Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 1. All students will measure and describe the things around us; explain what the world around us is made of; identify and describe forms of energy; and explain how electricity and magnetism interact with matter (Matter and Energy).

Benchmark
Describe and compare objects in terms of mass, volume, and density (SCI.IV.1.MS.1).

Benchmark Clarification
Scientists describe and compare objects by measuring some of their characteristics using standardized units. Some of these physical characteristics are volume (*link to Glossary*), mass (*link to Glossary*), and density (*link to Glossary*).
The volume of a solid can be measured by using water displacement or mathematical formulas; the volume of a liquid can be measured by using a graduated cylinder.

The mass of a solid or a liquid can be measured using a balance. Students should remember to subtract the mass of the container when they measure the mass of a liquid.

Density can be calculated by dividing mass by volume, or D = M/V.
Students will:

- Measure the following physical properties of matter: volume, mass, and density
- Identify differences in the densities of objects that have the same volume (For example, a brick versus a piece of wood of the same size _the brick is more dense because it has more matter [stuff] in the same amount of space)

See Making measurements.(*link to SCI.I.1.MS.4*).
See Standardized units (*link to SCI.IV.1.MS.2)*.

Volume: the space an object takes up, regardless of shape (the tools used in measuring volume include the ruler and graduated cylinder; the units used in measuring volume are the cubic centimeter, milliliter, and liter)

Mass: the amount of matter (stuff) within an object (the tool used to measure mass is the balance; the units used to measure mass are milligrams and grams)

Density: the amount of mass in a given space, calculated by mass divided by volume

Key Concepts (voc.)
Units of density – grams per cubic centimeter or grams per milliliter

Measurement tools:

- balance
- measuring cup or graduated cylinder
- metric ruler

Real-World Context
Common objects and substances

Instructional Example SCI.IV.1.MS.1

Benchmark Question: How are physical properties used to describe and compare matter?
Focus Question: How can objects be described and compared in terms of mass, volume, and density?

The teacher will set out several different liquids, solids, containers of various sizes, and measuring devices (balance, graduated cylinders, and metric rulers).
Students will work in small groups to create tables for recording mass, volume, and density. They will measure the mass, volume, and density of several items. After they have completed their investigations, the small groups should discuss and compare values for liquids and solids. Students also will discuss the differences in individual measurements within the class and focus on limitations of their personal knowledge.

(**Extension:** Students will research a scientist and give a presentation describing how he or she utilized mass, volume, and/ or density in the work he or she conducted. See "Culturally Relevant Materials for Science Education" (*link*).

Constructing: (*link toSCI.I.1.MS.1*), (*link to SCI.I.1.MS.3*), (*link to SCI.I.1.MS.4*), (*link to SCI.I.1.MS.5*).

Reflecting: (*link to SCI.II.1.MS.1*), (*link to SCI.II.1.MS.2*), (*link to SCI.II.1.MS.3*).

Resources/References:

Webliography
http://mtn.merit.edu/mcf/SCI.IV.1.MS.1.html

Floaters and Sinkers. AIMS.
http://www.aims.edu.org/aimscatalog/

Graham, Ian. *Boats, Ships, Submarines & Other Floating Machines.* Kingfisher, 1994.

Math + Science a Solution. AIMS.
http:// www.aims.edu.org/aimscatalog/

"Culturally Relevant Materials for Science Education." *MEGOSE*. (MDE), 1991.
(*Link to)*

Classroom Assessment Example SCI.IV.1.MS.1

The teacher will pass out the appropriate measuring tools and the following items to each group: a piece of Styrofoam, oil, toothpick, water, molasses, and marble. Students will calculate the density of these objects. Students will pour equal amounts of the liquids into a clear container in order from most dense to least dense. Then they will drop in the solids from most dense to least dense*.

Students should then draw and label a picture of these items when combined in one container and justify their answers using density calculations.

Finally, students should hypothesize based on the following: If air is added to the bottom layer of the container through a straw, what will happen to the air?

*Most dense to least dense is as follows: marble, molasses, water, oil, toothpick, styrofoam.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.1.MS.1

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of layers	Illustrates and labels layers in incorrect order.	Illustrates and labels some layers in correct order.	Illustrates and labels all layers in correct order.	Illustrates and labels all layers in correct order with neatness and accuracy that exceeds expectations.
Correctness of explanation	Utilizes density calculations to explain drawing but fewer than two calculations are correct.	Utilizes density calculations to explain drawing but only two to three calculations are correct.	Utilizes correct density calculations to explain drawing.	Utilizes correct density calculations to explain drawing and shows all work.
Correctness of hypothesis	Writes an incorrect hypothesis.	Writes a hypothesis with some inconsistencies.	Writes a complete and correct hypothesis.	Writes a complete and correct hypothesis based on past experimentation.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 1. All students will measure and describe the things around us; explain what the world around us is made of; identify and describe forms of energy; and explain how electricity and magnetism interact with matter. (Matter and Energy)

Benchmark
Explain when length, mass, weight, density, area, volume, or temperature are appropriate to describe the size of an object or the amount of a substance (SCI.IV.1.MS.2).

Benchmark Clarification
Scientists use specific tools to measure specific properties of matter. They record these measurements in standardized units (metric units).

It is important for students to become knowledgeable about the appropriate tools that are used to measure each property and the appropriate measurements that are used to describe the property. For instance, one wouldn't measure a table with a balance and record the measurement in miles; the table would be measured with a metric tape and described in centimeters.

Students will:

- Construct a table of physical properties of matter, the units used to describe each property, and the tools used to measure each property
- Use the appropriate tools to measure the size of an object and the amount of a substance in the object

Weight: Weight is not the same as mass; weight is the result of the pull of gravity on an object. For example, if you weigh one hundred pounds on the Earth, you would weigh sixteen pounds on the Moon while the mass remains constant.

See Mass (*link to SCI.IV.1.MS.1*).
See Weight (*link to Glossary*).
See Using measuring devices, (*link to SCI.I.1.MS.4).*
See Common substances *(link to SCI. IV.1.E.1)*

Key Concepts (voc.)
Appropriate metric (SI) units.

Measurement tools:
- balances
- spring scales
- measuring cups or graduated cylinders
- thermometers
- metric ruler

Real-World Context
Common substances hot and cold substances:
- ice, snow, cold water
- hot water, steam, cold air, hot air

Instructional Example SCI.IV.1.MS.2

Benchmark Question: How do we measure matter?
Focus Question: What is the appropriate equipment and metric units used to describe the size and amount of a substance?

The teacher should construct a large table listing the properties of matter, the tools that are used to measure each property, and the units of measurement that are used to describe each property. The table should be posted, so students can refer to it throughout these lessons.

Students will have misconceptions about English units and standardized/metric units. It is important that students understand that standardized units are used in science and industry around the world. Have students discuss the advantages and disadvantages of using standardized units.

- property of matter
- tools
- standardized units of measurement
- English units of measurement
- length
- metric ruler/tape
- centimeter/meter/kilometer
- foot/yard/ mile
- width
- metric ruler/tape
- foot/yard
- surface area
- calculator
- square meters
- square feet
- volume

- calculator
- graduated cylinder/metric measuring cup
- cubic centimeters/milliliters
- cup/quart/gallon
- weight
- spring scale
- newtons
- pounds
- Mass
- Balance
- Grams
- Pounds
- Temperature
- Thermometer
- Celsius
- Fahrenheit
- Density
- Calculator
- Liquid = g/cm3
- Solid = g/ml
- Pounds/cubic foot

The teacher should set up workstations with the following tools: metric ruler, meter stick, graduated cylinder, metric measuring cup (with printed measures on the side), spring scale, balance, and thermometer. Have students construct a data table, measure a variety of commonly found solids and liquids (water, wood block, box, vegetable oil, rubbing alcohol, etc.), and record their measurements in their data tables.

Students in groups will discuss their results and possible reasons for differences in their measurements. Students should share their observations and conclusions with the class. (**Extension:** Challenge students to find the volume, mass, and density of carbon dioxide that is formed when mixing vinegar and baking soda.) See SCI.IV.1.MS.1 (*link*).

Constructing: (*link to SCI.I.1.MS.1*), (*link to SCI.I.1.MS.3*), (*link to SCI.I.1.MS.4*).

Reflecting: (*link to SCI.II.1.MS.1*), (*link to SCI.II.1.MS.2*), (*link to SCI.II.1.MS.3*).

Resources/References:

Webliography
http://mtn.merit.edu/mcf/SCI.IV.1.MS.2.html

Molecular movement at different temperatures.
http://www.miamisci.org/af/sln/

Sussman, Beverley. "Building Atoms Shell By Shell." *Science Scope*, April 1993.

VanCleave, Janice. *Janice VanCleave's Molecules.Wiley, 1993.*

Weight on other planets + explanation of weight & mass differences.
http://www.exploratorium.edu/ronh/weight/index.html/

Classroom Assessment Example SCI.IV.1.MS.2

The teacher will give students a variety of objects. Students will choose six objects each and complete the given chart. Various measuring tools will be available for them to use. Before each measurement is made, students should estimate the measurement and include the appropriate unit of measurement. Objects could include different types of breakfast cereal of different shapes, dry and wet, water and different types of soda in varying quantities, different kinds of candy, powdered and liquid laundry detergent, classroom materials, and containers of different sorts.

Object

Physical property

Estimate
Actual measurement
Units
Tools
Length
Area
Volume
Mass
Density
Temperature

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.1.MS.2

Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of units	Contains two or fewer correct units.	Contains three to four correct units.	Contains five or six correct units.	Contains all correct units with additional objects measured.
Appropriateness of tool	Contains two or fewer correct choices of tools.	Contains three to four correct choices of tools.	Contains five or six correct choices of tools.	Contains all correct choices of tools with additional objects measured.
Correctness of measurement	Contains two or fewer correct measurements.	Contains three to four correct measurements (+/- 2 units).	Contains five to six correct measurements (+/- 2 units).	All objects are measured correctly within +/- 2 units.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 1. All students will measure and describe the things around us; explain what the world around us is made of; identify and describe forms of energy; and explain how electricity and magnetism interact with matter (Matter and Energy).

Benchmark

Classify substances as elements, compounds, or mixtures and justify classifications in terms of atoms and molecules (SCI.IV.1.MS.3).

Benchmark Clarification

Matter consists of extremely small, invisible particles called atoms. Atoms cannot be broken down into their smaller parts during a physical change, or during a chemical reaction. They can be broken into smaller particles during nuclear reactions. All elements (*link to Glossary*) are made of one kind of atom. See Periodic Table of Elements (*link* to http://pearl1.lanl.gov/periodic/default.htm)

Atoms may exist alone or be combined together. When two or more atoms join together, they form molecules. When different kinds of elements join together, they form compounds (*link to Glossary*).

For example, oxygen exists as a molecule containing two oxygen atoms in the atmosphere. When three oxygen atoms join together, they form the molecule called ozone.

Water is a substance/ a compound made of hydrogen and oxygen atoms. Each water molecule is made of two atoms of hydrogen and one atom of oxygen.

These molecules/compounds do not break down into individual atoms/elements when they are heated or cooled during phase changes.

Molecules can be broken down into separate atoms or simpler molecules when exposed to electrical current or during a chemical reaction. Examples of chemical reactions include:

- a reaction with acids
- decomposition
- burning (a chemical reaction with oxygen. .

When two or more elements and/or compounds are physically combined together, they are called a mixture (*link to Glossary*). Mixtures can be physically separated into their original components.

Students will:

- Classify substances as elements, compounds, or mixtures
- Justify their classifications in terms of atoms and molecules.

See Molecular Structure of solids, liquids, and gases, (*link to SCI.IV.1.MS.4).*

Elements: any of more than 100 fundamental substances that consist of atoms of only one kind and that singly or in combination constitute all matter. Elements are listed in the Periodic Table of Elements (*link* to http://pearl1.lanl.gov/periodic/default.htm)

Compounds: These exist when different kinds of atoms are joined together to form a new chemical substance (water [H_2O], table salt [NaCl], and chalk [$CaCO_3$] are all examples of compounds)

Mixtures: a combination of two or more substances (element and/or compounds) that keep their properties. Soil, salt and pepper, Kool-Aid, and sugar water are examples of mixtures. A solution is a type of mixture that is uniform throughout, such as Kool-Aid and sugar water.

Key Concepts (voc.)

- element
- compound
- mixture
- molecule
- atom

Real-World Context

Common substances such as those listed above, including:
Elements such as:

- copper
- coal
- aluminum
- graphite (carbon)
- sulfur
- helium
- iron

Compounds such as:

- water
- chalk
- salt
- sugar
- carbon dioxide

Mixtures such as:

- soil and water
- soil and Kool-Aid
- Italian salad dressing
- salt and pepper
- milk
- salt water
- air

Instructional Example SCI.IV.1.MS.3

Benchmark Question: How do we classify the things around us?
Focus Question: How are elements, compounds, and mixtures classified in terms of atoms and molecules?

Each student will construct at least one model of an element and one model of a compound by using broken toothpicks and raisins, colored mini-marshmallows, or gumdrops.

Students will work in small groups and create a concept map to classify elements, compounds, and mixtures in terms of atoms and molecules. They will glue and label the models they are creating onto the concept map.

Students will choose a single color item to represent one kind of atom. They will label this on the concept map as atom 1. They should repeat this step for atom 2 and atom 3. Then they should combine individual atoms (single color items) to form elements (all atoms the same color and property) and glue their element samples onto their concept maps and label them.

They should form compounds by attaching elements with toothpicks (toothpicks represent bonds) and glue these samples onto their concept maps and label them.

They should form mixtures by combining two or more elements and/or compounds (these are not bonded; do not use toothpicks) and glue these samples onto their concept maps and label them.

They should add definitions of terms and real-world examples for each element and compound.

Constructing: (*link to SCI.I.1.MS.1), (link to SCI.I.1.MS.6).*

Reflecting: (*link to SCI.II.1.MS.3).*

Resources/References:

Webliography.
http://mtn.merit.edu/mcf/SCI.IV.1.MS.3.html/

Edible Molecule. AIMS.
http://www.aims.edu.org/aimscatalog/

Molecular Model Kits.

Water, Precious Water—The Water Molecule. AIMS.
http://www.aims.edu.org/aimscatalog/

Classroom Assessment Example SCI.IV.1.MS.3

Students will create a chart, arranging at least nine items into the appropriate classification as an element, compound, or mixture. They should justify the classification in terms of atoms and molecules.

Possible items to choose from: Kool-Aid, water, salt, aluminum foil, salad dressing, copper wire, soil, chalk, air, salt water, milk**,** coal, graphite, helium, sulfur. The teacher will supply a list of ingredients for each of the items.

Note: Check Benchmark Clarification for proper classification.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.1.MS.3

Criteria	Apprentice	Basic	Meets	Exceeds
Completeness of chart	Creates a chart with few headings and some missing information.	Creates a complete chart with correct headings but some missing information.	Creates a complete and correct chart with proper headings.	Creates a complete and correct chart with proper headings and detailed explanations.
Correctness of identification	Identifies three or fewer items.	Identifies four to six items.	Identifies seven to eight items correctly and completely.	Identifies all nine items correctly and completely.
Correctness of justification	Justifies three or fewer items.	Justifies four to six items.	Justifies seven to eight items correctly and completely.	Justifies all nine items correctly and completely.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 1. All students will measure and describe the things around us; explain what the world around us is made of; identify and describe forms of energy; and explain how electricity and magnetism interact with matter. (Matter and Energy)

Benchmark

Describe the arrangement and motion of molecules in solids, liquids, and gases. (SCI.IV.1.MS.4).

Benchmark Clarification

Students tend to assume that the molecules of a substance have the same properties as the substance itself. Students may incorrectly say, "The ice molecules are cold and hard. As the molecules heat up, they melt and turn to liquid."

Students should correctly describe the state of matter based on the motion and arrangement of molecules as they interact with energy. There is nothing occupying the spaces between the molecules. The state of matter can be altered by a loss or gain of heat energy. *(Link to SCI.IV.2.MS.5).* Students should know that "phases of matter" is a synonym for "states of matter."

Students will:

- Describe correctly the arrangement and motion of molecules in states of matter:
  - solids (*link to Glossary*)
  - liquids (*link to Glossary*)
  - gases (*link to Glossary*)

See Molecular explanations of changes of state, (*link to IV.2.MS.4*).

Solids: atoms or molecules that are very close together and that move in a rigid pattern (e.g., a brick)

Liquids: atoms or molecules that are close together and that move in random motion (e.g., water)

Gases: atoms or molecules that are far apart and that move freely with random motion (e.g., helium)

Key Concepts (voc.)
Arrangement:
- regular pattern
- random

Distance between molecules:
- closely packed
- separated

Molecular motion:
- vibrating
- bumping together
- moving freely

Real-World Context
Common solids, liquids, and gases such as those listed above

Instructional Example SCI.IV.1.MS.4

Benchmark Question: How are molecules arranged in matter?
Focus Question: What is the molecular motion and arrangement of the molecules in the states of matter: solid, liquid, and gas?

Students will observe models of molecular motion in solids, liquids, and gases. The teacher will demonstrate each state of matter and discuss the motion and arrangement of molecules with the class.

For a gas, the teacher will pour peppermint extract into a petri dish placed on the overhead projector. Note the time it takes for everyone in class to notice the smell.

For a solid, the teacher will pre-make a petri dish with clear, thick gelatin*. During the demonstration, the teacher will drop dark food coloring around the inside wall of the dish. Note the time it takes to evenly color the gelatin.

For a liquid, the teacher will place a water-filled petri dish on the overhead projector and drop food coloring into the water. Note the time it takes to color the water throughout.

Students will record their observations on data tables during the demonstration. As a class, students will compare the rate of movement to the molecular motion in different states of matter and discuss real-world observations (e.g., room fresheners, scratch and sniff magazine advertisements).

Alternative activity: Students may demonstrate solids, liquids, and gases by using their bodies as molecules. In a solid, students should be shoulder-to-shoulder and slightly vibrating. In a liquid, students must be arm-to-arm, vibrating, and moving randomly but close together. In a gas, students should take on the shape of the room by moving in straight lines until they bounce off someone or something.

Extension: Students may design an experiment to test the effects of temperature by using cold and warm water.

***Note:** Gelatin is a suspension/mixture called a colloid, but it can be used in this demonstration to exhibit properties that are similar to a solid.

Constructing: (*link to SCI.I.1.MS.1*), (*link to SCI.I.1.MS.2*), (*link to SCI.I.1.MS.3*), (*link to SCI.I.1.MS.4*), (*link to SCI.I.1.MS.6*).

Reflecting: (*link to SCI.II.1.MS.3*).

Resources/References:

Cooper, Christopher. *Matter.* Dorling Kindersley, 1992.
Hann, Judith. *How Science Works.* Reader's Digest Association, 1991.

Matter & Molecules for Middle School. NEW DIMENSIONS UNIT.
http://www.BCMSC,k12.mi.us/

Classroom Assessment Example SCI.IV.1.MS.4

Students will respond to the following prompt by writing a short story

It is a hot summer day; you are an ice cube left in a glass. Identify the phases that you experience. Include your molecular motion and arrangement of molecules during each phase.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.1.MS.4

Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of identification	Identifies few or none of the states of matter correctly.	Identifies some of the states of matter correctly.	Identifies most of the states of matter Correctly.	Identifies all of the states of matter correctly.
Accuracy of description	Provides few or no correct descriptions of molecular motion and many misunderstandings of molecular motion.	Provides some correct descriptions of molecular motion and shows a few misunderstandings of molecular motion.	Provides many correct descriptions of molecular motion and shows no misunderstandings of molecular motion.	Provides all correct descriptions of molecular motion, shows no misunderstandings, and includes additional real-world examples.
Correctness of arrangement	Describes few or none of the molecular arrangements correctly.	Describes some of the molecular arrangements correctly.	Describes all of the molecular arrangements correctly.	Describes all of the molecular arrangements correctly and includes the terms melting, evaporating, and condensing.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 1. All students will measure and describe the things around us; explain what the world around us is made of; identify and describe forms of energy; and explain how electricity and magnetism interact with matter. (Matter and Energy)

Benchmark
Construct simple circuits and explain how they work in terms of the flow of current (SCI.IV.1.MS.5).

Benchmark Clarification
Electrical energy is the flow of electrons from one place to another. Energy is transferred when an electron moves from one atom to another. The energy is transferred through a conductor (*link to Glossary*) or material such as air, a copper wire, a human body, etc. Electricity will follow the path of least resistance through a material. Materials that will not conduct electricity are called non-conductors (*link to Glossary*).

In order for this movement to occur, the path or circuit must be closed and complete, which allows the energy to flow back to the original power source.
An open circuit is not a complete circuit because of a break in the pathway.

A short circuit is a complete, but unintended flow of energy that will take the easiest pathway back to its starting place. A short circuit may not always be the shortest path. Short circuits are often caused by insulated wires that become worn, which causes contact between the two wires. Fires may begin in homes due to short circuits.

Students will:

- Describe electricity as an energy transfer from a power source (such as a battery) through a conductor (such as a wire) to an electrical device (such as a bulb) and then back to the power source.

Conductors: materials that allow electrical energy to flow through them

Non-conductors: materials that do not allow electrical energy to flow through them

Key Concepts (voc.)

- complete circuit
- short circuit
- conductors
- non-conductors

Tools:

- batteries
- household current
- bulbs
- bells
- motors
- electrical switches

Real-World Context

- household wiring
- electrical conductivity testing
- electric appliances

Instructional Example SCI.IV.1.MS.5

Benchmark Question: How does current flow in simple circuits?
Focus Question: How many ways can you find to light a light bulb?

The teacher will give groups of students a “C” or “D” cell battery, a flashlight bulb, and two pieces of wire. Ask students to see if they can make the bulb light. Students will find several ways to make the bulb light. Students will discuss similarities among the different ways they found to light the bulb. For example, the points of contact on the battery will always remain the same.

Next, the students will try to light the bulb using one wire. As students experiment, explain that an electric bulb lights when it is part of a continuous path of materials that form a loop through which the electrical current moves. This path/ loop is called a circuit. Students will draw the circuit in each arrangement they make and label the current flow with arrows.

(**Extension:** Discuss various examples of simple circuits used in manufacturing, transportation, energy distribution, and housing.)

Constructing: (*link to SCI.I.1.MS.1*), (*link to SVI.I.1.MS.2*), (*link to SCI.I.1.MS.3*).

Reflecting: (*link toSCI.II.1.MS.2*), (*link to SCI.II.1.MS.4*).

Resources/References:

Webliography
http://mtn.merit.edu/mcf/SCI.IV.1.MS.5.html

Electrical Connections. AIMS.
http://www.aims.edu.org/aimscatalog/

Electrical Current/Light & Optics. Bill Nye Video. Disney Educational (800/295-5010).

Electricity. TOPS.
http://topscience.org/

Classroom Assessment Example SCI.IV.1.MS.5

After several completed activities on circuits, students will use the following materials to create at least four complete circuits that light a bulb and/or activate a buzzer: batteries, wires, light bulbs, switches, buzzers, and various conducting and non-conducting materials (e.g., paperclips, paper fasteners, tin foil, straws, etc.).

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.1.MS.5

Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of circuits	Constructs fewer than two correct simple circuits.	Constructs two to three correct simple circuits.	Constructs and completes four correct simple circuits.	Constructs and explains four correct simple circuits.
Completeness of diagram	Completes fewer than two correct diagrams.	Completes two to three correct diagrams.	Completes four correct diagrams.	Completes four correct diagrams, gives correct explanations of electron flow, and may give explanations and diagrams of failed attempts.

Science Benchmark Clarification, Instruction, and Assessment

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 1. All students will measure and describe the things around us; explain what the world around us is made of; identify and describe forms of energy; and explain how electricity and magnetism interact with matter. (Matter and Energy)

Benchmark
Investigate electrical devices and explain how they work, using instructions and appropriate safety precautions (SCI.IV.1.MS.6).

Benchmark Clarification
Many electrical devices are used in daily life. Examples: door bells, buzzers, light bulbs, toasters, battery-operated toys, and hair dryers.

It is important to follow the instructions for their use and to operate them safely. Grounding is an example of a safety precaution. An object is grounded when a charged object is connected to the ground by a conductor. For example, a lightning rod carries electricity from the top of a barn to the ground so that the barn does not ignite and burn. Surge protectors work as a circuit breaker to protect electrical appliances from an overload of current reaching the appliance.

Students will:

- Investigate electrical devices and explain how they work by following the flow of energy through a device
- Determine if the circuit is complete to make the appliance work by reading a flow diagrams , which is often included in an instruction manual.

See Transformations of Energy (*link to SCI.IV.2.MS.3).*

Caution:
Taking apart large appliances is dangerous! Residual charges in capacitors can injure students.

Key Concepts (voc.)
Flow of electricity for energy or information transfer

Safety precautions for using electrical appliances; grounding

Documentation for toys and appliances-wiring diagrams, written instructions

Real-World Context
Situations requiring assembly, use, or repair of electricity:

- electrical toys
- radios
- simple appliances (i.e., replacing batteries and bulbs)

Connecting electrical appliances:

- stereo systems
- TVs and videocassette recorders
- computers and computer components

Instructional Example SCI.IV.1.MS.6

Benchmark Question: How do humans use electricity safely?
Focus Question: How do electrical devices work and how are they safely used?

Students will work in small groups and compare characteristics of several working appliances. Characteristics include on/off switches, wires, complete circuits, etc. Have students take apart flashlights, reassemble them to work, and diagram the internal mechanism showing the current flow. Students may bring in small broken appliances from home. In small groups, students will take appliances apart and hypothesize why they are not working.

(**Extension:** Have an appliance repair person come to class to discuss students' hypotheses as to why the appliances are not working.)

Note: Remind students that before they work with an electrical appliance, they should disconnect it from the power source. The teacher should instruct students on proper electrical safety procedures (*see resource link)*

Constructing: (*link to SCI.I.1.MS.1*), (*link to SCI.I.1.MS.2*), (*link to SCI.I.1.MS.3*).

Reflecting: (*link to SCI.II.1.MS.3*), (*link to SCI.II.1.MS.4*).

Resources/References:

Webliography.
http://mtn.merit.edu/mcf/SCI.IV.1.MS.6.html/

Primarily Physics. AIMS.

Safety procedures.
http://www.consumersenergy.com/

Classroom Assessment Example SCI.IV.1.MS.6

The teacher will give each student a small, broken electrical device (e.g., flashlight, battery-operated toy). The students will list at least four reasons why the device might not be working. The students will list at least two safety precautions that should be taken while fixing the appliance.

Extension: Have students take their writing home and explain to their parents why the electrical device does not work.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.1.MS.6

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of explanation	Explains fewer than two valid reasons why appliance does not work.	Explains two to three valid reasons why appliance does not work.	Explains four valid reasons why appliance does not work.	Discusses five or more valid reasons why appliance does not work.
Appropriateness of safety precautions	Describes no safety precautions.	Describes one safety precaution.	Describes two safety precautions.	Describes three or more safety precautions.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 2. All students will investigate, describe, and analyze ways in which matter changes; describe how living things and human technology change matter and transform energy; explain how visible changes in matter are related to atoms and molecules; and how changes in matter are related to changes in energy. (Changes in Matter)

Benchmark

Describe common physical changes in matter:

- evaporation
- condensation
- thermal expansion
- contraction

(SCI.IV.2.MS.1).

Benchmark Clarification

Students are often confused by the terms physical change and chemical change. It is important that they understand that mass remains constant in a physical change in closed systems *(link to Glossary).* The amount of matter (stuff) remains the same; only the distance between the particles and the motion of the particles change.

Students will:

- Describe the following physical changes in matter:
  - Evaporation (*link to Glossary*)
  - Condensation (*link to Glossary*)
  - Sublimation (*link to Glossary*)
  - Thermal expansion (*link to Glossary*)
  - Contraction (*link to Glossary*)

Closed system: a system in which the total mass of each element in the system remains constant before as well as after any kind of chemical or physical change. No matter is created or destroyed during the change.

Evaporation: liquid changes to gas; this change is speeded up by heating

Condensation: gases change to a liquid; this change requires cooling.

Sublimation: gas changes to a solid or a solid changes to a gas without passing through the liquid state (e.g., dry ice, solid to gas)

Thermal expansion: an increase in volume (not mass) due to heat; this change may occur in solids, liquids, or gases

Contraction: a decrease in volume (not mass) due to heat loss; this change may occur in solids, liquids, or gases

Key Concepts (voc.)
States of matter:
- solid
- liquid
- gas

Processes that cause changes in states or thermal effect:
- heating
- cooling
- boiling

Mass/weight remains constant during physical changes in closed systems

Real-World Context
States of matter:
- solid
- liquid
- gas

Changes in state:
- water evaporating as clothes dry
- condensation on cold window panes
- disappearance of snow or dry ice without melting
- expansion of bridges in hot weather
- expansion and contraction of balloons with heating and cooling
- solid air fresheners

Instructional Example SCI.IV.2.MS.1

Benchmark Question: How does matter undergo physical change?
Focus Question: What physical changes take place when butane is heated and cooled?

Materials: 1 can butane lighter fluid, thirty locking sandwich bags, dry ice cut in small sections.

Each student will zip a small locking sandwich bag almost closed and leave an opening just large enough to insert the nozzle of a butane can. The teacher will squirt a small amount of butane (about one-quarter teaspoon) into the bag and quickly seal it. The body heat of the students' hands and fingers will cause the butane to boil and become a gas that inflates the bag. Students will discuss why the bag inflates (the volume of the gas increases, because the molecules move farther apart). Students may rub their bags over a small block of dry ice to reduce the heat energy in the bag. Students will discuss why the bag deflates (the volume of the gas decreases, because the molecules move closer together).

Students will draw a picture of the molecular motion for each change of state the butane undergoes.

This experiment can be repeated as often as desired and the changes of evaporation and condensation discussed. Sublimation of the dry ice can also be discussed.

Caution:

- Students should be aware of the dangers of butane gas (do not inhale, flammable).
- Students should dispose of butane gas properly.
- Room should be well ventilated during activity involving butane gas.
- Do not reuse bag for other activities.
- Do not handle dry ice with bare hands.

Note: Due to the porous property of the locking sandwich bags, bags cannot be prepared in advance.

Constructing: (*link to SCI.I.1MS.1*), (*link to SCI.I.1MS.6*).

Reflecting: (*link to SCI.II.1.MS.5*).

Resources/References:

Webliography
http://mtn.merit.edu/mcf/SCI.IV.2.MS.1.html

Steamed Up. NEW DIRECTIONS UNIT.
http://www.BCMSC.k12.mi.us/

Water, Precious Water. AIMS.
http://www.aims.edu.org/aimscatalog/

Gregg Zulauf—Math and Science Center, Muskegon, Michigan.

Classroom Assessment Example SCI.IV.2.MS.1

The teacher will present the following scenario:

Angelo wanted to make some spaghetti. He put a pot of water to heat on the stove and left the kitchen for several minutes. When he returned he observed the following: The water was bubbling, the water gave off heat, steam was rising from the pot, water droplets were on the hood above the stove, and the water level was lower in the pan. He was puzzled about the source of the water droplets on the hood above the stove.

Each student will write a letter to Angelo and explain where the water on the hood came from. Each letter should include a diagram with labels.

Note: The teacher may want to demonstrate this activity before students write.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.2.MS.

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of explanation-evaporation	Explains the process of evaporation with many misconceptions/ contradictions.	Explains the process of evaporation with a few misconceptions/ contradictions.	Explains the process of evaporation with one misconception/ contradiction	Explains the process of evaporation with no misconceptions/ contradictions and provides a labeled diagram.
Accuracy of explanation-condensation	Explains the process of condensation with many misconceptions/ contradictions.	Explains the process of condensation with a few misconceptions/ contradictions.	Explains the process of condensation with one misconception/ contradiction.	Explains the process of condensation with no misconceptions/ contradictions and provides a labeled diagram.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 2. All students will investigate, describe, and analyze ways in which matter changes; describe how living things and human technology change matter and transform energy; explain how visible changes in matter are related to atoms and molecules; and how changes in matter are related to changes in energy. (Changes in Matter)

Benchmark
Describe common chemical changes in terms of properties of reactants and products (SCI.IV.2.MS.2).

Benchmark Clarification
It is important for students to understand that a chemical change begins with original substances called reactants (*link to Glossary*). During a chemical change, a new substance with new properties is produced. This new substance is called the product (*link to Glossary*). The mass remains constant, because a chemical reaction is a closed system (*link to Glossary*) and no matter is lost.

Students will:
- Observe and describe that all chemical changes begin with original substances that are called reactants.

Reactant: substances that enter into a chemical reaction

Product: a substance produced by a chemical reaction

Closed system: a system in which the total mass of each element in the system remains constant before as well as after any kind of chemical or physical change. No matter is created or destroyed during the change.

Key Concepts (voc.)

Common chemical changes:
- burning
- rusting iron
- formation of sugars during photosynthesis
- acid reacting with metal and other substances

Mass/weight remains constant in closed systems

Real-World Context
Chemical changes:
- burning
- photosynthesis
- digestion
- corrosion
- acid reactions

- common household chemical reactions such as with alkaline drain cleaners

Instructional Example SCI.IV.2.MS.2

Benchmark Question: What happens to matter when it undergoes a chemical change?
Focus Question: What are the reactants and products when paper burns?

Students will work in small groups and brainstorm lists of different changes they have observed in matter. One student will cut paper into pieces and place the paper into an aluminum pie pan. The teacher should remind students that this is a physical change (*link to SCI.IV.2.MS.1).*

The students should carefully burn the paper in the pie pan. Each student will draw and describe the reactants involved in burning the paper. Reactants should include the sulfur on the match head, oxygen, and carbon (paper pieces). Each student will describe the chemical change and draw what they observed. Specifically, students should do the following:

- Describe the reactants: paper and oxygen in the air
- Identify the heat and light energy that are produced when the friction of striking the match on an abrasive surface ignites the sulfur on the match head and produces a chemical change
- Describe that the heat energy from the burning match causes the paper and oxygen to combine and form the products of smoke, ash, carbon dioxide, and water vapor

Each student will create a table , which includes the drawing and observations of the following:
Drawings

Reactants (before burning)
- paper (cellulose)
- oxygen (invisible in air)

Reactants and Products
(during burning)
- smoke
- gases (CO_2 and H_2O)
- light
- heat (flame)
- ashes form

Products (after burning)

- ashes
- gases (CO2 and H2O invisible in air)

Constructing: (*link to SCI.I.1.MS.1*), (*link toSCI.I.1.MS.6*).

Reflecting: (*link to SCI.II.1.MS.5*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.IV.2.MS.2.html/

Chemical Reactions/Phases of Matter. Bill Nye Video. Disney Educational (800/295-5010).

Chemistry That Applies. NEW DIRECTIONS UNIT.
http://www.BCMSC.k12.mi.us/

Off The Wall Science. AIMS.
http://aims.edu.org/aimscatalog/

Classroom Assessment Example SCI.IV.2.MS.2

After students have experienced and discussed burning in terms of products and reactants (see Instructional Strategy), they will be ready to assess the burning of a candle. Working within a small group, students will observe a burning candle. Students will list and categorize the reactants (wax, O_2, wick) and products (smoke, CO_2, and H_2O vapor) of the burning process.

The process of photosynthesis is related to a burning candle because they both involve an energy transfer utilizing reactants and producing products. Students will list the reactants and products of photosynthesis (*link to Glossary*) and (*link to SCI.III.2.MS.3).*

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.2.MS.2

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of identification-reactants	Identifies none of the reactants.	Identifies one of the reactants.	Identifies two reactants	Identifies three reactants
Accuracy of identification-products	Identifies none of the products.	Identifies one of the products. .	Identifies two of the products. .	Identifies three products.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 2. All students will investigate, describe, and analyze ways in which matter changes; describe how living things and human technology change matter and transform energy; explain how visible changes in matter are related to atoms and molecules; and how changes in matter are related to changes in energy. (Changes in Matter)

Benchmark
Explain physical changes in terms of the arrangement and motion of atoms and molecules (SCI.IV.2.MS.3).

Benchmark Clarification
It is important for students to understand that the substance does not change its chemical composition when it undergoes a physical change. It only changes the state of matter.

As a substance undergoes a physical change, for example, when water changes from a solid to a liquid or from a liquid to a gas, the motion of the particles (atoms and/or molecules) increases and the space between particles increases also. There is nothing occupying the spaces between the particles.

Students will:

- Identify and explain physical changes that occur when a substance changes size, shape, or state of matter (e.g., solid, liquid, gas)
-

<u>Solids</u> (*link to Glossary*
<u>Liquids</u> (*link to Glossary*
<u>Gases</u> (link to Glossary)

See Changes in state of matter, (*link to SCI.IV.1.MS.4).*
See Examples of Physical Changes of Matter, (*link to SCI.IV.2.E.1*) and
(*link to SCI.IV.2.MS.1).*
See Speed of molecular motion, (*link to SCI.IV.2.MS.1)*

Key Concepts (voc.)
Molecular descriptions of states of matter

- melting
- freezing
- evaporation
- condensation
- thermal expansion and contraction
- moving faster, slower
- vibrating
- rotating
- unrestricted motion
- change in speed of molecular motion with change in temperature

Real-World Context
Examples of physical changes of matter

Instructional Example SCI.IV.2.MS.3

Benchmark Question: How does heat energy change the physical arrangement and motion of atoms and molecules?
Focus Question: How can bb's in a petri dish be manipulated to model the arrangement and motion of atoms/molecules when heat energy is added and removed?

The teacher should place about one hundred bb's in a petri dish with a lid and place the dish on the overhead projector. The teacher should roll the bb's, so they clump in one spot. The teacher should discuss with students that this represents the arrangement and motion of atoms/molecules in a solid.

The teacher should tell students that heat energy is being added as he or she gently wiggles the petri dish (the teacher should use enough movement to make the bb's move freely but not wildly). The teacher should discuss that this change represents a solid to liquid phase change.

Finally, the teacher will shake the petri dish more rapidly while keeping the dish flat on the overhead projector. Bb's should rapidly ricochet off the sides and off each other. The teacher should discuss with students that this represents more heat being added and a phase change from liquid to gas.

Reverse the process to show heat energy being removed.

Constructing: (*link to SCI.I.1.MS.1*).

Reflecting:*(link to SCI.II.1.MS.3)*

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.IV.2.MS.3.html/

Hard as Ice. NEW DIMENSIONS UNIT.
http://www.BCMSC.k12.mi.us/

Heat/Energy. Bill Nye Video. Disney Educational. (800/295-5010).

Matter and Its Changes. OPERATION PHYSICS.

Classroom Assessment Example SCI.IV.2.MS.3

Using a Chinese checkerboard set in an open box, students should manipulate the set to demonstrate the phase changes from solid to liquid to gas. Students should explain how heat energy causes this process to occur. Ask them how they can tell heat energy is present.

Working in small groups, students will demonstrate the arrangement and motion of water molecules. During class discussion, students should describe each change of phase:

- In a solid, marbles should be next to each other, remaining in their holes, in a regular pattern and slightly vibrating.
- In a liquid, marbles should be rotating and vibrating throughout the checkerboard.
- In a gas, marbles should be far apart with some marbles bouncing in the box, in constant movement.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.2.MS.3

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of demonstration	Demonstrates movement without connection to phase changes.	Demonstrates one phase change for two states of matter with appropriate amounts of shaking.	Demonstrates two phase changes for three states of matter through appropriate amounts of shaking.	Demonstrates a complete understanding of the phase changes of the three states of matter through the heating and cooling process.
Accuracy of explanation	Explains the role of heat energy with significant errors.	Explains the role of heat energy in causing phase changes in two states of matter.	Explains the role of heat energy in causing phase changes in the three states of matter.	Explains the role of heat energy in causing phase changes in the three states of matter and through the heating and cooling process.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 2. All students will investigate, describe, and analyze ways in which matter changes; describe how living things and human technology change matter and transform energy; explain how visible changes in matter are related to atoms and molecules; and how changes in matter are related to changes in energy. (Changes in Matter)

Benchmark
Describe common energy transformations in everyday situations (SCI.IV.2.MS.4).

Benchmark Clarification
Students need to recognize that energy is never lost, destroyed, or created; it only changes form. In each transformation, the amount of energy that goes into a system is the same as the amount of energy that comes out of the system. When a system is analyzed, scientists must account for all types of energy. In most systems, energy is given off as heat.

Appliances, the body, plants, vehicles, musical instruments, toys, cold packs, hand warmers, etc. are examples of systems. In each system, energy changes form. For example, a battery demonstrates chemical energy being transformed to electrical energy.

Students will:
*Describe the energy transformations in everyday systems.

See Electricity in circuits, (*link to SCI.IV.1.MS.5).*
See (*link to SCI.III.2.MS.3*) and (*link to SCI.III.5.MS.2).*

Key Concepts (voc.)
- Forms of energy:
- mechanical
- heat
- sound
- light
- electrical
- magnetic
- chemical
- food energy

Total amount of energy remains constant in all transformations

Real-World Context

- motors
- generators
- power plants
- light bulbs
- appliances
- cars
- radios
- TVs
- walking
- playing a musical instrument
- cooking food
- batteries
- body heat
- photosynthesis

Instructional Example SCI.IV.2.MS.4

Benchmark Question: How are common energy transformations used in everyday situations?
Focus Question: What kinds of energy transfers occur in various toys?

Before beginning the explorations, students should be familiar with energy and its forms (see Key Concepts). Also, the teacher should discuss everyday examples of energy transformations (burning coal to produce electricity, digestion of food, speakers, photosynthesis, etc.).

The teacher will give each small group a toy that undergoes one or more energy transfers (See Toy Examples below). Groups will investigate the mechanics of their toy and identify its energy transfers. Groups will demonstrate and explain how the types of energy change in their toy.

Toy Examples: tops, music boxes, Jack-in-the-Boxes, wind-up toys, push and pull toys, string-pull toys, and battery-operated toys.

Constructing: (*link to SCI.I.1.MS.1*), (*link to SCI.I.1.MS.6).*

Reflecting: (*link to SCI.II.1.MS.3*).

Resources/References:

Webliography
http://mtn.merit.edu/mcf/SCI.IV.2.MS.4.html/

Inventions/Computers. Bill Nye Video. Disney Educational (800/295-5010).

Taylor, Beverley. *Teaching Science with Toys: Physics Activities for Grades K-9*. McGraw Hill, 1995.

Power Company.
http://www.consumersenergy.com/

Classroom Assessment Example SCI.IV.2.MS.4

After students have investigated various energy transformations, the following assessment can be used:

Pairs of students will observe the energy transformation that occurs when 250 ml (one-half cup) of cold water is combined with fifteen grams (one teaspoon) of calcium chloride in a locking sandwich bag. Each student will write a description of the energy transformation that is occurring and a description of a real-world application.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.2.MS.4

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of description - energy transformation	Describes an observation that does not include an energy transformation.	Describes the energy transformation with no details.	Describes the energy transformation with some details.	Describes the energy transformation with many details.
Accuracy of Description- real-world application	Does not describe a real-world application.	Describes a real-world application with no details.	Describes a real-world application with some details.	Describes a real-world application with many details.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 3. All students will describe how things around us move and explain why things move as they do; demonstrate and explain how we control the motions of objects; and relate motion to energy and energy conversions. (Motion of Objects)

Benchmark
Qualitatively describe and compare motion in two dimensions (SCI.IV.3.MS.1).

Benchmark Clarification
Most students have not practiced describing motions. They use the word speed with relation to fast and slow, but not increase and decrease. They need to learn how to describe the direction of motion: straight path, curved path, circular path.

For example, a thrown ball travels in a curved path. The speed changes as friction with the air slows the ball as it moves horizontally. The pull of gravity pulls the ball down, so the path of the ball curves downward.

Students will:

- Describe and compare the motion of objects using key concepts in terms of speed and direction

Key Concepts (voc.)
Two-dimensional motion:

- up
- down
- curved path

Speed:

- direction
- change in speed
- change in direction

Real-World Context
Objects in motion:

- thrown balls
- roller coasters
- cars on hills
- airplanes

Instructional Example SCI.IV.3.MS.1

Benchmark Question: How can the motion of objects in two dimensions be described and compared qualitatively?
Focus Question: How can the motion of objects be described and compared in terms of direction and speed?

While students observe, the teacher will place a checker on a table and flick it with a finger, roll a toy car in a straight line across the floor, and drop a ball from a table. The teacher will ask the students to describe the path of each object and to draw a conclusion about the direction of motion. Students will realize that each object moved in a straight line.

The teacher will tell the students that scientists call such motion "regular straight-line motion." The teacher will discuss other examples with students: a bicycle continues moving in the same straight line if the front wheel is not turned, and people lurch forward in a bus, train, or car when it stops quickly.

Working in small groups, students will roll marbles across a smooth, level surface. Students will see that the marbles always go in straight lines. Then students will roll a single marble and blow on it from the side as it travels. Students should discuss how this changes the motion. They should record their observations.

Next, one student will hold a strip of thin cardboard on edge and curve it slightly. S/he will roll a single marble into the curve of the strip and discuss any change in its direction. Students will write their ideas about the effect of the cardboard and the effect of the blowing on the motion of the marble. Students will begin to realize that all moving objects travel in a straight line (e.g., hockey pucks, rain drops) unless influenced by other forces.

Continue the study of the motion of objects by having students design and conduct an experiment to determine what variables affect the speed of various moving objects.

Constructing: (*link to SCI.I.1.MS.1*), (*link to SCI.I.1.MS.2*), (*link to SCI.I.1.MS.3*), (*link to SCI.I.1.MS.4*), (*link to SCI.I.1.MS.5*).

Reflecting: (*link toSCI.II.1.MS.2).*

Resources/References:

Webliography
http://mtn.merit.edu/mcf/SCI.IV.3.MS.1.html

Road Rally Activity. AIMS.
http://www.aims.edu.org/aimscatalog/

Classroom Assessment Example SCI.IV.3.MS.1

Small groups of students will set up two identical ramps with distinctly different slopes (one steep slope and one gradual slope). Before using two identical toy cars, each student will write a prediction about which car will go down the ramp the fastest and which car will go down the ramp the farthest. Each student will record his or her hypothesis. The students will take turns releasing both cars at the same time. Students will write observations of what happened and explain reasons why their prediction was correct or incorrect.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.3.MS.1

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of hypothesis	Does not write a hypothesis and contains possible misunderstandings.	Provides partial hypothesis with possible misunderstandings.	Provides hypothesis with few exceptions.	Provides a thorough and accurate hypothesis.
Completeness of conclusions	Does not write a complete conclusion or conclusion is erroneous.	Writes a conclusion based on erroneous information or correct information with no details.	Writes a conclusion based on correct information with some details.	Writes a conclusion Based on correct information with many details.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 3. All students will describe how things around us move and explain why things move as they do; demonstrate and explain how we control the motions of objects; and relate motion to energy and energy conversions. (Motion of Objects)

Benchmark
Relate motion of objects to unbalanced forces in two dimensions (SCI.IV.3.MS.2).

Benchmark Clarification
Motion can be described in terms of balanced and unbalanced forces.
Examples of balanced forces: When an object sits motionless on a table, the forces acting on the object are balanced. The force of the object on the table (action) is equal to the force of the table pushing up on the object (reaction). When a car travels at a constant speed, the forward force of the car is equal to the frictional forces acting on the car.
Examples of unbalanced forces: When a car speeds up, the forces are unbalanced because the forward force acting on the car is greater than the frictional forces pushing back on the car.

Students will:
- Explain the motion of objects due to balanced forces (*link to Glossary*) or unbalanced forces (*link to Glossary*)
- Demonstrate examples of motion caused by balanced and unbalanced forces

Balanced forces: These forces occur when an object is at rest or when an object is in motion at a constant speed and direction

Unbalanced forces: These forces cause an object to change direction or speed

Key Concepts (voc.)
Changes in motion and common forces:
- speeding up
- slowing down
- turning
- pushing
- pulling
- friction
- gravity
- magnets

Additional forces:
- attraction
- repulsion
- action/reaction pair (interaction force)
- buoyant force
-

Size of change is related to strength of unbalanced force and mass of object

Real-World Context
Changing the direction:

- changing the direction of a billiard ball
- bus turning a corner

Changing the speed:

- car speeding up
- a rolling ball slowing down
- magnets changing the motion of objects
- walking
- swimming
- jumping
- rocket motion
- objects resting on a table
- tug-of-war

Instructional Example SCI.IV.3.MS.2

Benchmark Question: How do forces affect the motion of an object?
Focus Question: How can the motion of objects be affected by balanced and unbalanced forces?

Each student will thread a string at least five meters long through a drinking straw and tie the string between two chairs that are set at least four meters apart so that the string is taut. The teacher will inflate the balloon ("hotdog" type balloons work best) and twist and hold the end to keep it inflated (do not tie). The teacher will attach the balloon with tape to the drinking straw with the twisted end closest to one chair. When releasing the balloon, the teacher will ask students, "What started the balloon moving?" and "What happened as the balloon was released?" Using the terms "balanced" and "unbalanced forces," students will explain the motion of the balloon. Discussion should include the terms found in the Key Concepts.

Students should be able to set up their own investigations and write formal lab reports for the second activity. The teacher will give each small group a wooden block with a sturdy eye hook on two opposite ends, two spring scales, and a flat surface to work on. Students will design and carry out an investigation to determine the effects of balanced and unbalanced forces on the motion of the block. Students will record data. Each student will write a lab report describing the investigation. Each student will discuss their results using the terms in the Key Concepts.

Students should have access to reference materials that could assist them in their investigation design (e.g., encyclopedias, science textbooks, etc.).

Constructing: (*link to SCI.I.1.MS.1*), (*link to SCI.I.1.MS.2*), (*link to SCI.I.1.MS.3*), (*link to SCI.I.1.MS.4*), (*link to SCI.I.1.MS.5*), (*link to SCI.I.1.MS.6*).

Reflecting: (*link to SCI.II.1.MS.2*), (*link to SCI.II.1.MS.3*).

Resources/References:

Webliography
http://mtn.merit.edu/mcf/SCI.IV.3.MS.2.html

Taylor, Beverley. *Teaching Physics with Toys*: *Activities for Grades K-9*. McGraw-Hill, 1995.

On-line Teaching Physics Manual.
http://192.239.146.18/resources/science/PSAM.html/

Classroom Assessment Example SCI.IV.3.MS.2

Each student will draw a picture of two teams of students playing tug-of-war. Using the words "balanced forces," "unbalanced forces," and "motion," each student will write an explanation of what happens when the tug-of-war teams both pull away from each other but there is no movement. Students should use arrows on the diagram to represent the forces of both teams. The stronger force should be represented by a larger arrow. Using the words "balanced forces," "unbalanced forces," and "motion," each student will write an explanation of what needs to happen for one team to be the winner of the tug-of-war.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.3.MS.2

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of description- forces in no movement situation	Identifies no balanced forces and incorrectly or incompletely draws force arrows on diagram.	Identifies both of the balanced forces and incorrectly or incompletely draws force arrows on diagram.	Identifies both balanced forces and correctly draws force arrows on diagram.	Provides clear and complete identification of balanced forces and correctly draws force arrows on diagram.
Accuracy of Description- forces in winning situation	Identifies none of the unbalanced forces and incorrectly or incompletely draws force arrow on diagram.	Identifies both of the unbalanced forces and incorrectly or incompletely draws force arrow on diagram.	Identifies both of the unbalanced forces and correctly draws force arrow on diagram.	Provides clear and complete identification of unbalanced forces and correctly draws force arrow on diagram.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 3. All students will describe how things around us move and explain why things move as they do; demonstrate and explain how we control the motions of objects; and relate motion to energy and energy conversions. (Motion of Objects)

Benchmark
Describe the non-contact forces exerted by magnets, electrically charged objects, and gravity **(**SCI.IV.3.MS.3).

Benchmark Clarification
Some forces are exerted from a distance with objects not touching. Examples of these forces are magnetic attraction or repulsion, attraction or repulsion between electric charges, and gravitational attraction.
These types of forces are called non-contact forces, because they occur between objects that don't touch. These forces can be demonstrated by the following:

The magnetic poles of a magnet (link to Glossary) will either repel or attract other magnet poles of another magnet. For example, the north pole of one magnet will repel the north pole of the other magnet (same thing will occur with two south poles), but the north pole of one magnet will attract the south pole of the other magnet.

Electrically charged objects (link to Glossary) will either repel other electrically charged objects if their charges are alike, such as a positively charged object near another positively charged object, or will attract other electrically charged objects, such as if one object is charged positively and the other negatively. Unlike charges attract, like charges repel.
Gravity is an attractive force that occurs between any two objects that have mass. These objects are attracted to each other (Moon held in orbit by the Earth). The greater the mass of the object, the stronger the gravitational pull. Increased distance between objects results in decreased gravitational pull.

Students will:

- Describe forces exerted from a distance with objects not touching.

Magnet (link to Glossary) any material, such as iron, that is able to produce and hold a magnetic field.

Electricaly Charged Object (link to Glossary) any object that carries either a positive charge or negative charge as a result of an imbalance in the number of charged particles which compose it.

See Forces and motion, (*link to SCI.IV.3.MS.2*).
See Weight and mass, (*link to SCI.IV.1.MS.2).*
See (*link to SCI.V.4.MS.2).*

Key Concepts (voc.)
Electrical charges and magnetic poles:
- North Pole
- South Pole
- positive charge
- negative charge
- mass
- weight
- gravitational pull

Charging by rubbing or touching
Electrical attraction and repulsion
Force depends on size of charges or masses, and decreases quickly with distance

Real-World Context
Electrically charged or polarized objects:
- balloons rubbed on clothing
- bits of paper
- salt grains
- static cling
- magnets
- magnetic materials
- Earth's gravitational pull on objects near its surface
- Sun's gravitational pull on solar system objects

Instructional Example SCI.IV.3.MS.3

Benchmark Question: What are the non-contact forces involved with magnets, electrically charged objects, and gravity?
Focus Question: How do magnets interact?

The teacher will ask students, "Between two magnets, where do pushes and/or pulls occur?" Students will discuss possible answers and reasons for their answers. Each student will write a prediction of how close two magnets must be before one magnet moves. Each small group will measure how close one magnet must be to another before the other one moves (any movement counts) using two similar magnets (any kinds) and a ruler. Each group will follow these procedures:
- Place a ruler flat on a desk.
- Place one magnet at the end of the ruler (zero cm).
- Place and slide a second magnet from the opposite end of the ruler until the first magnet moves (attracted or repelled).
- Repeat, using different magnetic end combinations, N to N, N to S, S to S, S to N.

Students will record their data and write their conclusions. Each group will present its data and the teacher will construct a graph of class data.

Students should conclude that the movement will occur at the same distance no matter what combination of poles is used. When like pole combinations are used, a push occurs, and when unlike pole combinations are used, a pull occurs.

Constructing: (*link to SCI.I.1.MS.1*), (*link to SCI.I.1.MS.3*), (*link to SCI.I.1.MS.4*).

Reflecting: (*link to SCI.II.1.MS.2*).

Resources/References:

Webliography
http://mtn.merit.edu/mcf/SCI.IV.3.MS.3.html

Mostly Magnets. AIMS.
http://www.aims.edu.org/aimscatalog/

Magnetism. TOPS.
http://topscience.org/

Mostly Magnets. AIMS.
http://www.aims.edu.org/aimscatalog/

Popping With Power. AIMS.
http://www.aims.edu.org/aimscatalog/

Classroom Assessment Example SCI.IV.3.MS.3

The teacher will give students several ring magnets and a pencil. Ask students, “What would happen if a student put two ring magnets on an upright pencil?”

Each student will write a prediction and then conduct the following investigation:.

Arrange various numbers of magnets and a pencil in various ways.

1. Draw and label observations.
2. Measure the spaces between the magnets.
3. Record data.
4. Write answers to the following questions based upon your observations:
    a. What patterns do you see in the behavior of the magnets and the spaces between them?
    b. What would happen if the pencil were not there?
    c. Why does the magnet float (occurs when the force of repulsion is balanced with the weight of the object) when on one side and not the other side?
    d. What happens to the spaces between the magnets as magnets are added?
    e. How can you make the top magnet jump off the pencil?
    f. What can you infer about magnets from this investigation?

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.3.MS.3

Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of answers	Answers fewer than two questions with some correct information.	Answers two to three questions correctly.	Answers all four questions correctly without contradictions.	Answers the four questions with complete responses and clear, coherent, unambiguous, and elegant explanations.
Accuracy of inference	Writes an inference with numerous inconsistencies and few consistencies.	Writes an inference that contains some consistencies.	Writes a complete and accurate inference.	Writes a complete and accurate inference based on past experimentation.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 3. All students will describe how things around us move and explain why things move as they do; demonstrate and explain how we control the motions of objects; and relate motion to energy and energy conversions (Motion of Objects)

Benchmark
Use electric current to create magnetic fields and explain applications of this principle. (SCI.IV.3.MS.4).

Benchmark Clarification
Electromagnets may be found in motors and generators. The Earth has a magnetic field at the North Pole and the South Pole. The location of the magnetic fields changes over time.
In an electromagnet, an electric current is applied through a conductive wire that creates a magnetic field around that wire.

A magnetic field is the area around a magnetic object where the force of the magnet can be detected. For example, if you take a wire, wrap it around an iron nail, and connect it to a battery it will result in a closed circuit. The electric current will create a magnetic field that will be able to pick up paper clips or other magnetic objects.

This same principle can be seen in junkyards (crane magnet) and doorbells. When a doorbell is pushed, a closed circuit results, causing the electromagnet to become magnetic; the armature (hammer that hits the bell) is then attracted to the electromagnet and hits the bell.
Students will:

- Construct an electromagnet
- Describe how an electromagnet works.

See Magnetic fields, (*link to SCIIV.1.MS.5).*

Key Concepts (voc.)

- electric current
- magnetic poles
- magnetic fields

Tools:

- magnetic compass
- battery
- wire

Real-World Context

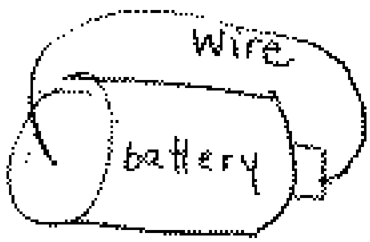
- electromagnets
- bells
- speakers
- motors
- magnetic switches
- Earth's magnetic field

Instructional Example SCI.IV.3.MS.4

Benchmark Question: How is electricity used to create a magnetic field?
Focus Question: Where is a magnetic field located in a simple circuit?

Small groups of students will place a navigational compass on a flat surface. They will pass a magnet near the compass, observe what happens, and discuss their observations.

Next, they will construct a simple circuit by using a 1.5 V battery and a twelve-inch length of bell wire (18-22 AWG insulated wire). Each student will write a prediction about where the magnetic field is located in the circuit. Then they will put a navigational compass flat on a desk or other flat surface. They will place the wire on top of the compass parallel to the needle and connect the battery to the ends of the wire. Each student will write observations of the movement of the compass needle. Students will compare and discuss results with the whole class.



After students have completed the activities, pairs of students will research and discuss one of the uses of electromagnets and the advantages and/or risks of those uses (MRI-magnetic resonance imaging, generators, etc.).

Note: When the circuit is connected, the battery gets hot and drains quickly. Limit connected time.

Constructing: (*link to SCI.I.1.MS.1*), (*link to SCI.I.1.MS.5*).

Reflecting: (*link to SCI.II.1.MS.3*), (*link to SCI.II.1.MS.4*).

Resources/References:
Webliography
http://mtn.merit.edu/mcf/SCI.IV.3.MS.4.html

Electrical Connections. AIMS.
http://www.aims.edu.org/aimscatalog/

Electrical Units. STC. Carolina Biological Supply,1988.
http://www.carolina.com/

Machine Shop. AIMS.
http://www.aims.edu.org/aimscatalog/

Magnetism and Electricity. Milliken, 1985.
Magnetism. TOPS.
http://www.topscience.com/

Mostly Magnets. AIMS.
http://www.aims.edu.org/aimscatalog/

Classroom Assessment Example SCI.IV.3.MS.4

After students have completed an investigation on electromagnets and their construction, they will experiment with the effects of different variables on the strength of an electromagnet. Working in groups, students will design and conduct an investigation to test the strength of their electromagnet designs. Each student will write a hypothesis and predict how many paperclips the electromagnet can pick up. They may change the number of wire wraps, the length of wire, core size (nail thickness), change in current, and tightness and space of wire on the core. Each group should experiment with a different variable and construct a chart that shows how changes in that variable affect the strength of their electromagnet and the number of paperclips it is able to attract. Each student will write a lab report describing the investigation.

After sharing and discussing their results with the rest of the class, students should choose two of the variables and write an essay that discusses the following: the affect these variables have on the strength of the electromagnet, the number of wire wraps, the length of wire, the core size (nail thickness), the change in current, and the tightness and spacing of wire on the core.

See *(resource link to Electrical Connections)*.

Scoring of Classroom Assessment Example SCI.IV.3.MS.4

Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of ideas	Explanation contains few correct ideas.	Explanation contains some correct ideas.	Explanation contains many correct ideas.	Explanation contains all correct ideas.

Science Benchmark Clarification, Instruction, and Assessment

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 3. All students will describe how things around us move and explain why things move as they do; demonstrate and explain how we control the motions of objects; and relate motion to energy and energy conversions. (Motion of Objects)

Benchmark
Design strategies for moving objects by application of forces, including the use of simple machines (SCI.IV.3.MS.5).

Benchmark Clarification
A simple machine is a device, such as a lever, pulley, screw, etc., for controlling the application of forces. For example, a lever can transform a small downward force into a large upward force. A small twisting force on a screw can transform into a large penetrating force into a piece of wood.

The only disadvantage for simple machines is that an external force must be applied over a greater distance in order to move an object a small distance. With a lever, a force must push down on the lever at a longer distance to lift an object a smaller distance. A screw must be twisted many times in order to move it into a piece of wood a shorter distance.

Students will:
Design strategies for moving objects using simple machines (e.g., moving furniture from a second story)

Key Concepts (voc.)
Types of simple machines:

- lever
- pulley
- screw
- inclined plane
- wedge
- wheel and axle
- gear

Other Key Concepts:

- direction change
- force advantage
- speed and distance advantage

Real-World Context
Objects being moved by using simple machines:

- wagons on inclined planes
- heavy objects moved by levers
- see-saw

Instructional Example SCI.IV.3.MS.5

Benchmark Question: How can we control the motions of objects?
Focus Question: How can we use simple machines to make work seem easier?

Students will work in small groups to complete the following activities:
Students will pound a large nail into a piece of wood. The teacher should make sure they leave at least three cm of the top of the nail above the board. Students will try to remove the nail with their fingers and then with the claw of a hammer. Students will discuss the difference in effort needed to remove the nail with their fingers and with the hammer claw. How and why did the hammer make the job easier?

Next, students will screw a screw into a piece of wood. Students will try to unscrew the screw with their hand and then with a screwdriver. Students will discuss the difference in effort needed to remove the screw with their fingers and with the screwdriver. How and why did the screwdriver make the job easier?

Caution: Make sure that all students wear safety glasses during this activity.

Constructing: (*link to SCI.I.1.MS.1*), (*link to SCI.I.1.MS.4*).

Reflecting: (*link to SVI.II.1.MS.3).*

Resources/References:

Webliography
http://mtn.merit.edu/mcf/SCI.IV.3.MS.5.html

Brick Layers. AIMS.
http://www.aims.edu.org/aimscatalog/

Friction/Simple Machines. Bill Nye Video. Disney Educational (800/295-5010).

Machine Shop. AIMS.
http://www.aims.edu.org/aimscatalog/

Momentum/Gravity. Bill Nye Video. Disney Educational *(800/295-5010).*

OPERATION PHYSICS.

Classroom Assessment Example SCI.IV.3.MS.5

The following assessment can be used at the end of the pulley section of the simple machine unit.
The teacher will read the following scenario to the class:

A man has fallen into a deep hole with slippery sides. He has tried but cannot climb out. Before falling into the hole, he left a long rope, two fixed pulleys, and two movable pulleys on the ground above. Traveling with the man was his small son. The man can shout directions to his son but his son cannot pull him out or run for help. There are no ladders or anyone else to help. The only way out is to use the pulleys and rope.

Each student will write out directions that explain to the son what to do in order to get the man out of the hole and will draw a picture of the procedure to get the man out of the hole.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.3.MS.5

Criteria	Apprentice	Basic	Meets	Exceeds
Completeness of directions	Writes few directions with no details.	Writes most steps of the directions in correct order using pulleys and including a few details.	Writes step-by-step directions in correct order using pulleys and including some details.	Writes step-by-step directions in correct order using pulleys and including many details.
Correctness of diagram	Draws a partial diagram with no labels.	Draws a diagram with most information correct and a few labels.	Draws a diagram that includes the proper set-up and use of pulleys with some labels.	Draws a diagram that includes the proper set-up and use of pulleys with all labels.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 4. All students will describe sounds and sound waves; explain shadows, color, and other light phenomena; measure and describe vibrations and waves; and explain how waves and vibrations transfer energy. (Waves and Vibrations)

Benchmark
Explain how sound travels through different media (SCI.IV.4.MS.1).

Benchmark Clarification
Sound energy is transferred when vibrating molecules hit other molecules, causing the other molecules to move and transferring energy. Since sound energy is transferred through matter, sound needs a medium *(Link to Glossary)* to be transmitted. Sound cannot travel through a vacuum (absence of matter).

In a gas, the molecules are far apart with unrestricted motion, which results in a slower transmission of sound waves. In a liquid, the molecules are closer together than in a gas, which allows sound to travel faster.

In a solid, the molecules are tightly packed together and more molecules bounce off each other and return to their original position, which allows an even faster transmission of sound.

Students will:
- Describe the difference in the transmission of sound through different media (solids, liquids, and gases)

Medium matter through which energy, such as light and sound, passes

Key Concepts (voc.)
Media:
- solids
- liquids
- gases

Vacuum

Real-World Context

Sounds traveling through solids:
- glass windows
- strings
- the Earth

Sound traveling through liquids:

- dolphin and whale communication

Sound traveling through gases:

- human hearing
- sonic booms

Instructional Example SCI.IV.4.MS.1

Benchmark Question: How does sound travel through different media?
Focus Question: How does sound travel differently in solids and gases?
The teacher might let students experiment by holding vibrating objects against various parts of their heads (e.g., chin, jawbone) to discover that sounds may reach the ear through solid parts of the body (e.g., bones). Students will discuss why, historically, Native Americans put their ears to the ground to listen for hoof beats. Students will discuss possible advantages for animals that live underground.

- Students will work in small groups and conduct the following investigations: Place a vibrating object (watch, tuning fork, music box, metronome, buzzer) in the center of a table. Try to hear its sound from a meter away
- Rest one end of a meter stick on the vibrating object
- Take turns placing an ear against the other end (Students should hear the sound more clearly)
- Place an ear on top of a table and listen to the vibrating object
- Students will answer in writing the question, "Does the medium affect the quality of the sound that is produced?" "How?"

Constructing: (*link to SCI.I.1.MS.1*).

Reflecting: (*link to SCI.II.1.MS.5*).

Resources/References:

Webliography
http://mtn.merit.edu/mcf/SCI.IV.4.MS.1.html

Primarily Physics. AIMS.
http://www.aims.edu.org/aimscatalog/

Sound/Light & Color. Bill Nye Video. Disney Educational (800/295-5010).

Sound waves through solid objects
http://www.mcrel.org/whelmers/#76 "Bells in Your Ears"/

Sound waves through gases .
http://www.mcrel.org/whelmers/#11 "Straw Oboes"/

Classroom Assessment Example SCI.IV.4.MS.1

After students have described the differences in the particles composing solids, liquids, and gases and have examined several musical instruments, they will work in small groups and conduct an investigation that answers the question, "How is sound transmitted by a telephone?"

Each group will make a cup phone consisting of two plastic cups and a piece of string held between the cups.
Students will take turns and whisper to one another from a fixed distance. One student will speak into one cup while another student listens for the first student's voice in the other cup. Students will test different distances.

Each student will complete a lab report that includes answers to the following questions:

1. How is sound transmitted from one cup to the other?
2. Why is sound not transmitted when the string is held by one of the students?
3. What is the difference in transmission through different mediums such as air vs. string?

Students should include the following terms in their writings: particles or molecules of matter, vibration, and collisions between particles.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.4.MS.1

Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of explanation	Explains how a cup phone works using the term "vibration" but does not connect particles and collisions to that vibration.	Explains how a cup phone works using the term "vibration" and connects particles or collisions to that vibration.	Explains how a cup phone works using the three criteria (terms from the assessment).	Explains how a cup phone works using the three criteria (terms from the assessment) and explains conditions that would prevent the cup phone from working and the reasons why.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 4. All students will describe sounds and sound waves; explain shadows, color, and other light phenomena; measure and describe vibrations and waves; and explain how waves and vibrations transfer energy. (Waves and Vibrations)

Benchmark
Explain how echoes occur and how they are used (SCI.IV.4.MS.2).

Benchmark Clarification

Echoes occur when sound waves are reflected (bounced off) a large object. The absence of an echo means the sound waves are absorbed and not reflected back to the ear or the reflecting object is too close to produce an echo. The controlling of echoes (reflected sound) in a room or building is called acoustics.

Echoes have many uses. With sonar, a sound wave is reflected back and received by a receiver. By using this device one can measure how far an object is from the sonar device. Sonar is used by bats to locate objects. Sonar is also used in medicine (ultrasound) and in recreation (fish-finders).

Students will:
- Explain how echoes occur
- Describe how echoes are used.

Key Concepts (voc.)
- echo
- sonar
- reflection

Real-World Context
Echoes in rooms:
- acoustics
- outdoors

Practical uses of echoes:
- navigation by bats and dolphins
- ultrasound imaging
- sonar

Instructional Example SCI.IV.4.MS.2

Benchmark Question: How do echoes occur and how are they used?
Focus Question: How can an echo be heard when a sound is made in an echo-producing place (hallway, stairwells, gym, auditorium, etc.) around the school?

Take students on a field trip to an echo-producing place in or around school. Once in place, students need to produce an echo by clapping two wooden boards together and should note the following: the distance from the reflecting surface, the type of reflecting surface, and any objects that might interfere with the sound's reflection (See Benchmark Clarification). Discuss what conditions are needed to produce an echo.

Constructing: (*link to SCI.I.1.MS.1*), (*link to SCI.I.1.MS.3*), (*link to SCI.I.1.MS.4*).

Reflecting: None.

Resources/References:

Bats Incredible. AIMS.
http://www.aims.edu.org/aimscatalog/

Weisler, Jules. *Physical Science Worktext*.
http://amscopub.com/

Classroom Assessment Example SCI.IV.4.MS.2

Students will sketch and label their location in a setting where an echo was produced. The following should be noted for each location: distance from the reflecting surface, the type of reflecting surface, and any objects that might interfere with the sound reflection. Students will then present and explain this information to the teacher.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.4.MS.2

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of explanation	Identifies some of the conditions needed to produce an echo and explanation is incomplete.	Identifies and explains conditions needed to produce an echo or simply identifies conditions.	Identifies and explains all conditions needed to produce an echo (appropriate distance, reflecting sound waves, and appropriate reflecting surface).	Identifies and explains all conditions needed to produce an echo (appropriate distance, reflecting sound waves, and appropriate reflecting surface) and determines that the distance must be greater than seventeen meters.

Strand: IV. Use Scientific Knowledge form the Physical Sciences in Real-World Contexts

Content Standard: 4. All students will describe sounds and sound waves; explain shadows, color, and other light phenomena; measure and describe vibrations and waves; and explain how waves and vibrations transfer energy. (Waves and Vibrations)

Benchmark
Explain how light is required to see objects (SCI.IV.4.MS.3).

Benchmark Clarification
When an object reflects light waves it is said to be illuminated. In order to see these objects, the light waves travel in a straight path and are received by the eye. A red sheet of paper appears red because red light is reflected off the paper, while all other colored light (orange, yellow, green, blue, indigo, violet) is absorbed by the paper. An object can be seen because of emitted or reflected light. In a "perfectly dark" room, an object cannot be seen because no light is reflected.

Students will:
- Demonstrate an understanding of how light is required to see objects

Key Concepts (voc.)
- light source
- object
- eye as detector
- illumination
- path of light
- reflection
- absorption

Real-World Context
- seeing common objects in our environment
- seeing "through" transparent media:
  - windows
  - water
- using flashlights to see in the dark

Instructional Example SCI.IV.4.MS.3

Benchmark Question: How is light required to see objects?
Focus Question: What must happen to light in order for a person or other animal to see objects?

Students will discuss the following situations:

Coal miners wear helmets with lights. Why is the light necessary for the job?
Sometimes it is easy to see at night; sometimes it is not. Why?

Students will work in small groups and conduct the following investigations that answer the question, "What must happen to light in order for a person or other animal to see light?" Each student will write a hypothesis before beginning the investigation.

1. Cut a 6.0 cm (2.5 inch) square door in one side of a shoebox.
   A. Cut a peep hole in the other end of the shoebox..
   B. With the door closed, students should describe what they see.
   C. With the door open, students should describe what they see .
   D. Put a small object in the box..
   E. Have one student open and close the door while another discovers what is in the box.

Through repetition, students will discover that they can see only when light is present.

Students will write answers to the following questions:

- What do you see when the door is closed?
- What do you see when the door is open?
- Why is there is a difference between the first and second question above?

(Extension: Have students use colored filters or cellophane and observe results.)

Constructing: (*link to SCI.I.1.MS.1*).

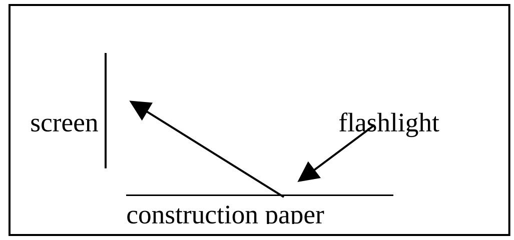
Reflecting: (*link to SCI.II.1.MS.3).*

Resources/References:

Webliography.
http://mtn.merit.edu/mcf/SCI.IV.4.MS.3.html/

Gore, Gordon. *Light & Colour*. EXPERIMENTING WITH…SERIES. Trifolium Books, 2001.

Classroom Assessment Example SCI.IV.4.MS.3



Students will work in small groups and conduct the following investigation to answer the question, “Which color paper reflects light the best?”

A. As seen in the diagram, a white screen (made of white cardboard or paper) should be placed on the table at an angle.
   In a darkened room:
B. Observe how a black sheet of paper reflects light by shining a flashlight on a piece of black construction paper lying flat on the table.
C. Observe how a white sheet of paper reflects light by shining a flashlight on a piece of white construction paper lying flat on the table.
D. Students should repeat this procedure with different colored sheets of paper.

Students will record their results in lab reports and answer the following questions:

1. Which color light reflects the most light?
2. Which color paper reflects the least light?
3. What must happen to light in order for a human to see an object (describe the path)?

NOTE: If you were to replace the screen in the diagram with an observer, this activity would explain correctly how the reflection of light off an object results in the observer’s ability to see that object.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.4.MS.3

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of explanation	Identifies white as brightest and black as dimmest but gives only partial explanation.	Identifies white as brightest and black as dimmest but only explains one of them.	Identifies white as brightest because it reflects more light and black as dimmest because it reflects a little light and absorbs most.	Identifies white as brightest and black as dimmest with a correct explanation and describes the image on the screen as diffused and explains why.
Accuracy of description - path of light	Identifies few parts of the path of light needed to see an object and uses few key terms correctly.	Identifies some part of the path of light needed to see an object and uses some key terms correctly.	Identifies all parts of the path of light needed to see an object and uses many key terms correctly.	Identifies all parts of the path of light to see an object and uses all key terms correctly.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 4. All students will describe sounds and sound waves; explain shadows, color, and other light phenomena; measure and describe vibrations and waves; and explain how waves and vibrations transfer energy. (Waves and Vibrations)

Benchmark
Describe ways in which light interacts with matter (SCI.IV.4.MS.4).

Benchmark Clarification
Light interacts with matter in many ways:

- Light can be reflected (bouncing off). This can be seen when a flashlight is shone on a mirror. It is through the reflection of light that we see objects and colors.
- Light can also be refracted (bending of light as it passes through a medium, e.g., lenses, prisms, water, air). One can see this principle when trying to grab something in the water and it is actually in a different position than perceived.
- Light can be transmitted (light passes through an object). If light passes straight through a medium (*link to Glossary*) and the object can be seen clearly, the medium is said to be transparent. If light is scattered as it passes through a medium and the object is distorted or hazy, the medium is said to be translucent. If the light does not pass through the medium and is absorbed and/or reflected, the object isn't seen and the medium is said to be opaque.

Students will:
- Describe the many ways light interacts with matter.

Medium: matter through which energy, such as light an sound, passes.

Key Concepts (voc.)
- reflection
- refraction
- absorption
- transmission
- scattering (or diffusion)
- medium
- lens

Transmission of light:
- transparent
- translucent
- opaque

Real-World Context
Objects that reflect or absorb light, including mirrors

Media that transmit light:
- clear and frosted glass
- clear and cloudy water
- clear and smoky air

Objects that refract light:
- lenses
- prisms
- fiber optics

Uses of lenses:
- eyes
- cameras
- telescopes
- microscopes
- magnifying lenses for magnification and light gathering

Instructional Example SCI.IV.4.MS.4

Benchmark Question: How does light interact with matter?
Focus Question: What happens to light when it is reflected, refracted, or transmitted?

The teacher will explain the terms: transparent, translucent and opaque. Students will brainstorm examples of materials that have these characteristics. Students will shine flashlights in a darkened room on a variety of transparent, translucent, and opaque objects (mirrors, plastic, clear water, water with a drop of milk, wood block, prism, etc.). With a partner, each student will classify objects into three categories based upon the way light does or does not pass through them.

As a class, students will discuss situations in the real world in which light is reflected (mirror/ calm water), refracted (light passing through water in a pool causing the perceived position of an object to be different from its actual position), and transmitted (stained glass window).

Students will use their knowledge of light and write a paragraph that explains a desert mirage.).

Constructing: (*link to SCI.I.1.MS.1*).

Reflecting: (*link to SCI.II.1.MS.3*).

Resources/References:

Webliography
http://mtn.merit.edu/mcf/SCI.IV.4.MS.4.html
DiSpezio, Michael. *Awesome Experiments in Light & Sound*. Sterling Publications, 1999.

Ray's Reflections. AIMS.
http://www.aims.edu.org/aimscatalog/

Sound/Light & Color. Bill Nye Video. Disney Educational (800/295-5010).

Zubrowski, Bernie. *Mirrors: Finding Out About the Properties of Light*. BOSTON CHILDREN'S MUSEUM ACTIVITY BOOK. Morrow, 1992.

Classroom Assessment Example SCI.IV.4.MS.4
Students will be given a diagram of a pencil placed in a four hundred ml beaker of water at an angle other than ninety degrees. This diagram will also include the incoming rays of light. Each students will draw the rays of light that are reflected, refracted, and transmitted from the beaker and pencil and write a paragraph that describes the behavior of the light rays.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.4.MS.4

Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of diagram	Draws one ray of light correctly.	Draws two of the three rays correctly.	Draws three rays of light correctly.	Draws three rays of light correctly.
Accuracy of description	Describes one light behavior correctly.	Describes one or two light behaviors correctly.	Describes all behaviors correctly and clearly.	Describes all behaviors correctly and clearly; explains why the pencil image is bent.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 4. All students will describe sounds and sound waves; explain shadows, color, and other light phenomena; measure and describe vibrations and waves; and explain how waves and vibrations transfer energy. (Waves and Vibrations)

Benchmark
Describe the motion of vibrating objects (SCI.IV.4.MS.5).

Benchmark Clarification
The motion of vibrating objects may be described by using the following terms:

- **Period:** the time it takes for one complete swing of a pendulum (back and forth) or one vibration
- **Frequency:** the number of periods or vibrations for a given time
- **Amplitude:** the distance the pendulum is "pulled out" from an at rest position

For example, the motion of a tuning fork can be described in the following way:

One vibration of the tines represents the period. The more vibrations the tines of the tuning fork make during a certain time period, the higher the frequency. The harder the tuning fork is struck, the higher the amplitude will be. This can be heard by an increase in loudness or volume with no change in pitch.

Students will:
- Describe the motion of vibrating objects using the following terms:
  - Period (*link to Glossary*)
  - Frequency (*link to Glossary*)
  - Amplitude (*link to Glossary*)

Key Concepts (voc.)
- period
- frequency
- amplitude

Real-World Context
Vibrating or oscillating objects:
- weights on springs
- vocal cords
- tuning forks
- guitar strings

Instructional Example SCI.IV.4.MS.5

Benchmark Question: How may the motion of vibrating objects be described by frequency, period, and amplitude?
Focus Question: How is the motion of vibrating objects related to sound?

Students will work in small groups to design and conduct an investigation that answers the Focus Question.
Each student will write a hypothesis before beginning the investigation. Then students will follow these procedures:

1. Stretch a rubber band tightly around three nails in a board.
2. Hang several small strips of paper, creased in half, over one section of the rubber band.
3. Pluck the section.
4. Observe how the paper strips move.
5. Measure how long a guitar string vibrates after it can no longer be heard.

Each student will write a lab report describing the investigation.

Extension: Give students various toys that make sound. Have them investigate the differences in pitch and loudness and how they can be changed. Similarly, strips can be placed over the different strings of string instruments.

Constructing: (*link toSCI.I.1.MS.1*), (*link to SCI. I.1.MS.3*).

Reflecting: (*link to SCI.II.1.MS.2*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.IV.4.MS.4.html/

Hisorical Connections.AIMS.
http://www.aims.edu.org/aimscatalog/

Popping With Power. AIMS.

Waves/Wind. Bill Nye Video. Disney Educational (800/295-5010).

Classroom Assessment Example SCI.IV.4.MS.5

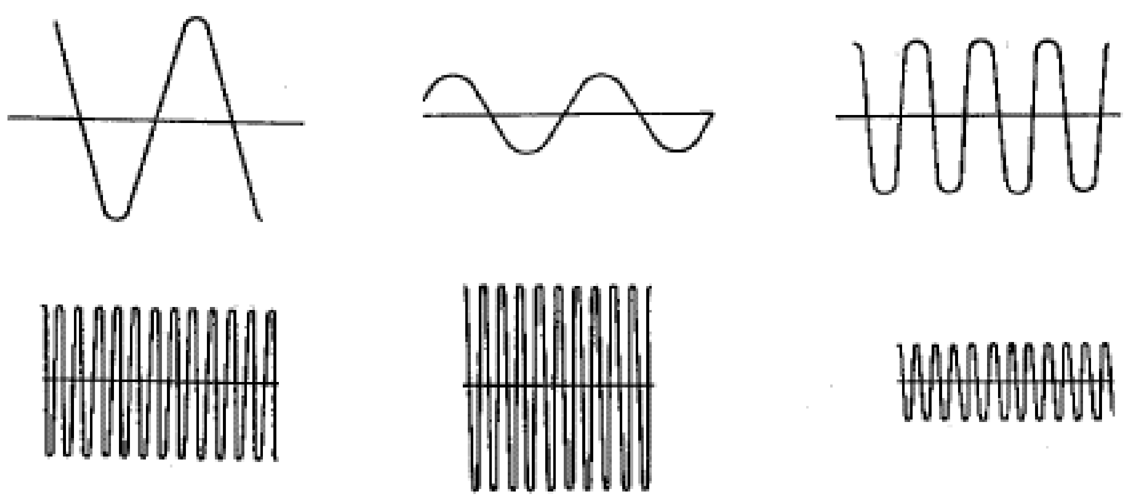
The teacher will give students pictures of sound waves produced by an oscilloscope or diagrams of sound waves that represent different sounds. Each student will write responses to the following questions on frequency, period, and amplitude:

1. Which wave was produced by the object with the longest period? How do you know?
2. Which wave had the greatest amplitude? How do you know?
3. Which wave was produced by the object with the highest frequency? How do you know?
4. Which wave produced the highest pitched sound? Why?

A. **B.** **C.**

F.

D. **E.**



(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.4.MS.5

Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of identification	Identifies one picture correctly.	Identifies two pictures correctly.	Identifies three pictures correctly.	Identifies four pictures correctly.
Accuracy of explanation	Writes one correct conclusion based on incorrect or no information.	Writes two correct conclusions based on some correct information.	Write three to four correct conclusions Based on some correct information.	Writes five to six correct conclusions based on all correct information.

Strand: IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts

Content Standard: 4. All students will describe sounds and sound waves; explain shadows, color, and other light phenomena; measure and describe vibrations and waves; and explain how waves and vibrations transfer energy. (Waves and Vibrations)

Benchmark
Explain how mechanical waves transfer energy (SCI.IV.4.MS.6).

Benchmark Clarification
Energy is transferred in mechanical waves (*link to Glossary*) via a medium (e.g., slinky, water waves, the Earth's crust as a result of an earthquake) when molecules of matter bump into each other and transfer their energy. Matter interacts with energy by absorption (*link to Glossary),* transmission (*link to Glossary*), or reflection (*link to Glossary*).

Students will:
- Identify a mechanical wave

Explain how a mechanical wave transfers energy.

See Electrical circuits transfer electrical energy, (*link to SCI.IV.1.MS.6).*

Absorption: energy that is taken in by matter
Transmission: the transfer of energy from one molecule to another through a medium
Reflection: the bouncing back of energy
Mechanical wave: waves that disturb a medium; a way of transferring energy through a medium such as through air, water or metals; these waves cannot pass through a vacuum(no medium); examples are sound waves and water waves.

Key Concepts (voc.)
- sound energy
- absorption
- transmission
- reflection

Media:
- air
- solids
- water

Real-World Context
Waves in slinkies and long springs:
- sound waves
- water waves
- earthquakes

Instructional Example SCI.IV.4.MS.6

Benchmark Question: How do mechanical waves transfer energy?
Focus Question: How is energy transferred through a medium?

The teacher will present a demonstration to the whole group or ask small groups to conduct investigations following the procedures below:

1. Stretch a slinky across the floor.
2. Quickly push the slinky forward and pull it quickly back to its original position.
3. Describe the motion of the coils in a slinky.
4. Put a piece of tape on one of the coils.
5. Describe the motion of the tape and the motion of the coil.
6. Repeat this motion.
7. Record observations of the movement of the wave through the entire slinky (reflection).
8. Record observations of how the coils interact with one another to produce the wave.

Each student will write a lab report that includes answers to the following questions:

- How is the energy transferred from one end of the slinky to the other (collision of one coil into another)?
- What do the coils represent (the particles of matter in a medium)?
- How is this movement like an earthquake wave?
- How is this movement like a water wave?
- How is this movement like a sound wave?

Extension: Have students research the use or effects of waves in real-world situations (e.g., the new technologies used in building earthquake-resistant buildings, in ultrasound technology, in lithotriptors, in sonar, etc.

Constructing: (*link to SCI.I.1.MS.1*), (*link to SCI.I.1.MS.5*).

Reflecting: (*link to SCI.II.1.MS.3*), (*link to SCI.II.1.MS.4*), (*link to SCI.II.1.MS.5*).

Resources/References:

Webliography.
http://mtn.merit.edu/mcf/SCI.IV.4.MS.4.html/

DiSpezio, Michael. *Awesome Experiments in Force & Motion*. Sterling Publications, 1999.
Gartrell, Jack.. *Methods of Motion: An Introduction to Mechanics: Book One*. NSTA, 1998.

Machine Shop. AIMS.
http://www.aims.edu.org/aimscatalog/

Classroom Assessment Example SCI.IV.4.MS.6

Using their bodies as particles, students will work in groups of six to eight to prepare demonstrations showing how a mechanical wave can be transmitted from one person to another. Each group will present to the class.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.IV.4.MS.6

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of demonstration	Interprets some information correctly. (Particles move too much or not enough to transfer energy.)	Provides an interpretation with some understanding of how the particle motion is related to the transmission of the wave's energy. (Particles move back and forth while their position changes only slightly.)	Provides a correct interpretation of how the vibration of the particles of matter transmits the wave's energy. (Particles move back and forth while their position changes only slightly, causing the wave to move from one end of the chain to the other.)	Provides a thorough and accurate interpretation of a mechanical wave continuing to transfer energy as the source of the vibration causes the particles of matter to continue to vibrate. (Particles move back and forth while their position changes only slightly. The wave moves from one end of the chain of students to the other and back again.)