

Lesson 2-4: Thermal Energy and States of Matter

Objective:

1. Students will describe the relationship between thermal energy and the states of matter.
2. Students will explain how thermal energy causes phase changes of matter.

Skills attained:

- Students identify the three states of matter
- Students describe the relationship among temperature, thermal energy and phase changes of matter.
- Students apply thermal and phase changes of matter to a real-life situation

Topics:

- Phases of matter (solids, liquids, gases)
- Phase changes of matter (melting, freezing, vaporization, condensation)
- Relationship among temperature, thermal energy and phase changes of matter

Procedure:

1. Students predict how thermal energy affects the states/phases of matter.
2. Students read for information about the phase changes of matter.
3. Students complete a diagram illustrating the relationship among temperature, thermal energy and phase changes of matter.
4. Students apply thermal energy and the phase changes of matter to a real-life situation (the water cycle).

Materials list:

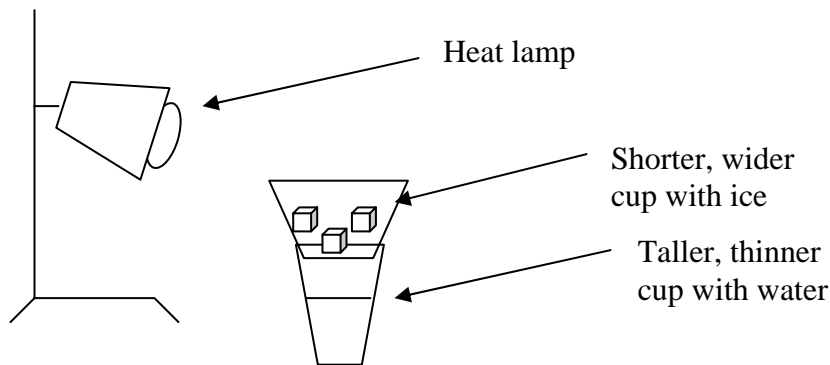
Teacher (MOTIVATION): Plastic cups (2), ice, water, heat lamp, ring stand

Per Student: **Worksheet 2-4**, "Matter and Energy" article

Teacher Resources: **Transparency 2-4.**

Motivation:

Prior to students entering the classroom set up the model of the water cycle as shown in the diagram below.



The plastic cups need to be clear and the smaller, wider cup should fit tightly into the taller, thinner plastic cup. Make sure that the bottom of the shorter cup is NOT touching the water. Turn the lamp on and direct it towards the water cycle model. As water in the bottom cup is heated, it will begin to evaporate. When the water vapor hits the cooler cup with the ice on top, it will begin to condense forming water droplets on the outside of the upper cup.

Discuss with students what might be causing these phase changes of matter. In addition to what is happening inside the water cycle cup, the ice in the top cup will also be melting. Discuss all possibilities with students but DO NOT provide them with the answer as to why/how the matter is changing. Tell students that after conducting today's lesson, they should be able to explain how/why the matter is changing in the model.

Content Background:

All matter exists in three states—solid, liquid and gas. The arrangement of matter's particles determines the phase of matter. In a solid, the particles are packed closely together and have very little space between the particles to move around. Therefore, a solid always has a definite shape and definite volume. The particles in a liquid on the other hand, have more space between them. The particles are still held closely together but have room to rotate or change their position in the liquid. As a result, a liquid has no definite shape but does have a definite volume. In a gas, the particles have a large amount of space between them. They have so much energy that they will occupy as much space as given to them. As a result, gases have no definite shape or no definite volume.

Matter can change from one phase to another by changing the matter's amount of thermal energy and temperature. To change a solid to a liquid, the solid must gain thermal energy and its temperature must increase. This process is known as melting.

Daily Lesson Plans

In order for the liquid to return to a solid, the liquid must lose thermal energy and its temperature must decrease. This process is called freezing. In addition, a liquid may also become a gas in a process called vaporization. In this process, the liquid must gain thermal energy and increase in temperature. Similarly, a gas can return to a liquid through condensation. In condensation, the gas must lose thermal energy and decrease in temperature.

In order for matter to change from one phase to another, a change in thermal energy and temperature must occur. This change in thermal energy and temperature will cause a change in the particle arrangement. As a result, a physical change in phase/state occurs.

Description:

Day 6

- Provide students with **Worksheet 2-4**.
- Allow students time to read the background information on **Worksheet 2-4**.
- Provide students with time to complete THINK ABOUT IT of **Worksheet 2-4**.
- Have students share their ideas with other students.
- Allow students time to complete TIME TO EXPLORE of **Worksheet 2-4**.
- Give students time to read the article, "Matter and Energy" for information about thermal energy and the phase changes of matter.
- Review the information about phase changes of matter and their relationship to thermal energy and temperature.
- Direct students to the diagram in Figure 1 of TIME TO EXPLORE.
- Provide students time to complete the diagram.
- Discuss the answers with the students.
- Return students attention to the demonstration shown in the motivation piece of this lesson.
- Ask students to explain what is causing the phase changes of water in each step of the water cycle.
- Assess students individually by having them complete PUTTING IT ALL TOGETHER of **Worksheet 2-4**.

Suggested Teaching Strategies:

It is suggested that the teacher conduct this investigation prior to assigning it to students. For this investigation, it is best to freeze the butter the night before. Students should be given two pats of butter which can be divided into equal quarters for the investigation. In addition, the teacher will need to make sure that water is heated prior to students conducting the investigation. DO NOT allow the water to boil. The water should be lukewarm at best. Make sure that students realize that the end of each strip containing the butter should be resting above the beaker. The end with the butter should NEVER touch the water.

Daily Lesson Plans

For the cold water, the teacher should realize that the butter will NOT melt on any of the substances. This is because the cold water does not have enough thermal energy to be transferred to melt the butter. Allow students approximately 2-3 minutes to observe that the butter will not melt. Have them record this data in the appropriate section of their data charts. Discuss the reasons behind their findings AFTER students have cleaned up their materials.

Homework:

If time becomes a factor, students can finish PUTTING IT ALL TOGETHER for homework. This should reinforce what students observed in the water cycle model.

Lesson 2-5: Some Like it Hot: Thermal Expansion

Objective:

1. Students will explain how energy affects the movement and arrangement of particles.

Skills attained:

- Students describe the relationship among energy, the movement and arrangement of particles in a substance

Topics:

- Thermal Expansion

Procedure:

1. Students predict the causes of a familiar, real-life problem.
2. Students conduct an investigation to show how energy affects the arrangement and motion of particles in a substance.
3. Students explain how scientists use indirect evidence to show the movement and arrangement of particles in a substance.
4. Students relate thermal expansion to a real-life problem.

Materials list:

Per Student: **Worksheet 2-5**, safety goggles

Per Group: ball and ring apparatus, burner, timer, beaker, 500 ml, insulated pad, water

Description:

Day 7

- Provide students with **Worksheet 2-5**.
- Allow students time to read the background information on **Worksheet 2-5**.
- Have students read the information in the box in THINK ABOUT IT of **Worksheet 2-5**.
- Discuss the scenario in THINK ABOUT IT. Ask students how many of them may have had a similar experience.
- Direct students to TIME TO EXPLORE of **Worksheet 2-5**.
- Have students review the materials that will be needed for this investigation.
- Allow students time to read the procedures for the investigation.
- Ask students to share some safety precautions that must be followed in this investigation (i.e., wear goggles, tie back hair, not allowing the ball and ring to touch the glass beaker, using the thermal pad to set the hot apparatus on, etc.)
- Provide students with appropriate time to conduct the investigation.
- Have students study the diagram in figure 1 of TIME TO EXPLORE.
- Ask students to identify and label the appropriate diagram for each situation listed.
- Have students complete question 2 of TIME TO EXPLORE. Allow students time to share their responses with other students in the classroom.
- Discuss the answers to questions 1 and 2 to assess student understanding.
- Assess students individually by having them complete PUTTING IT ALL TOGETHER of **Worksheet 2-5**.
- Allow students time to read and complete question 3 of Part B in TIME TO EXPLORE.

Suggested Teaching Strategies:

The ball and ring apparatus required for this investigation can be ordered from almost any educational science supplier. Use caution with the investigation. Since students are using flame, it is best to have students work in groups of two if possible. Remind students that the metal ball and ring will become extremely hot. Students should not touch the apparatus and any time they need to rest the apparatus, it should only be on the insulated pad.

Homework:

Pose the following problem to students:

Baked potatoes are a common dinner item. Many cookbooks recommend that you poke holes into a baked potato before placing it in the oven to bake. Explain why this is a good idea. Use the idea of thermal expansion to support your response.