Things are Heating Up

Strand Matter
Topic Investigating phases of matter
Primary SOL 5.4 The student will investigate and understand that matter is anything that has mass and takes up space; and occurs as a solid, liquid, or gas. Key concepts include
b) the effect of temperature on the phases of matter.
Related SOL 5.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
b) estimates are made and accurate measurements of length, mass, volume, and temperature are made in metric units using proper tools;
c) estimates are made and accurate measurements of elapsed time are made using proper tools;
d) hypotheses are formed from testable questions;
e) independent and dependent variables are identified;
f) constants in an experimental situation are identified;
g) data are collected, recorded, analyzed, and communicated using proper graphical representations and metric measurements;
h) predictions are made using patterns from data collected, and simple graphical data are generated.
5.4 The student will investigate and understand that matter is anything that has mass and takes up space; and occurs as a solid, liquid, or gas. Key concepts include
c) atoms and elements.

Background Information

Changes in the phases of matter are changes in the way molecules move. As matter heats up, its molecules move faster and farther apart. In this activity, students will design their own experiment to demonstrate how thermal energy affects the phases of matter. They will be given the option of showing how heat affects water, a rubber band, or a solid of their choosing. They will also design the way the information they gather will be recorded and what measurements will be made. They will graph the data they gather and present their findings to the class.

When performing this activity, for safety reasons students are not allowed to use heat-generating appliances in the classroom. Therefore, they must create experiments that use solar energy. Keep in mind that strong solar energy is generally more available in the fall and spring than in the winter.

Materials

- Pictures of concrete sidewalks, roadways, and bridge surfaces
- Balloon

- Thermometers
- Freezer (or cooler filled with ice)
- Tape measure
- Graph paper
- Rubber bands
- Water
- Ice cubes
- Materials as needed for the investigations, to be determined by student lists (e.g., bowls, water, plastic cups, etc.)

Vocabulary

solar energy, thermometer, matter, molecule

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Show the students pictures of sidewalks and concrete roadways that have cracks between sections and pictures of bridges with metal dividers and open space between them. Ask students why these cracks and open spaces exist.
2. After students have brainstormed a number of reasons, lead them to the understanding that concrete sidewalks, roadways, and bridges must have space to expand and contract as the temperature changes; otherwise, they will crack and break as the seasons change and the temperature fluctuates.
3. Ask students how heat and cold affect the states of matter. Lead them to understand that *in general* as matter heats up, it expands, and as it cools, it contracts. Relate expansion and contraction to the movement of molecules that make up the object: as an object heats up, the molecules that make up that object move faster and farther apart. This eventually results in a change in the matter, such as food cooking, water boiling, or ice melting.
4. Explain that an exception to this rule is water, which expands when it freezes and contracts when it melts.

Procedure

1. Model for the students the effects of thermal energy on matter by providing the students with an example of a balloon. At least several hours prior to class, blow up a balloon and place it in the freezer or in a cooler filled with ice. Also place a thermometer in the freezer. Place another thermometer in the room.
2. During class, explain that the balloon filled with air has been inside the freezer for many hours. Therefore, the temperature of the air inside the balloon is the same as the temperature of the air in the freezer. Have a student read and record on the board the temperature of the air in the room and another student read and record the temperature of the air inside the balloon (the same as temperature of the air in freezer).
3. Remove the balloon from the freezer, put it on a table, and have a student immediately measure and record its circumference on the board. (Using a string to measure the

widest part of the balloon and then measuring the length of the string is an easy way to record this measurement.)

4. Continue with class, and after about 15 minutes, have the student measure the circumference of the balloon again. Discuss with the class why the circumference changed as the air in the balloon warmed up.
5. Return the balloon to the freezer, and an hour later, take it out and measure and record its circumference once more. Discuss why it is again smaller. Have students explain what happens to the molecules of matter when heat is *removed* from matter.
6. Tell students that they will now create their own investigation that will show a change in the phases of matter when it is heated, using the sun as the source of heat.
7. Place students in small groups and instruct them to write a hypothesis and create the design of their investigation to prove their hypothesis. The design must identify the materials they will need to use, the measurement instruments they will need for measuring the changes, the data sheet they will need for recording the changes, and the graphical representation they will construct for explaining the results. Students may use materials that are in the classroom or bring materials from home.
8. Students must get approval of all designs before proceeding with the experiment.
9. Have the student groups carry out their investigations, gathering data and recording it on their data sheet and graphing the results. Make sure the experiments are performed on a sunny day.

Conclusion

1. Have each group present their investigations, their results, and their graphical representations to the class.
2. After the students have all presented their data, ask students to share what conclusions they can make about the relationship between matter and temperature. Students can either share these conclusions with each other or write them on a class bulletin board display.

Assessment

- **Questions**
  - Why is it important to conduct this experiment during fall or spring instead of winter?
  - What does intense solar energy (or heat) do to molecules?
- **Journal/writing prompts**
  - Write a paragraph stating the results of your experiment.
  - Write two paragraphs depicting how heat affects matter.
- **Other**
  - Assess the students' investigations, including their hypotheses, conclusions, and graphical data.
  - Assess the students' presentations to the class.

Extensions and Connections (for all students)

- Have students find other examples in the construction industry in which the design allows for expansion and contraction of the materials (e.g., wood paneling in which the panels “float,” etc.).

Strategies for Differentiation

- Create a template for the scientific investigation to complete with the experiment.
- Have students play a game similar to Simon Says. The teacher will use a large thermometer to demonstrate various temperatures. The students will act like molecules, moving fast as the temperature increases and slower as the temperature decreases.
- Have students divide a paper with the words “expands” and “contracts” on the page. The students will draw, list, or find pictures of objects that expand or contract when affected by heat.