humans use many geological resources for building materials as well as for energy sources. How does the use of petroleum affect the environment?

Resources
How Geological Resources Are Formed
Explain the general processes by which important geological resources are formed. Chapter 17 of Oceanography can help with your understanding of these processes.

Section 17.4 of Oceanography describes how petroleum, which is usually associated with marine sediment, is formed. The final conversion to hydrocarbons requires high temperature and pressure.

Pages 66-67 of Earth Science describe how coal is formed. Coals are either sedimentary or metamorphic rock, which likely began in swampy conditions.

Starting on page 76, Earth Science describes the formation of various mineral resources.

Environmental Impact of Resource Extraction
Discuss the environmental impacts of the extraction, processing, and the use of petroleum, coal, and ores. Begin reading chapter 18 of Oceanography to help with your understanding of how the use of petroleum affects the environment.
Movement on Earth Part I

Although Earth has a rocky base, there is much movement on its surface. Air, water, and the Earth itself are constantly moving. Due to the water cycle, water is continuously moving, which causes wear and tear on the Earth's surface. Gravity causes boulders and mud to move downhill. Convection currents keep the Earth's inner materials moving, which in turn moves the Earth's plates. What observations can you make that verify these movements on the Earth? After completing this section's activities, you will be able to do the following:

- Describe the effects of weathering.
- Describe examples of mass wasting.
- Describe the effects of streams on Earth's surface.

Topics

Effects of Wind, Water, and Ice on the Landscape

Weathering is part of the rock cycle. Weathering also affects the roads people drive on. Ice forms in cracks, causing them to expand. Falling rain and winds can erode the edges of cracks. Erosion occurs because of the effects of wind, water, or ice.

Resources

Weathering and Erosion
Read the section on glacial erosion that starts on page 159 of Earth Science to help you better understand how glaciers erode land.

Read the section on wind erosion that starts on page 177 of Earth Science to better understand how wind erodes land.

Mass wasting, or movement, is due to the effects of gravity. Rocks naturally want to roll downhill. Moving water can transport sediment, creating large deposits downstream.

Mass Wasting

Earth is wasting away, or more appropriately, Earth is moving due to gravity. What properties of soil cause mudslides?

Resources
The Work of Gravity
Read the pages 107-110 on mass wasting in chapter 4 of Earth Science. The beginning sections of this chapter describe how terms are used to describe mass wasting, which helps when distinguishing between the different types of mass wasting.

In your notebook, describe the types and mechanics of mass wasting, including the bold-faced terms used. Drawings may help with your learning. View the GEODe DVD to better understand the different forms of mass wasting.

Human Activity
Add to your notes on mass wasting your thoughts on the following question:

How might the destruction caused by mass wasting be prevented?

Check for Understanding of Chapter 4
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 4 of Earth Science.

Streams

Begin reading chapter 5 of Earth Science to review the water cycle and the benefits of running water. While looking at figure 5.3 in this chapter, notice the movement of water through the hydrologic cycle. What can humans do to slow down the erosion caused by streams?

Resources

The Work of Running Water
Read the section "Shaping Stream Valleys" in chapter 5 of Earth Science to help you better understand the processes by which streams erode and deposit sediment. Figure 5.17 in this chapter shows the stages of stream development from the beginning, as water accumulates in the mountains. In your notebook, describe these stages.

Stream Channels
As you read the section "Stream Channels" in chapter 5 of Earth Science, write down in your notebook the processes by which streams change their course.

Floods and Flood Control
As you read the section "Floods and Flood Control" in chapter 5 of Earth Science, write down in
your notebook the motivations for and consequences of human attempts to alter stream processes.

Check for Understanding of Chapter 5
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 5 of Earth Science.
Movement on Earth Part 2

Although Earth has a rocky base, there is much movement on its surface. Air, water, and the Earth itself are constantly moving. Due to the water cycle, water is continuously moving, which causes wear and tear on the Earth's surface. Gravity causes boulders and mud to move downhill. Convection currents keep the Earth's inner materials moving, which in turn moves the Earth's plates. What observations can you make that verify these movements on Earth? After completing this section's activities, you will be able to do the following:

Explain the theory of plate tectonics.

Describe the consequential effects of plate tectonics, such as volcanoes and earthquakes.

Describe the production, measurement, and effects of earthquakes.

Distinguish between types of volcanoes and describe the production and effects of volcanoes.

Topics

Plate Tectonics

In the early 1900s, there were no planes to circumnavigate the Earth, no satellite imagery, and no submersibles to view ocean ridges. Despite lacking these technological advances, Alfred Wegener was able to propose the idea of continental drift. What evidence do you suppose he collected to make such a radical hypothesis in 1915?

Resources

Supporting Evidence of Continental Drift
Read the section "Continental Drift" at the beginning of chapter 7 in Earth Science. In your notebook, write down the evidence Wegener used to support his ideas.

Plate Boundaries
There are three types of plate boundaries: divergent, convergent, and transform. As you read about these types of plate boundaries in chapter 7, write down what is occurring at each type.

When do volcanoes occur at divergent boundaries? When do volcanoes occur at convergent boundaries? How are earthquakes related to plate boundaries? Make a chart in your notebook to help you organize this information. As you read about each type of boundary, add to your chart. Which type of boundary created the Hawaiian Islands?

Modern Evidence of Plate Tectonics
As you read the sections "Testing the Plate Tectonics Model" and "Measuring Plate Motion" in chapter 7 of Earth Science, write down in your notebook the modern evidence that can now be measured because of technological advances.

**Experiment 14: Plate Tectonics**
Complete "Experiment 14: Plate Tectonics" in the Science Methods LabPaq. After completing the lab, send your lab report to the course mentor to receive feedback.

**Changes in the Lithosphere**
Based on what you have learned about plate tectonics, explain the formation and ongoing evolution of the ocean basins and continental land masses in terms of plate tectonics. Examine figure 7.12 on page 198 of Earth Science, which depicts a divergent boundary. The series of pictures in this figure shows the stages Pangaea went through for today's continents to form. It took 50 million years for even narrow seas to develop. Read box 7.1 on page 190 of Earth Science to better appreciate how current ocean basins developed.

**Review Animations for Plate Tectonics**
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, review the animations in order to better visualize some of the concepts and processes covered in this topic. Review all of the chapter 12 geoscience animations.

**Check for Understanding of Chapter 7**
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 7 of Earth Science.

**Earthquakes**

As the theory of plate tectonics describes, Earth's crust is moving. Occasionally, the movement is quick enough for you to feel. How do seismologists measure such movements?

**Resources**

**The Production of Earthquakes**
Read the first three sections of chapter 8 in Earth Science through page 226.

Earthquakes create P- and S-waves. You can remember these waves by their types. As figure 8.9 illustrates, P-waves push and pull (note that both words begin with p). Also, P-waves are considered the primary waves (another p word to associate with P-waves) since they move faster than S-waves, arriving ahead of the S-waves. S-waves actually create an s curve in the surface of land.
In your notebook, explain why earthquakes occur along faults and describe the waves that earthquakes generate.

**Measuring the Size of Waves**
Continue reading chapter 8 from page 227 through page 231 in Earth Science to help you better understand how scientists measure the size of an earthquake. These pages describe the modified Mercalli intensity scale, the Richter scale, and the moment magnitude scale.

In your notebook, describe these three scales and how these scales are used and calculated. Each scale serves a different purpose. Table 8.1 of this chapter describes the different levels of the modified Mercalli intensity scale. Isoseismal lines can be drawn on a map to connect areas with similar earthquake experiences.

**Destruction From Earthquakes**
Read the section of chapter 8 in Earth Science that starts on page 231. In your notebook, describe the hazardous effects of an earthquake. If the ground is saturated with water, what can occur during an earthquake?

**Review Animations of Earthquakes**
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, review the animations in order to better visualize some of the concepts and processes covered in this topic. Review all of chapter 10 geoscience animations.

**Check for Understanding of Chapter 8**
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 8 of Earth Science.

**Volcanoes**
As described earlier, the mantle is one layer of Earth’s structure. This material, which is partly molten, occasionally makes its way to Earth's surface. What causes debris to fill the sky when some volcanoes erupt?

**Resources**

**Types**
Read chapter 9 in Earth Science from the beginning through to page 260. In your notebook, explain why some volcanoes have explosive eruptions, while others are quiet. Create a table comparing the conditions for an explosive volcano versus a quiet volcano.
The Hazards of Volcanoes
Volcanoes can cause damage. Lava flows destroy objects in their path. Landslides can cause further destruction. Phreatic eruptions, such as Mt. St. Helens, are explosive because the hot magma encounters water on its ascent, and the created steam hurls ash and rocks into the sky.

Continue reading chapter 9 from page 260 through the end of the section "Living in the Shadow of a Composite Cone" in Earth Science to learn more about the devastating effects of a volcano.

In your notebook, describe the hazards associated with volcanoes. The section "Living With Volcanoes" that starts on page 277 of Earth Science also describes the hazards caused by volcanoes.

Review Animations of Volcanoes
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, review the animations in order to better visualize some of the concepts and processes covered in this topic. Review all of chapter 4 geoscience animations.

Check for Understanding of Chapter 9
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 9 of Earth Science.
Earth's History

Scientists collect data from around the world to better understand what has happened in Earth’s history. After completing this section's activities, you will be able to do the following:

- Describe common geological landforms.
- Understand how scientists determine the age of rocks they find.
- Appreciate Earth's unique qualities.
- Provide a timeline of events in Earth's past.

Topics

Geological Landforms

National parks are often known for certain geological features. The Grand Canyon shows the effects of the Colorado River carving into the Earth’s surface. What are landforms in your state that you can share in your classroom as a teacher?

Resources

Identifying Forms on Earth

Perhaps in your travels you have admired various land features and wondered how they were formed. Chapter 9 in Earth Science described forms caused by volcanoes. Figures 9.12, 9.13, and 9.15 in chapter 9 of Earth Science show examples of shield volcanoes and cinder cones. Figure 9.17 illustrates a stratovolcano (composite cone). Draw pictures of these in your notebook and describe their differences. Starting on page 262 of Earth Science, calderas are described, which are formed after a volcano collapses. Add to your notes a drawing of a caldera.

The Earth’s surface can also collapse because of ground water changes. Figure 5.39 on page 146 of Earth Science illustrates how caverns and karst landscapes are formed. Describe these formations in your notebook.

Glaciers also carve out landforms. Figure 6.15 on page 165 of Earth Science shows the moraines that are formed by glaciers. Read the section on moraines in chapter 6 of Earth Science and describe these land features in your notebook.

Streams can create interesting landforms. Figure 5.12 in chapter 5 of Earth Science shows the meandering path of streams that transport sediment. In your notebook, describe the alluvial channels created by streams.

Wind creates some interesting landforms as well, such as sand dunes. Figure 6.36 on page 180
Chapter 10 of Earth Science has pictures of landforms around the world created by different natural methods. For example, figure 10.8 on page 289 of Earth Science shows a fault scarp. Draw examples of various faults in your notebook.

Impressive landforms can also be created by meteors. Figure 22.30 on page 648 of Earth Science shows the impact structure created by a meteor that impacted Arizona within the last 50,000 years. The moon has many impact craters on its surface.

Fossils

There are many types of fossils. Footprints left in mud and preserved over many years are considered fossil evidence. What other types of fossils are there?

Resources

Fossils in the Making
Read the section on fossils in chapter 11 of Earth Science that starts on page 318. Explain how fossils are formed. Figure 11.13 shows various types of fossils. Box A of this figure shows petrified logs in which mineral deposits have replaced the organic matter. Box B of this figure shows the fossil of a trilobite, which is an organism that does not exist today.

Diverse preservation of fossils has been found in the Burgess Shale, which was first found in the Canadian Rockies. Organisms preserved in the Burgess Shale were buried in fine mud that maintained the details of the soft and hard parts of the organisms. Fossils found in this area have provided great insight into the diversity of organisms that existed during the Cambrian period.

Determining the age of fossils helps scientists determine their geological time frame. The age of fossils can be determined by measuring the amount of radioactive isotopes left in a fossil sample.

Diversity of Life
The section "Fossils and Correlation" on page 322 of Earth Science describes how fossils are used to better understand past events. In your notebook, explain how fossils provide evidence of the diversity and complexity of life over time. For example, the fossils in the Burgess Shale provide evidence that complex life-forms existed during the Cambrian period that do not exist today and did not exist before the Cambrian period. Diversity refers to the idea that different life-forms have existed over time, versus the idea that life-forms have remained the same over time.

Dating
Knowing the order of events helps to put a timeline in place. Scientists use the chemical properties of rocks to help them determine a rock's age. Do you expect to find older rocks deep in the ground or closer to the surface?
Resources

Introduction of Chapter 11
Read the first two sections of chapter 11 in Earth Science to help you better understand how studying rocks helps people understand the past.

Relative Dating
When studying layers of rocks, the layer on the bottom is older than the layer on top of it. Shifts in the rock layers provide clues to events in the past. Read the section on relative dating in chapter 11 of Earth Science. In your notebook, describe the methods used for relative dating.

Absolute Dating
Carefully read the section titled "Dating With Radioactivity" that starts on page 323 in Earth Science. Figure 11.17 in this chapter helps to show how half-lives can be used for dating. If a rock has 25% of the expected amount of parent isotope left, then two half-lives have passed for the rock. Table 11.1 shows the radioactive isotopes that can be used to date ancient rocks. For dating of more recent items, carbon-14 is used, since it has a shorter half-life.

Go through the review questions at the end of chapter 11 in Earth Science to solve simple half-life problems involving radiogenic isotopes and their daughter products.

Experiment 13: Radioactive Decay
Complete "Experiment 13: Radioactive Decay" in the Science Methods LabPaq. After completing the lab, send your lab report to your course mentor to receive feedback.

Review Animations for Radioactive Decay
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, review the animations in order to better visualize some of the concepts and processes covered in this topic. Review all of chapter 8 geoscience animations.

Geologic Timeline
Based on the evidence collected, a geologic timeline has been put together. In this timescale, a hundred or even a thousand years is a relatively short time span. How long ago did dinosaurs roam the Earth? When did plants first appear?

Resources

Geologic Timescale
Identify the principal divisions of geologic time. Read the section "The Geologic Time Scale" in chapter 11, starting on page 326 in Earth Science.
Earth’s History
Identify the approximate time period for important events in Earth’s physical and biological history. You can use figure 12.4 on page 339 and figure 12.23 on page 353 of Earth Science to help you with this information. Chapter 12 in Earth Science describes each era in further detail.

Look at figure 12.4; notice that the time an animal is predominant (such as "Age of the Fishes") is preceded by the first of that animal (such as "First Fishes"), which makes sense. Also, notice that the organisms become more complex over time -- from one-celled organisms, to multi-celled organisms, to invertebrates, to fishes, to amphibians, to reptiles, which lay their eggs on land, to birds, to mammals.

Knowing the order in the column "Development of Plants and Animals" is your goal. Take notes to help you remember this order.

Check for Understanding of Chapter 11
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 11 of Earth Science.

The Importance of Earth’s Placement

One thing you should appreciate is Earth’s placement in the solar system, which is not too close to the sun (where all water would vaporize), or too far from the sun (where all water would freeze). Earth has enough gravity to hold an atmosphere, but how did the atmosphere originate?

Resources

Conditions on Earth
Read about Earth’s spheres by reading the section "Earth's Spheres," starting on page 12 in Earth Science. These spheres are continuously interacting, which creates a system. Read the section "Earth as a System" that starts on page 22. This complex system is unique to planet Earth.

Earth’s Unique Characteristics
Why is Earth considered the right size? Why is Earth’s place in the solar system important? How is timing important? Read the beginning of chapter 12 in Earth Science, which describes Earth’s uniqueness. As you read this section, write down the important factors that allow life to exist here.

Massive planets, such as Jupiter, have enough gravity to retain light gases, such as hydrogen and helium, which create a hostile atmosphere. Earth is not large enough to keep these light gases in its atmosphere, but Earth is large enough to keep heavy gases, such as water vapor and oxygen, which are necessary to sustain life.
Compare Earth's surface temperatures to its neighboring planets Mars and Venus. How much hotter does Venus get than Earth? How much colder does Mars get than Earth? In the message board, share how Earth's placement in the solar system helps to create the conditions that enable organisms to survive.

**Origin of the Atmosphere and Oceans**
Continue reading chapter 12 in Earth Science to help you appreciate the beginnings of the atmosphere and oceans. In your notebook, describe the stages in the early formation and evolution of the atmosphere.

In addition, begin reading chapter 2 of Oceanography. The first few pages provide a preview to the astronomy topics you will learn in later sections, describing the formation of the solar system. Section 2.6 of this book describes the origin of Earth's atmosphere and oceans. As Earth cooled, gasses were released into the atmosphere. It still took millions of years for Earth to be cool enough for water to accumulate on its surface, creating the oceans. As figure 2.10 in this chapter depicts comets landing on Earth, which also helped with Earth's water accumulation.

**Check for Understanding of Chapter 12**
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 12 in Earth Science.
The Bottom of the Ocean

From the Earth’s surface, only the ocean’s top layer, exposed to the sun, can be seen. Using instruments such as sonar, scientists can detect the structures that are at the bottom of the ocean. Sea level is always the starting point for elevation measurements, whether measuring the height of a mountain or the depth of an abyss. After completing this section’s activities, you will be able to do the following:

Describe the ocean’s basins.

Describe how scientists gather information about the ocean.

Analyze ocean sediment.

Topics

The Ocean Floor

The ocean floor has a varied terrain, just as land’s surface does. Boundaries between continental plates are seen as ridges where new crust can be forming. How do scientists collect data at deep ocean depths?

Resources

Bathymetric Chart
A map showing the contours of the ocean floor is called a bathymetric chart. Begin reading chapter 4 of Oceanography to learn how these charts are made (chapter 13 of Earth Science also has information on bathymetric charts).

Contour lines are often drawn on bathymetric charts to show areas at the same depth. These charts show several examples of different charts depicting the ocean floor. Take the time to interpret these bathymetric charts. Keep in mind that sea level is the starting point for all measurements.

Tools and Procedures
As you read, write down descriptions of the tools scientists use to collect oceanic data. How do scientists map the ocean floor? While at sea, scientists also take other measurements to better understand oceans. Using Niskin bottles, scientists can collect a water sample at any depth. Scientists can perform tests on the water sample, such as determining the salinity of the water.

Ocean Basins
Read section 4.6 of Oceanography, starting on page 100, to better understand continental
margins and ocean basins. Figure 4.8 on page 106 of this book shows the deep ocean basin between two continental margins. As you can see, the center of the basin has an oceanic ridge, which is where new seabed is formed.

Review figure 4.9 in this book, which shows features of Earth's solid surface as percentages of the planet's total surface. For example, about 10% of the Earth's surface is covered by continental mountains. The largest percentage (29.8%) is for ocean basin floors. How much of the Earth is covered by oceanic ridges? Read through to page 112 in Oceanography to get a better sense of continental margins.

There are four main ocean basins: the Pacific, Atlantic, Indian, and Arctic. Read section 4.14, starting on page 113, in Oceanography. In your notebook, write a physical description of Earth's oceanic ridges.

**Topography**

Continue reading chapter 4 of Oceanography to help you better understand the general topography and principal structures of the ocean floor. Page 127 in this book has a list of terms and concepts to remember. Be sure you understand these terms and where they are found. Chapter 13 of Earth Science also describes most of these terms.

**Ocean Sediment**

Sediment includes particles of debris that accumulate in the oceans. This debris can include particles that wash from land and the shells of once-living organisms. What other sources are there for sediment in the ocean?

**Resources**

**Types of Sediment**

Chapter 5 of Oceanography describes ocean sediments. While reading about sediments, write down the different types by comparing their source, properties, and distribution.

Table 5.2 on page 133 of Oceanography classifies sediment by its source. Copy this chart into your notebook. You need to know the source and examples of the various sediment types in the ocean.

**Check for Understanding of Chapter 13**

URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 13 in Earth Science.
Properties of Oceans

The chemical properties of ocean water contribute to its movement and its ability to sustain living organisms. After completing this section's activities, you will be able to do the following:

Describe the physical properties of seawater.

Describe the various water masses that are distinguishable within oceans.

Describe the organisms living in oceans.

Topics

Properties of Seawater

The composition of seawater can change, which then can change seawater's behavior. For example, when icebergs are created, the excess salts are left dissolved in the ocean. Consequently, the seawater left after an iceberg freezes is denser and therefore sinks. Where do dissolved substances come from that are found in seawater?

Resources

Chemistry of Water
Begin reading chapter 6 of Oceanography. In your notebook, draw a diagram showing how hydrogen bonding affects the behavior of the water molecule. Carefully read through section 6.2 and take notes. Check your understanding by completing the concept-check questions at the end of this section.

Composition of Seawater
Continue reading in chapter 6 of Oceanography. In your notebook, describe the chemical composition of seawater (i.e., the dissolved substances). The beginning of chapter 14 of Earth Science also describes the composition of seawater.

Sources of Sea Salts
Figure 7.1 in Oceanography depicts the water cycle, which is involved in adding ions to the ocean. Read section 7.6 of Oceanography, which describes the source of the chemicals found in seawater. Study figure 7.4 in this book, which shows how ions are added and removed from seawater. In your notebook, explain how ions (salts) are added to the ocean. Figure 7.2 in this book shows how the salts are intermingled with the water molecules. Since the salts fill in the spaces between the water molecules, salt water is denser than fresh water.
Temperature and Density Variations

The temperature of water affects its density. The more particles in a given amount of water, the denser the water is. In cold water, the water molecules are closer together, and, consequently, cold water is denser than hot water. The temperature and density of water impacts its movement. How are different water masses dispersed globally?

Resources

Processes Affecting Seawater Salinity
Read chapter 14 of Earth Science from the beginning through page 398. In your notebook, explain how temperature and salinity affect the density of seawater. Ocean water masses organize themselves by density. Add to your notes how and where water masses of varying density are produced. Figure 14.2 in Earth Science describes processes that affect seawater's density. How does the formation of sea ice increase seawater salinity?

Ocean Temperature Variation
From the readings you have completed already, you should have some idea of the thermal layering that occurs in oceans. Since density and temperature are so closely related, thermal layering is also associated with layers of varying densities. Water near the surface is heated by the sun, and warmer water is less dense, so it remains at the surface.

Figure 14.4 shows the variation in ocean water temperature at different latitudes. Below the surface layer of the ocean is the thermocline layer, where the temperature changes dramatically. Notice that near the Earth's poles, there is not much of a thermocline since the surface water is cold as well. In your notebook, describe the thermal layering of the ocean.

Buoyancy

A ship floats due to the hydrostatic pressure of the water pushing up on the ship. This force is equal to the amount of water displaced by the ship.

Resources

Hydrostatic Pressure
An object's buoyancy depends on its density and mass. Read section 3.10, starting on page 64, of Oceanography. In your notebook, explain buoyancy in terms of hydrostatic pressure, using the floating behavior of icebergs and ships as examples.

Ocean Life

There are many organisms that live in oceans. Most organisms are adapted to a particular subset
of the ocean. For example, sea urchins and sea stars live along the ocean's bottom. What organisms can you name that live in other areas of the ocean?

**Resources**

**Effect of Tides**
Because of changing tides, coastal ecosystems present some unique challenges to living organisms. Read sections 11.14 and 16.10 of Oceanography. In your notebook, explain the effect of tides on coastal organisms. What are the benefits and challenges of living in the intertidal zone?

**Oceanic Lifestyles**
Read chapter 14 of Earth Science from page 398 to 402. In this section, you will learn that organisms are classified by where they live. If you know the prefixes and suffixes for terms, you will be able to decipher the terminology used to name organisms. You will also compare and contrast the three oceanic lifestyles by using examples of each (e.g., pelagic [planktonic], swimming [nektonic], and attached [benthic]). Figure 14.9 shows some pelagic organisms. Write down some examples in your notebook.

Now use Oceanography to further improve your knowledge of marine life. Figure 15.1 on page 409 of this book lists examples of the major invertebrate animal phyla that you should know. Most invertebrates are benthic. Can you name some examples? You can read the next pages in this book to better understand this classification.

Organisms that swim tend to be large fish. Page 425 in Oceanography describes the class of cartilaginous fish. Can you name some examples? What is the scientific name of this class? What does the suffix "ichthy" refer to? Most fish belong to the class of bony fish. Read section 15.19 in Oceanography to better appreciate this class. Can you name some examples of bony fish? What is the scientific name of this class?

**Ocean Productivity**
Organisms live where they can find the nutrients they need to survive. Continue reading in chapter 14 of Earth Science. Explain how the concentrations of the elements of life within the oceans affect the amount of living material the oceans can support. Read the section "Oceanic Productivity," starting on page 402 in Earth Science and take notes on what limits the productivity of oceans.

**Check for Understanding of Chapter 14**
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 14 of Earth Science.

**Cycling Nutrients**
Elements cycle between living organisms and their surroundings.

**Resources**

**The Carbon Cycle**
Look at box 3.1 on page 68 of Earth Science, which shows the carbon cycle. Page 357 of Oceanography shows another view of the carbon cycle. Section 13.11 in Oceanography describes this cycle. A product of chemical weathering is bicarbonate ions. Organisms in the hydrosphere can use this source of carbon to make skeletons and shells. When the organisms die, the carbon is returned to the geosphere. In your notebook, describe the carbon cycle in seawater.
The Movement of Oceans

Waves are just one example of the movement of oceans. Currents move water great distances on the surface, as well as deep in the ocean. After completing this section's activities, you will be able to do the following:

Describe the global circulation of water.

Describe how beaches change due to the ocean's impact.

Topics

Surface Currents

Surface currents are driven by wind.

Resources

Patterns
Begin reading chapter 9 of Oceanography to help you understand surface circulation. These ocean currents affect the climate. As the diagrams in this chapter illustrate, a general pattern in the Northern Hemisphere is for the currents to move clockwise. This pattern occurs because of the Coriolis effect and Ekman transport. Oceanography explains this in more detail.

In figure 9.8 you can see that in the North Atlantic, the Gulf Stream brings the warmer water from the south along the eastern United States to northern Europe, which provides more temperate climates to these areas. Without this current, these areas would have colder temperatures, which are more common for the areas located at these latitudes.

In contrast, along the California coast, currents bring colder arctic water south, which means water temperatures are much colder along this coast than along the East Coast.

You can see that in the Southern Hemisphere, the currents between the continents move counter clockwise. Note that the Southern Hemisphere has less land to block moving currents. The Antarctic current is able to move freely around the globe.

Upwelling
Starting on page 245, Oceanography describes the process of upwelling. In your notebook, explain the process and importance of coastal upwelling. What causes upwelling?
The cause for deep ocean circulation is primarily due to the vertical movement of water that is created as dense water moves downward.

Resources

Circulation
Read section 9.20 in Oceanography, starting on page 254. Describe the formation and importance of deep water masses and the deep ocean circulation that depends on them. What are the names of these water masses? Which direction do they flow?

Ocean Waves

Ocean waves are a form of energy moving through the water.

Resources

Cause of Ocean Waves
Read the section on waves, starting on page 421 in Earth Science. As described in the book, wind generates most waves. In your notebook, write down the three factors that determine a wave’s size. Read section 10.11 in Oceanography, which describes waves in more detail. After reading about waves, write down an explanation for the cause and behavior of ocean waves. Where are large waves likely to be found?

Impact of Ocean Waves
As described in the "Wave Erosion" section, which starts on page 424 of Earth Science, waves change the coastal topography over time.

Section 12.4, which starts on page 318 of Oceanography, describes the erosion of coasts. After reading these sections, explain the impact of ocean waves on coastal topography in your notebook. Both textbooks have pictures that illustrate coastal erosion.

Beaches

Sand is easily moved and will move in a fairly predictable manner.

Resources

Longshore Transport
Read the section "Sand Movement on the Beach," which starts on page 424 in chapter 15 of Earth Science. Section 12.12 in Oceanography, which starts on page 325, also describes longshore drift. In your notebook, describe the process of the longshore transport of sand.
The movement of sand creates various coastal conditions. Read the section "Shoreline Features" in Earth Science. In your notebook, describe the process of the creation and destruction of sandbars.

Figure 12.14 on page 325 of Oceanography shows a typical beach profile. Describe how this beach profile is created. Both textbooks have pictures that depict the various coastal features that are created by the movement of sand.

**Tides**

Gravitational forces create changing tides.

**Resources**

**Tidal Patterns**
Begin reading chapter 11 of Oceanography. The equations described in section 11.2 explain the differences between the sun's and the moon's influence on tides. Continue reading through page 304 to help you better understand how the sun and the moon influence tides.

**Check for Understanding of Chapter 15**
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 15 of Earth Science.
Heating Earth

Earth's atmosphere allows life to exist on this planet. After completing this section's activities, you will be able to do the following:

Describe Earth's atmosphere.

Explain the differential heating of the Earth's surface.

Explain why there are seasons.

Explain the greenhouse effect.

Topics

Atmosphere

Humans breathe to bring oxygen into their lungs, but air is made of more than just oxygen.

Resources

Composition of the Atmosphere
Begin reading chapter 16 of Earth Science. In your notebook, state the chemical composition of Earth's atmosphere.

Temperature Gradient
Continue reading chapter 16 to page 455 in Earth Science. In your notebook, describe the structure of the atmosphere in terms of the temperature gradient. In this case, the term gradient is referring to the change in temperature as the elevation changes.

As you can see from figure 16.8 in this book, the temperature trends vary within the various atmospheric layers. Create an acronym so that you can remember the layers of the atmosphere, which start with the letters T, S, M, and T. At the surface of the Earth, temperatures decline as elevation increases.

Ozone
Based on what you have read in chapter 16 of Earth Science, describe the ozone layer in the stratosphere. How does the ozone shield the Earth from ultraviolet (UV) rays?

GEODe Interactive: Slides 1327-1374
Insert and play the GEODe DVD on your computer. Using the narration active box in the bottom
right corner of the screen, navigate to and review slides 1327-1374.

Earth-Sun Relationships

Why do the hemispheres have seasons at opposite times?

Resources

Reasons for the Seasons
Read the section "Earth-Sun Relationships," starting on page 455 of Earth Science to help you understand the reason for days and seasons. How is the Earth positioned during the equinoxes and solstices? How does Earth's tilt affect its climate? Earth is farthest from the sun in July and closest to the sun in January. Why do the two hemispheres have opposite seasons? Explain why equatorial regions receive greater amounts of solar radiation per square kilometer than polar regions receive.

GEODe Interactive: Slides 1459-1618
Insert and play the GEODe DVD on your computer. Using the narration active box in the bottom right corner of the screen, navigate to and review slides 1459-1618.

Temperature, Heat, and Climate

Proper use of terminology is important. You need to be able to distinguish between the terms temperature, heat, and climate.

Resources

Weather and Climate
Weather changes daily, and even with today's technology, it is often difficult to predict. The first few pages of chapter 16 in Earth Science distinguished between weather and climate. Write definitions for each in your notebook.

Heat and Temperature
A thermometer is used to measure temperature. When two objects meet, heat will flow from the object with the higher temperature to the object with the lower temperature. Heat can be transferred between objects by radiation, conduction, and convection. For example, the sun's radiation increases the temperature on Earth.

Conduction occurs when two materials are touching, such as the objects in the earlier example. Most wind is generated by convection, which is the movement of the air due to the differences in density. Air is warmed near Earth's surface, causing its molecules to move and the air to become less dense. The rising of warmer air allows cooler air to take its place.
Read more about these concepts, starting on page 460 in chapter 16 of Earth Science. Begin by writing a formal definition for heat and temperature.

**GEODe Interactive: Slides 1301-1416**

Insert and play the GEODe DVD on your computer. Using the narration active box in the bottom right corner of the screen, navigate to and review slides 1301-1416. You can skip over the section on the composition of the atmosphere, since you have already reviewed this section in a previous activity.

**Greenhouse Effect**

Planet Earth acts somewhat similarly to a greenhouse.

**Resources**

**Incoming Solar Radiation**

What happens to all the incoming solar radiation on Earth? Some of it is reflected back into space. The albedo, or reflective power, of Earth is about 30%. What does this mean? Some of the sun's energy reaches the surface of the Earth. Of the light that reaches the Earth's surface and that is the correct wavelength for photosynthesis, only about 0.4% is actually converted to carbohydrates by plants.

Read the section "The Fate of Incoming Solar Radiation" starting on page 462 in chapter 16 of Earth Science to help you understand these concepts further.

**The Greenhouse Effect**

Begin reading from page 464 in chapter 16 of Earth Science to help you better understand the greenhouse effect. How is this effect related to a car's interior warming up in a parking lot? Draw a picture describing the greenhouse effect process in your notebook.

**GEODe Interactive: Slides 1327-1374**

Insert and play the GEODe DVD on your computer. Using the narration active box in the bottom right corner, navigate to and review slides 1327-1374.

**Differential Heating**

When provided with the same amount of sunlight, land and water change temperatures differently.

**Resources**
**Temperature Variations**
Continue reading in chapter 16 of Earth Science to analyze the temperature gradients within the continental United States. Figure 16.25 in this chapter uses isotherms to show distribution. Although the entire Earth is warmed by the greenhouse effect, there are great temperature variations on the Earth. Part of this is due to land and water heating up at different rates.

Notice on figure 16.25 in this chapter that the Midwest cities, such as Fargo, are colder than the more coastal cities, such as Boston. Water has a higher specific heat than land does, which means that water is slower to warm up and slower to cool down than land is. The land near Fargo will cool down faster than water, leading to cooler temperatures in Fargo than in Boston.

Finish reading chapter 16 in Earth Science. As you read the section "Land and Water," write down reasons for the differential heating of land and water. Also, write down the weather implications caused by the differential heating of land and oceans.

**Measuring Temperature**
There are three scales for measuring temperature. Celsius (C) marks zero as the freezing temperature of water and 100 as the boiling point of water. Kelvin (K) marks zero as much colder than the freezing point of water—the temperature at which molecules stop their movement, or the absence of all thermal energy. In the Fahrenheit (F) scale, water freezes at 32°F and boils at 212°F. To convert from Fahrenheit to Celsius, you need to subtract 32 from the temperature and then multiply by 5/9ths. Each degree Fahrenheit is 5/9ths of a degree Celsius. In your notebook, practice converting between Fahrenheit and Celsius.

In a bulb thermometer, the liquid is heated or cooled with the changing temperature. As the liquid is heated, the molecules move more and therefore move up the thermometer. In a spring thermometer, metal expands and contracts with the changing temperature.

**Check for Understanding of Chapter 16**
URL: [http://www.coursecompass.com](http://www.coursecompass.com)

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 16 of Earth Science.
**Clouds**

When air has reached its saturation level, meaning it cannot hold any more water, clouds, fog, or dew can develop. After completing this section’s activities, you will be able to do the following:

Define relative humidity.

Describe the effects of air moving upward.

Describe the weather associated with different types of clouds.

**Topics**

**Collecting Weather Data**

What causes people to comment that it is a "hot, sticky day"? Or comment that there is a "dry heat"?

**Resources**

**Humidity**

Begin reading chapter 17 in Earth Science to learn more about water and humidity, which refers to the amount of water in the air.

Warmer air can hold more water than colder air can, which make sense when viewed at the molecular level. As the temperature increases, the air molecules move more and spread out, creating more space between the air molecules. Consequently, warmer air is less dense than cooler air. This added space between air molecules allows more space for water molecules. Therefore, warmer air has the ability to hold more water.

Relative humidity is a measure of air’s actual water content compared to what it can potentially hold at that particular temperature and pressure. If the relative humidity is 30%, then the air is holding 30% of the water vapor that it could potentially hold at that particular temperature and pressure. You feel the effects of high humidity in the summer because your body sweats to release body heat, but your sweat does not evaporate since the air is already saturated.

After reading about humidity in chapter 17, write down a definition for relative humidity in your notebook as well as how humidity is measured.

**Instruments Used to Collect Weather Data**

To collect weather data, scientists use a variety of tools: a barometer for measuring air pressure, a hygrometer for measuring relative humidity, a weather vane for determining wind direction, etc.
For example, a south wind is a wind coming from the south. A weather vane will point south when a south wind is blowing. A simple mercury barometer shows air pressure as the pressure of the air pushes the mercury up a tube.

Read the section "Measuring Humidity" (pp. 483-485) of Earth Science to help you better understand how a psychrometer with wet and dry bulbs is used. As you study meteorology, keep a list of the instruments used to collect weather data.

**Adiabatic Cooling and Lapse Rate**

Why does air cool as it rises?

**Resources**

**The Basis of Cloud Formation**
As air rises, it expands and cools. This temperature change, which is due to the air’s expansion, is considered an adiabatic temperature change.

Read the section titled "The Basis of Cloud Formation: Adiabatic Cooling," starting on page 485 of Earth Science. There are different reasons air might rise, causing adiabatic cooling. Lapse rate refers to the rate at which temperature decreases as elevation increases. For unsaturated (dry) air, the air temperature drops 10°C for every 1000 m the air rises. What is the wet adiabatic rate?

**Inversions**

During inversions, there is an exaggeration of thermal layering.

**Resources**

**Temperature Inversions**
Read box 17.1, starting on page 492 of Earth Science. In your notebook, answer the following questions:

How do inversions originate?

What are the effects of an inversion?

Why might an inversion affect air quality?
Clouds

When air reaches its dew point, clouds can form.

Resources

Formation
Begin reading the section titled "Condensation and Cloud Formation" that starts on page 493 of Earth Science to help you better understand what is needed for clouds and fog to form. In addition to the air being saturated with water, water vapor needs a surface to condense on. In your notebook, write down what can serve as surfaces for condensation.

Types of Clouds
Chapter 17 in Earth Science depicts common cloud formations. There are three main forms that blanket the sky: high thin cirrus clouds, puffy cumulus clouds, and stratus clouds. Table 17.2 in this chapter describes the 10 basic cloud types that you should know.

Weather Associated With Clouds
For each of the 10 cloud types listed in table 17.2 of chapter 17 in Earth Science, draw a picture of the cloud. Use figure 17.20 in this chapter as a reference. For each of your cloud pictures, write down the weather associated with it.

GEODe Interactive: Slides 1729-1948
Insert and play the GEODe DVD on your computer. Using the narration active box in the bottom right corner of the screen, navigate to and review slides 1729-1948.

Check for Understanding of Chapter 17
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 17 of Earth Science.
Moving Air

Air moves from high pressure to low pressure. After completing this section's activities, you will be able to do the following:

- Explain air pressure and how it is used to predict upcoming weather.
- Describe the global patterns of moving air.
- Describe local weather patterns.

Topics

Air Pressure

Although air is not visible, its weight still exerts pressure on Earth.

Resources

Understanding Air Pressure
Begin reading chapter 18 in Earth Science. Define air pressure. What is the average air pressure at sea level? Does that seem like a lot of pressure per square inch? How is air pressure measured? Air will move from areas of high pressure to areas of low pressure. This movement of air is felt as wind.

Highs and Lows
Continue reading chapter 18 in Earth Science through the section on highs and lows. The Coriolis effect determines the wind patterns associated with high and low pressure. As you can see in the pictures shown on page 521 of this book, high pressure in the United States moves winds clockwise, away from the high's center. As you read this section, in your notebook describe the mechanics and weather effects of centers of high and low air pressure.

Predicting Weather
Now you can piece together the information from chapter 18 to explain how changes in air pressure help people predict upcoming weather. As the dial in figure 18.3 shows, fair weather is associated with high pressure and air moving down. In contrast, rising air (low pressure) often results in cloud formation and precipitation. Think about the process of precipitation. Water changes from a previous gaseous state to liquid precipitation. The liquid state requires less energy than the gaseous state; consequently, heat is given off when water goes from a gaseous to a liquid state. This is one reason that lowering pressure can have warmer weather.
Global Wind Circulation

The general circulation of air is complex. Forces caused by air pressure, the Coriolis effect, and solar radiation all need to be taken into account.

Resources

Hadley Cells
Continue reading in chapter 18 of Earth Science. In your notebook, describe global wind circulation, which includes the Hadley cells. Notice in figure 18.16 of this chapter that the Hadley cells near the equator cause trade winds. The Coriolis effect causes the wind to angle along the Earth’s surface. To help you remember these cell patterns, notice on figure 18.16 that the higher blue arrows all point away from the equator. The air moves down only at the subtropical 30° latitudes.

Jet Stream
The polar cells are related to jet streams. The colder arctic air at the poles travels toward the equator and then rises at around 60° latitude before reaching the midlatitude cell. Because of the Coriolis effect, this air movement is angled, which causes the jet stream.

Look at figure 8.13 on page 211 of Oceanography; you will see the jet streams labeled. In the Northern Hemisphere, this wind blows west to east. This wind circulation of the jet stream separates the colder polar air from the warmer air just southward. On typical weather maps of North America, the jet stream is shown. As the cooler polar air moves south, so does the jet stream. To help your understanding, recreate figure 8.13 from Oceanography in your notebook, and then explain it to someone else.

El Niño
Further in chapter 18 of Earth Science is a section describing El Niño. Read this section to help you better understand this phenomenon. As depicted in figure 18.23, the strong trade winds cause an equatorial current which flows from east to west in the Pacific Ocean under normal conditions. For reasons that are still unclear, this current can change directions, giving rise to the El Niño weather pattern.

Chapter 9 of Oceanography provides more details on this subject. In your notebook, describe the cause and effects of El Niño on regional conditions.
Local Winds

Global wind patterns show general trends. At the local level, wind direction can change for a variety of reasons.

Resources

Monsoon
Read page 524 of Earth Science as an introduction to monsoons. Read section 8.12 of Oceanography for more details on this subject. In your notebook, describe the causes and effects of Indian monsoons.

Land and Sea Breezes
Read the section on Land and Sea Breezes that starts on page 526 of Earth Science. Describe the causes and effects of the breezes described in this section.

Review your notes from chapter 16 of Earth Science on the differential heating of land and water. How does the differential heating of land and water affect land and sea breezes? Draw pictures of land and sea breezes in your notebook. If you were living at the beach, when would you feel an on-shore breeze blowing from the ocean to your house?

Mountain and Valley Breezes
Mountains and valleys alter wind patterns. Read the section on Mountain and Valley Breezes that starts on page 528 of Earth Science. In your notebook describe the causes and effects of mountain and valley breezes. Relate these concepts to those on page 487 in Figure 17.11 describing the processes that lift air.

Chinook and Santa Ana Winds
Read the section on Chinook and Santa Ana Winds that starts on page 528 of Earth Science. In your notebook describe the causes and effects of Chinook and Santa Ana winds.

Check for Understanding of Chapter 18
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 18 of Earth Science.

Fronts

Fronts are boundaries between air masses.

Resources
Moving Air Masses
Begin reading chapter 19 in Earth Science to learn about moving air masses and fronts, which are the boundaries between air masses. Cold fronts move cold air, whereas warm fronts move warm air. Compare and contrast cold and warm fronts in terms of the motion of air masses, and describe the weather these fronts bring.

Warm Front
URL: http://www.coursecompass.com

Draw a picture of a warm front in your notebook with the associated cloud formations. Notice the gentle wedge of air masses as the warm air gradually passes over the cold air. At a warm front, the cirrostratus clouds give a warning that precipitation is coming. Nimbostratus clouds eventually form, which bring steady rain. Watch the geoscience animation "Cold Front and Warm Fronts" available in CourseCompass.

Cold Fronts
URL: http://www.coursecompass.com

Draw a picture of a cold front in your notebook with the associated cloud formations. Notice the steeper grade between the air masses as the cold air pushes the warm air up. At a cold front, cumulonimbus clouds form, bringing heavy downpours, thunderstorms, and vigorous wind gusts. Watch the geoscience animation "Cold Front and Warm Fronts" available in CourseCompass.

GEODe Interactive: Slides 2027-2117
Insert and play the GEODe DVD on your computer. Using the narration active box in the bottom right corner of the screen, navigate to and review slides 2027-2117.

Weather Map

Watching the news on the television usually includes a view of a weather map.

Resources

Interpreting a Weather Map
URL: http://www.weather.com/

During your readings so far, there have been many examples of weather maps. Be sure you can interpret a weather map. Pages 548-551 of Earth Science show some examples. Warm fronts are shown with red semicircles, and cold fronts are shown with blue triangles. The air mass is moving in the direction the shapes are pointed. Make note of this as you look at the maps. If the blue triangles are pointing south, then the cold air mass is moving south.

As figure 19.10 in Earth Science shows, a developing front has alternating shapes, which shows that the air masses are moving in opposite directions on either side of the line. Review figure
19.10 to better understand how fronts are shown on a weather map.

You can visit the URL listed above to see the current national weather map and practice interpreting a weather map. The leading edge of a cold front has the most severe weather.

As you look at figure 19.11 in Earth Science, notice that city D has the most severe weather since it is located at the leading edge of the cold front. Cold fronts move faster than warm fronts. Afternoon summer thunderstorms can develop fairly quickly as a cold front moves through the area.

**GEODe Interactive: Slides 1418-1458**

Insert and play the GEODe DVD on your computer. Using the narration active box in the bottom right corner of the screen, navigate to and review slides 1418-1458.

### Electrical Storms

Thunderstorms can generate lightening.

### Resources

**Thunderstorms**  
Continue reading chapter 19 in Earth Science to help you better understand thunderstorms that generate lightning and thunder. Warm humid air needs to rise, which could occur near cold fronts as described in the previous section. What other conditions might cause warm humid air to rise?

### Tornadoes and Hurricanes

Tornadoes and hurricanes are weather systems that can have devastating effects.

### Resources

**Hurricanes**  
Read the section "Hurricanes" that starts on page 560 of Earth Science. By definition, a hurricane has winds of 74 mph or more. For a hurricane to form, the ocean temperature must be at least 80&deg;F. Write down the requirements for a tropical depression and tropical storm. As you read this section, describe how hurricanes and other large cyclonic weather systems form, move, and dissipate.

**Check for Understanding of Chapter 19**  
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your
understanding of the concepts from chapter 19 of Earth Science.

**Human Impact on Global Climate**

Climates on Earth were changing long before humans were prevalent on Earth. Human activity, however, can influence climate change.

**Resources**

**Anthropogenic Climate Change**
Read about human's impact on global climate, starting on page 584 of Earth Science.
The Solar System

As technology improves, so does the information that people can gather on the solar system. For example, Galileo was able to observe Jupiter's moons by using a telescope. Earth's solar system includes four dense inner terrestrial planets orbiting the sun, and four large outer Jovian planets that are less dense. Other objects rotate around the sun as well. After completing this section's activities, you will be able to do the following:

Describe Earth's solar system.

Explain how the sun, moon, and Earth are positioned during eclipses.

Topics

The Heliocentric Model

In Greek, helios means sun and kentron means center. The heliocentric model has the sun in the center of Earth's solar system.

Resources

Ancient Astronomy
Begin reading chapter 21 of Earth Science to help you appreciate the many ideas that different cultures had to explain their observations of the sky. As with all topics in science, the current understanding is based on discoveries made over time. The change in thinking from an Earth-centered model to a sun-centered model took thousands of years. The sun-centered model, with planets moving in circular orbits, did not explain the celestial observations. A more precise model was needed.

The Elliptical Orbit of Planets
Kepler helped with the current understanding of the elliptical path that planets take around the sun. Today, his discoveries are referenced as three laws. Continue reading in chapter 21 of Earth Science to learn about the current understanding of Earth's solar system. Kepler's second law relates to the speed at which planets revolve around the sun. Kepler's third law gives a formula to predict the time a planet takes to orbit the sun. Make flash cards listing Kepler's laws. To help with your learning, find a willing participant and explain Kepler's findings to them. Use your flash cards to reinforce your knowledge of Kepler's laws.

Astronomical Units
When measuring distances between planets and stars, measuring in meters or kilometers is cumbersome. Therefore, larger units are used. The average distance from the Earth to the sun is called one astronomical unit, or AU. When measuring length within the solar system, AUs are
Table 21.1 on page 608 in Earth Science shows the distance that planets are from the sun. You should know the order of the planets in the solar system. Light-years are used when measuring distances beyond the solar system. A light-year is actually a measure of length: the distance light travels in one year. When looking at a star 100 light-years away, what are you actually seeing?

The Heliocentric Solar System
In your notebook, write down Galileo's observations and how they influenced the establishment of the heliocentric model. Newton built upon this model by describing the forces involved in this model. On page 626 of Earth Science, you will notice a picture of the heliocentric solar system, with the sun in the center surrounded by orbiting planets. This arrangement has been deduced after hundreds of years of scientific observations and is now commonly taught in elementary school. Draw a diagram of the heliocentric model. The four dense rocky planets orbit closer to the sun, and the four large planets are much farther from the sun.

Observing the Night Sky

Understanding the solar system began by observing the night sky.

Resources

Celestial Sphere
To observe the night sky, you need to be away from city lights. Read the section "Positions in the Sky," starting on page 611 of Earth Science, which describes the celestial sphere. Box 21.2 in this section shows the placement of the constellations in relation to Earth and explains the reasoning for the 12 zodiac signs. The equatorial system is explained in this section. Appendix B on page 704 of Earth Science has more information on latitude and longitude. Using a grid system allows viewers to observe and discuss objects in the sky. Share what you enjoy about studying the night sky in the message board.

Retrograde Motion
Figure 21.6 in Earth Science shows why Mars might appear to be traveling backwards in the sky at times. Earth passes Mars on the inside of Mars's orbit, creating this illusion.

Identifying Objects
URLs:


A Planisphere http://www.washjeff.edu/physics/plan.html

Search for a Place in the U.S. http://www.census.gov/cgi-bin/gazetteer

Stars appear to be fixed objects in space and can be used as reference points in the sky. For
example, the Big Dipper has maintained the same configuration over time. As the Earth rotates, a person has a different viewing angle of the sky. Planets can be identified since they move in relation to fixed stars’ locations. You can see man-made satellites moving relatively quickly across the night sky because they are much closer than neighboring planets. A planisphere is a portable star chart, or map, that can help you locate constellations in the sky. To use it, you match its two attached disks to your date and time, allowing you to see which stars should be visible. Planispheres are designed for specific latitude zones, so you need to be sure that you are using one appropriate for your latitude.

There is a picture of a planisphere, found at the "Skymaps: Planispheres" website listed above.

From the "A Planisphere" website listed above, you can download, print, and construct a planisphere. Make sure you download the appropriate top plate based on your latitude.

If you live at or below 35 degreesN or at or above 55 degreesN, then you should probably search the Internet for a planisphere more appropriate for your location. If you are unsure what your latitude is, go to the "Search for a Place in the U.S." website listed above and enter your zip code.

Use your new planisphere to locate a constellation that you were previously unfamiliar with. Share your experience in the message board.

The Motions of Earth

Earth can act like a spinning top.

Resources

Earth's Orbital Parameters
Read the section "The Motions of Earth," starting on page 615 in Earth Science. In your notebook, write down a description of Earth’s precession. Recall the importance of Earth’s tilt in creating the seasons. The motions of Earth affect global climates.

Elliptical Movement
Earth moves around the sun in a slightly elliptical pattern. As you should recall, Kepler investigated the idea that planets have an elliptical path, versus a circular path.

To review this shape, refer to page 607, figure 21.11, in Earth Science, which depicts two different ellipses. The eccentricity of an ellipse is dependent on the distance between the foci. If the distance between the foci were zero, what shape would the ellipse have? Earth's path around the sun is almost a circle, but not quite. Asteroids and comets have more-eccentric paths around the sun than the Earth.

Look at figure 21.12 in Earth Science to review Kepler's law of equal areas. A comet far from the sun at aphelion moves slowly. Conversely, when the comet is close to the sun at perihelion, it moves quickly and also has a tail as the sun burns off some of the comet's ice.
Changes in Earth's Movement
There are three types of variation in Earth's orbit that have been recorded. Read the section titled "Variations in Earth's Orbit," starting on page 170 in Earth Science. Figure 6.24 in this section describes these changes. Earth's orbit around the sun changes on a 100,000-year cycle. The Earth's axis of rotation changes on a 41,000-year cycle. Earth's precession changes on a 26,000-year cycle. These cyclical events are thought to explain major climatic changes that have occurred over thousands of years.

Motions of the Earth-Moon System

As the moon orbits the Earth and the Earth orbits the sun, the lineup of these three bodies can cause some interesting effects.

Resources

Phases of the Moon
Read the section "Phases of the Moon" in chapter 21 of Earth Science (p. 618). Where is the moon in relation to the Earth and sun during a full moon? During a new moon? The sun is always lighting up half of the moon and Earth. It is the perspective from Earth that produces the phases of the moon.

Eclipses
Read "Eclipses of the Sun and Moon" in chapter 21 of Earth Science (p. 619). Where is the moon in relation to the Earth and sun during a lunar eclipse? During a solar eclipse? In your notebook, draw a diagram of each eclipse and label the umbra and penumbra. Using common household materials such as a flashlight and balls, create a demonstration to depict lunar and solar eclipses. Be sure you can demonstrate how each occurs and the results of each.

Check for Understanding of Chapter 21
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 21 of Earth Science.
Planets and Moons

There are eight planets, and some of these planets have moons. After completing this section's activities, you will be able to do the following:

- Describe the formation of the solar system.
- Describe the components of the solar system.

Topics

Formation of the Solar System

The solar system formed from rotating interstellar dust and gas.

Resources

Early Evolution of Earth
Take a moment to review the section "Early Evolution of Earth" back in chapter 1, page 11, of Earth Science. In your notebook, write down the importance of gravity in the formation of stars and planets from interstellar dust and in determining whether a body will be a star or a planet.

During the evolution of the solar system, rotating matter condensed and clumped together to form larger and larger pieces. This accretion (sticking together) continued as matter revolved around what would become the sun. Objects close to the sun were hotter than those far from the sun and therefore became more dense as gases burned off, leaving behind only metallic and rocky substances. In your notebook, describe the scientific explanation for the formation of the solar system.

Understanding Gravity
The effects of gravity are dependent on the distance between the objects involved and the mass of each object. The closer the objects and the higher their masses, the greater the gravitational effects will be between the objects.

Review the section "Sir Isaac Newton" from chapter 21 in Earth Science and be sure to understand Newton's law of universal gravitation. Newton described objects in motion in general, whereas Kepler's laws were specific to the path of planets in motion. Draw a picture of an object orbiting another object. Draw another picture with the object now orbiting a little farther away. In which of these two models is the gravitational force between the objects greater?

The majority of mass is in the center of the solar system, the present sun. The gravitational force of the sun keeps materials rotating around this center. Earth's moon is attracted to Earth due to the force of gravity. There is also a force propelling the moon forward that was created during the
Creating the Giant Planets
Carefully read the section "The Planets: An Overview" at the beginning of chapter 22 of Earth Science and the box on page 629 that describes why the Jovian planets are much larger than the four interior planets in the solar system.

Why are the four inner planets so much smaller than the outer planets? Because of their distance from the sun, the outer planets are colder. During the formation of the solar system, the accretion of ice and cold gases added to the mass of the outer planets. This increase in mass then increased the gravitational pull of the forming planet, thereby attracting even more mass. The increase in gravitational pull allowed the forming planet to hold gases even closer, causing the gaseous molecules to come closer together. Jupiter, for example, has hydrogen in its atmosphere and liquid hydrogen at its surface.

In your notebook, draw a picture of a planet with air molecules in its atmosphere. Then draw a second picture depicting how those same air molecules would behave if that same planet had a higher gravity. In this second picture, the air molecules should be drawn closer together. You should understand the effects of gravity on a planet's atmosphere.

Holding an Atmosphere
Gravity is important in determining whether a planet will be able to hold an atmosphere. The moon has one-sixth the gravity of Earth and consequently does not hold an atmosphere as Earth does. Conversely, Jupiter's huge gravitational forces create enormous pressures and cause hydrogen to be a liquid at its surface. Earth has enough gravity to hold an atmosphere and yet allow gases to persist, allowing for the existence of life.

As the section "The Atmosphere of the Planets" explains on page 628 in Earth Science, a planet's atmosphere depends on its mass and its temperature. The outer planets are colder and much more massive than Earth, which explains the existence of an atmosphere on these outer planets. Review this section in the text to further your understanding.

Reread the beginning of chapter 2 in Oceanography to review the origin of the solar system and the density stratification that created Earth's current layers.

GEODe Interactive: The Planets
Insert and play the GEODe DVD on your computer. Hover your mouse over "Earth's Place in the Universe" and click on "The Planets: An Overview," or navigate to slide 2118 using the narration active box in the bottom right corner of the screen. Review each slide in this section.

Earth's Moon
With a simple telescope, or even binoculars, you can see surface features of the moon. What caused these features?
Resources

Describing the Moon
Read the section titled "Earth's Moon" in chapter 22 of Earth Science, starting on page 629. In your notebook, write the description of the moon in terms of its relative size, mass, volume, density, general surface features, and general history.

GEODe Interactive: Earth’s Moon
Insert and play the GEODe DVD on your computer. Hover your mouse over "Earth's Place in the Universe" and click on "Earth's Moon," or navigate to slide 2147 using the narration active box in the bottom right corner of the screen. Review each slide in this section.

Planets

The greatest density of the solar system is at its center with the sun and the four rocky planets.

Resources

A Brief Tour
Earth in Perspective  https://web5.wgu.edu/aap/content/earth%20in%20perspective.pdf

Read the section "The Planets: A Brief Tour" in Earth Science, starting on page 632. For each planet, describe its type (rocky or gaseous), relative size, relative distance from the sun, general surface features, gravity, and special features (e.g., rings of Saturn, moons of Jupiter, etc.) in your notebook. The chart at the beginning of chapter 22 is also helpful.

The Earth in Perspective website listed above shows the relative sizes of the planets with each other. Figure 22.2 in Earth Science shows the relative sizes along with their order from the sun. Which planets are the dense, rocky planets? How far away is the farthest planet from the sun?

GEODe Interactive: A Brief Tour of the Planets
Insert and play the GEODe DVD on your computer. Hover your mouse over "Earth's Place in the Universe" and click on "A Brief Tour of the Planets," or navigate to slide 2175 using the narration active box in the bottom right corner of the screen. Review each slide in this section.

Composition and Motion of Galaxies, Asteroids, Comets, and Meteors

In a faraway galaxy, there are also asteroids and comets. Movies have been made about these. Should people be alarmed when an asteroid heads towards Earth?

Resources
**Objects in Space**
Read pages 643-649 in chapter 22 of Earth Science to better understand the terms asteroids, comets, and meteoroids. What are these things made of? What path do they take? What is found in the Kuiper Belt? What is found in the Oort Cloud?

**Compare Asteroids, Comets, and Meteoroids**
Compare asteroids, comets, and meteoroids. Make a three-circle Venn diagram to show similarities and differences between these things. Describe to a friend asteroids, comets, and meteoroids.

**Galaxies**
A galaxy is a massive system of stars. Use pages 692-695 in chapter 24 of Earth Science to understand the composition and movement of galaxies. In what galaxy is Earth located?

**Check for Understanding of Chapter 22**
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 22 of Earth Science.
Beyond Earth’s Solar System

The sun is just one star in the Milky Way galaxy. Young stars behave differently than old stars. When a star's fuel begins to be exhausted, heavier elements can be created. After completing this section’s activities, you will be able to do the following:

Describe properties of light.

Describe how stars use fuel.

Explain how black holes are formed.

Topics

Properties of Light and the Sun

By analyzing the light given off by stars, scientists can determine a star’s properties.

Resources

Spectroscopy

Scientists use spectroscopy to understand the composition of stars. Each gas atom has electrons at different energy levels. If an electron moves from a high energy level to a lower energy level, light waves are given off. When light is projected onto an atom, light waves are absorbed if the light’s energy matches with the atom’s difference in electron energy levels.

Read pages 654-656 (chapter 23) of Earth Science, which describe the concept of using spectroscopy to study astronomical bodies. As you read, write down in your notebook all the information on stars that can be gathered by studying the wavelength of light and spectroscopy.

Doppler Effect and Spectroscopy

Scientists use the Doppler effect of light rays to determine the radial velocity of stars in relation to the Earth. Light travels in waves. Different wavelengths determine the different colors of light. If a star is moving away from the Earth, the waves will be stretched and the appearance of the color of the star will be modified accordingly. If a star is moving toward the Earth, the light waves will be compressed and the appearance of the color of the star will be modified accordingly. Therefore, scientists can use the colors of stars to determine the stars’ movements in relation to the Earth.

Read pages 656-658 in chapter 23 of Earth Science. As you read, add to your list of information on stars that can be gathered by studying the wavelength of light and spectroscopy. Why is the Doppler effect not used to measure transverse velocity?
The Sun
Read the section "The Sun" in chapter 23 of Earth Science, pages 665-672. Make a labeled drawing describing the sun's structure and its surface, including sunspots (whose number cycles every 11 years). Include six layers of the sun in your drawing (inner core, radiative zone, convection zone, photosphere, chromosphere, and corona). In your notebook, describe the sun's process for moving energy.

It is important to understand how scientists make observations of the sun. Sunspots can be seen by projecting the sun's image through telescopes. Impressive details of the sun's surface (such as spicules and filaments) can be seen only by using photographic filters.

Check for Understanding of Chapter 23
URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 23 in Earth Science.

Stars
Stars evolve differently, depending on their size.

Resources
Observing Stars
Begin reading chapter 24 in Earth Science to better understand how scientists collect data on stars.

Hertzsprung-Russell Diagrams
Even the average person looking at the sky can tell that there are differences among the stars in the sky. Some stars appear big, some small. Some stars appear bright, while others quite dim. Over the years, numerous data have been recorded on stars. In 1912 Hertzsprung and Russell plotted attributes of stars and noted patterns. Hertzsprung and Russell's organization of collected data is referred to as the H-R diagram.

Read pages 681-683 in chapter 24 of Earth Science so that you are able to interpret information on the H-R diagram. Notice that the numbers on the axis do not necessarily go in the traditional direction. When interpreting an H-R diagram, you need to pay attention to the numbers on the axis.

Stellar Evolution
Read pages 684-692 of chapter 24 in Earth Science to help you understand stellar evolution. Notice on figure 24.12 in this chapter that medium- and high-mass stars go through a red-giant phase, which starts after the all usable hydrogen fuel is consumed. During this phase, heavier elements, such as carbon, are created. Take your time to understand the red-giant phase. All the
elements on the periodic table up to iron are made during the red-giant phase.

The section on "Burnout and Death" in chapter 24 describes what happens after all the fuel is used up and the star collapses. In high-mass stars, even elements heavier than iron are created before the supernova explosion spreads these elements into space.

**Black Holes**

From reading the section on stellar evolution, hopefully you will understand that only the high-mass stars can eventually form black holes. During a supernova, the star's core condenses. Read the section on black holes, starting on page 692 in Earth Science. What is emitted that helps scientists detect black holes?

**Check for Understanding of Chapter 24**

URL: http://www.coursecompass.com

Using the Earth Science (CourseCompass) website, take the chapter quiz to check your understanding of the concepts from chapter 24 of Earth Science.
Conclusion

Congratulations on completing all the sections for the Earth and Space Science course of study! As you now appreciate, Earth science covers a broad range of topics. Your studies included the physical properties of the Earth, weather patterns in Earth's atmosphere, the ocean environment where organisms live, and space beyond planet Earth. As a science teacher, you should comprehend how these topics are interrelated so that you can share the connections with your students. During your Earth science studies, you performed hands-on labs to apply your new knowledge. Share this experience with your students. What strategies helped you learn the material? Write these strategies down and share them with your students as you teach. You now need to demonstrate your competency in Earth science by passing the objective exam and performance assessment.

Topics

Objective Exam

Prepare for and then take the SEC4/5 objective exam.

Resources

Take the Pre-Assessment
Take the pre-assessment for the SEC4/5 exam. Use the following instructions to access the pre-assessment:

Log in to your MyWGU Student Portal.

Go to the "My AAP" tab.

In the list below "Course Details," find the assessment you are working on.

In the "Assessment Preparation" column, click "Pre-assessment."

In the window that pops up, click "Click here to refer for this pre-assessment." A request will be sent to your mentor for approval.

Once your mentor has approved your request, return to the "My AAP" tab and click "Pre-assessment" in the "Assessment Preparation" column.

In the window that pops up, click "Click here to take this pre-assessment." You will then begin the pre-assessment.

The results will provide a percentage for each of the topics in this course of study. You should
then review your notes for topics with low scores. The textbooks have quizzes to check your understanding. Another way to check your understanding is to start with blank paper and write down your understanding of the topic. Pretend you are teaching this topic to a student. You can also post your understanding in the message board for review. Once you have confidence with your new knowledge, take the pre-assessment again.

Take the SEC4/5 Objective Exam
Schedule the SEC4/5 exam after you pass the pre-assessment. Use the following instructions to schedule this exam:

Log in to your MyWGU Student Portal.

Go to the "My AAP" tab.

In the list below "Course Details," find the assessment you are working on.

In the "Assessment Scheduled Date" column, click "Schedule Now."

In the window that pops up, click "Search."

A new window will come up. In this window, you can either select a previously-used site or search for a different site approved by WGU. Select the site(s) by clicking on the box beside the name. This will move your selection(s) to the "Selected Sites" box.

Once you have selected at least one site, click "Update."

You will be returned to the previous window, and the site information will now be filled in. Click "Continue."

Enter three different potential dates with the times you can take the assessment. Note: The dates must be at least two weeks from the day you request the assessment.

Click "Continue" once your potential dates and times are filled in.

If there are other considerations you would like to inform the Assessment Delivery Team about, discuss them in the "Other Considerations" box that appears and then click "Continue." If not, simply click "Continue."

A request will be sent to your mentor for approval.

Once your mentor has approved your request, our Assessment Delivery Team will begin scheduling your assessment at the proctor site that you submitted. Once your assessment has been scheduled, you will receive a confirmation e-mail with the date, time, and proctor site. The status on your AAP will then change to "Scheduled."
Performance Assessment

Talk to your mentor about requesting the SEA4/5 through your AAP. Use the following instructions to request the SEA4/5 performance assessment:

Log in to your MyWGU Student Portal.

Go to the "My AAP" tab.

In the list below "Course Details," find the assessment you are working on.

In the "Assessment Scheduled Date" column, click "Schedule Now."

A new window will come up. If there are other considerations you would like to inform the Assessment Delivery Team about, discuss them in the "Other Considerations" box that appears and then click "Continue." If not, simply click "Continue."

A request will be sent to your mentor for approval.

Once your mentor has approved your request, our Assessment Delivery Team will open the tasks required for the assessment in TaskStream. You will log in to TaskStream to receive the instructions, see the rubric, and submit your assessment for grading.

After requesting this exam, you will be able to access the SEA tasks within TaskStream. The tasks can be completed in any order. The directions for each task are in TaskStream. Visit the message board for clarifications on the task directions. If you need help, contact your mentor.

For your convenience, screenshots showing the instructions for each performance task related to this course of study are available at the links below. Please note that the instructions may change slightly from time to time. For the most up-to-date instructions, evaluation rubrics, and other related material, please log in to TaskStream. You will not have access to these tasks in TaskStream until you request them through your AAP and your mentor approves your request.

TaskStream SEA4/5Task Earth's Motion

TaskStream SEA4/5Task Galileo

TaskStream SEA4/5Task Geological Time

TaskStream SEA4/5Task Greenhouse Effect

TaskStream SEA4/5Task Major Wind Systems

TaskStream SEA4/5Task Properties of Seawater
Resources

Properties of Seawater Task
Water Experiments
https://web5.wgu.edu/aap/content/amnh%20water%20experiments%201%20and%202.pdf

Sinking Water Activity http://www.amnh.org/education/resources/rfl/pdf/dsv_a02_sinking.pdf

To complete the Properties of Water task you will need to access the Water Experiment and Sinking Water Activity websites listed above.

Feedback

If you wish to provide feedback on this course of study, please contact Rob Duncan at rduncan@wgu.edu.

Click here to review University ADA policy.