

Earth/Environmental Support Document



Earth/Environmental Science Support Documents 2004 Curriculum

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Curriculum Support**

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This document was developed in response to the expressed needs of earth/environmental science teachers for materials to enhance the teaching of the revised *North Carolina Standard Course of Study for Science*. The materials provide a guide for translating the goals and objectives of the earth and environmental science curriculum into good instructional design.

A group of dedicated and talented science teachers spent many hours developing these materials. The result is this resource that will facilitate the implementation of the North Carolina Science Curriculum.

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Laura Berube, Kenan Fellow
Susan Escobar, Lincoln County Schools
Lynn Gronback, Orange County Schools
Dick Hilliard, Henderson County Schools
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Every effort is made to keep these materials accurate and up to date. Check the Department of Public Instruction's website <http://www.ncpublicschools.org/curriculum/science/scos/> for the most current version.

Please send your comments to:
Benita B. Tipton, M.Ed.
Secondary Division Science Consultant
North Carolina Department of Public Instruction
301 North Wilmington Street
Raleigh, NC 27699
Email: btipton@dpi.state.nc.us

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Introduction

This support document includes the *North Carolina Standard Course of Study* for Earth/Environmental Science goals and objectives along with detailed content description, a list of enrichment topics, a collection of activities, and lab investigations.

Earth/Environmental Science is intended to be a laboratory and field-based course.

These activities serve as examples of appropriate investigations and are not sufficient in number for this course.

The detailed content descriptions should serve as a minimum and not a maximum for earth and environmental courses. Teachers should differentiate instruction according to the needs and interests of their students.

Goal 1 is included to emphasize the importance of science as inquiry. Students should be provided many opportunities to apply, analyze, evaluate, and share data which they have experimentally collected. The materials should be taught and assessed in a manner that requires students to collect and analyze data.

Goals

The Earth/Environmental Science curriculum focuses on the function of Earth's systems. Emphasis is placed on matter, energy, plate tectonics, origin and evolution of the earth and solar system, environmental awareness, materials availability, and the cycles that circulate energy and material through the earth system. This section introduces teachers to the program strands and unifying concepts. During instruction, these concepts should be woven through the content goals and objectives of the course. Supplemental materials providing a more detailed explanation of the goals, objectives, and strands, with specific recommendations for classroom and/or laboratory implementation are available through the Department of Public Instruction's Publications Section.

Strands

The strands are: Science as a Human Endeavor, Historical Perspectives, Nature of Scientific Knowledge, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives. They provide the context for teaching of the content Goals and Objectives.

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Unifying Concepts

The following unifying concepts should unite the study of various Earth and environmental topics across grade levels.

Unifying Concepts	Ideas for integrating the unifying concepts
Systems, Order and Organization	<ul style="list-style-type: none">• Geologic systems• Ecological systems• Technological systems• Earth monitoring systems• Energy distribution systems
Evidence, Models, and Explanation	<ul style="list-style-type: none">• Climate models• Solar system models• Rock evidence
Constancy, Change, and Measurement	<ul style="list-style-type: none">• Measurement is key to scientific understanding.• Use various tools and units of measurement in investigations.
Evolution and Equilibrium	<ul style="list-style-type: none">• Changes over time• Plate tectonics• Formation of the universe• Stellar evolution
Form and Function	<ul style="list-style-type: none">• Physical and chemical properties of minerals• Equipment design• Economic resources

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The Strands: Nature of Science

This strand is divided into three sections: Science as a Human Endeavor, Historical Perspectives, Nature of Scientific Knowledge, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives. These sections are designed to help students understand the human dimensions of science, the nature of scientific thought, and the role of science in society. The earth and environmental sciences are rich in examples of science as a human endeavor, its historical perspectives, and the development of scientific understanding.

Strands	Ideas for integrating these strands
<p><i>Science as a Human Endeavor</i></p> <p>Intellectual honesty and an ethical tradition are hallmarks of the practice of science. The practice is rooted in accurate data reporting, peer review, and making findings public. This aspect of the nature of science can be taught by designing instruction that encourages students to work collaboratively in groups to design investigations, formulate hypotheses, collect data, reach conclusions, and present their findings to their classmates.</p> <p>The content studied in Earth/Environmental science is an opportunity to present science as the basis for civil engineering, mining, geology, oceanography, astronomy, and the environmental technical trades. The content diversity lets us look at science as a vocation. Scientist and technician are just two of the many careers in which an earth and environmental sciences background is necessary.</p> <p>Perhaps the most important aspect of this strand is that science is an integral part of society and is therefore relevant to students' lives.</p>	<ul style="list-style-type: none">• Design inquiry activities which allow all students to collect data and report their findings to their peers for review.• Encourage students to explore how Earth/Environmental science is an integral part of many diverse vocations.• Demonstrate using newspaper and magazine articles, and web resources the importance of understanding Earth/Environmental science.

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Strands	Ideas for integrating these strands
<p><i>Historical Perspectives</i></p> <p>Most scientific knowledge and technological advances develop incrementally from the labors of scientists and inventors. Although science history includes accounts of serendipitous scientific discoveries, most development of scientific concepts and technological innovation occurs in response to a specific problem or conflict. Both great advances and gradual knowledge building in science and technology have profound effects on society. Students should appreciate the scientific thought and effort of the individuals who contributed to these advances. Some examples are Eratosthenes' determination of the size of the earth, Wegener's apparent "fit" of the continents, Kepler's laws of planetary motion, and James Hutton's simple yet powerful idea that Earth's history must be explained by what we see happening now. Today, Hutton's uniformity of process principle is used to interpret the structure of landing sites on Mars.</p>	<ul style="list-style-type: none">• Allow students to investigate the diverse group of scientists and cultures who have contributed to our understanding of earth/environmental science.• Scientists to investigate: (This list is not comprehensive and is only to show examples)<ul style="list-style-type: none">• Alfred Wegener• Johannes Kepler• James Hutton• Galileo Galilei• Isaac Newton• Edwin Hubble• Carolyn Shoemaker• Mary Leaky• Evan B. Forde• Mae C. Jemison• Ellen Ochoa

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Strands	Ideas for integrating these strands
<p><i>Nature of Scientific Knowledge</i> Much of what is understood about the nature of science must be explicitly addressed:</p> <ul style="list-style-type: none"> • All scientific knowledge is tentative, although many ideas have stood the test of time and are reliable for our use. • Theories "explain" phenomena that we observe. They are never proved; rather, they represent the most logical explanation based on currently available evidence. Theories become stronger as more supporting evidence is gathered. They may be modified as new data is gathered or existing data is interpreted in different ways. They provide a context for further research and give us a basis for prediction. For example, the Theory of Plate Tectonics explains the movement of lithospheric plates. • Laws are fundamentally different from theories. They are universal generalizations based on observations of the natural world, such as the nature of gravity, the relationship of forces and motion, and the nature of planetary movement. <p>Scientists, in their quest for the best explanations of natural phenomena, employ rigorous methods. Scientific explanations must adhere to the rules of evidence, make predictions, be logical, and be consistent with observations and conclusions. "Explanations of how the natural world changes based on myths, personal beliefs, religious values, mystical inspiration, superstition, or authority may be personally useful and socially relevant, but they are not scientific." <i>(National Science Education Standards, 1996, p. 201)</i></p>	<ul style="list-style-type: none"> • Encourage students to explore the difference between a theory and a law. • Discuss with students how scientific explanations undergo rigorous scrutiny. • Have a discussion about "What is Science".

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Strands	Ideas for integrating these strands
<p><i>Science as Inquiry</i></p> <p>Inquiry should be the central theme in earth/environmental science. It is an integral part of the learning experience and may be used in both traditional class problems and laboratory experiences. The essence of the inquiry process is to ask questions that stimulate students to think critically and to formulate their own questions. Observing, classifying, using numbers, plotting graphs, measuring, inferring, predicting, formulating models, interpreting data, hypothesizing, and experimenting help students build knowledge and communicate what they have learned. Inquiry applies creative thinking to new and unfamiliar situations. Students should learn to design solutions to problems that interest them. This may be accomplished in a variety of ways, but situations that present a discrepant event or ones that challenge students' intuitions have been successful. For example, traditional labs, which emphasize observation of the sun or identification and classification of sediments, may be quite appropriate. These labs should, however, lead to open-ended explorations such as investigation of sun spot activity or the factors that influence the sorting of sediments. Although original student research has often been relegated to a yearly science fair project, continuing student research contributes immensely to understanding of the process of science and to problem-solving abilities. Earth/Environmental science provides many opportunities for inquiry. "Why does the location of sunrise or sunset change through the year?" "Why are sedimentary rock layers tipped at an angle?" "Why do sunspots move faster near the sun's equator?" The processes of inquiry, experimental design, investigation, and analysis are as important as finding the correct answer. Students will acquire much more than facts and manipulative skills; they will learn to be critical thinkers. A solid conceptual base of scientific principles, as well as knowledge of science safety is necessary for inquiry. Students should be given a supportive learning environment based on how scientists and engineers work. Adherence to all science safety criteria and guidelines for classroom, field, and laboratory experiences is imperative. Contact the Science Section at DPI for information and professional development opportunities regarding North Carolina specific Science Safety laws, codes, and standards. The Science Section is spearheading a statewide initiative entitled <i>NC-The Total Science Safety System</i>.</p>	<ul style="list-style-type: none"> • Because of the importance of science as inquiry, this strand has been integrated into Goal 1: The learner will develop abilities necessary to do and understand scientific inquiry. • This strand should be integrated into the entire course and not just taught as a separate "lab introduction" unit.

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Strands	Ideas for integrating these strands
<p><i>Science and Technology</i> It is impossible to learn science without developing some appreciation of technology. Therefore, this strand has a dual purpose: (a) developing students' knowledge and skills in technological design, and (b) enhancing their understanding of science and technology. The methods of scientific inquiry and technological design share many common elements - objectivity, clear definition of the problem, identification of goals, careful collection of observations and data, data analysis, replication of results, and peer review. Technological design differs from inquiry in that it must operate within the limitations of materials, scientific laws, economics, and the demands of society. Together, science and technology present many solutions to problems of survival and enhance the quality of life. Technological design plays an important role in earth/environmental science. For example, telescopes, lasers, satellites, transistors, graphing calculators, personal computers, and seismographs have changed our lives, increased our knowledge of earth/environmental science, and improved our understanding of the universe.</p>	<ul style="list-style-type: none"> • Provide opportunities for students to utilize technology to collect and analyze data in laboratory settings. • Allow students to brainstorm ways that technology can be used to enhance scientific study in the future. • Discuss the limitations of technology in scientific study.
<p><i>Science in Personal and Social Perspectives</i> This strand helps students formulate a basic understanding of and implied actions for many issues facing our society. The fundamental concepts that form the basis for this strand include:</p> <ul style="list-style-type: none"> • Environmental Quality - Students should develop an appreciation for factors that influence their need and responsibility to maintain environmental quality, including waste disposal and recycling of limited natural resources. The ability to make appropriate decisions based on cost-benefit and risk analysis is an integral part of the study of earth and environmental science. "Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, over-consumption, the capacity of technology to solve problems, poverty, the role of economic, political, and religious views, and different ways humans view the earth." (<i>National Science Education Standards</i>, 1996, p. 198). • Natural and Human-Induced Hazards - The study of earth and environmental science encourages students to investigate the effects of natural phenomena and human induced changes in natural systems on society. Appropriate examples include 	<ul style="list-style-type: none"> • Investigate factors that influence environmental quality: <ul style="list-style-type: none"> • population growth • resource use • population distribution • over-consumption • the capacity of technology to solve problems • poverty • role of economic, political, and religious views • different ways human view earth • Provide opportunities for students to develop an appreciation for their environment. • Research natural and human induced hazards and how these relate to the citizens of North Carolina. • Discuss how science has improved our environment.

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Strands	Ideas for integrating these strands
<p>natural phenomena such as earthquakes and human-induced changes such as increased carbon dioxide in the atmosphere. Students will acquire the ability to assess natural and human induced hazards - ranging from relatively minor risks to catastrophic events with major risk, as well as the accuracy with which these events can be predicted. It is particularly important for students to relate such phenomena to North Carolina and its citizens.</p> <ul style="list-style-type: none"> • Science and Technology in Local, National, and Global Challenges - Along with the need to understand the causes and extent of environmental challenges related to natural and man-made phenomena, students should become familiar with the advances proper application of scientific principles and products have brought to environmental enhancements. Topics such as improved energy use, reduced vehicle emissions, and improved crop yields are just some examples of how the proper application of science has improved the quality of life. This strand will help students make rational decisions in the use of scientific and technological knowledge. <p>"Understanding basic concepts and principles of science and technology should precede active debate about the economics, policies, politics, and ethics of various science and technology-related challenges. However, understanding science alone will not resolve local, national, or global challenges." (<i>NSES</i>, 1996, p. 199). The <i>NSES</i> emphasize that students should understand the appropriateness and value of basic questions 'What can happen?' - 'What are the odds?' - and 'How do scientists and engineers know what will happen?'" (<i>NSES</i>, 1996, p. 199).</p>	<ul style="list-style-type: none"> • Debate various science and technology challenges.

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COMPETENCY GOAL 1: The learner will develop abilities necessary to do and understand scientific inquiry in the earth and environmental sciences.	
<i>Objective</i>	<i>Content Description</i>
<p>1.01 Identify questions and problems in the earth and environmental sciences that can be answered through scientific investigations.</p>	<p>This objective has been designed by teachers to address the specific needs of this curriculum. The goal one objectives are an <i>integral</i> part of <i>each of the other goals</i>. In order to measure and investigate scientific phenomena, students must be given the opportunity to design and conduct their own investigations in a safe laboratory.</p>
<p>1.02 Design and conduct scientific investigations to answer questions related to earth and environmental science.</p> <ul style="list-style-type: none"> • Create testable hypotheses. • Identify variables. • Use a control or comparison group when appropriate. • Select and use appropriate measurement tools. • Collect and record data. • Organize data into charts and graphs. • Analyze and interpret data. • Communicate findings. 	
<p>1.03 Evaluate the uses of satellite images and imaging techniques in the earth and environmental sciences</p>	
<p>1.04 Apply safety procedures in the laboratory and in field studies:</p> <ul style="list-style-type: none"> • Recognize and avoid potential hazards. • Safely manipulate materials and equipment needed for scientific investigations. 	
<p>1.05 Analyze reports of scientific investigations and environmental issues from an informed scientifically literate viewpoint including considerations of:</p> <ul style="list-style-type: none"> • Appropriate sample. • Adequacy of experimental controls. • Replication of findings. • Alternative interpretations of data. 	
<p>1.06 Identify and evaluate a range of possible solutions to earth and environmental issues at the local, national, and global level including considerations of:</p> <ul style="list-style-type: none"> • Interdependent human and natural systems. • Diverse perspectives. • Short and long range impacts. • Economic development, environmental quality and sustainability. • Opportunities for and consequences of personal decisions. • Risks and benefits of technological advances. 	

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COMPETENCY GOAL 2: The learner will build an understanding of lithospheric materials, tectonic processes, and the human and environmental impacts of natural and human-induced changes in the lithosphere.		
<i>Objective</i>	<i>Content Description</i>	<i>Suggested Activities/Resources</i>
<p>2.01 Analyze the dependence of the physical properties of minerals on the arrangement and bonding of the atoms.</p>	<ul style="list-style-type: none"> • Will develop an understanding of how physical properties such are determined by the chemistry of the mineral such as streak, color, luster, cleavage, fracture, and hardness • Demonstrate an understanding of the variables involved in determining mineral crystal structure. 	<p>Review physical properties:</p> <ul style="list-style-type: none"> • Field Identification of Minerals- This lab will review physical properties of minerals. • Learning to Calculate Specific Gravity - students will develop the skill of calculating the physical property of specific gravity as it relates to mineral identification <p>Construct molecular models of mineral families –examples - halides, silicates, carbonates, and oxides</p>
<p>2.02 Analyze the historical development of the theory of plate tectonics.</p>	<ul style="list-style-type: none"> • Understand the scientific ideas and evidence that led to the theory of plate tectonics. • Analyze the relationship between the type of plate boundary and the locations of various features such as ocean trenches, mountain ranges and mid-ocean ridges. 	<p>Earthquakes and Volcanoes Lessons in <i>ArcView</i> or <i>ArcVoyager</i>. (See resource page for info on obtaining this free software.)</p> <ul style="list-style-type: none"> • These lessons assist students in investigating the magnitude of a quake to its relative depth and rock type. Are there patterns and trends? <p>Project: Create a mural showing significant events in history of Plate Tectonics</p>

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<i>Objective</i>	<i>Content Description</i>	<i>Suggested Activities/Resources</i>
<p>2.03 Investigate and analyze the processes responsible for the rock cycle:</p> <ul style="list-style-type: none"> • Analyze the origin, texture and mineral composition of rocks. • Trace the path of elements through the rock cycle. • Relate rock formation to plate tectonics. • Identify forms of energy that drive the rock cycle. • Analyze the relationship between the rock cycle and processes in the atmosphere and hydrosphere. 	<ul style="list-style-type: none"> • Analyze the relationship between density of magmas and igneous rock texture and mineral composition. • Describe the rock cycle in enough detail to relate the formation and destruction of the three major rock types to the forces responsible: including physical and chemical weathering, heat and pressure, deposition, foliation and bedding. Forms of energy that drive the rock cycle include: heat, gravitational potential energy, mechanical. 	<p>Use and create keys, charts or flow charts to identify rocks.</p> <p>Have students determine the densities for various intrusive and extrusive igneous samples. Have them rank the samples in order from most to least dense.</p> <p>Enrichment: Research the presence of arsenic in well water. What is the relationship of arsenic in well water and proximity to mining operations? Investigate and report on how this issue is currently monitored.</p>
<p>2.04 Analyze seismic waves including velocity and refraction to:</p> <ul style="list-style-type: none"> • Infer Earth's internal structure. • Locate earthquake epicenters. • Measure earthquake magnitude. • Evaluate the level of seismic activity in North Carolina. 	<ul style="list-style-type: none"> • Interpret how P and S waves have helped scientists theorize about Earth's internal structure. • Understand the quantitative values given on the Richter scale, moment magnitude scale, and the modified-Mercalli Scale. 	<p>Video: NOVA <u>The Day the Earth Shook</u></p> <p>NC Geological Survey-search for NC seismic activity http://www.iris.edu/seismon/ See current earthquake activity.</p> <p><u>Be a Virtual Seismologist - http://www.sciencecourseware.com/VirtualEarthquake/</u> online activity that addresses the goals for this section.</p> <p>See resource page for additional links and to download the FREE software Seismic Waves and Seismic Eruption.</p>

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COMPETENCY GOAL 2: The learner will build an understanding of lithospheric materials, tectonic processes, and the human and environmental impacts of natural and human-induced changes in the lithosphere.		
<i>Objective</i>	<i>Content Description</i>	<i>Suggested Activities/Resources</i>
<p>2.05 Create and interpret topographic, soil and geologic maps using scale and legends</p>	<ul style="list-style-type: none"> • Emphasis should be placed on maps of your local area and of North Carolina’s landscape and soil content. • Interpret various contour and geologic maps to the extent that conclusions regarding direction of water flow, elevation, steepness of slope, and patterns associated with formation and ages of rock types can be drawn. • Explain the importance of consistent use of symbols when mapping. 	<p>Basic Mapping Students learn pace and bearing and how it applies to map making.</p> <p>Compass Game a game that teaches students how to use a compass/</p> <p>Contour Mapping - Students learn how to do stick and string, how to map elevation changes and how to read topo maps.</p> <p>Enrichment: Use GPS units to focus on mapping and science activities www.geocaching.com</p>
<p>2.06 Investigate and analyze the importance and impact of the economic development of earth’s finite rock, mineral, soil, fossil fuel and other natural resources to society and our daily lives:</p> <ul style="list-style-type: none"> • Availability. • Geographic distribution. • Conservation/Stewardship. • Recycling. • Environmental impact. • Challenge of rehabilitation of disturbed lands 	<ul style="list-style-type: none"> • Identify natural resources and explain their association with plate tectonics and rock formations. • Explain the meaning of sustainable use of natural resources. • Explain examples of conservation and stewardship practices in your local area and of North Carolina such as agriculture, land use patterns, transportation, wildlife, forestry, mining, fisheries and marine environments. 	<p>Investigate the history of mining in North Carolina or your area. Research the economic value of minerals in NC economy.</p> <p>Cookie Mining Activity</p> <p>Research conservation and stewardship practices in your local area and in North Carolina such as agriculture, land use patterns, transportation, wildlife, forestry, mining, fisheries and marine environments.</p>
<p>2.07 Analyze the sources and impacts of society’s use of energy.</p> <ul style="list-style-type: none"> • Renewable & nonrenewable sources • The impact of human choices on Earth and its systems 	<ul style="list-style-type: none"> • Discuss the sources and consequences of climate change, smog and thermal pollution. • Investigate the advantages and disadvantages of various traditional (hydroelectric, coal, nuclear, natural gas) and alternative (geothermal, solar, wind) sources of energy in this country. 	<p>Power Shift video (video on renewable energy)</p>

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<i>Competency Goal 3: The learner will build an understanding of the origin and evolution of the earth system.</i>		
<i>Objective</i>	<i>Content Description</i>	<i>Suggested Activities/Resources</i>
<p>3.01 Assess evidence to interpret the order and impact of events in the geologic past:</p> <ul style="list-style-type: none"> • Relative and absolute dating techniques. • Statistical models of radioactive decay. • Fossil evidence of past life. • Uniformitarianism. • Stratigraphic principles. • Divisions of Geologic Time • Origin of the earth system. • Origin of life. 	<ul style="list-style-type: none"> • Compare absolute and relative age, understand the laws associated with relative age of rock formation and explain how half-life is used to determine actual age. • Relate geologic changes to major events including extinction and ice ages. • Diagram the main types of unconformities. • Explain how different types of fossils are formed. • Explain the theory of earth's origin and early characteristics including the processes of volcanic out-gassing with the formation of the ocean and atmosphere. • Discuss hypotheses of the origin of life. 	<p><u>Wet and Cold</u> - a lab about radioactive decay</p> <p><u>Radioactive Decay</u></p> <p>Project: <u>Geologic Calendar</u> Have students construct a geologic time calendar and investigate geologic time.</p> <p><u>http://people.uncw.edu/laws/gly337/Types.htm</u>- Website that discusses types of fossils</p>
<p>3.02 Evaluate the geologic history of North Carolina.</p>	<ul style="list-style-type: none"> • Relate current North Carolina geologic landforms to North Carolina's geologic history. 	<p><u>http://www.appalachiantales.com/geologic_history.htm</u>- Website that discusses the geology of the Appalachian Mts.</p>

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COMPETENCY GOAL 4: The learner will build an understanding of the hydrosphere and its interactions and influences on the lithosphere, the atmosphere, and environmental quality.		
<i>Objective</i>	<i>Content Description</i>	<i>Suggested Activities and Resources</i>
<p>4.01 Evaluate erosion and depositional processes:</p> <ul style="list-style-type: none"> • Formation of stream channels with respect to the work being done by the stream (i.e. down-cutting, lateral erosion, and transportation). • Nature and characteristics of sediments. • Effects on water quality. • Effect of human choices on the rate of erosion. 	<ul style="list-style-type: none"> • Observe and evaluate the effects of sedimentation on water quality. • Identify human activities that influence the rates of sedimentation in streams and rivers. • Evaluate water quality (biotic index, physical and chemical properties). 	<p>Project: Collect and analyze data for a local stream over time. Have students communicate their findings – such as PowerPoint presentations.</p>
<p>4.02 Analyze mechanisms for generating ocean currents and upwelling:</p> <ul style="list-style-type: none"> • Temperature. • Coriolis Effect. • Climactic influence. 	<ul style="list-style-type: none"> • Understand how the density of ocean water is affected by temperature and how this results in ocean currents. • Determine how the Coriolis Effect influences the ocean. • Relate ocean currents to atmospheric circulation. • Explain the cause of upwelling and its influence on biotic communities. • Compare and contrast different methods for obtaining ocean data such as waves, currents, sea surface temperatures, primary productivity, etc. 	<p>Classroom Activities on Oceanography - http://topex-www.jpl.nasa.gov/education/activities.html</p>
<p>4.03 Analyze the mechanisms that produce the various types of shorelines and their resultant landforms:</p> <ul style="list-style-type: none"> • Nature of underlying geology. • Long and short term sea-level history. • Formation and breaking of waves on adjacent topography. • Human impact. 	<ul style="list-style-type: none"> • Explain how underlying geology affects shorelines and landforms. • Explain the concept of isostatic adjustment. • Explain how barrier islands form and change over time. • Study the effects of human efforts to stabilize the shoreline. • Explain how humans and natural forces such storms impact shore lines. 	<p>Give students photographs of a beach before and after the construction of jetties or other structures, and have them describe and explain the differences they see.</p>
<p>4.04 Evaluate water resources:</p> <ul style="list-style-type: none"> • Storage and movement of groundwater. • Ecological services provided by the ocean. • Environmental impacts of a growing human population. • Causes of natural and manmade contamination 	<ul style="list-style-type: none"> • Illustrate the movement of groundwater. • Describe the ecological services provided by the ocean. • Describe how population growth affects the amount and quality of usable water. • Investigate water contaminants and determine their sources. • Diagram the global water cycle. 	<p>http://water.usgs.gov/education.html- USGS water resource page</p>

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COMPETENCY GOAL 4: The learner will build an understanding of the hydrosphere and its interactions and influences on the lithosphere, the atmosphere, and environmental quality.		
<i>Objective</i>	<i>Content Description</i>	<i>Suggested Activities and Resources</i>
<p>4.05 Investigate and analyze environmental issues and solutions for North Carolina’s river basins, wetlands, and tidal environments:</p> <ul style="list-style-type: none"> • Water quality. • Shoreline changes. • Habitat preservation 	<ul style="list-style-type: none"> • Assess the water quality of North Carolina rivers and describe possible clean up options. • Investigate how coastal development affects shoreline change. • Investigate the issue of non-point water pollution sources and their effect on water quality, specifically in the area of storm water runoff and sedimentation caused by forestry, farming, and housing developments in NC. • Assess the value of riparian buffers. • Assess the economic and ecological cost and benefits of groins, jetties, and sea walls. 	<p>http://www.bergen.org/AAST/Projects/ES/BS/BeachFactsSY.html - An interactive map of a beach</p> <p>http://www.epa.gov/weatherchannel/stormwater.html - A site that explains storm water runoff</p>

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COMPETENCY GOAL 5: The learner will build an understanding of the dynamics and composition of the atmosphere and its local and global processes influencing climate and air quality.		
<i>Objective</i>	<i>Content Description</i>	<i>Suggested Activities/Resources</i>
<p>5.01 Analyze air masses and the life cycle of weather systems:</p> <ul style="list-style-type: none"> • Planetary wind belts. • Air masses. • Frontal systems. • Cyclonic systems. 	<ul style="list-style-type: none"> • Explain factors that affect air density and understand their influence on winds, air masses, fronts and storm systems. • Analyze how weather is influenced by geography and the earth-sun relationship. 	<p>Jetstream an online weather school NOAA: http://www.srh.weather.gov/jetstream/global/global_intro.htm</p>
<p>5.02 Evaluate meteorological observing, analysis, and prediction:</p> <ul style="list-style-type: none"> • Worldwide observing systems. • Meteorological data depiction. 	<ul style="list-style-type: none"> • Investigate technological resources for observing, analyzing and predicting weather. • Interpret and analyze weather maps and relative humidity charts. • Identify the importance of water vapor and its influence on weather (clouds, relative humidity, dew point, precipitation). 	<p>Use weather instruments to collect weather data, analyze, and present findings. Send data to GLOBE www.globe.gov or to The Ceres S'cool Project http://asd-www.larc.nasa.gov/SCOOL/ or to some other agency.</p>
<p>5.03 Analyze global atmospheric changes including changes in CO₂, CH₄, and stratospheric O₃ and the consequences of these changes:</p> <ul style="list-style-type: none"> • Climate change. • Changes in weather patterns. • Increasing ultraviolet radiation. • Sea level changes. 	<ul style="list-style-type: none"> • Explain the inter-relationship between the atmosphere and lithosphere. • Analyze changes in atmospheric composition and predict potential changes in the future. • Identify human impacts on the atmosphere and air quality. • Explain how climate is determined. 	<p>Investigate the relationship between industry and changes in atmospheric chemistry.</p> <p>Research and present different theories regarding the formation of the atmosphere and the hydrosphere.</p> <p><u>Power Shift</u> Video</p>

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COMPETENCY GOAL 6: The learner will acquire an understanding of the earth in the solar system and its position in the universe.		
<i>Objective</i>	<i>Content Description</i>	<i>Suggested Activities/Resources</i>
<p>6.01 Analyze the theories of the formation of the universe and solar system.</p>	<p>Examine the different scientific theories centered around the formation of the universe and solar system.</p> <p>Formation of the Universe:</p> <ul style="list-style-type: none"> • Big Bang theory • Steady State theory • Inflation theory 	<p>Modeling the Universe and Scale Model of the Solar System http://cfa-www.harvard.edu/seuforum/mtu/ Have students model the universe and explain their model to the class. (good assessment tool)</p> <p>A primer on the formation of the universe. http://cosmology.berkeley.edu/Education/IUP/Big_Bang_Primer.html</p> <p>Activities from Cosmic Questions – See resource guide.</p>
<p>6.02 Analyze planetary motion and the physical laws that explain that motion:</p> <ul style="list-style-type: none"> • Rotation. • Revolution. • Apparent diurnal motions of the stars, sun and moon. • Effects of the tilt of earth’s axis. 	<ul style="list-style-type: none"> • Investigate Newton and Kepler’s laws of motion. • Compare and contrast rotation and revolution. • Describe the effect of the earth’s tilt on world climate. 	<p>Plot changes in angle and length of shadow over time.</p> <p><u>The Universe at Your Fingertips</u>- A resource notebook of activities published by the Astronomical Society of the Pacific</p> <p>http://www.classzone.com/books/earth_science/terc/content/visualizations/es0408/es0408page01.cfm?chapter_no=visualization</p> <p>An Applet of the Earth’s Revolution</p> <p>Enrichment: http://www.csr.utexas.edu/grace/education/activities/pdf/What_if_Kepler.pdf- A lab about Kepler’s laws using graphing calculators</p>

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COMPETENCY GOAL 6: The learner will acquire an understanding of the earth in the solar system and its position in the universe.		
<i>Objective</i>	<i>Content Description</i>	<i>Suggested Activities/Resources</i>
<p>6.03 Examine the sources of stellar energies:</p> <ul style="list-style-type: none"> • Life cycle of stars. • Hertzsprung –Russell Diagram. 	<ul style="list-style-type: none"> • Describe the formation and stage development of a star. • Create, interpret and analyze the H-R Diagram. 	<p>Plot stars - create the H-R Diagram using 60 randomly selected stars.</p> <p>Activities on Stellar Evolution from NASA- http://imagine.gsfc.nasa.gov/docs/teachers/lifecycles/Imagine2.pdf</p> <p><u>Stellar Evolution-</u> http://chandra.harvard.edu/edu/formal/stellar_ev/</p> <p>An H-R diagram simulator- http://www.astro.ubc.ca/~scharein/a311/Sim/hr/HRdiagram.html</p> <p>Show H-R diagram using Starry Night .</p>
<p>6.04 Assess the spectra generated by stars and our sun as indicators of motion and composition (the Doppler Effect).</p>	<ul style="list-style-type: none"> • Using the phenomenon of the Doppler Effect, demonstrate how the red/blue shift illustrates celestial movement. 	<p>http://archive.ncsa.uiuc.edu/Cyberia/Bima/doppler.html</p> <p>Applets on the Doppler Effect- http://www.colorado.edu/physics/2000/applets/doppler.html http://www.colorado.edu/physics/2000/applets/doppler2.html</p> <p>Red shift/blue shift- http://www.regentsprep.org/Regents/physics/phys05/cspectrum/default.htm</p>

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COMPETENCY GOAL 6: The learner will acquire an understanding of the earth in the solar system and its position in the universe.		
<i>Objective</i>	<i>Content Description</i>	<i>Suggested Activities/Resources</i>
<p>6.05 Evaluate astronomers' use of various technologies to extend their senses:</p> <ul style="list-style-type: none"> • Optical telescopes. • Cameras. • Radio telescopes. • Spectroscope 	<ul style="list-style-type: none"> • Compare and contrast the different types of telescopes and their technological advances. <ul style="list-style-type: none"> • Investigate the uses of spectroscopes. 	<p>Have students construct a telescope.</p> <p>Why we need more than one type of telescope- http://science.nasa.gov/newhome/headlines/features/ast20apr99_1.htm</p> <p>http://csep10.phys.utk.edu/guidr/violence/spectroscopy.html</p> <p>Build class sets of spectroscopes (\$7.00 for 45). http://solar-center.stanford.edu/activities/cots.html</p> <p>Enrichment: Electromagnetic Spectrum Activity- Students use different shapes of pasta to make an electromagnetic spectrum and explain their design to the class. http://chandra.harvard.edu/graphics/edu/formal/pasta/task1.pdf</p>

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Suggested Resources for the Earth/Environmental Science Support Document

Competency Goal 1:

GLOBE: Global Learning and Observations to Benefit the Environment www.globe.gov

The Globe site is an incredible site for the atmosphere, hydrology, land cover, and Earth Systems science areas. The site has all content material available in six (6) different languages. If you have not experienced GLOBE training, log on to the GLOBE site and local a workshop near you!

DLESE: www.dlese.org The Digital Library for Earth and Space Science Education

This site organizes sites of information according to topic. It is a wealth of information. For a new teacher, this site can be a life love to an exciting classroom. All sites are approved by a group of scientists and teachers before being entered into the library. Quality is assured.

North Carolina's clearinghouse for environmental education information & resources:
www.ee.enr.state.nc.us

NC Division of Air Quality Air Awareness Program: <http://daq.state.nc.us>

NC Zoological Park: "Edzoocation" & "Conservation": www.nczoo.org

NC Museum of Natural Sciences: "Education" & "Educator's Guide":
www.naturalsciences.org

NC Museum of Natural Sciences: "Nature Notebook" and "Ask a Naturalist":
<http://www.naturalsciences.org/funstuff/index.html>

NC Wildlife Resources Commission: "Coexisting with Wildlife" & "Wildlife & Species Identification": www.ncwildlife.org

NC Natural Heritage Program: Provides publications and a database of rare, endangered or threatened species and high quality natural communities by county:
<http://ils.unc.edu/parkproject/nhp/index.html>

Nova investigates forces that are affecting populations:
www.pbs.org/wgbh/nova/worldbalance

Websites where teachers can download Environmental Education Learning Experiences:

Each state park and recreation area has an EELE curriculum guide that includes on-site activities, pre- and post-visit activities, student information pages, worksheets, fact sheets, vocabulary, and references. This site has six EELEs that teachers can download: <http://www.ncsparks.net/eele/eele-listnew.html>

Website for the Office of Environmental Education:
www.ee.enr.state.nc.us/Educator_Resources/

Project Learning Tree- An award winning environmental program: www.ces.ncsu.edu/plt

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Competency Goal 2:

Great online tutorial on minerals and properties:

<http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Minerals/Minerals1.html>

Great tutorial on the factors that contribute to mineral color:

http://minerals.gps.caltech.edu/COLOR_Causes/index.htm

This site offers a concise index of common crystal lattice structures: [http://cst-](http://cst-www.nrl.navy.mil/lattice/index.html)

[www.nrl.navy.mil/lattice/index.html](http://cst-www.nrl.navy.mil/lattice/index.html)

North Carolina Geologic Survey: www.geology.enr.state.nc.us

Site that references data used to develop theory of plate tectonics:

<http://www2.nature.nps.gov/geology/usgsnps/pltec/pltec1.html>

This Dynamic Earth: <http://pubs.usgs.gov/publications/text/dynamic.html>

Site on history and proxy data used in plate theory development:

http://www.visionlearning.com/library/module_viewer.php?mid=65

Site with exercises on plate tectonics:

http://atlas.geo.cornell.edu/education/student/tectonics/continental_drift.html

Crystal/Cleavage Models. *Students cut and paste to build models:*

<http://csmres.jmu.edu/geollab/Fichter/Minerals/cleavage.PDF>

This site comes with a lesson plan and video clips to illustrate various concepts associated with the rock cycle with integration and discussion of plate tectonics:

www.pbs.org/americanfieldguide/teachers/rocks/rocks_sum.html#

Lesson plans that focus on interaction of hydrologic cycle and sedimentary rocks. A time table is provided: www.windows.ucar.edu

Office of Environmental Education: www.ee.enr.state.nc.us/ecoadr/ecoad_st.htm

A site for topographic maps: - www.topozone.com

A National Atlas website: www.nationalatlas.gov

A book on the mining culture of the NC mountains: Sheppard, M., & Wooten, B. (1991). *Cabins in the laurel*. Chapel Hill, NC: University of North Carolina Press.

Forest Certification Research Center-a clearing house for sustainable forests and products produced from sustainable, certified forests- a global directory:

www.certifiedwood.org

Products produced from sustainable resources: www.greenpages.org

NC Division of Soil & Water Conservation: www.enr.state.nc.us/DSWC

The famous site for the cookie mining simulation! *Also many other activities that reinforce rocks, minerals:* <http://www.womeninmining.org/activity.htm>

Division of Pollution Prevention (Case Studies on Energy Saving Programs):

www.p2pays.org

Project Learning Tree *Energy & Society Kit:* www.ces.ncsu.edu/plt

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The NEED Project-energy curriculum: www.need.org

Power Shift Video

World in the Balance-NOVA series: www.pbs.org/wgbh/nova/worldbalance

This site has a link to Debbie Michael's seismograph in her classroom:

<http://www.lincoln.k12.nc.us/sites/seis.htm>

Install Seismic Waves. *This FREE software illustrates how wave propagate from an earthquake hypocenter to seismic stations throughout the earth:*

<http://www.geol.binghamton.edu/~jones/#Seismic%20Waves>

Install Seismic Eruption - *Great FREE software for showing earthquakes and seismic waves:*

<http://www.geol.binghamton.edu/faculty/jones/QDDS.seismic.html>

Compare different seismographs: <http://jclahr.com/science/psn/as1/heli/allas1.php>

All major earthquakes are listed for last seven days: <http://neic.usgs.gov/neis/bulletin/>

The USGS site is a great site to search for any topic: www.usgs.gov

Great site for teacher/student independent learning. *Lots of nice links to resources. Some good lesson ideas:* <http://geology.csupomona.edu/alert/mineral/minerals.htm>

A real gem for the kid who loves to memorize formulas! *Online quizzes on mineral chemical composition:* <http://sial.org/geology/miniq/>

Awesome site about a Young Naturalist Winner. *Have students read his story. Challenge them to be curious! Wonderful!:*

<http://www.amnh.org/nationalcenter/youngnaturalistawards/2002/michael.html>

Very informative site on crystal systems. *For an advanced reader:*

<http://www.rockhounds.com/rockshop/xtal/index.html>

One of the best sites out there! *Great lessons and support materials:*

<http://www.mii.org/index.html>

This is a New York school's Regents test prep site. *Great tutorials with nice support:*

<http://regentsprep.org/Regents/earthsci/earthsci.cfm>

Great site from the UK. *Informative and fun to read:* <http://www.moorlandschool.co.uk/earth/>

Tour of Earth-good overview of interaction of systems. *Available in Spanish and English:*

http://www.windows.ucar.edu/tour/cool_stuff/tour_surface_earth_1.html

Recycle Guys: Lessons on recycling: www.p2pays.org

NC Division of Forest Resources: www.dfr.state.nc.us

NC Environmental Ed. Learning Experience: <http://www.ncsparks.net/eele/eele-listnew.html>

Project Learning Tree modules: www.ces.ncsu.edu/plt

A Look and Aluminum # 52

Every Drop Counts #38

Municipal Solid Waste Module 1-3, 7,8

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Competency Goal 3:

Willo, the Dinosaur with a Heart: www.dinosaur.org

Stone Mountain & Hanging Rock Environmental Ed. Learning Experience:
<http://www.ucmp.berkeley.edu/education/explorations/tours/geotime/index.html>

Teacher and student pages on Geologic Age:
http://interactive2.usgs.gov/learningweb/teachers/geoage_activity.htm

Interactive site with additional support on microfossils:
<http://www.ucmp.berkeley.edu/fosrec/Culver.html>

Fabulous website for teachers and students. *This is a great site! Stone Mountain & Hanging Rock Environmental Ed. Learning Experience:* <http://www.ncsparks.net/eele/eele-listnew.html>

Beyer, F. (1991). *North Carolina: the years before man: a geologic history.* : Carolina Academic Press.

North Carolina Geological Survey publications:

- Carpenter, III, P. (Ed.). (1989). *A geologic guide to north carolina's state parks.* Raleigh, NC: North Carolina Geological survey Section.
- Carter, M., Merschat, C., & Wilson, W. (Eds.). (1999). *A geologic adventure along the blue ridge parkway in north carolina.* Raleigh, NC: North Carolina Geological survey Section.

Find an EELE: <http://www.ncsparks.net/eele/eele-listnew.html>

National Park Service website: <http://www2.nature.nps.gov/geology/index.htm>

Competency Goal 4:

Polluted Runoff and Erosion: www.ee.enr.state.nc.us/Polluted%20Runoff/pollutedrunoff.htm

NC Division of Water Resources: “Education Assistance”: www.ncwater.org

NC Division of Soil and Water Conservation: “Education”: www.enr.state.nc.us/DSWC

Project Learning Tree: *Municipal Solid Waste Module #1, 2, 6 & 7:* www.ces.ncsu.edu/plt

Hydrology 101: <http://gw.ehnr.state.nc.us/hydro101.htm>

Activities about acid rain: www.epa.gov/airmarkets/acidrain/experiments/index.html

Project Learning Tree: *Water Wonders #44:* www.ces.ncsu.edu/plt

Discover North Carolina River Basins Book – Online:
<http://www.ee.enr.state.nc.us/ecoadr/riverbook.pdf> (Hard copy is available from Office of Env. Edu: at 1-800-482-8724)

NC River Basins Interactive Online Map: <http://www.ee.enr.state.nc.us/ecoadr/Watersheds-NC-map.html>

North Carolina National Estuarine Research Reserve: “Teachers and Students”:
www.ncnerr.org

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Video: "Pilkey, Orrin." *The Beaches are Moving: A Personal View of the Barrier Islands.* production of the University of North Carolina Center for Public Television.

Pilkey, O., & Rice, T. (2004). *How to read a north carolina beach: bubble holes, barking sands, and rippled runnels.* Chapel Hill, NC: University of North Carolina Press. with the cooperation of Duke University, Chapel Hill. 1990. -contains a number of wonderful suggested activities

Discover your Ecological Address: River, Basin, Soil and Topography:

www.ee.enr.state.nc.us/ecoadr/ecoad_rb.htm

www.ee.enr.state.nc.us/ecoadr/ecoad_st.htm

Discover Your Ecological Address: River, Basin, Groundwater and Wetlands:

www.ee.enr.state.nc.us/ecoadr/ecoad_rb.htm

www.ee.enr.state.nc.us/ecoadr/ecoad_gr.htm

www.ee.enr.state.nc.us/ecoadr/ecoad_we.htm

NC Aquariums: "Conservations & Research": www.ncaquariums.com

Discover Your Ecological Address: Wetlands & Biodiversity:

www.ee.enr.state.nc.us/ecoadr/ecoad_we.htm

www.ee.enr.state.nc.us/ecoadr/ecoad_bi.htm

NC Division of Coastal Management: "About Erosion and Oceanfront Development":

www.ee.enr.state.nc.us/ecoadr/ecoad_to.htm<http://www.ncsparks.net/eele/eele-listnew.html>

Project Learning Tree Intro. To Secondary Modules: *Watch on Wetlands* and *What's a Forest to You*: www.ces.ncsu.edu/plt

Eno River and Lake Norman Environmental Ed. Learning Experience:

<http://www.ncsparks.net/eele/eele-listnew.html>

Coastal hazards and storm information: <http://dcm2.enr.state.nc.us/Hazards/erosion.htm>

Competency Goal 5

Discover Your Ecological Address: Air & Climate:

www.ee.enr.state.nc.us/ecoadr/ecoad_as.htm

www.ee.enr.state.nc.us/ecoadr/ecoad_cl.htm

Weart, S. (2003). *The discovery of global warming.* Cambridge, MA: Harvard University Press.

Alley, R. (2002). *The two-mile time machine : ice cores, abrupt climate change, and our future.* Princeton, NJ: Princeton University Press.

Speth, . (2005). *Red sky at morning : america and the crisis of the global environment .* 2nd ed. New Haven, CT: Yale University Press.

NC Division of Air Quality Air Awareness Program: <http://daq.state.nc.us>

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Encyclopedia of Atmospheric Environment: *Truly an outstanding website-information is delivered to both high school and middle grades students via an easy to use topic menu. Wonderful collection of data focused on Global Climate Change information. Fabulous classroom resource:* <http://www.doc.mmu.ac.uk/aric/eae/english.html>

Competency Goal 6:

A notebook of astronomy activities for teachers - Fraknoi, A. (Ed.). (1995). *The universe at your fingertips*. San Francisco: The Astronomical Society of the Pacific.

Sky and Telescope magazine: <http://skyandtelescope.com/>

CHANDRA website: <http://chandra.harvard.edu/about/index.html>

Starry Night software-free 30 day trial period. Available Online: <http://www.starrynight.com/>

Learning Technologies: *Source for Project Star materials:* <http://www.starlab.com/>

On line lab book of activities: <http://www.cfa.harvard.edu/seuforum/exhibit/resources/resources.htm>

NASA homepage: www.nasa.gov - *Current events, great links including the 5 research enterprises:*

NASA Langley Research Center: www.larc.nasa.gov - *Links to current research and outreach going on at LaRC:*

NASA Education homepage: education.nasa.gov – *News about competitions, products and services for educators:*

Langley Education homepage: www.larc.nasa.gov/education/education.htm - *News about programs specific to LaRC:*

NASA's Spanish homepage: ciencia.nasa.gov/ - *Current events and links for Spanish-speaking individuals:*

Spacelink: spacelink.nasa.gov

Searchable on-line archive of just about everything NASA – Check out the Library!: Central Operation of Resources for Educators (CORE): core.nasa.gov

On-line catalogue of NASA multimedia educational resources: Educator Resource Center at VA Air and Space Center (ERC): www.vasc.org/erc/

Resources for teachers – videos, teachers' guides, posters, workshops, and more!:

VA Educator Resource Center: www.radford.edu/~trc

NC Educator Resource Center: libweb.uncc.edu/nasa/

Aerospace Education of the LaRC region's 5 states: Aerospace Education Services Program (AESP): www.okstate.edu/aesp/AESP.html

Support for systemic change, professional development, and programs for students: NASA Learning Technologies Program (LTP): learn.arc.nasa.gov/

NASA Explorer Schools (NES): explorerschools.nasa.gov

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Partner with NASA in a three year program to approach learning with a whole new light:
NASA Explores: www.NASAexplores.com

Very detailed lessons for all grade levels - NASA Student Involvement Program (NSIP):
www.nsip.net

Free national competitions for students of all grade levels - NASA Technology Portal:
nasatechnology.nasa.gov

Links to technology projects in research and education - Classroom of the Future:
www.cotf.edu

Interactive curriculum support materials and training incorporating NASA resources -
NASA Quest: quest.arc.nasa.gov

Short peer-reviewed articles on teaching science and math topics in interesting settings -
Summer High-School Apprenticeship Research (SHARP): www.mtsibase.com/sharp

Atmospheric sciences program training classes to collect and interpret data: *S'COOL*: asd-www.larc.nasa.gov/SCOOOL/

Great Images In NASA: grin.hq.nasa.gov

Archived images, film and sound clips from NASA: NASA's History Office:
history.nasa.gov

Complete archive of NASA activities and accomplishments: Global Learning and
Observation to Benefit the Environment: www.globe.gov

Hands-on experiments and observations for classroom collaboration around the world:
SciLinks: www.scilinks.org

Monitored and reviewed internet links for textbooks from participating publishers:
Southeast Regional Clearinghouse: serch.cofc.edu/serch/

Establishing connections between educators, universities, and NASA- Regional educational
centers involving classes in simulated missions: Challenger Centers: www.challenger.org

Astronomy activities from Thursdays Classroom- <http://www.thursdaysclassroom.com/>

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Safety in the Science Classroom and Laboratory

Chemical Management:

In North Carolina, it is the responsibility of the Superintendent of a school system to appoint a qualified chemical hygiene officer to direct the development of and compliance with the chemical hygiene plan for the school system. This plan must include protocols and processes for chemical management for science laboratories and preparation rooms, as well as, professional development for science teachers and administrators. Because laws, codes and standards change, the plan must be reviewed and updated annually or more often as necessary.

Instruction, Supervision, and Maintenance of a Safe Learning Environment:

In North Carolina, it is the teacher's responsibility to address safety in planning instructional activities, laboratory investigations, and to supervise students so that all activities and investigations are carried out in a safe manner. The teacher is responsible for adhering to professional standards, NC laws and codes when assessing the learning environment. Ongoing professional development is an essential part of ensuring laboratory safety.

It is the principal's responsibility to provide personal protective equipment and resources to ensure science teachers can teach the North Carolina's science curriculum safely. All *North Carolina Standard Course of Study* Science classes are designed to be laboratory courses and must include a laboratory component.

The suggestions and resources for science safety and resources included here are in no way comprehensive but may serve as a quick reference for a few common safety issues.

1) Chemicals:

- a. Order only the amounts you will use for one year. Do as much microchemistry as possible to minimize hazards
- b. Be sure you have an appropriate storage system for chemicals.
- c. You must have the MSDS available for all chemicals in your classroom/prep room (including kitchen/grocery store chemicals). You should go over the MSDS information with students each time they will be using a chemical. Document this in your lesson plan book.
- d. Use the smallest amounts and weakest/most dilute concentrations of chemicals that you can and still have a viable investigation/demonstration.
- e. Be sure you have appropriate disposal arranged before using a chemical.
- f. Avoid the use of toxic chemicals.
- g. Sulfur is a common allergen. Reactions that use or produce sulfur compounds should be performed under a working hood.
- h. Go over all hazards and safety precautions with students prior to each laboratory investigation/activity and document in your lesson plan book and with student work samples (i.e. quizzes or prelab assignments).

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- i. Be aware of latex allergies that some students have. Alternative types of gloves must be provided when students need gloves.
- 2) Be sure goggles are appropriate and meet standards for the planned investigation. Goggles designed for impact are different than those designed to protect against fluid splashing. Chemical splash goggles are required anytime students are using fluids. Be sure contact lens wearers have non-vented chemical splash goggles. Visor-type goggles are NOT appropriate or safe for activities using fluids.

DISCLAIMER: Mention of any company or product does not constitute endorsement by the NCDPI. In addition the inclusion of links to websites is not intended to reflect endorsement by DPI, nor is it intended to endorse any views expressed or products or services offered by the author of the reference or organization operating the server on which the reference is maintained. Also, suggestions for activities do not mean that these are the only way to conduct an experiment or activity.

Resources and References for Science Safety:

NCDPI Total Science Safety Program: Contact Benita Tipton, Science Consultant, btipton@dpi.state.nc.us. (919) 807-3933.

NCDPI School Insurance <http://www.ncpublicschools.org/fbs/insurance/>

This office will help you with risk control, safe facilities, and fire safety issues. Their website has several pages that address science safety issues and has links to websites with federal and state laws and codes.

NCDPI Publications

NCDPI has a variety of science safety posters – currently available: Science Safety Signs, Goggles: It's the Law, and a Science Chemicals Poster which provides a chart for the teacher to enter the title and date of a lab exercise along with information about specific chemicals, including the NFPA Hazards Rating, Personal Protective Equipment and the Waste Disposal Method.

The NCDPI **School Science Facilities Planner** is available to download as a PDF file <http://www.schoolclearinghouse.org/pubs/SCIENCE.PDF>

Other Resources

American Chemical Society

American Chemical Society Safety Guidelines

Chemical Safety for Teachers and Their Supervisors: Grades 7-12

Safety Audit/Inspection Manual

Teachers can order single copies by calling ACS at 1-800-227-5558.

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29 CFR 1910 OSHA
General Industry Regulations
www.osha-cfr.com

CRC Handbook of Laboratory Safety
5th edition
A. Keith Furr
www.crcpress.com

2000 Emergency Response Guidebook
U.S. Dept of Transportation
Research and special Programs Administration
<http://hazmat.dot.gov/guidebook.htm>

A Guide to Working With Corrosive Substances
Harry E. Payne, Jr
North Carolina Occupational Safety and Health Standards for General Industry
NC Department of Labor
Division of Occupational Safety and Health
4 West Edenton Street
Raleigh, NC 27601-1092

Handbook of Chemical Health and Safety
Robert J Alalmo editor
Learning by Accident
Edited: Fariba Mojtabai & James Kaufman
Volume # 2
The Laboratory safety Institute
192 Worchester Road
Natick, MA 01760

It's Elementary... and Beyond
www.chemed.org

MSDS Sheets for Chemicals (Material Safety Data Sheets)

Numerous sources – here are some links
www.flinnsci.com/homepage/cindex.html
www.uvm.edu/uvm/safety/labsafety/chemsafety/netmsds.html (grocery/kitchen chemicals)
www.msds.pdc.cornell.edu/msdssrch.asp
www.fishersci.com
www.osha.gov
www.cdc.gov/niosh

National Science Teachers Association www.nsta.org

Click on *Publications* and *Position Statements*.

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Numerous NSTA Position Statements on Safety, Field Trips, Class Size, etc.

NSTA Safety Publications:

Exploring Safely: A Guide for Elementary Teachers- Terry Kwan & Juliana Texley

Inquiring Safely: A Guide for Middle School Teachers- Terry Kwan & Juliana Texley

Investigating Safely: A Guide for High School Teachers- Juliana Texley, Terry Kwan, & John Summers

The OSHA Answer Book (7th edition)

Mark Moran

Right-To Know Pocket Guide for school & University Employees

National Fire Rating System Reference Guide

Lab Safety Supply

PO Box 1368

Janesville, WI 53547-1368

1-800-356-0783

Safetycertified.com

1536 Kingsley Ave

Suite 126

Orange Park, FL 3207

1-800-597-2040

Safety in Academic Chemistry Laboratories

Volume 2

Accident Prevention for Faculty and Administrators 7th ed.

(also have student version)

American Chemical Society

1155 16th St, NW

Washington, DC 20036

Safety in the Elementary (K-6) Science Classroom

Second Edition

Committee on Chemical Safety

1155 Sixteenth St, NW

Washington, DC 20036

Chemistry.org

Safety in High School and College Laboratories

Fisher Science Education

1 800 955 1177

1 800 955 0740 (f)

www.fisheredu.com

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Science Classroom Safety and the Law

Flinn Scientific Inc.

P.O. Box 219

Batavia, IL60510

E-mail: flinn@flinnsci.com

Website: www.flinnsci.com

Science Laboratory Safety Manual

Linda M. Stroud, Ph.D.

www.sciencesafetyconsulting.com

Other safety resources are available from several science supply catalogs.

Earth/Environmental Support Document

Field Identification of Minerals

Background for Field Identification of Minerals

Standard Course of Study Targeted Goals and Objectives

- 1.02: Design and conduct scientific investigations to answer questions about the earth and environmental sciences.
- Create testable hypotheses.
 - Identify variables.
 - Use a control or comparison group when appropriate.
 - Select and use appropriate measurement tools.
 - Collect and record data.
 - Analyze and interpret data.
 - Communicate findings.
- 1.04 Apply safety procedures in the laboratory and in field studies:
Safely manipulate materials and equipment needed for scientific investigations
- 2.01: Analyze the dependence of the physical properties of minerals on the arrangement and bonding of the atoms.

Introduction to the Teacher

Within the context of our natural environment, the earth, elements and compounds that are formed naturally are called minerals and mixtures of minerals are called rocks. Because minerals are elements or compounds, they possess identifiable characteristics called physical properties that are unique to each individual mineral.

If you do not have the required minerals, adapt the lab according to minerals at hand.

Time required: one ninety-minute lab period

Safety Considerations:

Remind students not to use samples as projectiles.

Remind students to place the glass and streak plate on the table to use. Do not experiment with the glass or streak plate in their hands.

References:

This activity was submitted by Dick Hilliard of North Henderson High School, Hendersonville, NC.

Earth/Environmental Support Document

Field Identification of Minerals

Field Identification of Minerals

Purpose:

In this lesson you will develop the skill necessary to determine the physical properties of minerals and use that data and a dichotomous key to provide an identification of mineral specimens.

Materials:

Numbered mineral specimens:

1	Quartz	5	Pyrite	9	Muscovite	13	Biotite	17	Hornblende
2	Barite	6	Calcite	10	Orthoclase	14	Galena	18	Magnetite
3	Hematite	7	Fluorite	11	Chalcopyrite	15	Talc	19	Gypsum
4	Augite	8	Halite	12	Corundum	16	Apatite	20	Sphalerite

Mineral identification kit containing: a glass plate, copper strip, a nail, a drop bottle of dilute HCl, a magnet, a magnifying lens and a streak plate.

Introduction to Students

Procedure:

Part 1 – How are minerals identified?

Perform the following tasks:

1. Place all of your minerals into a single pile in the center of your table.
2. Observe the mineral specimens in the pile and determine and record different characteristics that you observe
3. Separate your specimens into two different groups based upon a single characteristic difference.
4. Separate minerals in these two groups into two new groups based upon a single characteristic difference.
5. Continue to separate newly created groups into two new groups as long as defining characteristics can be identified.

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Field Identification of Minerals

Part 2 – Developing Skills – Using differences in physical properties to identify minerals.

1. **Hardness:** The hardness of a mineral is a test of its scratch resistance. Fill in the chart with yes or no below each column heading to express the hardness of each of your specimens (in order by number):

	Scratched by fingernail (≤ 2)	Scratched by copper (≤ 3)	Scratched by steel nail (4-5)	Will scratch glass plate (6-7)
1				
6				
7				
9				
10				
12				
15				
16				
19				
In this chart record your mineral's specimen numbers arranged in order from 1 (softest) to 9 (hardest) in Moh's hardness scale.				
1.		4.		7.
2.		5.		8.
3.		6.		9.

2. **Luster:** The luster of a mineral is a description of the way light is reflected from the mineral's surface. The two generalized luster types are:
- a. Metallic - which means that the mineral "looks like a metal"., or,
 - b. Non-metallic - which means that the minerals "does not look like a metal", non-metallic minerals are further described as:
 - i. Vitreous - looks like glass
 - ii. Waxy - looks like candle wax
 - iii. Greasy - looks (and feels) like the mineral is coated in a thin film of grease
 - iv. Resinous - looks like pine sap
 - v. Pearly - looks like a pearl
 - vi. Silky - looks like a bundle of silky fibers
 - vii. Dull (or earthy) - looks chalky or dirty

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Field Identification of Minerals

Use these terms to describe the luster of your mineral specimens.

Mineral	Luster	Mineral	Luster	Mineral	Luster
2		6		15	
3		11		18	
4		13		19	
5		14		20	

- 3. Streak:** The color of a mineral is not generally a good indicator of a mineral’s identification, because just a minute amount of some foreign substance can alter the color of a mineral. The color of the powdered mineral, however, is a good indication and is called streak color because the mineral is “streaked” across an unglazed porcelain tile. The hardness of the streak plate is about 7 so minerals harder than that do not leave a streak color. As a general rule, the streak of metallic minerals is black or darker than the color of the bulk specimen and the streak of nonmetallic minerals is lighter than the color of the bulk specimen. Record the bulk specimen and streak color for your specimens in the chart below.

	Specimen color	Streak color		Specimen color	Streak color
3			5		
6			7		
9			10		
11			12		
14			15		
18			20		

- 4. Cleavage and Fracture:** Minerals may break in one of two ways:
- a. Cleavage - cleavage simply means that a mineral will break in certain preferred directions with a smooth flat break, example mica.
 - b. Fracture - if a mineral does not cleave it is said to fracture. Fracture is an uneven break

Determine whether your minerals have cleavage or fracture and fill in the chart below:

Mineral	Cleavage or fracture	Mineral	Cleavage or fracture	Mineral	Cleavage or fracture
1		7		12	
4		8		14	
5		9		17	
6		10		20	

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Field Identification of Minerals

For all the above specimens, count the number of cleavage planes, if any, and record in this chart.			
Cleavage directions	Specimen #	Specimen #	Specimen #
None			
1			
2			
3			
4			
More than 4			

5. Some special tests: Some minerals have unique properties that help us identify them. Two particularly useful properties are listed below:

Magnetism - Minerals that contain iron will sometimes be attracted to a magnet. Magnetite is a common black, metallic mineral that is attracted to a magnet.

Acid test - Minerals of a family called carbonates sometimes react with acid to effervesce forming CO₂ gas. Calcite is a very common mineral that reacts well with dilute HCl.

Complete the following chart with either "Reacts to acid", "Magnetic", or "No reaction".

Mineral	HCl Reaction magnetic	Mineral	HCl reaction magnetic	Mineral	HCl reaction magnetic
6		7		11	
14		15		18	

Assessment:

Students will be assigned a rock and mineral collection composed of specimens they have collected. Students will identify the specimens to make the collection by using the identification skills they have learned in this activity along with identification keys.

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Learning to Calculate Specific Gravity

Background to Learning to Calculate Specific Gravity

Standard Course of Study Targeted Goals and Objectives

- 1.02 Design and conduct scientific investigations to answer questions about the earth and environmental sciences.
- Create testable hypotheses.
 - Identify variables.
 - Use a control or comparison group when appropriate.
 - Select and use appropriate measurement tools.
 - Collect and record data.
 - Analyze and interpret data.
 - Communicate findings.
- 2.05: Analyze the dependence of the physical properties of minerals on the arrangement and bonding of the atoms.

Introduction to the Teacher

Time required: one ninety-minute lab period

Safety Consideration:

Remind students not to use samples as projectiles!

References:

This activity was submitted by Dick Hilliard of North Henderson High School, Hendersonville, NC.

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Learning to Calculate Specific Gravity

Learning To Calculate Specific Gravity

Purpose:

Students will develop the skill of calculating the physical property of specific gravity as it relates to mineral identification.

Materials:

Equipment:	Rubber band	Balance w/specific gravity platform	
	Calculator (optional)	250 ml beaker	Water
Mineral Specimens:	Quartz	Calcite	Barite
	Chalcopyrite	Magnetite	Galena

Introduction to Students

Specific gravity is the density of a mineral. Students will develop the skill of calculating the physical property of specific gravity as it relates to mineral identification.

Procedure:

- 1.) Determine the mass of each of your specimens by placing each, in turn, onto the pan of the balance and adjusting the riders until the scale balances. Do this for all six of your specimens and record in the data table below as the mass of the specimen in the air.
- 2.) Remove the hanging pan from the balance and raise the specific gravity platform.
- 3.) Place your beaker three fourths full of water onto the platform.
- 4.) Make a hanger to suspend your mineral specimens from the balance arm using the rubber band.
- 5.) Zero your balance with the rubber band attached to the balance arm.
- 6.) Take each specimen in turn and attach it to the balance arm using the rubber band.
- 7.) Record the mass of each specimen suspended in the water (Make sure the specimen is completely submerged in the water and not touching sides or bottom of the beaker).
- 8.) Record the apparent loss of mass of each specimen in the data table.

NONMETALLIC MINERALS

DATA	SPECIMEN 1	SPECIMEN 2	SPECIMEN 3
Mass in air			
Mass in water			
Apparent loss of mass in water			

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Learning to Calculate Specific Gravity

METALLIC MINERALS

DATA	SPECIMEN 4	SPECIMEN 5	SPECIMEN 6
Mass in air			
Mass in water			
Apparent loss of mass in water			

Analysis and Conclusion: Record the following information in the charts below.

1.) Calculate the specific gravity by using the following formula and the data you collected:

$$\varpi \quad Sg = m_a/m_1$$

ϖ Where: Sg = specific gravity, m_a = mass of the specimen in air, and m_1 = apparent loss of mass of specimen in water.

2.) Identify your minerals based on the following specific gravity clues and other tests of physical properties we have learned in other labs.

ϖ For your nonmetallic specimens: Quartz has the lowest specific gravity and barite the highest

ϖ For your metallic specimens: Chalcopyrite has the lowest specific gravity

3.) Find the actual specific gravity for each specimen in your text (or other source specified by your teacher) and record it the table.

4.) Find the percent of error of your calculated specific gravity using the following formula and record in the table:

$$\varpi \quad \%e = [(Sg_a - Sg_c) / Sg_a] \times 100$$

ϖ Where: $\%e$ = percent error, Sg_a = actual specific gravity, and Sg_c = calculated specific gravity

NONMETALLIC MINERALS

DATA	SPECIMEN 1	SPECIMEN 2	SPECIMEN 3
Specific gravity (calculated)			
Mineral Name			
Specific gravity (actual)			
Percent of error			

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Learning to Calculate Specific Gravity

METALLIC MINERALS

DATA	SPECIMEN 4	SPECIMEN 5	SPECIMEN 6
Specific gravity (calculated)			
Mineral Name			
Specific gravity (actual)			
Percent of error			

5. Compare the average specific gravity of your nonmetallic minerals and your metallic minerals. Which is greater? Give an explanation.

6. What experimental variables could account for any error in your calculated specific gravity?

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Beginner's Compass Game

Background to Beginner's Compass Game

Adapted from Silva 1986

Standard Course of Study Goals and Objectives

1.02: Design and conduct scientific investigations to answer questions about the physical world.

- Create testable hypotheses.
- Identify variables.
- Use a control or comparison group when appropriate.
- Select and use appropriate measurement tools.
- Collect and record data.
- Analyze and interpret data.
- Communicate findings.

2.05: Create and interpret topographic, soil and geologic maps using scale and legends.

Introduction to the Teacher

This is a compass game which may be played in any open area (a park, football field, or a gymnasium). To play, the participant must be able to find a direction with a compass, once given a bearing. No pacing of distances is necessary. The course consists of 8 labeled markers placed in a large circle. While playing the game, players are contained by this circle. **Take care to reduce the influence of magnetic fields.**

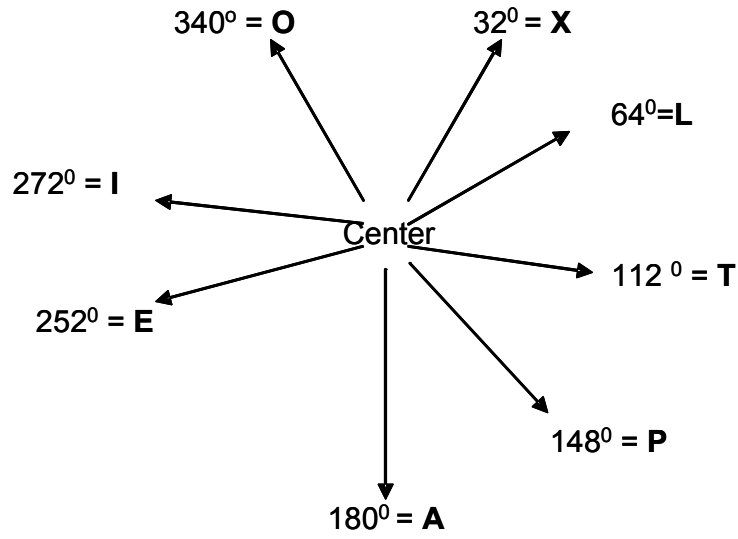
The course consists of 8 markers in a large circle. The accuracy of the bearings on the instruction cards depends on the careful positioning of these markers.

Place the unlabelled stake in the center of the area that will be used for the course. Attach the measuring tape or string (50 feet long) to the center stake. Working from the center stake each time, set the compass bearing as indicated in the illustration and walk the distance required by your measuring string.

Place the labeled stake in the correct position as illustrated. The radius of the course may be changed to suit the available space or the number of players participating.

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Beginner's Compass Game



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Beginner's Compass Game

Compass Game Answers

ALPETO196 290 92 316	206 52 180 40 358
# 2 EXLIPA 52 138 258 120 254	# 29 XLEAPO 137 248 126 74 334
# 3 ITEPOL 102 272 110 334 112	# 30 LXIAPT 317 242 136 74 10
# 4 OTALIX 136 236 32 258 62	# 31 TEAPOL 272 126 74 334 112
# 5 XILEPT 242 78 248 110 40	# 32 PEIAOT 290 352 136 350 136
# 6 LOPIAE 292 154 300 136 306	# 33 ALXETP 32 318 232 92 220
# 7 TPILXO 220 300 78 318 276	# 34 ETAOIP 92 236 350 216 120
# 8 PLIXEA 16 258 62 232 126	# 35 IPETAO 120 290 92 236 350
# 9 APLXTO 74 16 318 162 316	# 36 OLAPTX 112 212 74 40 342
# 10 ELOIXP 68 292 216 62 180	# 37 XAPLTO 196 74 16 178 316
# 11 IEOPXT 172 26 154 0 162	# 38 LAEPIO 212 306 110 300 36
# 12 OTLXPI 136 358 318 180 300	# 39 TOLIEX 316 112 258 172 52
# 13 XPEOIL 180 290 26 216 78	# 40 PLEIAT 16 248 352 136 56
# 14 LPTIXO 196 40 282 62 276	# 41 AEITOP 306 352 102 316 154
# 15 TOELPI 316 206 68 196 300	# 42 ETXAOI 92 342 196 350 210
# 16 POITEL 334 216 102 272 68	# 43 ILOTXP 78 292 136 342 180
# 17 AIPXEO 316 120 0 232 26	# 44 OEIPAX 206 352 120 252 16
# 18 EIXAOL 252 62 196 350 112	# 45 XLTAEO 138 178 236 306 26
# 19 IOAPXE 36 170 74 0 232	# 46 LIXTEA 258 62 162 272 126
# 20 OAXIEP 170 16 242 172 110	# 47 TAOEXL 236 350 206 52 138
# 21 XIOTLA 242 36 136 358 212	# 48 POXATL 334 96 196 56 358
# 22 LOATPI 292 170 56 220 300	# 49 APOTIL 74 334 136 282 78
# 23 TXALPO 342 196 32 196 334	# 50 ELPAXO 68 196 254 16 276
# 24 PXLOEA 0 138 292 206 126	# 51 IOTPLE 36 136 220 16 248
# 25 AOEXLP 350 206 52 138 196	# 52 OXIPTA 96 242 120 40 286
# 26 ETLIAX 92 358 258 136 16	# 53 XEILPO 232 352 78 196 334
# 27 IAXPOL 136 16 180 334 112	# 54 LIOETP 258 36 206 92 220
# 28 OEXPTL	

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Beginner's Compass Game

# 55 TPOEXI	220 334 206 52 242	78 318 196 56 316	
# 56 PLOXEA	16 292 96 232 126	# 84 OITAEI	216 102 236 306 68
# 57 ALTIXE	32 178 282 62 232	# 85 XAILOT	196 316 78 292 138
# 58 EIPAXO	352 120 254 16 276	# 86 LEXPTA	248 52 180 40 236
# 59 IOLEAT	36 112 248 126 56	# 87 TAPIXE	236 74 300 62 232
# 60 OATPLI	170 56 220 16 258	# 88 PXTIAE	0 162 282 136 306
# 61 XTOPLI	162 316 154 16 258	# 89 AOXEIT	350 96 232 352 102
# 62 LAXTEO	212 16 162 272 26	# 90 EXOALT	52 276 170 32 178
# 63 TLAPXE	358 212 74 0 232		
# 64 PAIETL	254 316 172 92 358		
# 65 AOPTLX	350 154 40 358 318		
# 66 EOTXIL	26 136 342 242 78		
# 67 IEAXPT	171 126 16 180 40		
# 68 OTPEAX	136 220 290 126 16		
# 69 XPOETA	180 334 206 92 236		
# 70 LAPOTI	212 74 334 136 282		
# 71 TLEOXP	358 248 226 96 180		
# 72 PIOXEL	300 36 96 232 68		
# 73 ALIXEP	32 258 62 232 110		
# 74 ETOXAI	92 316 96 196 316		
# 75 IOPXAE	36 154 0 196 306		
# 76 OTIALE	136 282 136 32 248		
# 77 XOALTI	276 170 32 178 282		
# 78 ETPXEI	178 220 0 232 352		
# 79 TILPAO	282 78 196 254 350		
# 80 PLXTOA	16 313 162 316 170		
# 81 AIXOLP	316 62 276 112 19		
# 82 ETPIOA	92 220 300 36 170		
# 83 ILXATO			

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Beginner's Compass Game

Cards for Students:

1 A

32 196 290 92 316

#2 E

52 138 258 120 254

#3 I

102 272 110 334 112

#4 O

136 236 32 258 62

#5 X

242 78 248 110 40

#6 L

292 154 300 136 306

7 T

220 300 78 318 276

#8 P

16 258 62 232 126

#9 A

74 16 318 162 316

#10 E

68 292 216 62 180

#11 I

172 26 154 0 162

#12 O

136 358 318 180
300

#13 X

180 290 26 216 78

#14 L

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Beginner's Compass Game

196 40 282 62 276

242 36 136 358 212

#15 T

#22 X

316 206 68 196 300

292 170 56 220 300

#16 P

#23 T

334 216 102 272 68

342 196 32 196 334

#17 A

#24 P

316 120 0 232 26

0 138 292 206 126

#18 E

#25 A

353 62 196 350 112

350 206 52 138 196

#19 I

#26 E

36 170 74 0 232

29 358 258 136 16

#20 O

#27 I

170 16 242 172 110

136 16 180 334 112

#21 X

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Beginner's Compass Game

#28

O

206 52 180 40 358

#29

X

138 248 126 74 334

#30

L

318 242 136 74 40

#31

T

272 126 74 334 112

#32

P

290 353 136 350 136

#33

A

32 318 232 92 220

#34

E

92 236 350 216 120

#35

I

120 290 92 236 350

#36

O

112 212 74 40 342

#37

X

196 74 16 178 316

#39

T

316 112 258 172 52

#40

P

16 248 353 136 56

#41

A

306 352 102 316 154

#42

E

92 342 196 350 216

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Beginner's Compass Game

74 334 136 282 78

#43 I
78 292 136 342 180

#50 E
68 196 254 16 276

#44 O
206 352 120 254 16

#51 I
36 136 220 16 248

#45 X
138 178 236 306 26

#52 O
96 242 120 40 236

#46 L
258 62 162 272 126

#53 X
232 352 78 196 334

#47 T
236 350 206 52 138

#54 L
258 36 206 92 220

#48 P
334 96 196 56 358

#55 T
220 334 206 52 242

#49 A

#56 P

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Beginner's Compass Game

16 292 96 232 126

#57 A

32 178 282 62 232

#58 E

352 120 254 16 276

#59 I

36 112 248 126 56

#60 O

170 56 220 16 258

#61 X

162 316 154 16 258

#62 L

212 16 162 272 26

#63 T

358 212 74 0 232

#64 P

254 316 172 92 358

#65 A

350 154 40 358 318

#66 E

26 136 342 242 78

#67 I

172 126 16 180 40

#68 O

136 220 290 126 16

#69 X

180 334 206 92 236

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Beginner's Compass Game

#70 L
212 74 334 136 282

#71 T
358 248 26 96 180

#72 P
300 36 96 232 68

#73 A
32 258 62 232 110

#74 E
92 316 96 196 316

#75 I
36 154 0 196 306

#76 O
136 282 136 32 242

#77 X
276 170 32 178 282

#78 L
178 220 0 232 352

#79 T
282 78 196 254 350

#80 P
16 318 162 316 170

#81 A
316 62 276 112 196

#82 E
92 220 300 36 170

#83 I

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Beginner's Compass Game

78 318 196 56 316

52 276 170 32 178

#84 O

216 102 236 306 68

#85 X

196 316 78 292 136

#86 L

248 52 180 40 236

#87 T

236 74 30 62 232

#88 P

0 162 282 136 306

#89 A

350 96 232 353 102

#90 E

Earth/Environmental Support Document

Beginner's Compass Game

Beginners Compass Game

Purpose:

To teach students how to use a compass

Materials:

- A compass (the game recommends Silva)
- stakes labeled with one of the following letters (I, O, X, L, T, E, A, P)
- One unlabeled center stake
- 50 feet measuring device (pre-measured clothesline is good)
- Bearing cards
- Answer key

Procedure:

Each participant receives an instruction card. This card tells the payers their starting positions as well as bearings that direct them from marker to marker around the course. Each player copies down the letter on each marker along their route. The six-letter code word thus produced is checked against the answer sheet. Each instruction card is a unique set of bearings.

Example:

A player receives the following instruction card:

#66 E

26, 136, 342, 242, 78

#66 = card number

E = the player must start at marker labeled "E"

26 At post E, the player follows a bearing of 26° that will lead to the next marker on the route. The player walks the bearing of 26 degrees and arrives at marker O. At this marker the player sets the bearing for 136°

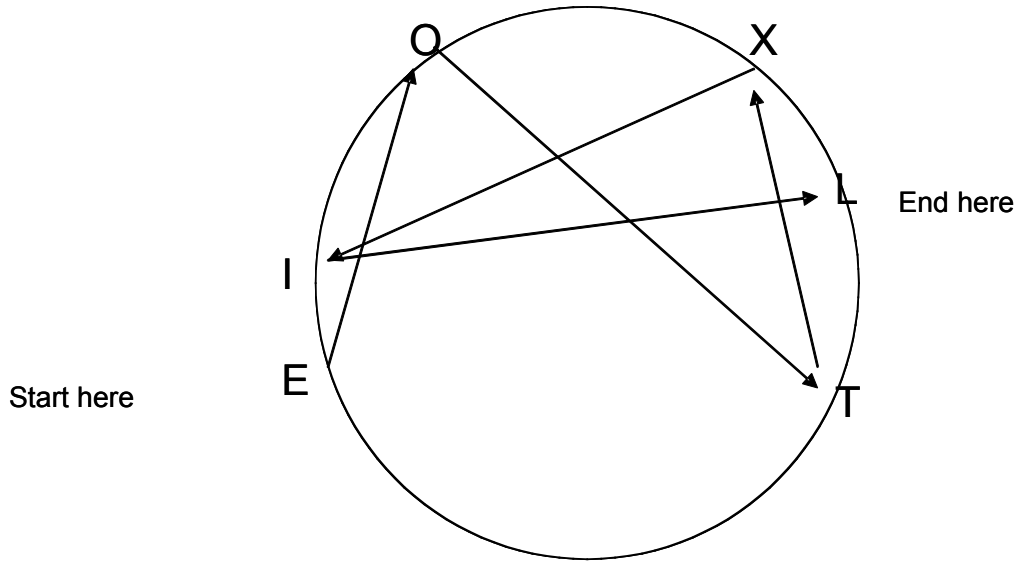
136 The player will walk the 136 bearing and should arrive at marker T. At marker T, the player sets and travels to the next marker at a bearing of 342.

This pattern continues until the player arrives at the last marker indicated on the card by the last bearing-in this case a bearing of 78 degrees.

The code word produced is "EOTXIL". It should match the code for # 66.

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Beginner's Compass Game



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Basic Mapping

Background to Basic Mapping

Standard Course of Study Targeted Goals and Objectives

- 1.02 Design and conduct scientific investigations to answer questions about the physical world.
 - Create testable hypotheses.
 - Identify variables.
 - Use a control or comparison group when appropriate.
 - Select and use appropriate measurement tools.
 - Collect and record data.
 - Analyze and interpret data.
 - Communicate findings.
- 1.04 Apply safety procedures in the laboratory and in field studies:
Recognize and avoid potential hazards.
- 2.05 Create and interpret topographic, soil and geologic maps using scale and legends

Introduction to the Teacher

Background Information: All maps are abstractions of a realistic place. In other words, maps are a two-dimensional representation of a three-dimensional area at a specific point in time. In the classroom, maps can be used to provide frame of reference for various types of information. Use your campus study site to investigate soils, human impact on ecosystems/environment, geohazards, and hydrologic issues.

1. Ask students to think about the types or kinds of maps that they or members of their families use. Engage in a discussion and record information that students share on the board.
2. Ask students to think about and offer ideas as to how a map might be made. Accept all reasonable answers.
3. Ask how many students used to build model cars or toys. “Do you have any idea what the fraction on the box meant when it said something was 1/32 scale model?” Accept all reasonable answers.
4. Ask students to think about a way that they could make a map that is a scale model of an area of the school. Accept all reasonable answers.

References:

This activity was submitted by Rick Johnson.

Earth/Environmental Support Document

Basic Mapping

Basic Mapping

Purpose:

To learn the basics of map making:

- Determining your “pace”
- Reading a compass
- Combining pace and bearing
- Drawing a simple map

Materials:

- Tape measure
- Pencil
- Pen
- Calculator
- 1 compass per two students
- Protractor

Introduction to Students

This activity allows you to determine distance by “pacing”, read a compass to determine your “bearing”, and to combine the two to create a simple map.

Procedure:

Determine the length of your “pace”:

Measure a known distance of a straight line between A (starting point) and B (finishing point). (e.g., 100 meters or yards) It is recommended that students work in both measurement scales. Many maps are in metric units. Have the students walk and count every other step of the measured distance and record that number. Do this 4 times and take the average to get your averaged pace count. (You can throw out the first one and take the average of the next 3 numbers).

To determine your Average distance per pace: The measured distance is the numerator and the average pace count is the denominator.

$$\text{Distance per Pace} = \text{Measured distance} \div \text{Average pace count}$$

For example, 100 yards is the distance (perhaps the football field) and my average pace count is 62.5.

$$\text{Distance per Pace} = 100 \text{ yards} \div 62.5 \text{ paces}$$

$$\text{Distance per Pace} = 1.60 \text{ yards per pace}$$

***Tip: Have the students carry out the division to 2 decimal places.**

To determine distance using Average Distance per Page:

Multiply pace number times average distance per pace

Example: 15paces x 1.60 yd/pace = 24 yards

September 2006

Earth/Environmental Support Document

Basic Mapping

***Teacher Tip: Record each student's Average Distance per pace in your grade book for safe keeping.**

Practice pacing a defined course:

Measure out a course that has 3 or 4 perimeter lines that close to make a shape and have the students pace the course (walk each leg and record the number of paces). See the example on the next page. Calculate the perimeter of the shape.

Reading a Compass (Determining Bearing):

Have students hold the compass with the black arrow pointed in the direction you want to go. Give the students a bearing (e.g., 245 degrees) and have the students turn the compass dial until 245 lines up at the top of the black arrow. Then have the students turn their bodies until the red floating arrow is lined up with the red arrow that turns with the dial. This is referred to as "the red is in the shed." All students should turn toward the same direction (245 degrees) and be facing southwest.

Most students know that there are 360 degrees in a circle. Those 360 degrees are angles of direction on a compass. For example, 360 degrees is North, 90 degrees is East, 180 degrees is south, and 270 degrees is west.

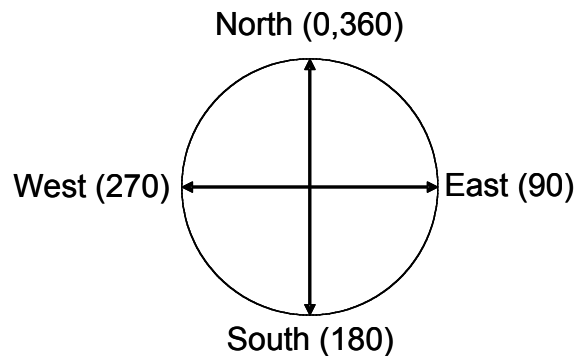


Figure 1

Combining Pace and Bearing

***Teachers: It is best if you make a map ahead of time so you can determine the scale factor and then facilitate a discussion about the "How Tos" in determining scale.**

When combining pace and bearing, students can map out a shape that is in the shape of an L. They take a compass bearing from a corner of the parking lot to another corner of the parking lot.

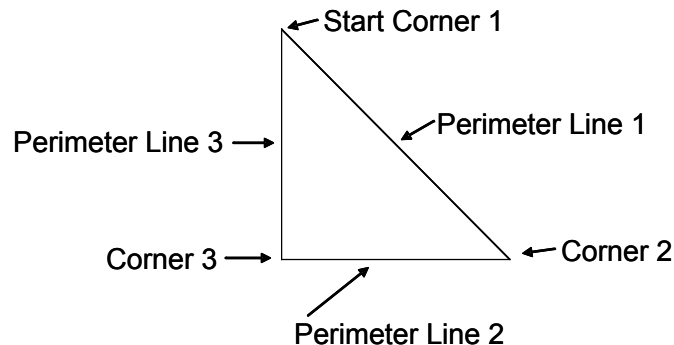


Figure 2

Earth/Environmental Support Document

Basic Mapping

1. Begin at the start point and square your body in the direction you want to go. In the example above, you should be facing southeast.
2. Point the compass in that direction, then turn the compass dial until the “red is in the shed.”
3. Read the bearing at the top of the compass. This bearing is the direction relative to North that you will travel to get to the next corner of the parking lot. Record the bearing in degrees and in cardinal direction.
4. Students then pace off the distance and record that number.

Data Table (example)

Line number	Bearing	Pace Count	Pace x yd/pace	Distance	Scaled distance
Line 1	135 SE	12	12 x 1.60	19.2 yards	1.92 cm

(Complete all but scaled distance in the table in your field journal. The scaled distance will be completed in the classroom.)

Back in the Classroom

Rules for drawing the map:

1. Draw a line on plain white paper and designate one end north. The north end of the line now represents 0 degrees or 360 degrees.
2. Put a dot on the North reference line to represent the first corner of the parking lot where you were standing when you took your first bearing.
3. Lay the protractor on the paper so that the protractors edge is lined up on top of the North reference line you just drew and so that the small hole in the straight edge of the protractor is lined up over the small dot you made on the North reference line.
4. Mark the angle on the protractor that corresponds to the bearing from your data for line 1. For example, if your first bearing is 90 degrees, you would move clockwise around the protractor until you come to the 90 degree spot (which is at a right angle to the north line) and mark the paper with a dot there.
5. Lift up the protractor and use the ruler to draw a line from your first dot in the direction of the second dot (90 degrees) that corresponds with the actual length of the line designated in your scale. For example, lets say the actual length of the line according to your pace count is 90 yards, and you designated a scale of 1 cm = 10 yards. Then the length of your first map line will be 9cm in the direction of 90 degrees (which you marked with your protractors.) Place a dot at the end of the line.
6. Now place the protractor hole over the dot at the end of the 9cm line you just drew. Line up the protractor edge with North “eyeballing” as close as possible. (The protractor edge should be as near parallel with your original North reference line as possible.) Then mark your second bearing for line 2.

Continue to follow these directions for all lines and see how close you come on your map to following the actual lines in the field. It is customary to connect the last line with the starting point. The student objective is to have the return line be within one cm of the start position.

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Contour Mapping

Background to Contour Mapping

Standard Course of Study Targeted Goals and Objectives

- 1.02 Design and conduct scientific investigations to answer questions about the physical world.
 - Create testable hypotheses.
 - Identify variables.
 - Use a control or comparison group when appropriate.
 - Select and use appropriate measurement tools.
 - Collect and record data.
 - Analyze and interpret data.
 - Communicate findings.
- 1.04 Apply safety procedures in the laboratory and in field studies:
Recognize and avoid potential hazards.
- 2.05 Create and interpret topographic, soil and geologic maps using scale and legends.

Essential Question:

How is relief (elevation) field data collected, managed, and drawn on a map?

Introduction to the Teacher

Background Information: Contour lines are features found on topographic maps that show relief in a given area. In this exercise students will create a contour map of a campus study site that will later be used to investigate soil deposition, water movement, and human impact issues on your campus.

Teacher Tip: Before you begin, you will want to decide where you are going to make your mapped area. There should be noticeable relief. If you have access to a stream valley within the mapped area, it can make further studies of soil and water more meaningful. Additionally, you will want to make and put together your surveying tools. See "[How to make Surveying Sticks](#)".

Materials:

OUTDOOR

- Stick and String set
- Line level
- Field journal
- Compass
- Survey flagging
- Bug spray
- Water
- Hat for sun protection

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Contour Mapping

INDOOR

- Calculator
- 8 x 11 white computer paper
- 36” roll of butcher paper or newspaper cut into 36” x 36” squares
- Pencils
- Colored pencils
- Meter stick
- Protractor

Preparing the Area: (Teacher)

1. Flag the corners of the chosen map area. It is suggested that the map perimeter have at least six lines of various lengths but should not exceed 12 lines.

A map encompassing 7 to 10 acres at a scale of 1cm = 20 yds that is fairly rectangular in shape should easily fit on a piece of 8 x 11 typing paper.

2. Each flagged corner point should be visible from the preceding corner point.
3. Make your own reference map so that you can evaluate students’ mapping skills and math applications.
4. Choose a “start” corner of the map and determine the elevation. See “[How to Determine Starting Elevation](#)” for several valid methods.

Safety Consideration:

- Do not do this activity on a steep slope.
- Be aware of poison ivy and other outside obstacles.
- Have a safety plan in place.
 - Have a cell phone or radio with you.
 - Let the office know where you are.

References:

This activity was submitted by Rick Johnson.

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Contour Mapping

Contour Mapping

Purpose:

Students will create a simple contour map of a prescribed area.

Materials:

- Compass
- Flagged area
- Journal with chart drawn to collect data (same as Pace and Bearing)
- Pencil
- Sunscreen
- Bug spray
- Hat
- Water bottle
- Big Map with perimeter lines already drawn
- Stick and string level surveying equipment
- Survey flags
- Color pencils
- Metric ruler
- Protractor

Introduction to Students

High Level Steps to Create a Contour Map:

1. Using the skills learned from the previous activities, students will make a Pace and Bearing map of the selected campus study site.
2. Student groups will show the teacher their 8 x 11 map of the study site. The teacher will decide whether or not students can move onto step 3. Students will be given a piece of 36" x 36" roll construction paper. Students will redraw the map using the scale: 1 cm = 5 yards.
3. Student map groups are ready to begin surveying. Mapping jobs should be assigned to group members and equipment secured.

Procedure:

Mapping Group: 9 students minimum

1 student per job below unless stated otherwise

Surveying Jobs:

- 1 Short stick holder
- 1 Long stick holder
- 1 Line level reader

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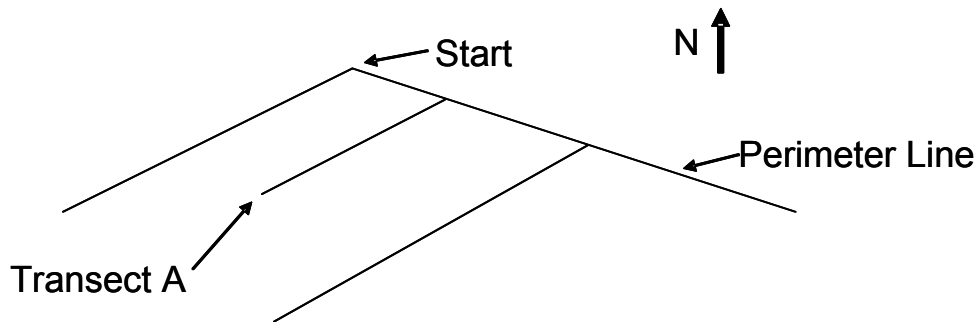
Contour Mapping

- 2 Tall stick data reader (may want 2 to increase accuracy)
- 1 Data Recorder and materials manager
- 2 Compass people to check bearings
- 1 Survey flag marker

GOAL: Elevation changes between points will be determined using surveying sticks, string and a line level.

Procedure:

Your teacher will assign each surveying group a particular perimeter line or transect to survey. Regardless of what your group is to survey, the following procedures are the same.



1. Choose a perimeter line and establish the elevation by running a string line down a perimeter line. The compass person will use a compass to make sure the long and short stick holders are staying on the bearing.
2. The short stick person will hold the stick at the corner of the line while the long stick person pull the string along the direction of the perimeter line.
3. With a survey flag, mark where the long stick is placed. Be sure to pull the sticks tight so that the string will be straight and avoid bowing down in the middle. When you are finished mapping, there will be a survey flag at every point you have taken elevation data.
4. The String Level person will place the level in the middle between the two sticks.
5. The person on the tall stick will move the string up or down on the stick until the line level reads level (bubble between marks). NOTE: Negative numbers indicate a rise in elevation and positive numbers indicate a drop in elevation.
6. The String Level person will determine that the string is level when the bubble in the line level is centered between the indicator marks.
7. The data person will call out the number on the tall stick to the recorder.

***Remember to include whether or not the number is negative or positive relative to the previous reading.**

8. The survey flag person will place a flag at the place where the tall stick is touching the ground.
9. The tall stick person MUST remain still and in place while the short stick person travels to the tall stick person. At this point, the short stick is placed into the space occupied by the tall stick and the person with the tall stick travels along the line until the string line is tight. REMEMBER to travel along the bearing-have your compass person check to make sure you "on line".

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Contour Mapping

***WHAT HAPPENS IF THE TALL STICK PERSON GOES UPSLOPE FROM THE SHORT STICK PERSON?**

10. Repeat steps 1-8 along the perimeter line. As the team moves down the line a row of flags will show where each reading took place and help keep the team in line.

Depending on your mapping assignment, your data page could look like either the perimeter or transect example. If you are mapping a transect, continue to measure the transect through the study site until you intersect another perimeter line.

Perimeter Line 1

Compass Bearing: 306 degrees West, Northwest

Distance	change in elevation inches	change in elevation converted to feet
30 feet	+18 inches	1 foot 6 inches

Transect A

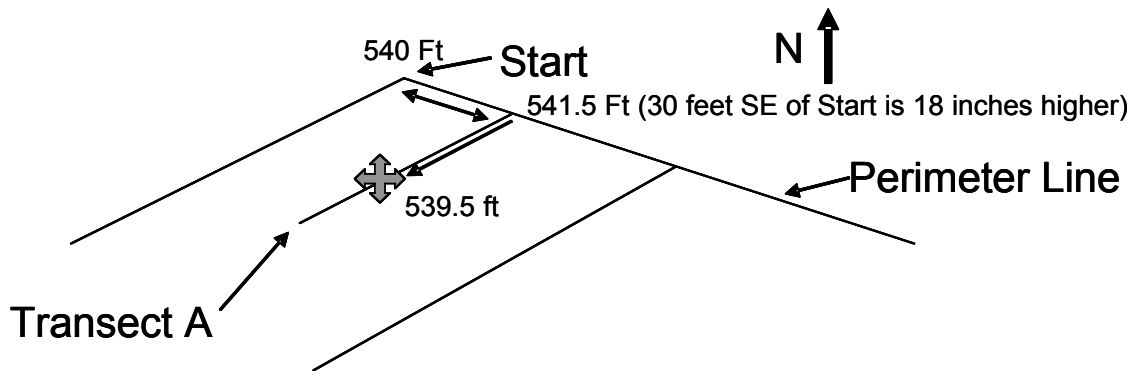
Compass Bearing: 264 degrees South West

Distance	change in elevation	change in elevation <i>Converted to feet</i>
30 feet	-24 inches	- 2 feet

How to put elevation data on the map:

The readings taken in the field can be converted to elevation changes on the map. Students may opt to convert all “inch” data to feet prior to drawing on the map or they may choose to convert as they go. It doesn’t really matter as long as there is a measure of quality control. It is always recommended that 2 students do the conversion work. This way fewer mistakes are made. Remember the scale on your map is 1cm = 5yds. 5yds = 15 ft. The string on the stick 10 feet; therefore, three pulls of the stick would be 30 feet. A 2 cm line on the map will represent 30 feet. Therefore by using the scale the exact elevation can be figured to the exact place on the map.

1. Make sure that you have drawn your “north” reference.
2. Locate your start corner and record the elevation of the start corner on the map.



Example: Let’s say our start corner had an elevation of 540 feet above sea level.

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Contour Mapping

If our first flag on our perimeter line is 30 feet from start and there is a change in elevation of +18 inches or 1 foot 6 inches, then the elevation 30 feet southeast of start is 541 and _ feet above sea level. You will record this elevation 2 cm away from start on the map.

3. Continue around the perimeter of your study site recording your elevations as you go.
4. Now add in the transect data. You should begin at a known elevation point. In the example figure above, transect A begins at 541 and _ feet.

Let's say we measure 30 from the perimeter and we determine the change in elevation to be negative 24 inches or -2 feet. If we started at 541 and half and we went downhill 24 inches, we would now have an elevation of 539 and _ feet above sea level. On our map, we will draw a 2 cm line at a bearing of 262 degrees from the perimeter point and record our elevation.

When the elevation numbers have been placed on the map the teacher can facilitate a discussion to decide on the contour interval. Once the distance is determined, drawing the contour lines becomes a dot-to-dot game following a pattern initiated by the first line.

The more frequently students take elevation data the more accurate a representation of the area. For example, instead of taking the change in elevation every 30 feet, you may want to consider collecting data every 10 feet.

Go to the study site to do the final visual data collection:

1. Using the pace and bearing map, walk the perimeter of the study area. Check to see if you have correctly recording bearings and that the figure you've drawn matches what you are walking.
2. Walk at least three transects through the study site. Sketch in boundaries of different ecosystems, erosion features, or human impact evidence. You may want to discuss these features prior to returning to the study site.
3. Return to the classroom to transpose additional visual data to the contour map.
4. Each map should have a legend with symbols that are referenced in the map.
5. Elevation is shaded with higher areas being reds, oranges, and yellows and lower areas blues, greens, violets.
6. Area of lowest elevation is marked.
7. Area of highest elevation is marked.
8. Area of steepest slope is marked.
9. Predicted flow of water through the study site is shaded in and labeled.

Reflect on the Map Making Process:

It is recommended that this be done as a classroom discussion with chart paper available for recording answers.

1. What skills were necessary for making pace and bearing map?
2. What skills were necessary for making the contour map?
3. How were those skills similar? Different?
4. Was there any particular part of the map making process you found difficult? If so, what was it and can you label what made that particular task difficult? Were you able to successfully problem-solve issue? How?
5. What parts of the map making process were easy for you? Explain your answer.

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Contour Mapping

6. How did you feel working in your group? Were there enough complimentary skills to get the job done well?
7. Other than teacher acknowledgment, how did you know you were doing something well?
8. How important is “ground truthing” in map making?
9. Do static maps have any advantages over digital maps? If so, what are they?
10. Do static maps have any disadvantages over digital maps? If so, what are they?
11. What other ideas, concepts, or content could be studied in your study site? How would you go about studying something of interest to you?

Investigate your study site: At this point, the teacher can facilitate a class discussion to determine what kinds of phenomena can be studied in the site. It is suggested that you share the Earth and Environmental Standard Course of Study with students. Ask them to decide what they can do with their new skills to learn about some of the content areas.

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Contour Mapping

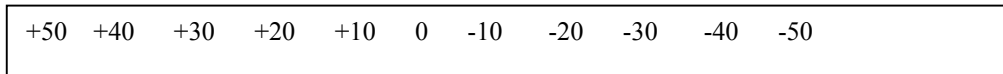
Stick and String Surveying System

Materials per Survey Set

- (1) 10 ft wooden stake
- (1) 8 ft wooden stake
- 11 feet of cotton or nylon twine
- Permanent marker
- Yard stick

What to Do:

1. Lay out the 10 ft wooden stake and measure to the center of the stake.
2. Using a permanent marker, label the center point “0” inches.
3. From the “0” mark, moving to the right, mark every inch and mark in bold every 10th inch until you reach the top.
4. Repeat the process moving to the left of the “0”.
5. Go back and mark a negative (-) sign in front of each number.
6. Moving to the left, mark a positive (+) sign in front of each number.



top

7. Measure off 11 feet of string.
8. Using a permanent marker, mark “0” and then measure 10 feet from 0 and mark.
9. You should use the 6 inches on either end to tie one end of the string to the short stick and
10. One end of the string to the long stick. This loop should slide up and down the stake.
11. Have 2 people stretch the string tight between the two sticks. Place the string at 0” on the tall stick. On the short stick, slide the string towards the top of the stick until the string appears level between the short and tall stick. Verify that the string is level using the line level. Adjust the string accordingly and when satisfied, secure the string to the short stick with a wood staple or small tack.

If you want to spend the money, you can purchase factory labeled rods and survey materials from a place like Forestry Suppliers or Ben Meadows.

How to determine starting elevation:

(It is recommended that you determine a start point and its elevation prior to beginning the surveying process. Students can then start with a specific elevation point and work from there.)

Method 1: Use a GPS to determine elevation.

Most GPS units today will provide you will relatively good data from satellites.

Place the GPS on the “start corner” and allow the unit to collect satellites. Use your manual to find out how to access the elevation page. This procedure varies from unit to unit.

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Contour Mapping

Method 2: www.topozone.com

1. Select our state and click “go”. On the next page, select schools for type, NC for state and your county. A list of schools with reported elevations will be displayed. Select your school and look at the topo map. You can adjust your elevation based on the map information. For example, if your study site is southwest of the school, you can use map information to interpolate the approximate elevation of your start point.
2. Using a GPS, find your lat and long readings. Plug those values into the correct place and Topozone will help determine an elevation.

Method 3: Use a local **topographic map** and interpolate your elevation using map information.

Earth/Environmental Support Document

A Cookie Mining Activity

Background to Cookie Mining Activity

Standard Course of Study Targeted Goals and Objectives

- 1.02 Design and conduct scientific investigations to answer questions about the earth and environmental sciences.
- Create testable hypotheses.
 - Identify variables.
 - Use a control or comparison group when appropriate.
 - Select and use appropriate measurement tools.
 - Collect and record data.
 - Analyze and interpret data.
 - Communicate findings.
- 1.06 Identify and evaluate a range of possible solutions to earth and environmental issues at the local, national, and global level including consideration of:
- Interdependent human and natural systems
- Economic development, environmental quality and sustainability
- 2.06 Investigate and analyze the importance and impact of the economic development of earth's finite rock, mineral, soil, fossil fuel and other natural resources to society and our daily lives.

Introduction to the Teacher

This activity is designed to give the player an introduction to the economics of mining. Each player buys “property”, purchases the “mining equipment”, pays for the “mining operation”, and finally pays for the “reclamation”. In return, the player receives money for the “mineral resource” retrieved in the mining process. The object of the game is to develop the mine, safeguard the environment, and make as much money as possible.

Time required: one ninety-minute lab period

Safety Consideration:

The teacher will need to buy three different types of cookies for this lab. I usually require the students to throw away the toothpicks and paperclips before they leave my classroom. Otherwise, some will leave with the objects hanging out their mouths. I also have the students place the cookie on a paper towel so that they are working on a clean area.

References:

This activity was submitted by Dick Hilliard of Henderson High School, Hendersonville, NC.

Adapted from Women in Mining Education Foundation Activities

Earth/Environmental Support Document

A Cookie Mining Activity

A Cookie Mining Activity

Purpose:

To instill in students an appreciation of the economics of the mining processes which provide raw materials for the needs of our culture and civilization with a minimum impact on the environment.

Materials:

Grid paper	Chocolate chip cookie	
Toothpicks, flat and round	Paper clips	Paper towels
Cookie mining spreadsheet	Electronic balance	

Introduction to Students

Your ultimate objective is to make a maximum profit with a minimum investment, just as is the case in an actual mining operation. Toward this end, considerable thought should be put into determining what “Mining property” you will purchase, the most efficient “Mining equipment” you can buy, and the “Mineral resource” extraction process you will use to insure a minimum of reclamation cost.

Procedure:

¹Based on your carefully considered decisions, you will purchase the following:

- “Mine property”: Only one cookie for each player
 - Bargain basement specials - \$3.00
 - Chips Ahoy - \$5.00
 - Chips Deluxe - \$7.00
- “Mining equipment”: No limit on purchases. No sharing of equipment allowed!
 - Flat toothpick - \$2.00
 - Round toothpick - \$4.00
 - Paper clip - \$6.00

After purchasing “Mine property” and Mining equipment” record those purchases on your spreadsheet. Next, place your cookie on the grid paper and, using a pencil, trace the outline of the cookie. The player must then count each square that is either totally or partially covered by the cookie outline, recording this number on the Cookie Mining Spreadsheet along with the requested cookie “properties”.

Players should now begin the mining process; extracting chocolate chips from their cookies, keeping in mind that:

¹ Adapted from Women in Mining Education Foundation Activities

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A Cookie Mining Activity

- Mining costs are \$1.00 a minute
- Chocolate chips mined from the cookie bring \$1.00 per each 0.1 g.
- Reclamation requirements are that the remains of the cookie be placed back onto the grid sheet in the cookie outline using only your mining tools. No hands! Players must pay \$1.00 per grid square over the original count.

2

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A Cookie Mining Activity

COOKIE MINING RULES

1. Players cannot use their fingers to hold the cookie. The only things that can touch the cookie are the mining tools and the paper on which the cookie is sitting.
2. Players should be allowed a maximum of five minutes to mine their chocolate chip cookies. Players who finish mining before the five minutes are used up should only credit the time spent mining.
3. A player can purchase as many mining tools desired; the tools can be of different types.
4. If the mining tools break, they are no longer usable and a new tool must be purchased.
5. The players that make money by the end of the game win.
6. All players win at the end of the game because they get to eat the remains of their cookie!

COOKIE MINING SPREADSHEET

Type of Cookie _____		
Price of cookie		\$
Size of cookie _____ squares covered		
Equipment used		
Flat toothpick	_____ x \$2.00	\$
Round toothpicks	_____ x \$4.00	\$
Paper clips	_____ x \$6.00	\$
Mining time _____ minutes x \$1.00 (chip removal cost)		\$
TOTAL MINING COST (cookie price + equipment cost + chip removal price)		\$
INCOME VALUE OF CHIPS (Mass (g) of chips x \$10.00)		\$
RECLAMATION COST (additional squares x \$1.00)		\$

PROFIT OR LOSS STATEMENT

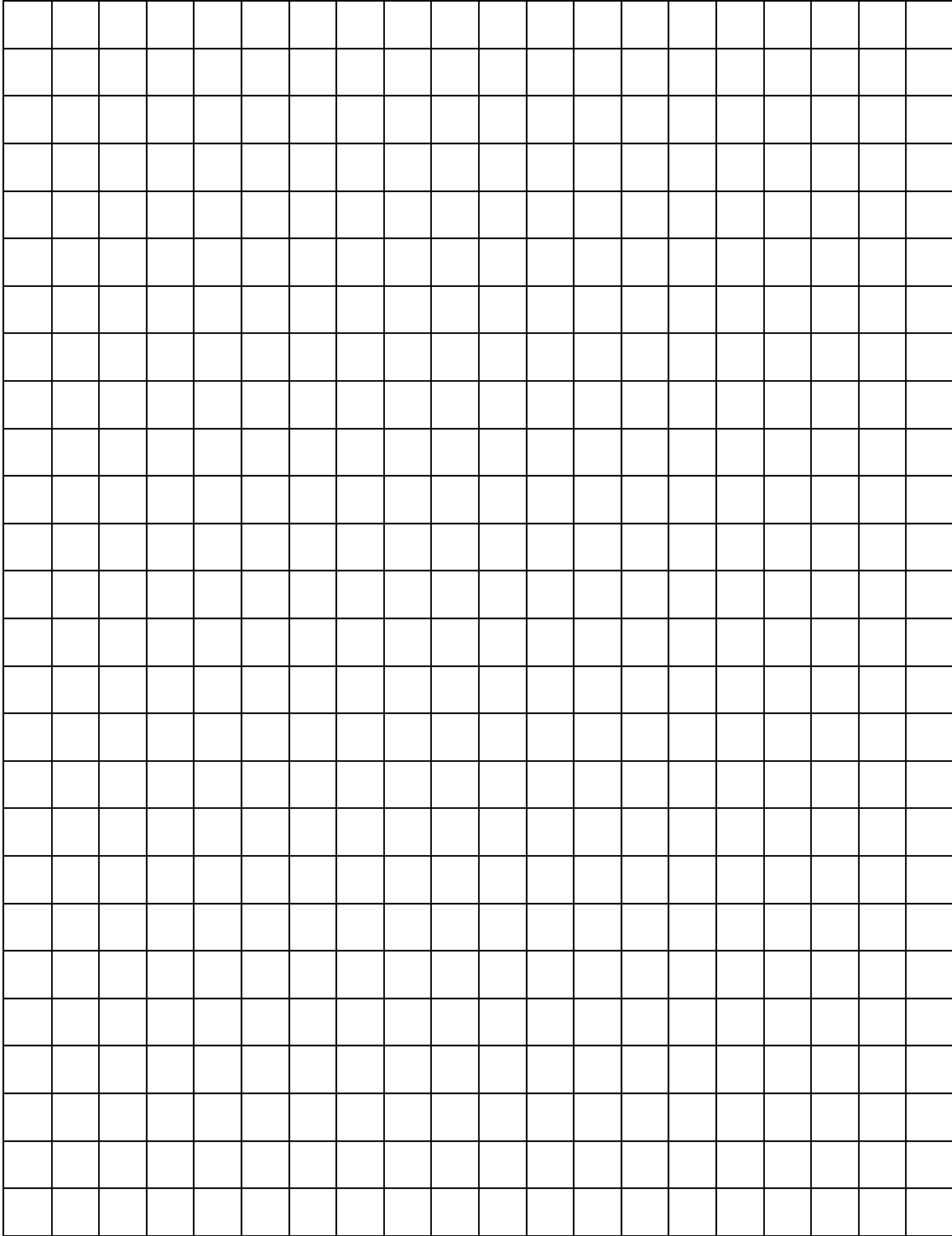
Starting amount	\$20.00
Value of chips	+
Subtotal	
Total cost of mining	-
Subtotal	
Reclamation cost	-
Profit or Loss =	

¹¹ Adapted from Women in Mining Education Foundation Activities

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A Cookie Mining Activity

COOKIE MINING GRID



¹¹ Adapted from Women in Mining Education Foundation Activities

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A Cookie Mining Activity

Questions to Guide Analysis:

1. How does the type of mining property (kind of cookie) affect the quantity of chocolate that you can mine in a five minute time period?

2. Extending your answer to question #1 above, how does the kind of cookie relate to the ore deposit of an actual mineral deposit?

3. Finish removing all the chips from your cookie and calculate the "Grade", or percentage composition of the ore mineral, by comparing the mass of all the chips in the cookie to the mass of the entire cookie. Express the grade of your ore as % chocolate.

4. Explain which mining equipment you found to be most useful and why.

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A Cookie Mining Activity

-
5. How do the efficiency and/or problems of your mining equipment relate to actual mining equipment used to mine an actual deposit?

6. What were some problems you encountered in reclaiming your mining property (cookie)?

7. Based upon the mining and mine reclamation experience that you acquired from this activity, how would you alter your mining process to make reclamation easier and more cost effective?

8. Explain some reasons that a mining company may have a difficult time making a profit.

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A Cookie Mining Activity

-
9. Explain factors that would result in a profitable mining operation in terms of mining property, mining equipment and reclamation.

Earth/Environmental Support Document

WET and Cold

Background to WET and Cold

Standard Course of Study Targeted Goals and Objectives

- 1.02 Design and conduct scientific investigations to answer questions about the physical world.
- Create testable hypotheses.
 - Identify variables.
 - Use a control or comparison group when appropriate.
 - Select and use appropriate measurement tools.
 - Collect and record data.
 - Analyze and interpret data.
 - Communicate findings.
- 3.01 Assess evidence to interpret the order and impact of events in the geologic past: Relative and absolute dating techniques.

Introduction to the Teacher

The most important aspect of this lab is students' ability to successfully and accurately project a decay curve back to time zero. Several practical suggestions are necessary:

Thin plastic and metal funnels seem to produce the most linear plots of the data. Thick glass funnels do not work well.

Super cool ice works best; do not delay the transfer of the ice from the refrigerator to the funnels.

Setup may be started almost one half hour before students will begin work.

Different funnel materials with different melting rates will "imitate" different radioactive isotopes. Salt may be added to some funnels to make the problem more intriguing and the Chemistry hooligans more dastardly. Your own mystery story may be more fun.

Record the time on a piece of paper and tape it to the bottom of the ring stand, out of sight.

References:

Mystery story, My wife Rebecca and Earth Science students, Apologies to all my Chemistry teacher friends. Wm.Tucci 3/99

Wise, Donald Underkofler, 1990, Using Melting Ice to Teach Radioactive Dating: Journal of Geologic Education, v. 38, p. 38

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WET and Cold

WET and COLD

Purpose:

To accurately project a decay curve back to time zero.

Materials:

- Funnel
- Graduated Cylinder
- Stop Watch
- Triple Beam Balance
- Graph Paper
- Rulers
- Pencils
- Ring Stands and Iron Rings
- Ice cubes (Try to keep these as cold as possible until they are placed in the funnels.)

Introduction to Students

Monday morning! Another dull first period class ...just stay awake until second period... two periods of Fun Science. Finally the Bell!

You race to Earth/Environmental Science anticipating another great laboratory session, only to find disaster has struck. Jealous chemistry students have frozen ALL of the lab manuals and text books into a large block of ice.

Negotiations with this pack of Chemistry Hooligans result in one concession... If the Earth/Environmental Science neophytes could determine the exact time small chunks of the ice began to melt, the books will be released from the icy grip of the frozen block.

Procedure:

A small block of the ice has been placed in a funnel and the melt water has been collected in a graduated cylinder since the ice began to melt.

You will have the materials and pieces of equipment listed under the materials list to help solve the problem: (Note: You are not required to use all of the items on this list.)

1. Clearly identify the problem you are trying to solve.

2. How did you solve the problem? (Make a list. What will you do first, second, etc?)

Earth/Environmental Support Document

Radioactive Decay

Background to Radioactive Decay

Standard Course of Study Targeted Goals and Objectives

- 1.02 Design and conduct scientific investigations to answer questions about the physical world.
- Create testable hypotheses.
 - Identify variables.
 - Use a control or comparison group when appropriate.
 - Select and use appropriate measurement tools.
 - Collect and record data.
 - Analyze and interpret data.
 - Communicate findings.
- 3.01 Assess evidence to interpret the order and impact of events in the geologic past:
Relative and absolute dating techniques.

Introduction to the Teacher

Have some groups do this lab with coins, some with spinners, and some with dice to represent different rates of decay. Spinners can be borrowed from the math department. Have students share their data with the class and explain how it relates to radioactive decay. The teacher will need to give the students problems in order to answer the following:

1. Determine the half-life of a radioactive substance, given its decay rate.
2. Determine the age of a sample, given the rate of decay, the amount of undecayed sample, and the original amount of sample

Earth/Environmental Support Document

Radioactive Decay

Radioactive Decay

Purpose:

To simulate radioactive decay

Materials:

- 100 small objects of one particular kind, such as paper clips, corn kernels, coins
- a box with a cover
- graph paper

Introduction to Students

It was not until after radioactivity was discovered at the end of the nineteenth century that scientists developed a method for determining the absolute age of rock layers. They discovered that a mass of a radioactive element "decays" (changes to other elements by emitting particles and energy) at a measurable and predictable rate. Furthermore, they found that for each different radioactive element the rate of decay was fixed and unaffected by environmental factors, such as temperature or pressure. In fact, the behavior of radioactive elements is so regular that they literally can be used as clocks!

In this investigation you will use a model to study radioactive decay in order to learn how it can be used to determine the age of an object.

Procedure:

Put about 100 small objects of one particular kind, such as paper clips, corn kernels, coins, etc. into a box with a cover. Decide upon an orientation for the objects to represent "decay" (for example, coin shows heads, kernel points toward a marked side of the box, etc.).

Cover the box and shake thoroughly. Remove from the box the objects that have "decayed" and count them. Record this number in the Data Table on the Report Sheet. Calculate the number of objects remaining undecayed, and calculate the percentage that decayed from the formula

$$\% \text{ Decaying} = \frac{\text{Number of objects removed}}{\text{Number of objects before shaking}} \times 100\%$$

Repeat the procedure for additional trials until all the objects have decayed.

Draw a graph of the number remaining vs. trial number.

Questions to Guide Analysis:

1. Describe how radioactive decay is used to determine the age of a rock.
2. List the assumptions that must be made when radioactive decay is used to determine the age of a rock sample.

Earth/Environmental Support Document

Geologic Calendar

Background to Geologic Calendar

Standard Course of Study Targeted Goals and Objectives

- 1.02 Design and conduct scientific investigations to answer questions about the physical world.
 - Create testable hypotheses.
 - Identify variables.
 - Use a control or comparison group when appropriate.
 - Select and use appropriate measurement tools.
 - Collect and record data.
 - Analyze and interpret data.
 - Communicate findings.
- 3.01 Assess evidence to interpret the order and impact of events in the geologic past
 - Divisions of Geologic Time

Introduction to the Teacher

Students will research geologic time and make a calendar showing correct placement of events. A teacher worksheet for grading is included in this document.

References:

This project was submitted by Susan Escobar, North Lincoln High School, Lincolnton, NC.

Earth/Environmental Support Document

Geologic Calendar

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Geologic Calendar

Geologic Calendar

Purpose:

In order for students to understand the vastness of time, it is useful to use the analogy of a calendar year. In this analogy, the Earth was formed on January first and we are currently just before midnight on December 31.

Materials:

- a calendar
- colored pens, pencils
- glue
- magazine pictures or clip art

Introduction to Students

Geologic Time Calendar Requirements:

You will be graded on the following categories:

- Neatness:** You must show that some time and consideration has been taken in creating your project
- Colorful/Interesting:** Use a variety of colors and your creativity for a project that is interesting to look at.
- Number of Events:** There are 29 required events. All must be in the calendar for full credit!
- Order of Events:** This is the most important and will count twice. All events must be within a couple of days of the actual date!
- Eras & Periods:** All eras must be color-coded. The day a period begins must be labeled.
- Pictures:** You must have at least 15 pictures! Pictures have to relate to an event (no more than one picture per event) or they do not count. More pictures will give you extra points.
- Picture Placement:** Pictures have to appear with the event, not scattered around the calendar.

Procedure:

On your calendar, count backwards from today (December 31, 11:59:59pm, just before the stroke of midnight) and record the name of the era, period, epoch and/or event. It is usually not necessary to calculate times for events or time periods that occurred over a few days ago.

Basic Formula:

Number of years ago x 365 days

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Geologic Calendar

4,600,000,000

1. Write in the actual number of years the event happened above the line. Hint: make sure the numbers line up.
2. Cross out all the zeroes that are one above the other.
3. Divide the number on top by the number on the bottom. Then multiply by 365. This gives you the number of days ago.
4. Since we don't refer to time using decimals, we need to convert the decimals into hours, minutes and seconds.
5. To calculate the number of hours take the numbers after the decimal point and multiply by 24.
6. To calculate the number of minutes, take the numbers after the decimal point of the calculation in step 5 and multiply by 60.
7. To calculate the number of seconds, take the numbers after the decimal point of the calculation in step 6 and multiply by 60.

Example:

$$\frac{66,000,000}{4,600,000,000} \times 365 \text{ days} = 5.24 \text{ days}$$

Days: 5

4,600,000,000

$$0.24 \text{ days} \times 24 \text{ hours} = 5.76 \text{ hours}$$

Hours: 5

$$0.76 \text{ hours} \times 60 \text{ minutes} = 45.6 \text{ minutes}$$

Minutes: 45

$$0.6 \text{ minutes} \times 60 \text{ seconds} = 36 \text{ seconds}$$

Seconds: 36

So, the event occurred 5 days, 5 hours, 45 minutes, and 36 seconds before today.

Questions to Guide Analysis:

1. Explain why it is difficult to mark the date of important events in U.S. history, such as the Declaration of Independence on your calendar.
2. Would it be possible to calculate a time that would represent the length of a person's lifetime? Explain your answer.
3. Why didn't we put the Declaration of Independence on July 4th?
4. Why does it seem like so much more has happened within the last several million years?
5. Why do we refer to the oldest known plants or animals?
6. Why are the oldest known plants listed before the oldest animals?
7. What significant organisms (to us anyway) really diversified after the extinction of the dinosaurs? Do you think this would have happened if the dinosaurs were not all killed off?
8. What might be some reasons why we do not see the same animals and plants on the earth today that could be found millions of years ago?
9. Why do some animals and plants, whose origins go back millions of years, still exist today relatively unchanged except for their size? Can you think of any animals that have been around for millions of years? Why have some changed a great deal?

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Geologic Calendar

Student Worksheet:

Geologic Time Calendar Organizer

Event	name	Era	Period	Epoch
1st amphibian				
1st fish				
1st flowering plants				
1st mammals				
1st primates				
1st true bird				
age of mammals				
Appalachian Mountains rise				
Brachiopods common				
Central American land bridge formed				
Columbus sails for America				
dinosaur extinction				
dinosaurs first appear				
early humans appear				
ferns appear				
forests and swamps cover most of land				
Great Lakes formed				
last ice age ended				
lots of glaciers				
pangea formed				
saber-toothed cat first appears				
stromatolites common				
trilobites common				
United States declares independence				
oldest known plants				
oldest known animals				

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BE A Virtual Seismologist

Background to BE A Virtual Seismologist

Standard Course of Study Targeted Goals and Objectives

- 1.02 Design and conduct scientific investigations to answer questions about the physical world.
 - Create testable hypotheses.
 - Identify variables.
 - Use a control or comparison group when appropriate.
 - Select and use appropriate measurement tools.
 - Collect and record data.
 - Analyze and interpret data.
 - Communicate findings.
- 2.04 Analyze seismic waves including velocity and refraction to:
 - Locate earthquake epicenters.
 - Measure earthquake magnitude.

Introduction to the Teacher

Students will need the use of a computer lab to complete this activity. Go to the website <http://www.sciencecourseware.com/VirtualEarthquake/>. There are two versions - the “old one” and the “new one. I prefer to use the “old one” because the students have to read and figure out how to read the seismograms. There are four earthquakes for the students to explore. When they finish the activity successfully, they will receive a certificate saying they are a virtual seismologist. To conserve paper, I have the students write the four earthquakes on a sheet of notebook paper and I check them off by putting my initials beside the finished work. Instead of printing the certificate, they receive a sign off from their teacher.

Once students have finished all four earthquakes, I deem them a mentor and have them help students that are still having trouble. The students enjoy this activity and feel like they are seismologists.

Advanced students may proceed to the “new” version. The teacher will need to obtain the free password for this site.

References:

This activity was suggested by Debbie Michael, North Lincoln High School, Lincolnton, NC.

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BE A Virtual Seismologist

Be A Virtual Seismologist

Purpose:

Virtual Earthquake is an interactive web based lab that helps students understand the concepts of how an epicenter is located and how the Richter magnitude can be determined.

Materials:

- A computer for each student
- paper
- pencil

Introduction to Students

Today you will be a virtual seismologist. Your mission is to read through the web site, place the correct answers in the blanks, and receive a certificate stating that you are a virtual seismologist.

Procedure:

1. Read the directions.
2. Work through the problems.
3. Obtain four certificates.

Questions to Guide Analysis:

1. What is an earthquake?
2. What are seismic waves?
3. What is a seismogram?
4. How is an epicenter located?
5. Sketch a seismogram showing where the P waves arrive and where the S waves arrive.
6. How fast does an S wave travel?
7. How well did you do?
 - a.
 - b.
 - c.
 - d.
8. How should the circles look?
9. What is the Richter scale? What is the Modified-Mercalli Scale? What is the moment magnitude scale? Compare and Contrast these scales.
10. What did you learn from this activity? Be specific!

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Stellar Evolution

Background to Stellar Evolution

Standard Course of Study Targeted Goals and Objectives

- 1.02 Design and conduct scientific investigations to answer questions about the physical world.
- Create testable hypotheses.
 - Identify variables.
 - Select and use appropriate measurement tools.
 - Collect and record data.
 - Analyze and interpret data.
 - Communicate findings.
- 6.03 Examine the sources of stellar energies:
- Life cycle of stars
 - Hertzsprung-Russell Diagram

Introduction to the Teacher

Go to the following website. http://chandra.harvard.edu/edu/epo/request_special.html

Request a copy of the stellar evolution poster if you do not have one. Also request cosmic connections card sets and stellar evolution card sets for your classroom. The images can also be downloaded, but the materials are FREE from Chandra! **Allow several weeks for delivery.**

Go to this site to download images: http://chandra.harvard.edu/edu/formal/stellar_ev/cosmic/

Have students complete the cosmic connections activity. Print all the directions and information you need from the website.

Stellar cycles can then be used as an assessment tool.

http://chandra.harvard.edu/edu/formal/stellar_cycle/

References:

This activity was suggested by Debbie Michael, North Lincoln High School, Lincolnton, NC.

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Stellar Evolution

Stellar Evolution

Purpose:

The Our Cosmic Connection task is a sequencing activity using a set of twenty four cards with astronomical images. This allows students to use inquiry to sequence the cards.

Materials:

- set of cosmic connections cards
- stellar evolution poster
- templates - optional

Introduction to Students

Scenario: copied from the Chandra website: -

http://chandra.harvard.edu/edu/formal/stellar_ev/cosmic/task_desc.html

While you were absent from school with the flu, you missed the day you were presenting your project on stellar evolution in Earth Science class. In two days you are going on a class trip to the National Air and Space Museum in Washington DC, and the principal has decided that no one can go on the trip if they are missing any classroom assignments. Your teacher agrees to let you present your project to the class the following morning. The project consists of an oral presentation, and an organized portfolio of supporting materials. The presentation and portfolio is 20% of your grade for the quarter. Before you got the flu, you had searched the internet and downloaded several images representing the different stages of evolution for mid-sized and massive stars, and written a brief description for each image on index cards. All you need to do is review the images and descriptions. When you get home, you spread the materials out on the dining room table, and spend several hours arranging the images into different sequences and matching the images to the descriptions to prepare for your presentation. You decide that you will leave everything on the table and get up early to review the images and descriptions one last time. You stack the images and the descriptions in two separate piles, both in the order that you will present the evolutionary stages for the different mass stars from the stellar nursery to their final end products.

The next morning you go downstairs for your final review. You are completely shocked! You cannot believe the mess on the table! Your new puppy had jumped onto the table during the night, knocked the stack of images onto the floor, and chewed and mangled the index cards containing the descriptions.

Task:

There is no way you can tell your teacher that "the dog ate my presentation!" You only have one hour to quickly place the images back in order and write a description for each one using available resources.

Procedure:

1. Arrange the cards in order to represent the life cycle of a mid-sized star.
2. Arrange the cards to represent the life cycle of a massive star.
3. Arrange the cards to represent the life cycle of a Ia supernova.

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List of Materials

	Activity	Materials
1	Field Identification of Minerals	Quartz barite, hematite, augite, pyrite, calcite, fluorite, halite, muscovite, orthoclase, chalcopryrite, corundum, biotite, galena, talc, apatite, hornblende, magnetite, gypsum, sphalerite Mineral identification kit. (glass plate, copper stripe, nail, dropper bottle of dilute hydrochloric acid, magnet, magnifying lens, streak plate)
2	Learning to Calculate Specific Gravity	Rubber band Calculator Balance with a specific gravity platform 250 ml beaker Mineral specimens (quartz, calcite, barite, chalcopryrite, magnetite, galena)
3	Beginners Compass Game	Compass 10 Stakes 50 foot measuring device
4	Basic Mapping	Tape measure (50 meters) Pencils Pens Calculator Compass Protractor
5	Contour Mapping	Stick and string set (1-10 foot wood stake, 1-8 foot wood stake, 11 feet of twine, permanent marker, yard stick) Line level Compass Survey flagging Calculator 36x36 inch roll or butcher paper or news print Colored pencils Meter stick Protractor
6	Cookie Mining Activity	Graph paper Chocolate cookie (three types) Tooth picks (flat and round) Paper clips Electronic balance

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List of Materials

7	Wet and Cold	Funnel Graduated cylinder Stop watch Triple beam balance Graph paper Rulers Ring stands and iron rings
8	Radioactive Decay	100 small objects (like paper clips) 1 box with a cover Graph paper
9	Geologic Calendar	Calendar Colored pencils Colored pens Glue Magazine pictures or clip art
10	Be a Virtual Seismologist	Computer with internet access Paper and pencil
11	Stellar Evolution	A set of cosmic connections cards Stellar evolution poster

Honors Earth/Environmental Curriculum
Support Document
Curriculum Support
for the 2004 revision of the
North Carolina Standard Course of Study for
Honors Earth/Environmental Science

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Honors Earth/Environmental Curriculum Support Document

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We make every effort to keep these materials accurate and up to date. Check the Department of Public Instruction's website <http://www.ncpublicschools.org/curriculum/science/scos/> for current versions.

Comments on these materials should be addressed to:

Benita Tipton, M. Ed.
High School Science Section
North Carolina Department of Public Instruction
301 North Wilmington Street
Raleigh, NC 27601-2825
Email: btipton@dpi.state.nc.us

Honors Earth/Environmental Curriculum

Support Document

Honors Courses in North Carolina: Science

Honors Science Courses

All of the honors science courses share the following characteristics and assumptions:

- Students enrolled in honors courses will learn the material in the standard course of study for the course at greater depth than in the standard level version of the course. The support documents for the course include appropriate honors extensions by objective.
- Students enrolled in the honors version of the course will take the same EOC as students enrolled in the standard level version of the course.
- Students who choose an honors science course are expected to work more independently than students in standard level courses.
- Because students can be expected to cover the standard level material more independently there will be time for more enrichment topics as specified in the course descriptions for specific honors courses.
- Students who choose an honors science course will be expected to complete more independent in-depth scientific investigations and to report on them using a more formal scientific laboratory report format.
- Students who choose an honors science course will be expected to read about recent scientific research and present their findings orally and in writing.

Many of the materials and activities suggested for honors courses will also be appropriate for some students enrolled in standard level versions of the course. The difference may be in the level of independence expected of students and the amount of time activities may take. All students, not just those in honors courses, should experience challenging work and some level of independent inquiry in their science courses. Teachers should include some of the enrichment topics for all students.

Definition of Honors Science Courses

Honors science courses are designed to demand more challenging involvement than standard science courses. They must be demonstrably more challenging than standard courses and provide multiple opportunities for students to take greater responsibility for their learning. Honors science courses should be distinguished by a difference in the quality of the work expected rather than merely by the quantity of the work required.

Purposes of Honors Science Courses

Honors science courses should be designed for students who have demonstrated an advanced level of interest and achievement in a given subject area. The rationale for honors courses is not to provide a means to attract students to enroll in classes for additional credit, but rather to offer challenging, higher level courses for students who aspire to an advanced level of learning. Furthermore, students and parents should be informed that honors science courses are more demanding and have requirements beyond those of standard science courses.

Honors courses should be developed as an integral component of a differentiated program of study that provides an array of opportunities for all students based on their aptitudes, affinities, and interests.

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Scheduling Honors Science Courses and Standard Level Courses Together

Honors and standard levels may be offered in the same classroom simultaneously when necessary. For example, a small school with limited physics enrollment may find it necessary to combine these two groups of students for instruction. Teachers in this position will need to put special emphasis on appropriate differentiation in their planning.

Professional development with a focus on differentiation is recommended in this case.

Characteristics of Honors Science Courses

Honors science courses will address the same goals and objectives as the corresponding *NC Standard Course of Study*; however, they should address the content with greater complexity, novelty, acceleration, and/or pacing. Honors science courses should reflect a differentiation of curriculum, both in breadth and depth of study. Honors science courses should exemplify the following characteristics:

- Require a higher level of cognition and quality of work than the standard course
- Enable students to become actively involved in classroom and laboratory learning experiences
- Involve students in exploratory, experimental, and open-ended learning experiences

Honors science courses should provide opportunities for the following:

- Problem-seeking and problem-solving
- Participation in scholarly and creative processes
- Use of imagination
- Critical analysis and application
- Personalized learning experiences
- Learning to express/defend ideas
- Learning to accept constructive criticism
- Becoming a reflective thinker
- Becoming an initiator of learning

Essential Questions

Essential questions are designed to focus attention on main ideas. They are used in honors courses to prompt thinking and spark discussion of key elements within a larger context. Essential questions are helpful in working through the steps in problem-solving, planning, and decision making processes.

Essential questions reflect the most historically important issues, problems and debates in a field of study. In the sciences, essential questions should be used to help students make connections across particular disciplines such as biology and chemistry to the larger unifying concepts of science as well as to focus on essential questions within disciplines. For example, “What factors affect the motion of objects?”, “How can we represent these factors?” and “How can we combine the various factors to predict motion?” are essential questions within Earth/Environmental Science. “What other explanations could account for this data?” and “How can we measure that?” are essential questions in all of the sciences. By examining such questions, students engage in higher order thinking. Essential questions are open-ended with no single, correct answer.

Honors Earth/Environmental Curriculum Support Document

Essential questions are meant to stimulate inquiry, debate and further questions, and can be reexamined over time. They are designed to be thought provoking to students, engaging them in sustained, focused inquiries, culminating in meaningful performances (McTighe & Wiggins, 2004).

Instructors of honors science courses are expected not only to pose essential questions to the students, but also to guide students in generating their own essential questions. The Honors Science Portfolio should include a list of essential questions with specific indications of how these essential questions are to be used in the honors class.

Honors Earth/Environmental Science Support Document

Introduction to Honors Earth/Environmental Science

These materials were developed to assist in the development and implementation of Honors Earth/Environmental Science courses. It should be noted, however, that **this document is not an honors teaching portfolio**. Each individual LEA and/or honors physics teacher needs to create a portfolio to document their own honors physics course. The materials included in this document are sample activities and suggestions provided to help in the portfolio development process. Honors courses may be developed at the LEA, school or teacher level. A local review and monitoring process should be put in place. As teachers develop their honors portfolios, they should use this opportunity to document what they are already doing well, while further developing the rigor in their courses. This should be seen as an on-going process. Courses should be revised and reviewed each year.

Essential Questions: Essential questions may be organized by teaching units rather than by the *Standard Course of Study*. Their purpose is to help focus teachers and students on the most important or essential concepts. Often an essential question bridges between objectives or serves as an organizing question for a unit that brings in concepts from several goals and objectives. Some essential questions will recur throughout the course. Sometimes after writing the overarching question, teachers will need to consider "entry point" questions to help students do the research and understand the background to access the topic at a higher level. Below are some internet resources related to essential questions.

http://www.myprojectpages.com/support/ess_questpopup.htm

http://www.essentialschools.org/cs/resources/view/ces_res/137

<http://members.tripod.com/~ozpk/0000000EQ> - this page starts with an assortment of links to other essential question sites and then has some examples - the ones in this site will help teachers make interdisciplinary connections beyond the sciences.

Precautions:

- **All students**, not just those in honors courses, should experience challenging work and some level of independent inquiry in their courses.
- Many of the materials and activities suggested for honors courses will also be appropriate for some students enrolled in standard level versions of the course.
- Teachers should include some of the enrichment topics for all students.
- **Independent does not mean unsupervised!**
 - Teachers must still provide appropriate supervision at all stages.
 - For independent projects teachers should give choices of topics or have a process in place for topic review and approval.
 - Teachers should always review project design carefully for safety reasons and to be sure the project will provide an appropriate learning experience.
 - Actual laboratory work must be supervised. Younger and less experienced students will need more scaffolding to make this a productive learning experience.
 - Independent **DOES** mean that the teacher will **NOT** provide all of the structure and step by step instructions.
- **Independent does not mean alone or unsupported!**
 - Just as adults in all sorts of industries usually work in teams, students may also work in teams.
 - Teachers may need to provide some assistance to students in finding appropriate sources and models of appropriate performances.

Honors Earth/Environmental Science Support Document

A more extensive introduction to the development of honors courses is in the *Honors Course Implementation Guide* available for download at <http://www.ncpublicschools.org/curriculum/honorsguide>.

Honors Earth/Environmental Science Support Document

Honors Earth/Environmental Science Course Description

Honors Earth/Environmental Science is a rigorous curriculum designed to allow highly motivated students to conduct an in-depth study of the Earth and Environmental Sciences. In Honors Earth/Environmental Science students are expected to work independently on a variety of assignments and accept greater responsibility for their learning. In order to develop a greater understanding of the processes that shape our everyday lives, the curriculum will integrate inquiry investigations and a variety of technologies with the study of earth as a system. The impacts of human activities on earth systems will also be a focus. The results of student investigations should be communicated through presentations and formal laboratory reports. Enrichment and integration with other disciplines is encouraged.

Students may not take Honors Earth/Environmental Science in addition to the standard level *Standard Course of Study* Earth/Environmental Science course.

Honors Objectives: The following objectives are extensions of those in the 2004 revision of the *Standard Course of Study* for Earth/Environmental Science. The numbers are to show placement in the *Standard Course of Study*.

- 1.02 H** Design, conduct and evaluate independent scientific investigations.
- Evaluate student-generated hypotheses related to questions in earth and environmental science by designing and carrying out independent investigations.
 - Relate student investigations to current issues and research in earth and environmental science.
 - Prepare formal written lab reports with analysis of data.
 - Discuss sources of error and bias in investigations.
 - Present findings to members of the community.

Teachers should also choose at least 3 of the following 6 honors objectives for in depth study and student projects.

- 1.08 H** Evaluate Earth and Environmental Science topics in materials from other subject areas (e.g. literature, social studies).
- Include print and electronic media
- 2.01 H** Evaluate the relationship between the density of magmas, heat, pressure and the texture and mineral composition of igneous rocks.
- 2.08 H** Evaluate the impact of a community on local natural resources.
- Renewable and nonrenewable resources
 - Conservation/Stewardship
 - Technological solutions to pollution issues.
 - Use of and recommendations for recycling technologies
 - Rehabilitation of disturbed lands
- 3.03 H** Research and design a guide to the geologic history of the local area, including rock formations, faults, and sea level changes.

Honors Earth/Environmental Science Support Document

4.06 H Evaluate changes in local bodies of water and/or watershed over time:

- Stream studies
- Human and natural impacts

6.01 H Evaluate evidence related to theories of the origin and nature of the universe:

- Big Bang theory
- Dark matter
- Black holes

Honors Earth/Environmental Science Support Document

Why Is Soil Important To Me?

Standard Course of Study Targeted Goals and Objectives

1.02: Design, conduct and evaluate independent scientific investigations.

2.05: Evaluate economic development and impact of our finite resources.

2.06: Interpret soil maps.

Essential Questions:

How do scientists solve problems?

Why is soil important to me?

Introduction to Teachers

Students will be designing their own investigation about the soil. The project starts with students researching information on soil. The teacher can direct what aspects they will investigate by supplying the research sites or materials. For example, if your goal is to relate understanding soil absorption to local flooding you would provide reading material or websites where they could access that topic. Other possible topic would be; soil nutrients, profile, or characteristic (texture, composition, structure, pH, or type). Groups could be given different pieces of the research to prepare for the class. Newspapers, websites, textual materials, soil survey manuals, or interview a soil scientists could be possibilities.

After research is prepared, students are lead in developing a hypothesis which would be feasible to undertake within your classroom constraints. Examples are: How does our soil compare to the books description of the soil profile? Is this soil suitable for building? What is the rate of water infiltration? For what is this soil suitable?

Students will than design the experimental procedure including materials and list of skills they will need to learn to test the hypothesis. The teacher's role will be to guide and teach the skills needed to prepare the soil samples and testing procedures. (See: <http://soil.gsfc.nasa.gov/index.html>) One hypothesis could be agreed upon by the class or the teacher could allow multiple investigations to occur. It will depend on the teacher and students level of expertise, materials available, etc. Methods for data collection and recording need to be explained to the students and examples given. Students prepare appropriate tables.

Now students go out into the field to collect samples, observations, and/or prepare a soil profile. To save time or due to local conditions it may be better to have samples available in the classroom for students to analyze. Exactly what you test will depend on the hypothesis your students have developed.

Final stage is to analyze the data and prepare their conclusions. At this stage, they local soil maps will be introduced as a resource for comparison. <http://websoilsurvey.nrcs.usda.gov/app/> This website will allow them to zoom in to their local area and access various data for comparison.

Honors Earth/Environmental Science Support Document

Differentiation from Standard Level:

This is an inquiry approach versus standard cookbook procedure to investigation. Students have to use higher-level thinking skills and math skills to design, carry out, and interpret all aspects of the scientific method to solve a practical problem.

Safety/Special Considerations:

You must contact the electric company before digging. They will come out and let you know where all underground cables are located. Make sure you give them plenty of notice before beginning this activity. Make students aware that this is a “dirty” job—but they’ll be doing it! They may want to bring a change of clothing and/or shoes. Depending on the experimental questions some test may not be able to be done by the students but they could send the sample into the Extension Service to have it analyzed. If there is some limitation that prevents samples being taken students could access the existing soil data bases of the Extension Service or local Universities Soil/Environment Department.

References:

Soil maps – Agriculture Extension Agent, State Soil Scientist, USDS OR NRCS-Natural Resource Conservation Service-web search <http://websoilsurvey.nrcs.usda.gov/app/>

<http://soil.gsfc.nasa.gov/index.html> -This site contains good general info as well as techniques to analyze the soil components. It’s linked to Globe Protocols.

Textbook

Honors Earth/Environmental Science Support Document

Why Is Soil Important To Me?

Standard Course of Study Targeted Goals and Objectives

1.02: Design, conduct and evaluate independent scientific investigations.

2.05: Evaluate economic development and impact of our finite resources.

2.06: Interpret soil maps.

Essential Questions:

How do scientists solve problems?

Why is soil important to me?

Information to Student

Introduction

Purpose: Students will use the scientific method to solve a practical problem related to soils.

Background Information: Before developing a hypothesis a scientist must research what is know about his subject. This would include finding out about the important local environmental issues related to soil. Use the materials provided to do your research and be prepared to provide 5 pieces of information you have learned.

Materials:

You will need to determine the materials and equipment you will need to conduct your investigation. If you can not name the piece of needed equipment, describe what you need it to do.

Procedure:

Brainstorm with your partners how you will use your materials and equipment to test your hypothesis. Your teacher will demonstrate how to use any special sampling equipment and materials.

Safety Consideration: (Provided by teacher)

Questions to Guide Analysis:

- 1) What materials will provide you the information you need?
- 2) What are the variables you need to compare?
- 3) What parts of the experiment need to be kept the same or controlled?
- 4) How will you organize your time to complete the experiment?
- 5) What is your hypothesis?
- 6) What were the results of your experiment?
- 7) How does your conclusion compare with your hypothesis?

Honors Earth/Environmental Science Support Document

References (for further research):

<http://soil.gsfc.nasa.gov/index.html>

<http://websoilsurvey.nrcs.usda.gov/app/>

Grading Sheet:

Area	Points
Research- Completed & Shared	
Problem Stated	
Testable Hypothesis Written	
Experimental Procedure Written <ul style="list-style-type: none">• Logical Sequence• Safety Concerns Addressed	
Field Work <ul style="list-style-type: none">• On Task• Conducted Safely• Follows Procedure• Data Organized & Neatly Recorded	
Group Participation	
Conclusion <ul style="list-style-type: none">• Mechanics• Organized & Logical Presentation• Addresses Problem	

Honors Earth/Environmental Science Support Document

Can Do: Soil Water Movement

Standard Course of Study Targeted Goals and Objectives

- 2.06: Investigate and analyze the importance and the impact of the economic development of Earth's resources to society and our daily lives.
- 2.07: Analyze the sources and impacts of society's use of energy.
- 4.04: Evaluate water sources – storage and movement of ground water.
- 4.05: Investigate and analyze environmental issues and solutions for North Carolina's river basins, wet lands and title environments/water quality.

Essential Question:

Where can you build a city that will have the least negative impact on the natural environment?

Introduction to Teacher

Background information:

Foundation Science Required:

- Geologic history of the area (rock and soil types)
<http://www.geology.enr.state.nc.us/Default.htm>
- Water systems of the area (Natural and man made)
<http://earth.google.com/>
- Ecosystems of the area
<http://www.fhwa.dot.gov/environment/ecosystems/nc.htm>
- Climate (Seasonal aspects)
<http://www.nc-climate.ncsu.edu/>
- Previous land use of area

Contact your local planning office for historical documents regarding the area of study in your area.

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Differentiation from Standard Level:

Application to real life situation-Basic information from the standard course of study is applied to a real life simulation requiring the students at a higher level of thinking. The conclusion requires abstract thinking where as a regular level class would have specific fact-related questions to answer.

Example product: At the beginning of the project, students will interpret the topographic map for water run off patterns, sediment deliver patterns, elevation.

At the end of the project, students will redraw the topographic to show how the building of the city has altered the topography.

Safety/Special Considerations:

- Tape edges of cans.
- Requires a safe location for soil collection.
- Wash hands upon completion.

References:

<http://www.globe.gov/tctg/sectionpdf.jsp?sectionId=405&rg=n&lang=en>

Enter the GLOBE site and click on protocol. Link to the “infiltration” protocol

<http://www.ncsmt.org/> Contact the NCSMT center for scientist support

<http://www.learner.org>

In the subject bar, select science and then 9-12. Take a look at “Learning that works” and “Planet Earth” These websites will help teachers become more familiar with inquiry learning and teaching.

Sarah Duffer
Katherine Davidson
Joan Pakenham
Lynne Gronback

Honors Earth/Environmental Science Support Document

Can Do: Soil Water Movement

Standard Course of Study Targeted Goals and Objectives

- 2.06: Investigate and Analyze the Importance and the Impact of the Economic Development of Earth's Resources to Society and Our Daily Lives
- 2.07: Analyze the sources and impacts of society's use of energy.
- 4.04: Evaluate Water Sources – Storage and Movement of Ground Water
- 4.05: Investigate and Analyze Environmental Issues and Solutions for North Carolina's River Basins, Wet Lands and Title Environments/Water Quality

Essential Question:

Where can you build a city that will have the least negative impact on the natural environment?

Information to Student

Background Information:

Foundation Science Required:

- Geologic history of the area (rock and soil types)
- Water systems of the area (Natural and man made)
- Ecosystems of the area
- Climate (Seasonal aspects)
- Previous land use of area

Materials (per group):

- 2 cans of different sizes with both top and bottom removed
- Small – chunky soup cans
- 1 large 2lb coffee can or Number 10 size commercial can.
- Milk jug of water
- 500ml graduated cylinder or 1 liter (with graduated lines) drink bottles
- Waterproof metric ruler
- Paper and pencil
- Internet resources: www.globe.gov (go to – protocol-soils-infiltration lab)

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Procedure:

1. Develop Data Table. You may use the following sample:

Data Table for Inner Can (or Outer Can)

Time (seconds)	Depth of water (cm)	Fall (cm) / Time (seconds)	Qualitative Observations
0			
5			
10			
15			
Etc.			

2. Assemble materials: 2 cans, ruler, wrist watch, pencil and paper with data table.
3. Outdoors, select two different sample sites (example: bare soil versus vegetation-covered soil, no/low gradient slope versus steep slope) *NOTE: Avoid hardened soil!*
4. Write a description of your site and soil. (Include qualitative data regarding soil, slope, land use, etc.)
5. Twist smaller can +/- 1 cm into soil. Then center larger can in relation to smaller can and twist larger can +/- 1 into soil. Check to make sure the smaller can is centered within the larger can.
6. Decide if you will put water into larger or smaller can.
7. Place waterproof metric ruler against that can's inner edge without displacing your cans.
8. Fill a graduated cylinder or 1 liter soda bottle, with graduated lines, to the 500 ml mark.
9. Pour water into the can that you chose. Do not displace the ruler.
10. Using a watch, record the level (in cm) every 5 seconds, starting at 0 seconds into your Data Table.
11. If the water level gets below half way down then add more water. (Measure and record the water volume). Then repeat steps 9 and 10 until you record the same drop for 3 consecutive intervals.
12. Go to your next plot and repeat steps 1 through 11.

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Results Section:

Reports should include both qualitative observations and a graph of the data.

Discussion Section:

Reports should reflect observations made in the results section in relation to the original question.

Honors Earth/Environmental Science Support Document

Forests- Mining Carbon from the Air: Computer Modeling Inquiry Lab (Background Information)

Standard Course of Study Targeted Goals and Objectives

- 1.02: Identify questions and problems in the earth and environmental sciences that can be answered through scientific investigations.
- 1.03: Design and conduct scientific investigations to answer questions related to earth and environmental science.
- 1.05: Analyze reports of scientific investigations and environmental issues from an informed scientifically literate viewpoint.
- 2.06: Investigate and analyze the importance and impact of the economic development of earth's finite rock, mineral, soil, fossil fuel and other natural resources to society and our daily lives.
- 2.07: Analyze the sources and impacts of society's use of energy.
- 5.03: Analyze global atmospheric changes including changes in CO₂, CH₄, and stratospheric O₃ and the consequences of these changes.

Essential Questions:

How does carbon content change over a period of time?

How does a tropical rain forest contribute to those changes over time?

What is carbon trading?

How do you create and use a carbon inventory for a forest?

Introduction to Teacher

Background Information:

Carbon released into the atmosphere, primarily from the burning of fossil fuels, is widely believed to be contributing to large-scale global climate changes. The global biosphere is a major absorber or "sink" for carbon and forest cover is thought to play a substantial role as a sink in the global carbon cycle. On average in the 1990s the biosphere absorbed 2.3 billion tons C y⁻¹ or about 36% of the annual fossil fuel emissions (IPCC 2001).

Trees grow by absorbing water and minerals from the soil and by taking in CO₂ from the air. They use the energy in sunlight to change these raw materials into wood and leaves. A very large number of factors work together to determine how much carbon from the air ends up in the wood and leaves of the tree, (or, using technical terminology, how much carbon is "sequestered" in the tree.) Fortunately a large number of scientists and forest managers have been collecting data on factors that affect tree growth for many years. The data they have collected has been fitted to equations so that a reasonable estimate of the amount of carbon sequestered in a given type of tree under specific circumstances can be modeled mathematically.

Scientists and economists at Wageningen University in Holland developed the model that will be used in

Honors Earth/Environmental Science Support Document

this lab for use by member countries of the European Union who have committed to the emission restrictions set out in the Kyoto Protocol. The United States has chosen not to participate in the Kyoto Protocol.

Differentiation from Standard Level:

1. Calculations using mathematical modeling.
2. Accessing publicly available information via the internet.
3. Creating forest management scenarios to compensate for fossil fuel emissions.
4. Quantitative approach to analyzing CO₂ environmental trends.
5. Comparing and contrasting managed and unmanaged tropical rain forests.

Safety/Special Considerations: All students need internet and excel access.

References:

CO2FIX V 2.0 This is the professional forest model used in this lesson. It was produced by the CASFOR project by G.J. Nabuurs, J.F. Garza-Caligaris, M. Kanninen, T. Karjalainen, T. Lapvetelainen, J. Liski, O. Masera, G.M.J. Mohren, A. Pussinen, and M.J. Schelhaas of ALTERRA, UNAM, CATIE and EFI at the Wageningen University and Research Center.

The software, including input files, can be downloaded free from: <http://www.efi.fi/projects/casfor>. **Note - teachers will need to register to download the file!**

[CO2FixWURex1](#) the stock and flow tables from the first sample forest are provided with the CO₂ Fix model to an Excel spreadsheet. Your students can analyze the data for this run. They won't be able to change the variables in the model for a new run.

[CO2FIXexharvest](#) is the second sample model provided with their suggested changes to include harvesting of the forest. The flow and stock tables are in an Excel spreadsheet.

[DGLBeedhComploggmort](#) is a third sample forest provided with the model. Again it is copied the flow and stock tables to an Excel spreadsheet. This forest is a Douglas Fir and Beech plot with logging.

If you use these three Excel spreadsheets, your students will be able to mine the data to see how these forests grow and interact with the atmosphere. They won't be able to change the parameters of the model to recommend changing the forest management practices in order to maximize the CO₂ sequestered.

The developed CO₂FIX model is intended to provide users with a tool to analyze the outcome of different forest management options as specified in the Kyoto protocol.

Answers can be found at the following web address: <http://www.shodor.org>

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Forests- Mining Carbon from the Air: Computer Modeling Inquiry Lab (Activity)

Standard Course of Study Targeted Goals and Objectives

- 1.02: Identify questions and problems in the earth and environmental sciences that can be answered through scientific investigations.
- 1.03: Design and conduct scientific investigations to answer questions related to earth and environmental science.
- 1.05: Analyze reports of scientific investigations and environmental issues from an informed scientifically literate viewpoint.
- 2.06: Investigate and analyze the importance and impact of the economic development of earth's finite rock, mineral, soil, fossil fuel and other natural resources to society and our daily lives.
- 2.07: Analyze the sources and impacts of society's use of energy.
- 5.03: Analyze global atmospheric changes including changes in CO₂, CH₄, and stratospheric O₃ and the consequences of these changes.

Essential Questions:

How does carbon content change over a period of time?

How does a tropical rain forest contribute to those changes over time?

What is carbon trading?

How do you create and use a carbon inventory for a forest?

Information to Student

Background Information:

Trees grow by absorbing water and minerals from the soil and by taking in CO₂ from the air. They use the energy in sunlight to change these raw materials into wood and leaves. A very large number of factors work together to determine how much carbon from the air ends up in the wood and leaves of the tree, (or, using technical terminology, how much carbon is “sequestered” in the tree.) Fortunately, a large number of scientists and forest managers have been collecting data on factors that affect tree growth for many years. The data they have collected has been fitted to equations so that a reasonable estimate of the amount of carbon sequestered in a given type of tree under specific circumstances can be modeled mathematically.

Materials:

Computer with Internet connection

Excel or comparable spreadsheet program

The software, including input files, can be downloaded free from <http://www.efi.fi/projects/casfor> or [CO2FixWURex1](#) the stock and flow tables from the first sample forest are provided with the CO2 Fix model to an Excel spreadsheet. Your students can analyze the data for this run. They won't be able to change the variables in the model for a new run.

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CO2FIXexharvest is the second sample model provided with their suggested changes to include harvesting of the forest. The flow and stock tables are in an Excel spreadsheet.

DGLBeedhComplogmort is a third sample forest provided with the model. Again it is copied the flow and stock tables to an Excel spreadsheet. This forest is a Douglas Fir and Beech plot with logging.

Procedure:

Exercises to Familiarize Yourself with the Model

Download CO2FIX from the web free of charge at <http://www.efi.fi/projects/casfor>

Or use the spreadsheets listed at the end of this lab.

1. Open 'WUR-ex1.co2' Note that once you have opened it, CO2FIX immediately carries out a run. So you will see a screen filled with numbers, i.e. the 'carbon stocks table'

WUR-ex1 is a model of an unmanaged forest. The model run is carried out for 300 years in this case. Scan through the screens to obtain an idea of the parameter values.

Analyze the net carbon sink evolution over time. You do this by copying the last two columns from the 'view flow table' into an Excel spreadsheet. Then subtract the right hand column from the left column. (The atmosphere losses *minus* atmosphere increments). This provides you with the net carbon sink of the whole system in tones of carbon per hectare per year from year 0 to year 300.

Analyze the trend in carbon sequestration. In which year is the peak in net sequestration reached, and how large is it?

What is the long-term average (yr 0 – 300) net sink in this system?

What is the long-term average (yr 0 – 300) carbon stock in the tree biomass in this system?

Look at the trend in carbon stock in "coarse litter".

What is the long-term average (yr 0 – 300) carbon stock in the coarse litter compartment in this system?

2. Open 'WUR-ex2.co2'. You will start to manage the forest and produce wood products with this part of the model.

Go to the biomass parameterization module, and choose the 'thinning harvest' tag

Parameterize two thinnings (year 30 and 60) and one final felling when the forest is 100 years old.

- Set the fraction removed is respectively 0.25, 0.25, and 1.
- Allocation of first thinning, .1 to logwood, and .7 to pulp-pap
- Allocation of second thinning, .3 to logwood, and .6 to pulp-pap
- **Allocation of final felling, .7 to logwood, and .2 to pulp-paper.**
- **Leave the rest of the cells as they are, i.e. all branches are allocated to slash.**

Now choose 'Apply' and 'OK'

Go to 'products parameterization module'. This has now been parameterized for you.

Try to get an idea what has been inserted for products.

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What fraction of products in long-term use will be recycled at the end of their life?

What fraction of recycled products in long-term use, will go to products with a medium term use?

Now choose ‘Apply’ and ‘OK’

Under the icon ‘View options’ choose the ‘products’. Analyze what you see.

Go back to the ‘view carbon stocks table’, and

- Copy the column with the total products carbon stock into an Excel spreadsheet.

Calculate the long-term average stock in products. What is it?

Now calculate again the long-term average (yr 0 – 300) carbon stock in the coarse litter compartment?

What is it now? How much has it been reduced compared to ex 1?

Now calculate again the long-term average (yr 0 – 300) carbon stock in the tree biomass. What is it now? How much has it been reduced compared to ex 1?

Look at the annual fluxes!

3. Open ‘WURex3.co2’. This is a managed forest ecosystem with high fire risk.

It is parameterized such that a fire is assumed to ‘destroy’ the forest at age 80 in the second rotation.

Check how this is incorporated in the ‘thinning-harvest’ tag.

How much of the biomass is assumed to directly burn?

How much is the peak of coarse litter?

Now calculate again the long-term average (yr 0 – 300) carbon stock in the coarse litter compartment? What is it now?

4. Additional: open WUR-ex4. This is a managed forest but with shorter life spans for long-life span products. Initially ex4 is set so that in the ‘end products’ tag in the ‘products’ module, all products are being burned at the end of their life. Check this.

Now parameterize the products module such that there is no recycling, but at the end of the life span all products are dumped in a landfill.

Analyze what happens to the carbon stock in the products total (i.e. including landfills).

Now that you have some familiarity with the model, work on the lab below.

Safety/Special Consideration: None

Questions to Guide Analysis:

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Lab Problem

You're working as a forestry consultant.

An insurance company leases 20 cars and wants to compensate for the CO₂ emissions that are caused by those cars through forestry projects. They want it to be a cost-effective measure and they want the carbon sequestration to be achieved in the same year as the emissions occur. Your client requests that you determine how many hectares of rain forest they will need to plant.

The Emissions:

Together the 20 cars are driven a total of 1 million kilometers per year. One liter of gas emits 0.85 kilogram C. The total annual emissions are thus 53.1 tones C.

Calculate how many hectares of rain forest you would have to establish to compensate for these emissions (if all the emissions have to be compensated for in the same year as their emissions). Create a power point presentation to defend your position.

References (for further research):

CO2FIX V 2.0 This is the professional forest model used in this lesson. It was produced by the CASFOR project by G.J. Nabuurs, J.F. Garza-Caligaris, M. Kanninen, T. Karjalainen, T. Lapvetelainen, J. Liski, O. Masera, G.M.J. Mohren, A. Pussinen, and M.J. Schelhaas of ALTERRA, UNAM, CATIE and EFI at the Wageningen University and Research Center.

The software, including input files, can be downloaded free from: <http://www.efi.fi/projects/casfor>

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If you use these three Excel spreadsheets, your students will be able to mine the data to see how these forests grow and interact with the atmosphere. They won't be able to change the parameters of the model to recommend changing the forest management practices in order to maximize the CO₂ sequestered.

The developed CO2FIX model is intended to provide users with a tool to analyze the outcome of different forest management options as specified in the Kyoto protocol.

Grading Considerations:

- Spreadsheets
- Graphs
- Answers to questions
- Power Point Presentation

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Create and Analyze a Stratigraphic Core Sample from each Geologic Province in North Carolina: Background Information

Standard Course of Study Targeted Goals and Objectives

- 1.02 H: Design, conduct and evaluate independent scientific investigations.
- 1.08 H: Evaluate earth and environmental science topics in materials from other subject areas.
- 3.03 H: Research and design a guide to the geologic history of the local area, including rock formations, faults, and sea level changes.

Essential Questions:

- Age – How Old are the materials within the core sample?
- Composition- What is the mineral/rock composition of the materials?
- Geologic Processes – What processes were involved in creating these materials?
- Topography- What processes are involved in creating the topography of the region?

Introduction to Teacher

- Basic plate tectonics
- Geologic history
- Soil Composition
- Mineral/Rock Formations
- Topographic map reading

Differentiation from Standard Level:

- Researching- utilizing internet and charts and maps
- Collaborating with in various groups to produce a creative interpretation of scientific data
- Initiating learning by providing peer group learning opportunities, Students learning to accept constructive peer criticism
- Self & peer evaluation

Safety/Special Considerations:

Materials used in core sample must be non-toxic.

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References:

Jessica Parker, Jay M. Robinson High School

Joe Pike, Jay M. Robinson High School

Micki Powell, South Granville High School

Kathryn Smith, South Brunswick High School

Terri L. Woods, East Carolina University Dept. of Geology

Classification charts of rocks/minerals

Mineral Guides of North Carolina

North Carolina Geological Survey website

Physiographic maps of NC

USGS website

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Create and Analyze a Stratigraphic Core Sample from each Geologic Province in North Carolina: Activity

Standard Course of Study Targeted Goals and Objectives

- 1.02 H: Design, conduct and evaluate independent scientific investigations.
- 1.08 H: Evaluate earth and environmental science topics in materials from other subject areas.
- 3.03 H: Research and design a guide to the geologic history of the local area, including rock formations, faults, and sea level changes.

Essential Questions:

- Age – How Old are the materials within the core sample?
- Composition- What is the mineral/rock composition of the materials?
- Geologic Processes – What processes were involved in creating these materials?
- Topography- What processes are involved in creating the topography of the region?

Information to Student

Purpose:

- To create and analyze core samples of each geologic province in NC.
- To describe what geologic processes went into creating materials in that province.
- To produce a reference tool (booklet, PowerPoint presentation, etc) to compile research.

Materials:

- Internet access
- Physiographic map of NC
- Classification charts of minerals/rocks
- Mineral guides
- Geologic Time charts and guides
- Miscellaneous craft materials to create core samples
- Regional topographic maps

Procedure:

1. Divide class into groups to research the geologic belts. Within each group the team must be divided into four areas: Age, Composition, topography, geologic processes. Teacher will conduct a process check to gauge understanding before returning to Province group.
2. The teams would separate into their four areas and research background information to bring back to their assigned province group to peer teach group about their areas.

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3. The Province groups would then research their province to create a scaled core sample from craft materials.
4. Students will make a model of a core sample for their province. Scale measurements should be correct for geologic age, composition, depth, and thickness of each layer. Grain size should be proportional to actual grain size, i.e. no cheerios for sand grains.
5. The group should also create a written document (booklet, PowerPoint, or poster) to explain how the four areas – age, composition, topography, and geologic processes influenced the creation of that province.
6. The group will present both the core sample and the written document to the rest of the class.

Safety/Special Consideration:

Materials are to be non-toxic.

Questions to Guide Analysis:

1. Determine the range of ages in province within core sample and their corresponding geologic ages.
2. What types of materials (rocks, minerals, fossil record) are present in each age range? Explain what geologic process may have affected the material at the time.
3. Describe the general topographic relief of province. What features are present? Explain what geologic processes would be the cause of these features.
4. How has tectonic activity played a role in developing this province? Explain why.

References (for further research):

Classification charts of rocks/minerals

Mineral Guides of North Carolina

NC Geologic History: *Years Before Man* by Fred Beyer

North Carolina Geological Survey website

Physiographic maps of NC

Regional Topographic Maps

Soil Maps

USGS website

www.geology.enr.state.nc.us/usgs/geomap.htm

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Rubric:

Category	0	1	2	3	4
Core Sample:	No valid information	Few layers are included and correctly ordered by geologic age, composition, depth, and relative position.	Some layers are included and correctly ordered by geologic age, composition, depth, and relative position.	Most layers are included and correctly ordered by geologic age, composition, depth, and relative position.	All layers are included and correctly ordered by geologic age, composition, depth, and relative position.
Key: Shows age, composition, & depth	No key or no correlation to sample provided	Key Provided-correlates 25% with core sample provided	Key Provided-correlates 50% with core sample provided	Key Provided-correlates 75% with core sample provided	Key Provided-correlates 100% with core sample provided
Scale: Shows scale in age, composition, & depth	NO Scale used	Scale used, but not reflected in sample.	Scale reflects in 1 out of 3	Scale reflects in 2 out of 3	Scale reflects in 3 out of 3
Written Document & Presentation: Paper, Poster, or PowerPoint Presentation	See categories below.	See categories below.	See categories below.	See categories below.	See categories below.

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Guidelines	Not followed	Followed some-not all	Followed most	Followed all
Organization	Sequence of information is difficult to follow.	Reader has difficulty following work because student jumps around.	Students present information in logical sequence which reader/audience can follow.	Information in logical, interesting sequence which reader can follow.
Content Knowledge	Students do not have grasp of information.	Students are uncomfortable with content and are able to demonstrate basic concepts.	Students are at ease with content, but fail to elaborate.	Students demonstrate full knowledge (more than required).
Grammar and Spelling	Work has four or more spelling errors and/or grammatical errors.	Presentation has three misspellings and/or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has no misspellings or grammatical errors.
Neatness	Work is illegible.	Work has three or four areas that are sloppy.	Work has one or two areas that are sloppy.	Work is neatly done.

Honors Earth/Environmental Science Support Document

Activities Using USGS Water Resources Investigations Report 00-4093: Background Information

Standard Course of Study Targeted Goals and Objectives

- 1.02: Design and conduct scientific investigations to answer questions related to earth and environmental science.
- 1.05: Analyze reports of scientific investigations and environmental issues from an informed scientifically literate viewpoint.
- 1.06: Identify and evaluate a range of possible solutions to earth and environmental issues at the local, national, and global level.
- 2.05: Analyze the dependence of the physical properties of minerals on the arrangement and bonding of the atoms.
- 4.01: Evaluate erosion and depositional processes.
- 4.03: Analyze the mechanisms that produce the various types of shorelines and their resultant landforms.
- 4.04: Evaluate water resources.
- 4.05: Investigate and analyze environmental issues and solutions for North Carolina's river basins, wetlands, and tidal environments.
- 5.01: Analyze air masses and the life cycle of weather systems:

Essential Questions:

What is the distribution of major storms?

What causes unusual flooding in some areas?

How does one measure water flow in a drainage basin and in streams?

Introduction to Teacher

The USGS Report mentioned above contains a wealth of information about the hydrologic, water-quality, and geologic effects of the flooding associated with the hurricanes and tropical storms that struck NC in the fall of 1999. It contains dozens of tables and figures that describe these effects, their causes, and the geologic and hydrologic processes involved. These exercises address various objectives including: 1.02, 1.05, 1.06, 2.05, 4.01, 4.03, 4.04, 4.05, and 5.01. Below I have suggested some of the most useful figures and tables, but many others are possible. The students can access the report at the website given below in the "Student Information" section.

- (Figure 1) numbers and intensities of tropical cyclones making landfall in North Carolina from 1890-2000. (5.01, 4.05)
- (Table 1 and Figure 6) Average rainfall and storm-induced rainfall (4.04, 5.01)
- (Figure 2) Compare the paths of Dennis, Floyd and Irene. (2.05,5.01)
- (Figures 3 and 4) Compare the amount of rain received in different regions of eastern NC during Hurricane Dennis and Hurricane Floyd. (4.04, 5.01)
- (Figure 5) Hurricane tracks (2.05,5.01)
- (Table 3) Drainage basins and how streams are measured and monitored. (1.06, 4.05, 5.01)
- (Figure 7 & Table 3) Flood frequency - prediction and causes (1.06, 4.05, 5.01)

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- (Figure 8) Use of hydrographs to describe streamflow. (1.02, 4.05, 5.01)
- (Figure 11 or 12) Annual variations in streamflow. (1.02, 4.05, 5.01)
- (Table 7, Table 8, Figure 20) Impact of storms on water quality (4.04)
- (Figure 26) Impact of hurricanes on shorelines. (4.03, 4.05)

More detailed description of activities using various figures and tables:

- **Figure 1.** Describe by decade the numbers and intensities of tropical cyclones making landfall in North Carolina from 1890-2000. Has every decade had the same number of storms?
- **Table 1.** For the location closest to you and for cities in several regions elsewhere in NC, compare the rainfall amounts associated with the 1999 s, Hurricane Fran (1996), and annual average rainfall for 1960-1990. What generalizations can you make?
- **Figure 2.** Compare the paths of Dennis, Floyd and Irene. (Be sure to use the proper names for NC Drainage Basins)
- **Figures 3 and 4.** Compare the amount of rain received in different regions of eastern NC during Hurricane Dennis and Hurricane Floyd.
- **Figure 5.** Compare the storm tracks of the 1999 hurricanes to Connie, Diane and Ione from 1955.
- **Figure 6.** Compare the monthly rainfall at selected sites near you and in a couple of other locations for August 1955 and September 1999. For each location in various river basins identify whether 1955 or 1999 had the most rain. Determine whether the 1955 or 1999 storms produced the most sites with the greatest rainfall amounts. Draw your own conclusions as to which set of hurricanes was responsible for dumping the most rain on NC.
- **Table 3.** For the area nearest you determine which streams listed have the largest drainage basins. Which sites have had gaging stations for the longest period of time? Which site has had a station the longest? At which site(s) is(are) the gage datum located at the highest elevation above sea level? Which is(are) closest to sea level? Which sites experienced the highest flood peaks above the gage datum? Which experienced the highest peak flows? By how many feet did the stations in your area exceed their previous peaks of record? In general for all the stations listed, how many flood peak records were set in each month of the year? Is there a particular time of year when more major floods tend to occur?
- **Figure 7 & Table 3.** List some locations that experienced greater than 500-year flood events. Which experienced 25- to 50-year flood events? Which experienced less than 5-year flood events? Is there a geographic pattern to the distribution of sites experiencing major floods and those experiencing only minor flooding? How does this pattern relate to the tracks of the hurricanes depicted in Figure 2? Is it easier to get this kind of geographic picture from Table 3 or from Figure 7?
- **Figure 8.** For how many days in September and October was the Tar River at Tarboro above flood stage? By how many feet did the September 1999 flood peak exceed the previous maximum stage (August, 1940)? How is the timing of the three peaks related to the passage of Hurricanes Dennis, Floyd, and Irene?
- **Figure 11 or 12.** Does every year have the same peak flow? Which year experienced the highest annual peak flow? Which the lowest? Pick out the 5 years with highest annual peak flows and list the magnitudes of those flows. Describe the pattern through time of the 5-year moving average of peak flows. How are high points in the 5-year moving average related to the major flooding events that occurred periodically during the 103-year time span of the historical record?

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- **Table 7.** Arrange the dissolved oxygen concentrations (DO) for Hurricanes Floyd and Fran (do the two separately) from lowest to highest. At each site sampled after both storms, compare the DO levels. Which storm generated the lowest DO levels?
- **Table 8.** Divide up into groups to handle each water-quality parameter listed. For each parameter determine if the maximum concentrations observed in samples collected from September-October 1999 were in the upper, middle or lower portion of the range observed for that site during the period January 1990-1999. Compare the results from each group and make some summary statements about the concentrations of constituents generated by the flooding compared to those observed during 1990-1999.
- **Figure 20.** Carefully study the diagram to determine which regions of the graph indicate the higher salinities. Then describe the change in salinity at Light 5 on the Pamlico River before and after Hurricane Dennis (9/4-5). What caused the change in salinity?
- **Figure 26.** Describe the differences in the pre-storm and post-storm profiles for the Outer Banks in the area north of Buxton. First study the photographs to orient yourself. Then, note the location of the Atlantic Ocean side of the island (to the east) and the Pamlico Sound side of the island (to the west). What was the height above sea level for the pre-storm dune? How many feet farther inland was the post-storm beach located than the pre-storm beach? How much narrower is the post-storm island than the pre-storm island at this point? What's the elevation difference between the highest pre-storm and post-storm dunes?
- The teacher will need to decide which activities to have the students complete!

Differentiation from the Standard Level:

The project can be an independent research experience of Earth/Environmental Science. It involves numerous math calculations, graphing, analyzing data, and critical thinking skills. Students will produce a written report and could possibly produce a presentation of results.

Safety/Special Considerations: None

References:

Submitted by: Terri L. Woods, Associate Professor, Department of Geology, East Carolina University

<http://nc.water.usgs.gov/>

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Activities Using USGS Water Resources Investigations Report 00-4093: Activity

Standard Course of Study Targeted Goals and Objectives

- 1.02: Design and conduct scientific investigations to answer questions related to earth and environmental science.
- 1.05: Analyze reports of scientific investigations and environmental issues from an informed scientifically literate viewpoint.
- 1.06: Identify and evaluate a range of possible solutions to earth and environmental issues at the local, national, and global level.
- 2.05: Analyze the dependence of the physical properties of minerals on the arrangement and bonding of the atoms.
- 4.01: Evaluate erosion and depositional processes.
- 4.03: Analyze the mechanisms that produce the various types of shorelines and their resultant landforms.
- 4.04: Evaluate water resources.
- 4.05: Investigate and analyze environmental issues and solutions for North Carolina's river basins, wetlands, and tidal environments.
- 5.01: Analyze air masses and the life cycle of weather systems:

Essential Questions:

What is the distribution of major storms?

What causes unusual flooding in some areas?

How does one measure water flow in a drainage basin and in streams?

Introduction to Student

The hydrologic cycle has profound effects on our daily lives. A single storm event or series of storms can impact all aspects of the hydrologic cycle and severely impact our lives for months to years. In this activity you will study various aspects of the hydrologic cycle (riverflow, rainfall patterns, hurricanes, water quality, etc.) and learn how it directly impacts your life.

Materials:

- Web access
- Pencil, paper, calculators, graph paper

Procedure:

- Go on-line at <http://nc.water.usgs.gov/>. Then click on on-line reports to find and select:
 - "Two Months of Flooding in Eastern North Carolina, September-October 1999: Hydrologic,
 - Water Quality, and Geologic Effects of Hurricanes Dennis, Floyd, and Irene"
- Print the figures, tables and photos you need to use to complete the exercises assigned by your teacher.

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- (Figure 1) numbers and intensities of tropical cyclones making landfall in North Carolina from 1890-2000. (5.01, 4.05)
- (Table 1 and Figure 6) Average rainfall and storm-induced rainfall (4.04, 5.01)
- (Figure 2) Compare the paths of Dennis, Floyd and Irene. (2.05,5.01)
- (Figures 3 and 4) Compare the amount of rain received in different regions of eastern NC during Hurricane Dennis and Hurricane Floyd. (4.04, 5.01)
- (Figure 5) Hurricane tracks (2.05,5.01)
- (Table 3) Drainage basins and how streams are measured and monitored. (1.06, 4.05, 5.01)
- (Figure 7 & Table 3) Flood frequency - prediction and causes (1.06, 4.05, 5.01)
- (Figure 8) Use of hydrographs to describe streamflow. (1.02, 4.05, 5.01)
- (Figure 11 or 12) Annual variations in streamflow. (1.02, 4.05, 5.01)
- (Table 7, Table 8, Figure 20) Impact of storms on water quality (4.04)
- (Figure 26) Impact of hurricanes on shorelines. (4.03, 4.05)

More detailed description of activities using various figures and tables:

- **Figure 1.** Describe by decade the numbers and intensities of tropical cyclones making landfall in North Carolina from 1890-2000. Has every decade had the same number of storms?
- **Table 1.** For the location closest to you and for cities in several regions elsewhere in NC, compare the rainfall amounts associated with the 1999 hurricanes, Hurricane Fran (1996), and annual average rainfall for 1960-1990. What generalizations can you make?
- **Figure 2.** Compare the paths of Dennis, Floyd and Irene. (Be sure to use the proper names for NC Drainage Basins)
- **Figures 3 and 4.** Compare the amount of rain received in different regions of eastern NC during Hurricane Dennis and Hurricane Floyd.
- **Figure 5.** Compare the storm tracks of the 1999 hurricanes to Connie, Diane and Ione from 1955.
- **Figure 6.** Compare the monthly rainfall at selected sites near you and in a couple of other locations for August 1955 and September 1999. For each location in various river basins identify whether 1955 or 1999 had the most rain. Determine whether the 1955 or 1999 storms produced the most sites with the greatest rainfall amounts. Draw your own conclusions as to which set of hurricanes was responsible for dumping the most rain on NC.
- **Table 3.** For the area nearest you determine which streams listed have the largest drainage basins. Which sites have had gaging stations for the longest period of time? Which site has had a station the longest? At which site(s) is(are) the gage datum located at the highest elevation above sea level? Which is(are) closest to sea level? Which sites experienced the highest flood peaks above the gage datum? Which experienced the highest peak flows? By how many feet did the stations in your area exceed their previous peaks of record? In general for all the stations listed, how many flood peak records were set in each month of the year? Is there a particular time of year when more major floods tend to occur?
- **Figure 7 & Table 3.** List some locations that experienced greater than 500-year flood events. Which experienced 25- to 50-year flood events? Which experienced less than 5-year flood events? Is there a geographic pattern to the distribution of sites experiencing major floods and those experiencing only minor flooding? How does this pattern relate to the tracks of the

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hurricanes depicted in Figure 2? Is it easier to get this kind of geographic picture from Table 3 or from Figure 7?

- **Figure 8.** For how many days in September and October was the Tar River at Tarboro above flood stage? By how many feet did the September 1999 flood peak exceed the previous maximum stage (August, 1940)? How is the timing of the three peaks related to the passage of Hurricanes Dennis, Floyd, and Irene?
- **Figure 11 or 12.** Does every year have the same peak flow? Which year experienced the highest annual peak flow? Which the lowest? Pick out the 5 years with highest annual peak flows and list the magnitudes of those flows. Describe the pattern through time of the 5-year moving average of peak flows. How are high points in the 5-year moving average related to the major flooding events that occurred periodically during the 103-year time span of the historical record?
- **Table 7.** Arrange the dissolved oxygen concentrations (DO) for Hurricanes Floyd and Fran (do the two separately) from lowest to highest. At each site sampled after both storms, compare the DO levels. Which storm generated the lowest DO levels?
- **Table 8.** Divide up into groups to handle each water-quality parameter listed. For each parameter determine if the maximum concentrations observed in samples collected from September-October 1999 were in the upper, middle or lower portion of the range observed for that site during the period January 1990-1999. Compare the results from each group and make some summary statements about the concentrations of constituents generated by the flooding compared to those observed during 1990-1999.
- **Figure 20.** Carefully study the diagram to determine which regions of the graph indicate the higher salinities. Then describe the change in salinity at Light 5 on the Pamlico River before and after Hurricane Dennis (9/4-5). What caused the change in salinity?
- **Figure 26.** Describe the differences in the pre-storm and post-storm profiles for the Outer Banks in the area north of Buxton. First study the photographs to orient yourself. Then, note the location of the Atlantic Ocean side of the island (to the east) and the Pamlico Sound side of the island (to the west). What was the height above sea level for the pre-storm dune? How many feet farther inland was the post-storm beach located than the pre-storm beach? How much narrower is the post-storm island than the pre-storm island at this point? What's the elevation difference between the highest pre-storm and post-storm dunes?

Safety/Special Considerations: None

References:

Submitted by: Terri L. Woods, Associate Professor, Department of Geology, East Carolina University

<http://nc.water.usgs.gov/>

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Rubric:

CATEGORY	4	3	2	1
Question/Purpose	The purpose of the lab or the question to be answered during the lab is clearly identified and stated.	The purpose of the lab or the question to be answered during the lab is identified, but is stated in a somewhat unclear manner.	The purpose of the lab or the question to be answered during the lab is partially identified, and is stated in a somewhat unclear manner.	The purpose of the lab or the question to be answered during the lab is erroneous or irrelevant.
Analysis	The relationship between the variables is discussed and trends/patterns logically analyzed. Predictions are made about what might happen if part of the lab were changed or how the experimental design could be changed.	The relationship between the variables is discussed and trends/patterns logically analyzed.	The relationship between the variables is discussed but no patterns, trends or predictions are made based on the data.	The relationship between the variables is not discussed.
Calculations	All calculations are shown and the results are correct and labeled appropriately.	Some calculations are shown and the results are correct and labeled appropriately.	Some calculations are shown and the results labeled appropriately.	No calculations are shown OR results are inaccurate or mislabeled.
Scientific Concepts	Report illustrates an accurate and thorough understanding of scientific concepts underlying the lab.	Report illustrates an accurate understanding of most scientific concepts underlying the lab.	Report illustrates a limited understanding of scientific concepts underlying the lab.	Report illustrates inaccurate understanding of scientific concepts underlying the lab.
Conclusion	Conclusion includes whether the findings supported the hypothesis, possible sources of error, and what was learned from the experiment.	Conclusion includes whether the findings supported the hypothesis and what was learned from the experiment.	Conclusion includes what was learned from the experiment.	No conclusion was included in the report OR shows little effort and reflection.

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Hydrograph and Flood Recurrence Activity

Standard Course of Study Targeted Goals and Objectives

- 1.02: Design and conduct scientific investigations to answer questions related to earth and environmental science.
- 1.06: Identify and evaluate a range of possible solutions to earth and environmental issues at the local, national, and global level.
- 4.01: Evaluate erosion and depositional processes.
- 4.03: Analyze the mechanisms that produce the various types of shorelines and their resultant landforms.
- 4.04: Evaluate water resources.
- 4.05: Investigate and analyze environmental issues and solutions for North Carolina's river basins, wetlands, and tidal environments.

Essential Questions:

What do hydrographs represent?

What can be learned from a flood recurrence diagram?

Introduction to the Teacher

Purpose:

- To learn how to construct a hydrograph
- To learn how to construct a flood recurrence diagram
- To learn how to interpret these diagrams

Materials:

- Data tables
- Pencil
- Graph paper
- Calculator

The data provided with this example are for the Tar River at Greenville, NC during the devastating Sept/Oct 1999 floods. Necessary data for the Tar River activity are found at the end of the Student Activity section. If preferred the teacher should provide flood stage or discharge data for the stream gaging station closest to their school, as well as providing flood recurrence data.

Differentiation from Standard Level:

This activity involves numerous math calculations, graphing, analyzing data, and critical thinking skills. Students will produce a written report and could possibly produce a presentation of results.

Safety/Special Considerations: None

References:

Submitted by: Terri L. Woods, Associate Professor, Department of Geology, East Carolina University
Water data from various sources

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Hydrograph and Flood Recurrence Activity

Standard Course of Study Targeted Goals and Objectives

- 1.02: Design and conduct scientific investigations to answer questions related to earth and environmental science.
- 1.06: Identify and evaluate a range of possible solutions to earth and environmental issues at the local, national, and global level.
- 4.01: Evaluate erosion and depositional processes.
- 4.03: Analyze the mechanisms that produce the various types of shorelines and their resultant landforms.
- 4.04: Evaluate water resources.
- 4.05: Investigate and analyze environmental issues and solutions for North Carolina's river basins, wetlands, and tidal environments.

Essential Questions:

What do hydrographs represent?

What can be learned from a flood recurrence diagram?

Introduction to Student

Purpose:

- To learn how to construct a hydrograph
- To learn how to construct a flood recurrence diagram
- To learn how to interpret these diagrams

Materials:

- Data tables
- Pencil
- Graph paper
- Calculator

HYDROGRAPHS

I. Introduction

A. A **Hydrograph** is a plot of stream stage or discharge versus time. Often field data consist of a continuous recording of the **stage (height of the water surface relative to a known reference datum)** versus **real time** to show the changes in stream stage over lapsed time, especially during flood events. **During a flood event**, a hydrograph shows a **distinct peak** as shown in the **figure** below. Generally, the **rising limb** of a **flood hydrograph** is **steeper** than the **falling limb** indicating that floods rise to their crests or peaks faster than they ebb after peak conditions. This is especially true for floods in small drainage basins/watersheds. These events are also referred to as **Flash Floods** or **Flashy Hydrographs**.

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II. Procedure

- Using the stage data in Table 1, construct a hydrograph for the Tar River at Greenville, NC from September 01, 1999 to October 06, 1999. Assume that the stage of 29.70 feet on September 21, 1999 was the peak flow in response to the Hurricane Floyd rainfall event (actually it was 29.74 feet on September 20). Plot the stage for each calendar date at the appropriate height on the grid line for that date.
 - Use your hydrograph to answer the following questions.
1. What day did the Tar River at Greenville, North Carolina go into flood stage? Flood stage for the Tar River at Greenville, North Carolina is 13 feet.
 2. Based on your hydrograph plot, what day do you project for the Tar River at Greenville, North Carolina to fall to bank full stage or less? (Assuming that there is no more heavy rainfall in the near future!)

FLOODS AND FLOOD RECURRENCE INTERVALS

I. Introduction

- A. A flood occurs when a stream overflows its channel banks. The size of a flood, as measured by **stage (elevation of the water surface)** or **maximum discharge**, varies from year to year. Flooding is ultimately related to the **duration and intensity of precipitation** and **runoff**. Catastrophic floods, like the flooding caused by Hurricane Floyd and weather fronts interacting with it, are produced by infrequent, large, intense storms. Smaller floods may be produced by less intense storms, which occur more frequently. By analyzing the frequency of floods of various sizes, a **Recurrence Interval** can be developed for a river at a particular locality. The **Recurrence Interval**, usually measured in **years**, is the **average interval between floods of a particular size or magnitude**. Thus, **on average**, a 100-year flood will recur at intervals of 100 years. **That does not mean that a flood that size or magnitude could not occur two years in a row** – it means that the chance of it occurring in **any year** is **1 in 100 or a 1 percent chance of occurrence**. A Flood Frequency Curve plots **stage**, or in some cases **discharge**, against **Recurrence Interval** as shown in the **figure** below. Flood frequency curves are plotted on log-linear graph paper with **stage or discharge plotted on the y- or vertical axis using a linear scale** and **recurrence interval plotted on the x- or horizontal axis using a logarithmic scale**.

Teacher Note: Add a picture of a flood recurrence diagram for a local stream.

- B. All flood events that can be measured from stream gaging stations can be arranged in order of their magnitude. The list of flood events or overbank flows can be plotted on a stage frequency curve by deriving the **Recurrence Interval** from the relationship:

$$RI = (N + 1) \div M$$

Where **RI** is **Recurrence Interval in years**; **N** is the **number of years of recorded flood events**, **M** is the **rank of each flood event**. For example, for a river in which records have been kept 19 years, the largest flood event during this time period would have a rank of 1 and the **Recurrence Interval for this flood event** would be:

$$RI = (19 \text{ years} + 1) \div 1 = 20 \text{ years} \div 1 = 20 \text{ years.}$$

- C. Flood plain zoning is based on recurrence intervals. If planners know what stage a stream will reach during, for example, a 100-year flood, they can determine what part of the flood plain will be under water, and they can zone accordingly. The data necessary to determine the size of the 100-year flood

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plain are available from flood frequency curves and from gaging station records. The longer flood-flow records are collected, the more accurate the forecasting of floods will be. However, designing structures for a 10-year, 25-year, 50-year, or even the 100-year flood event is a calculated risk because predicting/forecasting floods is based on probability. In the long-term, a 100-year flood happens **on the average once every 100 years**, but **two 100-year floods could occur in any given year, as could two 500-year floods!** As long as we continue to build dams, highways, bridges, homes, and other structures on flood-prone areas and continue to destroy natural wetlands in the 100-year flood plain, **we can expect continued loss of lives and property!**

II. Procedure

A. Introduction

The gaging station at the Green Street bridge north of First Street in downtown Greenville, North Carolina monitors the **stage** of the Tar River as well as its **discharge**. The stage at the Green Street bridge is the number of feet above the the gaging station elevation datum of 2.36 feet below sea level. The National Weather Service considers **Flood Stage** for the Green Street gaging station to be **13 feet** above the elevation datum of 2.36 feet below sea level. **Table 2** shows the maximum flood stage reached during selected years from 1887 to 1998 for the Green Street gaging station on the Tar River. A relative magnitude, M, has been assigned to each stage and is recorded in column 2 of Table 2. The **highest maximum stage was reached on July 28, 1919, so its magnitude, M, is 1**; the **lowest maximum flood stage was attained on March 13, 1912 and its magnitude, M, is 60**. Data in **Table 2** are from a summary of 112 years of flood records for the Tar River at Greenville, NC.

- B. Construct a **Flood Frequency Curve for the Tar River at Greenville, NC** as follows: Using the graph paper provided, plot the **stage** of the Tar River at Greenville, NC versus the **Recurrence Interval** for all the dates shown in **Table 2**. Plot the **stage data on the linear scale y-axis (vertical axis)** and **plot the Recurrence Interval on the logarithmic scale x-axis (horizontal scale)**. I will help you get started, especially reading and interpreting the logarithmic scale on the x-axis, by plotting a few points with you using an overhead transparency of this graph.
- C. Give your plot a title.
- D. Use a ruler to **draw an eye-ball best fit line through all of your data points and extend this line out to the flood event with a recurrence interval of 1000 years (the 1000-year flood)** on your flood frequency curve for the Tar River at Greenville, NC.
- E. **Using the flood frequency curve you constructed in #3, determine the maximum stages for the 20-year, 50-year, 100-year, 400-year, 500-year, and 1000-year floods (those with recurrence intervals of 20, 50, 100, 400, 500, and 1000 years).**

<u>Flood Event</u>	<u>Stage</u>
20-year Flood	
50-year Flood	
100-year Flood	
400-year Flood	
500-year Flood	
1000-year Flood	

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Note that the differences in stages for the 20-year versus the 50-year flood and the 50-year versus the 100-year flood and the 100-year versus the 500-year flood are not that great! Comment on what this tells you about the dangers of living anywhere on a flood plain.

- F. The rainfall from Hurricane Floyd and in part from Hurricane Dennis two weeks earlier produced record flooding in the Tar River Basin including along the Tar River at Greenville, NC. The **maximum flood stage** for the Tar River at Greenville, NC was **29.74** feet on September 20, 1999. Using the flood frequency curve you constructed in #3 of this exercise, **extrapolate the Recurrence Interval** for a flood event with a **peak flood stage of 29.74 feet**. **In other words what was the Recurrence Interval for the Hurricane Floyd induced flood event of September 1999 for the Tar River at Greenville, NC?**
- G. **In Table 2 calculate the probabilities for the five flood events with magnitudes of 1, 18, 33, 51, and 60 using the formula:**

$$\text{Probability (P)} = \{1 \div \text{Recurrence Interval (RI)}\} \times 100\% = \text{Probability (P) in \%}$$

For example, the number 8 ranked event in Table 2 with a Recurrence Interval of 14.13 years would have probability of recurrence in any given year of: $P = (1 \div \text{RI}) \times 100 = (1 \div 14.13) \times 100 = 0.07 \times 100\% = 7\%$

Record your probability data for each flood event in the Probability column in Table 2.

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TABLE 1

Tar River at Greenville, NC Hydrograph Data Sept 01, 1999 to 6-Oct-99

Date + Time	Stage (feet)
Sept 01 - 12 AM	4.62
Sept 02 - 12 AM	4.71
Sept 03 - 12 AM	5.29
Sept 04 - 12 AM	5.53
Sept 05 - 12 AM	8.43
Sept 06 - 12 AM	7.44
Sept 07 - 12 AM	9.15
Sept 08 - 12 AM	10.62
Sept 09 - 12 AM	11.77
Sept 10 - 12 AM	12.94
Sept 11 - 12 AM	14.28
Sept 12 - 12 AM	15.35
Sept 13 - 12 AM	15.91
Sept 14 - 12 AM	16.18
Sept 15 - 12 AM	16.32
Sept 16 - 12 AM	20.37
Sept 17 - 12 AM	24.80
Sept 18 - 12 AM	27.45
Sept 19 - 12 AM	29.00
Sept 20 - 12 AM	29.65
Sept 21 - 12 AM	29.70
Sept 22 - 12 AM	29.22
Sept 23 - 12 AM	28.47
Sept 24 - 12 AM	27.45
Sept 25 - 12 AM	26.08
Sept 26 - 12 AM	24.56
Sept 27 - 12 AM	22.88
Sept 28 - 12 AM	21.92
Sept 29 - 12 AM	20.77
Sept 30 - 12 AM	19.90
Oct 01 - 12 AM	19.11
Oct 02 - 12 AM	18.08
Oct 03 - 12 AM	16.97
Oct 04 - 12 AM	16.08
Oct 05 - 12 AM	15.49
Oct 06 - 12 AM	15.15

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TABLE 2 FLOOD DATA

Tar River at Greenville, NC

Flood Frequency Data 1887 thru 1998

Date	Magnitude	N + 1	R.I. = (N + 1)/M Recurrence Interval (yr)	Stage (ft)	P = 1/R.I. Probability
Nov 07, 1887	3	113	37.67	22.30	
2-Sep-08	8	113	14.13	19.40	
13-Mar-12	60	113	1.88	13.50	
28-Jul-19	1	113	113.00	24.50	
6-Oct-24	2	113	56.50	23.50	
25-Sep-28	5	113	22.60	21.90	
8-Oct-29	6	113	18.83	19.70	
3-Feb-37	14	113	8.07	18.70	
22-Aug-40	4	113	28.25	22.07	
25-Sep-45	9	113	12.56	19.24	
19-Feb-48	22	113	5.14	17.63	
14-May-58	7	113	16.14	19.66	
8-Mar-66	28	113	4.04	16.18	
24-Aug-67	18	113	6.28	18.50	
23-Mar-75	11	113	10.27	18.80	
3-Feb-76	33	113	3.42	15.60	
6-May-97	51	113	2.22	14.05	
28-Mar-98	21	113	5.38	18.08	

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Rubric:

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Analysis	The relationship between the variables is discussed and trends/patterns logically analyzed. Predictions are made about what might happen if part of the lab were changed or how the experimental design could be changed.	The relationship between the variables is discussed and trends/patterns logically analyzed.	The relationship between the variables is discussed but no patterns, trends or predictions are made based on the data.	The relationship between the variables is not discussed.
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Additional activities may be found at the following website:

<http://www.shodor.org/succeedhi/succeedhi/teachers/index.html>

Will Global Warming Push Trees to Extinction?

Surface Water Runoff Modeling

How to Weigh a Tree and Calculate its Carbon

Rain Gardens

Astronomy:

Calculating Orbital Speeds