Teacher Guide: Heat

Objectives

- Students will be able to describe how heat transfers through solids, liquids, and gases.
- Students will be able to identify examples of solids, liquids, and gases.

Concepts

- Heat (thermal energy) is everywhere and in everything. In strict scientific terms, heat is defined as a transfer of energy due to a temperature difference, and temperature is defined as the average kinetic (motion) energy of all the molecules. These strict definitions are difficult for younger students to understand and are rarely used in elementary texts. Text books usually define heat as thermal energy or the kinetic energy of molecules and temperature as a measure of the hotness or coldness of a substance. These more general definitions are used in this unit.
- Molecules in solids, liquids, and gases are always vibrating and moving.
- The space between molecules increases as heat is added. Heat gives molecules more energy so they move faster, and bounce harder off each other, creating more space between them. Solids expand a little, liquids expand more, and gases expand a lot as heat is added.
- Heat seeks balance and can move to achieve it. Heat can move by conduction, convection, and radiation.
- The molecular structure of a substance determines how well the substance conducts energy. Substances that do not conduct energy well are called insulators. Substances that conduct energy well are called conductors.
- We can measure the temperature of substances using thermometers. There are different scales we can use to measure temperature.

Time

- 2–4 hours

Materials

- Collect the materials as listed on page 6 of the Teacher Guide.

Preparation

- Project or copy the Thermometer and Student Thermometer masters on pages 12 and 13 of the Teacher Guide.
- Set up the teacher demonstration materials and workstations for the student explorations with the materials needed.

Key Words—Heat Answers *from Student Guide, page 11*

1. kinetic energy	2. convection	3. gas	4. boiling point	5. expand	6. temperature	7. radiation	8. solid
9. insulator	10. conduction	11. freezing point		12. molecules	13. contracts	14. conductor	15. liquid

Thermometer 1 Answers *from Student Guide, page 12*

100–212, 37–98.6, 0–32

Activity 1: Introduction

Time

▪30-45 minutes

✔Procedure

1. Introduce the heat module by discussing familiar things that heat does and the many ways we produce and use heat.
2. Have students read the informational text on pages 4-10 of their Student Guides. Students should take notes in their science notebooks about how heat transfers. Discuss the important ideas students learned in the reading.
3. Instruct students to complete the *Key Words—Heat* worksheet.

OPTIONAL: The *Key Words—Heat* worksheet may be completed at the end of the heat module to use as a review.

Activity 2: Teacher Demonstration

Time

▪30 minutes

✔Procedure

1. Use the *Thermometer* master on page 11 to explain how to read a thermometer and the Celsius and Fahrenheit scales. Use the *Student Thermometer* master on page 12 to show students the range of the thermometer they will be using in the kit.
2. Have students complete the *Thermometer 1* worksheet (Student Guide, page 12), obtaining the actual temperature readings of the classroom, outdoors, and drinking water, if possible. Use the *Thermometer* master to explain how to convert temperature from Celsius to Fahrenheit and vice versa.

Activity 3: Student Explorations

Time

▪Two to three 45 minute class periods

✔ Procedure

PART 1

1. Divide the class into three groups and assign each group one module to work on. There will be one group working on Module 1 (*Exploring Heat Transfer 1, 2, 3*), one group working on Module 2 (*Conductors and Insulators*), and one group working on Module 3 (*Exploring Heat in Solids, Liquids, and Gases 1, 2, 3*). Students should read through their exploration worksheets and write a prediction or hypothesis for each activity in their science notebooks. Students then conduct the investigations, recording observations and data in their science notebooks.
2. After students have completed the investigations they should work together to make sure they understand what happened. All students should be able to demonstrate and explain their investigations to their peers.

PART 2

1. Divide each group in half. On the first day, half of the group will stay at the station to present while the other half will rotate through the other stations. The next day students will switch roles. Everyone will have a chance to present, and everyone will rotate through the other stations.

OPTIONAL: Have groups rotate through all stations so everyone conducts each investigation, rather than presenting to their peers.

PART 3

1. Discuss the Conclusions questions on the worksheets after the completion of each of the explorations.
2. Evaluate the activities with the students.

Thermometer

A thermometer measures temperature.

The temperature of a substance is the average amount of thermal energy in the substance.

This thermometer is a long glass tube filled with colored alcohol. Alcohol is used in many thermometers because it expands in direct proportion to the increase in thermal energy.

Temperature can be measured using many different scales.

The scales we use most are:

▪ Celsius

The **Celsius (C)** scale uses the freezing point of water as 0°C and the boiling point of water as 100°C.

▪ Fahrenheit

The **Fahrenheit (F)** scale uses the freezing point of water as 32°F and the boiling point of water as 212°F.

In the United States, we usually use the Fahrenheit scale in our daily lives, and the Celsius scale for scientific work. People in most countries use the Celsius scale in their daily lives as well as for scientific work.

▪ Celsius to Fahrenheit Conversion

To convert from Celsius to Fahrenheit, multiply the C number by $\frac{180}{100}$ or $\frac{9}{5}$, then add 32, as shown in the formula below.

$$F = (C \times \frac{9}{5}) + 32$$

If C = 5

$$F = (5 \times \frac{9}{5}) + 32$$

$$F = 9 + 32$$

$$F = 41$$

▪ Fahrenheit to Celsius Conversion

To convert from Fahrenheit to Celsius, subtract 32 from the F number, then multiply by $\frac{100}{180}$ or $\frac{5}{9}$ as shown in the formula below.

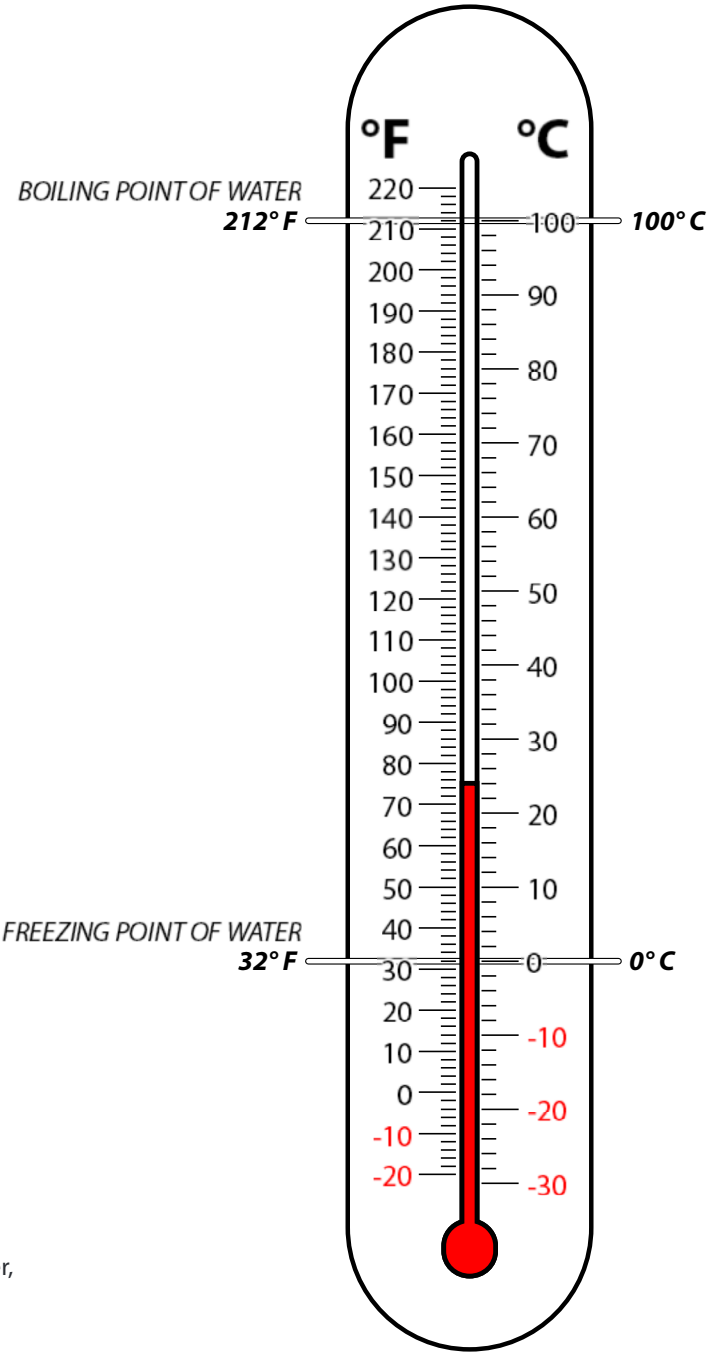
$$C = (F - 32) \times \frac{5}{9}$$

If F = 50

$$C = (50 - 32) \times \frac{5}{9}$$

$$C = 18 \times \frac{5}{9}$$

$$C = 10$$



Student Thermometer