TESTING THE LAW OF CONSERVATION OF MATTER
or
CHEMISTRY IN A PLASTIC MILK CONTAINER

Performance Standard 12C/11A/13A. F

Students will apply the processes of scientific inquiry to demonstrate interactions of energy with matter accordingly:

- *Knowledge*: Identify how energy interactions effect changes of state or properties.
- *Application*: Conduct scientific inquiry investigations which test the Law of Conservation of Matter.
- *Communication*: Explain findings from closed system chemical reactions in terms of the Law of Conservation of Matter.

Procedures

1. ***In order to know and apply concepts that describe properties of matter and energy and the interactions between them (12C) and the processes, concepts and principles of scientific inquiry (11A) and the accepted practices of science(13A),*** students should experience sufficient learning opportunities to develop the following:
   - Formulate inquiry questions associated with physical changes of matter to test the Law of Conservation of Matter.
   - Research sources of scientific information related to posed questions.
   - Brainstorm ways to categorize the differences between physical and chemical change.
   - Deliberate and explain the choice of applicable variables to test hypothesis.
   - Conduct inquiry investigation which finds answers to posed hypotheses.
   - Incorporate appropriate safety precautions and procedures to minimize safety hazards.
   - Use scientific technologies to collect and display data from investigation accurately and honestly.
   - Recognize the necessity of controlled variables and compare carefully recorded observations and summaries.
   - Communicate findings from investigation to explain the observations and explanations for the support of the Law of Conservation of Matter for peer review.
   - Identify faulty procedural steps which could cause different results, errors, or distort how variables interact.
   - Generate further questions for future investigations to evaluate the conservation of matter.

   Note to teacher: This activity relates to knowledge associated with the standard 12 C, while addressing the performance descriptors for stage C within standard 11A. Applying scientific habits of mind noted in standards 13A are foundational to these activities. Using various technologies to estimate, measure and record data address some performance descriptors in 13B. This whole activity, A Matter of State, is offered through the Science NetLinks website from the American Association for the Advancement of Science at: http://www.sciencenetlinks.com/lessons.cfm?BenchmarkID=4&DocID=160. Permission is granted for educational uses.
2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. Begin contextual inquiry investigation characteristics of matter with questions such as these: "How can matter ever change? How can we classify kinds of changes? What do we know about solids, liquids and gases? Students may add more questions, such as these: What is the difference between a chemical or physical change? What about water as a solid and a liquid and a gas—is it the same or different? What factors make it (or all substances) change? How are water particles moving? What does that mean, etc.? Lead discussion into explanation of the Law of Conservation of Matter and Energy. Instruct students to create large concept maps to visualize the connections between curricular vocabulary concepts. They should attach their questions and answers to appropriate links in their concept map and explain their reasoning for each placement. Guide students toward answering their questions and stating their understanding using appropriate scientific vocabulary terms and resources.
4. A brief overview of the Science Net Links activity is provided. More ideas for extensions and resources can be found within the lesson at the website. The inquiry activity is designed to observe water as it changes form vapor/gas to a liquid. Have the students hypothesize as to what they think will happen to particle motion of the water as it changes from a vapor/gas to a liquid: Will particle movement increase, decrease, or stay the same?

5. Students will heat approximately 200 ml water in open containers to boiling. Students should observe and respond to questions such as these: What is happening? What is heat? As the water heats, what is happening to the water particles? What is happening between the particles? After the boiling point is reached, students should carefully pour the water into their group's plastic milk containers and tightly cap the top. Weigh the container and contents. They should observe what happens to the container for approximately 20 minutes. (Note: The container will expand at first because of the increased particle movement of the water vapor.) They should continue to ask and answer questions, such as these: What is happening to the milk container and why? What is making the container do this? How can we test this idea? As the water begins to cool and the milk container goes through another change, ask students: Now what is happening and why? What is the difference between the water at this time versus the water when we initially poured it into the container? What change is happening to the water to make this event occur? Record mass of container and contents. Did the mass change?
6. Students should record their observations and data into appropriate tables for analysis. Upon completion of the observations, they should write a brief explanation of what they observed and their explanations, comparing their original hypothesis to their conclusions. They should predict what will happen if the water is reheated or if the container is cooled in an ice bath.
7. Encourage students to generate further questions which could follow from their initial research and presentations. They could vary the volume of the water or the container, or alter the temperature and time constraints. An extension is suggested at Science NetLinks involving an inflated balloon with a string tied snugly around its greatest dimension. The balloon should be placed in a freezer for approximately 30 minutes and retrieved for additional observations. Additional questions could be asked, such as these: What happened? Why? How did particle movement change? Did collisions of particles increase, decrease or remain the same? What would happen if we heated the balloon? The balloon should be weighed before and after temperature changes.
8. Evaluate each student's work using the Science Rubric as follows and add the scores to determine the performance level:

   Knowledge: The concept mapping showed appropriate and correct connections to concepts and observations.

   Application: The investigation was completed safely and observations were recorded correctly.

   Communication: The explanations were complete and accurate.

Examples of Student Work not available

Time Requirements

- Initial discussion and introduction to assignment: 20 minutes session; 1 class period to investigate Law of Conservation; 1-2 class periods for presentations and new question generation.

Resources

- Safety goggles, water, open containers to heat water (e.g., beakers, heat source, mitts to handle hot container
- Plastic milk container with screw cap
- Access to refrigerator or ice chest
- Balloons, string
- Science Rubric