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Integrating PHysical Science and the Geological Environment

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The purpose of this unit is to strengthen the middle school physical and natural science programs. It is an effort to generate excitement and enthusiasm toward physical and natural science and provide a foundation for future learning and continued study in both scientific fields. The curriculum unit also promotes the integration of physical science and natural science. The natural resources, minerals and geological environments of Connecticut support some of the major areas of physical science that are currently being taught in middle school curriculums. As students cover these areas they will broaden their applications to include the study of the earth. In this way they will be able to understand the connection between physical science and their natural world. The major areas of physical science that are addressed include the properties of matter, energy, force and motion. These areas will be integrated with topics in earth science such as the earth's changing surface, the continental crust, volcanic landforms, identification of minerals, land shape and abrasion, crystal structures and wave energy.

General background information is given on each of the physical and earth science topics being explored. Key vocabulary terms are defined for each area of study and investigation. Hands-on activities are provided and directed toward explorations that are appropriate for a class of approximately twenty five students and can be accomplished within a 50 minute time frame. All activities lend themselves toward a cooperative learning setting in which students groups will range from two to four. All activities are presented in a consistent format which includes the topic, objective, materials, procedure, observations, and rationale. This format will provide the framework for identifying problems, gathering information, stating a hypothesis, designing an experiment, making observations, recording data, analyzing data and stating a conclusion.

Thus, the unit focuses on providing a rich and varied menu of inquiry based hands-on student explorations supported by clear and descriptive background information. It provides opportunities for technology to assist and support instruction. Lastly, suggestions for relevant field trips and pertinent resources available in Connecticut are provided.

There are four main sections of the unit. They include the following topics in earth science: 1) Types of Rock 2) Mineral Identification, 3) Crystal Structures, and 4) Movement in the Earth's Crust. Each of these sections is divided into five subsections. The subsections include: 1) A description of the section topic with main concepts described and explored, 2) Definitions of Key Vocabulary, 3) Physical Science Connections, 4) Connecticut Applications, and 5) Hands-On Experiments.

SECTION I—TYPES OF ROCKS

The first section focuses on types of rocks. The three types of rocks include igneous, sedimentary and metamorphic. The first type to form were the igneous, or primary, rocks. Igneous rocks are formed at high temperatures. They are still forming today and can be seen as the hot lava or magma that flows from a volcano. Igneous rocks are the rocks that form when the lava cools and becomes solid. The rocks can be recognized by their crystals. Glassy obsidian has few tiny crystals, basalt contains very fine crystals, and gabbro has large crystals. A second type of rock is called sedimentary rock. When rocks are worn away by the weather, they break down into smaller pieces of rocks and minerals, forming sediment. Sediments harden into sedimentary rocks or rocks made of pieces of other rocks. They contain grains of material which are held together by different kinds of natural cement. The grains frequently show bands or patterns running through them. Some sedimentary rocks may be made of shells of sea creatures or possibly of salt layers. Common sedimentary rocks include sandstone, limestone, chalk, clay, conglomerate and breccia. A third type of rock is metamorphic. All metamorphic rocks have been changed from other kinds of rock. The changes are usually caused by great heat within the earth, pressure from movements in the earth's crust, or by a combination of both. Magma, the hot liquid rock inside the earth's crust moves into cracks in sedimentary rocks and may also flow between its layers. The heat of the magma causes a chemical reaction. Chemical elements in the magma react with chemical elements in the rocks. Thus new minerals and metamorphic rocks are formed.

From a physical science standpoint the concepts of force, pressure, phase change and temperature are significant. Force can be thought of as a push or a pull. A force will always act in a certain direction. Friction makes it hard to move objects. Force is needed to overcome the force of friction. The amount of force acting on a surface is called pressure. Pressure can be changed by changing the force. If the area stays the same, increasing the amount of force increases the pressure. Pressure acts in gases and liquids, as well as in solids. This pressure in gases and liquids is referred to as fluid pressure. Phases of matter must also be considered when studying earth science. Different forms of the same substance are called phases. The three phases of matter include solids, liquids and gases. A solid is a phase of matter that has a definite shape and volume. In a solid, particles of matter are packed together tightly and as a result are not able to change position easily. They can only vibrate. A liquid has a definite volume, but no definite shape. Liquids can change shape because the particles in the liquid are able to slide past each other and change their position. A gas is a phase of matter that has no definite volume or shape. The particles in gases are constantly moving. When matter changes from one phase to another it is called a phase change. During a phase change, there is also a change in heat energy, so temperature is directly related to changes in the states of matter.

KEY VOCABULARY

crust: The earth's outermost layer, about 7 to 70 kilometers thick, composed of relatively low-density silicate rocks.
crystal: A solid element of compound whose atoms are arranged in a regular, orderly, periodically repeated array.
igneous rocks: Rock formed by the cooling and consolidation of magma.
lava: Magma that reaches the earth's surface through a volcanic vent.

magma: Molten rock generated within the earth.
metamorphic rock: A rock that forms when igneous, sedimentary, or other metamorphic rocks recrystallize in response to elevated temperature, increased pressure, chemical change, and or deformation.
sediment: Small pieces of rocks, shells, or the remains of plants and animals that have been carried along and deposited by wind, water, or ice.
sedimentary rock: Any rock formed by chemical precipitation or by sedimentation and cementation of mineral grains transported to a site of deposition by water wind, ice, or gravity.
volcano: The vent from which igneous matter, solid rock, debris, and gases are erupted.

RELATED PHYSICAL SCIENCE TERMS

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chemical change: Change that produces new substances.
force: Push or pull exerted on or by an object.
gravity: Force of attraction between objects in the universe especially shown by the tendency of objects to fall toward the center of the earth.
motion: Any change in position or location.
phase: Different form of the same substance (solid, liquid and gas).
physical change: Change that does not produce new substances but only changes some of the physical properties of the substance.
pressure: The amount of force exerted by an object on the area of the surface on which it acts.
reactant: Substance that has been changed in a chemical reaction.
temperature: Degree of hotness or coldness of an object or an environment.

EXAMPLES IN CONNECTICUT

Metamorphic rocks can be found in the Eastern and Western Uplands of Connecticut. The Eastern Uplands are a group of hills, very closely packed together. One site where metamorphic rocks can be located is the Bolton Ridge, running from the Massachusetts border south to Portland. Another site is on Route 95 as it goes up into New York. Here shiny, scaly rocks can be seen on the left. Other metamorphic sites include Bald Mountain, Soapstone Mountain, Tolland Range, Woodstock, Drumlin Field, and the Willimantic Basin. Along the Rhode Island border and swinging around parallel to Connecticut's Coast is another range of ridgy terrain. The ridges of this range run north-south along the Rhode Island line to the town of north Stonington, and from there swing east-west to Joshua Rock on the Connecticut River in Lyme. This range is referred to as the Mohegan Range. The Western Uplands include several plateaus, the highest of which is the Taconic Plateau in the very northwest corner of the state where Connecticut, Massachusetts and New York meet. The most extensive and best-known plateau is the Litchfield Hills Plateau. It is the extension of the Berkshire Mountains in to Connecticut.

Sedimentary rock can be seen in the brownstone of the Central Valley. This reddish rock fills most of the valley and is the product of the erosion of ancient mountains. The thick deposits of recent glacial sediments from the ice age are not only favorable for agricultural development but are also most suitable to supporting residential, commercial and industrial development. Most of the soils that formed from the glacial deposits are well-drained, which means that waters from heavy rain flow freely and sewage systems are not likely to fail. Lake Saltonstall, east of New Haven and the Farmington River Valley is a site of sedimentary rock.

The Central Valley is also home to igneous rock called basalt and gabbro which can be found in the high ranges known as traprock ridges. The Great Wall of the Central Valley is the Metacomet Ridge, a nearly continuous ridge of rock that runs from Branford, Connecticut to Northampton, Massachusetts. The Ridge lies entirely in the Central Valley and is known by several local names along its north-south route. In Connecticut, it is called Saltonstall Ridge, Totoket Mountain, Beseck Mountain, Higby Mountain, Lamentation Mountain, The Hanging Hills, Avon Mountain, Talcott Mountain, Penwood Mountain, and West Suffield Mountain. Traprock that formed underground can be seen in New Haven's East and West Rock as well as in Hamden's Sleeping Giant.

EXPERIMENTS

ACTIVITY #1

TOPIC: LAVA FLOW

OBJECTIVE:

To demonstrate why different types of lava flow at different speeds

MATERIALS:

cooking oil, honey, pancake syrup, metal tray

PROCEDURE:

Drop a pool of each liquid along the edge of a metal tray. Slowly raise the edge of the tray to allow the liquids to begin flowing down the slope. The angle of the slope can be measured with a protractor. Experiment with the pan at different angles. Experiment with the liquids at different temperatures. Think of other ways to vary this experiment.

OBSERVATION:

Record which liquid flows fastest, slowest. How does temperature affect the rate of flow? How does the slope of the pan affect the rate of flow? Which liquid is the most viscous? Make a sketch of your observations and label it.

EXPLANATION:

The most viscous liquid is the stickiest one. The stickier the liquid the slower it flows. As liquids heat they flow more easily.

Adapted from experiment in Rocks and Fossils by Ray Oliver

ACTIVITY #2

TOPIC: SEDIMENT IN A JAR

OBJECTIVE:

To demonstrate how sedimentary rock layers are formed.

MATERIALS:

Mud, sand, pebbles (vary color and sizes)

PROCEDURE:

Half fill a glass jar with water. Add the mud, sand and pebbles. Stir the mixture very well and then allow it to settle. The experiment may be done by shaking also. Think of other ways to vary the experiment.

OBSERVATION:

Which materials sink quickest? Which sink slowest? Are layers formed? Where are the largest pieces? Compare to glacial till. Record your results, make a sketch of your observations and label it.

EXPLANATION:

Eventually the materials separate or form layers. The density of the materials determine the position of the layers. The most dense materials sink the lowest. They have the greatest mass for their volume. The largest stones will settle to the bottom.

Adapted from experiment in Rocks and Fossils by Ray Oliver

SECTION II—MINERAL IDENTIFICATION

The second section to be explored focuses on mineral identification. Minerals have special important properties. It is necessary to know these properties in order to identify samples. Important properties include color, luster, hardness, cleavage and density. Looking at color alone is usually not sufficient to identify a mineral. A mineral should be scraped across the unglazed back of a tile to find it's true color. The color of the powder mark is called the mineral's streak color and the scraping procedure is called the streak test. Luster is also important in identifying minerals. Some minerals containing metals have a metallic luster or a shiny surface that reflects light. Other minerals can have glassy, silky or even greasy lusters. The hardness of a mineral is one of the most useful properties to identify. The hardness scale was invented by the mineralogist Friedreich Mohs in 1822. The scale is divided into 10 degrees of hardness and is based on the principle that any mineral can scratch another one of the same hardness or softer than itself. Diamond, the hardest natural mineral, has a hardness value of 10 and can scratch anything else. Minerals also split or break into pieces with flat, smooth surfaces. This splitting is called fracture or cleavage. Some minerals split very easily in certain directions by using a chisel and hammer. Many minerals will break easily only if they are hit in exactly the right place. Minerals and rocks may also break unevenly. Quartz doesn't have a neat cleavage but instead fractures in various directions. Cleavage and fracture are important in identifying rocks and minerals. Another important way of identifying minerals is to use the density test. In order to find the density of a substance, it is necessary to measure both the mass and volume. By dividing the mass by the volume the density of a substance can be found. Specific gravity can be found by comparing the density of a substance to the density of water. Finding the specific gravity of an unknown mineral and comparing it to the constant specific gravity of known minerals is also very useful in mineral identification.

The concepts of density and specific gravity are particularly useful in mineral identification because density is a basic physical property of all matter. Every substance has a density that can be measured and the density of like substances is always the same. For example, the density of lead is always 11.3 grams (mass) per cubic centimeter (volume) and the density of iron is always 7.9 grams per cubic centimeter. Mass refers to the amount of matter in an object and volume refers to the amount of space something takes up. Density does not depend on the size or shape of the substance. For this reason density is extremely useful in identifying minerals by comparison.

KEY VOCABULARY

cleavage: The tendency of a mineral to break in preferred directions along bright, reflective plane surfaces.
fracture: (1)The manner in which minerals break other than along planes of cleavage. (2)A crack, joint or fault in bedrock.
luster: The quality and intensity of light reflected from the surface of a mineral.
mineral: A naturally occurring inorganic solid with a definite chemical composition and a crystalline structure.
streak: The color of a fine powder of a mineral; usually obtained by rubbing the mineral on an unglazed porcelain streak plate.

RELATED PHYSICAL SCIENCE TERMS

density: The mass of a substance divided by its volume.
element: A simple substance that cannot be broken down into simpler substances.
friction: Force that opposes the motion of an object.
light: Form of electromagnetic energy composed of streams of photons.
mass: Amount of matter in an object.
specific gravity: Density of a substance compared to the density of water.
volume: The amount of three-dimensional space occupied by matter.

EXAMPLES IN CONNECTICUT

Almost every town in the Uplands has some old mine or quarry. Many minerals and metals were sought in the old diggings, but most of the mines resulted in little more than dreams. A few mining ventures were successful, however. Quartz can be found in the Lantern Hill Mine in North Stonington. Iron mining occurs in the Marble Valley, Salisbury, Canaan, Cornwall and Kent. Pegmatite can be located on Route 9 in Deep River. Gems taken from pegmatite are beryl, aquamarine, emerald and tourmaline. Although there were dozens of pegmatite mines throughout the state, only a few in the Middletown-Portland area are still being worked. The Feldspar Corporation runs all of these quarries, producing feldspar for making glass and ceramics, and mica for use in wallboard compound.

MOHS SCALE / Mineral Examples / Ordinary Examples
1: Talc

2: Gypsum / 2.5 Fingernail

3: Calcite / 3.5 Copper penny

4: Fluorite

5: Apatite / 5.25 Glass / 5.5 Knife

6: Orthoclase

7: Quartz / 7.5 Steel file

8: Topaz

9: Corundum

10: Diamond

EXPERIMENTS

ACTIVITY #3

TOPIC: TESTING FOR HARDNESS

OBJECTIVE:

To demonstrate how the hardness of a mineral can be determined

MATERIALS:

Variety of rocks, fingernail, penny, glass, knife, nail file

PROCEDURE:

Scratch a mineral to measure its hardness by moving a sharp edge of the known object over the mineral to be tested. Then run a moistened fingertip over the surface to remove any loose powder. Think of some everyday objects other than rocks to test for hardness.

OBSERVATION:

Look to see if the mineral has been scratched. The hardness scale, invented by Friedreich Mohs is divided into 10 degrees of hardness. Can a mineral can be scratched with a knife blade but not with a copper coin? If so its hardness must be between 3.5 and 5.5. Record the results of the test. You can later use the results of your test minerals to test the hardness of other minerals. Make a sketch of your observations and label.

EXPLANATION:

Any mineral can scratch another one of the same hardness or softer than itself.

Adapted from experiment in Rocks and Fossils by Ray Oliver

ACTIVITY #4

TOPIC: Testing for Density and Specific Gravity

OBJECTIVE:

To demonstrate how the density of a material can be determined

MATERIALS:

Variety of rocks, graduated cylinder, pan or beam balance

PROCEDURE:

Find the mass (g) of a rock by balancing it on a pan or beam balance. Find the volume (v) of a rock by finding the amount of water it displaces in a graduated cylinder. Divide the mass by the volume to arrive at its density (D) Divide the density by 1 to arrive at the mineral's specific gravity. How many other ordinary materials can you think of to test for density?

OBSERVATION:

Do all rocks of similar volume have a similar mass? How is specific gravity related to density? Record your results, make a sketch of your observations and label.

EXPLANATION:

Mass is the amount of matter in an object. Volume is the amount of space something takes up. Density is mass per unit volume. Density allows us to compare one substance to another even though the amounts of mass and volume are different. Specific gravity is the density of a substance compared to the density of water which is always 1.

SECTION III—CRYSTAL STRUCTURES

The third section focuses on crystals. A crystal is a solid that is made up of atoms arranged in a regular orderly pattern. The edges of perfect crystals are straight, and the angles between edges remain the same size for like crystals. Crystals can be described by their shapes. The shapes of crystals are determined by the arrangement of atoms inside them. There are seven crystal systems or shapes. They include cubic, tetragonal, hexagonal, orthorhombic, monoclinic, triclinic, and trigonal. When identifying minerals that are crystalline, it is useful to know which crystal system the mineral represents. Since many samples do not have perfectly formed crystals, it is often necessary to make an intelligent guess. Although different crystal shapes help distinguish minerals from one another, crystal shape in itself is not always a valid test. Various crystals of the same mineral may develop the same external surfaces or faces even though they may not be the same size or shape. On the other hand, the crystals of two different minerals sometimes have the same shape. No two crystals are exactly alike since the conditions in which they develop vary. They need enough space to grow and if the space is restricted, unusual features or distortions may result. Crystals may range in size from microscopic to several yards long. Habit refers to the shape of a crystal.

When studying crystals it is essential to recognize that all matter is made up of atoms and that atoms contain smaller particles called protons, neutrons, and electrons. A proton has a positive charge, while an electron has a negative charge and a neutron has neither a positive or negative charge. If an atom has the same number of electrons and protons the atom is neutral. However, sometimes an atom gains or loses electrons. When the number of electrons and protons in an atom differ the atom has an electrical charge. An atom with an electrical charge is referred to as an ion. Particles of matter are held together by atomic bonds. An ionic bond refers to the bond formed when two atoms trade electrons. Since the force of attraction in an ionic bond is very strong, many compounds that contain ionic bonds are solids. An example of a solid that contains ions arranged in a regular pattern is a crystal. A crystal lattice is formed by the pattern of positive and negative ions. The shape of a crystal is determined by its crystal lattice.

KEY VOCABULARY

crystal: A solid element or compound whose atoms are arranged in a regular, orderly, periodically repeated array.
distorted: Not showing correct direction, distance, or shape.
habit: The shape in which individual crystals grow and the manner in which crystals grow together in aggregates.

RELATED PHYSICAL SCIENCE TERMS

atom: The smallest part of an element that can be identified as that element.
compound: Substance made up of two or more elements that are chemically combined.
crystal lattice: Positive and negative ions arranged in a regular pattern
element: Simple substance that is unable to be broken down into simpler substances by ordinary chemical means. An element is made up entirely of the same kind of atoms.
ion: An atom with either a positive or negative charge.
ionic bond: Bond formed when atoms gain or lose electrons.
molecule: The smallest part of a compound that still has all of the compound’s properties.

EXAMPLES IN CONNECTICUT

The most widely mined deposit in the Connecticut Uplands is pegmatite which can be found in Deep River, where there is a dramatic roadcut between Exits 3 and 4 on Route 9. Pegmatite is similar in composition to granite, except that the individual crystals are sometimes as large as three to four feet long. Pegmatite is a very striking rock that is white or pink in color. The large size of the mineral crystals and the random inclusion of precious and semiprecious gems are what makes pegmatites so valuable. The bigger crystals of quartz, feldspar and mica are also separated out of the rock easily allowing simplification of the purification process that is so important in a mining operation. Granite, although not as stunning as pegmatite, has also been quarried at several locations in Connecticut. Many important quarries were in the Coastal Slope of Eastern Connecticut which include Branford, Stony Creek, Guilford, Waterford, and Groton.

EXPERIMENTS

ACTIVITY #5

TOPIC: Crystal Formation

OBJECTIVE:

To demonstrate how crystals form

MATERIALS:

Graduated cylinder, beaker or cup and measuring spoon, Epsom salts, scissors, black construction paper, petri dish

PROCEDURE:

Cut a piece of black paper to fit inside the petri dish. Fill the graduated cylinder or beaker with 250 ml of water (1 cup). Add 60 ml (1 tablespoon) of Epsom salts to the water and stir. Pour a thin layer of the mixture into the petri dish. The petri dish should stand undisturbed for one day. Try repeating this experiment using different amounts of Epsom salts. Can you think of other ways to vary this experiment.

OBSERVATION:

What shape are the crystals that form on the paper? Record your results and make a sketch of your observations and label.

EXPLANATION:

As the water slowly evaporates from the solution the Epsom salts molecules move closer together . The salt molecules line up in an orderly pattern to form long needle shaped crystals. The salt molecules stack together just like building blocks, and the shape of the crystal is ultimately determined by the shape of the molecules.

Adapted from experiment in Earth Science for Every Kid by Janice VanCleave

ACTIVITY #6

TOPIC: Bubble Crystals

OBJECTIVE:

To demonstrate how atoms arrange themselves in crystals

MATERIALS:

Dish detergent, shallow dish, straw, plastic ruler

PROCEDURE:

Add detergent to water in a shallow dish or pan. Blow enough bubbles to cover the surface. Use the straightedge to move rows of bubbles past each other. Try changing the size of the straw to create different sizes of bubbles. Think of other ways to vary this experiment?

OBSERVATION:

What kind of arrangements do the bubbles form? How do the different sizes of bubbles affect the experiment. How easy is it to separate the bubbles? Record your findings, make a sketch of your observations and label.

EXPLANATION:

The different sized bubbles represent the different metals in crystalline alloys. Different size bubbles form a stronger bond and are more difficult to slide past each other than bubbles of the same size. Alloys have stronger bonds than pure metals.

Adapted from experiment in Rocks & Fossils by Ray Oliver

SECTION IV—MOVEMENT OF THE EARTH'S CRUST

The final section of the unit addresses the movement in the earth's crust. The earth's crust is always moving, even if very slowly, Slight movements of the ground are called tremors. There are more than six million tremors a year in the earth's crust. Although many of these tremors are too slight to be felt, there is an instrument called a seismograph which can measure these movements. The Richter scale reports a measure of how much energy an earthquake releases. Earthquakes are sudden, strong movements in the earth's crust that cause much damage. It is believed that the pressures in the earth's crust cause earthquakes. These pressures cause the earth's crust to break at a weak point and as the crust breaks, it also moves. One part of the crust slides or slips along the other. The break in the earth's crust is referred to as a fault and the movement of the ground along a fault is called faulting. Earthquakes are the result of faulting. An earthquake's point of fracture is its focus, which may be shallow, intermediate or deep (down to about 400 mi or 650 km). Two kinds of shock waves are produced by an earthquake. Body waves travel through the rock itself. Surface waves travel only on the earth's skin similar to the way waves travel in water. Compressional waves also known as P-waves produce push-pull forces. Distortional waves refer to secondary, shear or S-waves. They move in an up and down fashion, are slower and cause rock particles to oscillate at right angles to wave direction. Wave velocity increases with rock depth and density causing waves to be reflected and bent when they reach boundaries between two layers. Long waves or L-waves occur at the surface and they can be divided into waves that vibrate horizontally at right angles to their direction, and waves that move through ground just like waves move through the ocean. Seismic stations can plot the epicenter of an earthquake by timing the arrival of these waves. L-waves are responsible for landslides, avalanches and other earthquake damage.

As we study physical science we realize that we live in a world of waves. Water waves, sound waves, light waves, shock waves and heat waves are all linked to energy since all waves are basically pulses of energy. Waves disturbances are responsible for transferring energy from place to place. Any substance through which waves can travel is a medium. As a wave travels through a medium, only energy moves from one place to another. The particles of the medium remain in place and do not move forward with the wave. Every waves has three basic features. These features are amplitude, wavelength and frequency. Amplitude refers to the height of a wave, wavelength is the distance between two neighboring crests or troughs, and frequency refers to the number of complete waves passing a point in a given time. Waves directly influence erosion and the continual changing of the earth's surface.

KEY VOCABULARY

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avalanche: The falling of a large mass of snow, ice, or rock down a slope.
crust: The outermost and thinnest of the Earth's compositional layers, which consists of rocky matter that is less dense than the rocks of the mantle below.
earthquake: A sudden motion or trembling of the Earth caused by the abrupt release of slowly accumulated elastic stress in rocks.
epicenter: That point on the Earth's surface that lies vertically above the focus of an earthquake.
fault: A fracture in rock along which displacement has occurred.
fracture: (1)the manner in which minerals break other than along planes of cleavage. (2)A crack, joint or fault in bedrock.
focus: The initial rupture point of an earthquake within the Earth.
L Waves: An earthquake wave that travels along the surface of the Earth or along a boundary between layers within the Earth.
P Waves: Seismic body waves transmitted by alternating pulses of compression and expansion. P waves pass through solids, liquids, and gases.
S Waves: Seismic body waves transmitted by an alternating series of
sideways (shear) movements in a solid. S waves cause a change of shape and cannot be transmitted through liquids and gases.
seismograph: An instrument that records the earth's vibrations and an earthquake's duration, direction, and intensity.
tremor: A slight shaking of the earth's crust.

RELATED PHYSICAL SCIENCE TERMS

crest: Highest point of a wave.
force: Push or pull exerted on or by an object.
frequency: Number of vibrations per second of a wave form of energy, or the number of complete waves passing a point in a given time.
kinetic energy: Energy of motion or of a moving body.
medium: Substance through which waves can travel.
motion: Any change in position or location.
pressure: The amount of force exerted by an object on the area of the surface on which it acts.
refraction: Change in the direction of rays in going through a boundary when coming in at an angle to the normal.
speed: The rate at which something moves or distance traveled per unit of time.
trough: The lowest point of a wave.
wave: (1)An oscillatory movement of water characterized by an alternate rise and fall of the water surface. (2)Disturbances that transfer energy from one place to another.
wavelength: The distance between two neighboring crests or troughs.

EXAMPLES IN CONNECTICUT

On May 16, 1791, Moodus Connecticut suffered the worst of a long history of shakes and jolts that occurred over the last four centuries. These earth tremors have been associated with loud rumbling noises. The name Moodus is believed to originate from Machemoodus, a Wangunk Indian name referring to bad noise or place of noise. Although there has been no shock waves to compare to 1971, earthquakes still occur in Moodus. In 1981 and 1982 there were more than 500 quakes during a several month period. Most of these were considered to be micro-quakes that were too small to even be felt without sensitive instrument. However, in 1917 and in 1968 moderate to large earthquakes occurred which resulted in shaking houses and rattling windows. In Connecticut there are many more inactive than active faults. The state is cut by several hundred faults of various sizes, although nearly all are totally inactive. No spot in Connecticut is more than five miles from a fault. Even though the potential for earthquakes is very small, these fault lines often mark the boundary between two contrasting rock types brought in contact by crustal motions in past times. Frequently, faults mark the boundaries between landscape regions. The Eastern Border Fault separates the brownstone of the Central Valley from the metamorphic rocks of the Eastern Uplands. The Cameron's Line Fault divides the Northwest Highlands from the rest of the Western Uplands.

EXPERIMENTS

ACTIVITY #7

TOPIC: Wave Energy

OBJECTIVE:

To demonstrate the forward movement of a wave

MATERIALS:

Book, 8 marbles, ruler

PROCEDURE:

Lay the book on a table or floor. Open the book and place 4 marbles together in the center of the groove of the book. Position one marble about 3 cm. from the other marbles and thump it toward the last of the group of marbles. Try using different size books, number and types of marbles. What other ways could you vary this experiment?

OBSERVATION:

What happens when the thumped marble strikes the end marble? What happens to the original end marbles? the center marbles? Record and sketch your observations and label.

EXPLANATION:

The thumped marble stops when it strikes the end marble, and the marble on the opposite end of the group moves away from the group. The thumped marble has kinetic energy and upon contact, this energy is transferred to the stationary marble which in turn transferred it to the marble next to it. Every marble transfers the energy to the next marble until the end marble receives it and moves forward. Any marble would move forward if it weren't blocked by another marble. Although water waves appear to move forward, only the energy is transferred from one water molecule to the next, and each water molecule stays in relatively the same place. Like the end marble, liquid moves forward when there is nothing holding it back.

Adapted from experiment in Earth Science for Every Kid by Janice VanCleave

ACTIVITY #8

TITLE: Pressure and the Earth's Crust

OBJECTIVE:

To demonstrate how pressure affects the earth's crust

MATERIALS:

1 sheet of newspaper, 1 sheet of tissue paper

PROCEDURE:

Fold the paper in half. Keep folding the newspaper as many times as possible. Do the same with the paper bag. Think of other materials to use to vary this experiment.

OBSERVATION:

What happens as you continue to fold the paper? How many times are you able to fold it? Does the type of paper affect the number of times you can fold it? Make a sketch and label.

EXPLANATION:

The paper becomes increasingly harder to fold. After 8 foldings there are 256 sheets. Like the paper, the earth's crust requires little pressure to fold thin, lighter layers on the surface. Enormous amounts of pressure are required to fold over large, denser sections of land.

Adapted from experiment in Earth Science for Every Kid by Janice VanCleave

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Additional information on the topics in this unit can be found on the Internet World Wide Web and in museums across the country. Museums in the Northeast include:

Yale Peabody Museum

170 Whitney Avenue

New Haven, CT 06511

(203)436-0850

Vermont Marble Exhibit

Route 3

Proctor, VT 05765

(802)459-3311

Harvard University Mineralogical

And Geological Museum

24 Oxford Street

Cambridge, MA 02138

(617)495-3045

National Museum of Natural History

Tenth Street & Constitution Ave. NW

Washington, D.C. 20560

(202)357-2810

Southeast Museum

Main Street

Brewster, NY 10509

(914)279-7500

American Museum of Natural History

Central Park West at 79th NY 10024

New York, NY 10024

(212)732-1236

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