



Comprehensive Curriculum

Revised 2008

Grade 6 Science



Louisiana Department of
EDUCATION

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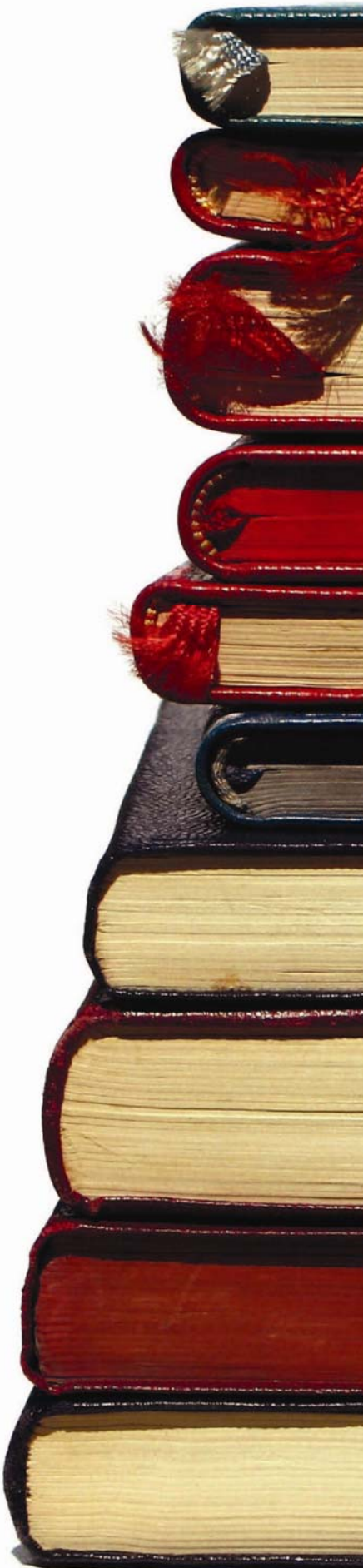


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Louisiana Comprehensive Curriculum, Revised 2008 **Course Introduction**

The Louisiana Department of Education issued the *Comprehensive Curriculum* in 2005. The curriculum has been revised based on teacher feedback, an external review by a team of content experts from outside the state, and input from course writers. As in the first edition, the *Louisiana Comprehensive Curriculum*, revised 2008 is aligned with state content standards, as defined by Grade-Level Expectations (GLEs), and organized into coherent, time-bound units with sample activities and classroom assessments to guide teaching and learning. The order of the units ensures that all GLEs to be tested are addressed prior to the administration of *iLEAP* assessments.

District Implementation Guidelines

Local districts are responsible for implementation and monitoring of the *Louisiana Comprehensive Curriculum* and have been delegated the responsibility to decide if

- units are to be taught in the order presented
- substitutions of equivalent activities are allowed
- GLEs can be adequately addressed using fewer activities than presented
- permitted changes are to be made at the district, school, or teacher level

Districts have been requested to inform teachers of decisions made.

Implementation of Activities in the Classroom

Incorporation of activities into lesson plans is critical to the successful implementation of the Louisiana Comprehensive Curriculum. Lesson plans should be designed to introduce students to one or more of the activities, to provide background information and follow-up, and to prepare students for success in mastering the Grade-Level Expectations associated with the activities. Lesson plans should address individual needs of students and should include processes for re-teaching concepts or skills for students who need additional instruction. Appropriate accommodations must be made for students with disabilities.

New Features

Content Area Literacy Strategies are an integral part of approximately one-third of the activities. Strategy names are italicized. The link ([view literacy strategy descriptions](#)) opens a document containing detailed descriptions and examples of the literacy strategies. This document can also be accessed directly at <http://www.louisianaschools.net/1de/uploads/11056.doc>.

A *Materials List* is provided for each activity and *Blackline Masters (BLMs)* are provided to assist in the delivery of activities or to assess student learning. A separate Blackline Master document is provided for each course.

The *Access Guide to the Comprehensive Curriculum* is an online database of suggested strategies, accommodations, assistive technology, and assessment options that may provide greater access to the curriculum activities. The *Access Guide* will be piloted during the 2008-2009 school year in Grades 4 and 8, with other grades to be added over time. Click on the *Access Guide* icon found on the first page of each unit or by going directly to the url <http://mconn.doe.state.la.us/accessguide/default.aspx>.



**Grade 6
Science
Unit 1: Building a Better Scientist**

Time Frame: Approximately two weeks



Unit Description

This unit is designed to build a foundation of learning and investigation that will serve the teacher and the students in the units that follow.

Student Understandings

The students will develop a foundation of science skills that include measurement, classification, setting up and using a science learning log, investigation procedures, safe science practices, documenting science observations, and working in cooperative groups. Students will also practice note-taking skills using the literacy strategy of split-page notetaking.

Guiding Questions

1. Can students accurately use measurement tools to collect quantitative data?
2. Are students able to describe and classify common objects by their attributes?
3. Does the student’s science learning log reflect their attention to the details of science, a consistent and legible recording of their observations and investigations, and does it adhere to the guidelines established by the teacher for format?
4. Does the student create concise, legible notes when using a written resource or text?
5. Do students practice safe science, and are they able to identify safety concerns?

Unit 1 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry GLEs are embedded in the suggested activities for this unit. Other activities incorporated by teachers may result in additional SI GLEs being addressed during instruction.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
4.	Design, predict outcomes and conduct experiments to answer guiding questions (SI-M-A2)

GLE #	GLE Text and Benchmarks
5.	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
10.	Identify the difference between description and explanation(SI-M-A4)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
23.	Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8)
25.	Compare and critique scientific investigations (SI-M-B1)
31.	Recognize that there is an acceptable range of variation in collected data (SI-M-B3)
32.	Explain the use of statistical methods to confirm the significance of data (e.g., mean, median, range) (SI-M-B3)
33.	Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
34.	Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5)
36.	Explain why an experiment must be verified through multiple investigations and yield consistent information before the findings are accepted (SI-M-B6)
37.	Critique and analyze their own inquiries and the inquiries of others (SI-M-B5)
Physical Science	
1.	Measure and record the volume and mass of substances in metric system units. (PS-M-A1)
19.	Identify forces acting on all objects)PS-M-B3)
20.	Draw and label a diagram to represent forces acting on an object (PS-M-B4)
33.	Predict the direction in which light will refract when it passes from one transparent material to another. (e.g. from air to water, from prism to air) (PS-M-C4)
35.	Determine through experimentation whether light is reflected, transmitted, and/or absorbed by an object or material. (PS0M-C4)

Sample Activities

Activity 1: Questions, Questions! (SI GLEs: 7, 19, 22, 23, 31, 34)

Materials List: We're all Different! We're the Same BLMs, pencils, group sets of assorted objects (i.e., buttons, carnival trinkets, shells, dried beans, old mis-cut keys from the hardware store, etc.), loose-leaf paper. Each set should be in a small sealable bag and should include 20-30 objects for each group of students. It is preferable for each group to have the same kinds of items.

This activity is completed over two days. Use three days if the students are extremely involved in the classification process.

Day 1

Arrange all students into groups of four to six. Give each group page one of the We're all Different *graphic organizer* ([view literacy strategy descriptions](#)) BLM. The BLM will accommodate two students, so distribute enough so all group members will have a space to record their information. Each member of the group writes their name near a box on a page. Challenge them to talk and ask questions of each other to identify how each member of the group is different from all the others in that group. This activity does get a little noisy if it is really working well.

Each student must record eight (8) things that make them different from everyone else. Keep the group paper moving as team members identify attributes to record so that no one student is waiting for another to complete their list. Challenge them to consider personal experiences, families, pets, likes, dislikes, accomplishments, trips, transportation, birth order, and such to really dig for the differences. Give the groups about 20-30 minutes to go through this process.

When groups have completed all member lists, have each person select two items from their list to share with the entire class; however, if something they have chosen to share is said by another member of the class, they must choose again from their list. (This keeps everyone listening, a great science skill!) Move quickly through the sharing so that page two can be completed during this first class period.

When all have shared, give each group copies of the next graphic organizer, We're All the Same! BLM and have them identify ten (10) things that make them all the same. They may be able to use some of the information they tossed out in the first exercise in questioning. This process usually goes more quickly but if it slows down and time is a concern, stop the activity when teams have listed 6 or 8 similarities. Have each group share two ways in which they are all the same, and again, do not allow repeat information.

These are the points to be made during closure of this activity:

- Scientists sometimes ask questions to collect information, keeping the usable information and putting aside that information they cannot use at that time. Good questioning gets better information.

- Sharing information is part of the scientific process and allows us to add to the bigger pot of information.
- Scientists classify everything in our world and looking at details, differences, and similarities is the process they use to construct classification systems.

Day 2

Use the same teams already established for the Day 1 activity. Give each team a bag of objects. The teacher will model good safety practices and should begin by establishing safety guidelines for the use of small objects, respecting toys as science tools, staying on task, and using the materials as intended. It is preferable to have the same types of objects for each group, but if difficulty is encountered in gathering this large collection, use several smaller ones.

Have each group identify as many different ways to classify the objects as possible (i.e., keys that have square holes in the top), listing all attributes used for classifying to compare with the other group lists. Have the students list all groupings on the loose leaf and label with their group number or student names. Color can be eliminated as a classification so as to challenge the students to think beyond the obvious and to look to the smaller details for classification ideas.

Move amongst the students and guide them to look for not-so-obvious details to group. If they seem to be “stuck,” guide the group members to consider identified details to get them back on track. Example: “Why did I group these five keys together?” (*Answer: They all have a number 4 on them.*) Leave them with the challenge and only tell them the answer after they have struggled with the challenge and ask for the answer. Move around the room while they work on their solutions. Students may separate the whole collection into several groups and then not look any further. Encourage them to always put the entire collection back together to look for new classification patterns.

When they seem to have exhausted as many ways to group or classify the objects, have each group select three ways to classify the objects to share with the rest of the class, remembering to choose a new grouping if someone names one they have selected to share. This works best if all groups have the same types of items in their bags (keys, bottle tops, doubloons, buttons, etc.).

Points for closure include the following:

- Scientists have to keep looking for details to make certain every attribute of an object is considered for classification.
- Scientists working together can pool their observations to include better information.
- Observations, like questioning, can lead scientists to information that can be used or that makes it necessary to re-evaluate and do more observations.

This activity can lead very nicely into constructing dichotomous keys. Students would divide their bag of items into two groups, then take one group and divide that by attributes into two groups, then select one of those groups to divide into two groups by attributes, and so on and so on, until they are down to one item. This skill is introduced in grade 5 but more exposure strengthens it significantly.

Activity 2: Collecting Data (SI GLEs: 2, 6, 8, 11, 12, 19, 22, 23; PS GLEs: 1)

Materials List: scales (triple beam balance recommended), coffee filter papers, large spoons or measuring scoops, disposable paper bowls, colored aquarium gravel, sand, charcoal
Optional additional materials: plaster of Paris (1 cup or a metric equivalent for each group), water, stirring (craft) sticks, graduated cylinder to measure water, measuring cup /scoop for plaster, goggles for each student, paper and pencils to use for making data charts

The teacher is still *modeling* good safety practices and sets the safety standards at the beginning of this unit. Review safety concerns for this lab (e.g., carefully scoop and measure all materials, provide for clean up in case of a spill, do not sniff or taste any materials, use goggles during the entire lab, and keep materials away from the edge of the table).

Distribute the scales to each group or set up a station at which measurements can be made. Set all materials out at a supply table and include a scoop in each container. Put the 1 cup measuring cup scoop in the plaster of Paris powder, if used. Students need to consider all problems they may have with collecting measurement data and maintaining consistency with their measurements. Teach each group to “zero out” the scales so they can be certain their data is always as accurate as possible when using this measuring tool.

Have students take one scoop of each material and place it in a coffee filter paper to be measured on the scale. Students should measure one scoop of each material in a separate coffee filter paper each time. Instruct students to create a data table with a column for each material (sand, gravel, charcoal, filter, bowl, optional water and plaster, total) and a place to record the measurements of each in grams. When they have collected and measured each substance, have them pick up a disposable paper bowl and place the empty bowl on the scale to measure, also. Record this measurement on their chart.

Each group will then total the mass on the chart of all materials they have measured, including the bowl. Have each group combine all ingredients in the paper bowl and measure all again. Have students measure the mixture to see if the combined masses of each part of the mixture total the whole when combined.

At this time, offer 100 ml of water for each group to stir into the mixture they made *if* the plaster of Paris was used. Students must find the mass of the water so as to add the correct water measurement to the mixture data. Students need to stir until the plaster of Paris looks like mashed potatoes in consistency, add a small, measured amount of water if it is too thick. Let the mixture harden and measure the whole mass. (Bonus experience – Can they feel the heat when the plaster sets?)

The emphasis is on the measurement and the use of the scales. Since students are measuring several different types of materials, they will get more practice measuring and the teacher will have plenty of time to circulate and check their accuracy in measuring.

When all is mixed ask “Does the mixture, with the bowl, equal the same as all individual ingredients measured separately?” Point out that this is a type of *heterogeneous* mixture! This is

a mixture in which parts of the mixture are discernible – except for the water and plaster part, which is a *homogeneous* mixture!

If their measurements are way off, now is a good time to check HOW they measured. This is also the time to initiate a consistent means of reporting data, always labeled with the correct units of measure, and neatly recorded in a data table. The table should reflect that time and effort were used in its construction and the information recorded makes sense.

Check their materials handling skills, also. Can they carry a scale safely back to its storage place? Can they “zero out” a scale before they use that scale to collect data? Can they describe why it was important to measure the containers that held the materials that were added to the mixture?

Activity 3: Science Learning Logs That Swing! (SI GLEs: 5, 6, 7, 8, 12, 19, 25, 32, 36, 37; PS GLE: 19, 20)

Materials List: for each student: student-made science learning logs or marble notebooks to use throughout the year or semester, pencils, separate ½ page teacher-generated rubric to adhere inside front cover as a reminder to students of how these science learning logs are to be kept, several balls of string, 1 box small size paper clips, pennies or small metal washers (1 for every 2 students), stopwatches (1 for every 2 students, if possible) or class clock with second hand, 1 metric ruler or meter stick for each 2 students, several pair of scissors and several rolls of masking tape to be shared or one for each group, Learning Logs That Swing BLM setup illustration for each group

Generate a guide sheet or rubric that will provide consistency in the use of the science *learning logs*. Consider the following suggestions for the guide:

- always use pencil and date each page
- use descriptive language to document observations and avoid pronouns
- make certain all charts are neatly drawn and labeled
- always include units of measure for the numbers recorded
- whenever possible include predictions before the investigation
- include conclusions and summaries at the close of the investigation
- make sure the steps of any investigation are written so someone else may follow them

Provide a copy of these guidelines for each student to adhere to the inside cover of his or her log or notebook.

Review the use of the science *learning log* ([view literacy strategy descriptions](#)) for recording observations and data, making predictions, and tracking investigations. (The key is to get the students to record their observations and ideas, to write descriptions in detail, to build and fill charts, and to draw clear, understandable diagrams and illustrations.) Then distribute the remaining supplies.

This activity will be done in partner teams of two. Give each team a length of string about 50 cm, a paper clip, either a washer or penny, a stopwatch, and a meter stick or metric ruler. Provide the

Learning Logs That Swing BLM, if needed. To make the pendulums, have each team tie a paper clip to the end of their string, then measure from the end of the paper clip to 40 cm and make a loop in the other end of the string. They can use the tape to secure the loop at 40 cm. Extra string can be cut off, if desired. Have each team tape a pencil (eraser end out) to the edge of their desk and slip the loop over the pencil. Clip the penny or washer to the paper clip and a pendulum is ready for testing.

The teacher should include the students in a discussion about safety concerns for the investigation. Together, establish safety rules that should be observed throughout the lab.

(e.g., Do not swing the pendulum around, make certain the pencil point is facing inward and the eraser is facing out, and stay in the assigned area to avoid disrupting the investigation of other groups.)

Have students set up their science *learning log* to record how many complete swings they count through the trials of their pendulums. They will release the pendulum, level with the table and count the number of complete swings (when the pendulum returns to the release point) in 15 seconds (dependent variable). Each trial is recorded and an average is calculated at the end of the trials. (Ask students to explain why an average is an appropriate data selection to use for this investigation.) Each partner team should record their averages on a class chart on the board or on large chart paper.

Once all averages are posted, students should consider the groupings of averages and decide what “variable” or change they could make to get different response. The independent or manipulated variables they could possibly change are string length, release position, and adding or removing mass on the end of the pendulum.

Have each team select a variable to change and record their thoughts on what effect the change will have on their results. Once they have recorded their plans, allow each team to construct a new pendulum or change the system they used before to run a new investigation. They should also run this investigation multiple times, and be able to explain why experiments must be verified through multiple investigations to be considered acceptable. To conclude the investigation, have students identify what forces are working on the pendulums as they move (friction, gravity) and draw a diagram in their log that illustrates these forces at work on the pendulum. Students should also be able to identify the dependent and independent variables.

Have the teams identify the independent variable that truly had an effect on the number of swings in 15 seconds (string length). Make sure they have used their science *learning log* to record predictions, data collections, conclusions, variables, etc. The information gathered here can be used later when they investigate motion and forces.

Activity 4: Split Page Note-Taking (SI GLEs: 7, 19)

Materials List: notebook, textbook, resources, pencils, rulers (if requested)

Sometimes teachers need to refer to the textbook to ensure students are getting adequate reading for information and note-taking skills. The teacher presents the material to be covered in the textbook with the *split-page notetaking* format ([view literacy strategy descriptions](#)).

This is done by drawing a straight line from top to bottom of a piece of paper (preferably a sheet of normal-sized, lined notebook paper) approximately 2 – 3 inches from the left edge. The page should be split into one-third/two-thirds. In the left column big ideas, key dates, names, etc. should be written and supporting information in the right column. Students should be urged to paraphrase and abbreviate as much as possible. The teacher shows students how they can prompt recall by bending the sheet so that information in the right or left columns is covered. The teacher can also get a quick idea of who is having difficulty harvesting pertinent information from their textbooks.

See example below for use of *split-page note taking* using the science textbook.

Atoms and the Particles That Are Involved (Science Textbook Notes)

October 12, 2007

Parts of an atom→	-- nucleus -- electron cloud (shells)
Three kinds of particles→	-- neutrons, protons, electrons
Atomic number→	-- number of protons in the nucleus
Atomic mass→	-- total number of particles in the nucleus, protons + neutrons

Activity 5: Lab Rules and Safety Contracts (SI GLEs: 23, 33)

Materials List: one large piece of plain paper or chart paper for each group, markers, science learning logs, Safety Contract BLM (*Alter the contract as needed to fit needs of the classroom.*)

Now that the teacher has modeled how to plan for safety concerns and students have experienced hands-on labs and the use of science materials in their investigations, the teacher will lead

students in a class discussion of all safety concerns to be considered during these and all future investigations.

Have the students contribute to a class set of lab rules to identify general safety procedures for lab investigations. Each group will create a list and all lists will be combined to form the class list. Limit rules to 6 or 8 main concerns. Post the final set of safety rules. Have the students also copy the lab rules into their notebooks or science *learning logs* ([view literacy strategy descriptions](#)) for reference and reiteration. Send the safety contract home for parent and student signatures.

Now is also a good time to check class thermometers. Do not use any older, mercury-type thermometers in class investigations. If the school has any mercury thermometers, follow proper disposal procedures to remove them from the classroom immediately.

Activity 6: Cooperative Groups & the Power of Light (SI GLEs: 1, 2, 4, 7, 10, 11, 12, 19, 22, 23; PS GLEs: 33, 35)

Materials List: Provide one plastic tub for each group, labeled with the group name or number to hold all of the supply needs for each lab. Set up each tub with 3 small mirrors for each group (unbreakable, if possible, otherwise purchase inexpensive, framed mirrors), 3-4 clear plastic cups for each group, one flashlight with batteries for each group, transparent colored plastic report covers or colored cellophane to cut into about 4" X 4" squares (enough for two colors for each group), pencils, colored pencils or crayons, paper on which to draw a target shape

Set up the following at a supply table or counter: water source, pitchers, or jugs of plain water, 2 jugs of colored water (one red and one blue), jug of cloudy water (weak powdered milk solution, but do not keep after class has ended), materials for clean up (paper towels, old towel, etc.), and meter sticks.

Students will need science learning logs. Lab Role Cards (Use the Cooperative Groups BLM to run one set of cards for each of group, and one copy of The Power of Light Lab Instructions BLM for each student in the class

Introduce the Cooperative Groups and the responsibility of each role the day before the light investigation is to be done. See Cooperative Groups BLM. Make certain students know that roles with the word "manager" mean that this student must coordinate the jobs within the group, but not do all the work themselves. Other jobs are done within the function of group tasks and can be shared, if needed. Each time students do an investigation requiring set up, running the investigation, and clean up, they should do a different job. The group or the teacher may wish to keep a record of who has done which jobs to avoid arguments.

It is also advisable to review procedures for cleaning up a spill in the room. Encourage students to avoid spilling by being careful and following the class safety plan. Just in case there is a spill, plan for its immediate clean-up so students don't lose their focus and create a bigger disruption. Plan for disposal of the water used by each group.

Review safety concerns. By now students are experienced in identifying areas in which safety takes priority. Have them explain what safety issues must be in the action plan for all groups. Flashlights are a new addition to their experience base for investigations and they must agree not to shine them in the faces of other people.

Set up a central materials station with clear water, colored water, cloudy water, paper towels, clear plastic cups, and meter sticks. Have students take out their colored pencils or crayons, their science *learning logs* ([view literacy strategy descriptions](#)), and a pencil. Have them set up a page in their learning logs for this investigation.

This activity focuses on building cooperative group skills which are essential for a successful lab experience. The activity uses an exploration of reflecting and refracting light as the vehicle to train students to work cooperatively through (1) being responsible for a portion of the lab, (2) getting materials from a central supply station, (3) setting up, staying on track, working through an organized investigation, (4) recording their observations and data, (5) reporting their findings, and (6) cleaning up. (All done without making the teacher crazy!)

Distribute the Cooperative Group cards before the students enter the room, if possible. Otherwise, place a card face down at each student's seat in the group. They may only switch roles, if the teacher decides that it is necessary. If there are fewer students in the group than there are roles on cards, the primary roles that must be covered are Materials Manager, Clean-Up Manager, Reporter / Recorder, Project Manager, Time Keeper (in order of importance). Double-up jobs if there are three or four students instead of five and split the roles of recorder (oral report to the class) and reporter (turns in all written work or posts group results on the board) if there are six in a group.

Distribute a copy of the *Power of Light* lab instructions to each student to read. This is suggested for this first investigation so that all students get the feel for what they must do, what they will need, and what the reporting will involve. The teacher may choose to create his/her own lab instructions for future investigations and it is recommended each group be given two copies, one for the Project Manager and one for the Materials Manager. Identify one counter, a shelf, or a cabinet that can serve as the supply station for the year so students will always know where to return supplies.

Once all students have read their copy of the lab instructions, the Materials Manager may assign other group members to help gather the group supplies. The investigation does not begin for the group until all supplies are ready, all science *learning log* pages are set-up, and all investigation goals or plans have been noted in writing. The key to success is to make certain all students have a role and that they work within the time frame to accomplish the task. This is a simple self-guided lab and the results will be recorded in the science *learning logs* and reported to the whole group. The information acquired through this investigation can be connected to the study of light later in the year. Have students focus on a description of what occurred. Build time for discussion to provide an opportunity to identify the explanation for what the students observed. Can they discriminate the difference between description and explanation? Have them use diagrams where possible.

Investigation activities can include the following:

- Predictions should precede observations for all parts of this investigation.
- Viewing light as it passes through cloudy water. What happens to the light?
- Viewing light as it passes through colored water and then coloring the light with the cellophane or plastic folder material and shining it through the different waters.
- Viewing a pencil sticking out of a cup of clear water and drawing what they see when they look at the pencil above the water and then through the water.
- Once students have completed their investigations sending light through various medium, have them use the mirrors to send the light around the room (*not in someone's eyes!*).
- Have them hold the flashlight in one direction and place a target somewhere behind the light. Challenge them to use the mirrors to bounce the light from the source back to the target. The more mirrors involved the better!

After all light investigations are completed, students must return all materials to a designated area, clean up, dispose of disposables, re-set the supplies if needed for another class and be seated with their results. Closure at the end of class is also the key to making cooperative groups work for the students and the teacher. Make certain there is time to hear or visit results of the investigation and to commend groups for particular behaviors observed. If time runs short, give the commendations and do the reporting at the start of the next science class period.

Sample Assessments

General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Science learning log entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory skills. All student-generated work, such as drawings, data collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities.
- All student-developed products should be evaluated as the unit continues.
- When possible, students should assist in developing any rubrics that will be used, and provided the rubric during task directions.
- Students should contribute to the class safety rules.

General Assessments

- The students will use questioning to collect information and compare similarities and differences amongst their peers.
- The students will identify and describe the properties of various objects while classifying the objects into groups.

- The students will accurately measure different materials and create a mixture which will then be measured again for comparison.
- The students will investigate pendulum and assess which variable affects the number of swings in 15 seconds.
- The students will create and maintain a science *learning log* to document what they observe in the pendulum investigations and later investigations.
- The students will utilize split-page note taking to summarize important information from resources.
- The students can identify and name common safety concerns faced in the classroom.

Activity-Specific Assessments

- Activity 1: Students will identify, through effective questioning, similarities and differences among group members. They will classify objects according to visible attributes and record their observations, communicate the groupings, and evaluate through listing and listening which attributes are similar.
- Activity 2: Students will correctly measure the mass of materials provided and identify how mass is affected when materials are combined.
- Activity 3: Students will observe the performance of a standard pendulum and construct a plan to alter the pendulum that will affect (increase or decrease) the number of swings the pendulum completes in 15 seconds. Students will identify all dependent and independent variables and evaluate the average and median number of swings in 15 seconds.
- Activity 6: Students will work cooperatively to execute the investigation and will correctly identify the direction light takes when it passes through a transparent source, a translucent source, and is reflected by a mirror.

Resources

- Classification activity on Teacher's Net.
<http://www.teachers.net/lessons/posts/1228.html>
- Investigations and information regarding reflection and refraction of light
<http://www.uen.org/Lessonplan/preview.cgi?LPid=11556>
- Promoting literacy
Stenson, Cheryl 2006, Learning Logs In the Science Classroom, April/ May 2006, Science Scope

**Grade 6
Science
Unit 2: Matter and Its Properties**

Time Frame: Approximately six weeks



Unit Description

Matter and its states/phases are reviewed and chemical and physical properties are explored. This unit also introduces the concept of density and illustrates how density can be used as an example of a physical property.

Student Understandings

Students will develop and strengthen their ability to identify and discriminate between physical and chemical properties of matter. Developing the student’s ability to measure matter correctly is also a necessity when building science concepts. Students will develop an understanding of the relationship between mass, volume, and density.

Guiding Questions

1. Can students explain the difference between mass and weight?
2. Can students determine the volume of regular-shaped and irregular-shaped objects?
3. Can students explain the difference between mass and density?
4. Can students determine the density of a liquid and a solid?
5. Can students differentiate a physical property from a chemical property?
6. Can students identify the chemical or physical changes associated with the reactions they observed in their investigations?

Unit 2 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry GLEs are embedded in the suggested activities for this unit. Other activities incorporated by teachers may result in additional SI GLEs being addressed during instruction.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)

GLE #	GLE Text and Benchmarks
3.	Use a variety of sources to answer questions (SI-M-A1)
4.	Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2)
5.	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
9.	Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)
10.	Identify the difference between description and explanation (SI-M-A4)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
13.	Identify patterns in data to explain natural events (SI-M-A4)
14.	Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
15.	Identify and explain the limitations of models used to represent the natural world (SI-M-A5)
16.	Use evidence to make inferences and predict trends (SI-M-A5)
17.	Recognize that there may be more than one way to interpret a given set of data, which can result in alternative scientific explanations and predictions (SI-M-A6)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
20.	Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7)
21.	Distinguish between observations and inference (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
23.	Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8)
25.	Compare and critique scientific investigations (SI-M-B1)
26.	Use and describe alternate methods for investigating different types of testable questions (SI-M-B1)
27.	Recognize that science uses processes that involve a logical and empirical, but flexible approach to problem solving (SI-M-B1)
28.	Recognize that investigations generally begin with a review of the work of others (SI-M-B2)

GLE #	GLE Text and Benchmarks
29.	Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3)
31.	Recognize that there is an acceptable range of variation in collected data (SI-M-B3)
33.	Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
34.	Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5)
35.	Explain how skepticism about accepted scientific explanations (i.e., hypotheses, and theories) leads to new understanding (SI-M-B5)
36.	Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5)
38.	Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6)
39.	Identify areas in which technology has changed human lives (e.g.; transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7)
40.	Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7)
Physical Science	
1.	Measure and record the volume and mass of substances in metric system units (PS-M-A1)
2.	Calculate the density of large and small quantities of a variety of substances (e.g., aluminum foil, water, copper, clay, rock) (PS-M-A1)
4.	Differentiate between the physical and chemical properties of selected substances (PS-M-A3)
5.	Compare physical and chemical changes (PS-M-A3)
6.	Draw or model the movement of atoms in solid, liquid, and gaseous states (PS-M-A4)
7.	Simulate how atoms and molecules have kinetic energy exhibited by constant motion (PS-M-A4)
8.	Determine the temperatures at which water changes physical phases (e.g., freezing point, melting point, boiling point) (PS-M-A5)
9.	Describe the properties of reactants and products of chemical reactions observed in the lab (PS-M-A6)
11.	Compare the masses of reactants and products of a chemical reaction (PS-M-A7)
40.	Identify heat energy gains and losses during exothermic and endothermic chemical reactions (PS-M-C7)

Sample Activities

Activity 1: What's It All About? (SI GLEs: 3, 19, 26, 27, 28, 29, 34, 35, 38, 39, 40)

Materials List: examples of modern technology (real or pictorial), teacher generated guidelines for student research, internet access for students or teacher-generated hard copies of internet search results

Assign this project early in the unit and provide *at least* two deadlines: one for the research part and one for the final project. The resulting project may be in the format of a poster with a report, an info-mercial, or a tri-fold brochure.

Introduce students to the art of investigation and discovery. This is also a good starting point to emphasize that, investigations and discoveries begin with the work of others. Provide a few examples of modern technology and household items (e.g., cell phones, a DVD, microwave oven, coffee maker, Velcro, microwave dinner containers, small keychain lights, auto alarm remotes, VHS Tape, digital camera, can openers, plastic bottles, antibacterial cleansers, satellite based automobile programs, GPS).

Have each student or student partner team select one invention or innovation of his or her choice and research its origin. Students should track the development of the innovation from its earliest conception and uses to its use in present times. All scientists involved in the evolution of the innovation, the impetus behind its existence, and a timeline showing the progression of the development through the ages should be included.

Students must use three sources that include the Internet and at least one source in print media. Scientists involved in the development of the object should be presented in a short biography within the final presentation.

The final presentation of their research should include the following:

- timelines, illustrations, and maps, if possible
- recognition of the fact that collecting information and designing prototypes involves systematic, logical, but flexible approaches to problem solving
- indications of where the work of earlier scientists led to further studies, even if the conclusions of earlier scientists were not supported
- how communication between scientists advanced the development of the concept
- an evaluation of the impact of the design, invention, or technology on society and humans
- an essay or written report that highlights the scientists involved in the evolution of their object
- short biographies of each scientist mentioned in the development of the object
- an explanation of how technology allows us to expand our senses, collect better information, and improve our scientific knowledge

The teacher should set deadlines for completion of each phase of the project. Allow one class period for the introduction. Students work on projects on their own time. Allow two days for presentations in class.

Activity 2: It Does Matter! (SI GLEs: 7, 8, 19; PS GLEs: 6, 7, 8)

Materials List: familiar examples of the three states of matter (helium balloon, wooden building block, colored water, ...), textbook as student resource, air freshener, dryer sheet or lemon zest, thermometers, hot plate or electric kettle, water, access to a freezer

To make certain students have a working vocabulary of the terms they will need to use to discuss the changes that matter undergoes, the teacher will display examples of each of the states of matter: a solid (a block of some sort), a liquid in a clear container (colored liquid suggested), and a gas (helium balloon, air in the room). The student teams will then complete a chart that describes the action of the particles of matter, whether or not the volume is constant and how easily it can be compressed. (Use textbook as a resource here.) The results are discussed as a class and a set of characteristics or properties should be decided upon for each example.

The teacher will demonstrate the movement of particles that are not visible or easily seen in the air by standing at one end of the room, behind the students, and briefly spraying a room air freshener in the air. Students are instructed to stand up as the aroma reaches them. (Use a dryer sheet waved in the air, a freshly cut lemon or lemon zest from the peel, if there are concerns about allergic reactions.) Have students explain why the particles of the aromatic substance were able to travel across the room and also give additional examples of where they can observe this phenomenon of diffusion (the smell of baked bread, passing by a paper mill, etc.).

Have students illustrate the organization and movement of particles in the three states of matter. Have students draw illustrations that reflect their understanding of the movement of atoms in the different states. Challenge students to create a want ad for one of the states of matter. Begin with a *RAFT* writing ([view literacy strategy descriptions](#)) to demonstrate the students' understanding of the properties of matter.

To begin have students identify

R → role = scientist needing matter to study

A → audience = matter in different states

F → form = want ad

T → topic = matter needed as described by the student (gas, liquid, solid)

Example: "Wanted: Particles that are willing to stick close together and not move much. Must be able to hold a shape without a container."

The teacher should next demonstrate the changing of the states of water (freezing, boiling, and melting) and should be sure to model safety guidelines while doing so. During the demonstration, students should take turns recording the temperatures on a large chart as the water changes states. Have students observe, record the temperature as the teacher reads it,

and construct a statement that describes the melting point, freezing point, and boiling point. Have students discuss the importance of using consistency and precision in data collection and reporting, as they consider the results. This is also a good time to compare the Celsius and Fahrenheit temperature scales with regards to freezing and boiling points.

Activity 3: Can You Measure Up? (SI GLEs: 1, 6, 7, 8, 9, 11, 13, 16, 19, 23, 31; PS GLEs: 1, 2)

Materials List: bag of assorted objects for each group of students to measure; chart on which to record measurements and descriptions; triple beam balance for each group or balance scale with gram weights for each group; calculators; water source or large containers of water for each group and a tub, sink or bucket for students to use to receive used water; graduated cylinders that will hold the size of objects collected; Can You Measure Up? BLM; science learning log

Part 1 -- Students are given the opportunity to gather data about a selection of objects using qualitative (the use of senses) and quantitative assessment (the use of tools). Give each student team a plastic bag with the same types of objects in each group bag (six to ten objects). Include irregular objects such as; novelty pencil erasers, carnival trinkets, a chunk of modeling clay, an almond-sized fishing lead weight, and a jumbo crayon. Include in each bag, regular shaped objects such as a blackboard eraser, an alphabet block, a block of wood, and a new rectangular-shaped eraser.

Complete a data chart *graphic organizer* ([view literacy strategy descriptions](#)) that allows room for each object to be listed and described and for the mass and volume to be recorded. See Can You Measure Up? BLM. The teacher should introduce *qualitative assessment* as the observations of each object. *Quantitative assessment* occurs when mass and volume data are collected on the chart through measurement. Both terms are included in the chart headings.

Ask students to construct and identify safety guidelines for this investigation. After observations and descriptions are noted, review the procedure for using balance scales and gram weights or a triple beam balance scale to determine mass. Remind students to always label the data collected by its unit of measure (e.g., grams or kilograms). Have each group find the mass of each object in their bag and record the data. Students should use consistency and precision in data collecting.

Part 2 -- Review the formula for finding the volume of a regular-shaped object ($L \times W \times H = \text{Volume}$). Elicit input from the teams to indicate which of their objects can be measured with that formula. Point out to students that their measurements will produce a volume to be labeled as cubic centimeters (cm^3). Provide access to calculators for volume computations.

Demonstrate the use of water displacement in the graduated cylinder as a means to find the volume of irregular objects. Have students fill the graduated cylinder to a level deep enough to immerse each object. Students will note and record the starting water level, carefully

place the object into the water and record the new water level. By subtracting the original water level measurement from the resulting water level measurement students will identify the volume of each irregular shaped object. Point out that the resulting volume measurement will be labeled as milliliters for these objects (one milliliter equals one cubic centimeter).

Lead a student discussion to compare and evaluate the data and the relationship to the object's size and feel. Students may recognize some discrepancies in the quantitative data. This is a good lead-in for discussion and to elicit explanations for differences in measurements from the students. Students should recognize when there is an acceptable range in data and when data should be questioned. As students generate questions from this discussion, keep a record of those student questions and allow opportunity for students to investigate further.

Generate definitions for the terms *mass*, *weight*, and *volume* with the student's assistance. It is also beneficial to have students differentiate between weight and mass. (Mass is the amount of matter in an object.) (Weight is the measure of the force of gravity on an object) Have students generate a statement to include in their science *learning log* ([view literacy strategy descriptions](#)) to summarize their experiences with measuring and discovery. Do students see any trends in the relationship between mass and volume?

If the students seem to readily grasp the concepts of matter, volume, and mass then introduce the concept of density (Density is the amount of matter in a given volume). Use the data collected from the investigation to complete the density calculations at this time or hold until density investigations in Activity 4 are complete (Density = mass/volume).

Take advantage of the measuring activity to help students discover that 1 ml of water (volume) is equal to 1 gram (mass) of water. Have students use the balance scale to measure the mass of 50 ml of water. This can also be compared to 50 cm³.

Activity 4: Volume VS. Mass (SI GLEs: 6, 7, 8, 11, 12, 16, 17, 21, 22; PS GLEs: 1, 2)

Materials List: 4 - 6 small regular-shaped blocks that appear very close in shape and size, permanent marker, scales for group use, rulers, student generated chart, chart used in Activity 3 if density problems have not been completed, science learning log

The teacher can construct four to six small blocks that appear to be the same size and shape but are dramatically different in mass. Materials that could be used include tile, wood, foam, box, cardboard, clay, etc. (Small density blocks are also available for purchase through science suppliers.) The constructed blocks should measure the same dimensionally and look the same. Cover all with aluminum foil or wrap in tape to make them appear similar. Another source of *density blocks* is to use small, empty student milk cartons, each filled with a different material: cotton, un-popped corn, sand, gravel, potting soil, and salt. Seal the top and push it down flat. Tape the top down on the carton so that a cube-shape results. Label each with a different number (not the contents) and move each from group to group until all groups have measured each carton.

If using blocks, number them and give each group a different block. Move these from group to group. Have students describe each of the blocks, then measure, weigh, and determine its mass and volume in order to calculate the density of each. They should be able to provide consistency and accuracy in their measurements.

Have them switch blocks until they have measured all of them. Students should record their measurements in a common class chart. The chart should provide space for *each group* to record their measurement of *each block*. Compare the findings of each group on the class chart. The teacher may choose to have a mass, volume, and density measurement for each block against which students may check the accuracy of theirs, or the teacher may use the student findings and arrive at a reasonable conclusion based on their data. Discuss any widely different findings with the class and arrive at an explanation for the differences. Discuss what may be the reason for any widely discrepant measurements.

Use this opportunity to discriminate between observations and inferences. The student's experience with the visually similar but quantitatively different blocks is a good tie-in to a discussion about density (how much matter is in a given volume). If the concept wasn't introduced in Activity 3, then present this concept now. Have students complete the density calculations from Activity 3, if they did not do so earlier.

Work with students to create a summary statement that reflects the observations of the entire class. These can be added to the science *learning log* ([view literacy strategy descriptions](#)). They should be able to make an inference based on all data collected and a statement reflecting the trend they observed in the similar but obviously different objects.

Activity 5: It's All In How You Look At It (SI GLEs: 1, 2, 3, 4, 5, 6, 7, 11, 12, 19, 22, 23, 25, 33, 36)

Material List: measuring tools, student generated materials lists, resources, index cards, It's All in How You Look at It! BLM (one per group), *vocabulary card* illustration BLM

The teacher should clarify and review with the students, definitions for *matter*, *weight*, *mass*, *volume*, and *density*. Students may use textbooks, Internet resources, dictionaries, etc. to prepare for the review. Have students use *vocabulary cards* ([view literacy strategy descriptions](#)) to reinforce each concept before presenting their selected word to the entire class in the next part of this activity. Use the *vocabulary card* BLM as a guide to show students how to set up each vocabulary word card.

Student groups may be assigned or select a term to investigate and present to the class. Students will devise an experiment that illustrates their term and includes a measurement element. Once they have identified the matter terminology to investigate (*weight*, *mass*, *volume*, or *density*), they must determine materials they will need and problems they may encounter in the investigation. They should also identify variables, outcomes, and equipment needs. They must include charts and multiple repetitions in data collecting. They should also be practicing good measurement procedures so that they have consistent results.

Safety concerns must be addressed in the plans for the investigation. Each group presents or leads the other groups through the steps in the lab they have designed. Students should gain experience and understanding with each terminology through this activity. Students will use a checklist provided by the teacher (See, It's All in How You Look at It! BLM) to critique and evaluate the other group presentations. The evaluation should include recommendations for improvement.

Activity 6: Density Exploration (SI GLEs: 1, 2, 4, 7, 8, 10, 11, 12, 13, 14, 15, 16, 19, 22, 23, 31, 33)

Materials List: Demo1- can of diet cola, can of regular cola (same brand), clear tub with water

Demo 2 – 4 cups of water (1 with warm water, 1 with cold water, 1 with salt water, 1 with fresh water), food coloring

Class Lab Materials: science learning logs, Internet access to instructions for the hydrometer, lab role cards (if used), 6 or 7 used water bottles to hold *each group's* liquids, a small amount of 6 or 7 different liquids to layer by density (vegetable oil, dark corn syrup, mineral oil, rubbing alcohol, colored dishwashing liquid, water with food coloring, any other liquids desired), in the water bottles for group use, test tubes and holders or similar small clear containers that will stand up

Hydrometer supplies: rulers, clear drinking straws, clay, very small finishing nails or lead shot, fine line permanent markers, graduated cylinders, and water to calibrate hydrometers

Safety concerns should be addressed by the students prior to beginning the investigation.

Introduce the concept of density with an engaging activity such as the following that compares floating (diet) and sinking (regular) carbonated soft drinks. Place a can of diet drink into a large clear container of water. Students should be able to see if the can sinks or floats. Next, place the regular can of soft drink into the container of water. Note results. The teacher should have a student to read the liquid volume of each can afterwards. They should be the same. Ask students if both cans have the same volume, and what would account for the difference in their ability to float?

The teacher will record all student comments and questions. This may result in a separate investigation regarding the differences in soft drinks. Demonstrate the differences in density of fresh water versus salt water and cold water versus warm water to further show students how density can be affected by temperature and adding matter, like salt, to water. Add drops of food coloring to a clear cup of each representative type of water, one at a time, to observe the action of the food coloring.

Make sure they watch closely so as not to miss the science! Students should see different reactions of the food coloring as it enters the cold water (holds together and sits on top more), the warm water (drops through the water easily and spreads throughout quickly), fresh water

(coloring spreads throughout but not as quickly as the warm water), and salt water (coloring sits on the top of the more dense salt water). Have students compose a statement summarizing their observations of the demonstration.

As a connection to the soft drink demonstration, student groups should now investigate the density of several liquids. Students should review safety rules! They should also identify problems, factors, and questions that must be considered in this investigation.

It is recommended that each group have their own set of liquids to order by density. Recycled water bottles make good sealable containers for the group's liquid sources. Provide for each group vegetable oil, dark corn syrup, mineral oil, rubbing alcohol, colored dishwashing liquid, water (addition of one or two drops of food coloring is optional), and any other viscous liquids that would provide an interesting contrast in density and would be safe to use in class. Also provide test tubes in holders (translucent film canisters may also work) and pipettes.

Have students create a chart to record their investigations and observations. Challenge students to compare the densities of each liquid with the goal being that they will create a density column model in a test tube (or bud vase, anything small enough to see the layers and large enough to pour into) to order the liquids from least to most dense or vice versa. Recommend a prediction prior to each trial. Provide water and a clean-up source for student investigation.

Students must be able to explain the order of their resulting column, not just describe it. Any differences observed between the layers of liquids in the resulting density columns should prompt a class discussion. They should also be able to explain trends in liquids and infer which liquids may be denser than others. Use science *learning logs* ([view literacy strategy descriptions](#)) to record student observations, understandings, and questions. They should also give oral reports to share their group results.

To take this a step further and allow students to create a tool to measure what they observed as differences in density, students should construct hydrometers to measure the density of the liquids. These websites for making and using student hydrometers may be helpful:

<http://www.lessonplanspage.com/printables/PScienceMakingAHydrometer79.htm>

Ontario Maple Syrup Producers association website has one version

<http://www.ontariomaple.com>

Using a student-generated *graphic organizer* ([view literacy strategy descriptions](#)) to record data, students will test the various liquids used with their hydrometers to determine density of each when compared to water. Measurements should be recorded in metric notations and students should be effectively measuring with precision, consistency, and considering the outcomes as they review their data. Student made tools of measurement may not be as accurate as purchased tools, but students need to be consistent in the way they collect their data.

The following question is an example of how to make this connect to the student's world and build relevance for these activities. Ask, "How is evidence of differences in density observed at home in your world?" (oil and vinegar dressings, swimming in a pool versus swimming in salt water of the ocean, marshmallows floating on hot chocolate, the plain water that sits on top of the undisturbed soft drink after the ice melts, etc.)

Activity 7: Hey, Sugar! (SI GLEs: 1, 6, 12, 23; PS GLEs: 4, 5)

Materials List: hand lens for each student, sugar cube for each student, small container of water for each group, eyedroppers or pipettes, chart paper and marker, electric skillet or hot plate, skillet for teacher demonstration

To assess understanding of physical and chemical properties, provide each student with a sugar cube and a hand lens. Review safety precautions, particularly since students will be using what appears to be a common food item. Ask students to list all properties they can identify while describing the sugar cube.

After a reasonable amount of time to record descriptions, give each group a container of water with pipettes. Allow students to add several drops of water to their sugar cube and then observe the interaction of the water and sugar. The group may then compile a class list of properties for sugar, based upon their observations and experiences. Each student should also construct several questions that arise through their investigation of the sugar cube.

Examples of student questions may be the following:

- Can the sugar be put back into a cube form?
- Does the sugar cube come apart faster in water or by crumbling it?
- Will it come apart or dissolve in the mouth?

Make sure students understand that no materials are tasted in science unless directed to do so by the teacher. Consider Diabetic students will not be able to do that investigation and that purity of the sugar will be compromised as the cubes will be handled during the descriptions. Ask students to classify the properties they identify as physical or chemical properties. Ask what criteria they used to decide their classification.

Collect student questions in one large format (on the board or on a chart). Collect student charts to compare properties. Through probing questions, elicit student understanding of the requisites of physical and chemical properties.

Examples of questions to use:

- Is the dissolving of sugar a physical or chemical change and explain your answer?
- Will sugar burn? (This should be done as a teacher demonstration. An electric skillet can be used. Position the skillet so that it is under teacher control and away from student movement.)
- Is burning a physical or chemical change?

Return to the student questions to devise any tests on the sugar that have not been investigated. Complete those investigations if possible.

In closing, as a quick reminder of the difference between chemical changes and physical changes, use the switching of capital letters to lower case letters in the word (MATTER / matter) to represent *physical change* and rearranging the letters of the word matter to make a new word (matter / met rat) to represent a *chemical change*.

Activity 8: Changes (SI GLEs: 2, 4, 6, 7, 10, 12, 19, 22, 23; PS GLEs: 4, 5, 9, 11, 40)

Material List: safety goggles for each student at the station, virtual simulations of physical or chemical changes if Internet is available at a station, cards for each station, thermometers, scales to measure mass of chalk, graduated cylinder to measure vinegar, science learning logs, Changes BLM, materials for stations as described below:

Safety Note: Safety concerns should be considered and students should generate safety rules for each of the investigations. Safety goggles should be worn and water available to wash hands in case of contact with chemicals. Since food items will be used, include safety plans for handling foods and clean up. Disposable gloves are a good idea here. Plan for clean up and disposal of chemical mixtures that will include a precipitate. Plan for a smooth transition between stations, also, possibly using a predetermined signal for wrap-up and then a signal for movement.

Set up learning stations around the room for student exploration of physical changes and chemical changes through concrete interaction with materials or virtual simulations. Establish a flow and an amount of time to complete each investigation. Each station should focus on a particular type of change. Science *learning log* ([view literacy strategy descriptions](#)) entries will be used to briefly document their investigations and their observations for each station. Make certain students can discriminate between their observations and their explanations or conclusions.

The Changes BLM summarizes their observations and uses check marks for each investigation.

Examples of physical changes may include the following:

- filtering coffee grounds from water (use coffee filters, a tablespoon, plastic cup)
- sifting sand and rocks (use gravel, sand, sieves from toy stores)
- evaporating sugar water (use rock candy recipe, string or skewers, individual cups for each student and let these sit for a week or more, students label their cup)
- using a magnet to separate iron filings from sand (magnets, tub with sand and iron filings mixed together, a paper plate on which to move the rescued filings)
- tearing newspaper (folded newspaper, Superman feat of strength!)
- cutting fruit (apples, bananas, pears), plastic knives or stainless butter knives, clean hands! Wear disposable gloves.

Examples of chemical changes could include:

- chalk (not dustless and have baking soda to substitute in case the chalk doesn't dissolve) small container of vinegar, empty cups (select a piece of chalk, find the mass of the chalk to get a *before* measurement, record this in the learning log, place the chalk in the cup, cover with 50ml vinegar and gas bubbles should result while the vinegar breaks down the chalk) students should record their observations and an *after* measurement to document the product of the chemical reaction
- a chemical ice pack (dollar store packs of ice packs and/or heat packs to activate)
- precipitate formation from mixing two different compound solutions (milk and vinegar) (empty cups in which to mix, vinegar source container, milk container, pipettes, container in which to dump lumpy milk)
- neutralization of dilute acid (lemon juice or vinegar) with a base (baking soda) using an indicator (use liquid from processing red cabbage in a blender with a small amount of water), cups with lemon juice, baking soda, cabbage juice, empty cups, pipettes
- steel wool soaking in vinegar (heat produced when the vinegar breaks down the coating on the steel wool and oxidation begins)
- citrus acid mixed with baking soda (heat absorbed / cool liquid results)

Include reactions that are endothermic and exothermic in nature such as citric acid + baking soda = endothermic reaction (absorbing heat) and steel wool + vinegar = exothermic reaction, (giving heat). Be sure to explain the difference between these two reactions. Students should use their science *learning logs* and write an observation or description of the material tested at each station. They may create a statement for *before* and *after* testing.

After cycling through the stations, students will use the Changes BLM which contains a *word grid* ([view literacy strategy descriptions](#)) to organize their observations and experiences. The grid gives them the opportunity to check which attributes they observed in their investigations. Students need to make certain to differentiate between explanations and descriptions.

Explain to the students that describing an observation is important and the better the description, the easier it is for someone else to understand what they saw. Focus on descriptive writing when doing investigations, also. Explanations go a step further and give the reasons behind your observations.

Activity 9: Ice Cream in a Bag (SI GLEs: 2, 5, 6, 7, 8, 11, 12, 19, 20, 23; PS GLEs: 5, 6)

Material List: ice cream recipe (several websites for recipes are noted in the resources), sealable *freezer* bags, quart and gallon size (OR use a sealable coffee can for the gallon size/outside container), ice, ice cream salt, thermometers (electronic probe or standard class thermometers), chart or table on which to record temperatures, science learning logs, spoons, 2oz paper cups

For each bag: 4 cups ice, 1/4 cup ice cream salt, 1 cup whole milk, 1 teaspoon vanilla, 2 tablespoons sugar or sugar substitute (other flavorings may be used), gloves or towels, if needed.

Safety note: When food is part of the investigation plan for safe and sanitary handling.

Using the NASA website, begin with a review of NASA's expansion on the concept of salting the roads and railroads during icy situations. Students should recognize that investigations generally begin with a review of the work of others. See the website below for background.

Each group of students will begin with a basic ice cream recipe mixture provided by the teacher or see NASA's version of this lab *We All Scream for Ice Cream* at www.NASAexplores.com.

If using an electronic probe, the probe would need to be covered with a plastic sleeve, bag, or disposable glove before measuring the temperature of the ice cream. Have students create data tables in their science *learning logs* ([view literacy strategy descriptions](#)) to record their temperature and time data, as well as their observations.

Students will pour the ice cream mixture into a quart-size freezer bag and record both the time and the temperature of the liquid ice cream. Remove air from the bag and seal well. Students should then place the sealed bag of ice cream mixture into a larger, gallon plastic freezer bag (or a large sealable coffee can that will hold the bag and ice). Add ice all around the bag and the quarter cup of rock salt to the ice. Push as much air out of the bag as is possible and be sure that the larger bag is sealed well! Make certain the ice surrounds the smaller bag.

Students should time the process, so that they will be able to graph their data with time coordinates for the recorded temperatures. Students will then shake the sealed bag *system* until the ice cream starts to thicken. At this time a second time and temperature reading should be recorded, quickly. Continue shaking or tossing the mixture until it freezes or is VERY thick, measuring the temperature every three minutes for about a ten-minute period. Record the time and temperature during each stop in the shaking process. If 10 minutes has passed and the mixture is not frozen, add a measured amount of additional rock salt and note addition in logs.

All measurements should be recorded consistently so as to track the variables in this investigation. Students should be able to identify the independent and dependent variables.

Temperature conversions (Fahrenheit / Celsius) can also be calculated.

$$[F=1.8C+32] \qquad [C = \frac{F-32}{1.8}]$$

The use of an electronic probe would allow for precise temperature readings. If an electronic probe is available, use one group's set up to collect this data. The readings can be done as the mixture freezes, without interrupting the process. The bag would need to be rigged so that a seal is still viable with the probe inside of the liquid. Students should devise a plan to address the challenges offered by this procedure.

Ask students to suggest what advantage charting the changes in temperature with the electronic thermometer offers. What would account for any differences in the data collected by each group? Once comparisons are made and a conclusion is drawn, have students write step-by-step instructions in their science *learning logs*, written well enough for someone else to perform this lab activity. They must be able to identify the variables involved, safety concerns, and guiding questions.

If the question is not posed by a student, challenge the students to identify the role salt played in this activity. (The salt lowers the freezing point of the water which allows it to get colder than ice, about 28 degrees. This also means it will get very cold as the students work the machine!)

As a culminating activity, have students describe the differences between the movement of atoms in liquids, solids and then gases. The teacher may choose to serve the ice cream at the end of the investigation, but make certain sanitary conditions were maintained.

Sample Assessments

General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory skills. All student-generated work, such as drawings, data collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities.
- All student-developed products should be evaluated as the unit continues.
- When possible, students should assist in developing any rubrics that will be used and provided the rubric during task directions.

General Assessments

- The student will create illustrations that indicate their understanding of the placement of atoms in different states of matter.
- The students will construct and describe the order of liquids in their density column.
- The students will investigate and measure the density of different materials.
- The students will create a chart of the properties of the three states of matter.
- The students will create and maintain a science learning log on physical and chemical properties and changes they observe in the investigations.

Activity-Specific Assessments

- Activity 2: Students should correctly identify examples of each of the states of matter, identify the arrangement of each state's molecules, and be able to accurately describe the attributes of each state of matter
- Activity 3: Students will correctly measure the mass and volume of the selected objects. Students will demonstrate an understanding of when to use the water displacement method of finding volume or the $L \times W \times H$ formula. Students will correctly calculate volume of regular and irregular objects.
- Activity 6: Students will successfully order the different liquids and then correctly identify the order of density of the liquids in the density column. (Less dense to more dense or more dense to less dense)
- Activity 8: Students will correctly identify characteristics of physical and chemical changes and report the resulting products of chemical changes.

Resources

- *MathMol—Density Lab*. Available online at http://www.nyu.edu/pages/mathmol/modules/water/density_lab.html
- *Physical and Chemical Changes*. Available online at <http://www.iit.edu/~smile/ch9312.html>
- Examples and animations of chemical and physical changes http://www.saskschools.ca/curr_content/science9/chemistry/lesson8.html
- *Your Weight on Other Worlds*. Available online at <http://www.exploratorium.edu/ronh/weight>
- Student website with explanation and examples of changes http://www.chem4kids.com/files/matter_chemphys.html
- Ice Cream recipes at <http://home.att.net/~teaching/science/icecream.pdf>
<http://www.teachnet.com/lesson/science/icecream051999.html>
<http://jas.familyfun.go.com/recipefinder/display?id=40986>

**Grade 6
Science
Unit 3: Elements, Compounds, and Reactions**

Time Frame: Approximately five weeks



Unit Description

This unit is designed to incorporate tasks that will introduce the student to the basics of chemical reactions and atomic structure.

Student Understandings

An understanding of the structure of the atom, properties of the atom, and various ways that elements react are the foci of this unit. The periodic table should be introduced, and students should learn the basis for placement of an element on the chart, as well as the information about the element that is included on this reference tool. Students should be able to identify an element's atomic mass and know the relationship of atomic number to the number of protons and electrons. Students should recognize that some solutions are better conductors of electricity.

Guiding Questions

1. Can students model atomic structure in chemical reactions?
2. Can students recognize and identify the factors that determine the rate of a chemical reaction?
3. Can students explain how an element's mass is determined from the periodic table?
4. Can the student explain the difference between covalent and ionic bonding?
5. Can students describe how the mass of the products in a chemical reaction compares with the mass of the reactants in that reaction?

Unit 3 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry GLEs are embedded in the suggested activities for this unit. Other activities incorporated by teachers may result in additional SI GLEs being addressed during instruction.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)

GLE #	GLE Text and Benchmarks
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
3.	Use a variety of sources to answer questions (SI-M-A1)
4.	Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2)
5.	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
10.	Identify the difference between description and explanation(SI-M-A4)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
14.	Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
15.	Identify and explain the limitations of models used to represent the natural world (SI-M-A5)
16.	Use evidence to make inferences and predict trends. (SI-M-A5)
18.	Identify faulty reasoning and statements that misinterpret or are not supported by the evidence (SI-M-A6)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
21.	Distinguish between observations and inferences (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
23.	Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8)
25.	Compare and critique scientific investigations (SI-M-B1)
28.	Recognize that investigations generally begin with a review of the work of others (SI-M-B2)
29.	Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3)
30.	Describe why all questions cannot be answered with present technologies. (SI-M-B3)
31.	Recognize that there is an acceptable range of variation in collected data (SI-M-B3)
33.	Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)

GLE #	GLE Text and Benchmarks
34.	Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5)
35.	Explain how skepticism about accepted scientific explanations (hypotheses and theories) leads to new understanding (Si-M-B5)
36.	Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5)
37.	Critique and analyze their own inquiries and the inquiries of others (SI-M-B5)
Physical Science	
1.	Measure and record the volume and mass of substances in metric system units (PS-M-A1)
3.	Construct models that replicate atomic structure for selected common elements from the periodic table (PS-M-A2)
4.	Differentiate between the physical and chemical properties of selected substances (PS-M-A3)
5.	Compare physical and chemical changes (PS-M-A3)
9.	Describe the properties of reactants and products of chemical reactions observed in the lab (PS-M-A6)
10.	Identify the average atomic masses of given elements using the periodic table (PS-M-A7)
12.	Determine the effect of particle size of the same reactants on the rate of chemical reactions during a lab activity (e.g., powdered vs. solid forms) (PS-M-A8)
13.	Use a variety of resources to identify elements and compounds in common substances (PS-M-A9)
18.	Explain how the resistance of materials affects the rate of electrical flow (PS-M-B2)
30.	Trace energy transformations in a simple system (e.g. flashlight)(PS-M-C2)
40.	Identify heat energy gains and losses during exothermic and endothermic chemical reactions (PS-M-C7)

Sample Activities

Activity 1: A is for Atom (SI GLEs: 3, 14, 15, 19, 28, 29, 30, 34, 35; PS GLE: 3, 10)

Materials List: textbooks, resource books, copies of Internet resource materials to share, teacher-created element cards from which students can select an element name to create as a Bohr model (select atoms from the periodic table that have small atomic mass so that there are less particles to place in the nucleus and on each shell of a Bohr Model), cardstock or construction paper on which models can be created, colored paper or foam shapes to cut and use to represent neutrons, electrons, and protons, glue, markers, pencils, scissors, science learning logs, Periodic Table of Elements from textbook or other teacher resources (poster)

This is a two-part activity. Part One is to research the history and progression of the model of the atom. In Part Two, students re-create a Bohr-type model of one of the elements of the periodic table.

Part One: Provide access to or assign research of the progression of models of the atom through the works of Dalton, Rutherford, Thomson and Bohr. Discuss how one scientist's skepticism about another scientist's theory leads to a new investigation. While this research does not include all scientists who contributed to the development of ideas about the structure of atoms, it does provide an evolving pattern that will allow students to see that ideas are constantly being evaluated and reworked. It is through the investigation of the history of the atom that students will begin to see how science is constantly changing. Technology broadens our awareness of the atom and its parts. While newer theories are available, the Bohr Model offers an easy to understand arrangement of the particles.

Have student groups present their information in an order that reflects the evolution of the model of the atom. Each group will research a different scientist. If there are more groups than four in the class, assign one group to research the latest model of the atom and then double up on any other scientist.

Groups should be prepared to present their research in three parts: a labeled diagram of the atom model proposed by their scientist with the date of that model, professor-know-it-all presentation, and an explanation of the model including the limitations of that model. They can use their science *learning logs* ([view literacy strategy descriptions](#)) to record the result of their research.

This activity lends itself very well to a *professor know-it-all* ([view literacy strategy descriptions](#)) approach. All students in the group should be familiar with all information regarding their scientist and the model presented. The rest of the class will create reasonable questions to ask of each scientist and the groups presenting act as one *professor know-it-all*, helping each other field the class questions. The teacher should keep the questions focused on the topic and should also ask questions. This presentation should be limited in time and move quickly.

Part Two: Using the model created by Neils Bohr in 1913, demonstrate the arrangement of the nucleus with shells and the placement of the protons, neutrons, and electrons of an atom. Explain the atomic number, symbol, and atomic mass used for elements in the periodic table. Make certain students know the limits of each shell's capacity. Students should be able to discriminate between the atomic number and atomic mass of an element. Introduce the Hydrogen atom and the placement of its electron and proton. The hydrogen atom is one atom that makes a good lead-in to types of bonding, since it can share an electron.

Assign an element to each student or allow them to select or draw for one. Each student must correctly diagram the atom, provide the correct number of shells, and illustrate the placement of electrons and protons for his/her element. Students must add the information from the periodic table (symbol, element name, atomic mass, atomic number) to their diagram. Have students round the atomic mass to a whole number, if necessary.

Point out to the students that they are still using a model created in the early 1900's, but that there is a relatively new Refined Neils Bohr model at the following site that shows how there are even sub-shells in each shell. (http://education.jlab.org/qa/atom_model.html)

Ask students to reflect on why all questions about the structure of an atom may not be able to be answered at this time. Solicit responses as to what advances in technology might mean to future models of the atom. The cloud-charge model may be introduced at this time as an illustration of the changes the model has undergone.

Activity 2: Shell Collecting (SI GLEs: 10, 15, 19; PS GLE: 3)

Material List: element models made by students in Activity 1, card stock or sentence strips to make labels for the bonds they make (covalent bonding and ionic bonding, large enough to be seen from across the room).

The teacher will introduce ions, bonding, and the terms *covalent* and *ionic bonding*. Students should be able to connect the “giving up” of electrons to ionic bonds and the “sharing of” electrons to covalent bonds. The illustrations of the elements from the first activity could be used again.

Given an element and knowing how many electrons are in the outer shell, students will physically link up with another student holding the card of an element with which they could form a bond. They must then identify which bond, covalent or ionic, they have formed and make a large card or sign to label their bond. Have students explain their reasoning behind the label they chose (shared or transferred), not just describe the label they have chosen. Students should recognize that their bonding model will have limitations and should be able to identify some of these limitations.

Activity 3: Action / Reaction (SI GLEs: 1, 2, 4, 5, 6, 7, 8, 10, 11, 12, 18, 19, 21, 22, 23, 25, 31, 36, 37; PS GLEs: 5, 9, 40)

Materials List: safety goggles for each student, disposable gloves for each, science learning logs, pencils, water, 3 clear plastic cups for each group, a materials station or table with calcium chloride (also sold as closet dehumidifier compound), salt, diatomaceous earth powder (pool supply or building supply store), 5 ml scoops or measuring teaspoons, stirrers, graduated cylinder to measure 50 ml of water each time it is added, thermometers for each group's access, gallon size sealable freezer bags

Safety note: Students should be able to identify safety procedures that must be considered when using chemicals. Protective safety goggles should be worn and water available to wash hands in case of contact with calcium chloride. Plan for clean-up and disposal of chemical mixtures that will include a precipitate.

This activity will introduce students to a chemical reaction involving the formation of a gas, the formation of a precipitate, and a temperature change. As the students will actually hold the plastic cups in their hands, they will be able to see and feel the reaction take place. Provide a one-gallon-size sealable freezer bag for each group to use for the final investigation.

Set up a materials station. Challenge student groups to create mixtures using the chemicals provided (calcium chloride, salt, diatomaceous earth powder, and water). They may make three mixtures, but must document each mixture made with the amounts used and the results observed. Can the students identify the results of the combinations as physical or chemical reactions? Remind students that every result is science data or information, even if it seems rather mundane! Each team needs to create a data collecting chart *before* the investigation begins.

Students may combine water and one other material during this part of the investigation but must keep records of all combinations and results. Have students establish procedures that will assure consistent, comparable results. Did they measure and record all amounts used? Did they record which materials they combined? Did they see evidence of a reaction? Did they measure their mixtures again to compare the mass of the combined reactants? Did they record the effects of the mixing of the materials, even if the effects were insignificant in appearance? Can they identify the variables that must be considered? Each team/group should preface each investigation with a recorded prediction.

Water should be added in 50 ml. amounts. All measurements should be completed with precision and accuracy. Students should describe their processes and explain their results from the data they collect. Remind students to keep their observations limited to what they can observe with their own senses and to connect their inferences to their observations and their conclusions. Each group will give an oral presentation of the investigation with their data chart as evidence. Provide a guiding statement so that presentations reflect a description of the process and an explanation of the results, such as, Describe what you did and explain what occurred.

Groups may challenge conclusions of other groups *ONLY* with supporting data to do so. Have students compare the results presented by each group. They should recognize that there is an acceptable range in the end results for each group. Can they explain why experiments must be verified through multiple investigations?

When each group has presented their findings, have students mix two scoops of each material (salt, powder, calcium chloride) in the sealable bag. They will then add 50ml of water, seal the bag, and pay close attention to the events that follow. They should record all observations.

Students are to respond to the following statements / questions in their science *learning logs* ([view literacy strategy descriptions](#)):

- Describe any changes that were observed in the material combinations.
- Can you classify your changes as chemical or physical?

- If a temperature change is noted, at what point did it occur? Identify the change. Is it exothermic (loses heat / baking soda & water) or endothermic (gains heat / calcium chloride and water)?
- What observations did you make that tell you a chemical reaction is taking place?
- Can students compare how the mass of the product of the combined chemicals compares with the original chemicals combined?
- Did the combination produce a physical or chemical reaction or change? Have students filter (coffee filter over a strainer) and dry the precipitate they made in the plastic bag and mass the resulting matter to compare with beginning proportions.

Activity 4: Electrical Conductivity (SI GLEs: 1, 2, 4, 7, 11, 12, 16, 19, 21, 22, 23; PS GLEs: 18, 30)

Materials List: (For each group) D cell, small light bulb, wires with ends stripped and ready to use, bulb holder, battery holder (if available), masking tape, pencils, assorted materials to test for conductivity (plastic, wood, assorted metals, clay, etc.) salt water solution (2TBSP salt to 100 ml water), bowl or graduated cylinder to hold the salt water solution, science learning logs

Have students review safety procedures for the use of batteries and caution students about maintaining an electrical circuit too long during tests (battery will run down). Provide batteries (D), tape or battery holders, bulbs, bulb holders, and wires for each student or student team. Do not give instructions as to HOW to do it, but direct them to light the bulb with the objects provided. Once the students have had success, have them diagram the set-up that worked in their science *learning logs* ([view literacy strategy descriptions](#)). They should include all contact points, all parts of the system, and the arrangement of the parts that made the bulb light. They should also label all parts of their system.

Also, watch student trials to make certain for safety reasons that they do not leave one wire connecting both ends of the same battery. Have teams review each other's diagrams, point out to the whole group that there must be visible contact points wherever they are needed. Move throughout the group and check diagrams for details, labeling, and contact points.

The teacher should then have students test various materials within this circuit to illustrate *conductors* and *insulators*. Students can insert plastic, wood, clay, metals, etc. between the contact points to see which will allow the electricity to pass.

Have students predict what other substances might serve as conductors or insulators. Their observations should help them infer which materials will work to carry a current and which materials resist carrying an electrical current. Students should be able to explain how different materials affect the rate of electrical flow. The teacher will help clarify their explanations by using and explaining the word *resistance*. Students will then use their working circuit to test the conductivity of a salt solution.

For the next step, students will need to have two wires long enough to immerse in a salt water solution without making contact. It may be necessary to make additional wire available. The students will use their previous circuit with the addition of the longer wires to submerge in the salt water. The bulb should light again as the electricity travels through the salt water. Students should then be able to conclude through discussion that the path for electricity continues through the salt water as well as through the conductors tested earlier and that the path through the insulators offers more resistance to the flow of electricity.

Summarizing activities should include class discussion led by teacher-guided questioning and direct instruction as needed, enabling students to respond either orally or in written format in the science *learning logs* to summative questions as follows:

- What do the materials that were used in this activity and that conduct electricity have in common?
- How does the material used in the circuit affect the rate of the flow of electricity?
- Is electrical conductivity a physical or chemical property? Explain your answer.
- What makes it possible for an electric current to travel through salt water?

Activity 5: If Salt Works, Will Sugar? (SI GLEs: 1, 2, 4, 6, 7, 8, 16, 19, 22, 23, 33; PS GLEs: 4, 5, 9)

Materials List: Kosher salt, granulated sugar, hand lens (one for each student), dark construction paper to use as a work surface for observing characteristics of the crystals, water, effervescent tablets, stop watches, science learning log, If Salt Works, Will Sugar? BLM, measuring tools for water, salt, sugar

This activity uses the information they acquired in the last activity regarding salt water as a conductor and extends it to compare another familiar crystalline material, sugar. It also has the students create a conductivity tester specifically for the investigation. Safety must be considered and students should be able to verbalize what concerns this lab may provide and plan for those concerns.

In this activity, students will work individually or in small groups to make observations of salt and sugar crystals using hand lenses (put crystals on the colored paper to see more easily and to limit their workspace). Students should predict if both of the substances, when put into solution, will conduct electricity. Students may choose to vary their salt solutions to either weaker or stronger than the solution used in the last activity. They should identify an appropriate means of measuring the materials and practice precision and accuracy each time they measure.

They will then make a salt water solution and a sugar water solution and use a homemade conductivity tester to determine if the solutions are conductors or nonconductors. Students should record their results in their science *learning log* ([view literacy strategy descriptions](#)) by diagramming the path of electricity through the circuit and the liquids.

Instructions for constructing a conductivity tester can be found at http://www.abc.net.au/science/surfer/scientist/pdf/lesson_plan11.pdf. Students may also use the bulb, battery, and wires from the previous activity if the systems provided enough success in the previous activity. Students should evaluate which model they feel would work and pursue that design, evaluating the effectiveness as they use it to test the solutions.

The students should next observe the reaction between water and an effervescent tablet and determine if the resulting solution from the reaction is a conductor or nonconductor. Have students identify problems that must be considered in conducting this investigation.

Summarizing activities should include class discussion led by teacher-guided questioning and direct instruction as needed, enabling students to respond either orally or in written format to summative questions as follows:

- How do the crystals of salt and sugar compare? How are they alike and how are they different? (Use hand lens to gather details.)
- Which of the solutions observed were conductors and which were nonconductors (insulators)?
- What property of a material makes it a conductor?
- What evidence of change did you observe in each mixture? What type of change was observed, physical, or chemical?

Use the If Salt Works, Will Sugar? BLM by placing an “x” in the appropriate box OR have students recreate this in their science *learning log*.

Activity 6: We’ve Got Zip (SI GLEs: 1, 2, 4, 5, 6, 7, 8, 10, 12, 16, 19, 22, 23; PS GLEs: 1, 9, 12, 13)

Materials List: two effervescent tablets per group, water source or containers of water, clear plastic cups, graduated cylinders, thermometers, ice and heated water available as requested, stopwatches, balance scales, science learning logs, and Lab Report BLM (2 pages or 2-sided/one for each student) This lab report format can be used for later investigations, also.

Students will work in small groups to observe the reaction between water and an effervescent tablet. Students should begin the investigation with a review of safety concerns. They should construct a chart on which to record their results making certain they use appropriate labels for all measurements.

They will observe and record what factors change the reaction time by manipulating and controlling variables. Each student group will design their own investigation and should receive two effervescent tablets and water with which to work. Measurement tools should be used and consistency in measuring followed. The investigation should also include research into the components of the tablet. Have students generate a question for each investigation they will design. Inform students they must plan for at least 4 tests, using only the two tablets provided and they may break the tablets as needed.

Distribute the Lab Report BLM to each student to use to formalize their investigation. Along with students submitting a laboratory report, summarizing activities should include class discussion led by teacher-guided questioning and direct instruction as needed, enabling students to respond either orally or in science *learning logs* ([view literacy strategy descriptions](#)).

- Discuss variables and identify the variables that are involved when determining factors that affect the reaction rate between tablet and water. (Variables include such factors as water temperature, size of the tablet being dissolved, stirring, and amount of water used.)
- Predict which conditions favored the quickest reaction. Allow students to conduct self-designed investigations to answer this question.
- Using complete sentences, students should write an explanation of their answer to the previous question and support their explanation with experimental data.
- What part of the investigation will be described and what part will be explained? (Students should be able to discriminate between describing and explaining.)

Activity 7: Modeling the Periodic Table (SI GLEs: 11, 22; PS GLE: 10)

Materials List: resources for investigating the periodic table of elements (textbooks, charts or posters, student created element cards from activity 1), colored pencils, crayons or markers, Periodic Table of Elements BLM

Given an explanation for the terms used to define the organization of the periodic table of elements (groups or families, periods, metal, nonmetals, and metalloids), students will investigate the organization of the elements on the periodic table. They may use the tools they created in activity 1 to arrange their element cards in logical order according to the periodic table.

The remaining elements not covered in the first activity could be assigned to the students individually to research and would allow the completion of the periodic table model. Use the Periodic Table of Elements BLM for each student to color-code and identify each classification used on the table. This may also be helpful in recognizing the patterns of arrangement of elements on the table.

The website, <http://www.uky.edu/Projects/Chemcomics>, connects the elements with comic books that reference the elements. Students might enjoy this twist.

Activity 8: What's In A Name? (SI GLEs: 3, 19; PS GLE: 10, 13)

Materials List: resource materials, internet (if available), poster board, Periodic Table of Elements for reference from textbook or teacher resources

This activity has three different components to explore: (1) elements found in everyday objects and household chemicals, (2) common elements found in the human body, and (3) the origin of the names of familiar elements. The teacher may let the students select from one of these categories or have them pick from teacher-generated cards to randomly choose their topic. Make certain all three are covered in the class.

Challenge students to research the information to present to the class in an entertaining format (television commercial, poster, interview, etc.). Atomic mass and atomic number of the specific elements researched should be a part of the final product, also.

If students have difficulty identifying household chemicals to research, the teacher may also provide students with a list of at least twenty common names of substances such as vinegar, baking soda, quicksilver, lye, water, table salt, table sugar, milk of magnesia, aspirin, rubbing alcohol, antifreeze, ammonia, bronze, pewter, brass, chalk, stomach acid, laughing gas, carbon dioxide, lime, limestone, plaster of Paris, etc. Have students complete research to determine the correct chemical name, the formulas (including the names of the elements found in the formula), how produced, and the major uses for each substance. The American Chemical Society has a Periodic Table of Elements that shows common uses of all of the elements: www.chemistry.org/ncw

Some suggested formats for student presentations include the following:

- posters on the origin of the element names that would detail the history of the naming of elements, the names and symbols used by the ancient Greeks and Romans, as well as by the alchemists of the Middle Ages
- commercials that would highlight the sale of household products spotlighting their ingredients (elements)
- elements of the body could be introduced by using road maps through the body or other creative means

Sample Assessments

General Guidelines

Assessment will be from teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Learning log entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be utilized to evaluate inquiry and laboratory technique skills. All student-generated work, such as drawings, data collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities.
- All student-developed products should be evaluated as the unit continues.
- When possible, students should assist in developing any rubrics that will be used, and provided the rubric during task directions.

- Science learning logs should be completed in pencil and should reflect careful attention to detail, science investigations well-documented, and obvious effort

General Assessments

- The student will create a laboratory report for variables affecting the rate of reaction for the effervescent tablet and the water.
- The students will research historical models of the atom and identify the parts of the Bohr model.
- The student will draw illustrations of the atoms of selected elements and explain the relevance of atomic mass and atomic number.
- The student will present a report or poster on common chemicals.
- Students will successfully complete the bonding movement activity without error and with the type of bond identified.
- The students will create a thorough lab report and descriptive science learning log entries for chemical reaction observations and summaries.

Activity-Specific Assessments

- Activity 1: Students will correctly represent the number and placement of electrons and protons in selected elements of the periodic table.
- Activity 2: Teacher will observe student responses to bonding with their peers as they link up to demonstrate ionic and covalent bonding.
- Activity 5: Student charts will reflect organization of observations and awareness of properties of chemical or physical changes and conductivity.
- Activity 6: Students will correctly identify variables of their investigation. They will present thorough documentation of the facets of the investigation, providing a summary that reflects an awareness of the correlation of data to support or disprove a conclusion.

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Resources

- Answers questions about models of atoms and number of electrons on shells
http://education.jlab.org/qa/atom_model.html
- *Alka-Seltzer Student Science Experiments*. 8 different activities
http://www.alkaseltzer.com/as/experiment/student_experiment.htm
- *Atoms, Elements, and Molecules*. Available online at
http://education.jlab.org/qa/atom_idx.html

- *The Formation of Water Simulation*. Available online at http://www.visionlearning.com/library/flash_viewer.php?oid=1858
- *Law of Conservation of Mass*. Available online at <http://chemistry.about.com/library/glossary/bldef5660.htm>
- *Periodic Table of the Elements*. Available online at <http://pearl1.lanl.gov/periodic/default.htm>
<http://environmentalchemistry.com/yogi/periodic>
- *Periodic Table of Elements* with common uses of elements and other great chemistry resources for teachers and students
<http://www.chemistry.org>
- Kid-friendly information on chemistry
<http://www.chem4kids.com>
- Electricity, circuits, conductors, insulators with lesson plans and activities
http://www.abc.net.au/science/surfingscientist/pdf/lesson_plan11.pdf (easy version)
<http://www.instructables.com/id/E8X4ZKJCCSETOMLNME/> (harder)
- The Periodic Table
<http://www-tech.mit.edu/chemicool/>
- *What You Need to Know about Chemistry*. Available online at <http://chemistry.about.com/bla/016952.htm>
- *Chemcomics* available online at <http://www.uky.edu/Projects/Chemcomics/>

**Grade 6
Science
Unit 4: Forces and Motion**

Time Frame: Approximately four weeks



Unit Description

This unit is designed to introduce students to the concepts of force and motion with an emphasis on Newton’s Laws of Motion. This unit provides a good opportunity to introduce controlled experimentation, as well as the concept of measurement errors and how to address them in data interpretation.

Student Understandings

Newton’s Laws of Motion explain movement, direction, speed, and forces that can and do influence objects in nature and in the laboratory. Using models and investigations, the laws of motion can be demonstrated. Students can then explain and predict actions and reactions.

Guiding Questions

1. Can students state and explain Newton’s three fundamental Laws of Motion?
2. Can students identify the forces that act upon objects and the effect those forces have on the object?
3. Can students relate their understanding of Newton’s laws to real life situations?

Unit 4 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry GLEs are embedded in the suggested activities for this unit. Other activities incorporated by teachers may result in additional SI GLEs being addressed during instruction.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
3.	Use a variety of sources to answer questions (SI-M-A1)
4.	Design, predict outcomes, and conduct experiments to answer guiding questions (SI- M-A2)
5.	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)

GLE #	GLE Text and Benchmarks
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
9.	Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)
10.	Identify the difference between description and explanation (SI-M-A4)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
13.	Identify patterns in data to explain natural events (SI-M-A4)
14.	Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
15.	Identify and explain the limitations of models used to represent the natural world. (SI-M-A5)
16.	Use evidence to make inferences and predict trends (SI-M-A5)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
21.	Distinguish between observations and inferences. (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
23.	Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8)
25.	Compare and critique scientific investigations. (SI-M-B1)
28.	Recognize that investigations generally begin with a review of the work of others (SI-M-B2)
31.	Recognize that there is an acceptable range of variation in collected data (SI-M-B3)
32.	Explain the use of statistical methods to confirm the significance of data (e.g. mean, median, mode, range) (SI-M-B3)
33.	Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
36.	Explain why an experiment must be verified through multiple investigations and yield consistent results before findings are accepted (SI-M-B5)
37.	Critique and analyze their own inquiries and the inquiries of others. (SI-M-B5)
39.	Identify areas in which technology has changed human lives (e.g. transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7)

Physical Science	
14.	Construct and analyze graphs that represent one-dimensional motion (i.e., motion in a straight line) and predict the future positions and speed of a moving object (PS-M-B1)
15.	Explain why velocity is expressed in both speed and direction (PS-M-B1)
16.	Compare line graphs of acceleration, constant speed, and deceleration (PS-M-B1)
17.	Describe and demonstrate that friction is a force that acts whenever two surfaces or objects move past one another (PS-M-B2)
19.	Identify forces acting on all objects (PS-M-B3)
20.	Draw and label a diagram to represent forces acting on an object (PS-M-B4)
21.	Determine the magnitude and direction of unbalanced (i.e. net) forces acting on an object (PS-M-B4)
22.	Demonstrate that an object will remain at rest or move at a constant speed and in a straight line if it is not subjected to an unbalanced force (PS-M-B5) (PS-M-B3)
23.	Predict the direction of a force applied to an object and how it will change the speed and direction of the object (PS-M-B5)
24.	Describe and give examples of how all forms of energy may be classified as potential or kinetic energy (PS-M-C1)

Sample Activities

Activity 1: How Do You Know It's Moving? (SI GLEs: 1, 4, 5, 11, 12, 19, 23, 25, 31, 32, 36, 37; PS GLEs: 14, 17, 19)

Materials List: chart paper or chalkboard/whiteboard, markers, stopwatches for each partner team or group, 2-3 meter sticks or tapes for each group, science learning logs, pencils, objects to roll and measure for speed (large and medium cans of vegetables, toy cars and/or trucks, or playground balls, etc.), masking tape, graph paper, safety goggles

PART 1 -- Brainstorm with the class to make a list of all things they can observe as *moving* in the classroom. Use a *graphic organizer* ([view literacy strategy descriptions](#)) to record their ideas. An example of a graphic organizer that could be used is as follows: one large sheet of chart paper or an area on the chalkboard with room to make a list titled, *Things we think are moving*. Have students revisit this list when they identify what reference point helped them recognize movement. If they need a larger field to consider, use the school grounds and take a walk to identify things that are moving.

Once a large sampling is taken, ask the students to describe how they knew the items were indeed moving. (*They should ultimately get to the point where they recognize that the position changed and that was evident through comparing the change in position with a reference point.*) The teacher may need to guide them to draw this conclusion.

Pose the question, How is movement measured? Students should offer input that refers to how far the object moved (*distance*) and how quickly it changed position (*time*).

We can identify the speed of an object by looking at the distance traveled and dividing that by the time it took to travel that distance. (Speed = distance / time) Elicit comments from the students regarding where they might have heard those terms used together (e.g., Cars travel down the highway in *miles per hour*).

PART 2 -- Ask students to identify a unit of measure that they could use to describe the speed of an object in the classroom, reminding them they must use metric based measurements (*meters per second*).

Provide an object for each group to roll and then measure its speed. Provide enough room so each group's paths of travel will not cross. If the objects are small, a table or counter can be used, if the objects are larger, the students will need to use the floor or a hall. It would be beneficial to have each group use the same type of object so data can be compared. With this approach the teacher would also be able to point out any extreme differences in data (outliers) that should be questioned or re-tested.

To have students recognize that mass is a factor in motion, the data from teams using large cans (example: 2lb. cans of tomatoes) can be compared to data from teams using medium cans (example: 15oz. cans of tomatoes) OR the speed of small cars can be compared to that of large trucks.

Have teams establish a path or track for their trials and mark the start and finish lines with masking tape. Recommend they use a measured track that will be easy to reference in their final calculations for speed (1 meter for small cars, 3-5 meters for cans, 5-10 meters for balls, etc). Students should identify safety concerns and consider any problems they may run into during this investigation.

Provide meter tapes or sticks for each team and have them create a chart for data collecting in their science *learning logs* ([view literacy strategy descriptions](#)). The data table must be labeled and neatly drawn. Provide stopwatches. Review how to use and read the stopwatch. Make certain students understand the importance of running multiple test trials (5-10) and that the data is collected with consistency so that they may make an informed conclusion. Make certain the students are aware that the method of release is a variable that they must consider and that there must be a consistent method of release of the object for each trial. Can students identify the dependent (*responding*) and independent (*manipulated*) variables for this investigation?

The teacher should move about the room and check the student systems as they work.

- Have they set up a reasonable data chart?
- Are they consistent in their rolling of the object and in collecting their data?
- Are they reading and recording the time on the stopwatch correctly?
- Can they set up their data using a graph?

- Have students order their times, and then find an average, mean and median of their recorded times. Can they explain the significance of this information?
- Can they improve on their investigation in any way?

As a wrap up to the investigation, students should compare their graphs and discuss any major differences and what variables would account for those differences. They should recognize that there is an acceptable range for data.

- Can the students identify the variables that affected the way their object rolled? (*surface of the area they used, rug vs., floor, release method, etc.*)
- Lead the discussion to have students consider the way the objects acted as they rolled. Was their speed constant? (*faster at the start, slower until it stopped*)
- What forces acted upon the objects and affected the speed? (*gravity and friction*)
- Can they explain the effect these forces will have on the rolled objects?

Activity 2: Where Does Velocity Come In? (SI GLEs: 11, 12, 19, 22; PS GLEs: 14, 15, 16, 17, 19)

Material List: weather information from the newspaper (copies for each group), Motion Graphs (labeled) BLM, Motion Graphs (unlabeled) BLM to compare and analyze (copies for each student), hurricane tracking maps, hurricane data from website (for each group)

Graphing the speed and velocity of a storm and reading graphs that show changes in speed are the focus of this activity. Revisit the definition of motion (*a change in position*). Hand each group a copy of the weather page from the newspaper and ask them to identify what feature described on the newspaper page (*winds, cold or warm fronts, tropical storms*) would be considered moving. Have the students scrutinize the information on the pages to identify what new piece of information is added to speed to make weather information more relevant to each population (*direction of movement*). Pose a question to the students, “How does knowing the speed and direction of a weather event help you prepare for that event?”

Have students identify other times when both the speed and direction of an object would be important. (Examples: when traveling on a train, plane, boat, or in a car, when preparing for school, and when you want to go fishing or hunting and you need to know from what direction the winds are coming, etc.) *Speed in a given direction is called velocity.*

Remind students of what forces cause motion to change (friction and gravity). Point out that even moving weather events are affected by forces that cause them to slow down or speed up. Can students identify what force(s) may slow down a tropical storm or hurricane?

Speed can be constant, but most animals and objects do not travel at a constant speed the entire time of the event. Both animals and objects speed up or accelerate and slow down or decelerate (also known as negative acceleration).

Provide a hurricane mapping chart and tracking data for each group to record or graph the various paths of a past hurricane. In doing so, students should note its velocity (speed in a

certain direction). See Resource section for websites to obtain this information. If speeds noticeably decrease as the storm gets near land (remember to have students look at distance traveled and the time it took), ask students to identify what force may affect the motion of the storm. (*When the storm hits the land mass, friction comes into play.* If temperature differences exist, there may be a density of air masses to consider.)

Provide students with copies of the Motion Graphs (labeled) BLM which shows acceleration, deceleration, constant speed, and standing still. Use these graphs to discuss how changes in speed or direction are reflected on each graph. Use the unlabeled version to assess student understandings of this concept as a pretest or posttest. Have students identify the different segments on each graph and what they mean for the motion of the object. They should be able to name each graph by the motion it represents.


Activity 3: You Need To Speak the Language (SI GLE: 3, 19; PS GLE: 15, 17, 19)

Materials List: index cards for vocabulary word cards, textbooks, notes, and other available resources to locate definitions of motion terminology

Review or re-teach the meanings of the terms used in this unit: acceleration, forces, friction, gravity, velocity, motion, and speed. To complete *vocabulary cards* ([view literacy strategy descriptions](#)) individually and compare finished cards with group members would serve this purpose well. Students will research each vocabulary word, construct a meaningful definition, provide a relevant, real-world example of each, a formula, if available, and illustrate the example. Emphasis should be placed on the student's ability to connect an understanding of these terms with real-life applications they've observed.

Example:

speed in a given direction



Velocity

$$\text{Average Velocity} = \frac{\Delta \text{position}}{\text{time}} = \frac{\text{displacement}}{\text{time}}$$

The butterfly's velocity was $\frac{1}{2}$ mph NNE as it migrated from Mexico

Students will select a way in which to share their vocabulary cards. (post them in sets on the wall, create a power point with them, trade until they have a complete set of each, play guessing games using the illustrations and hints, etc.)

Questions or statements to elicit student responses are geared to helping students connect with these terms. These might include the following:

- You observe acceleration in action on your way to school. What form would it take? (*in the auto, changing lanes, going down hill, or passing a vehicle*)
- When would deceleration be helpful or harmful? (*coming to a stop sign, trying to merge onto Interstate*)
- What forces act on you as you go about your daily routines? (*gravity, friction*)
- Explain how the school zone speed limit contributes to the time it might take to travel a particular distance. (*It interrupts your speed and makes it less constant.*)
- What examples at the amusement park would illustrate the terms we have explored? (*lots of examples here, but note, rides that go in a circle have zero velocity because the seat you sit on returns to the same point*)
- How is velocity important to your daily life? (*knowing where to move to get out of the way of a moving vehicle, planning for storms, fishing with the right winds, air traffic controllers directing planes in and out of an airport, etc.*)
- How is *velocity* of an object different from the *speed* of an object?

Activity 4: Inertia—Newton’s First Law ---(SI GLEs: 7, 8, 12, 16, 19, 21, 23, 28; PS GLEs: 14, 17, 19, 22, 23)

Materials List: (for each team) a plastic cup, index card, safety goggles, coins (2 dimes and a quarter) or metal washers of a size comparable to the coins, 20 ounce water bottle filled with water and sealed, golf ball, ramp about 24 inches long, 8 textbooks of similar thicknesses, masking tape, rulers or meter sticks, science learning logs, Cooperative Groups cards created in Unit 1, Activity 6

Note: The teacher may choose to create a set of lab instructions for each of these investigations. Use the Cooperative Groups cards and set up a supply station. Once students have the instructions and have gotten their supplies, they can run the investigations themselves. Be sure that students consider safety issues before starting.

Introduce Sir Isaac Newton and his studies as a springboard to the rest of the unit activities and as a reminder that investigations begin with a review of the work of others.

Students should create a data table in their science *learning logs* ([view literacy strategy descriptions](#)) to record predictions, measurements, and observations for the following 3 investigations.

Have the students set up the first investigation using the cup, index card, and quarter.

- They must first record a fully worded prediction as to the reaction of the coin when the card is flicked as described in the set-up below (e.g., The card and the coin will fly across the top of the cup together.).
- Cover the cup with the index card. Lay the coin on top of the card. Flick the card only (straight across the cup top) and observe the reaction of the coin. Record observations.

- Each member of the group goes through the same process and records their own observation (card moves away and coin drops into cup).

Have the students set up the second investigation using a quarter and a dime.

- Students must record a prediction first as to the reaction of the coins (e.g., The quarter will travel farther across the table when hit by the sliding dime than the dime will travel when hit by the sliding quarter.).
- Have students place the coins on a smooth, flat surface about 2-3 inches apart.
- Have the students mark the starting point for the target coin (the coin farthest from the student) with a small piece of tape nearby and flick the closest coin at the target. Have them then measure the distance the target travels and the distance the coin they flicked travels, attending to measurements with precision and accuracy.
- Ask students, What do you think will happen if you flick a dime at a quarter? a dime at a dime? a quarter at a dime?
- Have students run multiple tests each using the same strength and the same delivery.
- Record all observations; include measurements in a graph that shows how far each coin traveled when hit.

Have students set up the third investigation using a ramp, a filled, sealed water bottle, a golf ball, and 8 books.

- Have students begin with a prediction as to the reaction of the water bottle and golf ball (e.g., The golf ball will move the bottle full of water 10 cm. away from the starting point).
- Set the ramp up on two books.
- Have students lay the water bottle at the bottom of the ramp.
- They should mark the position of the bottle with a piece of masking tape at the base of the ramp, running in the same direction as the bottle is lying.
- Students will place the bottle on the tape.
- Once the bottle is stationary, have the students place the golf ball at the top of the ramp.
- They will roll the ball, measure the movement of the bottle with the ruler, and record the results. Multiple tests should be run for each ramp position.
- Repeat the investigation, adding two books after each time to increase the height of the ramp.

When all investigations are complete, student groups should report their observations to the entire class, keeping in mind that they are reporting on what occurred based on their evidence and observations. Have students respond to the following questions in their science *learning logs* after all groups have presented. Explain that their answers to these questions become the basis for inferences after their observations are made. Students should be able to clearly distinguish between observations and inferences.

- Why did the coin fall into the cup and not move with the card when the card was flicked? (*force was on the card, not the coin*)
- Why was it important to place the coins on a *smooth, flat surface* when doing the coin investigations? (*friction would be a factor in the response*)

- What caused the coins at rest to move? What impacted the distance each coin moved? (*an object in motion transferred energy*) (*mass of each*) What happened to the coin you flicked towards the other coin once it hit? (*energy from the flicked coin passed to the target coin*)
- How many books did it take to move the bottle the farthest?
- Why do you think the bottle moved even though it was heavier than the golf ball?
- What forces were at work in each investigation? (*gravity, and to a degree, friction*)
- Can you predict a trend from what you observed with the responding movement of the coins? the interactions of the golf ball and bottle?

Activity 5: Newton’s Second Law (SI GLEs: 5, 6, 7, 8, 9, 11, 23, 31; PS GLEs: 15, 19, 20, 21, 23)

Material List: (for each group) meter tapes, meter sticks, rulers, safety goggles, stopwatches, triple beam balance scales, film canisters or plastic containers with sand for extra mass, wheeled objects (inexpensive plastic trucks or cars, wheeled vehicles built by students using construction kits, etc.) calculators, ramp large enough to provide a solid starting point for the vehicles, masking tape, science learning logs

Have students revisit safety guidelines prior to beginning the activity. They should consider safe use of the space in the room and the rolling of vehicles.

In this activity, student groups will use a wheeled object to study the relationship between mass and acceleration when a constant force is applied to the object.

Depending on the size of the objects used, measure and mark 1 – 5 meter distances on a flat surface. Be sure to include the ramp in the measurements. Using a ramp standardizes the release method. Students place the vehicle at the top of the ramp, line rear wheels up with a masking tape start line and release, without any push. Make meter sticks, meter tapes, and rulers available for student use during the investigation. They are expected to measure with accuracy at all times.

The object will be released and the time it takes to move the distance will be recorded. Students will need to measure the mass of their objects, and record the time it takes to travel until the object stops (or has negative acceleration). Have students run several trials before adding more mass to their vehicles. Each addition of mass should also be measured and recorded on a student generated chart in their science *learning logs* ([view literacy strategy descriptions](#)).

Students should contemplate what problems must be considered in this investigation. Provide access to calculators. The experiment will be repeated by placing additional mass in or on the object. Try using a film canister or plastic container half-filled or filled with sand. Students should see that the increased mass results in a smaller change in speed, thus a smaller acceleration.

The teacher should have the students identify what changes they will see (dependent or responding variable) and what changes they will make (independent or manipulated variables). The trials should be repeated to obtain an average for each variable tested.

Students should note variations in data collected from the different groups, if the groups used similar vehicles. They should discuss if the variations fall within an acceptable range.

In addition to the students completing a laboratory report, summarizing activities should include a class discussion led by teacher-guided questioning and direct instruction as needed, enabling students to respond either orally or in written format to summative questions and tasks as follows:

- Make predictions about the time it will take the vehicle to travel the required distance.
- Use observations and data from the activity to give a definition of accelerated motion.
- Explain the difference between velocity and speed and why velocity is expressed in both speed and direction. Give an example of when knowing both the speed and direction of an object is important.
- Draw and label a diagram to represent the forces acting on the car.
- Predict how the speed and direction will change if the direction of the force changes.
- How does a change in the vehicle's mass affect the acceleration of the vehicle?
- When would students observe that with increased mass, increased force is needed to move the mass? (moving a refrigerator vs. a small table, etc.)
- Write a description of what was learned in the experiment.

Activity 6: Catapults (SI GLEs: 2, 4, 11, 12, 14, 19, 23, 33; PS GLEs: 19, 20, 21, 22, 23, 24)

Materials List: provide information and/or research on catapults and trebuchet if students do not have Internet access, safety goggles, heavy corrugated cardboard from boxes, rubber bands, aluminum pie tin for each group, masking tape, scissors, string, paint stirring sticks, binder clips, paper clips, small 2 oz paper cups, index cards, small wood scraps, science learning logs, pencils, rulers, spring scales (optional), any other materials that the teacher thinks may be useful in constructing a catapult, large pompons (craft section of variety store) or ping pong balls, unlined paper on which students will draw a diagram of their catapult design

Begin with student research on catapults and the trebuchet including their origin and the various types. Provide rubber bands and pompons for each student and a pie tin target for each group. Challenge each student to hit the pie tin target with the pompon using the rubber band as the catapult. Students will need to make various adjustments to their system as they work to hit the target. Tell students to move away from the target once successful so as to identify the longest distance at which they will have success.

After the students have had sufficient time to explore this simple catapult, initiate a discussion of motion and energy and what affects the movement of objects, have students design and create more complicated catapults out of everyday objects. They should provide a written plan that details what materials they will use, how they will build the catapult, and what will create the force needed to propel the load.

Safety concerns must also be considered and prominently addressed in the student plan. Students work in teams to compete with the catapults. They must document their trials with anecdotal notes, measurements, and diagrams. Measurement must be approached with consistency in order to provide reliable data.

All data should be recorded in the science *learning logs* ([view literacy strategy descriptions](#)). They will demonstrate their understanding of motion and the forces at work by utilizing the final catapult to project pompons or ping pong balls. Students should be able to recognize that the projectile and arm of the catapult will remain at rest until it is subjected to an unbalanced force.

Distance and accuracy can be charted by providing a target. Students will need to identify all variables (independent and dependent), record their trials and the changes that they made as they pursued a successful catapult. Their final model must be diagrammed and should reflect all of the forces working on the model and should be drawn on unlined paper. Can students determine the magnitude and direction of the forces? Can they identify where unbalanced forces are at work?

At the conclusion have students critique the catapult models, identify problems with design and offer recommendations to improve accuracy or distance.

Students should be able to demonstrate the effect that adding the unbalanced force to the catapult has on the projectile. They should also be able to predict how the direction and magnitude of the force applied to projectile by the catapult will affect the distance the projectile travels and the accuracy of the system as a whole. Can they predict how changing the magnitude of the force of the catapult changes the reaction of the pompon or ping pong ball?

This activity also allows the teacher to introduce or emphasize examples of potential and kinetic energy. If available, students should use spring scales to measure the force their catapult provides.

Activity 7: Seat Belts-R-U's (SI GLEs: 1, 2, 4, 6, 7, 8, 10, 11, 12, 13, 15, 19, 22, 23, 39; PS GLEs: 19, 22, 23, 24)

Materials List: modeling clay, small to medium toy car or truck (one for each group), ramp(s), books for ramp supports, meter sticks or tapes, safety goggles, masking tape, pencil or any other speed bump material (depending on the size of the car), science learning logs

Always begin with a review of class safety guidelines and plans to provide for safety concerns.

Students will use a toy car or truck for this investigation. They will assemble a ramp to test what happens to a passenger moving with the car when the car hits an obstacle.

Students should be introduced to Newton's First Law, The Law of Inertia. Students will demonstrate that a moving object has inertia. A ramp can be set-up against two books with a pencil or such taped to the floor just past the end of the ramp to serve as the "speed bump" or

obstacle. A meter stick should also be attached to the floor parallel to the path of the car so as to measure the effect the collision of the car with this obstacle has on the passenger.

Students will create a modeling clay figure to sit in their test car. The figure should be balanced in the car and not stuck in too tightly. The students should record their predictions regarding the direction of the forces working on the vehicles and passengers. They will then run multiple trials, recording their observations in their science *learning logs* ([view literacy strategy descriptions](#)) on a data chart.

Students will observe the effect that stopping the car has on the passenger. They should collect quantitative data by measuring how far the passenger traveled after the vehicle stopped quickly and/or qualitative data regarding the condition of the passenger after the vehicle stops quickly. This lab provides a good opportunity to have students identify potential and kinetic energy. Measuring should reflect attention to accuracy.

After several test runs with the measurement data collected, have the students describe what occurred and then explain why it occurred. They should be able to demonstrate and explain that an object will remain at rest or move at a constant speed unless acted upon by an outside force. The passengers in the vehicles should provide many examples of this. The students should be able to apply Newton's Law of Inertia to the investigation and possibly other laws, if they can justify them.

Further tasks/questions might include the following:

- Identify all forces acting upon the car and the passenger.
- Predict how the direction and magnitude of the force affects the reaction (speed and direction) of the vehicle's occupant.
- Identify and describe the variables that are involved in designing this investigation. Do they understand the difference between their description of what occurred and their explanation of why it occurred?
- Explain the benefits of using crash test dummies to evaluate the effects of automobile crashes.
- How does testing with crash dummies compare with a scientific investigation? What are some of the limitations?
- When you are riding in a car and the car stops quickly, why do you fling forward?
- Explain the benefits of seatbelts and headrests in automobiles. How has new technology changed human lives?

Activity 8: Newton's Third Law—Action / Reaction Pairs (SI GLEs: 1, 2, 4, 5, 6, 7, 12, 13, 16, 21, 22, 23; PS GLEs: 19, 20)

Material List: two skateboards, rolling chairs or wheeled scooters used in physical education classes, meter sticks or tapes, science learning logs

Safety Note: Students should identify safety issues to be considered for this investigation and create guidelines for use of the skateboards or wheeled vehicles.

Newton's Third Law can be demonstrated by using two students of nearly the same mass/weight and two skateboards. A large clear area is needed either in the classroom or in the hallway. Students sit on skateboards facing one another. Ask students to predict what will happen if they push on each other's hands. Have students on skateboards reach towards one another and push off from each other's hands. (Both will move in opposite directions.)

Run several tests, recording observations each time. Use different students to run additional tests but allow each pair to repeat their test at least three times. Discuss predictions versus what actually happened. Solicit input from the students for suggestions on how to continue the investigation (push off while moving towards each other, push off from a stationary wall, pull towards each other, use different sized students, etc.).

Ask students to predict what will happen and why in each example. They should record their predictions in their science *learning logs* ([view literacy strategy descriptions](#)). Have students identify problems and factors that must be considered in the investigation. These should be documented in the *learning log*, also. Run multiple investigations. Discuss predictions versus what actually happened. Have students create diagrams of the results for each investigation, being sure to represent all forces acting on the object(s).

Students should be able to identify all of the variables (independent and dependent). It is important to compare what happens when the students are of equal mass and when they differ in mass. Have a class discussion to make these observations clear. Can the students identify the pattern that evolves through each action/reaction involving changes in mass? Students should be able to discriminate between observations and inferences in their written report.

Use the investigations as a basis for direct instruction on Newton's Third Law of Motion. Students should be able to identify all forces acting on the objects for each investigation.

Activity 9: It's The Law! (SI GLEs: 10, 12, 14; PS GLEs: 19)

Material List: student copy of Newton's Laws from textbook or notes; large index cards; markers; large labels on sentence strips or cardstock for Newton's First Law, Newton's Second Law, and Newton's Third Law; It's the Law! BLM for each student

Students are asked to work with their group and create a list of real life scenarios that give examples of Newton's Laws. They need to make certain to describe or illustrate the scenarios and not just explain the connection.

Have students use the It's The Law BLM which contains a *word grid* ([view literacy strategy descriptions](#)) to help them think critically about each of Newton's Laws and identify several scenarios for each. Distribute the handout to each student and have them check which law they think pertains to the illustration pictured.

Once they have their group list completed, students must put each scenario on a separate index card, remind the students they may not use any examples from the BLM. They may use

magazine pictures depicting scenarios, draw scenarios, or just depict them through descriptive writing. S must be able to identify all forces acting on the objects in their scenarios.

While the groups work on their list and scenario cards, post labels on a table or the board so students may place their cards under which ever law of motion applies to their cards.

Each group will give their completed set of scenario cards to another group and the receiving group will post the cards on the wall or board where the labels for each law are displayed. The group must correctly place each scenario under the appropriate law. The group responsible for creating the card set will check the placement, but may not move any cards to a different law without allowing the group that placed them to justify the placement. Keep one version of each scenario to use for assessment at a later date.

Sample Assessments

General Guidelines

Assessment will be from teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be utilized to evaluate inquiry and laboratory technique skills. All student-generated work, such as drawings, data collection charts, models, etc., may be incorporated into a portfolio assessment system.

General Assessments

- The student will submit plans, observations, and comparisons for evaluation as each unit continues.
- Students will assist in developing any rubrics that will be used, and will be provided the rubric prior to and/or during task directions.
- Students will be able to explain Newton's Laws of Motion in writing or orally. Have students brainstorm examples of types of motion. Then ask them to decide if the motions are describing Newton's first, second, or third laws.
- Given an opportunity to see a bicycle, students will describe in essay form how applying the brake to stop a bicycle is an example of a force applied.

Activity-Specific Assessments

- Activity 2: Students will correctly identify each segment of the graphs provided (horizontal line = stopped, downward sloping line = decelerating, upward incline = acceleration, etc.)

- Activity 5: Students will correctly describe how an objects mass affects its motion. Students will identify friction and gravity as two forces that affect movement
- Activity 7: Students will give a reasonable explanation regarding the use of head rests and seatbelts as related to Newton’s Laws.
- Activity 9: Students will correctly match real-life scenarios to Newton’s Laws.

Resources

- *Newton’s Laws of Motion*. Available online at <http://www.glenbrook.k12.il.us/gbssci/phys/class/newtlaws/u211b.html>
This site has an online quiz for students to check their understanding.
<http://www.grc.nasa.gov/WWW/K-12/airplane/newton.html>
- *Discoveryschool.com – Making Catapults* Available online at <http://school.discovery.com/lessonplans/programs/motionforces>
- *Friction Investigation –The Magic School Bus* Available online at <http://content.scholastic.com/browse/article.jsp?id=1648>
- *Individual storm tracking information is available here*
<http://weather.unisys.com/hurricane/atlantic/2006/ALBERTO/track.dat>
- *Hurricane tracking maps are found here*
<http://www.accuweather.com/hurricane/facts.asp?partner=accuweather&fact=tracking>

**Grade 6
Science
Unit 5: Properties of Energy**

Time Frame: Approximately five weeks



Unit Description

This unit introduces the student to the basic forms of energy with an emphasis on the properties of energy. Energy transfer and transformation are also explored. Relationships between forms of energy and classifications of renewable, nonrenewable, and inexhaustible resources will be considered.

Student Understandings

Students need to understand how energy can be transformed or transferred. Forms of energy (i.e., light, heat, and sound) are explored as are the ways to transform energy for practical use. Students should be able to distinguish renewable, nonrenewable, and inexhaustible energy resources.

Guiding Questions

1. Can students identify examples of common uses for the various forms of energy?
2. Can students trace various forms of energy as they are transformed from one form to another?
3. Can students identify renewable, nonrenewable, and inexhaustible resources?
4. Can students describe how light is reflected and refracted?
5. Can students identify ways in which people can reuse, reduce and recycle resources?

Unit 5 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry GLEs are embedded in the suggested activities for this unit. Other activities incorporated by teachers may result in additional SI GLEs being addressed during instruction.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
3.	Use a variety of sources to answer questions (SI-M-A1)

GLE #	GLE Text and Benchmarks
4.	Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2)
5.	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
13.	Identify patterns in data to explain natural events (SI-M-A4)
14.	Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
15.	Identify and explain the limitations of models used to represent the natural world (SI-M-A5)
16.	Use evidence to make inferences and predict trends (SI-M-A5)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
21.	Distinguish between observations and inferences (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
23.	Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8)
25.	Compare and critique scientific investigations (SI-M-B1)
33.	Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
Physical Science	
7.	Simulate how atoms and molecules have kinetic energy exhibited by constant motion (PS-M-A4)
24.	Describe and give examples of how all forms of energy may be classified as potential or kinetic energy (PS-M-C1)
25.	Compare forms of energy (e.g., light, heat, sound, electrical, nuclear, mechanical) (PS-M-C1)
26.	Describe and summarize observations of the transmission, reflection, and absorption of sound, light, and heat energy (PS-M-C1)
28.	Explain the law of conservation of energy (PS-M-C2)
30.	Trace energy transformations in a simple system (e.g., flashlight) (PS-M-C2)
31.	Compare types of electromagnetic waves (PS-M-C3)

GLE #	GLE Text and Benchmarks
32.	Identify and illustrate key characteristics of waves (e.g., wavelength, frequency, amplitude) (PS-M-C4)
33.	Predict the direction in which light will refract when it passes from one transparent material to another (e.g., from air to water, from prism to air) (PS-M-C4)
34.	Apply the law of reflection and law of refraction to demonstrate everyday phenomena (e.g., how light is reflected from tinted windows, how light is refracted by cameras, telescopes, eyeglasses) (PS-M-C4)
35.	Determine through experimentation whether light is reflected, transmitted, and/or absorbed by a given object or material (PS-M-C4)
36.	Explain the relationship between an object's color and the wavelength of light reflected or transmitted to the viewer's eyes. (PS-M-C4)
37.	Compare how heat is transferred by conduction, convection, and radiation (PS-M-C5)
38.	Identify conditions under which thermal energy tends to flow from a system of higher energy to a system of lower energy (PS-M-C5)
39.	Describe how electricity can be produced from other types of energy (e.g., magnetism, solar, mechanical)
Science and the Environment	
42.	Identify energy types from their source to their use and determine if the energy types are renewable, nonrenewable, or inexhaustible (SE-M-A6)
43.	Explain how the use of different energy resources affects the environment and the economy (SE-M-A6)
46.	Identify ways people can reuse, recycle, and reduce the use of resources to improve and protect the quality of life (SE-M-A6)

Sample Activities

Activity 1: Safety for Energy Investigations (SI GLE: 23)

Materials List: safety rules from Unit 1

Prior to beginning this unit, have students identify and discuss what they think would be relevant safety concerns when studying energy. Stress responsible behaviors regarding electricity and other energy sources, and pay particular attention to assignments completed at home. Emphasize care and the use of protective materials when dealing with heated items.

Activity 2: Home Energy Hunt (SI GLEs: 3, 7, 19, 21, 22, 23; PS GLEs: 25; SE GLE: 42)

Materials List: Home Energy Hunt BLM, textbooks, reference materials, websites if internet access is available, large class chart on which to transfer results of the Home Energy Hunt, science learning logs

In this activity students should be familiar with the different forms of energy that may be used in the home (electricity, chemical, solar heat and light, biomass, or fossil fuels). Use textbooks, posters, internet, or reference materials to help students develop an understanding of these different types of energy before they identify them at home.

Once students have a grasp of each of the different forms of energy, challenge them to identify where in the home these sources are used to power familiar objects or provide services. Give each student a copy of the Home Energy Hunt BLM. Instruct students to locate and identify things that are powered in the home, what the source of energy is for each, and the form the energy takes in the use of the object or service. The students should then identify whether or not they believe the source to be (R) Renewable, (NR) Nonrenewable, or (IE) Inexhaustible. The following website provides a resource that helps explain *inexhaustible resources*:

<http://reference.howstuffworks.com/conservation-encyclopedia.htm>

Example:

Energy user	R	NR	IE	Form of energy used	The product of the energy use
Calculator				Solar Powered	Electricity, light
Lamp				Electricity	Heat, light

The teacher should have the students share the results of their Home Energy Hunt in a way that allows the students to assess the accuracy of their conclusions (on a chalk or white board, chart paper, etc.) Reserve the R / NR / IE columns to complete during closure.

The teacher will review the *form of energy used* column on the Home Energy Hunt BLM to make certain students can accurately track the energy used to provide power for the objects or appliances they listed. *The product of the energy use* column should reflect an understanding of the different types of energy. As an example, students often identify the wind produced by fans as wind power. They may need guidance to see that the electrical energy used to power a fan produces mechanical energy to move the fan blades. Another difficult concept involves the use of batteries (chemical energy) to produce electrical energy to power lights, games, etc.

Once misconceptions have been cleared and the students have a good grasp of the examples of energy use in the home, the teacher should have the students enter several examples from their corrected list into their science *learning log* ([view literacy strategy descriptions](#)).

The teacher should create a large, class-sized Energy Hunt chart onto which samplings of their results may be recorded. A variety of energy users should be recorded. The teacher should also add a narrow column between energy user and source of energy to include check marks or a code (R = Renewable, NR=Nonrenewable, IE=Inexhaustible).

As a part of closure, the teacher should work with the students to classify the forms of energy used by putting a checkmark in the appropriate column (R, NR, or IE) for each item listed. Typically, the check marks overwhelmingly point to how much electricity we use in the home and this should lead neatly into a discussion of how their electricity is generated and what alternative energy sources are available in the area in which students live.

The completed chart will be used to discuss energy transformations in the next activity. See websites such as, www.eia.doe.gov/kids/energyfacts/science/formsofenergy.html, for a concise list and descriptions of the forms of energy. The teacher should also take this opportunity to clarify the difference between observations and inferences. Remind the students to be specific when noting what they have observed and identify inferences as the conclusions they draw after their observations. Brainstorm with the students to fill any voids in the class chart. Retain chart for future discussions.

Activity 3: Conservation of Energy (SI GLEs: 1, 7; PS GLEs: 7, 24, 25, 26, 28, 30, 39)

Material List: Energy Hunt class chart from Activity 2, wide strips of chart paper or sentence strips for each group (for flow chart graphic organizers)

Introduce students to the Law of Conservation of Energy and the concept that energy is neither created nor destroyed, but changes from one form to another. Use the Energy Hunt class chart to identify the different forms energy may take (light, heat, sound, chemical, mechanical, electricity). Point out to students that while energy is found in many forms, they can all be placed into two main categories: kinetic and potential.

Student groups will select several energy users from the class chart or from their own Home Energy Hunt charts and create a *graphic organizer* ([view literacy strategy descriptions](#)) or flow chart that illustrates how the use of one form of energy produces another form of energy. They should track each transformation of energy from start to finish.

Example: incandescent bulb lamp → electrical → heat → light
blow dryer → electrical → heat & mechanical (fan) → wind
flashlight → chemical (battery) → electrical → light
radio → electrical → sound

The flow charts should be written on sentence strips or chart paper to encourage students to produce large flow charts. Each group should be able to complete at least five different paths of energy. The groups will exchange flow charts to critique the accuracy of the transformations tracked. Students must create a corrected version of the tracking in question if they disagree with any. They may not change the original group's version; just provide their own corrected version.

Once each group has completed their critiquing,

- Have the groups that challenge any of the paths present their version and justify why they believe it to be more accurate.

- Add the more accurate paths to the collection and remove those less accurate.
- Post the results in the room for all students to see.
- Have students identify the sources of energy for each object tracked on the strips.
Can they trace the producer of the energy source for the object back to its origin?
(e.g., Blow dryer → runs on electricity → produced by burning coal)

Challenge students to locate and identify the energy plants in Louisiana and the source of fuel for the production of energy.

Review the concept that heat is internal energy or kinetic energy and that this energy can be transformed. Help students recognize that kinetic energy involves motion of waves, electrons, atoms, molecules and objects. When students rub their hands together to demonstrate friction, heat is produced and the demonstration can, on a simple scale, simulate the movement or kinetic energy of particles and the production of heat. Students should be able to identify energy that is stored as potential energy and other forms of energy as kinetic. (Remind students that they also observed kinetic energy changing to potential energy and back to kinetic energy when they did the pendulum investigation in Unit 1 and with catapults in Unit 4.)

Identify the energy users that produce heat.

- Is the heat transferred through direct contact (*conduction*), such as the hot plate on a coffee pot or the flat plate of an iron?
- Is the heat transferred through the air (*convection*), such as a blow dryer, central heat unit, or a convection oven?
- Is the heat transferred as it radiates from the source (*radiant*), such as incandescent light bulbs, regular ovens, or fireplaces?

Students should identify any energy transformations that involve an energy source that produces electricity. Examples would include solar powered calculators, battery powered objects, or crank- type weather radios. If these examples do not show up in the student explorations, bring examples that allow the students to discover this connection. Ultimately, students should be able to describe how electricity can be produced from other types of energy (solar, chemical, mechanical). The students should also be able to look at the big picture and connect state energy producers to the sources used for energy production (coal, hydropower, natural gas, nuclear energy, petroleum, and biomass).

Activity 4: Waves (SI GLEs: 1, 2, 4, 7, 23; PS GLEs: 25, 26, 28, 31, 32, 35, 36, 37, 38)

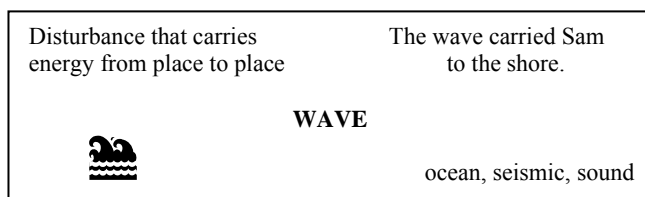
Material List: for DEMO: 1 large spring toy or long, flexible spring from hardware store, for ACTIVITY: copy of the electromagnetic spectrum for each student or for whole class use, empty food cans (2 per group, top removed, nail hole in center bottom), string, flashlights, hot water, coffee mug, pot holder, science learning logs, class Energy Hunt chart from Activity 2, safety goggles, Vocabulary Word Card Guide BLM for each student

Safety Note: Caution needs to be taken that spring toys are not overstretched or suddenly released; injury may result. Protective eye goggles should be worn by the teacher and assistant while using a metal coiled spring toy or spring.

Part 1- DEMO: the teacher will model wave types and demonstrate the movement of energy along the wave. A metal-coiled spring toy is the modeling instrument of choice (Inspect all metal spring toys before and after laboratory use.) Long, flexible springs are also available at hardware stores.

Select a student to assist in a demonstration of the movement of waves and how energy is transferred along the wave. Lead students to describe what they see and explain their observations with appropriate vocabulary: *waves, amplitude, frequency, crest, trough, speed, and energy.*

Have students create *vocabulary word cards* ([view literacy strategy descriptions](#)) to strengthen their understanding of the wave vocabulary. Distribute the Vocabulary Word Card Guide BLM to each student to use as an example. Students will place one vocabulary word in the center of each card; add a diagram to one corner, a definition to another corner, a sentence that correctly uses the term in the third corner, and a related word (an opposite or a word that goes with the center word) in the last corner.



Provide examples of where they may see waves in action and provide information on the difference between transverse waves (i.e., light, water) and longitudinal waves (i.e., sound). Students should be able to draw a correlation between the information they gain from the wave demonstrations and the Law of Conservation of Energy.

PART 2

Ask students how they think light, sound, and heat energy get from one place to another. Set up a student investigation involving how light travels (students use a flashlight and pay attention to how the light moves across the room, and through different media), how sound travels (students use two cans with a string knotted through the bottom and pulled taut in order to talk to another student across the room), and how heat travels (fill a coffee mug with hot water; warmth comes through the cup materials from the heated liquid).

Heat always moves from a warmer medium (material through which it travels) to a cooler medium. When we *lose* heat it is moving to that cooler medium. Can students identify specific instances where *thermal energy* or *heat* travels from higher energy to lower energy?

Heat can travel from material to material by *conduction*, from material through the air by *convection*, and by radiating out from a source like the Sun in *radiant heat from the Sun*. Students should revisit the class Energy Hunt chart of energy users from the home and review which involve radiant heat (fireplace, gas heaters, etc.), which involve heat conduction (coffee maker, hot plate, stove tops), and which involve convection (blow dryers, convection ovens, central heat in the home).

Sound needs a medium through which to travel, which is why we cannot hear in the vacuum of space. Speaking into the can sent sound vibrations (*waves*) traveling along the string to the other can.

Light does not need a medium in order to travel and so we can see the light of stars through the vacuum of space. This will be explored in a following activity but can be incorporated at this time, if the teacher chooses.

Students will examine a diagram of the electromagnetic spectrum and identify the parts of the spectrum of which they are familiar. Have students compare the wavelengths of each part of the spectrum and identify what type of energy falls on either side of the visible spectrum. Can students recognize the relationship between shorter wavelengths and higher frequencies? Students should add this observation to their science *learning log* to expand their documentation of the characteristics of waves.

The teacher will need to help students understand that a red tomato reflects red back to the eye of the viewer and that an object's color is related to the wavelength of light transmitted to the observer's eye.

See NASA's website on the electromagnetic spectrum to provide information for this.

http://imagine.gsfc.nasa.gov/docs/science/know_11/emspectrum.html

or for a copy of the electromagnetic spectrum see

http://www.nasa.gov/centers/langley/images/content/114284main_EM_Spectrum500.jpg

PART 3

Review the vocabulary of waves (*trough, crest, frequency, and wavelength*) and the *electromagnetic spectrum*. Challenge each student to select light, heat, or sound and create a home investigation to identify the ways their energy topic can be absorbed, reflected, transferred and transformed. Create testable investigation questions with the students such as

- How does this energy travel?
- What substance is most efficient or least efficient as a medium for travel?
- How is this energy reflected, absorbed, transferred, or changed to a new form?

Students will use a variety of resources to collect information on the various energy forms as they plan their home investigation. Students must present safety considerations along with their investigation plan. The home investigations should include a component that indicates that parents are aware of the object of the investigation. Students will plan investigations, create chart or tables for data, record their observations /data and communicate their results with others in the class. They must identify potential problems, safety aspects, and questions that should be considered in the investigation.

Set aside one day for *professor know-it-all* ([view literacy strategy descriptions](#)). Students with similar energy sources (light, heat, sound) will form a team to act as the energy *travel agents*. All students will generate several questions to ask of the other groups and to respond to regarding their own topic. The teams may take a question, huddle, and have a spokesperson from the team of *professor know-it-alls* answer the question.

Activity 5: Refract and Reflect Exploration Centers (SI GLEs: 1, 4, 7, 12, 13, 15, 16, 22, 23; PS GLEs: 26, 33, 34, 36)

Materials List: glass containers or plastic cups, water, white tempura paint, several flashlights, two cardboard boxes with insides painted white, small working fluorescent fixture with bulb, incandescent bulb in working lamp base, small black-light bulb and fixture, access to electricity, prisms or discarded CDs, mirrors, water in a bowl with a light source over it, small mirrors, small stick-on convex mirrors (auto parts stores), squares of transparent colored plastic sheets in red, blue, and yellow, clear overhead transparency sheets cut into fourths, eyedroppers or pipettes, pencils, diffraction (*rainbow*) glasses (available from catalogue and online novelty stores), ½ project board to serve as a table-sized visual obstacle, several small brightly colored objects (apple, lemon, ball, etc.), newspaper or magazine pages, science learning logs

Have students identify and discuss the safety concerns that must be addressed before beginning this activity (moving from center to center carefully, keeping glass and lights away from the edge of tables, flashlights not to be shined in anyone's eyes, keeping cords away from avenues of travel, etc.).

Set-up exploration centers in the room to demonstrate some of the unique phenomena that can be demonstrated by examining some of the properties of light. Students should use their science *learning logs* ([view literacy strategy descriptions](#)) when recording their observations, illustrations, and explanations.

Center options include:

- Two glass containers, vases or clear plastic containers, water with 2 ml of white tempura paint added for one container and clear water for the other, and a flashlight. Students will investigate the properties involved when the light is shined through the water at various angles. Where does the light go in? Where does it come out? What difference is noted between shining the light through the milky water and the clear water? (light shined into the cloudy water is absorbed and does not pass through the container)
- Two cardboard boxes with one end open and painted white in both interiors, one small fluorescent light (bulb in fixture), and one incandescent light (bulb in fixture). Place or install a light source in each box and provide a set of brightly colored objects to view, describe, and compare under each light source. A third station with a black light may also be set up. Students should note the subtle differences in the colors of the objects under each light source. Student's science *learning log* entries should include reference to the relationship of an object's color and how the viewer sees colors that are reflected versus those that are absorbed.
- Have diffraction glasses available for students to view the different types of light used (incandescent, fluorescent, and black-light). They should note any differences in the widths of the colors of the spectrum they see while using the glasses to view each light (the width of each band of the spectrum appears in different widths according to the type of light viewed).
- Provide research that explains the workings of a black-light for students to read. The following website explains how a black-light works.

<http://science.howstuffworks.com/black-light.htm>

- A clear cup filled with water. Place a pencil in the glass and look at it at eye level. Ask: What is different about the image as seen under water? Students should illustrate what they observe from the top and side. Draw a diagram of the pencil as seen from the top and as seen from the side. Students should also hold the pencil straight in the center of the cup and note the difference in the submerged portion of the pencil (the pencil will appear broken or bent as the object is viewed through the water).
- A prism or a discarded CD and a flashlight. Shine the flashlight through the prism or over the unprinted side of the CD. Students should note what is seen (a rainbow) and draw and color their observations exactly as seen.
- Provide sections of colored clear plastic (red, yellow, blue) through which students may shine their lights and observe the color combinations, as well as the paths of the light. They may even be able to see the combination of all three colors will create white light.
- Provide a flashlight, a large cardboard tabletop divider (1/2 project boards work well), and several small mirrors. An obstacle is placed between two students, with one student facing the obstacle and the other holding the flashlight. Challenge the students to use the mirrors to direct the light around the obstacle to where the other student can see the light. How does this explain the workings of a periscope? Students should diagram the solution they create to the problem. (A good lead in for the teacher to discuss the *angle of incidence = angle of reflection!*)
- Provide small clear plastic sheets (cut transparencies into fourths), pipettes, sections of newspaper pages or magazine pages, and water. Have students use the drops of water on the transparencies and create a water drop lens. Have students draw the set-up and the resulting view or the print through the “lens.”
- Provide several different sized stick-on convex mirrors (often used to increase viewing area on side view mirrors) and a flashlight. Have students shine the light into the lens and observe the angle at which the beam is reflected.

Students should summarize their observations at each station in brief, but concise, science *learning log* entries and include sketches and drawings when appropriate. They should be able to generalize any patterns in data they recognize and what those patterns may indicate.

Once observations have been made, the teacher should guide a class discussion regarding the properties of light and how these properties were observed in their explorations. Students should also give examples of where these phenomena are seen in everyday life. Through the discussion, students may be able to identify the limitations of the models used to represent natural phenomena.

The teacher should present information on the Laws of Reflection and Refraction, along with terms such as *angle of incidence*, *angle of reflection*, *diffused light*, *transparent*, *translucent*, and *spectrum*. Have students add these words (and others as identified) to their science *learning logs* where they apply. Students should be able to describe in their learning log entries, how light was reflected, absorbed, or transmitted.

Activity 6: Flashlight Investigation (SI GLEs: 1, 11, 12, 14, 19, 22, 23, 25, 33; PS GLEs: 30)

Material List: working flashlight for each pair of students, unlined paper for each pair of students, pencils

Have students review and discuss safety guidelines for investigations using batteries and lights.

Distribute flashlights and paper. Instruct students to determine how the flashlight works and then draw a detailed, labeled diagram or model of all the workings of the flashlight. Students will explain the points where energy is transformed into a different form of energy (chemical, light, heat). They should label these points on their illustrations.

Each pair of students will work together to disassemble the flashlight and determine the flow of energy required to light the bulb. As the students are generating their testable questions regarding the energy flow through the flashlight, they should be able to identify factors that should be considered in a scientific investigation.

Each team will draw an illustration to show the path of the energy and label the energy transformations that occur within the flashlight. They must work with their partner to provide the most detailed and accurate illustration of every step involved in the operation of the flashlight.

The teacher should display the results and discuss the interpretations. While drawings should be compared and critiqued, the accuracy of the path of energy is the focus. Have students check to make sure contact is visible throughout the entire path of electricity for the flashlight. Peers should make recommendations for improvement of those models where the path of electricity is not clear or connected.

Direct students to research the development of personal light sources and identify areas in which this technology has changed the way we do things. This exploration also sets the stage for a guest speaker such as an electrician who could present the path of energy that runs to and through the school and powers the equipment there. Students may also track energy paths in common household or classroom objects (toaster, projector, fans, lamps, etc.). Safety must be a priority in home investigations, also. Suggest students visit <http://www.howstuffworks.com/> for explanations of how simple appliances work.

Activity 7: Solar Collector: (SI GLEs: 1, 2, 4, 5, 6, 7, 8, 11, 12; PS GLEs: 26, 37, 38)

Materials List: colored paper, water, plastic cups, rocks, paint, thermometers, timers, plastic wrap, aluminum foil, fabrics, tape, foam, science learning logs, internet access

Begin with a discussion on dressing appropriately for the weather. Students will need to be guided through a discussion of how wearing certain colors will impact our comfort on warm days. Lead them to conclude that dark colors tend to absorb heat (make us hotter) and lighter colors tend to reflect heat (keep us cooler).

Set up an investigation to provide proof that darker colors do absorb more heat than lighter colors and that lighter colors reflect more heat than darker colors. Suggested sites for this investigation:

- http://www.all-science-fair-projects.com/science_fair_projects/58/728/1bbc768c13fc337d3c85917052da2c51.html
- <http://www.reachoutmichigan.org/funexperiments/agesubject/lessons/smoers.html>

From this point move to a discussion of how people keep warm in the winter months (wear coats, hats and gloves and maybe they'll add Wear dark colors!) Lead them to a discussion of the benefit of wearing a hat and the heat loss that occurs through our heads or through other exposed body parts. This is where students should be able to connect the flow of thermal energy (heat) from a system of high temperatures to a system of lower temperatures. This is the "we don't get cold; we lose heat" concept.

Challenge the students to create a way to measure the collection of radiant energy and retain the radiant energy as thermal energy. They must formulate a question to investigate before they begin the actual investigation. (Example: Will the number of layers of fabric help insulate to prevent the loss of thermal energy for a longer period of time?)

Have students review safety guidelines and include a plan for a safe investigation.

Provide a collection of materials that they can use to evaluate their ability to gather thermal energy and other materials that might be used to contain or insulate the loss of thermal energy. Suggested materials might include colored paper, water, plastic cups, rocks, paint, thermometers, timers, plastic wrap, aluminum foil, fabrics, tape, foam, etc. Make certain the students/student teams provide a system of methodically collecting data that will ensure consistency and precision when they prepare the report summarizing their findings.

Student teams should then critique and analyze their investigation model and the model of the other teams.

- Were independent and dependant variables identified?
- Were all variables controlled?
- Does the data collected reflect consistency and accuracy?
- Was the metric system utilized in the collection of data?

The students need to be able to plan their investigation thoroughly and then show reflective evidence that their plan addresses the initial goals of collecting and retaining thermal energy. Their conclusions should be presented to the class in an oral report and the presentation should reflect a conclusion based on their findings. This may take several days to complete.

Students should recognize the importance of the information they generate regarding the use of collecting, reflecting, and storing energy and its relevance to daily living. During the investigations and once the investigations are completed students may add reflective entries to their science *learning logs* ([view literacy strategy descriptions](#)) that are based on *SPAWN* ([view literacy strategy descriptions](#)) *writing prompts*.

Using the following prompts, encourage reflective writing at the start of class periods, for homework, and at the end of the investigation.

S – Special Powers

You have the power to collect energy and transfer it to anything you deem in need. What form does your energy take and how is it transformed?

P-- Problem Solving

We've been studying how thermal energy is retained. How might this knowledge be used to improve the quality of life for people?

A – Alternative Viewpoints

Your parents keep fussing about your opening the refrigerator and staring inside for a snack. Why do you think they see this as a waste of energy?

W – What If?

What would you do if your heat went out early this winter and the repair man said it would be 24 hours before he could fix it? How would you deal with the lower temperatures in your house (besides going to another place to stay!)?

N – Next

You've just learned that because the moon has one side that is always lit by the Sun, NASA is going to set up a solar energy station there. What do you think will be the next step of that plan?

Activity 8: Saving Energy @ Home (SI GLEs: 3, 11, 19; SE GLEs: 43, 46)

Materials List: Internet access, copies of selected survey for each student, poster materials

Locate a home energy use survey online (see below) or by contacting a local energy company or cooperative extension service/county agent.

Energy Scavenger Hunt and energy saving activities and games:

<http://www.energyhog.org/childrens.htm>

Home energy survey:

http://www.energyquest.ca.gov/library/documents/2007_HOME_ENERGY_SURVEY.PDF

Teacher guide:

<http://www.energyhog.org/adult/educators.htm>

Students will survey the use and/or waste of energy in the home. Some students may want to investigate the energy use at school as an alternative. Students should also explain how the use of different energy resources affects the environment and the economy.

Students can track the use of energy and the impact that energy consumption has. Create “campaign” posters to encourage people to conserve energy and/or resources. Posters can also focus on ways to reuse, recycle, and reduce energy use.

Sample Assessments

General Guidelines

Assessment will be from teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be utilized to evaluate inquiry and laboratory technique skills. All student-generated work, such as drawings, data collection charts, models, etc., may be incorporated into a portfolio assessment system

- Students should be monitored throughout the work on all activities.
- All student-developed products should be evaluated as the unit continues.
- When possible, students should assist in developing any rubrics that will be used and provided the rubric during task directions.
- Team assessment should also be based on a rubric developed with student input.

General Assessments

- The students will describe the transfer of energy from one form to another and connect this with real life examples.
- The students will diagram/illustrate the flow of energy in a flashlight.
- The students will design and report on sound, light, or heat experiments.
- The students will identify and describe how light, heat, and sound energy travel.
- The students will be able to correctly use the terms reflection and refraction when describing how light travels.
- The students will be able to compare renewable, nonrenewable, and inexhaustible resources and give examples of each.

Activity-Specific Assessments

- Activity 2: Students will correctly and completely track the energy transformations in common household items and appliances.
- Activity 4: Students will correctly utilize appropriate wave vocabulary to describe wave phenomena and to illustrate the parts of a wave. Entries in their science *learning logs* should reflect an understanding of the terms used, also.
- Activity 6: Students will correctly illustrate the flow of energy through a flashlight, beginning with the switch and ending with the light produced. Students should also produce a reasonable diagram of the path of energy and the transformation of energy as it travels through the flashlight.

- Activity 8: Students will create posters that demonstrate an understanding of how resources can be sustained through recycling, reducing, and reusing our natural resources.

Resources

- NASA provides illustrations and information regarding visible light
<http://science.hq.nasa.gov/kids/imagers/ems/visible.html>
- Cooling underwear at this one
http://www.nasaexplores.com/show_58_teacher_sh.php?id=02123180757
- *Saving Energy and Energy Conservation*. Available online at
<http://www.energyquest.ca.gov/story/chapter19.html>
- *Do It Yourself Energy Quiz* for students. Available online at <http://www.epatrol.org>
- *Forms of Energy and Energy Consumption by Source*, Available online at
<http://www.eia.doe.gov/kids/energyfacts/science/formsofenergy.html>
- *Solar Collectors*. Available online as science fair projects
<http://www.need.org/energyfair.php>
- *Energy Transfer / Energy Rules*. Available online at
<http://www.uwsp.edu/cnr/wcee/keep/Mod1/Rules/EnTransfer.htm>
- *Potential Energy*. Available online at
<http://www.glenbrook.k12.il.us/gbssci/phys/Class/energy/u511b.html>
- *Waves*. Available online at
<http://www.glenbrook.k12.il.us/gbssci/phys/Class/waves/u1011a.html>

**Grade 6
Science
Unit 6: Work, Power, and Efficiency**

Time Frame: Approximately four weeks



Unit Description

This unit introduces the concepts of *force*, *work*, *power*, and *efficiency* and how they are interrelated. The review of simple machines is an integral part of this unit. The relationships among work, machines, and the real world will be considered.

Student Understandings

Students will be able to identify forces. They will describe the relationship between kinetic and potential energy. Further, the idea of work and its relationship to power and efficiency will be introduced with regard to simple machines.

Guiding Questions

1. Can students identify forces such as push, pull, lift, twist, and press?
2. Can students explain the relationship between kinetic energy and potential energy?
3. Can students describe the relationship between work input and work output in a simple machine?
4. Can students explain the relationship between work, power, and efficiency??

Unit 6 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry GLEs are embedded in the suggested activities for this unit. Other activities incorporated by teachers may result in additional SI GLEs being addressed during instruction.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
3.	Use a variety of sources to answer questions (SI-M-A1)
4.	Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2)
5.	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)

GLE #	GLE Text and Benchmarks
6.	Select and use appropriate equipment, technology, tools, and metric units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
9.	Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)
10.	Identify the difference between description and explanation (SI-M-A4)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (SI-M-A4)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
16.	Use evidence to make inferences and predict trends (SI-M-A5)
18.	Identify faulty reasoning and statements that misinterpret or are not supported by the evidence (SI-M-A6)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
21.	Distinguish between <i>observations</i> and <i>inferences</i> (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
23.	Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8)
28.	Recognize that investigations generally begin with a review of the work of others (SI-M-B2)
29.	Compare and/or investigate the relationships among work, power, and efficiency (PS-M-C2)
31.	Recognize that there is an acceptable range of variation in collected data. (SI-M-B3)
32.	Explain the use of statistical methods to confirm the significance of data (e.g., mean, median, mode, range) (SI-M-B3)
36.	Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5)
37.	Critique and analyze their own inquiries and the inquiries of others (SI-M-B5)
39.	Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7)
Physical Science	
17.	Describe and demonstrate that friction is a force that acts whenever two surfaces or objects move past one another (PS-M-B2)
19.	Identify forces acting on all objects (PS-M-B3)
20.	Draw and label a diagram to represent forces acting on an object (PS-M-B4)

GLE #	GLE Text and Benchmarks
22.	Demonstrate that an object will remain at rest or move at a constant and in a straight line if it is not subjected to an unbalanced force (PS-M-B5) (PS-M-B3)
23.	Predict the direction of a force applied to an object and how it will change the speed and direction of the object (PS-M-B5)
27.	Explain the relationship between work input and work output by using simple machines (PS-M-C2)
29.	Compare and/or investigate the relationship among work, power, and efficiency (PS-M-C2)

Sample Activities

Activity 1: The Force May Be With You (SI GLEs: 6, 7, 10, 12, 19, 22, 28, 37; PS GLEs: 17, 19, 20)

Materials List: science learning logs, chart paper or sentence strips, Simple Machines Opinionaire BLM (1 for each pair of students)

Review the work of Isaac Newton in the study of forces and point out to students that investigations generally begin with a review of the work of others who have made significant contributions in that field.

Students should be aware of all safety issues that need to be considered while conducting investigations at home as well as at school.

Force can be defined as any push or pull on an object that causes that object to move in a particular direction. Students will search throughout the home to identify places where forces are used. Students should include a description of how the force is employed and an explanation of what the force is doing. Their observations and explanations should be recorded in their science *learning log* ([view literacy strategy descriptions](#)) and should include supporting evidence. An example of how this might look is *a push on the lawnmower handle causes the lawnmower to move forward and the lawn that it moves over gets cut*. Other examples to consider might include opening and closing a door, raising a window, opening a jar or bottle, making a bed, and certain parts of cleaning a room!

Students should select one example from the home search to illustrate the forces at work using a diagram. These illustrations can be used to categorize the work being done, keeping in mind that *work* is defined as *movement (as a result of a force), in the direction of the force*. Students can create a symbol to classify those illustrations that represent work and this symbol can be added to each illustration once it has been determined through the class discussion that it depicts work being done.

The teacher should lead a class sharing of the diagrams and a discussion of how the forces that were used were employed. The discussion could flow very neatly into a further discussion of how to identify *work* by noting the force applied and the responding movement.

Display and compare the student results so that all may critique the investigation (not the artwork!) and make recommendations for improvement. The teacher may also assist students in identifying the counter-forces at work (*gravity, air resistance, and friction*). Evidence of these forces can be seen as wear-down of the surface, drag or a reduction in speed, or the existence of heat.

Have students complete the Simple Machines *Opinionnaire* ([view literacy strategy descriptions](#)) BLM to establish a starting point for a discussion of simple machines. Students will work in pairs to read and discuss statements about simple machines. They will take a position with regard to each statement and defend their position with a written point of view. Once all pairs have completed the Simple Machines Opinionnaire BLM, allow time for each pair to share and debate their stances. This activity should heighten their interest in learning about simple machines. Revisit the *opinionnaire* at the close of this unit to see if students want to reevaluate their position.

Activity 2: Rolling Right Along! (SI GLEs: 1, 2, 4, 5, 6, 7, 12, 21, 22, 23, 32, 36; PS GLEs: 22, 23)

Materials List: inclined plane for each group (may use a ramp made with a board and books), a collection of sealable, cylindrical containers from which each group will select (can with snap on lid, tennis ball can, film canister with lid, plastic jar with lid, etc.), meter tapes or sticks, additional mass for students to put inside the container (clay, sand, etc.), carpet samples, fabric, large sandpaper sheets, rulers for speed bumps, other materials as requested by students as they design their investigation, science learning logs

Students should be able to explain what safety consideration must be observed. They will need to agree on the safety guidelines for the lab and particularly if several ramps are set up and used simultaneously.

In this activity, students will gain a quantitative understanding of the relationship between potential (stored) energy and kinetic (movement) energy and how a force, like friction, may affect the speed and direction of the rolling container. Students may work in small groups of two or three.

Using an inclined plane and an empty cylindrical container, students will observe the container's action as it rolls down the inclined plane and continues to roll until it stops. They will make observations based on the speed and direction of the container and create an investigation in which they change one variable so they can predict and control the forces which affect the speed and direction of the container. The initial observation should include measurements so as to provide a base of comparison and to provide a springboard from which they can formulate their

plan. For the initial observation have each group set their ramp on four (4) books and have additional books available that can be used to change the height of the ramp.

The teacher should make certain the students understand that *only one* variable may be changed at a time. Each group should design an investigation that explores a different testable question. (e.g., How does adding more (or less) mass affect the speed of the container? How does changing the surface of the ramp affect the distance the container will roll? How does adding an obstacle to one side of the ramp affect the speed and direction the container rolls?) Students will need to create a chart in their science *learning log* ([view literacy strategy descriptions](#)) so that all data and measurements collected can be recorded in an organized manner.

Using the metric system, students are to measure the height of the inclined plane (distance from the floor, straight up to the top of the ramp/inclined plane) and the distance the container rolled (distance between the start point of the container at the top of the ramp to the position when the container comes to rest). The container should be released five times for each testing situation. This would be a good time to investigate the mean, median, and range of data collected. Solicit input from the students as to the logic of running multiple tests.

Students should identify independent variables, dependent variables, and variables that can be controlled in designing this experiment. Variables that can be employed in this investigation include changing the height of the inclined plane, adding mass to the container, changing the size of the container, changing the surface over which the container will travel (e.g., bare floor, carpet, sand paper on the ramp).

Through class discussion and/or science *learning log* entries, students should respond to the following:

1. Where does an observation end and an inference begin? (Observation→ The container rolled straight down the ramp and stopped when it hit the carpet on the floor. Inference→ Contact with the carpet caused the container to stop rolling.)
2. Describe the energy transformations that occur, beginning when the container is placed at the top of the inclined plane and released to when the can stops rolling on the floor. Students should be able to indicate potential energy and kinetic energy, as well as any forces that may be acting on the container.
3. Compare the amount of potential energy initially given the container with the amount of kinetic energy acquired at the bottom of the plane, as indicated by the horizontal distance the container rolls.
4. For each ramp height tested, graph the vertical height of the container when it is at the top of the inclined plane versus the horizontal distance rolled.
5. What variables seem to affect the distance the container rolls from the release point until stopping? Which variables affect the speed at which the container rolls?
6. Why is it important to run multiple trials?

Activity 3: Simply Machines (SI GLEs: 3, 19, 39; PS GLE: 27)

Materials List: 4 X 4 inch squares of colored paper (1 for every two students), scissors, markers, pencils, cellophane tape, examples of general simple machines: pulleys (windows and flag poles), screws (jar lids and spiral staircases), inclined planes (ramps), wheels with axle (doorknobs and screwdriver), and levers (scissors and see saws), Internet access, resource books for support with research of simple machines, science learning logs, presentation resources may also be needed (*PowerPoint*[®] access, poster materials, paper for flyers, etc.)

PART 1

Review the different types of simple machines. With the students, take an inventory of the simple machines they come in contact with each day (screw, inclined plane, wedge, pulley, wheel with axle, and lever). Create a class list that includes how the students may see simple machines used in everyday life.

Revisit the inclined plane. Have the students cut a square of paper in half, diagonally. The resulting triangle represents a ramp or inclined plane. Trace the cut edge of the triangle with a bright marker color. Tape one of the sides that end in the 90-degree angle to a pencil and slowly wrap the rest of the triangle around the pencil. The colored edge wraps around the pencil in a winding path. Ask students if this reminds them of any previous machine they have studied? This example illustrates that winding mountain roads, jar lids and even screws are inclined planes in origin. What are the limitations of this model of an inclined plane? See <http://www.edheads.org/activities/simple-machines/> for examples of assessments involving the identification of simple machines.

Have students explain the benefits of using simple machines. Introduce the terms *work input* and *work output* to explain efficiency. Students should be able to identify when they are “putting in” work (applying a force over a distance) and when the machine is “putting out” work. Have students identify the input work and output work for each of the samples of simple machines. Students should be able to identify how forces are transferred within the use of the machine to make work easier (changing the direction of force, changing the amount of force, or changing the distance over which the force is exerted)

PART 2

Students will work in small groups to investigate, create a visual display of information, on a *simple machine* of their choice, and make a presentation, based on an adaptation of the *professor know-it-all* ([view literacy strategy descriptions](#)) strategy. A variety of resources should be identified by the group. They must research the following:

- its place in history and/or how long ago this machine was reported in use
- the components of the machine
- the forces that are employed with the use of the machine
- how it works—work input and work output (use calculations and graphs where appropriate)
- how the mechanical advantage of this simple machine would be calculated (output force divided by the input force)
- a discussion of the energy changes that occur with its use, if any

- the progression of the development of this machine, from earlier models through improvements
- present-day versions of the machine
- how the invention and subsequent improvement of this machine has changed human lives

Students may also create a model of their simple machine using building materials, or recycled materials, if time permits.

This activity leads nicely into an adaptation of a *professor know-it-all* strategy. Once groups have researched their simple machine and are knowledgeable in its attributes and uses, they can present their machine as a product of technology to be purchased and sold by a local chain store. Their sales pitch is to a group of supporters from whom they seek endorsements for their simple machine. The supporters (remaining students and teacher) then ask prepared questions of the presenters.

Through the presentation student supporters will question the usefulness of the product, the ease of which it is operated, how the product was developed and how it will change their lives. Each group will be given the opportunity to pitch their simple machine and may use a variety of tools to do so such as posters, Power Point® presentation, flyers, etc.

Activity 4: Work and the Inclined Plane (SI GLEs: 2, 4, 5, 6, 7, 9, 12, 16, 19, 22, 23; PS GLE: 29)

Materials List: calculators, spring scales and meter sticks / tapes (one of each per group), string suitable for tying and holding small loads, books and boards to create ramps, science learning logs

Begin with a review of safety concerns regarding lifting and pulling. It is beneficial for students to lead the review and construct safety guidelines. The teacher may also choose to limit the size of the load to a size that it can be easily accommodated by the available spring scales.

Student groups will compare the work done in lifting a mass to a vertical height with the work done in lifting the same mass to the same height using an inclined plane. This activity can be done by groups of two or three students. Work is defined as force acting through a distance (work = force X distance).

A spring scale will be used to measure the force required to lift an object, of the group's choice, to a specific height above a horizontal surface. Students will calculate the work output (*reading on spring scale times the specific height above the horizontal surface*). They will then construct an inclined plane.

Have students predict whether the work output will be more or less using the inclined plane. Using the spring scale, the students will now pull the object up the inclined plane until the object reaches the same height as before. Suggest students set the number of times each investigation should be done to provide reasonable data.

Students will calculate the work input (*reading on spring scale times the distance moved along the surface of the inclined plane*) and compare the input with the output. In addition, they will calculate the efficiency of the inclined plane ($\text{efficiency} = \text{work output} \div \text{work input} \times 100$). Provide access to calculators for students who need assistance with the computations.

Have students change the angle of the inclined plane, run several tests again, and compare each group's findings to identify a trend in the force needed to move the object from start to finish. They should be able to identify a trend that indicates that the work input lessens as the inclined plane's height decreases. This simple machine makes work easier by increasing the distance over which the force must be applied and so lessens the amount of force needed.

Through class discussion and/or science *learning log* ([view literacy strategy descriptions](#)) entries, students should respond to the following:

- Identify the variables that are to be considered in this investigation.
- Track the transformations of the energy involved. Where does the energy change from potential to kinetic?
- Compare the force needed to move the object to the specific height using the inclined plane to the force needed to lift the object vertically.
- Identify the trend that is evident when the height of the inclined plane is lowered / raised.
- Identify examples of the use of inclined planes to lessen the effort needed and make work easier. (wheelchair ramps, inclined sections of curbs on the sidewalk, etc.)
- How might this information be useful to a student?

Activity 5: Classy Levers (SI GLEs: 7, 18, 19, 22, 29; PS GLE: 27)

Materials List: collection of familiar lever-based simple machines (scissors, hammer, pliers, tweezers, nail clippers, corkscrew, screwdriver, tongs, can openers, kid-sized broom, kid-sized shovel, nutcracker, staple remover, etc.), photocopy of each machine (place tools directly on the copier) for each group, small adhesive note pads for each group (used for labeling), science learning logs, resources for teacher support regarding simple machines and classes of levers

The teacher will guide an exploration of the various lever-based simple machines and help students identify where the load will be (L), the point at which effort is applied (E), and the point at which the simple machine pivots or the fulcrum (F). Students should be able to identify and label the point of input force and output force.

The teacher should demonstrate how changing the position of the effort with regards to the fulcrum affects the effort needed to deal with the load. Using scissors to cut cardboard with the cardboard placed near the fulcrum and then towards the tip of the scissors is a great demonstration of how moving the effort near and away from the fulcrum affects the amount of effort needed. Provide concrete examples such as this so that students can connect the concept of levers with real world experiences.

Once students are confident that they can identify these points on the simple machine, give each group a set of the photocopied machines and a small adhesive note pad. Have the student groups use adhesive notes to label the effort (E), load (L), and fulcrum (F).

Discuss the three classes of levers and how the class relates to the position of the fulcrum with relation to the effort and force.

Class 1 levers are those with the fulcrum between the load and the effort. (L / F / E)

Class 2 levers are those with the load between the fulcrum and the effort. (E / L / F)

Class 3 levers are those with the effort between the load and the fulcrum. (L / E / F)

Once students seem to grasp the concept of classes of levers, have the groups use the small adhesive notepads to label each photocopy of a simple machine with effort, load, and fulcrum and the correct class of the lever. Groups should also indicate where the input force and output force are located for each simple machine illustrated. Have student groups exchange sets of illustrations to check and critique. Students should illustrate the different classes of levers in their science *learning logs* ([view literacy strategy descriptions](#)).

The following website offers an illustrated guide to identifying classes of levers and may be helpful: <http://www.enchantedlearning.com/physics/machines/Levers.shtml>

Activity 6: Power (SI GLEs: 2, 5, 6, 7, 8, 11, 12, 22, 23, 31; PS GLE: 29)

Materials List: bathroom scale, access to stairs, yard sticks (measurement in feet), stopwatches (several per group), science learning logs

If the absence of stairs creates difficulty for completing this activity, use bleachers, playground equipment, or use a computation of work in lifting objects such as lifting cans of paint up onto the table, or moving books from a shelf to the floor. This will move you away from the foot-pounds/per second computations but will still be a valid measurement of “work” or force applied over a given distance (work = force X distance).

Have students plan for safety concerns once the activity parameters are defined (stairs vs. lifting). The teacher should plan for several groups using an area once safety concerns are defined.

Understanding that power is the rate of doing work, students will experimentally determine their own power in walking up a flight of stairs. Because the vertical height is needed to calculate the work done, challenge students to figure out how to calculate the height of the stairs being used (measuring the height of one step and multiplying by the number of steps in the flight can make a good estimate). Use the standard measurement of feet as opposed to meters for this activity.

Have all students create a data table in their science *learning log* ([view literacy strategy descriptions](#)) to record each trial. The table should include room for multiple tests, student weight, and height of the stairs, time, and power generated.

Since you will need the weight of a student for these computations, elicit volunteers instead of making each student stand on the scale. The student volunteer is weighed and then walks up the stairs while the other students time how long it takes to do so. Multiple data collections should be run to provide an average upon which the computations may be based. Solicit from students why it is important to use consistency and precision in their data collection.

From this data, the power the students generate can be calculated in foot-pounds/second. Students must be cautioned not to run up the stairs, although they may walk up briskly. An extension of this activity is to calculate the students' horsepower, knowing that 1 HP = 550 foot-pounds/second. Students should identify independent variables, dependent variables, and factors that should be controlled in designing this experiment.

Through class discussion and/or science *learning log* entries, students should respond to the following:

- Calculate the work done by each participating student in climbing the flight of stairs.
- Calculate the power generated by each participating student.
- Determine the horsepower of each student who participates.
- Research the origins of the term horsepower as a unit of power.
- Write a laboratory report describing the experiment and results.
- Propose a simple machine that would make lifting a load to the second floor easier (elevator/pulley). Comment on the efficiency of this machine to decrease the amount of effort needed to lift the load.

Sample Assessments

General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Science learning log entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory skills. All student-generated work, such as drawings, data collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities.
- All student-developed products should be evaluated as the unit continues.
- When possible, students should assist in developing any rubrics that will be used and have copies of the rubrics during task directions.

General Assessments

- The students will provide laboratory reports on experiments, such as potential-kinetic energy conversion and the inclined plane.

- The student will create a presentation, display, and model on a simple machine of their choosing.
- The student will maintain science learning log entries for all investigations.

Activity-Specific Assessments

- Activity 1: The student collection of forces used in the home and how they are used should reflect an understanding of forces and their use in the home.

Activity 2: Students should be able to discriminate between kinetic and potential energy. They will correctly identify kinetic energy and potential energy when the containers roll down the ramp. They should recognize the forces that affect the speed and direction of the container as it rolls down the ramp.

- Activity 4: Students will measure and compare efficiency when using an inclined plane to lift a load.

Resources

- *Horsepower*. Available online at <http://auto.howstuffworks.com/horsepower1.htm>
- <http://www.gmhsscience.com/problems/kineticpotential.htm>
- *Kinetic and Potential Energy*. Available online at <http://users.bigpond.net.au/mechtoys/mouse.html>
<http://www.k12.wa.us/assessment/WASL/Science/ClassroomAssessments/ScenarioMousetrapCar.pdf>
- *Machines and Work*. Available online at <http://www.sasked.gov.sk.ca/docs/elemsci/gr5ugesc.html>
- *Potential Energy*. Available online at <http://www.glenbrook.k12.il.us/gbssci/phys/Class/energy/u511b.html>
http://dept.physics.upenn.edu/courses/gladney/phys150/lectures/lecture_oct_08_1999.html
- NSTA Science Scope, April 2003 issue, *Shaky Head Dogs*
- *Forces Worksheets*. Available online at <http://science-class.net>
- *Simple Machines Pretest & Posttest*. Available online at <http://www.edheads.org/activities/simple-machines/>

**Grade 6
Science
Unit 7: Energy Use and Renewal**

Time Frame: Approximately three weeks



Unit Description

This unit introduces the real-world applications of energy use and renewal, with special emphasis on the varied sources from which our energy comes. Environmental and social questions concerning energy use and overuse of selected energy forms and sources will be the main focus of this unit.

Student Understandings

The focus of this unit is on sources, use, and renewal of energy. An understanding of the potential as well as the detrimental effects of overuse of selected forms of energy overlaps with environmental studies and social studies. Public information brochures, science fair projects, or case studies involving decision-making questions would be different ways to approach these understandings.

Guiding Questions

1. Can students identify the sources of energy used in our society that allow it to function in its present state?
2. Can students tell how these sources of energy are used in our society?
3. Can students classify renewable and nonrenewable energy sources?
4. Can students determine who is affected by overuse of selected energy sources?
5. Can students explain potential environmental effects involved in the overuse of selected sources of energy?

Unit 7 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry GLEs are embedded in the suggested activities for this unit. Other activities incorporated by teachers may result in additional SI GLEs being addressed during instruction.</i>	
3.	Use a variety of sources to answer questions (SI-M-A1)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written words, equations) (SI-M-A7)

GLE #	GLE Text and Benchmarks
25.	Compare and critique scientific investigations (SI-M-B1)
37.	Critique and analyze their own work and the work of others (SI-M-B5)
38.	Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6)
39.	Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7)
40.	Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7)
Physical Science	
39.	Describe how electricity can be produced by other types of energy (e.g., magnetism, solar, mechanical)
41.	Identify risks associated with the production and use of coal, petroleum, hydroelectricity, nuclear energy, and other energy forms (PS-M-C8)
Science and the Environment	
42.	Identify energy types from their source to their use, determine if the type is renewable, nonrenewable, or inexhaustible, and explain how these types affect the environment and economy (SE-M-A6)
43.	Explain how the use of different energy resources affects the environment and the economy (SE-M-A6)
44.	Explain how an inexhaustible resource can be harnessed for energy production (SE-M-A6)
45.	Describe methods for sustaining renewable resources (SE-M-A6)
46.	Identify ways people can reuse, recycle, and reduce the use of resources to improve and protect the quality of life (SE-M-A6)
47.	Illustrate how various technologies influence resource use in an ecosystem (e.g., forestry management, soil conservation, fishery improvement) (SE-M-A8)

Sample Activities

This unit requires students to gather information and resources in order to collaborate for a group oral presentation and visual presentation.

Assign a deadline each week for the different steps required to complete this project so that students may pace themselves and complete each task in a thorough manner.

Week One: Establish 8 Teams: All students conduct research on the selected team topic (draw for topic)

Week Two: Energy teams pool all information and collaborate to present their energy viewpoint, teams work on energy brochure or tri-fold

Week Three: Energy Brochure/Tri-fold presented and oral presentations by teams

This unit requires frequent, extensive monitoring to assure that all students are developing skills and knowledge to meet the targeted GLEs. Teachers should promote student questions throughout the evolution of the project. A checklist for the culminating oral presentation and brochure should be presented or constructed with the assistance of the teams so that all students

are focused on a quality final product. Throughout the time frame devoted to this project, the teacher may choose to add energy games and other learning activities to the classroom agenda. Locate websites for games and activities that may include the construction of models employing solar power, wind power, batteries, or water power.

Activity 1: Creation of Energy Research Teams (SI GLEs: 3, 37, 38, 39, 40; PS GLEs: 39, 41; SE GLEs 42, 43, 44, 45, 46, 47)

Materials List: eight cards from which teams will draw their topic (solar, water, wind, oil/natural gas, biomass, coal, geothermal, nuclear), one copy of the Presentation Job List BLM for each team, Internet access, resources for student use

Eight teams need to be assembled. These student teams will then draw from cards labeled to represent the following energy sources: solar, water, wind, oil/natural gas, biomass, coal, geothermal, and nuclear. All teams will use the Presentation Job List BLM to identify each team member's responsibilities in researching the key points and in following the project guidelines.

Students will research the topic selected so as to address these key points:

- Can you identify source of the energy form?
- Is it considered renewable, nonrenewable, or inexhaustible?
- How is this energy source utilized for communities, etc?
- What are the risks associated with the production of this energy source?
- What are the risks associated with the use of this energy source?
- Are there any environmental concerns?
- If inexhaustible, how is it harnessed for energy?
- If renewable, how is it maintained or sustained?
- What programs of reducing, reusing, and recycling support this resource?
- How do various technologies or practices influence the use of this resource?
- What industries rely on this energy source?
- Who are the primary consumers?
- Describe Louisiana's use of this resource and what determines our dependency on or "non-use" of this resource.

The Presentation Job List BLM is provided for each team so that all *key points* will be covered in the research and all team members contribute.

Suggested guidelines for the research project should include the following:

- establish and maintain a team science *learning log* ([view literacy strategy descriptions](#)) to reflect the on-going research that is used to prepare for the presentation
- teacher observation of the ongoing process
- use of at least 4 sources of information: 2 Internet (must be reliable source, as determined by the teacher), and 2 from printed media
- a tri-fold brochure used to gain public support for that energy source.

- an optional, personal interview with a pre-approved individual could be added for “bonus points”
- a timeline to assure all team members are ready for the collaboration process
- an oral presentation, in the guise of an infomercial, to present the information gathered to the class, while the *audience* listens for information, accuracy and understanding (class members, as the audience, may ask clarifying questions)
- grammar and spelling must be considered in the final products

Activity 2: The Brochure (SI GLEs: 3, 19, 38, 39, 40; PS GLEs: 39, 41; SE GLEs: 42, 43, 44, 45, 46, 47)

Material List: Presentation Job List BLM for each group, *Microsoft Publisher*[®] (optional), paper for brochure as needed

Microsoft Publisher[®] offers templates for informational brochures. Provide samples of various tri-fold brochures so students can visualize how their topic should be presented. For classes without computer access, the brochure can be assembled with hand-printed text and collected graphics. Students should focus on presenting information in a manner that is easy to read, offers a logical flow of information, and is appealing to the eye. They may create a large version so that adding text will be easier.

Students will use *RAFT writing* ([view literacy strategy descriptions](#)) to project themselves into the role of Energy Sales Teams so as to look at the use of energy from a unique perspective. Their audience will be community leaders shopping for an energy source for a new town being planned. The form the writing will take is a tri-fold brochure on energy sources to be presented in an infomercial. The topic will be determined by the energy source card drawn.

The team members should meet and pool all information collected on a regular basis. The key points that should be addressed in each project (job list) should be revisited to make sure that all information has been gathered. The first presentation of information will be in the form of the tri-fold. The tri-fold will be two-sided and the cover should contain the title of the energy source.

All points will be addressed in the tri-fold, and graphics will be utilized to give the project appeal. Student teams must keep a science *learning log* ([view literacy strategy descriptions](#)) that reflects the contributions of each member, as well as the action plan for accomplishing the task and a record of research. Student teams should make certain all *key points* are well-covered in the tri-fold brochure. Use the Presentation Job List to verify that all goals are being met and that all members are fulfilling their responsibilities for the project. Teams will work together to plan the layout and discuss the information collected.

Activity 3: Oral Presentation (SI GLEs: 19, 25, 37, 38, 39; PS GLEs: 39, 41; SE GLEs: 42, 43, 44, 45, 46, 47)

Materials List: Oral Presentation Peer Evaluation Rubric BLM for *each* student to use for *each* team, one presentation rubric for teacher use for each team presenting, visual or prompts as indicated by the teams (provided by the teams)

Each team will use a Oral Presentation Peer Evaluation Rubric BLM to score the oral energy presentations for the other groups. An alternative peer evaluation for oral presentations is available online at http://www-ed.fnal.gov/help/kuhrt/student/energy_rubric1.html or at other oral presentation rubric sites. The checklist of all points that are covered well by the presenting group should be utilized by the observers and will serve as an indication of the effectiveness of the presentation and research.

Students will give their energy source presentation as a group in 6-10 minutes. The use of visuals is encouraged. Students may select to use an “infomercial” format.

The following points should be included in the rubric:

- All information was presented in an interesting and memorable manner.
- All members of the team shared in the presentation.
- Keys points were made on energy source use: risks, benefits, and whether or not it is renewable, nonrenewable, inexhaustible.
- Students appeared knowledgeable and confident with the information.
- Students presented accurate and thorough information about their energy source.
- Students were able to present a persuasive presentation in a concise, effective manner.

This topic may be appropriate for use in a science fair or energy fair, which would provide an alternative venue for this research and presentation format.

Sample Assessments

General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory skills. All student-generated work, such as drawings, data collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities.
- All student-developed products should be evaluated as the unit continues.
- When possible, students should assist in developing any rubrics that will be used and have copies of the rubrics during task directions.
- Student work should reflect an ongoing process as opposed to an overnight creation.

General Assessments

- Teams will present information, in written and oral format that shows understanding of the energy source.
- Teams will utilize a peer evaluation form when listening to the presentations of other groups.
- Teams will present compelling evidence of energy risks, benefits, uses, and other current information from a variety of sources.
- Each student will demonstrate participation in team project.

Activity-Specific Assessments

- Activity 1: Students' evidence of research and organization of information reflects an understanding of the topic and the project goals. Energy facts collected will provide a basis for an educational, informative presentation. Team learning log entries will reflect all research, responsibilities of each team member, and the processes used to assemble for delivery.
- Activity 2: Deliverable is a hard copy of a finished tri-fold brochure that adheres to the guidelines set and reflects the key points outlined at the start of the project. Key points are addressed thoroughly and provide usable information relative to studying the origin, benefits, and drawbacks of the selected energy source. Student log reflects active participation by all members in the planning process for the brochure. The teacher observes all team members contributing to the project. Any information lacking for the brochure could be added for the oral presentation. A completed job list should provide additional evidence of each team member's contributions during the process. Teamwork rubric templates are available online. See a rubric, such as those at <http://www.uwstout.edu/soe/profdev/rubrics.shtml> for team member self-assessment.
- Activity 3: Energy Sales Teams will present their oral presentation or "infomercial." Presenters should be well informed with key points thoroughly addressed during the presentation, with the idea of influencing public opinion to gain support for their energy source as the preferred source for the newly planned community. All students should be knowledgeable about the team energy source and this will be evident by their participation in presenting support for the key points during the presentation or during the peer review afterwards. Peer Evaluation Rubric BLM will be used for each team presentation by the audience (remaining teams).

Resources

- For explanation of energy terms, online at <http://www.eia.doe.gov/kids/energyfacts/science/formsofenergy.html>
- Also useful for terminology online at <http://www.energyquest.ca.gov/indhtml>
- Additional peer oral presentation rubric is online at <http://serc.carleton.edu/introgeo/campusbased/presentation.html>
- Energy stories for many of the energy sources online at <http://www.energyquest.ca.gov/story/chapter08.html>
- Coal info available online at <http://energy.usgs.gov/coal.html>
- Biomass energy info available online at <http://www.nrel.gov/rredc/>
- Wind power information available online http://www.eere.energy.gov/windandhydro/windpoweringamerica/wind_maps.asp, <http://www.geology.wisc.edu/geo411/hasselman.html> and <http://www.eere.energy.gov/RE/wind.html>
- *Fossil Fuels Quiz* available online at <http://www.ecokidsonline.com>
- *Energy Education Resources*. Available online at www.eia.doe.gov/kids/onlineresources.html