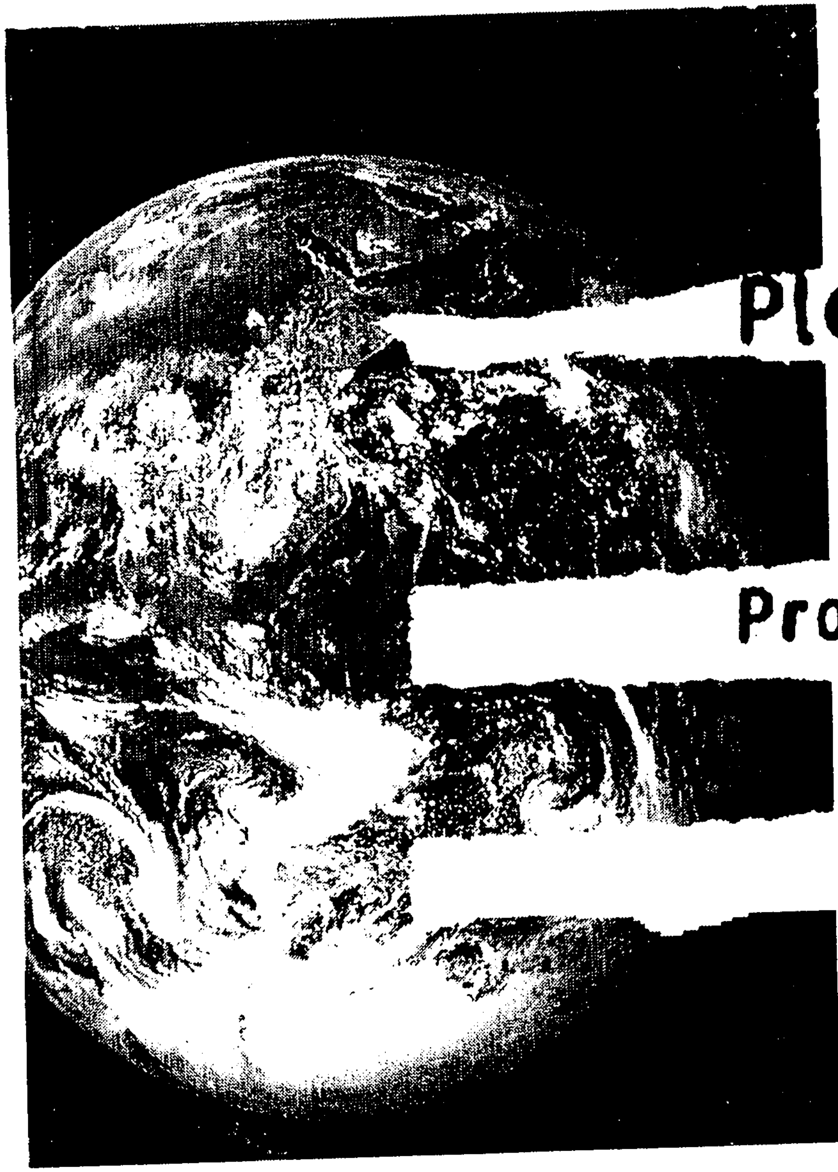

Planet Earth

Program Guide

Variance

A Collaboration of the New York City Board of Education and the American Museum of Natural History

ACKNOWLEDGMENTS

The *Planet Earth* curriculum, a science variance, was submitted to the New York State Education Department by the Office of School Programs and Support Services of the New York City Board of Education, Margaret R. Harrington, Ed. D., Chief Executive. It was developed under the direction of Laura Rodriguez, Administrative Assistant Superintendent.

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The following served as consultants and reviewers Tony Restivo, Susan Wagner HS; Mitchell Fox, Bronx HS of Science; Melanie Papkov, John F. Kennedy HS; Steve Soter, American Museum of Natural History; and Nicholas Coch, Queens College.

The project was done in collaboration with the American Museum of Natural History, with support from the New York State Education Department, City University of New York, and the New York City Urban Systemic Initiative. Special help was provided by Elise Russo, Associate in Science Education, State Education Department and Myles Gordon, Director of Education, American Museum of Natural History.

The final draft was reviewed and revised by Joel Beller, Assistant Principal (retired).

The overall organization and production of this variance was provided by the Publications Unit of the Office of School Programs and Support Services, Carl Raab, Director. Maria Ramirez was the chief editor, assisted by Judy Goldberg. Jacqueline McPhie were the word processor. The cover and logo were designed by Jennifer B. Danza.

In addition to interfacing the standards and concepts, and presenting the performance objectives and teaching strategies, each unit also includes sample student activities, technology resources (American Museum of Natural History and NASA Websites) and programmed museum visits to current Halls and those under development.

This course will prepare students not only in terms of subject matter, but also for the use of technological research techniques for the coming Millennium. Some of the innovative teaching techniques include hands-on, active learning, inquiry-based strategies; a constructivist approach to teaching and learning; use of heterogeneous cooperative learning groups; emphasis on interdisciplinary instruction, including reading and writing in the content area.

Most importantly, curriculum coherence will be increased because of careful sequencing of the learning goals within each unit to take into account how student understanding of scientific ideas builds over time.

While the sequence of units presented in the outline follows a logical progression from earth to space, it is flexible enough so that educators should feel free to change the sequence of the units to adapt to local needs of teaching and learning styles.

The course will culminate in a Regents-level assessment prepared locally by assistant principals and teachers of science. It will be submitted to the state for review. The examination will be modeled after the New York State Regents examination.

The examination format for this course to determine Regents credit will be as follows:

PART ONE (40 credits)
Multiple Choice questions dealing with performance indicators drawn from material from each unifying theme.

PART TWO (20 credits)
Blocks of in-depth questions of mixed format: multiple choice, free response, paragraph response, graphing, reading, etc.

PART THREE (25 credits)
Two essays. One essay will require the application of interdisciplinary science concepts, principles, and theories to a real world problem. The other essay will emphasize either data analysis or scientific reasoning related to experimentation.

PART FIVE (15 credits)
Laboratory Performance Task

PAGE

Planet Earth

UNIT I

The Earth Alive

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TOPIC A: Theory of Plate Tectonics

TOPIC B: The Effects of the Movements of Plates

TOPIC C: Earthquakes

TOPIC D: New York City Earthquakes

STANDARDS: THE EARTH ALIVE

Standard 1: Analysis, Inquiry, and Design

Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

Scientific Inquiry

1. The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Students:

- elaborate on basic scientific and personal explanations of natural phenomena, and develop extended visual models and mathematical formulations to represent their thinking.
- hone ideas through reasoning, library research, and discussion with others, including experts.
- work toward reconciling competing explanations; clarifying points of agreement and disagreement.

Standard 2: Information Systems

Students will access, generate, process, and transfer information using appropriate technologies.

Information Systems

1. Information technology is used to retrieve, process, and communicate information and as a tool to enhance learning.

Students:

- access, select, collate, and analyze information obtained from a wide range of sources such as research data bases, foundations, organizations, national libraries, and electronic communication networks, including the Internet.
- model solutions to a range of problems in mathematics, science, and technology using computer simulation software.

Students:
- explain chemical bonding in terms of motion of electrons.
- compare energy relationships within an atom's nucleus to those outside the nucleus.

The Living Environment

1. Living things are both similar to and different from each other and nonliving things.

Students:
- explain how diversity of populations within ecosystems relates to the stability of ecosystems.

3. Individual organisms and species change over time.

Students:
- explain the mechanisms and patterns of evolution.

5. Organisms maintain a dynamic equilibrium that sustains life.

Students:
- explain the basic biochemical processes in living organisms and their importance in maintaining dynamic equilibrium.

6. Plants and animals depend on each other and their physical environment.

Students:
- explain factors that limit growth of individuals and populations.
- explain the importance of preserving diversity of species and habitats.
- explain how the living and nonliving environments change over time and respond to disturbances.

Standard 6: Interconnectedness: Common Themes

Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

Models

2. Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.

Connections

1. The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena.

Students:

- explain and evaluate phenomena mathematically and scientifically by formulating a testable hypothesis, demonstrating the logical connections between the scientific concepts guiding the hypothesis and the design of the experiment, applying and inquiring into the mathematical ideas relating to investigation of phenomena, and using (and if needed, designing) technological tools and procedures to assist in the investigation and in the communication of results.

UNIT I
THE EARTH ALIVE

THEME I
"IN THE BEGINNING"

CONCEPTS/
PERFORMANCE OBJECTIVES/
TEACHING STRATEGIES

PLANET EARTH - THE EARTH ALIVE

UNIFYING THEME: **In the Beginning**
TOPIC A: **Formation of the Earth**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
5. The Periodic Table is an ordered arrangement of all presently known natural and artificial elements.	Students will be able to: 5. explain the basic usage of the Periodic Table.	5. Display and review briefly a Periodic Table. You may wish to distribute a copy of the Periodic Table to students to keep as a reference. Have the students research the origins of some of the names of elements, such as, gold, silver, lead, tungsten, sodium, and potassium.
6. Heavier elements would form through cooling processes and atomic collisions. Two such elements, iron and nickel sank toward the center and formed the core of the earth.	6. describe a process to explain the formation of heavier Earth elements.	6. Display a laserdisc/video demonstrating heavy element formation through atomic collisions.
7. Temperature increases with depth toward the center of the Earth.	7. describe the change of temperature with depth.	7. Graph the change of temperature with depth in certain locations in solid Earth.
8. The surface of the earth is solid, the outer core is liquid and the inner core is solid.	8. describe how scientists have determined Earth's structure with seismic waves.	8. Compare the structure of the Earth to the cooling of Jell-O. Describe the structure of the (real) Earth.
9. Analysis of earth's crust, hydrosphere and troposphere shows that ten elements are most abundant (O, Si, Al, Fe, Ca, Na, Ng, K, N, and H). All other elements are found in much smaller quantities.	9. identify the ten most abundant elements in the earth's crust.	9. Using reference tables(es), have students make a bar graph of the ten most abundant elements by volume.

PLANET EARTH - THE EARTH ALIVE

UNIFYING THEME: **In the Beginning**
TOPIC C: **Formation of the Oceans**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Scientists are not certain how the Earth's atmosphere and ocean forms but the most widely accepted theory is that condensed water vapor in the atmosphere and steam generated from the Earth's interior helped form the oceans in basin regions.	1. describe the scientific principles to explain how the oceans formed.	1. Diagram and analyze the processes of condensation ⇌ evaporation in the water cycle. Build a model of the water cycle in the classroom using a plastic shoebox, bag of ice and heat lamp (NSTA).
2. Water was heated through a deep sea hydrothermal vents at the Mid-ocean Ridges and was distributed throughout the seas by convection currents.	2. explain the importance of heat passing through ocean vents and the circulation of water and energy through the ocean region.	2. Perform a Laboratory Activity on Convection Currents. Visit the American Museum of Natural History Hall of Planet Earth featuring Los Alamos National Laboratory ocean convection model and the exhibit on deep sea hydrothermal vents.
3. Heated water rose to the surface, evaporated back into the atmosphere, carrying minute amounts of dissolved rock material and undersea volcanic gases.	3. describe how materials from Earth regions are distributed through the processes of convection currents and evaporation.	3. Demonstrate the evaporation process of salt water. Collect the evaporated material, and test it for salt content.
4. This dynamic circulation of materials between the oceans, atmosphere and lithosphere was an essential component in the evolution of Earth's early history.	4. relate how the Earth's evolution is contingent upon physical processes to create a dynamic environment.	4. Students should draw detailed diagrams displaying inter-related processes among land, air, and water.

PLANET EARTH - THE EARTH ALIVE

UNIFYING THEME: **In the Beginning**
TOPIC D: **The Heat Within**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
6. The majority of the heat energy generated in the interior of the earth is by radioactive decay.	6. describe how radioactive decay processes generate the greatest amount of heat in the earth.	6. Display a computer simulation depicting the energy output from radioactive decay models. Discuss how radioactive elements can also be used to generate electricity.
7. Convection current flow within the liquid iron core regions deep within the Earth's interior is not uniform, creating magnetic fields.	7. explain how convection current flow and density differences relates to the production of magnetic fields.	7. Demonstrate that moving charges (liquid core material) generates a magnetic field. Demonstrate how a suspended bar magnet aligns with the Earth's magnetic field. Also demonstrate and discuss how a compass works. Visit the Hall of Planet Earth at the American Museum of Natural History exhibit on convection in outer core and the origin of the Earth's magnetic field.

PLANET EARTH - THE EARTH ALIVE

UNIFYING THEME: **In the Beginning**
TOPIC G: **Chemistry of the Ocean Vents**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
1. Hydrothermal vents exist in the deep sea and contain hot, mineral-rich water emanating from sulfide structures.	Students will be able to: 1. describe the hydrothermal vents and why they are important (shows conditions for life or hot water and minerals, no photosynthesis). Changes our theories about conditions needed for life.	1. Connect through the Internet (www.amnh.org) to the "Black Smoker Homepage" created by the American Museum of Natural History or show a video, pictures, etc. Follow expedition to obtain a Black Smoker for the Hall of Planet Earth.
2. These regions are not directly affected by typical surface processes, such as, climatic changes, surface volcanic eruptions, or possibly even meteorite impacts due to their depth.	2. explain why hydrothermal vent zones are areas unaffected by usual surface processes.	2. Display laserdisc/video of "Black Smokers" at various locations in the world. Visit the American Museum of Natural History Hall of Planet Earth section on Black Smokers plus a real sample.
3. The energy contained with the nutrient-rich environment was abundant. It is theorized that the earth environmental conditions around these vents fostered the development of adaptations resulting in unusual life forms.	3. relate how the raw materials and energy for life were ready at these regions.	3. Analyze energy potentials of various elements that are found in hot vent zone waters.
4. Ancient bacteria (Archaea) are simple prokaryotic organisms that exist at these deep sea vents. Prokaryotes are simple organisms lacking a membrane-bound nucleus.	4. identify primitive simple prokaryotes as the earliest "true" life form. Define "prokaryote."	4. Observe bacteria under a microscope and sketch images.
5. Today's life forms inhabiting this ecosystem include tube worms, clams, mussels, crabs and shrimp. These species have special adaptations that distinguish them from species familiar to us. They survive without sunlight.	5. describe life conditions in an ecosystem at present day hydrothermal vent zones.	5. Compare the adaptations of commonly known species and related hydrothermal vent zone species through images (photograph, laserdisc, Internet sources).

UNIFYING THEME: **In the Beginning**
TOPIC H: **Chemosynthesis**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Chemotrophs are believed to be the first "true" organisms, since they produce their own food through specialized chemical reactions.	1. relate chemotropic organisms to their ability to generate energy.	1. Connect to the Internet to get information on the type of life found in deep sea hydrothermal vents.
2. Certain types of bacteria are chemotrophs, making food from CO_2, and using inorganic substances, such as nitrogen or sulfur, as their energy source. $6CO_2 + 12H2S \rightarrow C_6H_{12}O_6 + 6H_2O + 12S(s)$	2. describe the process of chemosynthesis.	2. Analyze the chemical equation for chemosynthesis (sulfur) and trace the pathway for energy production and compare it to photosynthesis.
3. The hydrothermal vents were extremely rich in these inorganic materials, providing a breeding ground for the development of life forms.	3. characterize the hydrothermal vents as a rich site for the development of living organisms.	3. Display a laserdisc/video of the hot vent zones detailing the sulfur-bacteria living within this nutrient-rich zone.
4. Materials were able to be exchanged between the living and non-living (physical) environment (recycled).	4. trace the recycling of materials between a living system and its physical environment.	4. Analyze the various cycles (carbon, water, nitrogen) as examples of the interaction between the living and non-living environments.
5. Research findings indicate that chemosynthesis was the first energy producing biochemical pathway in living organisms. It evolved before photosynthesis or respiration.	5. identify chemosynthesis as a process which yields limited energy for an organism's use.	5. Compare the energy production in chemosynthetic and photosynthetic organisms.

PLANET EARTH - THE EARTH ALIVE

UNIFYING THEME: **In the Beginning**
TOPIC 1: **Aerobic and Photosynthetic Organisms**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
1. Photosynthetic organisms added tremendous amounts of O_2 to the atmosphere. Some organisms were able to use the O_2 to produce more energy as they broke down the nutrients found in food.	Students will be able to: 1. relate that increasing O_2 levels led to changes in some organisms' ability to produce energy.	1. Have students classify oxygen-using organisms and relate the complexity of each to its energy needs.
2. These organisms carried on aerobic respiration, a more efficient energy conversion necessary to sustain more complex life than those organisms using anaerobic respiration. AEROBIC RESPIRATION $C_6H_{12}O_6 + 6H_2O + 6O_2 \rightarrow 6CO_2 + 12H_2O + 36ATP$ ANAEROBIC RESPIRATION (FERMENTATION) $C_6H_{12}O_6 + H_2O \rightarrow 2(C_2H_5OH) + H_2O + 2CO_2 + 2ATP$ ATP is an energy carrying molecule.	2. describe the process of aerobic respiration. Identify ATP as an energy carrying molecule.	2. Have students mathematically analyze the efficiency of aerobic respiration as compared to anaerobic respiration. Visit the Hall of Planet Earth at the American Museum of Natural History exhibit on early life including its effect on the atmosphere and subsequent affect of atmosphere on the evolution of life.
3. The life activities of organisms greatly changed the Earth's environment. As the environment changed, organisms changed. In response to these changes, the environment changed again. This interaction (feedback loops [negative vs. positive]) between organisms and the environment is a continuous and ongoing process.	3. Explain how the presence of O_2 allowed for more complex aerobic life to exist on the surface of the Earth.	3. Have students describe the interrelated processes of photosynthesis and respiration and the organisms responsible in these processes. $6CO_2 + 12H_2O + \text{energy} \rightleftharpoons C_6H_{12}O_6 + 6H_2O + 6O_2\uparrow$ [photosynthesis $\rightleftharpoons$ respiration]

UNIT I
THE EARTH ALIVE

THEME II
"PROGRESSION OF LIFE"

CONCEPTS/
PERFORMANCE OBJECTIVES/
TEACHING STRATEGIES

PLANET EARTH - THE EARTH ALIVE

UNIFYING THEME: **Progression of Life**
TOPIC B: **Radioactive Dating**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. The earth contains radioactive elements left over from the formation of the planet. A radioactive element is unstable and emits particles or energy.	1. explain the origins of radioactive elements and define radioactive.	1. Visit the American Museum of Natural History to see their collection of radioactive minerals. Visit the exhibit on radioactive dating of rocks found in the Hall of Planet Earth at the American Museum of Natural History.
2. Due to their atomic structure, radioactive elements decay in order to reach a state of equilibrium.	2. describe the process of radioactive decay.	2. Challenge students to visit the Virtual Rock Dating site on the Internet. It will be available by September 1998. It can be found at http://vquake.calstatela.edu.
3. Radioactive elements decay at characteristic and constant rates. The rate at which an element decays is known as a half life. This is the amount of time it takes for half of the atoms of the original material to decay into stable end products.	3. identify the rates of decay of common radioactive elements and define half life.	3. Use pennies in a shoebox to show the idea of half lives. You could also use M and M's for a more edible way.
4. All living things contain carbon 14, which decays to carbon 12. C14 is found in the atmosphere and is taken into plants through photosynthesis. Animals that eat these plants absorb carbon 14. When an organism dies, it stops taking in C14, and the amount of C14 is reduced through radioactive decay. By measuring the proportion of C14 assumed to be present in the organisms tissue when it died, versus the amount present in the remains, scientists can figure out approximately how long ago the organism died. This is considered accurate for dating fossils and artifacts less than 35,000 years old.	4. predict the ages of materials based on the half lives of the radioactive elements found in the material.	4. Have students visit the library and look up references to the "Hitler diaries." *The Shroud of Turin*. Show how radioactive dating proved them to be hoaxes.

PLANET EARTH - THE EARTH ALIVE

UNIFYING THEME: **Progression of Life**
TOPIC C: **Fossil Evidence**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
1. Organic evolution is the process through which species change over time to become new species.	Students will be able to: 1. describe the process of evolution	1. Allow students access to the "Evolution" computer simulation or game. They could also use the "Sim Life" computer program to study evolution.
2. The geologic time scale is based on events that have occurred in the earth's past.	2. analyze the geologic time table for changes in the types of life.	2. Have students create a simple geologic time table.
3. Life began in the oceans. Eventually, some species evolved structures enabling them to survive on land. Plants were the first organisms to inhabit the land, animals came next.	3. describe the reasons for the movement of living things from the ocean to the land.	3. Enhance students conception of competition by using different kitchen implements to pick up the most M & M's.
4. As organisms with adaptation moved onto the land they survived and reproduced. Eventually, some species overpopulated resulting in competition which led to a struggle for existence and survival for those varieties in the species with certain adaptation. This meant that certain adaptations were necessary for survival in certain environments.	4. explain how adaptations allowed organisms to survive in different environments.	4. Visit the American Museum of Natural History to visit the new "Hall of Biodiversity" spectrum of life section.
5. Humans have inhabited this planet for only a short period of time compared to the history of life on earth.	5. compare the amount of time that humans have inhabited the earth to the age of the earth itself.	5. Challenge students to create a time line that demonstrates the short period of time that humans have been on earth.

PLANET EARTH - THE EARTH ALIVE

UNIFYING THEME: **Progression of Life**
TOPIC E: **Death of the Dinosaurs**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. The Mesozoic era marked the high point of dinosaur life on earth.	1. describe the Mesozoic era in terms of environment and life forms	1. Allow students to access the Internet and discover dinosaur sites.
2. The fossils of many different dinosaurs from this period have been found all over the earth.	2. relate fossil records of dinosaurs to the amount of animals that must have existed, and the different environments they lived in.	2. Use the *Craters* workbook by NSTA to examine the types of dinosaurs that existed in the past.
3. There is no evidence of nonavian dinosaurs living after 65 million years ago.	3. identify the K/T boundary.	3. Challenge student to examine the work of the Alvarez family on the K/T boundary.
4. Many theories attempt to explain the disappearance of the dinosaurs. Some of the more accepted theories are: - Pele Hypothesis - Global Temperature Change - Asteroid Impact	4. compare the evidence that supports each of these theories.	4. Assign students to groups and give each group one of the theories of dinosaur extinctions. Challenge them to create a flowchart of their theory. Have them transfer the flowchart to a piece of oaktag and display the best examples in the classroom.
5. Even though nonavian dinosaurs became extinct, other forms of life survived. Mammals which had been small creatures and birds exploded in numbers and variety after the extinction of the dinosaurs left many environments open for use. Humans evolved from these early mammals.	5. relate the rise of mammals to the death of the dinosaurs, and the availability of new niches.	5. Compare the size of dinosaurs to humans. (*Earth Science*, Spaulding and Namowitz) 6. Visit the Fossil Halls at the American Museum of Natural History.

UNIT I
THE EARTH ALIVE

THEME III
"SHAKES, QUAKES AND PLATES"

CONCEPTS/
PERFORMANCE OBJECTIVES/
TEACHING STRATEGIES

PLANET EARTH - THE EARTH ALIVE

UNIFYING THEME: **Shakes, Quakes and Plates**
TOPIC B: **The Effects of the Movement of Plates**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Plates made of ocean crust (basalt) are generally denser than those made of continental crust (granite).	1. compare the densities of oceanic and continental crust.	1. Do a lab on the densities of different rock materials, especially, basalt vs granite. Compare densities.
2. When two plates collide, the denser one of them is subducted under the other.	2. define subduction. Predict which plate is subducted. Relate subduction to density differences.	2. Simulate this by holding a balloon full of air under water. The balloon will not be subducted because the water is denser than the air.
3. As the subducted plate sinks into the earth, its temperature increases and the rocks begin to melt.	3. describe the change of temperature with the depth underground.	3. Have students graph the estimated change in temperature with depth underground.
4. The magma is less dense than the material around it, so it begins to rise.	4. compare the density of the magma to the surrounding rock.	
5. When the magma under tremendous pressure reaches the surface it can form a volcano by forcing its way through the crust.	5. explain how magma arriving at the surface can create a volcano.	5. Connect to the Internet to the *Volcanoes* Home Page.
6. If two continental plates collide, neither of them will subduct. They will force each other up into a mountain range (folding).	6. describe the result of two continental plates colliding. Explain how folding caused by collision of two continental plates can form a mountain range.	6. Use the "Plate Tectonics: *The Inside Story*" CD to show the result of the collision between India and Asia. Simulate the collision and orogeny by using two terry cloth towels sliding across the table into each other, examples - Rocky Mountain, Himalayas or discuss two cars colliding head on.

PLANET EARTH - THE EARTH ALIVE

UNIFYING THEME: **Shakes, Quakes and Plates**
TOPIC C: **Earthquakes**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
5. Seismic waves move out in all directions from an earthquake.	5. explain how the energy released in an earthquake travels.	5. Relate the energy released in an earthquake to a pebble being dropped in a pond. Demonstrate on overhead projector using a large beaker of water and dropping in a pea.
6. The damage from an earthquake depends on the magnitude of the earthquake, the distance from the epicenter, the type of land the waves travel through, and the amount and type of human construction in the area.	6. predict the likelihood of damage from an earthquake based on important factors, such as magnitude, distance, type of land, density, etc.	6. Have students "build" different types of land (clay, mud, sand) and then subject them to severe shaking.
7. The Richter scale measures the intensity of an earthquake. Each step up is a tenfold increase in energy.	7. explain how the Richter scale is used to rate earthquakes.	7. Connect to the Internet and collect data on the strength of recent earthquakes. 8. Reading Language Arts - Famous authors accounts of earthquakes (Mark Twain, Jack London, etc.) http://www.crustal.ucsb.edu/ics/understanding/accounts/ 9. Online earthquake quiz with photos; rotating globe showing past 5 years of quakes. Quiz, explain why certain answers are incorrect with good explanations. Some URL as above/understanding/.

PLANET EARTH - THE EARTH ALIVE

UNIFYING THEME: **Shakes, Quakes and Plates**
TOPIC D: **New York City Earthquakes**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
7. The unpreparedness of the population, the state of the buildings and the number of people in the New York area create the potential for a disaster in the next earthquake.	Students will be able to: 7. predict the effects of a large earthquake on the New York City metropolitan region.	7. Challenge students to come up with an earthquake disaster plan for New York City. Contact the mayor's office to get a copy of the real plan and compare them.

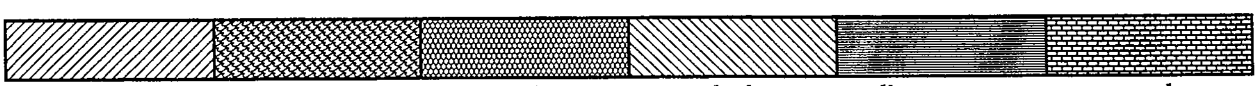
Name ______________________________ Period: ______________

DEATH OF THE DINOSAURS

65 millions years ago, dinosaurs ruled the Earth. They were found at nearly all locations on Earth and in many shapes and sizes. We can tell this by looking at fossil remains of dinosaurs. However, no evidence of dinosaurs have been found in rock layers from less than 65 million years ago. At the same time mammals and birds exploded in numbers in the years after 65 million years ago. How can we explain this? What happen to the dinosaurs?

The following data represents the rock layers found at different parts of the world during different times in the past. The numbers represent their average thickness.

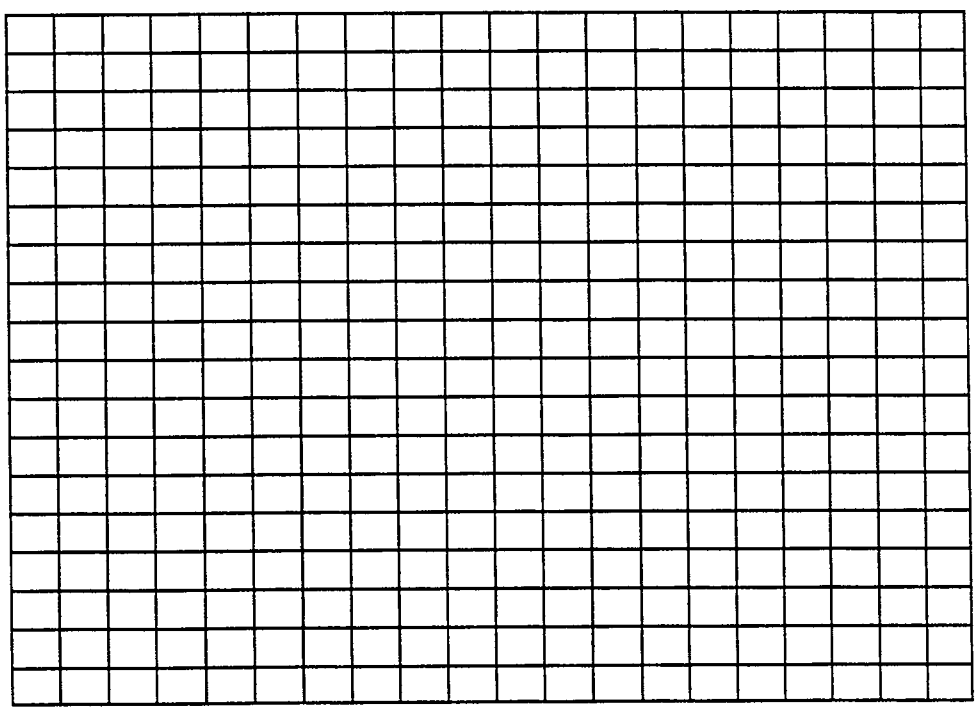
Location	Carmel CO	Raton Basin, NM	Arroyo El Mimbral, Mexico	Beloc, Haiti	Carvaca, Spain	Gubbio, Italy
38-53mya	sandstone (2)	unknown	marl (2)	limestone (2)	unknown	unknown
54-64mya	coal (2)	coal (2)	shale (1)	sandstone (2)	sandstone (2)	sandstone (2)
65mya	clay/quartz (1)	clay/quartz (3)	clay/quartz (8)	clay/quartz (6)	clay/quartz (1)	clay/quartz (2)
66-143mya	shale (2)	sandstone (5)	marl (1)	limestone (2)	marl (3)	shale (1)
144-213mya	marl (3)	sandstone (2)	unknown	limestone (1)	marl (2)	unknown



Sandstone clay/quartz coal shale limestone marl

The table below shows the levels of iridium in a sample taken from Carlsbad, New Mexico. Please graph this on the paper below.

Depth below surface (meters)	Iridium Abundance (ppb)
0	0.00
50	0.00
100	0.00
111	0.50
113	1.00
115	0.50
119	13.5
120	0.50
122	0.25
128	0.25
132	0.25
135	0.00



Depth Below the Surface (m)

What element is the most likely one from the list above to match this data?

____

Abundance of Iridium in Geologic Formations

Location	Iridium Abundance (PPB)
65 million year old layer	0-50
Earth's surface	0.02-0.2
Earth's core	1000
Martian rocks	0.2
Moon rocks	0.1
Metallic Meteorites	1000
Metal rich asteroids	500-1000

List the three most likely sources for the amount of iridium found in the 65 million year old layer.

1) ____

2) ____

3) ____

Planet Earth

UNIT II

Climates Through the Ages

PLANET EARTH CURRICULUM OUTLINE

UNIT II: CLIMATES THROUGH THE AGES

THEME I: "CLIMATE - PAST/PRESENT/FUTURE"

TOPIC A: Climate vs. Weather

TOPIC B: How Can We Determine Past Climates?

TOPIC C: Earth's Deep Freezes - Ice Ages

TOPIC D: What Causes Ice Ages?

TOPIC E: Fire or Ice? - Future Climates

THEME II: "GLOBAL WARMING"

TOPIC A: What is Global Warming?

TOPIC B: The Greenhouse Effect

TOPIC C: Greenhouse Gases and the Carbon Cycle

TOPIC D: The Politics of Carbon

TOPIC E: Think Globally; Act Locally

Physical Setting

2. Many of the phenomena we observe on Earth involve interactions among components of air, water, and land.

Students:
- use of the concepts of density and heat energy to explain observations of weather patterns, and seasonal changes.
- explain how incoming solar radiation, ocean currents and land masses affect weather and climate.

Standard 6: Interconnectedness: Common Themes

Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

Models

2. Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation or design.

Students:
- Revise a model to create a more complete representation of a system, e.g., Global Warming.
- Compare predictions to actual observations, e.g., use of fossil fuels as causes of pollution, the greenhouse effect.

Patterns of Change

5. Identifying patterns of change is necessary for making predictions about future conditions.

Students:
- Search for multiple trends when analyzing data for patterns, and identify data that do not fit the trends.

Standard 7: Interdisciplinary Problem Solving

Students will apply the knowledge and thinking skills of mathematics, science and technology to address real-life problems and make informed decisions

UNIT II
CLIMATES THROUGH THE AGES

THEME I
"CLIMATE - PAST/PRESENT/FUTURE"

CONCEPTS/
PERFORMANCE OBJECTIVES/
TEACHING STRATEGIES

PLANET EARTH - CLIMATES THROUGH THE AGES

UNIFYING THEME: **Climate - Past/Present/Future**
TOPIC A: **Climate vs Weather**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
5. The effect of prevailing winds on climate depends on the season and regional weather, and if the winds are from the north or the south.	5. explain how prevailing winds help determine climate by transferring heat energy from the oceans to land masses.	5. Use a fan blowing over a hot plate to simulate wind blown heat. Measure temperature with a thermometer (as it rises).
6. When the trade winds over the Pacific Ocean reverse direction, the warm Pacific Ocean currents also reverse direction giving us an El Niño event.	6. explain how changes in prevailing winds can change ocean currents. Describe the El Niño effect.	6. Compare prevailing winds, ocean currents and global climate in a typical year with an El Niño year. Example 1997-1998. American Museum of Natural History visit to the <u>Hall of Planet Earth.</u> Section on Climate and Climate Change. Visit the El Niño Theater featuring a film about El Niño in context of global climate variability.
7. Ocean currents moderate climate by transferring heat energy.	7. describe the effect of ocean currents on climate.	7. Examine a chart of the Gulf Stream and analyze its effect on Eastern United States and Europe. American Museum of Natural History visit to the <u>Hall of Planet Earth.</u> Section on Climate and Climate Change. See the energy transfer model which is a dynamic model showing how heat is transferred from the equator to the poles.
8. Lakes and oceans carry moisture and heat which is transferred to land nearby.	8. describe the effects of large bodies of water on climate.	8. Analyze weather maps of New York State to determine the effect of the Atlantic Ocean and Lake Ontario on the climate of the region. Also: Lake Effect Snow at Buffalo, New York. Lab Lesson - compare the heat retention of water vs. soil.

PLANET EARTH - CLIMATES THROUGH THE AGES

UNIFYING THEME: **Climate - Past/Present/Future**
TOPIC B: **How Can We Determine Past Climates?**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
1. Fossils are the remains of living things. Index fossils are fossils that help identify the age of the rock in which they occur. They are found over a wide geographic area but they lived in a narrow range of time.	Students will be able to: 1. define fossil, index fossil.	1. Compare samples of fossils with organisms living today to explain how certain fossils can be useful in dating rocks and determining past climates. Use the article at website http:/helios.org/news/60.html. It describes how a fossilized sea bed 160,000 years old tells us about climate.
2. We can determine the past location of continents by analyzing fossils, dating rocks and comparing rock formations.	2. use the concepts of rock correlation, fossils, and radioactive dating to determine past placement of continents.	2. Students will plot the positions of the continental plates during the early Triassic period based on fossil, mineral and rock evidence. Discuss PANGEA and its breakup. American Museum of Natural History visit to the <u>Hall of Planet Earth</u>: tools for reading rocks section. It is an exhibit on radioactive dating including rock samples, mineral separates and graphic display.
3. Currents and prevailing winds in the past followed the same physical laws that today's currents and winds follow, thus allowing us to model them if we have sufficient information.	3. determine the location of past currents.	3. Model ocean currents and prevailing winds.
4. By accurately dating objects that reflect the climate of the time at which they were fossilized, we can infer the climate of a particular region and build up a picture of the climate of the entire planet.	4. analyze past climates based on fossil and rock evidence, also use information from ice cores from glaciers and dendrochronology. Refer students to *Natural History Magazine* (Feb. 98) for an excellent article on ice core sampling.	4. Design climate models for the Mesozoic Era based on placement of the continents, ocean currents and prevailing winds. American Museum of Natural History visit to the <u>Hall of Planet Earth</u>: Climate and Climate Change. See the section featuring ice cores, deep sea sediment cores, coral cores and tree cores. Watch the video that explains how research on ice cores reveals detailed information about climate variability for 100,000s of years.

PLANET EARTH - CLIMATES THROUGH THE AGES

UNIFYING THEME: **Climate - Past/Present/Future**
TOPIC C: **Earth's Deep Freezes - Ice Ages**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
1. Scientific evidence of past ice ages include: striations on rocks, sediments which indicate past moraines and fossil remains of cold climate organisms and radioactive dating of isotopes of oxygen in fossil shells ($CaCO_3$).	Students will be able to: 1. analyze rock and fossil evidence of past glaciations.	1. a. Plot evidence of past glaciations on maps of the past to determine the extent of ice cover. b. Graph episodes of ice ages against Earth's time line to determine the frequency of glaciations. American Museum of Natural History visit to the Hall of Planet Earth: - "tools for reading rocks" section featuring glacial striations, drop stones and varves. - early earth history section featuring rocks with evidence of earth's oldest glaciation (over 2 billion years ago). A good resource for many performance objectives in this section is Rice University's Glacier Project website http://www.glacier.rice.edu. Click on the ice section to learn why we have ice ages, how ice moves, etc.
2. Much of North America was tundra, boreal forests and temperate forests.	2. compare North American ecosystems of today with those of the last glacial advance.	2. Using the American Museum of Natural History - Hall of Mammal Origins, N. A. Forests Hall of the Earth (Planet Earth), and Natural History Museum, students will compare life during the last glacial advance with Arctic life today. American Museum of Natural History visit to the Hall of Planet Earth: Climate and Climate Change section: especially the ice core record from Greenland showing past glaciations and the deep sea sediment cores showing past glaciations.

PLANET EARTH - CLIMATES THROUGH THE AGES

UNIFYING THEME: **Climate - Past/Present/Future**
TOPIC D: **What Causes Ice Ages?**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. During the ice ages, the South Pole is covered by a continent of ice, warm currents are blocked from reaching much of the continent. Deep ocean current circulation plays an important role in producing climate variations.	1. analyze continental placement, ocean currents, and compare sea levels during ice ages and non ice ages.	1. Students will compare maps of Earth's past that they have previously constructed looking for differences between ice and ice-free ages. American Museum of Natural History visit to the Hall of Planet Earth: Climate and Climate Change section: look at the graphic display explaining the relationship between deep ocean circulation and mini-ice ages.
2. Glaciers form when more snow falls during the winter then melts during the summer.	2. describe the formation of glaciers.	2. Compare temperature and precipitation patterns in regions with glaciers today. A resource for many performance objectives in this section is Rice University's Glacier Project website http://www.glacier.rice.edu. Click on ice section to learn why we have ice ages, how ice moves, etc.
3. Ice sheets, like the one which covers Antarctica today, reflect heat back out of the atmosphere thus decreasing temperature.	3. explain how ice cover reduces global temperature.	3. In a lab lesson, students will place a white, flat, smooth painted rock, such as quartzite and a similar dark colored rock under incandescent lamps and measure the temperature of each rock.
4. The sun's energy output varies and contributes to the formation of Ice Ages.	4. describe the events that have brought us this present ice age.	4. Using maps, charts and graphs students will analyze the continental placement, currents and cycles that led to the present Ice Age. Students will research sunspot activity and determine the effect of sunspots on climate.

PLANET EARTH - CLIMATES THROUGH THE AGES

UNIFYING THEME: **Climate - Past/Present/Future**
TOPIC E: **Fire or Ice? Future Climate**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
3. If global temperatures continue to rise, more precipitation at high latitudes may reduce the salt percentage in the oceans and stop, weaken or change the Gulf Stream.	Students will be able to: 3. explain how and why the Gulf Stream current can change.	
4. Without a Gulf Stream current, Europe would be much colder (about 8^0C). This may cause an increase in ice and snow build up in the north latitudes possibly bringing about an ice age.	4. determine the possible effects of a changed Gulf Stream on Europe and the East Coast United States of America.	4. Compare the climate of Europe with that of American cities at the same latitude.
5. Current evidence indicates that eventually there will be another ice age.	5. explain how cyclical variations in solar insolation will affect the climate of Planet Earth.	
6. Increased solar brightness as well as increased emission of greenhouse gases will increase planetary warming.	6. describe the events that could lead to a future of increased Global Warming.	6. Students will examine models, charts and graphs comparing increased emissions of greenhouse gases with their predicted effect on climate.
7. The sun is slowly but constantly brightening. Greenhouse gases are increasing. Ocean currents are inherently unstable. With Antarctica sitting on the South Pole, eventually cyclical variations in solar insolation will cause the glaciers to expand again.	7. state reasons why Earth is headed for another ice age.	7. Students will use the Internet to construct a model to examine those factors and events that can change the climate of Planet Earth. Using this model and graph of climate change over the past century, students will try to determine the climate of the near future.

UNIT II
CLIMATES THROUGH THE AGES

THEME II
"GLOBAL WARMING"

CONCEPTS/
PERFORMANCE OBJECTIVES/
TEACHING STRATEGIES

UNIFYING THEME: **Global Warming**
TOPIC B: **The Greenhouse Effect**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
1. The "greenhouse effect" is the absorption of heat by the atmosphere. Heat transferred from the Earth's surface is not allowed to be released into space.	Students will be able to: 1. explain how greenhouses heat up as an analogy for the "greenhouse effect."	1. Construct a model of the "greenhouse effect" using clear soda bottles and a heat source; collect, graph and interpret temperature data. American Museum of Natural History visit to the <u>Hall of Planet Earth:</u> in the Climate and Climate Change section, see the exhibit on greenhouse gases.
2. "Greenhouse gases" in the atmosphere absorb the heat radiated from the surface of the Earth.	2. explain/describe mechanisms by which the greenhouse gases, carbon dioxide, methane, cfc's, nitrous oxide) allow passage of incoming sunlight. The earth's surface absorbs the light energy and converts it to heat. This heat is emitted from the earth as infrared radiation, however, the "greenhouse gases" absorb most of the infrared radiation.	2. a. Play a simulation game which models photon absorption and re-emission. b. Add carbon dioxide to your model of a greenhouse; collect, graph and analyze temperature data.
3. Life on earth has always depended on the "greenhouse effect."	3. explain the "Goldilocks Effect;" Venus (too hot), Mars (too cold), Earth (just right); relate this to CO_2 in the atmosphere, greenhouse warming and the conditions necessary for life.	3. Examine NASA photos of Venus, Earth and Mars in order to visually compare their atmospheres.
4. A rapid increase in "greenhouse gases" in recent times may be a major cause of Global Warming.	4. analyze the graph "Projected Growth of Greenhouse Gases" (*GEMS*) and speculate on possible links to Global Warming.	4. Increase the concentration of carbon dioxide in the soda bottle models of the "greenhouse effect;" collect, graph and analyze temperature data.

PLANET EARTH - CLIMATES THROUGH THE AGES

UNIFYING THEME: **Global Warming**
TOPIC C: **Greenhouse Gases and The Carbon Cycle**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
1. Carbon dioxide makes up about 60% of the human induced "greenhouse effect."	Students will be able to: 1. explain how human activity produces carbon dioxide from the combustion of fossil fuels and the burning of forests for agriculture.	1. a. Read and analyze the graph "Source of Greenhouse Gases from Human Activity" (GEMS). b. Collect samples of gases from burning wood, car exhaust, and ambient air; test and compare for CO_2 concentration using a chemical indicator (Brom Thymol Blue).
2. Carbon dioxide is released by respiration and absorbed by photosynthesis.	2. compare and contrast respiration and photosynthesis in relation to the stability of atmospheric CO_2.	2. Use a chemical indicator to demonstrate that green plants remove CO_2 from air and water while animals exhale CO_2. (Brom Thymol Blue)
3. The element carbon cycles through air, land, water and living things.	3. describe the carbon cycle, including carbonate rocks, atmospheric and dissolved CO_2, and organic carbon molecules.	3. Construct a concept map that visually displays all aspects of the carbon cycle. American Museum of Natural History visit to Hall of Planet Earth, Habitable Earth section. Visit the display on the carbon cycle including rock samples, graphics, video and computer interactives.
4. Methane enters the atmosphere from organic decomposition and animal digestive processes.	4. relate methane emissions to decomposition in rice paddies and land fills, grazing livestock, and termite activity in destroyed rain forests.	4. a. Investigate why methane emissions are increasing worldwide. Use the Internet and other sources. b. Calculate the amount of methane released daily by earth's 1.3 billion cattle.

PLANET EARTH - CLIMATES THROUGH THE AGES

UNIFYING THEME: **Global Warming**
TOPIC D: **The Politics of Carbon**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Scientists are not in agreement on whether global warming has already begun.	1. discuss whether observed warming has been caused by increased greenhouse gases, natural variations, or a combination.	1. Compare graphs of solar magnetism and changes in the northern hemispheric land temperature from 1950-1984, explain any correlations.
2. Reducing fossil fuel consumption could have serious economic consequences.	2. state a direct relationship between fossil fuel use, standard of living, and economic growth.	2. Use the Internet. Research the relationship between GDP and energy use in the United States.
3. Environmentalists fear that taking no action on global warming will lead to severe ecological consequences.	3. predict the consequences of a projected 2^0F to 7^0F increase in global temperatures by 2050 if there is no change in the rate of fossil fuel consumption.	3. Create a worst case scenario for your local area in the year 2050 using projected temperatures.
4. The nations of the world have differing agendas on global warming.	4. research and report on the position taken by the United States, the EEC and the Developing Nations on control of CO_2 emissions at the 1997 Kyoto meetings.	4. Conduct a mock "World Conference on Global Warming" with groups representing scientists, industries, environmentalists, consumers, and governments. (GEMS)
5. Science and technology can only indicate, not dictate, the course of human affairs.	5. debate and discuss that individuals and societies must decide the global warming issue based on carefully calculated risks and benefits, using all available science and technology.	5. a. Detail what the individual can do to respond to the threat of global warming. b. Make a list of what the average citizens can do to lessen the effect of global warming.

Global Warming

& THE Greenhouse Effect

Grades 7–10

Skills

Observing, Measuring, Recording Data, Interpreting Graphs, Experimenting, Drawing Conclusions, Synthesizing Information, Role-Playing, Using Simulation Games, Problem Solving, Brainstorming Solutions, Critical Thinking

Concepts

Atmosphere, Visible and Infrared Photons, Greenhouse Effect, Sources of Carbon Dioxide, Climate and Weather, Effects of Climate Change, Molecular Model of Heat, Interaction of Energy and Matter

Themes

Systems and Interactions, Models and Simulations, Patterns of Change, Stability, Matter, Energy, Evolution, Structure, Scale, Diversity and Unity

Mathematics Strands

Number, Measurement, Logic and Language, Statistics and Probability, Function, Algebra

Nature of Science and Mathematics

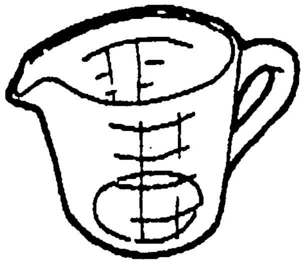
Scientific Community, Science and Technology, Changing Nature of Facts and Theories, Creativity and Constraints, Theory-Based and Testable, Cooperative Efforts, Objectivity and Ethics, Real-Life Applications, Interdisciplinary

by

Colin Hocking
Cary Sneider
John Erickson
Richard Golden

LHS GEMS

Great Explorations in Math and Science (GEMS)
Lawrence Hall of Science
University of California at Berkeley



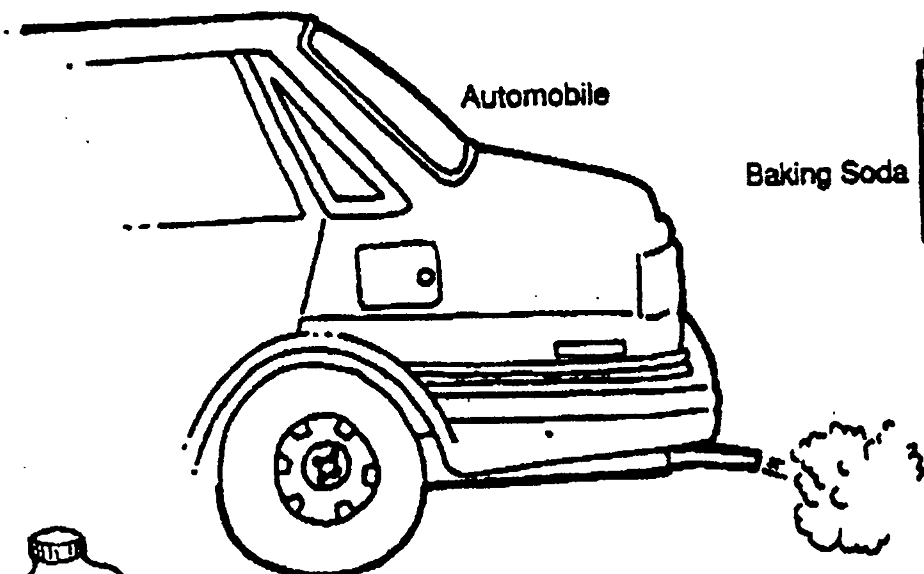
Measuring Cup
or Graduated Cylinder

What You Need

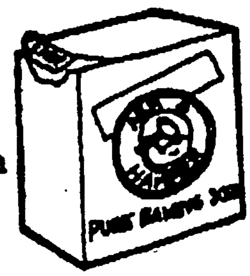
For this session, you will need all of the materials prepared for Session 4 plus the items listed below. Items from Session 4 are marked with an asterisk.

For the class

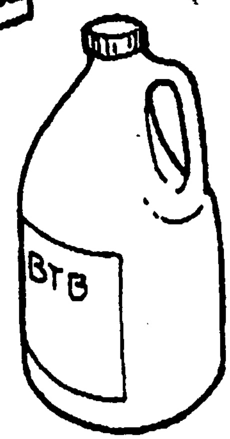
- *❑ 1 box of baking soda
- *❑ 1 gallon of dilute BTB
- *❑ 1 air pump
- *❑ 1 gallon bottle white vinegar
- *❑ 1 graduated cylinder or measuring cup
- ❑ 1 car
- ❑ 1 manila folder
- ❑ 1 roll of masking tape or duct tape
- ❑ 1 chalkboard or butcher paper and marker



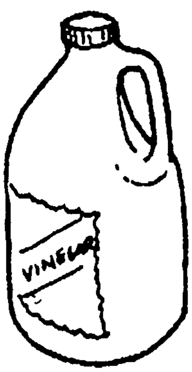
Automobile



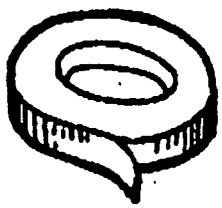
Baking Soda



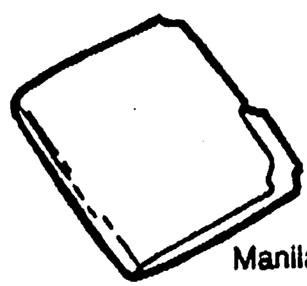
BTB Solution
(1 Gallon)



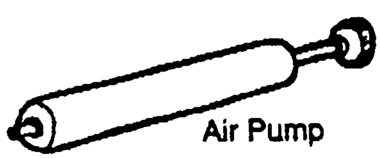
Vinegar
(1 Gallon)



Masking Tape



Manila Folder



Air Pump

Four Gas Samples: Observation Sheet

Collect all four samples of gas before making any tests. Each sample should be sealed in a balloon with a twist-tie. Make sure each balloon is a different color and each balloon is at least three inches wide. Record the colors of the balloons and their contents on your data sheet.

Test each of the samples for carbon dioxide as follows:

1. Do not touch the first twist-tie yet. Tightly tie another twist-tie over the balloon's neck and seal it around one end of a drinking straw.

2. Slowly loosen the top twist-tie and adjust the size of the balloon by letting gas escape. It should just fit through a ring three inches wide.

3. Bubble the gas that is left in the balloon into one of the cups of BTB. Work together to make it easier to hold the balloon and the straw while controlling the bubbling.

CARBON DIOXIDE
Collected from a reaction of 3 oz. vinegar with 4 tsp. baking soda

Place each of the cups of BTB solution, along with a control, in the spaces below for comparison. Record your observations on the data sheet.

EXHAUST FROM BURNING FUEL
Collected from the tail pipe of a car

CONTROL

CUP OF BTB

AIR
Collected from an air pump

HUMAN BREATH
Collected from a student's lungs

Getting Ready

Before the Day of the Activity

1. Use a car with a round exhaust pipe (square tail-pipes are difficult to seal). Prepare a cone for collecting car exhaust by rolling up a manila folder the long way. One end must be larger than the opening of a car's tail pipe, and the other end must be small enough for a balloon to fit over it. Use plenty of tape to hold the cone in shape and to make the sides of the cone airtight. Trim the ends of the cone with scissors if necessary. Make a spare cone and have tape, folders, and scissors on hand when you collect the gas. Practice filling a balloon with car exhaust before class. Approach the exhaust pipe from the side and hold your breath when filling the balloons so you do not inhale the gases.

2. Make one copy of the two-sheet homework assignment: "Carbon Dioxide In the Atmosphere: Who Contributes and How Much?" and the data sheet for each student (see pages 89–91). Make one copy of the observation sheet for each group of four students (see page 88).

On the Day of the Activity

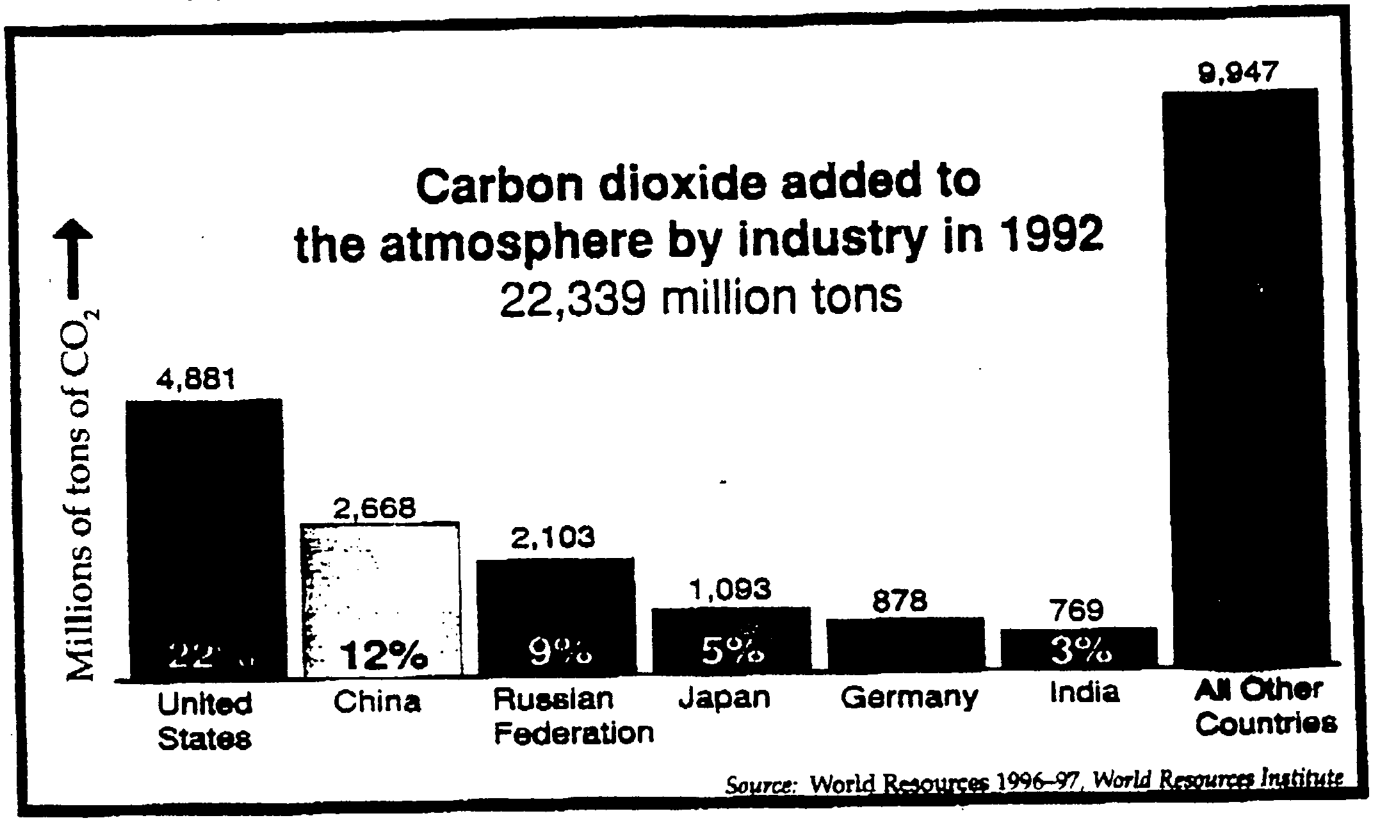
1. Park the car within close walking distance of your classroom. Preferably, the class should not have to cross a street to get to the car. Decide where the students should stand to watch you collect the gas samples so they can see what is happening, but are not in traffic. Since auto exhausts contain toxic gases, the students should stand back far enough so they do not have to breathe in car exhaust.

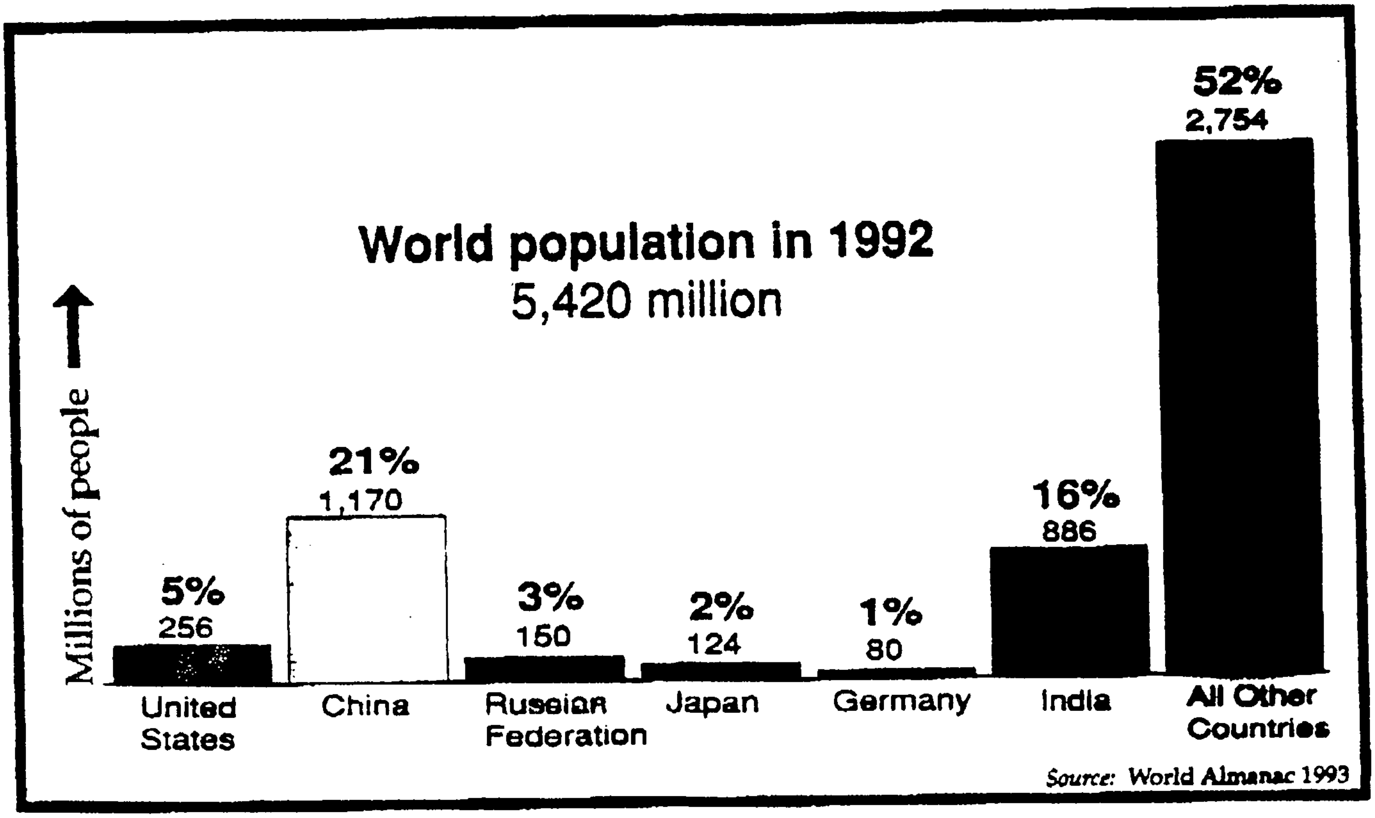
Using the funnel you made with a manila folder and tape, practice filling the balloon from the car exhaust pipe.

2. Assemble the equipment that each student team will need, as in Session 4, using trays for easy distribution. Use the amounts indicated above for this session.

3. Have the air pump available to be passed around from group to group.

Carbon Dioxide in the Atmosphere: Who Contributes and How Much?





Planet Earth

UNIT III

New York City- A City Surrounded by Water

PLANET EARTH CURRICULUM OUTLINE

UNIT III: NEW YORK CITY - A CITY SURROUNDED BY WATER

THEME I: "THE OCEANS AND RIVERS THAT SURROUND OUR CITY"

TOPIC A: The Gulf Stream

TOPIC B: The Ocean As a Resource

TOPIC C: Ocean Currents - Beaches and Tides

TOPIC D: New York's Shifting Coastline

TOPIC E: "Biological" Pollution and Ocean Dumping

THEME II: "OUR DRINKING WATER"

TOPIC A: From Salt to Fresh

TOPIC B: Water Politics and History

TOPIC C: Our City's Drinking Water: Where Does It Come From? Quality Control, Where Does It Go?

STANDARDS: NEW YORK CITY - A CITY SURROUNDED BY WATER

Standard 1: Analysis, Inquiry, and Design

Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

Scientific Inquiry

1. The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Students:

- elaborate on basic scientific and personal explanations of natural phenomena, and develop extended visual models and mathematical formulations to represent their thinking.
- hone ideas through reasoning, library research, and discussion with others, including experts.
- work toward reconciling competing explanations; clarifying points of agreement and disagreement.

Standard 2: Information Systems

Students will access, generate, process, and transfer information using appropriate technologies.

1. Information technology is used to retrieve, process, and communicate information and as a tool to enhance learning.

Students:

- access, select, collate, and analyze information obtained from a wide range of sources such as research, data bases, foundations, organizations, national libraries, and electronic communication networks, including the internet.
- model solutions to arrange of problems in mathematics, science, and technology using computer simulation software.

Standard 4: Science

Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

UNIT III
NEW YORK CITY-A CITY SURROUNDED BY WATER

<u>THEME I</u>
<u>"THE OCEANS AND RIVERS THAT SURROUND OUR CITY"</u>

CONCEPTS/
PERFORMANCE OBJECTIVES/
TEACHING STRATEGIES

PLANET EARTH - NEW YORK, A CITY SURROUNDED BY WATER

UNIFYING THEME: **The Oceans and Rivers that Surround Our City**
TOPIC B: **The Ocean as a Resource**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Ocean bottoms are covered with sediment and bedrock materials consisting of land material that once was organic matter.	1. explain that sediments carried far into the oceans by density currents form the graded bedding of the sea floor.	1. Collect and display a variety of ocean floor sediment material. Interpret maps of ocean bottoms which display various sediment distributions.
2. Ocean water contains a variety of dissolved minerals, mostly from land erosion.	2. identify the "impurities" in ocean water which have potential value as important resources.	2. Perform water analysis tests for various minerals found in "sea" water.
3. Phytoplankton are microscopic plants that produce most of the food in the ocean. Zooplankton are microscopic organisms that feed on the phytoplankton.	3. describe phytoplankton as the first link in the vast food web in the ocean, and its importance as the most abundant food resource in the open waters.	3. Examine phytoplankton under a microscope. Show a video displaying these organisms in the open ocean waters.
4. The ocean offers a vast source of food for human consumption. These include: **plant life:** sea kelp, sea weed **animal life:** fish, crabs, lobsters, clams, and mussels.	4. explain that the sea offers a number of food sources for the human diet in various cultures.	4. Display various marine organisms used as food sources, and the way in which different cultures make use of their natural marine resources.
5. Aquaculture is the process of growing and reproducing marine organisms in a man made environment to increase food production. Examples include the culturing of algae, clams, oysters, salmon, etc.	5. identify aquaculture as a technological means to increase food production.	5. Invite a guest speaker from a fish hatchery, e.g, Cold Spring Harbor Lab - dissection of clam, crayfish or perch or discuss careers in aquaculture.
6. Shells from a variety of marine organisms are used as jewelry, ornaments and trinkets.	6. explain the importance of certain mollusk shells in the making of ornamental jewelry.	6. Display a variety of jewelry and ornaments made from mollusk shell material.

PLANET EARTH - NEW YORK, A CITY SURROUNDED BY WATER

UNIFYING THEME: **The Oceans and Rivers that Surround Our City**
TOPIC C: **Ocean Currents - Beaches and Tides**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Ocean currents are generated by winds and water density. Prevailing winds and nearby ocean currents may influence the climate.	1. relate surface currents to planetary wind patterns that exist on Earth. Compare warmer waters to the currents of cold arctic water that circulate underneath the warmer waters. Relate wind speed to the distance over which it blows. Describe the impact of ocean currents on climates world-wide.	1. Examine global wind pattern and ocean current maps and compare climate regions across the continents. Visit to the American Museum of Natural History Hall of Planet Earth. Observe how oceans and atmosphere work to create climates on Earth.
2. Surface ocean currents are affected by the rotational spin of the Earth.	2. describe why major ocean currents curve to the right in the northern hemisphere.	2. Demonstrate the Coriolis Effect and relate it to the direction of ocean current movement. Visit a website concerned with oceanography as it is studied from the space shuttle. http://daac.gsfc.nasa.gov/CAMPAIGN-DOCS/OCDST/Shuttle-oceanograph-web/OSS-cover.html. It depicts pictorial survey of oceanic phenomenon visible to the naked eye from space.
3. The oceans distribute the Earth's solar energy due to their high specific heat.	3. explain why water's high specific heat makes it a very efficient carrier of energy.	3. Conduct an activity demonstrating the high specific heat of water.
4. Tides are the periodic rise and fall of the sea's surface due to the gravitational attraction of the sun and moon.	4. compare tides during various parts of the day and of the year.	4. Analyze tide tables for New York City at the Battery and other locations as a long-term investigation.
5. New York Harbor has semi-daily tides (two high and low tides each day).	5. identify tide tables for New York Harbor. Describe tidal patterns and make predictions regarding the time of the next tide cycle.	5. Examine a map of New York Harbor and analyze the tide tables. Have students predict the time of the next tide cycle. Check with the weather bureau for accuracy.

UNIFYING THEME: **The Oceans and Rivers that Surround Our City**
TOPIC C: **Ocean Currents - Beaches and Tides**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
12. Sand bars and barrier islands run parallel to the shoreline. Sand bars usually protect the water (lagoons) behind them. Barrier islands are located some distance from the shore.	12. identify sand bars and barrier islands as distinct "beach" systems.	12. Study a map of Jamaica Bay identifying the variety of land/water regions that exist within the area. Make a field trip to Jamaica Bay.
13. Rockaway Beach is an example of an attached-end hook sandbar. Fire Island is an example of a barrier island.	13. identify local examples of sandbar and barrier island areas.	13. Research the history of Rockaway Beach and Fire Island in the library or on the Internet.
14. Ocean currents distribute pollutants deposited by human activities.	14. describe the results of using the oceans as dumping grounds.	14. Read a journal article or newspaper account about recent ocean dumping (oil spills, garbage barges, etc.) and its implications for the ocean environment.

PLANET EARTH - NEW YORK, A CITY SURROUNDED BY WATER

UNIFYING THEME: **The Oceans and Rivers that Surround Our City**
TOPIC D: **New York's Shifting Coastline**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
7. Many coastal regions are severely damaged by storm surges from "Nor'easters" and hurricanes which usually have a long-lasting impact on the features of the coastline.	7. describe the effect of severe weather systems on coastline areas.	7. Display photographs or videos to show the devastating effect of severe weather conditions on a coastline area.
8. Humans have altered and helped rejuvenate coastal regions for recreational use and to protect natural ecosystems that depend upon the coastline region for their survival.	8. explain that humans shape coastal areas in order to use them as recreational areas.	8. Discuss the need to regulate construction in shoreline areas to protect and preserve natural systems and existing homes and businesses.
9. Garbage, medical wastes, oil spillage and raw sewage not only pollute the waters, but often wash up on the shore damaging the shoreline region.	9. explain the harmful effects of wastes and pollutants washing up on the shore.	9. Display photographs of coastline regions that have been contaminated with wastes. Read an article on oil spills and their impact on the shoreline areas. Visit the website http://www.oilspill.state.ok.us/Oil spill restoration. Read historical information on Exxon Valdez, its impact, recovery, etc.

UNIT III
NEW YORK CITY-A CITY SURROUNDED BY WATER

THEME II
"OUR DRINKING WATER"
CONCEPTS/
PERFORMANCE OBJECTIVES/
TEACHING STRATEGIES

PLANET EARTH - NEW YORK, A CITY SURROUNDED BY WATER

UNIFYING THEME: **Our Drinking Water**
TOPIC A: **From "Salt to Fresh"**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
6. An estuary is a semi-enclosed tidal body of saline water with a free connection to the sea.	6. identify estuaries and their relationship to the ocean waters.	6. Use a map to identify and locate various estuaries in the New York City area.
7. Present-day estuaries were formed at the last glacial retreat. The sea level rose and river valleys flooded forming coastal plain estuaries.	7. describe how estuaries form and their relationship to sea level height.	7. Analyze sea level heights for this area for the last 100 years.
8. There is a wide variety of life (animals and plants) that lives or breeds in an estuary region. Examples include mussels, blue crabs, copepods, Atlantic shad, sea robin, brown algae and sea moss.	8. identify animal and plant species that live or reproduce in estuarial regions.	8. Visit an estuary site and observe the variety of organisms that inhabit the region.
9. Freshwater (low saline content) flows toward the sea, and saltwater (high saline content) coming in from the ocean flows along the bottom of an estuary.	9. compare the movement of water from freshwater sources and the movement of sea water into a coastal estuary region.	9. Visit a coastal estuary area and identify the plant life that grows in this region.
10. Jamaica Bay, inlets on the south shore of Long Island and Queens, and the Long Island Sound are other bodies of water that are vital for the fishing and shellfish industries, wildlife refuges and reaction.	10. identify other important bodies of water in the New York City area for industry, wildlife sanctuaries and recreational purposes.	10. Use a map of the New York City region to locate other important water and ecosystem habitats in our local area. Students should create posters of animal life at an estuary showing interrelationships (food chains). These can be displayed in classrooms or in hallways.

PLANET EARTH - NEW YORK, A CITY SURROUNDED BY WATER

UNIFYING THEME: **Our Drinking Water**
TOPIC C: **Our City's Drinking Water: Where Does It Come From? Quality Control, Where Does It Go?**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Large volumes of water are used by the City of New York daily.	1. explain the need for water conservation. Example, drought periods.	1. Calculate personal water consumption per day.
2. The water distribution system consists of a complex network to provide the city with water.	2. create a map that identifies major aspects of the New York City water system.	2. Provide contour maps of New York State. Have students map the current water system.
3. a. Gravity is the principle vehicle for getting water into the city. b. Parts of Queens get their water from ground aquifers.	3. a. explain how engineers used gravity to direct water towards New York City. b. discuss how the water supply and pressure is maintained. c. explain how aquifers provide water.	3. a. Have students design a water system. b. Measure water pressure in different settings. Punch holes in a can and observe the flow of water. c. Show overheads of aquifers and have students explain the process.
4. Different reservoirs serve different areas of the city.	4. identify locations, physical features, names and sizes of the different reservoirs.	
5. New York City Department of Environmental Protection is responsible for monitoring water. Laws exist which provide for safe water.	5. a. discuss the DEP's sampling procedures. Explain what a watershed is and its importance to New York City. b. explain how a water plant functions	5. Use LAB-AIDS, CEPUP Kits and visit the water plant to explain water sampling and monitoring.
6. a. Water quality problems within the distribution areas are rare. Local problems are more frequent. b. Some water contaminants are carcinogenic.	6. a. explain why local water is frequently contaminated. b. discuss why chlorinated water may be dangerous.	6. Design a water taste test. Compare water from different parts of the City.
7. Acid Precipitation/Acidification Potential historically have not been a problem but are monitored.	7. explain how reservoir water might become acidic.	7. Activity: Bubble CO_2 into water to show how it becomes acidic. Use Brom-Thymol blue as an indicator.

PLANET EARTH - NEW YORK, A CITY SURROUNDED BY WATER

UNIFYING THEME: **Our Drinking Water**
TOPIC C: **Our City's Drinking Water: Where Does It Come From? Quality Control, Where Does It Go?**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
14. a. Primary treatment is the removal of debris and grit from wastewater by passing water through a coarse screen and grit settling chamber. b. Secondary treatment is a sewage-treatment process that follows primary treatment. It is any of a variety of methods that remove most of the remaining organic matter by enabling microorganisms to feed on it. Trickling filters and activated-sludge systems are the most important ones used. c. Tertiary treatment is the most advanced water treatment.	Students will be able to: 14. a. explain how water is treated after it is used. b. discuss the comparative costs of the various treatments.	14. a. Create and simulate primary treatment in the classroom (do a simple filtration). Visit a secondary treatment plant. Review Clean Water Act. Create a mock congressional hearing. b. Create an environmental impact study and cost/benefit analysis survey for the water plant nearest the school.
15. Sewer management and control of floating debris, e. g., wood from piers and street litter that washes down storm drains and into sewers during heavy rain contribute to New York City water pollution. This problem is dealt with by skimmer vessels. These vessels using nets that skim the surface of the water catching the debris.	15. identify materials that can be found on the surface of the water and determine methods of removal.	15. Use fish tanks and invent skimmers. Writing Activity, Role Playing - Imagine you are a drop of water leaving the Croton Reservoir, describe your journey from there to your kitchen sink.

Planet Earth

UNIT IV

The Air We Breathe

PLANET EARTH CURRICULUM OUTLINE

UNIT IV: THE AIR WE BREATHE

THEME I: "AIR POLLUTION"

TOPIC A: THE ATMOSPHERE

1. Structure
2. Temperature inversions

TOPIC B: AIR CHEMISTRY

1. The elements
2. Creation of smog
3. Acid rain

TOPIC C: THE FUTURE

1. Success stories
2. Current problems
3. Options

Standard 2: Information Systems

Students will access, generate, process, and transfer information using appropriate technologies.

Information Systems

1. Information technology is used to retrieve, process, and communicate information and as a tool to enhance learning.

Students:

- access, select, collate, and analyze information obtained from a wide range of sources such as research data bases, foundations, organizations, national libraries, and electronic communication networks, including the Internet.
- model solutions to an array of problems in mathematics, science, and technology using computer simulation software.

Standard 4: Science

Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Physical Setting

2. Many of the phenomena we observe on Earth involve interactions among components of air, water, and land.

Students:

- use the concepts of density and heat energy to explain observations of the movements of the Earth's plates.

3. Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

Students:

- explain the properties of materials in terms of the arrangements and properties of the atoms that compose them.
- use atomic and molecular models to explain common chemical reactions.
- apply the principle of conservation of mass to chemical reactions.
- use kinetic molecular theory to explain rates of reactions and the relationships among temperature, pressure and the volume of a substance.

Connections

1. The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena.

Students:

- analyze science/technology/society problems on a community, national, or global scale and plan and carry out a remedial source of action.
- analyze and quantify consumer product data, understand environmental and economic impacts, develop a method for judging the value and efficacy of competing products, and discuss cost/benefit tradeoffs is arriving at the optional choice.
- design solutions to real world problems on a community, national, or global scale using a technological design process that integrates scientific investigation and rigorous mathematical analysis of the problem and of the solution.

UNIT IV
THE AIR WE BREATHE

THEME I
"AIR POLLUTION"

CONCEPTS/
PERFORMANCE OBJECTIVES/
TEACHING STRATEGIES

PLANET EARTH - THE AIR WE BREATH

UNIFYING THEME: **Air Pollution**
TOPIC A: **The Atmosphere - Temperature Inversions**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Density is the amount of matter in a given space or volume. D = M/V	1. define density as D = M/V	1. Students should complete a lab activity on density, e.g., compare densities of different liquids such as water, alcohol, oil, and can syrup.
2. Cold air has more molecules crowded into a given space than does warm air for the same space. Therefore, cold air is denser.	2. compare the differing densities of cold and warm air. Explain why cold air is denser than warm.	2-3. Have students build a model of the air by putting cold water and warm water into a fish tank. Drop a weighted baggie containing blue dyed water in it. Have students record observations. Demonstrate differing air densities by using a convection box.
3. Due to the fact that the atmosphere is layered with colder air above warm air, cold air sinks and warm air rises, allowing mixing of the air.	3. explain the reason for and the importance of the natural mixing of air.	
4. When the air near the ground becomes colder than the air above it, this creates a temperature inversion.	4. explain the formation of temperature inversions.	4. Have students connect to the Internet and download diagrams showing the change of temperature as height increases.
5. Temperature inversions do not allow the air to mix. This allows the levels of air pollutants to increase, making the air dangerous to breathe.	5. predict the effects of temperature inversions on air quality and on living things. Explain why temperature inversions do not allow air to mix.	5. Connect to the Internet and view a picture of L.A. on a smoggy day or obtain photos from books, magazines, etc.
6. Inversions that last for a few days can cause air pollution to reach harmful and even lethal levels.	6. relate the amount of time under an inversions to decreasing air quality.	6. Contact a local hospital to invite a doctor/nurse to talk about the effect of ozone on people. Compare the incidence of chronic obstructive pulmonary disease (COPD) or other respiratory diseases in people living in urban vs. rural settings.

PLANET EARTH - THE AIR WE BREATH

UNIFYING THEME: **Air Pollution**
TOPIC B: **Air Chemistry - The Elements**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Air pollutants are combinations of elements. Elements are pure substances consisting of one type of atom.	1. define elements.	1. Use a computer program showing the elements and their properties. Show actual samples of common elements.
2. The 92 naturally occurring elements can be found on the Periodic Table. They are grouped according to their characteristics. Some other elements are artificially made in the laboratory.	2. determine characteristics of elements from the Periodic Table.	2. Students should have a basic idea of how the Periodic Table is organized and how it is used to gather information.
3. All atoms are composed of protons, neutrons and electrons.	3. identify the components of an atom and draw a Bohr model of an atom.	3. Use ball and stick models to identify the components of an atom.
4. Atoms may gain or lose electrons in order to reach a stable state.	4. predict possible combinations of elements based on the electrons in their outer shells.	4. Challenge students to predict which elements will bond with others.
5. Compounds are stable combinations of two or more different atoms. Atoms can combine to form molecules. When they combine they are held together by bonds.	5. describe the role of chemical bonding. Compare and contrast atom, molecule, element, and compound.	5. Use ball and stick models and computer simulations to show this point. Show synthesis of simple compounds, e.g., ZnO, Fe_2O_3
6. The number and type of atoms on both sides of a chemical equation must be the same.	6. predict the conservation of mass in simple chemical reactions.	6. Students should be able to balance simple equations.

PLANET EARTH - THE AIR WE BREATH

UNIFYING THEME: **Air Pollution**
TOPIC B: **Air Chemistry - Creation of Smog**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
6. The nitrogen dioxide interacts with sunlight and is converted to nitric oxide and high energy oxygen atoms. $NO_2 + \text{Sunlight} \rightarrow NO + O$	6. explain the result of the chemical interaction between nitrogen dioxide and sunlight.	6. Use a radiometer to show that sunlight contains energy.
7. These high energy oxygen atoms then combine with molecular oxygen to form ozone. $O_2 + O \rightarrow O_3$	7. identify the chemical reaction that produces ozone in the troposphere.	7. Have students compare and contrast ozone in the troposphere to the ozone in the stratosphere. Have students relate the steps in the formation of ozone in a concept map.
8. Ozone in the stratosphere is beneficial to life, however, it is poisonous when located near the surface.	8. differentiate between stratospheric ozone and tropospheric ozone.	8. Connect to the Internet to examine the ozone "hole" over Antarctica. Research articles of a similar nature in *Natural History Magazine* and other sources.
9. Ozone in the troposphere is an irritant and can cause difficult in breathing and trigger asthma attacks.	9. explain the effects of ozone in the troposphere on living things.	9. Contact a health worker to come into the class and talk about asthma. Have students do a research project on the correlation between asthma and increasing ozone levels.
10. The levels of nitric oxide and nitrogen dioxide peak in the late afternoon. This is usually when the highest levels of ozone are found.	10. explain the relationship between the levels of tropospheric ozone and the ambient levels of nitric oxide and nitrogen dioxide.	10. Contact the EPA and NYCDEP for information on data and prepare a graph relating time vs. levels of $NO + NO_2$. Have the students speculate on why these levels peak in the afternoon.
11. Smog levels can reach dangerous and even lethal levels during inversions in the summertime when many motor vehicles are on the road.	11. predict conditions that could lead to dangerous or lethal levels of ozone in the troposphere.	11. Have students research extended inversions in New York City and what occurred as a result.

PLANET EARTH - THE AIR WE BREATH

UNIFYING THEME: **Air Pollution**
TOPIC B: **Air Chemistry - Acid Rain**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
7. Some of the nitrogen dioxide reacts with water vapor in the air to produce nitric acid vapor and nitric oxide. $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$	Students will be able to: 7. describe the production of nitric acid.	
8. The nitric acid vapor condenses in the cloud and is released in the form of precipitation. This is one ingredient of acid rain.	8. explain the movement of nitric acid from the atmosphere to the surface of the earth.	8. Form a cloud in a bottle to show condensation.
9. Sulfur reacts with oxygen in the air to create sulfur dioxide. $S + O_2 \rightarrow SO_2$	9. explain the production of sulfur dioxide in the atmosphere.	9. Have students use simple ball and stick models to show transformation.
10. Sulfur dioxide will react with other oxygen molecules to produce sulfur trioxide. $2SO_2 + O_2 \rightarrow 2SO_3$	10. explain the process of sulfur trioxide formation.	10. Challenge students to predict the common yet advanced chemical reactions in the atmosphere.
11. Sulfur trioxide will then react with water vapor to produce sulfuric acid. $SO_3 + H_2O \rightarrow H_2SO_4$	11. identify the chemical reactions that produce sulfuric acid in the atmosphere.	11. Show the corrosive nature of H_2SO_4 by reacting it with Fe or Zn or Mg.
12. Sulfuric acid is also carried to the surface in precipitation. It also is an ingredient of acid rain.	12. describe the movement of sulfuric acid to the surface.	12. Have students grow plants in acidic soil to show the effects of acid rain on living organisms.
13. These acids can be carried hundreds of miles downwind.	13. predict the movement of these acids given the wind direction.	13. Connect to the Internet and determine the latest wind conditions.

PLANET EARTH - THE AIR WE BREATH

UNIFYING THEME: **Air Pollution**
TOPIC C: **The Future - Success Stories**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Due to the realization of the air pollution problem, congress implemented the original Clean Air Act of 1967 and amended it in 1970, 1977 and 1990.	1. describe the purpose of the Clean Air Act.	1. Have students research the Clean Air Act and its amendments.
2. The Clean Air Act sets limits on the amount of pollutants that should be found in the atmosphere. The Environmental Protection Agency is the entity responsible for measuring these levels.	2. identify current trends in levels of ozone, nitrogen dioxides and sulfur dioxides as regulated by the EPA.	2. Connect to the EPA via the Internet and download data of the latest trends in air pollutants.
3. Power plants and motor vehicles have had limits placed on the types and amounts of pollutants that they can release into the air.	3. predict the likely results of these limits on air quality.	3. Contact a local motor vehicle inspection station and ask them to save data on inspection receipts for class projects.
4. Since 1970, air quality in many American cities has improved.	4. identify the successes of the Clean Air Act.	4. Have students research the air pollution problems of Pittsburgh, PA or New York City. **Debate:** Should drivers be made to pay higher fees to have their cars inspected if it means cleaner air?

PLANET EARTH - THE AIR WE BREATH

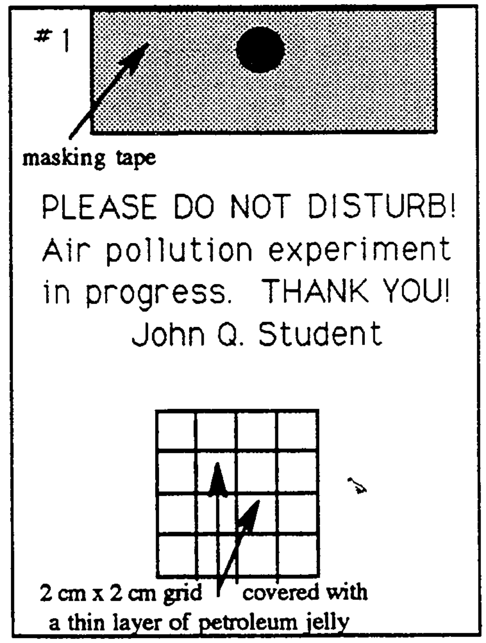
UNIFYING THEME: **Air Pollution**
TOPIC C: **The Future - Options**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
1. The main source of air pollution is the reliance on fossil fuels to meet energy demands.	Students will be able to: 1. identify the need for energy as the main source of air pollution.	1. Have students track the amount of energy that is used each month using electric bills.
2. In order to lower the levels of air pollutants in the atmosphere, there are several possibilities: a. invent "cleaner" fossil fuel burning facilities. b. use natural gas instead of coal. c. invest in new technologies such as solar power and wind energy.	2. describe different ways in which the levels of air pollutants can be lowered to acceptable levels.	2. Visit the Maine Solar house on the Internet. (http://solstice.crest.org/renewable/wlord/index.html). Display solar powered devices. Show how a windmill can generate electricity.
3. Changes will only occur when the cost of preventing air pollution is lower than the cost of polluting.	3. analyze the different costs of current energy technologies.	3. Use current electric bills to measure the actual cost of polluting. How can we make the cost of polluting higher? For example, taxes or we can lower the cost of preventing pollution through tax credits.
4. These changes will have profound effects on the way average people live their lives.	4. predict ways in which people will be affected by changes in energy technology.	4. Have students develop and use a questionnaire to measure the "trade-offs" that people would accept.

13.2 Detecting Air Pollution: Instructions

In this activity, you will be making particulate collectors to test for the presence of particulates in various areas of your community. Each student should make at least one particulate collector. When you place your detector(s), be sure to record the information on the top part of the data page.

To make your particulate collector:



1. Attach a 1" (2–3 cm) piece of masking tape to the narrow side of a 2.5" × 3" card provided by your teacher. Use a hole punch to make a hole in the masking tape. The hole is for attaching a string with which to hang the card if it is not attached with push pins or tape. The masking tape will reinforce the hole.
2. Use a PENCIL to write the following on both sides of your card(s):
   "Please do not disturb. Air pollution experiment in progress. Thank you!"
3. Use the pencil to write your name on the card. If you are placing more than one card, number each one so that you do not get them mixed up.
4. Use the pencil to draw a 2 cm × 2 cm square on one side of the card. Use the pencil to divide the square into a grid of squares with 0.5 cm sides.
5. EITHER:
   a. Place a small amount of petroleum jelly in the middle of the square. Use your (clean) finger, a clean toothpick, or the edge of a card to spread the petroleum so that it forms a thin, even layer over the square. Carry your pollution detector in a small box so that the petroleum doesn't get smeared or contaminated before you place it in the community.

   or

   b. Obtain a small amount of petroleum jelly in a piece of foil or plastic. Apply the jelly as above when you place the card in the community.
6. Obtain push pins, masking tape, and/or string to use to place the pollution detector(s) in the community.
7. On the assigned day, place your collector(s), recording the appropriate data.
8. On the assigned day, bring your collector(s) to class, again recording the appropriate data.
9. Use magnifying lenses or microscopes to examine the particulates collected.
10. Record your observations on the data table.

Taken from: Environmental Science Activity Kits: Michael Roa, Simon & Schuster Co.

Name ______________________ Class ____________ Date ____________

13.3 Detecting Air Pollution: Questions

1. What are "particulates"? (Define and give several examples.)

2. What is the major single source of outdoor air pollution in the United States?

3. List the major stationary sources of air pollution in your community. For each one, list one thing that you could do to reduce its air pollution.

source	something that I can do

4. Describe several things that you as an individual can do to reduce air pollution from transportation. Circle those that you are now doing or are willing to do.

5. Some people feel that what they as individuals do is not important, that they cannot do much to address major problems such as air pollution. Others say that the problems are caused by individuals and that individuals can work together to address the problems. Individuals can change buying habits, which will then change the habits of industries; they can drive more fuel-efficient cars that pollute less; they can save energy; and they can enact and enforce laws. What do you think—can the individual make a difference? Why do you think as you do?

14.1 Acidic Precipitation: Background Information

When air pollutants such as sulfur dioxide (SO_2) and nitric oxides (NO_X) are released into the air, they do not just "go away." They are carried by air currents and can chemically react with one another and with other chemicals in the air. They can form nitrogen dioxide (NO_2), sulfuric acid (H_2SO_4), nitric acid (HNO_3), and solid particles of sulfates and nitrates.

Many of these chemicals can be dissolved in rain water, snow, sleet, fog, and dew. When this polluted water falls to Earth, it is called "acidic precipitation" or, more commonly, "acid rain."

Acidity is measured in terms of **pH**. A low pH value indicates a high acid content in the substance. Each whole number on the pH scale represents an increase or decrease by a factor of 10. Thus, a substance with a pH of 5 is ten times as acidic as one with a pH of 6.

Acidic substances have a pH less than 7. **Basic or alkaline** substances have a pH of between 7 and 14. A pH of 7 is **neutral,** neither acidic nor basic. Pure water has a pH of 7. The accompanying table gives some approximate pH values of common substances.

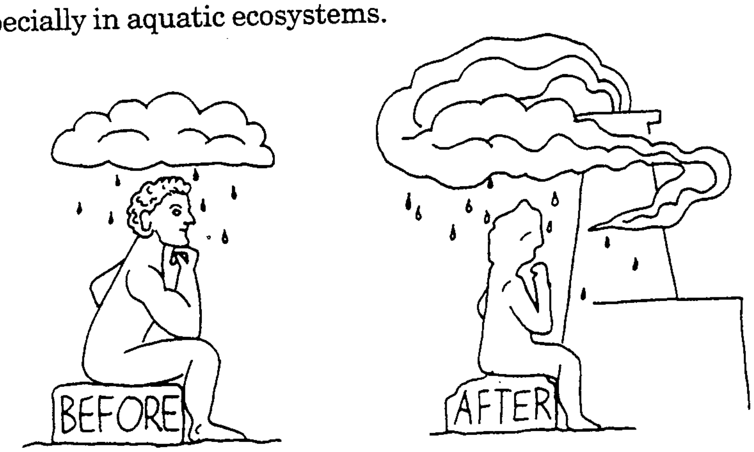
Natural **precipitation** has an average pH of about 5.1 due to the presence of carbon dioxide and other naturally occurring atmospheric chemicals. This slight acidity is useful because it helps dissolve soil minerals that plants need.

Even precipitation with a pH of less than 5.0 can be harmful. It can cause too many chemicals to dissolve from the soil, thereby polluting water. The precipitation itself may be acidic enough to cause damage. It damages trees, crops, paints, buildings and other structures such as monuments (especially those made from marble), artwork, tires, and it may even be dangerous to health.

The SO_2 emissions and NO_X emissions come from a variety of sources. In the United States, coal-and oil-burning power plants are major sources. So are industries that burn coal and oil. The northeastern United States and southeastern Canada have very high acidity in the precipitation, in the range of a pH of 4.2 to 4.4. Much of the Canadian acidic precipitation probably originates in the United States and is carried into Canada by the prevailing winds. This is a cause of some animosity between the United States and Canada. In some areas where coal and oil are not heavily used, automobile exhaust is a major source. This seems to be the case in southern California.

The type of soil upon which the acidic precipitation falls is an important factor in determining how much damage will be done. Some soils, such as those with limestone or other basic substances, can react with the acids to partially neutralize them. Other soils, such as granitic and some types of sandstone, do not have this neutralizing capability. Such soils are very susceptible to damage by acidic precipitation.

While a pH of 4.2 or 4.3 may not seem very harmful, it is important to consider the effects of exposure over extended periods of time. Even slight changes in pH can have disastrous results, especially in aquatic ecosystems.



TAKEN FROM: Environmental Science Activity Kit, Michael Roa
Simon & Schuster

Name ______________________ Class __________ Date __________

14.3 Acidic Precipitation: Questions

1. How are the types of rocks that you tested used by people?

2. What implications do your observations have for builders?

3. Many of the chemicals that form acidic precipitation are produced at power plants. If we save energy, less coal or oil needs to be burned, so there will be less of these acid-producing chemicals discharged into the air. List several ways that you can save energy.

4. List several economic advantages and disadvantages of reducing acidic precipitation by installing equipment on power plants.

5. List several other causes of acidic precipitation besides power plants.

6. In addition to saving energy wherever possible, what can you do to reduce acidic precipitation?

Planet Earth

UNIT V

The Inevitable Storm

TOPIC D: FORMATION AND MOVEMENT

1. Time of hurricane season
2. Stages of development
3. Importance of the position of the Bermuda High
4. Hurricane strength and the Gulf Stream

TOPIC E: INTERACTION WITH LAND

1. Saffir-Simpson scale
2. Coastal flooding
3. Right side of the hurricane is most damaging
4. Location is important in damage assessment
5. Hurricane affects in urban areas
6. Evacuation procedures
7. Flooding and tornados likely inland

STANDARDS: THE INEVITABLE STORM

Standard 1: Analysis, Inquiry, and Design
Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

Scientific Inquiry

1. The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Students:
- elaborate on basic scientific and personal explanation of natural phenomena, and develop extended visual models and mathematical formulations to represent their thinking.
- hone ideas through reasoning, library research, and discussion with others, including experts.

2. Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

Students:
- devise ways of making observations to test proposed explanations.
- refine their research ideas through library investigations, including electronic information retrieval and reviews of the literature, and through peer feedback obtained from review and discussion.
- develop and present proposals including formal hypotheses to test their explanations, i.e., they predict what should be observed under advised specified if the explanation is true.

3. The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

Students:
- use various means of representing and organizing observations (e.g., diagrams, tables, charts, graphs, equations, matrices) and insightfully interpret the organized data.

Models

2. Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.

Students:

- collect information about the behavior of a system and use modeling tools to represent the operation of the system.
- compare predictions to actual observations using test models.

Standard 7: Interdisciplinary Problem Solving

Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

Connections

1. The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena.

Students:

- design solutions to real world problems on a community, national, or global scale using a technological design process that integrates scientific investigation and rigorous mathematical analysis of the problem and of the solution.

UNIT V
THE INEVITABLE STORM

THEME I
"HURRICANES"

CONCEPTS/
PERFORMANCE OBJECTIVES/
TEACHING STRATEGIES

PLANET EARTH - THE INEVITABLE STORM

UNIFYING THEME: **Hurricanes**
TOPIC B: **Thunderstorm Formation**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Due to a high Sun angle, the tropics receive a large amount of incoming solar energy.	1. describe how direct solar rays differ from indirect solar rays in terms of producing heat.	1. Students should experiment with heat lamps situated at different angles to show the effect of direct and indirect light.
2. This incoming energy heats up the tropical oceans. They reach their highest temperatures in late summer.	2. determine where the warmest ocean water would be found in the late summer.	2. Connect to the Internet to find current and historical sea surface temperature maps of the Atlantic Ocean.
3. Temperature is a measure of the average speed of molecules in a substance. Heat is the sum total of the kinetic energy of all the molecules in a substance.	3. a. define temperature in terms of KMT. b. differentiate heat from temperature.	3. Heat two different sized containers of water to the same temperature. Have students explain why they do not give off the same amount of heat.
4. a. The water in the tropical oceans warms the layer of air directly above it. b. Water exists in all three phases in the atmosphere. c. Evaporation occurs when water molecules absorb heat and change into water vapor.	4. a. explain how warm ocean water affects the air above it. b. explain the transformations of water in the atmosphere. c. define evaporation.	4. Create a model of the water cycle in a clear plastic box using a heat lamp, water, sand and a bag of ice.
5. Condensation is the changing of water vapor molecules into water molecules.	5. define condensation.	5. Create a "cloud" in a bottle.
6. Density is the amount of material in a given space. Warm air rises due to the fact that it becomes less dense than the air around it.	6. explain how density differences cause air to rise naturally.	6. Have students build a simple balance scale that could be used to measure differences in air density. Use balloons.

PLANET EARTH - THE INEVITABLE STORM

UNIFYING THEME: **Hurricanes**
TOPIC B: **Thunderstorm Formation**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
13. This rotation causes even more air to rise producing even more thunderstorms.	13. show how the rotation of the Earth aids in hurricane formation.	
14. The Coriolis Effect is less at the equator, therefore, hurricanes can only form some distance away from the equator.	14. explain why hurricanes usually form some distance from the equator.	14. Connect to the Internet to learn more about the formation of thunderstorms. (Weather World 2010)

PLANET EARTH - THE INEVITABLE STORM

UNIFYING THEME: **Hurricanes**
TOPIC C: **Transformation of Energy**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
8. The strongest winds are found just outside the center of the hurricane. This area is called the **eye wall.**	8. explain why the hurricane's strongest winds are near the center of the storm.	8. Students should collect data on air pressure and wind speed. Have them graph this data and explain the significance.
9. At the center of a hurricane, air is sinking. This causes the air to be relatively cloud free with gentle winds. This area is known as the **eye.**	9. describe the development of a hurricane's eye.	9. Connect to the Internet and find satellite images of present or past hurricanes.

PLANET EARTH - THE INEVITABLE STORM

UNIFYING THEME: **Hurricanes**
TOPIC D: **Formation and Movement**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
7. During the summertime, a very large area of high pressure forms near the island of Bermuda. This is known as the **Bermuda high.**	7. define the Bermuda high.	7. Use the Internet to find satellite images and weather maps of the tropical Atlantic in the summer.
8. The winds around a Bermuda high are clockwise. These winds steer hurricanes westward.	8. describe how the Bermuda high affects hurricane movement.	8. Experiment with rheoscopic fluid to build a Bermuda high. Spin the fluid clockwise with a stick to show the motion of the atmosphere near a Bermuda high.
9. As hurricanes get closer to the United States, their path is determined by the position of the Bermuda high.	9. relate the position of the Bermuda high to future hurricane movement.	9. Use a computer software package (e.g., Tracking the Eye) to show paths of historic Atlantic Hurricanes.
10. Due to the Bermuda high, some storms are steered due westward into Florida or the Gulf of Mexico. Other storms begin to turn more northward toward the east coast of the United States.	10. compare the movement of Florida and Gulf Coast hurricanes to East Coast storms.	10. Connect to the Internet to download images of current or historical Atlantic Hurricanes.
11. Satellites can be used to track hurricane movement across the ocean.	11. explain the important role of satellites in following hurricane movements.	11. Show on a map the position of the Bermuda high and how the anticyclonic flow steers hurricanes.
12. Hurricanes require an ocean temperature of 80 degrees F or higher to retain or increase in strength.	12. explain why hurricanes need warm water to retain their strength.	12. Have students access Atlantic Ocean sea surface temperature data. Have them draw isothermal lines to show the temperatures of the ocean water in the Atlantic.

PLANET EARTH - THE INEVITABLE STORM

UNIFYING THEME: **Hurricanes**
TOPIC E: **Interaction With Land**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
1. Hurricane strength is rated by wind speed, storm surge and air pressure.	1. predict the power of a hurricane based on changes in wind speed, storm surge and air pressure.	1. Have students access data of historical hurricanes to determine hurricane strengths.
2. The Saffir-Simpson scale measures the likely destructive power of a hurricane.	2. analyze the destructive power of a hurricane using the Saffir-Simpson scale.	2. Connect to the National Hurricane Center using the Internet for more information on the Saffir-Simpson scale.
3. Due to the low pressure in a hurricane's eye, the ocean level can be raised several feet.	3. explain the rise in sea level near the eye of a hurricane.	3. Challenge students to build a basic model of the creation of a storm surge. Example, use a vacuum chamber bell jar.
4. When the eye of a hurricane nears the coast, this dome of water is known as the **storm surge**.	4. describe the formation of a storm surge.	4. Use a stream table to model a coastal area. Place several small "houses" along the shore and use a fan to show the effect of the storm surge.
5. When ocean waves and tides are added to the storm surge, the water level can be raised several feet above sea level.	5. predict the height of the storm surge using the Saffir-Simpson scale.	5. Have students graph the effects of similar hurricanes striking the coast at different tides.
6. This excess water can cause beach erosion, destruction of property, and death.	6. predict the damage that will be found along the coastal areas after the passage of a hurricane.	6. Use newspapers, magazines and the Internet to collect images and articles of coastal areas that have been affected by storm surges.
7. The shape of the coastline can affect the amount of flooding.	7. predict the areas of the coastline that will experience the worst flooding.	7. Use maps of the East Coast and determine which areas have coastlines that would experience flooding.

PLANET EARTH - THE INEVITABLE STORM

UNIFYING THEME: **Hurricanes**
TOPIC E: **Interaction With Land**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
14. Large urban areas would experience particular problems from a hurricane such as - broken glass and falling bricks - downed power lines - pollution of water supply - closing of bridges, tunnels, subways - flooded roads and streets.	14. predict the various problems that hurricanes present in large urban areas such as New York City.	14. Allow students to contact the New York City Mayor's office and request information on New York City's Hurricane Evacuation Plan.
15. Large areas of New York City would be without these services for long periods of time.	15. examine the effects of these problems on themselves and their neighbors.	15. a. Have students brainstorm in groups to determine what other types of damage would be expected in New York City. b. Show students a video on the blackout of 1997 (The Hidden City, NOVA). Also visit the American Museum of Natural History - second floor, to see a cross-section of a New York City street. c. Have students write a reaction paper weighing risks and benefits of living on the shore. How would they deal with people who refuse to evacuate?
16. Due to the fact that New York City is a collection of islands, evacuations must be completed hours before the hurricane strikes the coast.	16. explain the importance of evacuating coastal areas BEFORE the hurricane arrives.	16. Have students role play and pretend that a hurricane has struck New York City. Have them write a letter to a friend in another part of the country explaining the problems they faced.
17. There are several safety steps that people can take to protect lives and property.	17. list several simple safety precautions that could save lives in a hurricane disaster.	17. Allow the class to spend time creating their own evacuation plan for the local area.

ROCKAWAY HURRICANE

READING ASSIGNMENT

In this laboratory we will look at the consequences of a landfall of a major hurricane in the New York metropolitan area. While these events occur about every 70 years, the consequences could be catastrophic. In 1938, a major hurricane destroyed much of eastern Long Island and New England, so we could have another hit any year now.

Hurricane Structure

A hurricane is an intense low pressure system of tropical origin. While the storm forms in the tropics, it can be transported into subtropical and temperate areas depending on the steering winds. Steering winds are typically 10-20 miles per hour East (Trade Winds) in southern areas and 25 miles per hour and about West (Westerlies) in areas north of Georgia. These winds determine the rate of progression of the storm system. At the center of a hurricane is an area of low pressure and calm called **the eye.** The section beginning at the edges of the eye is the **eyewall.** The strong **vortex winds** in the eyewall move counterclockwise around the eye. At some distance from the eye center, the radius of maximum winds, where the highest winds (and surge levels) are found. Hurricane force winds (>74 mph) can persist 75 miles from the eye center. A belt of **gale force winds** (>34 mph) may extend 125 miles or more out from that point.

The most dangerous part of the storm is the right (looking forward) front quadrant. Here the vortex and steering winds are moving in the same direction, and the velocities can be added in part. Thus a storm moving 30 miles an hour with vortex (sustained) winds of 100 mph may have an effective wind velocity up to 130 mph on the right side.

The first rule in emergency management is that evacuation much be complete before the onset of gale force winds (typically 3-6 hours before the arrival of the hurricane force winds). When gale force winds arrive, water levels rise enough to flood low points on evacuation routes and trees start to topple down across roads. Boats are no longer useable in gale force winds and extensive tree and structural destruction begins at wind speeds of 60 mph.

C. Saffir Simpson Scale ______________________

____

D. Eyewall ______________________

____

E. Vortex Winds ______________________

____

2. Peninsula Hospital (B52-B54) on Averne.

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3. Base on the wind speeds of actual hurricanes below, estimate the amount of water (storm surge) that was found when the hurricane came ashore.

HURRICANE	WINDS(MPH)	STORM SURGE (FT.)
Andrew (1992)	120	
Bob (1991)	85	
Camille (1969)	165	
Storm of 1938	85	
Hugo (1989)	125	

4. Power Plant along the Motts basin near the NYC-Nassau Company border.

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5. Solid waste landfill (bulkheaded on the water side) on the peninsula north of B63 Street)

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The Goddard Institute for Space Studies(GISS) located here in New York City, an adjunct of Goddard Space Flight Center, has a program involving CUNY college and New York City public school teachers and students in research and education related to climatology and meteorology. A major component of the project is the development of an Earth Science curriculum using Web-developed resources.

To support the research/education efforts for the individual campuses and colleges, we also secured a large grant from MUSPIN/NASA- at Goddard Space Flight Center. This grant enables us to provide resources for technology and applications related to NASA's overall strategic enterprises. The geographic region we were assigned in the Northeast.

The weather project is a merger of the two projects. While schools can assess NASA and other datasets using the Internet, we also wanted to show that they can use the Internet in more creative ways as well - to create, share and analyze local weather data. We felt that this would provide a stimulating way to support science classes that include weather-related material and that there are a number of interesting problems that students could study based on the local weather patterns they observe. (There are a number of applications here and some are directly related to significant research).

We have identified schools in New York City that are getting set up now but felt that good signatures of this area would necessarily involve schools in Long Island, New Jersey and Connecticut. Teachers seem to be really excited about using this not just in science classes but also in math and technology-related classes as well. After talking to Donna, a partnership with Cablevision's schools seemed ideal because CV is serious about educational content and already has related material.

We (actually the schools) set up local weather stations. There are linked to a PC as well as pushed to a central server for area sharing. Students have an opportunity to focus on their local weather and weather in wider areas. We are really working on the development of software for this project so that the Web-based interface has broad data manipulation, analysis and visualization capabilities. We want to make the data available in real-time as well as archival storage for downloading. We are also going to be working with GISS to broaden the overall weather picture, having overlays of satellite, radar and other data available. (This can be really exciting when we have some major storms)

We are using the Davis Weather Monitor II and are supplying it at no cost to schools participating in the first phase of this project. This is a popular low cost weather station used in a number of schools and other institutions. It also includes some pretty good software for plotting the data. (The software is not, however, networkable so I am completing some Java applets so that if teachers want to have the data available in their labs, their local Web severs can be used for student access) There are a few other similar projects I have seen and students would also have the ability to do wider comparisons. This kind of project also opens up a lot of paths that students can explore.

Look Up!

This sky awareness program will inspire educators to greater heights. Test your knowledge of the sky above us and learn the answer to the age old question, "why is the sky blue?" Those wishing inspiration for teaching and learning need look no further than the sky for a treasure of cross-curricular activities. Get ready to set a course for sky exploration!

Weather Focus

See what aspect of weather we are focusing on this season! Chosen with the student and educator in mind, these sites let you zoom in on the most fascinating phenomena of the global weather machine. Some of the areas spotlighted include El Nino, tornadoes, and hurricanes.

Teachers Resources

The Weather Channel has some great ideas for teaching and learning about the weather through various means. Explore our interactive CD-ROM, "Everything Weather," or find out how a hurricane is created in our comprehensive Storm Encyclopedia.

Weather Glossary

Curious to know what an Alberta Clipper is? Our Weather Glossary has over 800 terms to help you out. Ever wonder about becoming a meteorologist? How about making your own weather station? There are many exciting ways to discover the hows and whys to weather.

Cable In The Classroom

Cable in the Classroom Comes Home encourages parents--and anyone who cares about education--to volunteer to help schools by videotaping Cable in the Classroom programs so that teachers can use them in the classroom.

Project SkyMath: Making Mathematical Connections Using the Science and Language of Patterns to Explore the Weather.
http://www.unidata.ucar.edu/staff/blynds/Skymath.html
Note: this could be adapted for high school or science courses
SkyMath: "Making Mathematical Connections, Using the Science and Language of Patterns to Explore Temperature, " is a comprehensive six-week module for the middle school mathematics classroom. It uses current environmental and real-time weather data to promote the learning of mathematics.

Planet Earth

UNIT VI

Beyond Earth, The Search For Life

PLANET EARTH CURRICULUM OUTLINE

UNIT VI: BEYOND EARTH, THE SEARCH FOR LIFE

3. Earth's Motions
    a. rotation
        - daily apparent motion of sun and stars
        - day and night
    b. revolution
        - annual traverse of the constellations
        - signs of the Zodiac

TOPIC B: THE TELESCOPIC VIEW

1. Invention of the telescope
    a. advantages
    b. types

2. Galileo's observations with the telescope
    a. moon's surface
    b. Jupiter's moons
    c. Phases of Venus
    d. Evidences for the heliocentric theory
    e. Church's opposition to the heliocentric model

PLANET EARTH CURRICULUM OUTLINE

UNIT VI: BEYOND EARTH, THE SEARCH FOR LIFE

TOPIC D: THE SPACE TELESCOPE

1. Importance of satellite-based viewing
   a. Effects of atmosphere on viewing.
   b. Types of telescopes based on spectrum (IR, UV, visible light, radio).

2. Discoveries
   a. Age of the universe
   b. Black holes
   c. Pulsars
   d. Colliding galaxies
   e. Extra solar planetary systems

PLANET EARTH CURRICULUM OUTLINE

UNIT VI: BEYOND EARTH, THE SEARCH FOR LIFE

TOPIC B: LIFE IN THE SOLAR SYSTEM

1. Comparison of Earth with Nearby Planets-Conditions for Life
   a. Presence of liquid water
   b. Temperature
   c. Atmosphere
   d. Surface features

2. Life on Mars- "Fact or Fiction"
   a. Observation of canals
   b. "Martians"
   c. Meteorite with possible evidence of fossilized microbes (1996)

3. Space probes to the planets
   a. Manned vs. Unmanned
   b. Space travel-distances
   c. Exploring Mars and Venus
   d. Exploring Jupiter and Saturn and their major moons
   e. Controversies-cost/benefit, plutonium

STANDARDS: BEYOND EARTH, THE SEARCH FOR LIFE

Standard 1: Analysis, Inquiry, and Design

Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

Scientific Inquiry

1. The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Students:

- elaborate on basic scientific and personal explanation of natural phenomena, and develop extended visual models and mathematical formulations to represent their thinking.
- hone ideas through reasoning, library research, and discussion with others, including experts.

2. Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

Students:

- devise ways of making observations to test proposed explanations.
- refine their research ideas through library investigations, including electronic information retrieval and reviews of the literature, and through peer feedback obtained from review and discussion.

3. The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

Students:

- use various means of representing and organizing observations (e.g., diagrams, tables, charts, graphs, equations, matrices) and insightfully interpret the organized data.

Students:
- explain complex phenomena such as apparent motion of the planets and the annual transverse of the constellations.
- describe current theories about the origin of the universe and the solar system.

3. Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

Students:
- explain the properties of materials in terms of the arrangements and properties of the atoms that compose them.
- use atomic models to explain spectral lines of elements.

4. Energy exists in many forms, and when these forms change energy is conserved.

Students:
- observe and describe transmission of various forms of energy.
- explain variations in wavelength and frequency in terms of the source of the vibrations that produce them.

5. Energy and matter interact through forces that result in changes in motion.

Students:
- explain and predict different patterns of motion of objects.

Standard 6: Interconnectedness: Common Themes

Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

Models

2. Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.

Students:
- revise a model to create a more complete or improved representation of the system.
- collect information about the behavior of a system and use modeling tools to represent the operation of the system.

Students:

- analyze science/technology/society problems and issues on a community, national, or global scale and plan and carry out a remedial course of action.

Strategies

2. Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

Students participate in an extended, culminating mathematics, science, and technology project. The project would require students to:

- work effectively
- gather and process information
- generate and analyze ideas
- observe common themes
- realize ideas
- present results

UNIT VI

BEYOND EARTH, THE SEARCH FOR LIFE

THEME I

"NEW TRUTHS BECOME EVIDENT WHEN NEW TOOLS BECOME AVAILABLE"

CONCEPTS/
PERFORMANCE OBJECTIVES/
TEACHING STRATEGIES

UNIFYING THEME: **New Truths Become Evident When New Tools Become Available**
TOPIC A: **The Naked Eye View**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
5. The stars always seem to be in the same position with respect to each other. The patterns they create in the sky are called **constellations**.	5. identify patterns of stars as constellation.	5. Celestial Names: How did the constellations get their names? How are newly discovered celestial bodies named today?
6. Constellations help observers remember the position of the stars.	6. explain how constellations are useful.	6. Have students construct a star finder and learn how to use it to locate stars and constellations. (Project Star)
7. Different constellations are seen in the night sky at different times of the year.	7. identify patterns of stars as constellation.	7. a. Use the star finder to help students visualize what constellations they would see at different times of the year. b. Artistic project - Have students create a poster showing constellations of the summer or winter sky. Display these in the classroom.
8. a. Some bright stars appear to wander. The Greeks named these wonderers - planets. The planets move against the background of fixed stars and at times appear to stop their motion and move backward. b. Several models were developed to explain the motions of the sun, stars and planets.	8. compare stars and planets in appearance and motion.	8. Have students compare stars and planets in appearance and motion.
9. A good scientific model provides the simplest possible explanation for all available observations and predicts accurately what will be observed in the future.	9. state the characteristics of a good scientific model.	9. American Museum of Natural History Visit to the Hall of the Universe and the new Hayden Planetarium. A variety of exhibits of the night sky seen with the naked eye.

UNIFYING THEME: **New Truths Become Evident When New Tools Become Available**
TOPIC A: **The Naked Eye View**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
13. This view prevailed for over 1400 years until Copernicus, a Polish astronomer, proposed the sun-centered or heliocentric universe.		13. Make models or diagrams to compare and contrast the geocentric and heliocentric views. Why was Nicolaus Copernicus's model so controversial? Copernicus died shortly after publishing his great work - *On the Revolution of the Celestial Spheres.* http://es.rice.edu/es/humsoc/Galileo/things/telescope.html- The Galileo Project presents online information on the life and work of Galileo. It includes a section on the telescope. It also discusses geocentric astronomy.
14. The heliocentric model placed the sun at the center with the earth and planets moving in circular orbits around it. The planets moved at different speeds. As the earth moved around its orbit, it passed the other planets in their orbits. This makes the planets appear to move backwards.	14. compare the models of the universe developed by Ptolemy and Copernicus.	14-15 Have students model the sun moving around a motionless earth and the earth moving around a motionless sun. How does each model explain the daily apparent motion of the sun and stars? How does each model explain the different constellations that appear at different times of the year?
15. Both the geocentric and heliocentric models explain the naked eye view of the sky. However, there were problems with both models because neither fit all the observations of planetary motion.	15. rate each model for its ability to explain all available observations.	

PLANET EARTH - BEYOND EARTH, THE SEARCH FOR LIFE

UNIFYING THEME: **New Truths Become Evident When New Tools Become Available**
TOPIC B: **The Telescopic View**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
1. The invention of the telescope, about 400 years ago, had a major impact on our knowledge of the universe. Galileo was the first scientist to use the telescope for observation of the sky.	Students will be able to: 1. list the advantages of using an optical telescope to look at objects in the sky.	1. a. Point out to students that Galileo Galilei (1562-1642) did not invent the telescope. However, he was one of the first to use it to look at objects in the sky. (Invented by the Dutch lens maker, Hans Lippershey in 1608.) b. Describe how Galileo was overwhelmed when he observed the constellation Orion with his telescope and discovered 500 new stars.
2. The optical telescope collects and focuses visible light to form images of distant objects.	2. explain how the telescope forms images.	2. **Activity:** With either good binoculars or a modest telescope, students could observe the Milky Way and note how it resolves into countless stars invisible to the naked eye.
3. **The optical telescope:** a. magnifies distant objects and makes them appear closer to the viewer. b. reveals stars that are too faint to be seen by the unaided eye because it collects more light than the eye. c. separates distant objects that appear as a single objects to the unaided eye.	3. explain how the telescope increased our knowledge of the universe.	3 Discuss how science and technology influence each other. Lippershey was not a scientist, and invented the telescope by tinkering. Galileo, who understood how it worked, built a much better telescope and used it to make scientific observations. The telescope (technology) increased our knowledge of the universe (science). Compare the impact of the telescope on the science of astronomy to the microscope on science of biology.

UNIFYING THEME: **New Truths Become Evident When New Tools Become Available**
TOPIC B: **The Telescopic View**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
7. Galileo used the refracting telescope to observe craters and mountains on the moon, sunspots, Jupiter's moons and the phases of Venus.		7. a. Bring in a telescope and focus (indirectly) on the sun to observe sunspots. b. Demonstrate how Galileo discovered mountains on the moon as a result of tracking shadows. Have students shine a spotlight (from different angles) on a model landscape with mountains, valleys and note the behavior of shadows. Galileo discovered a moon with its own unique landscape.
8. Galileo's observations of heavenly bodies supported the heliocentric model. a. Heavenly bodies were not perfect, smooth spheres. b. Earth is not the only center of motion in the universe. c. Phases of Venus support the sun-centered view.	8. a. explain how each of Galileo's discoveries contradicted the geocentric model. b. demonstrate how the phases of Venus support the heliocentric model. c. explain why scientific models and hypotheses are sometimes changed.	8. a. Show students pictures of Galileo's other discoveries. Ask students how each observation contradicted the geocentric view of the universe. (Jupiter and Moons/ animation http://bang.lanl.gov/solar sys/raw/Jup/index.htm) Students model the phases of Venus in the Ptolemaic system and Copernican system to determine which system is supported by Galileo's observations. b. Discuss with the students how the value of a scientific model is based upon how well it represents the actual object. The geocentric model no longer fit most of the scientific observations.
9. Galileo's observations contradicted the geocentric view of the universe which was widely accepted at the time and supported by the Roman Catholic Church. Martin Luther (Protestant Church) denounced Copernicus in scathing terms.		9. Discuss the Catholic Church's view of the universe and its influence on scientific studies. Describe the conflict between Galileo and the Church. How did Galileo respond to the Church's opposition? Why did he recant his belief in the heliocentric model?

UNIFYING THEME: **New Truths Become Evident When New Tools Become Available**
TOPIC B: **The Telescopic View**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
13. Galileo discovered the Law of Inertia which states that a body at rest remains at rest and a body in motion tends to remain in motion in a straight line with constant speed unless acted upon by an outside force.	13. define and give examples of inertia.	13. Illustrate the concept of inertia. A laboratory activity demonstrating the principle of inertia is suggested. (Pulling the Rug Out, NSTA Scope, Sequence and Coordination)
14. A force is a push or pull.	14. define force.	14. Demonstrate that to change either the speed of an object or its direction of motion, there must be a force acting on the object. (Activity: Going Around in Circle, NSTA SS&C) NSTA Website http://www.gsh.org/NSTA-SS and C/
15. All bodies moving in space keep moving because of inertia.	15. describe how a body moves in empty space.	15-16 Demonstrate that to change either the speed of an object or its direction of motion, there must be an interaction of the object with a force. (Activity: Going Around in Circle, NSTA SS&C) NSTA Website http://www.gsh.org/NSTA-SS and C/
16. A body moves in a circle only if there is a force pulling it towards the center. Without such a force it will move in a straight line in the direction it was traveling at a constant speed.	16. predict what would happen to the orbit of the earth without inertia.	

UNIFYING THEME: New Truths Become Evident When New Tools Become Available
TOPIC B: The Telescopic View

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
22. Bigger and better telescopes constructed in the 20th century, have greatly increased our knowledge of the universe.	Students will be able to: 22. a. state the reasons why the size of refracting telescopes is limited. b. describe conditions that interfere with telescopic observations.	22. Cooperative learning: a. Provide each group with a list of the largest optical telescopes. Students brainstorm why the largest ones are reflecting telescopes. Locate the large observatories on a world map. Identify what these locations have in common. Why? b. Use the Internet to research recent telescope technological advances such as: - Keck Telescope, Hawaii - Very Large Telescope (VLT) Project, Europe - Japanese National Large Telescope - Columbus Project
23. The universe is made up of a great many galaxies separated by great distances. Each galaxy consists of billions of stars in motion around a center.	23. define galaxy.	
24. Our solar system is located in a spiral arm of the Milky Way Galaxy. The earth is neither the center of the solar system nor of the galaxy.	24. locate the solar system in the Milky Way galaxy.	24. Activity: Locate the solar system in the Milky Way Galaxy. Our position in the Milky Way reinforces the idea that we do not occupy a special position in the universe. (Project Star: The Universe in Your Hands)
25. There are three basic types of galaxies - spiral, elliptical and irregular.	25. name the three basic types of galaxies and draw a simple model of each.	25. Students look at pictures of galaxies and classify them according to their shape, (Classify galaxies ⇨http://www.cea.berkeley.edu/sii/segway/⇨Learn to identify and classify galaxies the way astronomers do.)

PLANET EARTH - BEYOND EARTH, THE SEARCH FOR LIFE

UNIFYING THEME: **New Truths Become Evident When New Tools Become Available**
TOPIC C: **The Spectroscopic View**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
1. Visible light is a form of electromagnetic. (E-M) radiation.	Students will be able to: 1. list the different forms of E-M radiation.	1. Display different forms of E-M radiation. Example: a sunlamp (UV) heat lamp (IR), and flashlight (visible light).
2. Visible light is wavelike in nature.	2. a. describe the different parts of a wave. b. define wavelength (λ) and frequency (f)	2. a. Have students "flick" a long rope to visualize a wave. b. Hook up a wave generator to an oscilloscope to visualize waves and to show how f changes with λ. c. http/www.cea.berkeley.edu/education/light /light-tour.htm/. Explains how light behaves, how you measure a wavelength, what is the amplitude of a wave and why astronomers use wavelengths.
3. White light is a mix of all different colors: - The colors can be separated using a spectroscope. - The separated colors form a specific arrangement called **a spectrum.**	3. a. define spectroscope and spectrum. b. list the display of colors produced by white light.	3. a. Display the spectrum that forms when sunlight (white light) is passed through a prism or diffraction grating. b. Pass around a compact disc (CD) and have students observe the spectrum that forms as light reflects off its surface.
4 Different colors of light have different wavelengths and frequencies.	4. a. relate color to λ and f. b. describe the inverse relationship of λ and f.	4 To explain inverse relationships between λ and f, use analogy of a parent walking with his/her young child. (Stride is λ; steps/second is f).
5. a. Glowing hot solids produce light with a continuous spectrum. b. Specific elements in a gas when excited, produce light with a bright-line spectrum.	5. define continuous spectrum, bright-line spectrum, element, and compound.	5. a. Demonstration: Using an incandescent bulb and gas discharge tube, have students observe a continuous and bright-line spectrum. b. Show students a Periodic Chart of the elements and discuss the general arrangement of elements.

UNIFYING THEME: **New Truths Become Evident When New Tools Become Available**
TOPIC C: **The Spectroscopic View**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
9. The spectroscope can measure the DE as a shift in the spectrum of light.		
10. The DE can indicate direction of motion: - Blue shift: A shift in the spectrum toward the blue end (shorter λ s). Indicates the source of waves is moving toward the observer. - Red shift: A shift in the spectrum toward the red end (longer λ s). Indicates the source of waves is moving away from the observer.	10. a. describe blue shift and red shift. b. explain how a blue or red shift indicates direction of motion.	10. a. Illustrate the Doppler effect on the chalkboard by drawing a "bobbing" duck in a pond creating wave fronts. The duck represents the wave source. As it swims, it causes a Doppler effect. b. Observe the sky from any point in the solar system with CD-ROM Red Shift by Maxis (Space simulation software). Witness the birth of a star or the night sky as seen by the Pharaohs of Egypt. Voyager II CD-ROM offers the same feature.
11. The universe is expanding.	11. explain an expanding universe based on the observed red shifts of all galaxies.	11. Inflate a balloon marked with galaxies to facilitate understanding of an expanding universe. (Students can also conceptualize a "rising" raisin bread.)
12. The spectroscope can measure speed.	12. explain that the greater the Doppler shift (or change in λ), the faster the object is moving.	12. Teacher may wish to do simple problems with students, using the formula: Speed of object = speed of light x $\frac{\text{change in } \lambda}{\text{normal } \lambda}$
13. The spectroscope can measure distance: the farther away galaxy is, the faster it is moving. Distance and speed are directly related.	13. describe the relationship between distance and speed.	13. Using the table below, have students discover the relationship between distance and speed.

PLANET EARTH - BEYOND EARTH, THE SEARCH FOR LIFE

UNIFYING THEME: **New Truths Become Evident When New Tools Become Available**
TOPIC C: **The Spectroscopic View**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
16. The telescope can measure age: - the farther away something is, the older it is - the universe is 12-15 billion years old.	Students will be able to: 16. Explain that, in cosmology, <u>distance</u> is a measure of <u>age</u>.	
17. The universe we observe began with a Big Bang from a very dense and small point.	17. a) explain the Big Bang logically based on the expanding universe. b) explain the Big Bang based on the fact that all galaxies, no matter how far away, are the same age (common origin from a common point).	17. a) Use a "deflating balloon" model to facilitate an understanding of the Big Bang. b) Have students discuss or write a brief paragraph on how the result obtained in the performance objective 17b could lead to the idea that the universe began at a single point in time (Big Bang). c) American Museum of Natural History Visit - <u>Hall of the Universe</u> Big Bang Theater.
18. The fate of the universe depends on its gravitational attraction, which depends on the amount of matter it contains. There are three possibilities. It may: - expand forever - slow down to a stop reverse into a Big Crunch	18. explain the three possible fates of the universe and its dependence on the amount of matter in the universe.	

UNIFYING THEME: New Truths Become Evident When New Tools Become Available
TOPIC D: The Space Telescope

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
5. a. Radio astronomers use their instruments almost anytime day or night. b. Radio telescopes are important tools for studying quasars and pulsars.	Students will be able to: 5. list the advantages of radio telescopes over optical telescopes.	5. Have students compare pictures of radio telescopes with optical telescopes.
6. Most kinds of light energy given off by stars, galaxies and other celestial objects cannot pass through the earth's atmosphere.	6. list the types of radiation that cannot pass through the earth's atmosphere.	6. Have students analyze a bar graph which shows the transparency of the earth's atmosphere to various kinds of radiation.
7. High flying aircraft, balloons, rockets and satellites are used to carry instruments which can detect ultraviolet, X-rays, gamma rays and most infra-red waves given off by celestial objects. Black Holes have been detected by X-ray telescopes.	7. explain why instruments to detect ultraviolet, X-rays, gamma rays and most infra-red waves must be located above the earth's atmosphere.	7. American Museum of Natural History visit to the Hall of the Universe to see a view of the night sky seen through different wavelengths of light such as infra-red and ultraviolet.

UNIT VI
BEYOND EARTH, THE SEARCH FOR LIFE

THEME II
"IS ANYONE OUT THERE ?"

CONCEPTS/
PERFORMANCE OBJECTIVES/
TEACHING STRATEGIES

UNIFYING THEME: **Is Anyone Out There?**
TOPIC A: **The Race to the Moon - Our Nearest Neighbor**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
4. A launch vehicle is required for liftoff. The Saturn V rocket launched the Apollo 11.	Students will be able to: 4. state the function of the launch vehicle	4-6 Have students work in groups and identify each stage of the Saturn V multistage rocket. Students measure the height of the launch vehicle and compare it to the height of each stage and the spacecraft. What is the function of each stage? Which stage has the most powerful engines? What type of fuel is used? What are the advantages of a multistage rocket over a single stage rocket?
5. The amount of force needed to launch a spacecraft depends upon its inertia or mass. An object's mass is always the same no matter where it is.	5. identify the factors that determine the amount of force needed for liftoff.	
6. a. Scientists calculate the size of the force by using Newton's Second Law of Motion: Force = mass x acceleration ($F = ma$). Changes in speed or direction is called **acceleration.** b. A larger mass is harder to accelerate than a smaller mass. c. Starting from rest (speed = 0), the rocket has to reach a speed of 11km/s to overcome the earth's gravitational force.	6. explain why a large force is needed for liftoff.	

UNIFYING THEME: Is Anyone Out There?
TOPIC A: The Race to the Moon - Our Nearest Neighbor

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
12. Astronauts experience weightless conditions in space travel.		
13. A smaller spacecraft, the Lunar Module, landed two astronauts on the moon. The module was designed to lift off the moon and rejoin the Command Module for the trip back to earth.	13. a. explain the role of the Lunar Module. b. show how the design of the Lunar Module is related to its function.	13-14 Have students compare the size and shape of the Lunar Module with the Saturn V vehicle. Why would the Lunar Module have less powerful motors and be less streamlined than the Saturn V? How does the escape speed for the moon compare to the escape speed for the earth? Review the factors that affect gravitational force between two bodies. Compare the moon's gravity to the earth's gravity.
14. The escape speed for the moon is less than that for the earth because the gravitational pull of the moon is one-sixth that of the earth.	14. a. compare earth's gravity to the moon's gravity. b. explain why escape speed for the moon is less than escape speed for the earth. c. explain the effect of the moon's gravity on mass and weight.	
15. Neil Armstrong and Edwin "Buzz" Aldrin explored the moon's surface, photographed and collected lunar rocks and sediment, and set up experiments on the moon.	15. describe the activities of the astronauts on the moon.	15. a. Show video clips of the Apollo 11 landing. Ask students why the moon landing captured the imagination of the world. How did the moon's gravity affect the way the astronauts moved on its surface? How did the moon's gravity affect the astronauts' mass? weight?

UNIFYING THEME: **Is Anyone Out There?**
TOPIC A: **The Race to the Moon - Our Nearest Neighbor**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
	Students will be able to:	
c. The moon has little erosion and no sedimentary rocks because there is no weather. The surface consists entirely of volcanic rocks.		
20. Since 1972, no person has returned to the moon. However, much information has been gained from instruments left on the moon. Seismographs, gravimeters and lunar gas analyzers send data back to the earth for analysis.	20. a. name some instruments that have been left on the moon. b. explain why instruments were left on the moon.	20. **Classroom Discussion**: Discuss why no one has returned to the moon since 1972.
21. Many important scientific discoveries were made during the Apollo exploration of the moon. Research laboratories throughout the world continue to study the Apollo lunar samples.	21. explain why research laboratories continue to study the Apollo lunar samples.	21. Ask students why research laboratories throughout the world continue to study the Apollo lunar samples. (Many new analytical technologies, which did not exist in 1969-1972 when the Apollo missions were returning lunar samples, are now being applied to these samples.)
22. After 25 years NASA is going back to the moon. The Lunar Prospector was launched in 1998. It is an unmanned space probe that will orbit the moon searching for water and mapping the lunar landscape.	22. describe the goal of the Lunar Prospector Program.	22. Lunar Prospector: http://nssdc.gsfc.gov/planetary//lunarprosp.html Welcome to the Moon: http://lunar.arc.nasa.gov/

PLANET EARTH - BEYOND EARTH, THE SEARCH FOR LIFE

UNIFYING THEME: **Is Anyone Out There?**
TOPIC B: **Life in the Solar system**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
4. a. The first four planets out from the sun are Mercury, Venus, Earth and Mars. They are called **the inner planets.** b. The inner planets are small and rocky and have few or no moons. c. The **outer planets** are Jupiter, Saturn, Uranus, Neptune and Pluto. d. Except for Pluto, the outer planets are large and mostly gaseous and have many moons.	Students will be able to: 4. a. compare and contrast the inner and outer planets. b. recognize the appearance, special features and distinct markings of each planet such as Saturn's ring, Jupiter's red spot and bands.	4. a. Ask students why the inner planets are less gaseous than the outer planets. b. **Activity:** <u>Best of the Solar System</u> Students look at images of the planets. Describe them and try to identify them. They compare their descriptions to those of experienced researchers. http://www.cea.berkley.edu/sii/SEGway/
5. Pluto, the ninth planet, is not like the other outer planets, it is very small, very far away and difficult to study.	5. explain why Pluto is more difficult to study than the other planets.	5-6 Have students make a bar graph showing the average surface temperature of the planets. Put the bars in order of increasing distance from the sun. Write a brief explanation of the pattern observed. Ask students why Venus is hotter than Mercury even through it is farther from the sun. (Greenhouse Effect)
6. The inner planets are closer to the sun and are warmer than the outer planets.	6. a. state the relationship between surface temperature of the planets and distance from the sun. b. explain why Venus is hotter than Mercury.	
7. As far as scientists know, earth is the only planet is our solar system that supports living things. It is a living planet because it has liquid water. It has liquid water because it has a moderate surface temperature and pressure.	7. a. compare conditions on earth to those on other planets. b. explain why it is unlikely that life as we know it exists on the surface of any of the other planets in the solar system. (It is entirely possible that life exists below the surface of Mars, Europa, etc. It may also exist on the surface of Titan.)	7. a. Discuss with students the unique properties of water that make it necessary for life. b. American Museum of Natural History Visit - Hall of Planet Earth Comparative Planetology Themes; why the earth's atmosphere makes it habitable and why the planet earth has liquid water.

UNIFYING THEME: **Is Anyone Out There?**
TOPIC B: **Life in the Solar system**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
10. Aerospace workers design and build spacecraft. They work in teams and come from many different careers such as engineers, scientists, computer technicians, accountants, machinists and managers. Courses in science, mathematics and shop help prepare for an aerospace career.	Students will be able to: 10. explain why teams of hundreds of individuals from many different fields are needed to plan and carry out a space probe mission.	10. a. Have students work in teams to plan a space expedition to a planet. What do they have to know about the planet? Who would they want to have on their planning team? Their plan should consider: - distance and travel time - data transmission time - launch vehicle - spacecraft design - manned or unmanned - fly by or landing probe - costs and funding b. American Museum of Natural History Activities: 1-Egg Drop 2-Mapping Unknown Surfaces. (www.amnh.org/mars/) c. Have students read the *New York Times* article "NASA Still Dreams of Mars Outpost," February 3, 1998. In groups students draw up a list of pros and cons for the human mission to Mars. Have students take sides and debate the issue.

PLANET EARTH - BEYOND EARTH, THE SEARCH FOR LIFE

UNIFYING THEME: **Is Anyone Out There?**
TOPIC C: **Life Beyond the Solar System**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
1. Planets have been detected around extra-solar stars since 1993. It took so long because they are difficult to detect. - Even the nearest stars are very far away (4.2 light-years). - Compared to stars, planets are small. - Planets do not give off their own light. They shine by reflected light and are, therefore, dim.	Students will be able to: 1. list reasons why it has been so difficult to detect planets around the stars other than the sun.	1. a) Hold up a lit candle (star) and a grain of salt or sand (planets) next to it. Emphasize the difficulty of seeing planets compared to the star they orbit. (Imagine these objects 2 miles away.) b) To gain a sense of perspective, students can calculate, in Km and miles, the distance from Earth to several stars around which planets have been discovered.
2. Planets around extra-solar stars are detected indirectly, by the gravitational wobble they produce on the star they orbit, - by direct observation of the star's gravitational wobble over years. - by the Doppler shift resulting from the star's wobble.	2. describe the indirect methods used to detect extra-solar planets.	2. Have two students hold opposite ends of a rope; let one revolve around the other to simulate the wobble of a star as a planet revolves around it. Website: A high school student's search for extra-solar planets as part of a 3 year science research course: http://members.aol.com/hyrstnlycp/planets.html
3. There are, to date, more than a dozen confirmed extra-solar planets. Several circle sunlike stars. At least one may have conditions suitable for liquid water - and life.	3. describe the characteristics of a star-planet system that can support life.	3. "A Planet for Life" a. List and give relevant data of several star-planet systems that have been discovered. Have students discuss/debate the likelihood of life existing on these planets. b. American Museum of Natural History visit: Hall of the Universe. An exhibit on the search for life in the universe and planet comparsions.

UNIFYING THEME: **Is Anyone Out There?**
TOPIC C: **Life Beyond the Solar System**

CONCEPTS	PERFORMANCE OBJECTIVES	TEACHING STRATEGIES
7. Astronomers differ greatly on whether they believe intelligent life is out there.	Students will be able to: 7. discuss the uncertainty among astronomers today as to whether or not we are alone. - Some believe we are. - Frank Drake (SETI Scanner) believes there are about 4,000 planets with intelligent life in our galaxy. - The late Carl Isaac Asimov believes there are 530,000. - Sagan and others believe there are many.	7. Have students discuss whether or not they believe there is life (or intelligent life) out there.
8. SETI has had a difficult history.	8. list and discuss key programs in SETI history.	8. a) Have students do research reports on the history of SETI. b) Show clips from the popular film *Contact*. Ask: "Should the United States or world community undertake SETI projects?" List and explore the pros and cons. (Can be done as a class discussion or organized into a debate format.) c. American Museum of Natural History Hall of the Universe, story on Carl Sagan. d. Website resource: The quest for Extraterrestrial Intelligence, by Carl Sagan, cosmic search Vol.1 No.2. An overview of SETI and its meaning to humanity. http://www.point-and-click.com/radobs /vol1no2/Sagan.htm/ e. Have students create a knowledge tree of all the people and cultures in the unit. The tree will show who built upon the knowledge and discoveries of others.

PLANET EARTH ACTIVITY

AIM: How can we determine Kepler's Second Law?

PROCEDURES:

1. Group students into cooperative learning teams of 3-4.

2. Look at the diagram of a planet's orbit as it follows an elliptical path around its sun. The sectors labeled with capital letters represent areas of the ellipse that are "swept out" by the planet while it travels in its orbit. The sun is at one of the focal points of the ellipse.

3. Count the number of squares within each of the sectors of the ellipse. Estimate the size of incomplete squares, for example, 2 half squares equal 1 whole square. Write your number of squares in the spaces below:

   Sector AB has _______ squares
   Sector CD has _______ squares
   Sector EF has _______ squares
   Sector GH has _______ squares

4. How do the number of squares in EACH sector compare with one another? 225

5. The number of squares inside the sector is a measure of the area within that sector. How do the areas of the sectors compare with one another?

6. The Planet ZORG takes four months to travel along its orbit from A → B. It also takes four months to travel from C → D and from E → F and from G → H. Write a statement which compares and relates the time of travel of the planet with the area of the ellipse covered during that time for each sector.

7. Notice that at Position 1, the planet is much farther from its sun than at Position 2. Using a string and a ruler, measure the distance along the ellipse from A to B and from E to F. Use a scale of 1 cm - 100,000 km. Write your answers below:

   Distance from A to B- _________ cm- _________ km
   Distance from E to F= _________ cm- _________ km

   Remember, we know the planet takes the same amount of time in moving from A to B and from E to F. Calculate the velocity (speed) of the planet at Position 1 and Position 2. We can do this by using the formula:

   $$\text{VELOCITY} = \frac{\text{DISTANCE}}{\text{TIME}}$$

   Speed of Planet at Position 1 = ________ km/month
   Speed of Planet at Position 2 = ________ km/month

SAMPLE ACTIVITY

FINGERPRINTS OF THE ELEMENTS

How do astronomers know what the sun and other stars are made of?

CONCEPT: Each element, when "excited" by additional energy, produces a characteristic spectrum that is different from the spectrum of all other elements.

SKILLS:

- using laboratory equipment
- observing and evaluating observations
- drawing conclusions

MATERIALS:

Per person: spectroscope
Per Lab Group: Bunsen burner, matches, porcelain depression plate, dropping bottles with concentrated solutions of: Lithium chloride (LiCl), sodium chloride (NaCl), potassium chloride (KCl), calcium chloride ($CaCl_2$), barium chloride ($BaCl_2$), strontium chloride (SrCl), copper chloride ($CuCl_2$), unknown solution, nichrome wire loop, and a small beaker.

* **Teacher Note:** unknown solution should be one of the seven known solutions.

Per class: Spectrum chart, gas discharge tubes of: mercury (Hg), hydrogen (H_2), helium (He), neon (Ne), gas discharge tube apparatus, Petri dish bottom, mossy zinc, bottle of 6M HCl, solid Li Cl, scoopula, Bunsen burner, matches sodium (Na), and vapor lamp, if available.

BACKGROUND:

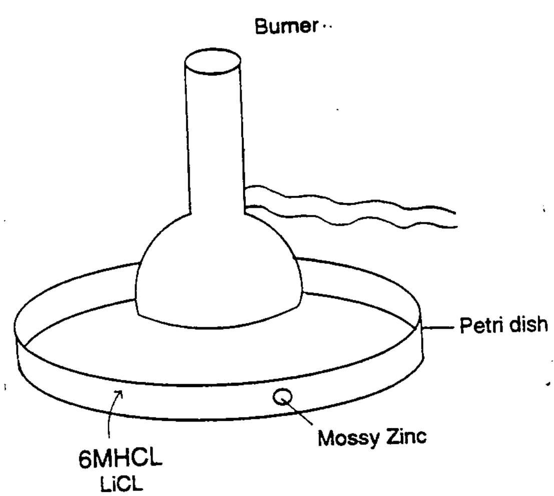
Helium was not originally discovered on Earth, where it is present in trace amount, but on the sun, which is 25% helium, by mass (The Greek word for "sun" is **helios**). Astronomers identified the element by analyzing light coming from the sun with a **spectroscope.** This is a simple instrument that separates the light emitted from a substance into specific wavelengths. These wavelengths are displayed as colored lines against a dark background. Such display is called a **bright-line** or **emission spectrum.**

C - **Bright-Line Spectrum** (Students work individually.)

1. Using the gas discharge tables at the teacher's desk and your spectroscope, observe the spectrum of:
   - (a) mercury
   - (b) hydrogen
   - (c) helium
   - (d) neon
   - (e) sodium (if a sodium vapor lamp is available). Record what you see on Table 2.

2. Using your spectroscope, observe the spectrum of lithium produced by the flame test at the teacher's desk. Record what you see on Table 2.

   <u>Teacher note:</u> Do the flame test by:
   - (a) half-filling the bottom of a petri dish with 6M HCl.
   - (b) dissolving a scoopula-tipful of LiCl in the HCl
   - (c) adding a piece of mossy zinc.
   - (d) support the Bunsen burner on top of the Petri dish. Turn on the gas and light the burner.



The effervescence will cause Li^+ ions to be carried up the barrel of the burner, producing a continuous red flame that students can easily observe with their spectroscope.

3. Compare your bright-line spectrum with those shown on the Spectrum Chart.

EXTENDING THE CONCEPT:

The sun and other stars do not produce a bright-line or emission spectrum. They produce a dark-line or absorption spectrum. (a) What is an absorption spectrum and how is it produce. (b) What would an absorption spectrum of hydrogen look like?

DATA TABLES

TABLE 1

Metallic Element in Compound	Flame Color
sodium	
barium	
calcium	
copper	
potassium	
strontium	
lithium	

Name of Unknown Element: ______________

TABLE 2

Lamp	Spectrum
sunlight	
sodium (if available)	
mercury	
hydrogen	
helium	
neon	

Technology Resources

These are just a few of the many Web sites that are available. The list of Astronomy multimedia products and Web sites is endless.

Hands on Universe (HOU)
http://hou.lbl.gov/

Using the Internet, HOU participants around the world request observations from an automated telescope, download images from a large image archive, and analyze them with the aid of user-friendly image processing software. Hands-On Universe (HOU) has developed and piloted an educational program that enables high school students to request their own observations from professional observatories. HOU students download CCD images to their classroom computers and use HOU's powerful image processing software to visualize and analyze their data. HOU also provides comprehensive curriculum that integrates many of the topics and skills outlined in the national goals for science and math education into open- ended astronomical investigations. Last year two high school girls discovered a black hole that scientists had not yet identified.

Galileo Project
http://es.rice.edu/ES/humsoc/Galileo/

This site uses the visual metaphor of Galileo's family villa to enable visitors to explore the life and work of Galileo Galilei (1564-1642). Find out about the struggles, triumphs, and lifelong curiosity of the man who set the stage for modern science. It presents information about Galileo and the science of his time to viewers of all ages and levels of expertise.

Project STAR (Science Teachers As Reformers)
http://edap.bgsu.edu/STAR/

Materials for Project STAR were developed by science teachers and scientists and were thoroughly tested by teachers and students from around the country. Simple labs enable

students to use scientific tools in the classroom for exploration. Students can build a telescope that is similar to Galileo's, readily study color and light as well as learn about absorption and emission through personal observation, see the absorption lines in the sun's spectrum, see the spectra of energized elements in gaseous states and the double yellow line of Mercury in the spectrum of a fluorescent lamp, or study light pollution can be studied by checking yellow street lights to see if they are high- or low-pressure sodium lamps. The online activities are abundant.

Welcome to Mars!
http://www.amnh.org/mars/
Offline Activities available on this Web site:

- Mars Math

Offline Activities available on this Web site:

- Do It Yourself Rocketry
- Safe Landings?
- Mapping Unknown Surfaces
- Egg Drop

Nine Planets
http://www.seds.org/nineplanets/nineplanets/
A Multimedia Tour of the Solar System, by Bill Arnett, includes a nice introduction to Mars.

Views of the Solar System
http://bang.lanl.gov/solarsys/
An excellent overview of the entire solar system by Calvin Hamilton. The featured link to Mars includes a chronology of exploration.

Ask the Astronomer
http://www2.ari.net/home/odenwald/qadir/qanda.htm

Other Worlds, Distant Suns
http://garber.simplenet.com/

Views of the Solar System
http://www.fis.uc.pt/astronomy/solar/homepage.htm

Black Holes and Neutron Stars
http://antwrp.gsfc.nasa.gov/htmltest/rjn_bht.html

Constellations
http://www.astro.wisc.edu/~dolan/constellations/constellation_list.html

Earth Rise
http://earthrise.sdsc.edu/

Live from Mars
http://quest.arc.nasa.gov/mars/index.html

OFFICIALDOM/INSTITUTIONS

IAU: Central Bureau for Astronomical Telegrams
http://cfa-www.harvard.edu/cfa/ps/cbat.html

NASA and its field centers
http://www.nasa.gov/

META-REFERENCES:

AstroWeb (NRAO, STScI, CERN)
http://www.stsci.edu/astroweb/astronomy.html

Bill Arnett's WWW Documents (many resources)
http://www.seds.org/billa/offerings.html

NASA's Planetary Photojournal
http://www-pdsimage.wr.usgs.gov/PIA/PIA.html

PLANETARIUM SOFTWARE:
Master list
http://www.seds.org/billa/astrosoftware.html

Distant Suns
http://www.romt.com/products/distsuns/index.html

Voyager II
http://www.carinasoft.com/Voyager.html

Xerox PARC Map Viewer:
http://pubweb.parc.xerox.com/map

Breathing Earth
http://japan.park.org/Japan/Theme/sware/be/unsw/index.html

PLANETARIA ON THE WEB
http://www.pa.msu.edu/abrams/planetaria.html

SPACE NEWSLETTERS/ADVOCACY

SpaceCast
http://www.spacer.com/

Case for Mars
http://spot.colorado.edu/~marscase/

Films

- Cosmic Voyage (currently at AMNH Imax Theater); discuss scale
- Powers of Ten; watch film and discuss the power of an atom

NASA Resources

All NASA materials are free to teachers.

http://www.vasc.org/erc/
NASA Regional Educator Resource Center

http://www.cea.berkeley.edu/Education/sii/sii_sii.html
Home of the Science Information Infrastructure, a NASA-funded project linking science museums, research centers, and teachers, to produce Earth and space science curricula for K-12 students and teachers using NASA remote sensing data.

Mars Pathfinder: Welcome to Mars!
http://mpfwww.arc.nasa.gov/default.html
The Mars Pathfinder home page, with all the images and other info from Mars.

Mars Global Surveyor (MGS)
http://mars.jpl.nasa.gov/mgs/
The current status of the MGS mission including the latest images and scientific data from Mars.

Mars Pathfinder Preliminary Results
http://nssdc.gsfc.nasa.gov/planetary/marspath_results.html
A technical summary of scientific findings with many links.

Center for Mars Exploration
http://cmex-www.arc.nasa.gov/
Lots of Marslinks, including "Life on Mars?" and Mars missions.

Live from Earth and Mars: Pathfinder Mission Summary
http://www-k12.atmos.washington.edu/k12/mars/MPF_short_facts.html
A detailed and fairly technical description, including good graphics on the Entry, Descent and Landing sequence.

Live from Mars/Passport to Knowledge
http://quest.arc.nasa.gov/mars/
Lots of Marslinks and educational materials.

Mars Pathfinder Fact Sheet
http://mpfwww.jpl.nasa.gov/mpf/fact_sheet.html
The basic mission specifications, nicely encapsulated.

Mars Pathfinder Project Information
http://nssdc.gsfc.nasa.gov/planetary/mesur.html
Complete summary of the mission, with color images and many links.

Marslink Essays
http://barsoom.msss.com/http/ps/intro.html
Excellent articles on various aspects of Mars, written by Mike Caplinger for the Planetary Society.

PDS Mars Explorer for the Armchair Astronaut
http://www-pdsimage.wr.usgs.gov/PDS/public/mapmaker/
A giant "room sized" global map of Mars, from Viking orbiter images. Starting from a global Mercator map, you can choose any specific spot on Mars and pan and zoom your way across the entire planet.

The Red Planet: A Survey of Mars
http://cass.jsc.nasa.gov/publications/slidesets/msurvey.htmlAn illustrated guided tour, with brief descriptions, prepared by W.S. Kieffer, A.H.Treiman and S.M. Clifford for the Lunar and Planetary Institute.

NASA Educational Resource
http://iita.ivv.nasa.gov/

Starry Night
http://www.scds.org/billa/StarryNight/sn.html

Windows to the Universe
http://www.windows.umich.edu/

Space Weather
http://windows.engin.umich.edu/spaceweather/

IMAGES

Astronomy Picture of the Day
http://antwrp.gsfc.nasa.gov/apod/astropix.html

The Aurora page
http://www.geo.mtu.edu/weather/aurora/

Regional Planetary Image Facility
http://ceps.nasm.edu:2020/rpif.html
http://ceps.nasm.edu:2020/RPIF/RPIFsources.html

Hubble Space Telescope
http://www.stsci.edu/

The Planetary Data System (PDS)
http://pds.jpl.nasa.gov/

US Geological Survey
http://www.usgs.gov/

Space Science Photography
http://pao.gsfc.nasa.gov/gsfc/spacesci/pictures/spacepic.htm

The NASA Shuttle Web Archives
http://www.stsci.edu/

About the NSSDC Photo Gallery
http://nssdc.gsfc.nasa.gov/photo_gallery/photogallery.html

Jupiter & Moons/animation
http://bang.lanl.gov/solarsys/raw/jup/index.htm

INTERACTIVE MAPS/LIVE FEEDS/etc.

EarthView
http://www.fourmilab.ch/cgi-bin/uncgi/Earth/action?opt=-p

NASA Cameras (slow)
http://www.ambitweb.com/nasacams/nasacams.html

RESOURCES PROVIDED BY AMERICAN MUSEUM OF NATURAL HISTORY

ACTIVITIES

Galileo Activities

American Museum of Natural History will be developing this into a field activity. The activities apply to the Telescopic View area of the course. They require either good binoculars or a modest telescope. The class could also set up a telescope at the school and have special evening astronomy sessions to find when and where in the sky the following objects are visible, consult the monthly sky chart in "Sky and Telescope" or "Astronomy" magazine. When making observations, sketch what you see and note the data and time. All of these observations were made by the Italian astronomer Galileo in 1609-10 with the newly invented telescope. He published them in a popular 20 page pamphlet called "The starry Messenger," which revolutionized astronomy-this could be a good non-textbook resource for the variance.

Moon: Observe the Moon for several weeks and keep a moon journal. Note how the shadows advance across the valley floors with the changing phases of the Moon. Galileo discovered mountains on the Moon as a result of tracking shadows. The shadows are a result of the changing direction of the incoming sunlight. For comparison, make a model landscape with mountains and valleys and shine a spot light on it from different angles (corresponding to early morning, high noon and late afternoon) and not the behavior of the shadows. Most of the shadows on the Moon are cast by mountain rims on the crater floors and surrounding plains. **Conclusion:** The Moon is a world with it's own unique landscape.

Venus: Observe Venus over a period of several months and note how the apparent disk of the planet goes through the same phases as the Moon.

Jupiter: Observe Jupiter for several successive nights and watch the changing positions of the four Galilean satellites due to their orbital motion around the planet. Find and identify each satellite. Sometimes only two or three are visible because Jupiter is behind another planet so observe over a week. Galileo realized when looking at Jupiter that he was looking at a sub-solar system.

Saturn: Observe the shape of the Saturn's rings. Students will observe that the rings are detached and they are not round. Galileo thought Saturn had ears.

AMERICAN MUSEUM OF NATURAL HISTORY VISITS

Hall of the Universe

The Hall of the Universe is a new permanent exhibition hall opening in the year 2000. The exhibits within the hall will be formalized by June 1998. We roughly know the designs at this point although there are liable to be some changes during development. The new Sky Theater, part of the Hayden Planetarium reconstruction, will take kids out of New York City by means of a virtual digital galaxy. This Sky Theater will allow students to better visualize and experience the astronomy they are studying in class. The stories addressed by the exhibit are formation and evolution of the universe, galaxies, stars, and planets.

The concepts addressed by the exhibit are:

- Unity of matter and forces.
- The universe has evolved and continue to evolve.
- Rotation and gravitation are two of the most important physical "laws" that govern the structures we see in the universe.
- Spectra are the key codes to unlocking the mysteries of the universe.

Classroom visits to the Museum can utilize the following resources:

- Formation and evolution stations for the universe, galaxies, stars, and planets making up the system of cosmic evolution.
- An exhibit on the search for life in the universe.
- A galaxies wall: colliding galaxies, active galaxies, Milky Way, and ancient galaxies
- A Big Bang Theater that reenacts the moment that our solar system was created.
- A timeline of the universe that shows cosmic evolution: the origin and evolution of the universe, galaxy, stars, and planets.
- A cosmic zoom module of the scales of space-from subatomic particles on up.
- A virtual tour of the galaxy at the new Sky Theater.
- Special digital galaxy shows at the new Sky Theater that move through the galaxy to interesting places.
- A variety of views of the night sky starting with a naked-eye view.
- A view of the night sky that allows a visitor to view it through different waves of light such as infrared and ultraviolet.
- A design that allows students to bring binoculars to the Sky Theater and enhance their view of the night sky as they would outdoors.
- A special moon exhibit that shows a high resolution image of the back of the moon which nobody ever sees; a level of detail that you can't see with the naked eye.

ASTRONOMY UNIT

REFERENCES

Science Grade 9: Bureau of Curriculum Development, Board of Education, City of New York 1968-1969 Series #9.

Lesson/Activity	Page
How do mirrors and lenses enable us to study astronomy?	146
How can we construct and use a refracting telescope?	148
How can light be used to determine the composition of stars?	151
What is the orbital path of the earth around the sun?	179
How does the change of energy explain the orbits of the planets?	181
What makes a Rocket move?	196
How will we overcome the forces of gravity in our space investigations?	198
What dangers will man encounter on a trip through space?	203
How can a man's needs be provided for in space?	205

Prime Science: High School Level 2, The Prime Science Education Group, University of California at Berkeley. Kendall Publishing Company. Dubuque, Iowa,1992

Section: The Earth in Space, **pages 319-359**

Project Star: Science Teaching Through its Astronomical Roots. Coyle, Harold P. et. al. Kendall/Hunt Publishing Company: Dubuque, Iowa, 1993.

Filled with astronomy projects and experiments such as:

- making a telescope
- building a rocket
- making a scale model of the Earth and the Moon
- mapping the moon
- measuring the height of moon mountains
- the solar system to scale
- testing for life (mimics Viking landing)
- making a spectroscope
- the red shift
- how many aliens are there (equation)

Note: This book was written with younger students in mind but the projects can easily be adapted to high school.