# 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** | |
| *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.* | |
| 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 lever. 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 $cm^3$.

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

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, <u>4</u>, 7, 8, 10, 11, 12, 13, 14, 15, 16, 19, <u>22</u>, <u>23</u>, 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, <u>6</u>, 7, 8, 11, <u>12</u>, 19, <u>20</u>, 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.

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

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 X W X 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