Grades 6 - 8

A New Phase In Town

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Overview

Topic: Phase change and graph comparison. This lesson looks at the phases of matter and how the phases all depend on energy. Students and/or the teacher will use the CBL and the temperature probe to collect data as ice is changed to water and then to water vapor. (If CBL is not available, a Celsius thermometer and timer can be used.) The data is then graphed and compared to the Phase-Change Graph. This activity explores how heat energy is used to change the phase but temperature does not increase or decrease until the phase change is complete.

Subject: Science

Length of Lesson

Three 45-minute sessions

Video/Technology Hardware & Software

Physical Science Series #102, Phases of Matter

Web Applications

- http://www.Miamisci.org/af/sln/phases/watersolid.html

Learning Objectives

The student will be able to:

- collect, graph, and interpret data (Va. SOL Science 6.1, LS.1, PS.1)
- investigate heat and heat transfer (Va. SOL Science PS.6)
- investigate the physical properties and physical changes of matter (Va. SOL Science 6.7, PS. 2, PS.5)
- measure and report investigations using SI (metric) units (6.1, LS.1, PS.1)

TV/VCR (preferably with remote control)
TI-80, TI-82, or TI-83 Graphing Calculators
TI View Screen
Overhead Projector
PHYSICS program for graphing calculator
Calculator-Based Laboratory(s) (CBL)
CBL temperature probe(s)

- use the CBL to process, store, and retrieve data collected (C/T8.4)

Materials and Teacher Preparations

- 1 ice cube per student
- timer

Per group of four students

- 1 Pyrex beaker (300 or 500 mL)
- 1 hot plate (can use other heating sources, such as Bunsen burner)
- 1 cup of ice (cubes),
- 50 mL of water
- 1 thermometer and/or CBL temperature probe
- graphing calculator
- graph paper
- pencil
- ruler
- goggles

Vocabulary

- Vaporization
- Solids
- Phase changes
- Liquids
- Sublimation
- Gases
- Condensation
- Melting
- Heat of Fusion
- Freezing
- Heat of Vaporization
- Dependent variable
- Independent variable

Preparatory/Pre-Viewing Activities

Give each student an ice cube approximately the same size and have the student hold it tightly in his/her hand. When the ice cube has disappeared, the student is to hold up his hand. (Students will probably complain that they got their ice cube later than another student did.) Use this to ask what happened. Ask why some ice cubes melted faster than others. (Even though they were to be the same size, some could have been smaller than others. Some students could possibly have warmer hands than others. Accept reasonable answers.) Were all the cubes the same size? (The ice cubes were supposed to be the same size.) What caused the ice to melt? (Heat) Did cold go into the hand or heat go into the ice? (The heat went from the hand to the ice causing it to melt. Heat goes from an area of high concentration to an area of low concentration of heat.) What did the ice become? (The ice became liquid or water.)

Focus for Viewing/ Other Technology

Brainstorm with students the many uses of water. Listen for such words as ice or water vapor. Say: Now, we are going to watch parts of a video and I want you to look for the different ways that the video shows water being used. Also, watch for the reason(s) that water can be used in the ways shown.

Viewing and/or Online Activities

1. **Start** the ***Physical Science Series*** # 102 video entitled Phases of Matter where it shows the words "Phases of Matter" and a surfer surfing on water. **Pause (00:42)** after you hear the words "and all depends on the phases of water". Ask students to recall the uses of water that was shown on the video. (Surfing on water, sailing on ice, water evaporating, cutting ice) Ask: What makes the things that water is used for possible?(the different phases of matter and we know water is matter.)

2. **Focus:** Ask students if they know the four states of matter. (Most will know liquid, solids, and gases) Tell students to watch for the four states of matter. **Resume** the video and **Stop** (1:03) where you hear the words "We will explore the four states of matter: solid, liquid, gas, and plasma." Ask: What are the four phases of matter?(solid, liquid, gas, plasma)

3. **Focus:** Now I want you to watch and listen for the answer to these two questions. What makes a substance like water able to exist in three phases? And what causes water to change phases? **Fast Forward (8:29)** to where you see the words "Phase Changes" and after you see the fluorescent light. **Pause (9:23)** when you hear the words "in other words, water becomes ice." Ask: What causes water to change and exist in three phases? (Heat energy) Ask: How is energy used to cause water to change into ice? (the taking away of heat energy) How is energy used to change ice into water? (heat energy is added) Which contains the most energy, a solid, liquid, or gas? (Gas) If students cannot answer these questions, **Rewind (8:29)** where you see the fluorescent light and **Play** until you hear the words "in other words, water becomes ice", then **Stop (9:23).** Ask again: How does water become ice? How does ice become water? Which contains the most energy?

4. **Focus:** Now the video is going to name the phase changes of matter. See how many you can list. **Resume** the video and **Stop (10:22)** when you hear the words "whereas water or ice has a melting point of zero degrees centigrade." Say: Now on a sheet of paper I want you to list as many of the phase changes as you can remember. Give students time to respond. Ask a student to read what he/she has listed. If the student did not have all of the phases listed, ask another student to name other phase changes that were left out. (melting, vaporization, condensation, freezing, and sublimation.) Ask: What is a good definition of the melting point? (The temperature at which a solid becomes a liquid.) What about the freezing point? (The temperature at which a liquid becomes a solid.)

5. **Focus:** Ask: Does anyone know the difference between boiling, vaporization, and evaporation? Tell students to listen and see if they can tell how

they differ. **Resume** the video and **Pause (11:50)** when you hear the words "Here, particles of liquid slowly change to the gaseous state at the surface." Ask: What is the difference between boiling, vaporization, and evaporation? (Vaporization is when a liquid changes to a gas. Boiling is when a liquid changes to a gas at its boiling point, and evaporation is when vaporization takes place at the surface of a liquid.)

6. **Focus:** Ask students to watch for the temperature when melting is occurring. Tell students to watch and see whether or not the temperature increases during the time that the ice melts. What about boiling? Does the temperature increase as water boils and changes to water vapor? **Resume** the video and **Stop (12:13)** when you hear the words "and water changed to water vapor." Ask: Did the temperature increase during the melting process? (No) Did it increase during the boiling process? (No) Why not? (The energy is used for breaking apart the molecular bonds of ice (melting) and water (boiling).

7. **Focus:** Watch for other phase changes and see if heat energy is added to or taken away. **Resume** the video and **Stop (13:35)** when you hear the words "and does not pass through the liquid phase." Ask: What were the phase changes mentioned here? (condensation, freezing, and sublimation) Was heat energy added or taken away during these processes? (condensation and freezing – taken away; sublimation – heat energy was added) Ask students to explain the meaning of condensation, freezing, and sublimation. (condensation – gas changes into a liquid; freezing – liquid changes into a solid; sublimation – solid changes into a gas without becoming a liquid)

Post-viewing and/or Online Activities

1. Give students graph paper and the data information found on Data Information Table in back of lesson plan.

2. Talk to students about the independent and dependent variable. Have students decide if temperature is the dependent or independent variable. Do the same with time. Have students set up their graphs by labeling and titling the graph. (Make sure that they have time on the x-axis and temperature on the y-axis.)

3. When students are finished, they are to turn the graph in for evaluation. If time does not allow them to finish, assign as homework.

Day two

Activity with CBL

Problem: How is energy absorbed when matter changes states?

Give each group of students a graphing calculator, a CBL unit, a temperature probe, a Pyrex beaker, a hot plate, a cup of ice, goggles for each student, and 50 ml of water. Have students follow the procedure:

1. Have students connect the CBL with the graphing calculator, using the link cable. Then put the temperature probe in Channel I of the CBL.

(Graphing calculator has to have the PHYSICS program on it.)

2. Turn on the CBL and the graphing calculator. Push "**program**" on calculator and arrow down to **Physics** and press **Enter** two times. You will see:
   Vernier Software
   Physics
   With the CBL
   Press **Enter.**

3. Set up probes (1). Press **Enter.**
Enter number of probes. Press **1** and **Enter.**
For type of probe, arrow down to temperature and press **Enter.**
It will ask for the channel number. Press **1** and **Enter.**

4. It will go back to Main Menu. Now we want to collect data. Arrow down to number 2 (Collect Data) and press **Enter.** We now want to choose the type of data collection. Arrow down to number 2 (Time graph) and press **Enter.** We see "Enter time between samples in seconds." Enter **60** for the between samples and press **Enter.** It now asks for the number of samples. Enter **25** and press **Enter.**

5. The screen now shows the sample time 60s, samples 25, and experiment length 1500.00s. Press **Enter.** Press **1** (Use time setup). For time graph, press **1** (non-live displ). The screen now shows "Press {enter} to begin collecting data." Tell students, **"DO NOT PRESS ENTER YET**!"

6. Put 50 mL of water into the 300-mL beaker. Add ice cubes to the water. Place the temperature probe in the ice and water mixture and wait several seconds. (Say: Now you are going to begin to collect your data. If CBL and graphing calculator

has gone off, turn both back on). Put the beaker on a hot plate and turn on the hot plate. Now press Enter on the graphing calculator. (Students should be cautious because the hot plate and water become very hot. They should also make sure that the cord to the CBL does not touch the hot plate.)

7. This experiment will take 25 minutes, but can be shortened if the hot plate or heat source is very hot. During this time students can be working on a graph using data of time and temperature (See attached Data Information Table) that will show the Phase Change Graph (Explain that this data on the Data Information Table was gathered by another class. They can use this graph for comparison with their graphs.) After students have graphed the data, go over the terms *independent* and *dependent* variable and identify each. Explain that (1) the place on the graph where temperature stays at zero for a period of time is where melting is occurring and is called Heat of Fusion and (2) the place where the temperature stays at 100 degrees for a period of time is where vaporization is occurring and is called Heat of Vaporization.
8. During the time that the CBL is collecting data it will say *sampling* on the CBL screen and *Data Collecting* on the graphing calculator screen. When the data has been completed, the screen will read *Done* on the CBL Screen and *Time in L1, Channel 1 in L2* on the graphing calculator. Press Enter on the graphing calculator and the data will be graphed. Compare this graph with the Phase Change Graph found in back of lesson. Have students look for similarities in their graphs, the Phase Change Graph, and the graph completed with previously collected data from the Data Information Table.

Activity without the CBL

1. Put 50 ml of water into the 300 ml beaker. Add the ice cubes to the water.

2. After waiting several minutes, measure and record the temperature of the ice-water mixture, using a Celsius thermometer.

3. Place the beaker of ice and water on the hot plate and heat slowly.

4. Read the temperature of the mixture every minute and record the data in The Data and Observation Table.

5. Continue heating and measuring the temperature. Note the time when the ice melts. Heat the water until it begins to boil. Note the time when boiling started. Continue to measure and record the temperature until the water has boiled for five minutes.
6. Have students graph their data, using graphing calculator or graphing paper. Have students compare their graph to the Phase Change Graph.

For CBL or without CBL

Have the students answer the following questions to analyze and draw some conclusions:

1. Describe how the temperature varies with time.
2. What do the horizontal portions of your graph represent?
3. What was the maximum temperature reached when there was still ice in the beaker?
4. What was the maximum temperature reached by the water?
5. How would the experiment have been changed if a hotter hot plate had been used?
6. How is energy absorbed when matter changes state?
7. How does your graph compare to the Phase Change Graph (found at back of lesson)?

Assessments

1. Collect data table and graph(s) and use for assessment.

2. Give students 2 sets of data (Time and temperature) and let students graph and explain what has happened.

3. If using the CBL and graphing calculator, ask to see the graph for evaluation.

4. Evaluate answers to the questions when students analyzed and concluded at the end of the experiment.

5. Take up “Phase Change Scavenger Hunt” for assessment.

Action Plan: Community Connections

1. Invite a meteorologist to the classroom to discuss phase change and weather and how they are related.

2. A VDOT (Virginia Department of Transportation) representative could be invited to discuss phase change and when using salt or other substances on the highway is effective and when it is not effective and why.

3. Have a Home Economist come to the classroom and explain how different phases are related to cooking, cleaning, etc. Examples: melting butter, freezing meat, making ice cream.

Extensions

Science: In order to demonstrate how changes in pressure, as well as temperature, can result in phase change, wrap a wire around a large ice cube and attach a weight to a wire. Suspend the ice and study the effects of pressure on phase change.

Social Studies/Geography: Bullets (lead shots) were made by letting drops of liquid lead fall from the top of a tower. While the liquid dropped and cooled, it "froze" into its spherical shape. Research this topic and find places where such towers were located.

Home Economics: As students cook or bake, have them identify each state of matter of each item used. Students could state if the item or substance could change phase and if so, to what would it change?

About the Author

Mairlyn Kiser

Mairlyn teaches at Tazewell Middle School in Tazewell, Virginia. She is married and has three children. Mairlyn graduated from Bluefield College with a Bachelor of Science in Education. She taught a homebound student who has a life threatening illness for two years prior to teaching in the Tazewell School System. Mairlyn makes every effort to take as many classes as she can to continue to grow as an educator, and improve her teaching strategies. She has attended various workshops including the Eisenhower Math Institute.

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The Data Information Table

Time	Temperature
0 mins.	-2 C
1	-1
2	0
3	0
4	0
5	4
6	8
7	9
8	13
9	21
10	29
11	34
12	51
13	69
14	84
15	92
16	98
17	98
18	99
19	100
20	100
21	100
22	100
23	100
24	100

The Data and Observation Table

Time	Temperature

PHASE CHANGE GRAPH