Glencoe Science

Chapter Resources

Heat and States of Matter

Includes:

Reproducible Student Pages

ASSESSMENT

- ✔ Chapter Tests
- ✔ Chapter Review

HANDS-ON ACTIVITIES

- ✔ Lab Worksheets for each Student Edition Labs
- ✔ Two additional Laboratory Activities
- ✔ Foldables–Reading and Study Skills activity sheet

MEETING INDIVIDUAL NEEDS

- ✔ Directed Reading for Content Mastery
- ✔ Directed Reading for Content Mastery in Spanish
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Teacher Support and Planning

- ✔ Content Outline for Teaching
- ✔ Spanish Resources
- ✔ Teacher Guide and Answers

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Glencoe Science

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ASSESSMENT ADVANTAGE

Additional Assessment Resources available with Glencoe Science:

- Exam*View*® Pro TestMaker
- Assessment Transparencies
- Performance Assessment in the Science Classroom
- Standardized Test Practice Booklet
- MindJogger Videoquizzes
- Vocabulary PuzzleMaker at: **gpescience.com**
- Interactive Chalkboard
- The Glencoe Science Web site at: **gpescience.com**
- An interactive version of this textbook along with assessment resources are available online at: **mhln.com**

To the Teacher

This chapter-based booklet contains all of the resource materials to help you teach this chapter more effectively. Within you will find:

Reproducible pages for
- Student Assessment
- Hands-on Activities
- Meeting Individual Needs (Extension and Intervention)
- Transparency Activities

A teacher support and planning section including
- Content Outline of the chapter
- Spanish Resources
- Answers and teacher notes for the worksheets

Hands-On Activities

MiniLAB and Lab Worksheets: Each of these worksheets is an expanded version of each lab and MiniLAB found in the Student Edition. The materials lists, procedures, and questions are repeated so that students do not need their texts open during the lab. Write-on rules are included for any questions. Tables/charts/graphs are often included for students to record their observations. Additional lab preparation information is provided in the *Teacher Guide and Answers* section.

Laboratory Activities: These activities do not require elaborate supplies or extensive pre-lab preparations. These student-oriented labs are designed to explore science through a stimulating yet simple and relaxed approach to each topic. Helpful comments, suggestions, and answers to all questions are provided in the *Teacher Guide and Answers* section.

Foldables: At the beginning of each chapter there is a *Foldables: Reading & Study Skills* activity written by renowned educator, Dinah Zike, that provides students with a tool that they can make themselves to organize some of the information in the chapter. Students may make an organizational study fold, a cause and effect study fold, or a compare and contrast study fold, to name a few. The accompanying *Foldables* worksheet found in this resource booklet provides an additional resource to help students demonstrate their grasp of the concepts. The worksheet may contain titles, subtitles, text, or graphics students need to complete the study fold.

Meeting Individual Needs (Extension and Intervention)

Directed Reading for Content Mastery: These worksheets are designed to provide students with learning difficulties with an aid to learning and understanding the vocabulary and major concepts of each chapter. The *Content Mastery* worksheets contain a variety of formats to engage students as they master the basics of the chapter. Answers are provided in the *Teacher Guide and Answers* section.

Directed Reading for Content Mastery (in Spanish): A Spanish version of the *Directed Reading for Content Mastery* is provided for those Spanish-speaking students who are learning English.

Reinforcement: These worksheets provide an additional resource for reviewing the concepts of the chapter. There is one worksheet for each section, or lesson, of the chapter. The *Reinforcement* worksheets are designed to focus primarily on science content and less on vocabulary, although knowledge of the section vocabulary supports understanding of the content. The worksheets are designed for the full range of students; however, they will be more challenging for your lower-ability students. Answers are provided in the *Teacher Guide and Answers* section.

Enrichment: These worksheets are directed toward above-average students and allow them to explore further the information and concepts introduced in the section. A variety of formats are used for these worksheets: readings to analyze; problems to solve; diagrams to examine and analyze; or a simple activity or lab that students can complete in the classroom or at home. Answers are provided in the *Teacher Guide and Answers* section.

Note-taking Worksheet: The *Note-taking Worksheet* mirrors the content contained in the teacher version—*Content Outline for Teaching*. They can be used to allow students to take notes during class, as an additional review of the material in the chapter, or as study notes for students who have been absent.

Assessment

Chapter Review: These worksheets prepare students for the chapter test. The *Chapter Review* worksheets cover all major vocabulary, concepts, and objectives of the chapter. The first part is a vocabulary review and the second part is a concept review. Answers and objective correlations are provided in the *Teacher Guide and Answers* section.

Chapter Test: The *Chapter Test* requires students to use process skills and understand content. Although all questions involve memory to some degree, you will find that your students will need to discover relationships among facts and concepts in some questions, and to use higher levels of critical thinking to apply concepts in other questions. Each chapter test normally consists of four parts: Testing Concepts measures recall and recognition of vocabulary and facts in the chapter; Understanding Concepts requires interpreting information and more comprehension than recognition and recall—students will interpret basic information and demonstrate their ability to determine relationships among facts, generalizations, definitions, and skills; Applying Concepts calls for the highest level of comprehension and inference; Writing Skills requires students to define or describe concepts in multiple sentence answers. Answers and objective correlations are provided in the *Teacher Guide and Answers* section.

Transparency Activities

Section Focus Transparencies: These transparencies are designed to generate interest and focus students' attention on the topics presented in the sections and/or to assess prior knowledge. There is a transparency for each section, or lesson, in the Student Edition. The reproducible student masters are located in the *Transparency Activities* section. The teacher material, located in the *Teacher Guide and Answers* section, includes Transparency Teaching Tips, a Content Background section, and Answers for each transparency.

Teaching Transparencies: These transparencies relate to major concepts that will benefit from an extra visual learning aid. Most of these transparencies contain diagrams/photos from the Student Edition. There is one *Teaching Transparency* for each chapter. The *Teaching Transparency Activity* includes a black-and-white reproducible master of the transparency accompanied by a student worksheet that reviews the concept shown in the transparency. These masters are found in the *Transparency Activities* section. The teacher material includes Transparency Teaching Tips, a Reteaching Suggestion, Extensions, and Answers to Student Worksheet. This teacher material is located in the *Teacher Guide and Answers* section.

Assessment Transparencies: An *Assessment Transparency* extends the chapter content and gives students the opportunity to practice interpreting and analyzing data presented in charts, graphs, and tables. Test-taking tips that help prepare students for success on standardized tests and answers to questions on the transparencies are provided in the *Teacher Guide and Answers* section.

Teacher Support and Planning

Content Outline for Teaching: These pages provide a synopsis of the chapter by section, including suggested discussion questions. Also included are the terms that fill in the blanks in the students' *Note-taking Worksheets.*

Spanish Resources: A Spanish version of the following chapter features is included in this section: objectives, vocabulary words and definitions, a chapter purpose, the chapter Labs, and content overviews for each section of the chapter.

Reproducible Student Pages

Reproducible Student Pages

Hands-On Activities

Mini LAB Comparing States of Water

1. Fill a **plastic bowl or ice tray** with **water.** Mark the level of the top surface of the water with a **marker** or piece of **masking tape.**
2. Place the container in a freezer overnight.
3. Remove the container from the freezer and observe the level of the ice that has formed.

Analysis

1. How does the level of ice compare with the level of water that you placed in the container?

____

____

2. Explain why the level of ice is different from the level of the water.

____

____

Mini LAB

Comparing Thermal Conductors

Procedure

1. Obtain a **plastic spoon,** a **metal spoon,** and a **wooden spoon** with similar lengths.
2. Stick a small **plastic bead** to the handle of each spoon with a dab of **butter or wax.** Each bead should be the same distance from the tip of the spoon.
3. Stand the spoons in a **beaker,** with the beads hanging over the edge of the beaker.
4. Carefully pour about 5 cm of **boiling water** in the beaker holding the spoons.

Analysis

1. Describe how heat was transferred from the water to the beads.

____

____

____

2. Rank the spoons in their ability to conduct heat.

____

____

Name Date Class

Convection in Gases and Liquids

Lab Preview

Directions: *Answer these questions before you begin the Lab.*

1. What does the safety symbol that shows a thermal mitt tell you?

2. How many milliliters of water will you need for this activity? How many grams of black pepper?

A hawk gliding through the sky will rarely flap its wings. Hawks and some other birds conserve energy by gliding on columns of warm air rising up from the ground. These convection currents form when gases or liquids are heated unevenly and the warmer, less dense fluid is forced upward.

Real-World Problem

How can convection currents be modeled and observed?

Materials

water
500-mL beaker
black pepper
burner or hotplate
candle

Safety Precautions

WARNING: *Use care when working with hot materials. Remember that hot and cold glass appear the same.*

Goals

- **Model** the formation of convection currents in water.
- **Observe** convection currents formed in water.
- **Observe** convection currents formed in air.

Procedure

1. Pour 450 mL of water into the beaker.
2. Use a balance to measure 1 g of black pepper.
3. Sprinkle the pepper into the beaker of water and let it settle to the bottom of the beaker.
4. Heat the bottom of the beaker using the burner or the hotplate.
5. **Observe** how the particles of pepper move as the water is heated and make a drawing showing their motion in the Data and Observations section.
6. Turn off the hotplate or burner. Light the candle and let it burn for a few minutes.
7. Blow out the candle and observe the motion of the smoke.
8. Make a drawing of the movement of the smoke in the Data and Observations section.

LAB (continued)

Data and Observations

Drawing of pepper in beaker **Drawing of candle smoke**

Conclude and Apply

1. **Describe** how the particles of pepper moved as the water became hotter.

2. **Explain** how the motion of the pepper particles is related to the motion of the water.

3. **Explain** how a convection current formed in the beaker.

4. **Explain** why the motion of the pepper changed when the heat was turned off.

5. **Predict** how the pepper would move if the water were heated from the top.

6. **Describe** how the smoke particles moved when the candle was blown out.

7. **Explain** why the smoke moved as it did.

Communicating Your Data

Compare your conclusions with those of other students in your class.

Name Date Class

LAB Conduction in Gases

Lab Preview

Directions: *Answer these questions before you begin the Lab.*

1. What does the safety symbol that shows an open flame tell you?

____

2. At what temperature should you keep the water in the beaker while you complete the data table?

____

Does smog occur where you live? If so, you may have experienced a temperature inversion. Usually the Sun warms the ground, and the air above it. When the air near the ground is warmer than the air above, convection occurs. This convection also carries smoke and other gases emitted by cars, chimneys, and smokestacks upward into the atmosphere. If the air near the ground is colder than the air above, convection does not occur. Then smoke and other pollutants can be trapped near the ground, sometimes forming smog. In this activity, you will use a temperature inversion to investigate the conduction of heat in air.

Real-World Problem

How do the insulary properties of air cause a temperature inversion to occur?

Materials

thermometers (3)
foam cups (2)
400-mL beakers (2)
burner or hotplate
paring knife
thermal mitts (2)

Goals

- **Measure** temperature changes in air near a heat source.
- **Observe** conduction of heat in air.

Safety Precautions

WARNING: *Use care when handling hot water. Pour hot water using both hands.*

Procedure

1. Using the paring knife, carefully cut the bottom from one foam cup.
2. Use a pencil or pen to poke holes on opposite sides about 2 cm from the top and bottom of each foam cup.
3. Turn both cups upside down, and poke the ends of the thermometers through the upper holes and lower holes, so both thermometers are supported horizontally. The bulb end of each thermometer should extend into the middle of the bottomless cup.
4. Heat about 350 mL of water to about 80°C in one of the beakers.
5. Place an empty 400-mL beaker on top of the bottomless cup. Record the temperatures of the two thermometers in the data table.
6. Add about 100 mL of hot water to the empty beaker. After one minute, record the temperatures of the thermometers in the data table.

LAB (continued)

7. Continue to record the temperatures every minute for 10 min. Add hot water as needed to keep the temperature of the water at about 80°C.

Data and Observations

Air Temperatures in Foam Cup

Time (min)	0	1	2	3	4	5	6	7	8	9	10
Upper Thermometer (°C)											
Lower Thermometer (°C)											

Analyze Your Data

1. **Graph** the temperatures measured by the upper and lower thermometers on the same graph. Make the vertical axis the temperature and the horizontal axis the time.
2. **Calculate** the total temperature change for each thermometer by subtracting the initial temperature from the final temperature.

3. **Calculate** the average rate of temperature change for each thermometer by dividing the total temperature change by 10 min.

Conclude and Apply

1. **Explain** whether convection can occur in the foam cup if it's being heated from the top.

2. **Describe** how heat was transferred through the air in the foam cup.

3. **Explain** why the average rates of temperature change were different for the two thermometers.

Communicating Your Data

Compare your results with other students in your class. **Identify** the factors that caused the average rate of temperature change to be different for different groups.

LAB 1 Laboratory Activity

Density of a Liquid

All matter has these two properties—mass and volume. Mass is a measure of the amount of matter. Volume is a measure of the space that the matter occupies. Both mass and volume can be measured using metric units. The standard unit of mass in the SI system is the kilogram (kg). To measure smaller masses, the gram (g) is often used. In the metric system, the volume of a liquid is measured in liters (L) or milliliters (mL). Density is a measure of the amount of matter in a given volume of space. Density may be calculated using the following equation.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Density is a physical property of a liquid. By measuring the mass and volume of a sample of a liquid, the liquid's density can be determined. The density of a liquid is expressed as grams per milliliter (g/mL). For example, the density of distilled water is 1.00 g/mL.

Strategy

You will determine the capacity of a pipette.
You will measure the masses of several liquids.
You will calculate the densities of the liquids.
You will compare the densities of the liquids with that of water.

Materials

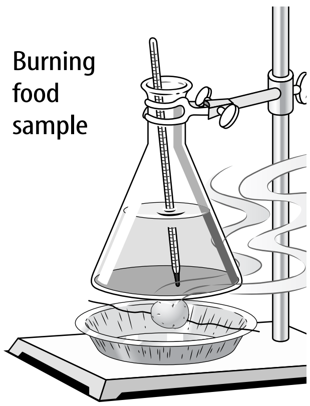
plastic pipettes (4)
metric balance
distilled water
small plastic cups (4)
ethanol
corn oil
corn syrup

Procedure

Part A—Determining the Capacity of a Pipette

1. Measure the mass of an empty pipette using the metric balance. Record the mass in the Data and Observations section.
2. Completely fill the bulb of the pipette with distilled water. This can be done as follows:
   - **a.** Pour distilled water into a small plastic cup until it is half full.
   - **b.** Squeeze the bulb of the pipette and insert the stem into the water in the cup.
   - **c.** Draw water into the pipette by releasing pressure on the bulb of the pipette.
   - **d.** Hold the pipette by the bulb with the stem pointed up. Squeeze the bulb slightly to eliminate any air left in the bulb or stem. MAINTAIN PRESSURE ON THE BULB OF THE PIPETTE.
   - **e.** Immediately insert the tip of the pipette's stem into the cup of water as shown in Figure 1. Release the pressure on the bulb of the pipette. The pipette will completely fill with water.

Figure 1



Laboratory Activity 1 (continued)

3. Measure the mass of the water-filled pipette. Record this value in the Data and Observations section.

Part B—Determining the Density of a Liquid

1. Completely fill the bulb of another pipette with ethanol as in Step 2 in Part A. Measure the mass of the ethanol-filled pipette. Record this value in Table 1. Repeat two more times using corn oil and corn syrup.

Analysis

1. Calculate the mass of water in the water-filled pipette by subtracting the mass of the empty pipette from the mass of the water-filled pipette. Enter this value in the Data and Observations section.
2. The capacity of the pipette, which is the volume of the fluid that fills the pipette, can be calculated using the density of water. Because the density of water is 1.00 g/mL, a mass of 1 g of water has a volume of 1 mL. Thus, the mass of the water in the pipette is numerically equal to the capacity of the pipette. Enter the capacity of the pipette in the Data and Observations section. Record this value in Table 1 as the volume of liquid for each of the liquids used in Part B.
3. Determine the mass of each liquid by subtracting the mass of the empty pipette from the mass of the liquid-filled pipette. Record the values in Table 1.
4. Using the volumes and the masses of the liquids, calculate their densities and record them in the data table.

Data and Observations

Part A—Determining the Capacity of a Pipette

Mass of empty pipette: ___________ g

Mass of water-filled pipette: ___________ g

Mass of water: ___________ g

Capacity of pipette: ___________ mL

Part B—Determining the Density of a Liquid

Table 1

Measurement	Liquid		
	Ethanol	Corn Oil	Corn Syrup
1. Mass of liquid-filled pipette (g)			
2. Mass of liquid (g)			
3. Volume of liquid (mL)			
4. Density (g/mL)			

Questions and Conclusions

1. Rank the liquids by their densities starting with the least dense.

2. How does the density of water compare to the densities of the other liquids?

3. What would you observe if you poured corn oil into a beaker of water? Why?

4. The specific gravity of a substance is the ratio of the density of that substance to the density of a standard, which is water. Specific gravity is a measure of the relative density of a substance. Determine the specific gravity of ethanol, corn oil, and corn syrup.

5. Why doesn't specific gravity have units?

Strategy Check

_______ Can you determine the capacity of a pipette?

_______ Can you measure the masses of several liquids?

_______ Can you calculate the densities of the liquids?

_______ Can you compare the densities of the liquids with that of water?

LAB 2 Laboratory Activity

Thermal Energy from Foods

You use food as fuel for your body. Food contains the stored energy you need to be active, both mentally and physically. Too keep your body processes going, your body must release the energy stored in food by digesting the food.

You cannot directly measure the energy contained in food. However, you can determine the amount of thermal energy released as a sample of food is burned by determining the thermal energy absorbed by water heated by the burning sample. By measuring the temperature change of a given mass of water, you can calculate the energy released from the food sample. Raising the temperature of 1 kg of water by 1° Celsius requires 4,190 joules of energy. This information can be expressed as the specific heat (C) of water, which is 4,190J/kg • °C. You can use the following equation to determine the heat (Q) released when a food sample is burned.

energy released = energy absorbed

energy absorbed = temperature change of water × mass of water × specific heat of water

$$Q = (T_f - T_i) \times m \times C$$

Strategy

You will calculate a change in thermal energy.

You will account for the difference between energy released and energy absorbed.

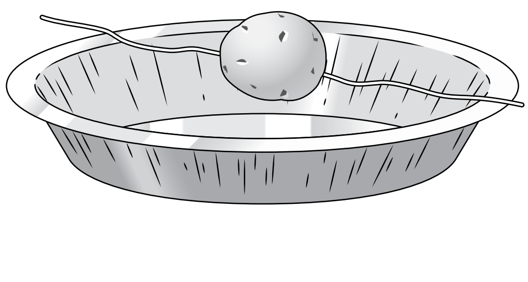
Materials

large paper clip or long pin	water	thermometer
food sample	100-mL flask	wood splint
aluminum potpie pan	utility clamp	matches
metric balance	ring stand	watch or clock
100-mL graduated cylinder		

Procedure

1. Wear a laboratory apron and safety goggles throughout this experiment. Straighten the paper clip and insert it through the food sample. Position the paper clip on the edges of the aluminum potpie pan as shown in Figure 1. Use the balance to determine the mass of the pan, paper clip, and food sample. Record the mass in Table 1 as m_1.

Figure 1

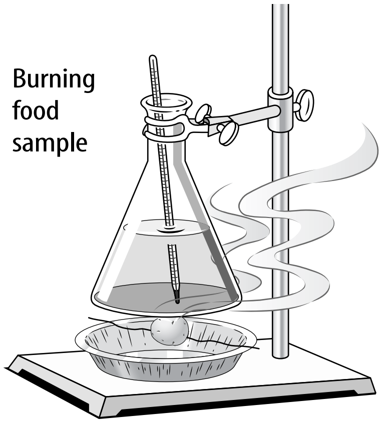


2. Use the graduated cylinder to add 50 mL of water to the flask. Clamp the flask on the ring stand about 5 cm above the tabletop. Use the thermometer to measure the temperature of the water. Record this value in Table 1 as T_i.
3. Ignite the wood splint with a match. **WARNING:** *Always use care with fire.* Use the burning splint to ignite the food sample. Once the food sample is burning, safely extinguish the splint. Position the aluminum pan under the flask. The water in the flask should absorb most of the energy released by the burning food.

Laboratory Activity 2 (continued)

4. Stir the water. Use the thermometer to closely observe the temperature rise.
5. Blow out the flame of the burning food after about two minutes. Record the highest temperature of the water during the two minutes in Table 1 as T_f.
6. Allow the aluminum pan and its contents to cool. Determine the mass of the pan and contents after the release of energy. Record this value in Table 1 as m_2.

Figure 2



Data and Observations

Table 1

Food Sample	Mass (kg)		Temperature (°C)	
	m_1	m_2	T_i	T_f

$T_f - T_i$ = ____________________

m (mass of 50 mL of water) = ____________________

$(m_2 - m_1)$ = ____________________

Q = ____________________

Heat absorbed per gram of food burned = ____________________

1. Calculate the rise in the water temperature by subtracting T_i from T_f. Record this value.

2. Use the equation given in the introduction to calculate the energy absorbed by the water when the food sample was burned. Be sure to use the mass of the water for m. Record this value.

3. Calculate the heat absorbed per gram of food by dividing the energy absorbed by the water by the mass of food burned $(m_2 - m_1)$. Record this value.

4. Your teacher will make a data table of food samples and energy absorbed by the water in the flask. Record your data in this table.

Laboratory Activity 2 (continued)

Questions and Conclusions

1. In order to calculate the amount of energy released or absorbed by a substance, what information do you need?

2. How do you know that energy was transferred in this experiment?

3. Did you measure the energy released by the food sample or the energy gained by the water?

4. Most of the energy of the burning food was absorbed by the water. What do you think happened to the small amount of energy that was not absorbed by the water?

5. Look at the data table of different food samples tested by your class. Which food sample released the most energy? Which food sample released the least energy?

6. Suppose 20.0 g of your food sample is burned completely. Use a proportion to calculate the value of energy released.

Strategy Check

_______ Can you calculate a change in thermal energy?

_______ Can you determine whether energy is released or absorbed?

FOLDABLES Reading & Study Skills

Heat and States of Matter

Directions: *Use this page to label your Foldable at the beginning of the chapter.*

Thermal Energy

States of Matter

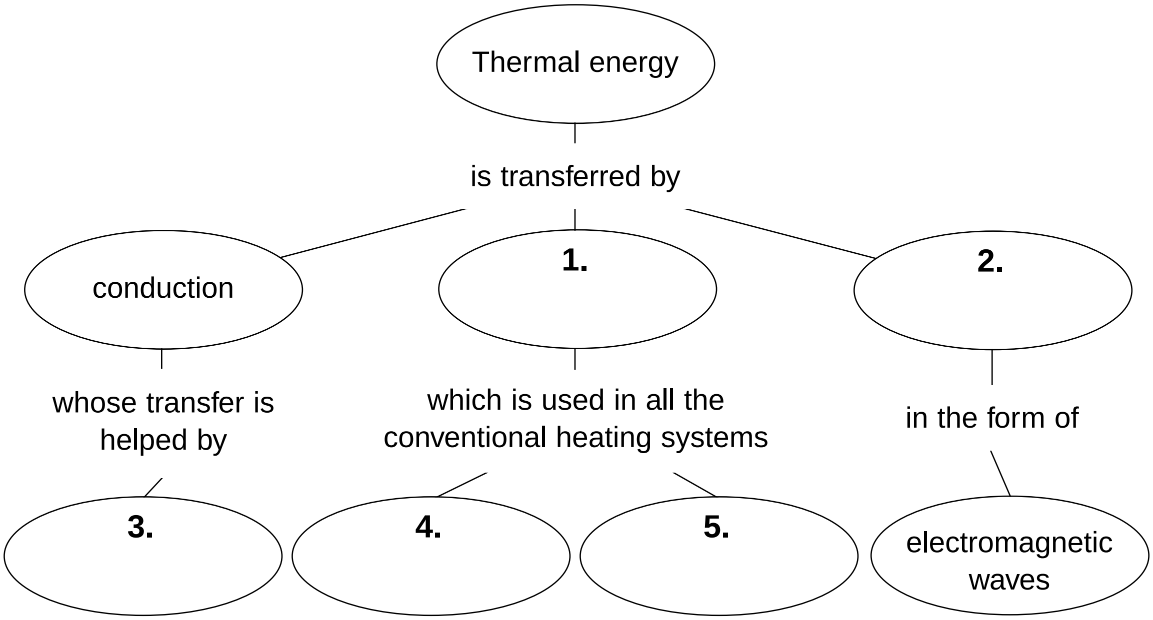
Meeting Individual Needs

Directed Reading for Content Mastery

Overview
Heat and States of Matter

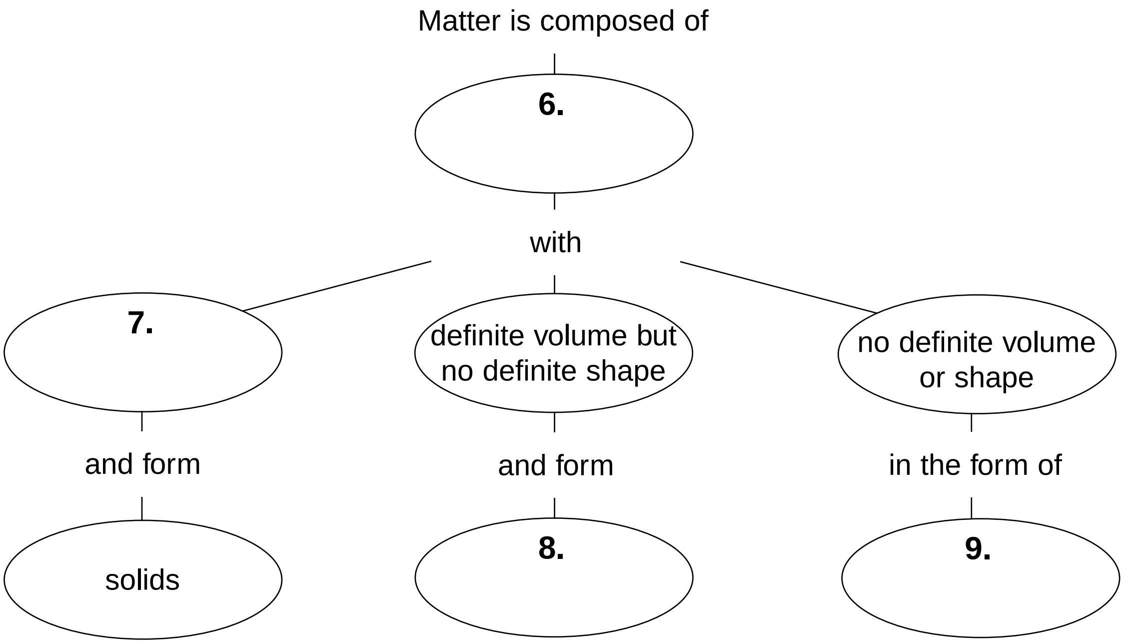
Directions: *Complete the concept map using the terms listed below.*

radiation **forced-air** **electrical** **conductors** **convection**



Directions: *Complete the concept map using the terms listed below.*

particles **liquids** **define shape and volume** **gases**



Directed Reading for Content Mastery

Section 1 ▪ Temperature and Thermal Energy
Section 2 ▪ States of Matter

Directions: *Match the term in column I with the definition in column II. Write the letter of the correct definition in the blank at left.*

Column I	Column II
______ **1.** kinetic theory of matter	**a.** water vapor
______ **2.** plasma	**b.** state of matter with no definite shape but with definite volume
______ **3.** fluid	**c.** any material that can flow
______ **4.** conductor	**d.** any material that allows heat to pass through it easily
______ **5.** waves	**e.** state of matter that has no definite shape and no definite volume
______ **6.** solid	**f.** transfer of radiant energy
______ **7.** metals	**g.** Matter expands when it gets hotter and contracts when it cools.
______ **8.** radiant energy	**h.** state of matter with definite shape and definite volume
______ **9.** steam	**i.** water in solid state
______ **10.** thermal expansion	**j.** explains the buoyant force on an object submerged in fluid
______ **11.** matter	**k.** good heat conductors
______ **12.** liquid	
______ **13.** gas	
______ **14.** ice	

Meeting Individual Needs

Directed Reading for Content Mastery

Section 3 ▪ Transfering Thermal Energy
Section 4 ▪ Using Thermal Energy

1. Directions: *On the lines provided, explain the differences between conduction, convection, and radiation. Write your answer in complete sentences.*

____

____

____

____

____

____

____

____

____

____

Directions: *Fill in the blanks using the correct terms from the list below.*

active combustion	**heating systems**	**heat pump**	**metals**
conduction	**stroke**	**radiant energy**	**matter**

2. Many conductors, such as silver and copper, are __________________.

3. __________________ is energy that travels by radiation.

4. The transfer of thermal energy by convection and conduction both require __________________.

5. Most __________________ use fuel or electricity as a source of energy.

6. Fuel burned in a stove or a fireplace transfers thermal energy to the surrounding air by __________________, convection, and radiation.

7. __________________ means rapid burning.

8. A two-way heat mover is a __________________.

9. A __________________ is the movement of a piston up or down.

Directed Reading for Content Mastery

Key Terms
Heat and States of Matter

Directions: *In each of the following statements, a term has been scrambled. Unscramble the term and write it on the line provided.*

______________ **1.** The transfer of energy through matter by direct contact of particles is called *docniotucn.*

______________ **2.** The transfer of energy by the movement of matter is called *vecconniot.*

______________ **3.** The type of heat transfer that does not require matter is *iadraniot.*

______________ **4.** Any material that does not allow heat to pass through it easily is an *roinsulta.*

______________ **5.** An *ntieanrl busmcotoin* engine burns fuels inside chambers called cylinders.

______________ **6.** Liquid rising in a thermometer as temperature increases is an example of *tlhhaemr enxopiasn.*

______________ **7.** A device on a building that absorbs radiant energy form the sun is *lraos lleocctro.*

______________ **8.** Heat of *vnaopiotraiz* is the energy needed for a substance to change from a liquid state to a gaseous state.

______________ **9.** The *kciinte hyhroe* is an explanation of how particles in matter behave.

______________ **10.** The SI unit for temperature is the *nkievl.*

______________ **11.** The amount of heat needed to raise the tempature of 1 kg of some material by 1°C is called the *spiefci htae* of the material.

______________ **12.** To measure specific heat, use a *craeltoermi.*

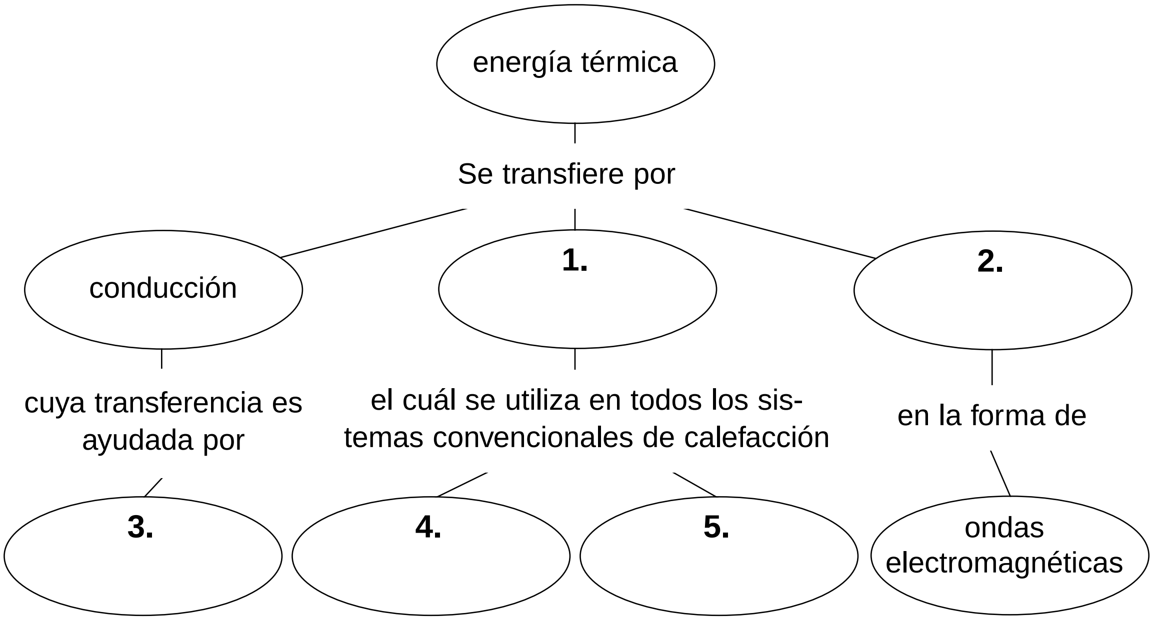
______________ **13.** The most common state of matter in the universe is *apmlsa.*

Lectura dirigida para Dominio del contenido

Sinopsis Calor y estados de la materia

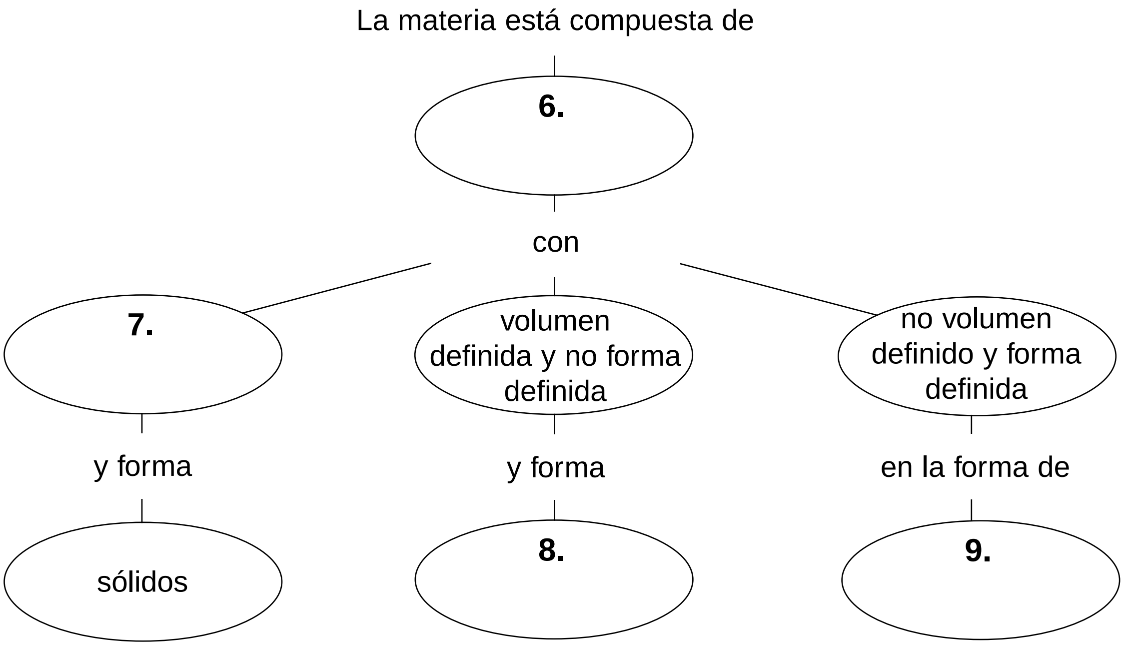
Instrucciones: *Completa el mapa conceptual usando los siguientes términos.*

radiación **aire forzado** **eléctrico** **conductores** **convección**



Instrucciones: *Completa el mapa conceptual usando los siguientes términos.*

partícles **líquidos** **forma y volumen definido** **gases**



Lectura dirigida para Dominio del contenido

Sección 1 ▪ Temperatura y energía térmica
Sección 2 ▪ Los estados de la materia

Directions: *Coordina el término de la Columna I con su definición en la Columna II. Escribe la letra de la definición correcta en el espacio en blanco.*

Column I

_______ **1.** teoría cinética de la materia

_______ **2.** plasma

_______ **3.** fluido

_______ **4.** conductor

_______ **5.** ondas

_______ **6.** sólido

_______ **7.** metales

_______ **8.** energía radiante

_______ **9.** vapor

_______ **10.** dilatación térmica

_______ **11.** materia

_______ **12.** líquido

_______ **13.** gas

_______ **14.** hielo

Column II

a. vapor de agua

b. estado de la materia que no tiene forma definida pero volumen definido

c. cualquier material que pueda fluir

d. cualquier material que permite fácilmente el paso de calor a través de él

e. estado de la materia que no tiene ni forma ni volumen definido

f. transferencia de energía radiante

g. materia que se dilata cuando se calienta y se contrae cuando se enfría

h. estado de la materia con forma y volumen definido

i. agua en estado sólido

j. explica la fuerza flotante sobre un objeto que está sumergido en fluido

Lectura dirigida para Dominio del contenido

Sección 3 ▪ Transferencia de energía térmica
Sección 4 ▪ Uso de energía térmica

Instrucciones: *En el siguiente espacio en blanco, explica las diferencias entre conducción, convección, y radiación. Escribe tu respuesta en oraciones completas.*

____
____
____
____
____
____
____
____
____
____

Instrucciones: *Rellena los espacios en blanco con los siguientes términos.*

combustión activa	**sistemas de calefacción**	**compresor**	**metales**
conducción	**tiempo**	**energía radiante**	**materia**

2. Muchos conductores, como la planta y el cobre son ____________________.

3. ____________________ es la energía que viaja a través de la radiación.

4. La transferencia de energía térmica mediante la convección y conducción requieren de ____________________.

5. Muchos ____________________ usan combustible o electricidad como fuente de energía.

6. El combustible quemado en una estufa o chimenea transfiere energía térmica al aire circundante por ____________________, convección y radiación.

7. ____________________ significa combustión rapida.

8. Una fuente de calor con dos direcciones es una ____________________.

9. Un ____________________ es el movimiento de un pistón hacia arriba o hacia abajo.

Satisface las necesidades individuales

Lectura dirigida para Dominio del contenido

Términos claves
Calor y estados de la materia

Satisface las necesidades individuales

Instrucciones: *En cada una de las siguientes afirmaciones hay un termino desordenado. Ordena las letras del termino y escribelo en el espacio en blanco.*

_______________ **1.** La *docniócucn* es la transferencia de eneregía a través de la materia por el contacto directo de partículas.

_______________ **2.** La transferencia de eneregía a través del movimiento de la materia se llama *vecconnióc.*

_______________ **3.** El tipo de transferencia de calor que no requiere de materia es *iacrdanció.*

_______________ **4.** Cualquier material que no permita fácilmente el paso de calor a través de él es un *ainsalte.*

_______________ **5.** Un motor de *busmcotóin ntieanr* quema combustible dentro de las cámaras que reciben el nombre de cilindros.

_______________ **6.** El líquido que se eleva en un termómetro cuando aumenta la temperatura es un ejemplo de *dltacniaió trmcéai.*

_______________ **7.** Un dispositivo en un edificio que absorbe la energía radiante del sol es un *lcroecto lraos.*

_______________ **8.** El calor de *vnaopíocraiz* es la eneregía necesaria para hacer que una sustancia cambie de un estado líquido a un estado gaseoso.

_______________ **9.** La oríate ciéntiac es una explicación del comportamiento de las partículas dentro de la materia.

_______________ **10.** El *nkievl* es la unidad SI para la temperatura.

_______________ **11.** La cantidad de calor que se necesita para elevar la temperatura de un material de 1 kg en un 1° C se llama *alorc secpíefico* del material.

_______________ **12.** El calor específico se mide con un *craeltoermí.*

_______________ **13.** El estado más común de la materia en el universo es el *apmlsa.*

Name ____________________ Date ____________ Class ____________

SECTION 1 Reinforcement

Temperature and Thermal Energy

Directions: *Determine whether the italicized term makes each statement true or false. If the statement is true, write* **true** *in the blank. If the statement is false, write in the blank the term that makes the statement true.*

__________ **1.** Particles that make up matter are in *constant* motion.

__________ **2.** The faster particles move the *less* kinetic energy they have.

__________ **3.** *Temperature* is the measure of the average kinetic energy of the particles in an object.

__________ **4.** When temperature *increases*, the kinetic energy of the particles decreases.

__________ **5.** The thermal energy of an object is the *total* energy of the particles in a material.

__________ **6.** A 5-kg chunk of aluminum and a 5-kg block of silver that are at the same temperature have *the same* thermal energy.

__________ **7.** Heat flows from a *higher* temperature to a lower temperature.

__________ **8.** Heat is measured in *newtons*.

__________ **9.** Different materials need *the same* amounts of heat to have similar changes in temperatures.

__________ **10.** The amount of energy it takes to raise the temperature of 1 kg of a material 1 kelvin is the *specific heat* of the material.

__________ **11.** Water has a relatively *low* specific heat.

__________ **12.** Materials with a high specific heat can absorb a lot of energy and show *little* change in temperature.

Directions: *Answer the following questions about specific and thermal energy.*

13. Change in thermal energy can be calculated using the equation $Q = m \times \Delta T \times C$.

a. In this equation, what does Q represent? ____________________

b. What does m represent? ____________________

c. What does ΔT represent? ____________________

d. What does C represent? ____________________

e. What does the symbol Δ mean? ____________________

f. Why is the symbol Δ used with T but not Q? ____________________

____

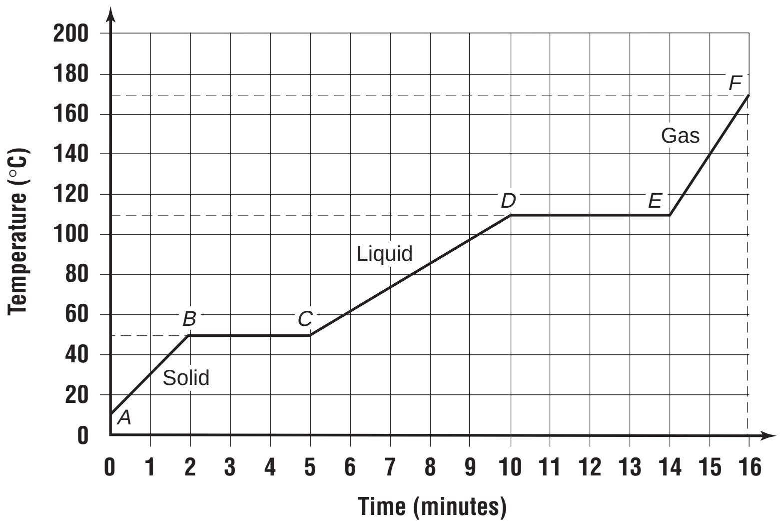
14. What formula is used to calculate ΔT? ____________________

Meeting Individual Needs

SECTION 2 Reinforcement

States of Matter

Directions: *Look carefully at the graph. It was drawn from the data collected when a substance was heated at a constant rate. To heat at a constant rate means to add heat evenly as time passes. Use the graph to complete the paragraphs that follow.*



At the start of observations, Point A, the substance exists in the **1.** ____________________ state. The temperature at this point is **2.** ____________________. As energy is absorbed, the temperature of the substance rises at a constant rate for two minutes. At Point B, the temperature is **3.** ____________________, and the solid begins to **4.** ____________________. The temperature remains constant until the change from solid to **5.** ____________________ is complete. It has taken three minutes to add enough energy to melt the solid completely. From Point C to Point D, the substance is in the **6.** ____________________ state. Its temperature rises at a constant rate to **7.** ____________________. The temperature remains constant while the liquid changes to a **8.** ____________________. At Point E, the substance exists as a **9.** ____________________. Its temperature rises evenly as energy is added.

When the gaseous substance is allowed to cool, it releases energy. The cooling curve will be the reverse of the warming curve. Energy will be released as the substance changes from a **10.** ____________________ to a **11.** ____________________ and also from a **12.** ____________________ to a **13.** ____________________. The amount of energy released during condensation will be the same as the amount absorbed during vaporization.

SECTION 3 Reinforcement

Transfering Thermal Energy

Directions: *Determine whether the italicized term makes each statement true or false. If the statement is true, write* **true** *in the blank. If the statement is false, write in the blank the term that makes the statement true.*

____________ **1.** Materials that are poor conductors are *poor* insulators.

____________ **2.** The transfer of energy through matter by direct contact of its particles is *convection.*

____________ **3.** The transfer of energy in the form of invisible waves is *conduction.*

____________ **4.** Solids usually conduct heat *better* than liquids and gases.

____________ **5.** Air is a *poor* heat conductor.

____________ **6.** Wind and ocean currents are examples of *conduction* currents.

____________ **7.** Energy is usually transferred in fluids by *radiation.*

____________ **8.** As water is heated, it expands, becomes *less* dense, and rises.

____________ **9.** Dark-colored materials absorb *less* radiant energy than light-colored materials.

Directions: *Circle the object in each pair that will take in more heat. In the blank, explain why that object will take in more heat.*

10. a silver spoon ____________

a wooden log ____________

11. a white shirt ____________

a red shirt ____________

12. foil in the sunlight ____________

a sidewalk in the sunlight ____________

13. single-pane window ____________

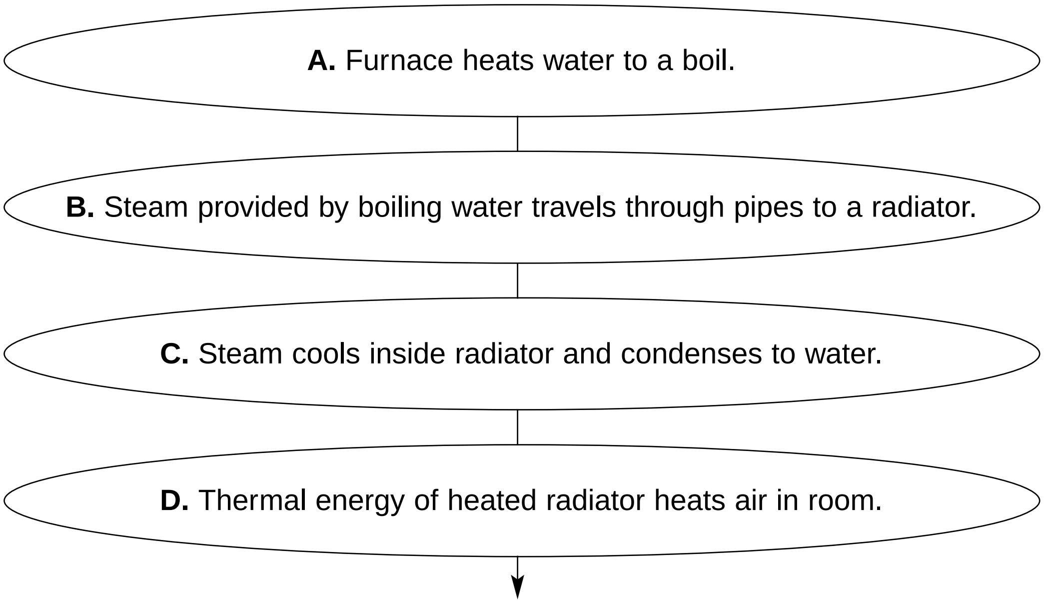
double-pane window ____________

Meeting Individual Needs

SECTION 4 Reinforcement

Using Thermal Energy

Directions: *Answer the following questions about the heating system represented in the flowchart.*



1. Is the system in the flowchart a hot-water system or a steam-heating system?

   ____

2. How does the furnace get the energy needed to heat the water?

   ____

3. Is the furnace an internal or external combustion engine? ______________

4. How is the thermal energy produced by the furnace transferred to the water?

   ____

5. Why do the pipes carrying the steam to the radiator need to be insulated?

   ____

6. How is the thermal energy from the steam transferred to the radiator?

   ____

7. How is the thermal energy of the radiator transferred to the surrounding air?

   ____

8. What happens to the steam as it gives up thermal energy inside the radiator?

   ____

9. How is heat from the air surrounding the radiator transferred to the air in the rest of the room?

   ____

SECTION 1 Enrichment

Hot and Cold

Directions: *Answer the following questions on the lines provided.*

1. If you put a heated rock in a bucket of water, the temperature of the water will increase and the temperature of the rock will decrease until the temperature is equal for both substances. If you drop a heated rock in the ocean, will the same thing happen? Explain.

2. Before the days of central heating, it was common to take a hot item to bed with you to keep warm. Would you rather have a 10-kg heated brick or a 10-kg jug of hot water that are at the same temperature? Explain.

3. Glass bottles have more mass than aluminum cans. When beverages in glass bottles are cooled, ten times as much heat must be removed as when the same beverages in aluminum cans are cooled. If you were a shop owner and had to pay the electric bills, would you rather sell beverages in glass containers or aluminum? Explain.

4. During the winter, after a hot bath, is it more efficient to drain the tub immediately or let it sit? Why?

SECTION 2 Enrichment

Carbonated Beverages

Soda "Pops" When you open a container of your favorite soft drink, what do you hear and see? Have you ever wondered why it went "pop" or why it fizzed? Carbon dioxide is added to the drink to give it a lively, tingling sensation. Inside that bottle or can is a lot of chemistry.

Ingredients Soft drinks are made when purified water, flavors, and sweeteners are mixed together to form a syrup. The syrup is mixed with carbon dioxide and preservatives, such as phosphoric acid.

Carbonation Process To add the carbon dioxide to the syrup, water flows through a large sealed chamber called a carbonator. The air inside this device is replaced with carbon dioxide. As the cold water moves over a series of plates, the carbon dioxide dissolves in the water. The temperature is kept between zero and four degrees Celsius, and the pressure is higher than normal. More carbon dioxide dissolves in the water at a low temperature and high pressure than would dissolve at room temperature.

Pressure Equilibrium When the bottle or can is sealed, the gas in the area above the liquid, called the headspace, is at room pressure. Soon the pressure in the headspace increases as the carbon dioxide comes out of the soft drink. This pressure can reach two to three times that of atmospheric pressure. Over time, the number of carbon dioxide molecules leaving the liquid and going into the headspace equals the number of molecules leaving the headspace and entering the liquid. At this point the system is at equilibrium.

1. In your own words describe how carbon dioxide is added to the water.

____

____

____

2. Why are bubbles released when the bottle or can is opened?

____

____

____

3. When a bottle or can of soft drink is opened, why does it "pop"?

____

____

____

SECTION 3 Enrichment

Thermal Energy and the Need for Ventilation

Materials

large (tall) cardboard box
100-watt bulb in a ceramic socket
thermometer
scissors
clock

Constructing the Apparatus

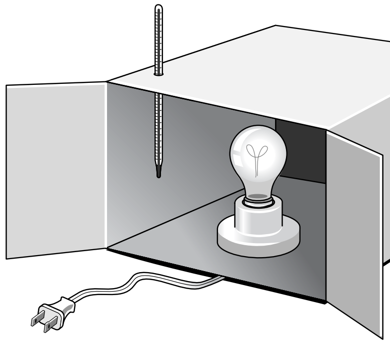


Figure 1

Follow Figure 1 as you proceed. Cut two flaps on one side of the box, one near the top and one below the first one near the bottom. Make a hole in the top of the box away from the side with the flaps. This hole should be just big enough to hold the thermometer. Use tape to secure the thermometer if the hole is too big. Set the bulb inside the box but be sure it is not under the thermometer.

WARNING: *Be sure the bulb is not touching the sides or any part of the box.* Run the wire from the bulb out through a hole in the bottom of the box. Close the box. Record the temperature before plugging in the cord.

Procedure

Trial A: Predict what you think the temperature inside the box will be after the light is on for 5 min. Be sure both flaps are closed. Plug in the cord. Wait 5 min. Unplug the cord. Record the temperature. Open the box and allow the temperature to return to what it was before you plugged in the bulb.

Trial B: When the temperature has returned to the starting temperature, close the box except for the top flap. Repeat the procedure in Trial A.

Trial C: When the temperature has returned to the starting temperature, close the box except for the bottom flap. Repeat procedures in Trial A.

Trial D: When the temperature has returned to the starting temperature, open both flaps. Repeat the procedure described in Trial A.

Data

Starting Temperature ____________________

Conditions	Predicted Temperature	Actual Temperature
Both flaps closed		
Top flap open, bottom closed		
Top flap closed, bottom open		
Both flaps open		

Conclude

1. How close were your predictions to the actual values?

____

2. By what method(s) is air inside the box heated?

____

Meeting Individual Needs

SECTION 4 Enrichment

Home Heating

Analyze the heating system in your home. Find someone who knows the heating system well. Maybe a parent or a brother or sister could help you. Other sources of help are a heating and cooling service person, representative of a utility company, and literature on energy conservation measures. Once you have found someone, have him/her help you answer the following questions.

1. What type of heating system does your home have?

2. What type of fuel is used to heat your home?

3. How much does it cost to heat your home per year?

4. What kind of low-cost actions could you take to help conserve heat in your home?

5. Suppose you had to replace your old heating system. What options are available to you?

6. Suppose you already had a highly efficient heating system. What kind of major improvements could you do to make your home even more heating efficient?

7. Your heating system should have maintenance done on an annual basis. Why is this important?

Note-taking Worksheet

Heat and States of Matter

Section 1 Thermal Energy and Heat

A. _______________ **theory** explains how particles of matter behave.

1. All matter is composed of small _______________.
2. Particles are in constant, random _______________.
3. Particles _______________ with each other and walls of their containers.

B. _______________—related to the average kinetic energy of an object's atoms or molecules

1. The SI unit for temperature is _______________(K).
2. Two other temperature scales are the Celsius scale and the _______________ scale.

C. _______________—the sum of the kinetic and potential; energy of all the atoms in an object

1. Thermal energy _______________ as temperature increases.
2. At constant temperature, thermal energy increases if _______________ increases.

D. Thermal energy that flows from something at a higher temperature to something at a lower temperature is called _______________.

E. _______________—amount of heat needed to raise the temperature of 1 kg of a material by one degree C or K

F. Changes in thermal energy can be calculated as *change in thermal energy equals* _______________ *times change in temperature times specific heat.*

1. When heat flows into an object and its temperature rises, the change in temperature is _______________.
2. When heat flows out of an object and its temperature decreases, the change in temperature is _______________.
3. A _______________ is used to measure specific heat.

Section 2 States of Matter

A. _______________ of matter—solid, liquid, gas

1. _______________ state—particles are closely packed together in a specific type of geometric arrangement.

Meeting Individual Needs

Note-taking Worksheet (continued)

2. _______________ state—a solid begins to liquefy at the melting point as the particles gain enough energy to overcome their ordered arrangement
   a. Energy required to reach the melting point is called the **heat of** _______________.
   b. Liquid particles have more space between them, allowing them to flow and take the shape of their container.
3. _______________ state—a liquid's particles have enough energy to escape the attractive forces of the other particles in the liquid
   a. **Heat of** _______________ is the energy required for a liquid to change to a gas.
   b. At the _______________, the pressure of a liquid's vapor is equal to the pressure of the atmosphere, and the liquid becomes a gas.
   c. Gas particles spread evenly throughout their container in the process of _______________.
4. _______________ state of matter consisting of high-temperature gas with balanced positively and negatively charged particles.

B. _______________ expansion—increase in the size of a substance when the temperature increases
   1. The size of a substance will then _______________ when the temperature decreases.
   2. Expansion and contraction occur in _______________ solids, liquids, and gases.
   3. _______________ is an exception because it expands as it becomes a solid.

Section 3 Transferring Thermal Energy

A. _______________ —transfer of thermal energy through matter by direct contact of particles
   1. Kinetic energy is transferred as particles _______________.
   2. _______________, particularly metals, are good heat conductors.

B. The transfer of energy by the motion of heated particles in a fluid is called _______________.
   1. Convection _______________ transfer heat from warmer to cooler parts of a fluid.
   2. Convection currents create _______________ and _______________ over different regions of Earth.

C. _______________—energy transfer by electromagnetic waves

Note-taking Worksheet (continued)

1. Some radiation is ______________ and some is ______________ when it strikes a material.
2. Heat transfer by radiation is ______________ in a gas than in a liquid or solid.

D. ______________—material that does not let heat flow through it easily

1. Gases such as ______________ usually make better insulators than liquids or solids.
2. A ______________ layer in a thermos is a good insulator because it contains almost no matter to allow conduction or convection to occur.

Section 4 Using Thermal Energy

A. ______________ systems—warm homes and buildings

1. ______________ system—fuel heats air, which is blown through ducts and vents; cool air is returned to the furnace to be reheated
2. ______________ system—hot water or steam in a radiator transfers thermal energy to the air
3. ______________ heating system—electrically heated coils in ceilings or floors heat air by conduction

B. ______________—the study of the relationships among thermal energy, heat, and work

1. ______________ the increase in energy of a system equals the energy *added* to the system.
2. ______________ the increase in *thermal* energy of the cool object equals the *decrease* in thermal energy of the warm object.

C. ______________—an engine that converts thermal energy into mechanical energy

1. An ______________ engine burns fuel inside the engine in chambers or cylinders.
2. Internal combustion engines convert only about ______________ % of the fuel's chemical energy to mechanical energy.

D. ______________is a measure of how dispersed energy is.

Assessment

Chapter Review

Heat and States of Matter

Part A. Vocabulary Review

Directions: *Write the term from the word list that best completes each statement. Use each term once.*

liquid	**decrease**	**calorimeter**	**conduction**	**particles**
insulators	**radiation**	**kinetic energy**	**convection**	

1. A type of heat transfer that does not require matter is ____________________.

2. Energy is transferred through matter by direct contact of particles by ____________________.

3. ____________________ crystals do not lose their ordered arrangement completely upon melting.

4. The size of a substance will ____________________ when the temperature decreases.

5. Materials such as air, wood, and rubber that do not allow heat to pass through them easily are called ____________________.

6. The transfer of heat energy by movement of matter is called ____________________.

7. All matter is composed of small ____________________.

8. A ____________________ is used to measure specific heat.

9. The particles of an object with a high temperature have a high ____________________.

Chapter Review (continued)

Part B. Concept Review

Directions: *Determine whether the italicized term makes each statement true or false. If the statement is true, write* ***true*** *in the blank. If the statement is false, write in the blank the term that makes the statement true.*

________________ **1.** The transfer of thermal energy by conduction and convection *does not* require matter.

________________ **2.**The transfer of thermal energy by radiation *does not* require matter.

________________ **3.** A material that allows heat to pass through it easily is an *insulator*.

________________ **4.** Energy is usually transferred in fluids by *radiation*.

________________ **5.** Wind and ocean currents are examples of *conduction* currents.

________________ **6.** Air is a *poor* heat conductor.

________________ **7.** A *steam-heating* system uses radiators to transfer thermal energy.

________________ **8.** Steam-heating systems require *more* water than hot-water systems.

________________ **9.** Solids usually conduct heat *better* than liquids and gases.

________________ **10.** The transfer of energy in the form of invisible waves is *conduction*.

________________ **11.** *Temperature* is a measure of the kinetic energy of an object.

Directions: *Explain the difference between the terms. Write your answers on the lines provided.*

12. internal combustion engine, external combustion engine.

____

____

____

____

Chapter Test

Heat and States of Matter

I. Testing Concepts

Directions: *In the blank at the left, write the letter of the term or phrase that completes the statement or answers the question.*

_______ **1.** Matter that has a definite volume and a definite shape is a _______.
a. solid **b.** liquid **c.** gas **d.** plasma

_______ **2.** Matter in which particles are arranged in repeating geometric patterns is a _______.
a. solid **b.** liquid **c.** gas **d.** plasma

_______ **3.** A gaslike mixture with no definite volume or shape that is made up of positively and negatively charged particles is a _______.
a. solid **b.** liquid **c.** gas **d.** plasma

_______ **4.** Matter with no definite volume and no definite shape is a _______.
a. solid **b.** liquid **c.** gas **d.** plasma

_______ **5.** Matter that has a definite volume but no definite shape is a _______.
a. solid **b.** liquid **c.** gas **d.** plasma

_______ **6.** Matter in which the particles are free to move in all directions until they have spread evenly throughout their container is a _______.
a. solid **b.** liquid **c.** buoyant **d.** gas

_______ **7.** Most matter _______ when heated.
a. expands **b.** contracts **c.** solidifies **d.** condenses

_______ **8.** Liquids which keep some ordered structure are _______.
a. plasma **b.** amorphous **c.** liquid crystals **d.** not real

_______ **9.** Wind and ocean currents are formed by _______.
a. radiation **b.** convection **c.** conduction **d.** condensation

_______ **10.** The amount of energy needed to change a material from the solid state to the liquid state is the heat of _______.
a. vaporization **b.** condensation **c.** fusion **d.** evaporation

_______ **11.** A material that reduces the flow of heat by conduction, convection, and radiation is a(n) _______.
a. conductor **b.** insulator **c.** solar collector **d.** radiator

_______ **12.** All of the following are good conductors of heat EXCEPT _______.
a. silver **b.** copper **c.** aluminum **d.** air

_______ **13.** The process by which engine fuels burn is _______.
a. radiation **b.** convection **c.** combustion **d.** insulation

_______ **14.** Convection will most likely occur through _______.
a. solids and liquids **b.** gases only **c.** solids only **d.** liquids and gases

Chapter Test (continued)

_______ **15.** The transfer of energy that does not require matter is _______.
a. combustion **b.** conduction **c.** convection **d.** radiation

_______ **16.** Energy from the Sun travels to Earth as _______.
a. work **b.** chemical energy **c.** radiant energy **d.** combustion

_______ **17.** A device that converts thermal energy into work is a _______.
a. heat mover **b.** radiator **c.** conductor **d.** heat engine

_______ **18.** Temperature measures the _______ of the particles of a material.
a. heat **c.** potential energy
b. kinetic energy **d.** kinetic and potential energy

_______ **19.** Of the following, the best insulator would be _______.
a. silver **b.** copper **c.** air **d.** iron

II. Understanding Concepts

Skill: Comparing and Contrasting

Directions: *Answer the following questions on the lines provided.*

1. Compare and contrast heat and temperature.

____

____

2. How does thermal energy relate to
a. heat?

____

____

b. temperature?

____

____

3. What is specific heat?

____

____

4. Compare and contrast convection and conduction.

____

____

5. What is the equation for measuring the change in thermal energy?

____

____

6. What happens to steam when it condenses?

Skill: Making and Using Tables

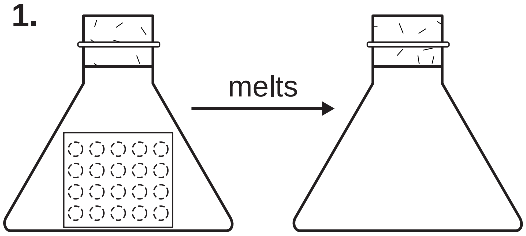
Directions: *Use the terms,* ***definite, not definite, close together,*** *and* ***spread apart*** *to complete the table below.*

State	Shape	Volume	Particles
a. Gas			
b. Liquid			
c. Solid			
d. Plasma			

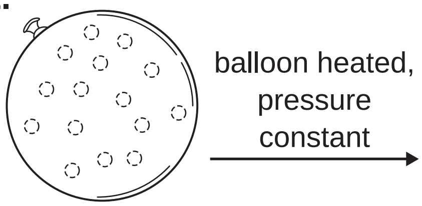
III. Applying Concepts

Directions: *Complete each of the following diagrams by showing how the positions of the particles will change under the conditions described.*

1.



2.



Chapter Test (continued)

IV. Writing Skills

Directions: *Answer the following questions using complete sentences.*

1. Where might you find plasma?

2. Water has a very high specific heat. Why does this make it a very good substance for use in cooling systems of automobiles?

3. Why do the pipes in a steam-heating system need to be insulated?

Transparency Activities

Name Date Class

SECTION 1 Section Focus Transparency Activity

A Spectacular Reentry

In 1968, *Apollo 8* became the first piloted vehicle to orbit the Moon. Below you see *Apollo 8* as it reenters Earth's atmosphere. Friction between the atmosphere and the hurdling spacecraft created temperatures of up to 3,000°C. The craft and the astronauts inside needed special protection in order to survive these inferno-like temperatures.

1. Why is it a concern that the exterior of a spacecraft experiences very high temperatures upon reentry?
2. If a metal pan with a metal handle sits on a lit burner for a long time, what happens to the handle?
3. When it's cold out, why does a jacket help you stay warm?

Name Date Class

SECTION 2 Section Focus Transparency Activity

Water Works

Sculptors use a variety of materials to create their works of art. Those who sculpt marble or wood expect their work to last for many years. Ice sculptors, on the other hand, know that the Sun will soon turn their intricate works into pools of water.

1. What happens to molecules of water as ice melts?

2. Why does snow melt when you hold it in your hand?

3. What happens when water boils?

SECTION 3 Section Focus Transparency Activity

Steam Power

Steam engines convert thermal energy into mechanical energy. The engines use thermal energy to produce steam that powers the locomotive. During the 1800s, steam engines were used in factories and mills and to propel boats and trains.

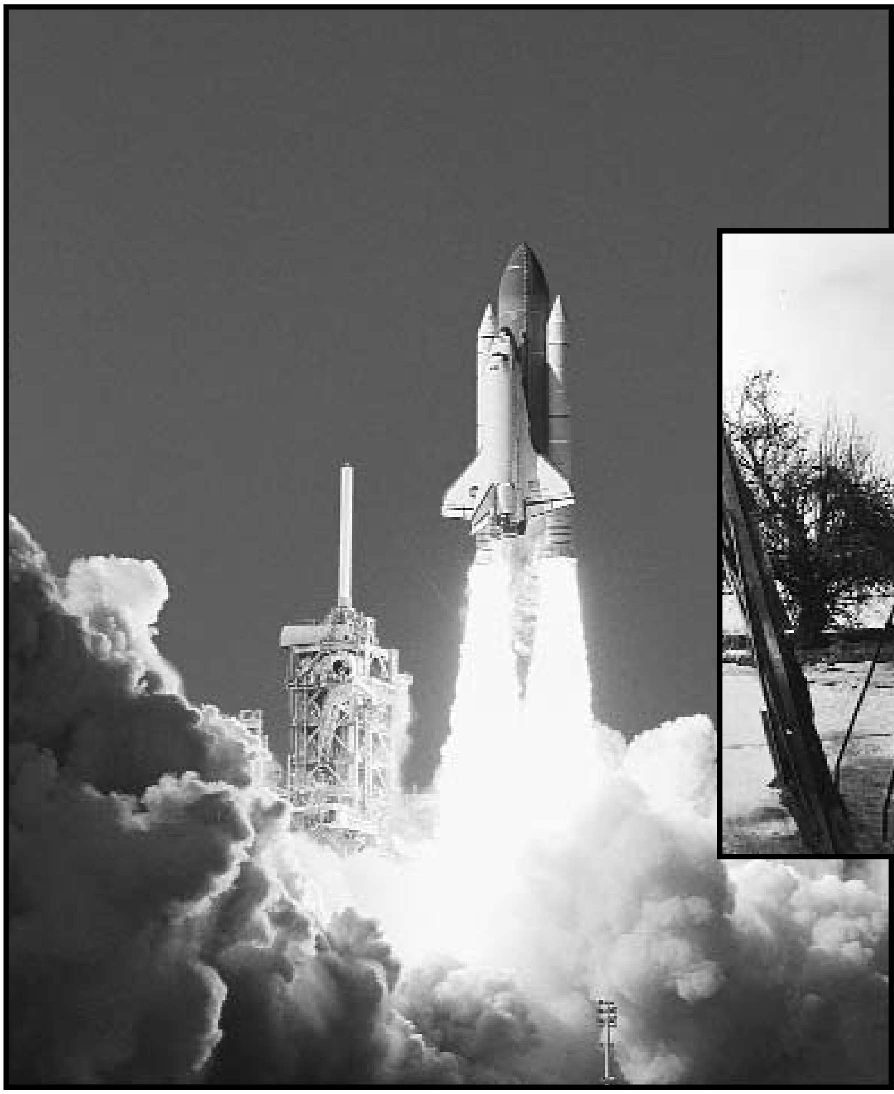
1. **What are some fuels that the engines might burn to create steam?**
2. **Describe how liquid water is different from steam (gaseous water).**
3. **What changes steam energy to mechanical energy in the locomotive?**

Name Date Class

SECTION 4 Section Focus Transparency Activity

One Small Step

From a farm in Massachusetts, Robert Goddard launched the first liquid–powered rocket in 1926. Using liquid oxygen and gasoline as propellants, the small rocket rose to 41 feet, arched over, and landed in a cabbage patch. The flight lasted only 2.5 seconds, yet it was the beginning of the rocket age.

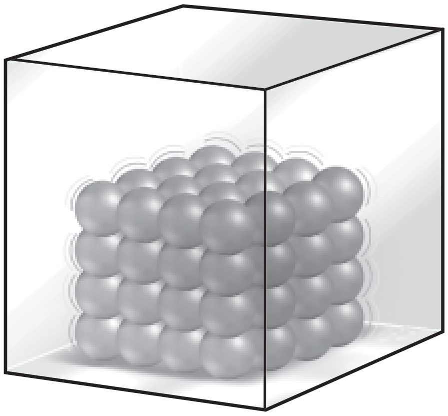


1. When you heat a liquid, what happens?
2. When you heat a gas, what will it do?
3. Why do you think gases are cooled to a liquid state for use in rocket fuel?

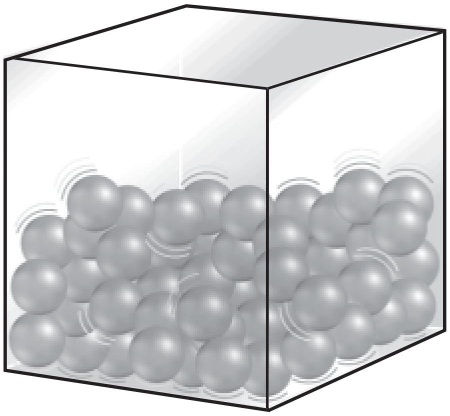
Name Date Class

SECTION 2 Teaching Transparency Activity

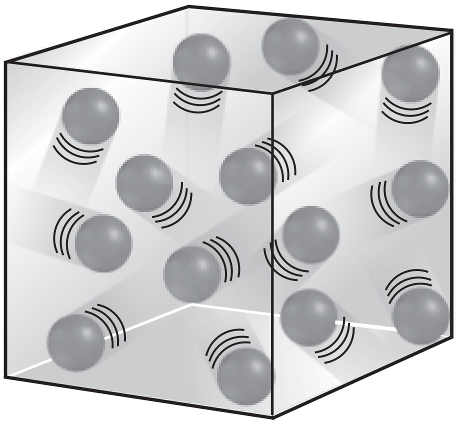
Structure of a Solid, Liquid, and Gas



Solid



Liquid



Gas

Teaching Transparency Activity (continued)

1. What are the four states of matter?

2. How do the positions of the particles in a solid compare with the positions of the particles in an equal volume of liquid?

3. What do we call the amount of energy required to change from a liquid to a gas?

4. What do we call the temperature at which a solid begins to liquefy?

5. How does decreasing the temperature of a liquid change the particles that make up the liquid?

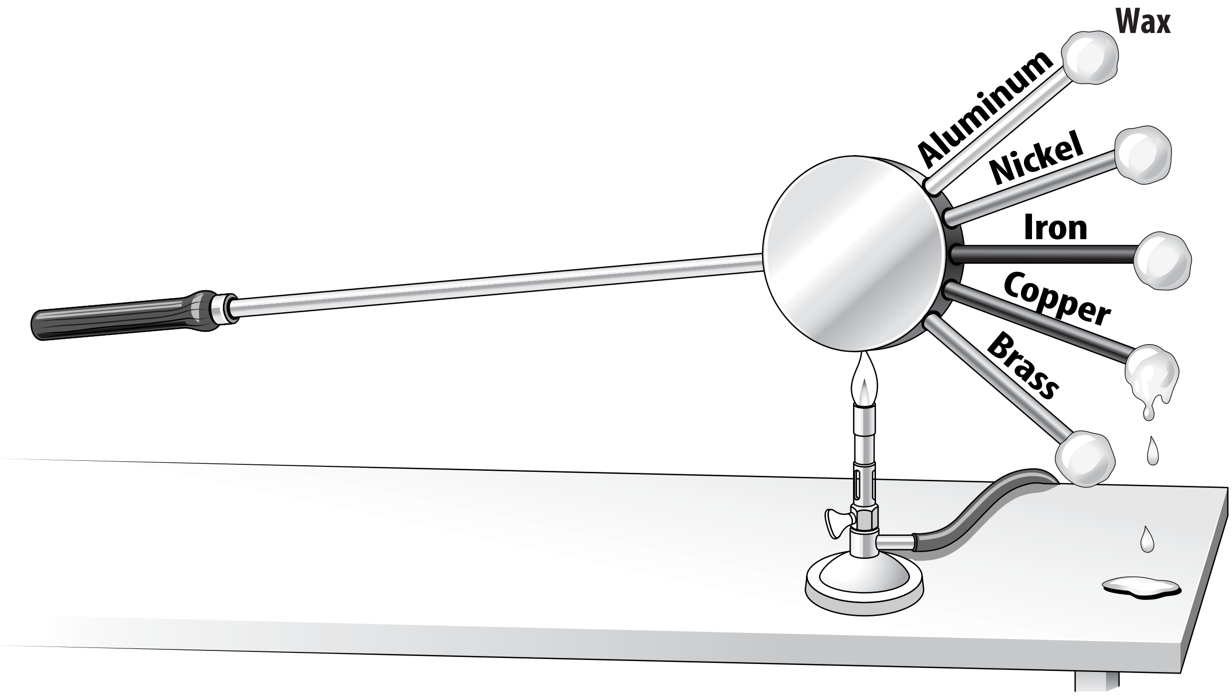
6. What causes the particles in a solid to vibrate?

7. What is heat of fusion?

Assessment Transparency Activity

Heat and States of Matter

Directions: *Carefully review the diagram and answer the following questions.*



1. Which hypothesis is probably being tested by this experiment?
A Different metals conduct thermal energy at different rates.
B Brass conducts thermal energy better than any other metal.
C Metals are good insulators.
D Different kinds of wax melt at different rates.

2. According to the diagram, which metal conducts heat BEST?
F Aluminum
G Nickel
H Iron
J Copper

3. Most metals will have all of the following properties EXCEPT ___.
A shiny luster
B good conductor
C solid at room temperature
D good insulator

Teacher Support and Planning

Teacher Support and Planning

Content Outline for Teaching — Heat and States of Matter

Section 1 Temperature and Thermal Energy

Underlined words and phrases are to be filled in by students on the Note-taking Worksheet.

A. **Kinetic theory**—explains how particles in matter behave
  1. All matter is composed of particles.
  2. Particles are in constant, random motion.
  3. Particles collide with each other and walls of their containers.

B. **Temperature**—related to the average kinetic energy of an object's atoms or molecules
  1. The SI unit for temperature is Kelvin (K).
  2. Two other temperature scales are the Celsius scale and the Fahrenheit scale.

C. **Thermal energy**—the sum of the kinetic and potential energy of all the atoms in an object
  1. Thermal energy increases as temperature increases.
  2. At constant temperature, thermal energy increases if mass increases,

D. Thermal energy that flows from something at a higher temperature to something at a lower temperature is called heat.

E. **Specific heat**—amount of heat needed to raise the temperature of 1 kg of a material by one degree C or K

F. Changes in thermal energy can be calculated as *change in thermal energy equals mass times change in temperature times specific heat.*
  1. When heat flows into an object and its temperature rises, the change in temperature is positive.
  2. When heat flows out of an object and its temperature decreases, the change in temperature is negative.
  3. A calorimeter is used to measure specific heat.

DISCUSSION QUESTION:

How do temperature and heat differ? *Heat is thermal energy that flows from something warmer to something cooler; temperature is related to kinetic energy of atoms in a substance.*

Section 2 States of Matter

A. States of matter—solid, liquid, gas, plasma

1. Solid state—particles are closely packed together in a specific type of geometric arrangement
2. Liquid state—a solid begins to liquefy at the melting point as the particles gain enough energy to overcome their ordered arrangement
   - **a.** Energy required to reach the melting point is called the **heat of fusion**.
   - **b.** Liquid particles have more space between them allowing them to flow and take the shape of their container.
3. Gaseous state—a liquid's particles have enough energy to escape the attractive forces of the other particles in the liquid
   - **a.** **Heat of vaporization** is the energy required for a liquid to change to a gas.
   - **b.** At the boiling point, the pressure of the liquid's vapor is equal to the pressure of the atmosphere, and that liquid becomes a gas.
   - **c.** Gas particles spread evenly throughout their container in the process of diffusion.
4. **Plasma**—state of matter consisting of high-temperature gas with balanced positively and negatively charged particles.

B. Thermal expansion—increase in the size of a substance when the temperature increases

1. The size of a substance will then decrease when the temperature decreases.
2. Expansion and contraction occur in most solids, liquids, and gases.
3. Water is an exception because it expands as it becomes solid.

DISCUSSION QUESTION:
How are temperature and kinetic energy related? *Temperature means the average kinetic energy of a substance, or how fast the particles are moving.*

Section 3 Transferring Thermal Energy

A. **Conduction**—transfer of thermal energy through matter by direct contact of particles

1. Kinetic energy is transferred as particles collide.
2. Solids, particularly metals, are good heat conductors.

B. The transfer of energy by the motion of heated particles in a fluid is called convection.

1. Convection currents transfer heat from warmer to cooler parts of a fluid.

Content Outline for Teaching (continued)

2. Convection currents create rain forests and deserts over different regions of Earth.

C. **Radiation**—energy transfer by electromagnetic waves.

1. Some radiation is absorbed and some is reflected when it strikes a material.
2. Heat transfer by radiation is faster in a gas than in a liquid or solid.

D. **Thermal insulator**—material that does not let heat flow through it easily.

1. Gases such as air usually make better insulators than liquids or solids.
2. A jacket with air pockets is a good insulator because the air slows the flow of body heat to the colder outside air.

DISCUSSION QUESTION:
What state of matter generally makes a good heat conductor? Heat insulator? *Solids generally conduct heat better than liquids or gases; gases usually make better insulators than liquids or solids.*

Section 4 Using Thermal Energy

A. Heating systems—warm homes and buildings

1. Forced-air system—fuel heats air, which is blown through ducts and vents; cool air is returned to the furnace to be reheated.
2. Radiator system—hot water or steam in a radiator transfers thermal energy to the air
3. Electric heating system—electrically heated coils in ceilings or floors heat air by conduction

B. Thermodynamics—the study of the relationships among thermal energy, heat, and work

1. **First law of thermodynamics**—the increase in energy of a system equals the energy added to the system
2. **Second law of thermodynamics**—the increase in thermal energy of the cool object equals the decrease in thermal energy of the warm object.

C. Heat engine—an engine that converts thermal energy into mechanical energy

1. An internal combustion engine burns fuel inside the engine in chambers or cylinders.
2. Internal combustion engines convert only about 26 percent of the fuel's chemical energy to mechanical energy.

D. **Entropy** is a measure of how dispersed energy is.

DISCUSSION QUESTION:
What are three types of heating systems? *Forced-air systems, radiator systems, and electric systems.*

SECCIÓN 1 Temperatura y energía térmica

Lo que aprenderás

- **A definir** qué es la temperatura.
- **A explicar** en qué se relacionan la energía térmica y la temperatura.
- **A calcular** el cambio en la energía térmica de un cambio de temperatura.

Vocabulario

kinetic theory / teoría cinética: es el movimento de las partículas en la materia.
kelvin / kelvin: es la unidad SI de la temperatura.
temperature / temperatura: es una medida de la energía cinética promedio de sus partículas.
thermal energy / energía térmica: es la suma de las energías cinética y potencial de todas las partículas en un objecto.
heat / calor : es la energía térmica que fluye desde un objecto con una temperatura superior a otro cuya temperatura es inferior.
specific heat / calor específico: es la cantidad de energía térmica necesaria para elevar la temperatura de 1 kg de un material en un 1°C.

Por qué es importante

Los automóviles, autobuses, camiones y aviones no podrían funcionar sin energía térmica.

SECCIÓN 2 Estados de la materia

Lo que aprenderás

- **A describir** las diferencias entre los cuatro estados de la materia.
- **A explicar** de qué manera el movimiento de las partículas en un material cambia en su punto de fusión y de ebullición.
- **A explicar** por qué occurre la dilatación térmica.

Vocabulario

plasma / plasma: es la materia compuesta de partículas con carga positiva y negativa y además no tiene ni forma ni volumen definido.
heat of fusion / calor de fusión: es la cantidad de energía que se requiere para que una sustancia de 1 kg cambie de sólido a líquido en su punto de fusión.
heat of vaporization / calor de vaporización: es la cantidad de energía que se requiere para que un líquido de 1 kg se convierta en gas en su punto de ebullición.

Por qué es importante

Puedes usar la energía que se pierde o gana cuando una sustancia cambia de un estado a oro.

SECCIÓN 3 Transferencia de energía térmica

Lo que aprenderás

- **A comparar y contrastar** la transferencia de energía térmica mediante conducción, convección y radiación.
- **A comparar y contrastar** los conductores y aislantes térmicos.
- **A explicar** de qué forma se utilizan los aislantes para controlar la transferencia de energía térmica.

Vocabulario

conduction / conduccion: es la transferencia de energía térmica entre las partículas que chocan o colisionan.
convection / convección: es la transferencia de energía térmica en un fluido mediante el movimiento del fluido de un lugar a otro.
radiation / radiación: es la transferencia de energía por medio de las ondas electromagnéticas.
thermal insulator / aislante térmico: es un material en el que la energía se mueve lentamente.

Por qué es importante

Puedes controlar el flujo de energía térmica para evitar tener demasiado calor o frió.

SECCIÓN 3 Uso de energía térmica

Lo que energía térmica

- **A describir** la primera y segunda ley de termodinámica.
- **A explicar** cómo un motor de combustión interna convierte la energía térmica en energía mecánica.
- **A explicar** cómo una heladera o refrigerador transfiere energía térmica de temperatura fría a caliente.
- **A describir** cómo la entropía del universo cambia cuando ocurre cualquier acontecimiento.

Vocabulario

first law of thermodynamics / primer ley de termodinámica: establece que la energía térmica de un sistema cerrado no cambia.

second law of thermodynamics / segunda ley de termodinámica: establece que es imposible que la energía térmica fluya de un objecto frío a uno más caliente a menos que se realice un trabajo.

entropy / entropía: es una medida de cómo es la energía que se extiende o disipa.

Por qué es importante

Imagina tu vida sin sistemas de calefacción, aire acondicionados o autos.

LABORATORIO Convección en gases y líquidos

Un halcón que planea en el cielo rara vez batirá sus alas. Los halcones y algunos otros pájaros ahorran energía al planear en columnas de aire caliente que se elevan del suelo. Estas corrientes de convección se forman cuando los gases o líquidos se calientan de modo irregular y el fluido más caliente y menos denso es empujado hacia arriba.

Problema del mundo real

¿De qué manera se pueden modelar y observar las corrientes de convección?

Materiales

quemador o placa calentadora
agua
vela
vaso de precipitado de 500 mL
pimienta negra

Metas

- **Modelar** la formación de corrientes de convección en el agua.
- **Observar** las corrientes de convección que se forman en el agua.
- **Observar** las corrientes de convección que se forman en el aire.

Medidas de seguridad

PRECAUCIÓN: *Maneja con cuidado los materiales calientes. Recuerda que el vidrio caliente o frío se ve igual.*

Procedimiento

1. Coloca 450 mL de agua dentro del vaso de precipitado.
2. Usa una balanza para pesar 1 g de pimienta negra.
3. Espolvorea la pimienta en el vaso de precipitado con agua y déjala que se asiente en el fondo.
4. Calienta el fondo del vaso de precipitado con un quemador o la placa calentadora.
5. Observa de qué manera se mueven las partículas de la pimienta a medida que el agua se calienta y haz un dibujo para mostrar sus movimientos.
6. Apaga la placa calentadora o el quemador. Enciende la vela y déjala quemar durante unos minutos.
7. Sopla la vela y observa el movimiento del humo.
8. Dibuja el movimiento del humo.

Concluye y aplica

1. **Describe** cómo se movieron las partículas de la pimienta mientras se calentaba el agua.
2. **Explica** de qué manera se relaciona el movimiento de las partículas de la pimienta con el movimiento del agua.
3. **Explica** cómo se formó una corriente de convección en el vaso de precipitado.
4. **Explica** por qué el movimiento de la pimienta cambió cuando se apagó el calentador.
5. **Predice** de qué manera se moverá la pimienta si se calentara el agua desde arriba.
6. **Describe** cómo se movieron las partículas del humo cuando se apagó la vela.
7. **Explica** por qué el humo se movió de la forma en que lo hizo.

LABORATORIO

Conducción de gases

¿Hay contaminación del aire o smog en el lugar en que vives? Si es así, quizás hayas experimentado una inversión de temperatura. Por lo general, el sol calienta el suelo y el aire encima de este. Cuando el aire cerca del suelo es más caliente que el aire de arriba se produce la convección. Ésta convección también transporta humo u otros gases que emiten los automóviles, chimeneas y chimeneas de fábricas hacia arriba en la atmósfera. Si el aire cerca del suelo es más frío que el aire de arriba, la convección no ocurre. Entonces el humo y otros agentes contaminantes pueden quedar atrapados cerca del suelo, algunas veces forman smog.

Problema del mundo real

¿De qué manera causan las propiedades aislantes del aire una inversión de la temperatura?

Materiales

termómetro
vasos de goma espuma
vasos de precipitados de 400 mL
quemador o placa calentadora
cuchillo de cocina
manoplas térmicas

Metas

- **Medir** los cambios de temperatura en el aire cerca de una fuente de calor.
- **Observar** la conducción del calor en el aire.

Medidas de seguridad

PRECAUCIÓN: *Trabaja con cuidado cuando utilices agua caliente. Vierte el agua caliente con ambas manos.*

Procedimiento

1. Usa el cuchillo de cocina para corte con cuidado el fondo de un vaso de goma espuma.
2. Haz agujeros de aproximadamente 2 cm con un lápiz o lapicera desde la parte superior hasta el fondo de cada vaso de goma espuma, según se muestra en la foto.
3. Coloque ambos vasos hacia abajo e introduzca las puntas de los termómetros a través de los agujeros más altos y más bajos, para que ambos termómetros permanezcan colocados en forma horizontal. La punta de la cubeta de mercurio de cada termómetro debe extenderse en el medio del vaso sin fondo.
4. Calienta aprox. 350 mL de agua a una temperatura aproximada de 80°C en uno de los vasos de precipitado.
5. Coloca un vaso de precipitado de 400 mL vacío sobre el vaso que no tiene fondo. Anota la temperatura de los dos termómetros en una tabla de datos como la que se muestra a continuación.
6. Agrega aprox. 100 mL de agua caliente en el vaso de precipitado vacío. Después de un minuto, anota las temperaturas de los termómetros en tu tabla de datos.
7. Continúa anotando las temperaturas cada minuto durante 10 minutos. Agrega agua caliente cuando sea necesario para mantener la temperatura del agua aprox. a 80°C.

Temperaturas del aire en el vaso de goma espuma		
Tiempo (min.)	Termómetro superior (°C)	Termómetro inferior(°C)
0		
1	Las temperaturas medidas variarán.	
2		
3		
4		
5		

Analiza tus datos

1. **Grafica** las temperaturas que midieron los termómetros superior e inferior en el mismo gráfico. Anota en el eje vertical la temperatura y en el eje horizontal el tiempo.
2. **Calcula** el cambio total de la temperatura de ambos termómetros al restar la temperatura inicial de la temperatura final.
3. **Calcula** la taza promedio del cambio de temperatura de cada termómetro al dividir el cambio total de la temperatura por 10 minutos.

Concluye y aplica

1. **Explica** si puede ocurrir la convección en el vaso de goma espuma cuando se calienta desde la parte superior.
2. **Describe** de qué manera se transfiere el calor a través del aire en el vaso de goma espuma.
3. **Explica** por qué las tazas promedio del cambio de temperatura fueron distintas en los dos termómetros.

Guía de estudio

Repasa las ideas principales

Sección 1 Temperatura y energía térmica

1. De acuerdo con la teoría cinética, toda materia está compuesta de partículas en constante movimiento que colisionan sin perder energía.
2. La temperatura de un material es una medida de la energía cinética promedio de las partículas del material.
3. La energía térmica de un objeto es la suma total de las energías cinética y potencial de las partículas de un objeto.
4. El calor es energía térmica que fluye desde una temperatura superior a una inferior.
5. El calor específico es la cantidad de energía que se necesita para elevar la temperatura de una sustancia de 1 kg en 1°C.

Sección 2 Estados de la materia

1. Los estados de la materia son sólido, líquido, gaseoso y plasma.
2. Los cambios de estado pueden interpretarse en términos de la teoría cinética de la materia.
3. La mayoría de la materia se expande al calentarse y se contrae al enfriarse. Una junta de dilatación permite que el concreto se dilate y se contraiga sin producir daño alguno.

Sección 3 Transferencia de energía térmica

1. La conducción ocurre cuando la energía térmica se transfiere mediante las colisiones entre las partículas. No se transfiere materia.
2. La convección ocurre en un fluido cuando el líquido más caliente y más frío se mueve de un lugar a otro.
3. La radiación es la transferencia de energía a través de las ondas electromagnéticas. La radiación puede transferir energía a través del espacio vacío.
4. La energía térmica fluye más rápidamente en materiales que son conductores que en los que son aislantes.
5. Algunos materiales aislantes contienen burbujas de aire que reducen el flujo de la energía térmica.

Sección 4 Uso de energía térmica

1. De acuerdo con la primer ley de termodinámica, el aumento en la energía térmica de un sistema es igual al trabajo realizado y la cantidad de energía térmica que se añade al sistema.
2. La segunda ley de termodinámica establece que la energía térmica no puede fluir desde una temperatura más fría a una más caliente a menos que se realice un trabajo.
3. Cada acontecimiento que ocurre disminuye la cantidad de energía utilizable y aumenta la entropía del universo.

Hands-On Activities

MiniLAB: Try at Home (page 3)

1. It is higher.
2. The water expanded as it changed from a liquid to a solid.

MiniLAB (page 4)

1. by conduction through the spoons and by conduction and convection through the steam
2. metal, plastic, wood

Lab (page 5)

Lab Preview

1. to exercise caution due to extreme temperatures
2. 450; 2

Conclude and Apply

1. The particles swirled upward.
2. As the water heated, the convection currents in the water carried the black pepper upwards.
3. The water was hotter in the bottom of the beaker because it was nearer the heat source. The hot water rose in the beaker and the cool water dropped
4. There was no longer a temperature gradient in the beaker so convection stopped.
5. The pepper would stay on the top because hot water is less dense than cool water
6. The smoke rose as long as there was a heat source. The rise of the smoke became slower as the wick cooled.
7. When the heat source is turned off, the temperature gradient becomes less as the wick cools and convection slows down.

Lab (page 7)

Lab Preview

1. Protect hair, loose clothing from flammable chemicals
2. 80˚

Analyze Your Data

1. Check students' graphs.
2. Answers will vary. Check students' work.
3. Answers will vary. Check students' work.

Conclude and Apply

1. No; if the cup is heated from the top, the air at the top becomes warmer and less dense than the air below. As a result, this air does not sink and transfer thermal energy to the cooler air below.
2. Because convection could not occur, thermal energy was transfered by conduction in the air.
3. The thermometer at the top was closer to the hot water, so it took less time for thermal energy to be transfered to that air around it. Thermal energy had to be transfered by conduction to the lower thermometer. Because thermal energy moves slowly through air, it took more time for thermal energy to reach this thermometer and the temperature change of this thermometer occurred more slowly.

Laboratory Activity 1 (page 9)

Notes: Make sure there are no open flames when students are working with ethanol—it is flammable. Make sure that students do not taste the corn syrup. Tasting substances, even edible ones, is not good laboratory practice.
As students squeeze the air out of their pipettes, tell them not to release the bulb because it will suck air back into it.

Questions and Conclusions

1. corn oil, ethanol, water, corn syrup
2. The densities of corn oil and ethanol are less than that of water. Corn syrup is denser than water
3. The corn oil would rise to the top and float on the surface of the water. Because corn oil is less dense than water and less dense materials float on more dense materials, the corn oil will float on water.
4. ethanol—0.80, corn oil—.65, corn syrup—1.40
5. Because the ratio of measurements that have the same units, the units cancel out.

Laboratory Activity 2 (page 13)

Lab Note: Reminder—some children are highly allergic to nuts, especially peanuts. If you have a student who is allergic, substitute raisins or another energy food.
Lab Note: use different nuts, such as peanuts, almonds, and walnuts, for food samples. Students can compare energy released by each type of food.
Lab Note: This activity actually measures the energy absorbed by the water from the burning food sample. Some energy will be absorbed by the flask and surrounding air.
Lab Note: Times of more than two minutes may be needed for some food samples.

Data and Observations

Data will depend on samples used.
Lab Note: Determine an average value for each food sample. Enter this value in the class data table.

Questions and Conclusions

1. the mass of substance burned, the mass of water heated, the change in temperature of the water, and the specific heat of water
2. The water temperature rises.
3. the energy gained by water
4. Energy was absorbed by the flask and the surrounding air.
5. Answers will vary.
6. 209 J/0.4kg = Q/20.0g
   Q = 10,450J

Meeting Individual Needs

Directed Reading for Content Mastery

Overview (page 19)

1. convection
2. radiation
3. conductors
4. forced-air
5. electrical
6. particles
7. definite shape and volume
8. liquids
9. gases

Sections 1 and 2 (page 20)

1. j
2. m
3. c
4. d
5. f
6. h
7. k
8. l
9. a
10. g
11. n
12. b
13. e
14. i

Sections 3 and 4 (page 21)

1. Conduction transfers heat through direct contact of particles of matter. Convection moves heat from warmer parts of an object to cooler parts. Radiation transfers energy by electromagnetic waves.
2. metals
3. Radiant Energy
4. matter
5. heating systems
6. conduction
7. active combustion
8. heat pump
9. stroke

Key Terms (page 22)

1. conduction
2. convection
3. radiation
4. insulator
5. internal combustion
6. thermal expansion
7. solar collector
8. vaporization
9. kinetic theory
10. Kelvin
11. specific heat
12. calorimeter
13. plasma

Lectura dirigida para Dominio del contenido

Sinopsis (pág. 23)

1. convección
2. radiación
3. conductores
4. aire forzado
5. eléctrico
6. partículas
7. forma y volumen definido
8. líquidos
9. gases

Sección 1 y 2 (pág. 24)

1. j
2. m
3. c
4. d
5. f
6. h
7. k
8. l
9. a
10. g
11. n
12. b
13. e
14. i

Secciones 3 y 4 (pág. 25)

1. La conducción transfiere el calor a través del contacto directo de las partículas de la materia. La convección mueve el calor de las partes más calientes de un objeto a las partes más frías de este. La radiación transfiere energía por medio de las ondas electromagnéticas.
2. metales
3. energía radiante
4. materia
5. sistema de calefacción
6. conducción
7. combustión activa
8. compresor
9. tiempo

Términos claves (pág. 26)

1. conducción
2. convección
3. radiación
4. aislante
5. combustión interna
6. dilatación térmica
7. colector solar
8. vaporización
9. teoría cinética
10. Kelvin
11. calor específico
12. calorímetro
13. plasma

Reinforcement

Section 1 (page 27)

1. true
2. more
3. true
4. decreases
5. true
6. different
7. true
8. joules
9. different
10. true
11. high
12. true
13. **a.** change in thermal energy
    b. mass of the sample of matter
    c. change in temperature
    d. specific heat
    e. change
    f. Change is included in *Q*, which is the variable for energy change.
14. $\Delta T = T$ final $- T$ initial

Section 2 (page 28)

1. solid
2. 10°C
3. 50°C
4. liquefy
5. liquid
6. liquid
7. 110°C
8. gas
9. gas
10. gas
11. liquid
12. liquid
13. solid

Section 3 (page 29)

1. good
2. conduction
3. radiation
4. true
5. true
6. convection
7. convection
8. true
9. more
10. silver spoon: Silver is a better conductor of heat than wood.
11. a red shirt: Darker-colored materials absorb more heat than lighter-colored materials.
12. a sidewalk in the sun: Dull materials absorb more radiant energy than shiny materials.
13. single-pane window: Air between the two panes of glass in the double-pane window acts as insulation.

Section 4 (page 30)

1. a steam-heating system
2. furnace heats water to a boil
3. internal combustion engine
4. conduction
5. to prevent the heat from escaping
6. conduction
7. radiation
8. It cools and condenses to water.
9. convection

Enrichment

Section 1 (page 31)

1. The water immediately near the rock will increase in temperature as the rock cools, but the heat will dissipate through the water. The overall effect will be that the rock will cool to be the same temperature as the ocean. It doesn't provide enough heat to affect the massive quantity of water in the ocean.
2. The hot water has more energy than the brick because it has a very high specific heat. Therefore, the water has more energy to transfer to your cold body than the brick does.
3. Aluminum containers would require less cooling than glass containers; therefore, aluminum containers require less electricity to cool.
4. Let the water sit. The thermal energy from the water will warm the surrounding air as the water cools.

Section 2 (page 32)

1. The water gets into a carbonator where the carbon dioxide dissolves at cold temperatures and high pressure.
2. The equilibrium is disrupted. Carbon dioxide leaves the liquid. At reduced pressure, the liquid can hold far less dissolved gas, so the excess must come out of the solution.
3. The pressure of the carbon dioxide gas in the headspace is much greater then the room pressure. When the bottle or can is opened, the gas rushes out, creating the popping sound.

Section 3 (page 33)

Data

Starting Temperature: room temperature

Conclude

1. Answers will vary. Students should be able to select the conditions with highest and lowest

temperature.
2. The bulb warms air molecules by radiation and conduction. Warmed air molecules transfer thermal energy by conduction and convection.

Section 4 (page 34)
1. Either radiator, forced air, electric radiant heating, solar, or a combination of these are possible types.
2. natural gas, fuel oil, propane, electricity (from coal, nuclear, hydro, etc.)
3. Example: small ranch home, gas forced air, $50 per month for a year-long budget plan = $600 per year.
4. Clean furnace filter monthly, insulate hot water and steam pipes, caulk around doors and windows, keep fireplace flue closed when not in use, pull curtains at night to help insulate windows, open drapes during day to allow sunlight to heat the inside
5. New gas furnaces and hot-water boilers are much more efficient than older ones. Heat pumps can help heat in the winter and cool in the summer. Solar collectors can be used to supplement heating systems.
6. add insulation to the attic or walls, install new thermal replacement windows, add solar collectors
7. Cleaning and proper adjustment allow the heating system to function at its maximum efficiency. It also makes sure that the fuel is burning properly. Improperly burned fuel could allow deadly carbon monoxide gas to be released into the home.

Note-taking Worksheet (page 35)

Refer to Teacher Outline; student answers are underlined.

Assessment

Chapter Review (page 39)

Part A. Vocabulary Review
1. radiation (7/3)
2. conduction (7/3)
3. liquid (5/2)
4. decrease (6/2) (5/2)
5. insulators (5/3)
6. convection (8/3)
7. particles (4/2)
8. calorimeter (3/1)
9. kinetic energy (5/2)

Part B. Concept Review
1. does (7/3)
2. true (7/3)
3. conductor (8/3)
4. convection (7/3)
5. convection (7/3)
6. true (8/3)
7. true (7/3)
8. less (7/3)
9. true (8/3)
10. radiation (7/3)
11. true (1/1) (2/1)
12. An internal combustion engine burns its fuel inside itself. Fuel for an external combustion engine is burned outside the engine.

Chapter Test (page 41)

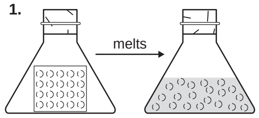
I. Testing Concepts
1. a (4/2)
2. a (4/2)
3. d (4/2)
4. c (4/2)
5. b (4/2)
6. d (4/2)
7. a (6/2)
8. c (4/2)
9. b (7/3)
10. a (5/2)
11. b (8/3)
12. d (8/3)
13. c (11/4)
14. d (7/3)
15. d (7/3)
16. c (7/3)
17. d (4/4)
18. b (1/1)
19. c (8/3)

II. Understanding Concepts
1. Temperature is the measure of the average kinetic energy of a substance's particles. Heat is thermal energy that flows across a temperature gradient. (1/1) (2/1)
2. **a.** Heat is thermal energy that flows from an area of higher temperature to lower. (2/1)
b. Temperature is a measure of the moving part of thermal energy. (1/1)
3. Specific heat is a measure of how much energy it takes to increase the temperature of 1 kg of a material 1° C. (3/1)
4. Convection transfers heat by movement of particles. Conduction transfers heat by contact of particles. (7/3)
5. $Q = m \times \Delta T \times C$: Change in thermal energy = mass × change in temperature × specific heat (3/1)
6. It becomes liquid water. (5/2) (4/2)

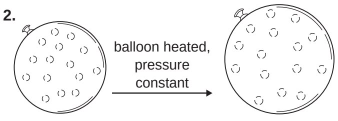
III. Applying Concepts

1-2

State	Shape	Volume	Particles
a. Gas	not definite	not definite	spread apart
b. Liquid	not definite	definite	close together
c. Solid	definite	definite	close together
d. Plasma	not definite	not definite	spread apart

1.


(4/2)

2.


(5/2)

IV. Writing Skills

1. Answers could include the Sun, stars, nuclear reactors, and lightning. (4/2)
2. Water can absorb a lot of energy before its temperature increases. It will be able to cool an auto engine by absorbing heat for a long time before it starts to heat up. (8/3) (5/2)
3. The insulation helps to keep the steam from losing thermal energy and condensing to water before reaching the room to be heated. (9/3)

Section Focus Transparency 1 (page 46)

A Spectacular Reentry

Transparency Teaching Tips

- The concept introduced here is thermal energy transfer. Ask the students to explain why the *Apollo 8* spacecraft generated such high temperatures upon reentry. Traveling through Earth's atmosphere creates friction, which generates thermal energy.
- Explain that thermal energy can be transferred by direct contact, called conduction. In conduction, applied heat causes the affected particles to move faster and faster. The moving particles collide with other particles, transferring energy to them.
- Liquids and gases transfer heat through convection, in which heated particles move from one location to another, transferring energy as they do so.
- The heat shield of the *Apollo 8* vehicle, pictured on the transparency, protects the ship and crew by absorbing the generated heat and conducting it equally to all parts of the shield (which is attached, but separate from the cabin itself). Heat shields have changed since the Apollo missions. The heat shield of a space shuttle is now made from heat resistant materials (ceramic, silica tiles reinforced with a special carbon material), which act as insulators.

Content Background

- The spacecraft pictured isn't burning. Nitrogen and oxygen in the atmosphere have been ignited as the blunt heat shield on the bottom of the craft plows into the atmosphere. The friction generates thermal energy and ignites the gases. The command module struck the atmosphere at almost 40,000 kph (25,000 mph), subjecting the heat shield to temperatures near 3,000°C (5,400°F).
- The angle of reentry must be around 6.2°, with only one degree of leeway. If the angle is higher, excess thermal energy and high g-forces will destroy the spacecraft. If the angle is to shallow, the craft will bounce off the atmosphere and back into space.
- *Apollo 8* successfully completed the first piloted orbit of the Moon. It was crewed by Frank Borman, James A. Lovell, Jr., and William A. Anders.

Answers to Student Worksheet

1. The temperature during reentry can destroy the spacecraft and everything within the spacecraft.
2. Heat is conducted from the pan through the handle, and it becomes hot, too.
3. The jacket acts as an insulator, keeping body heat in.

Section Focus Transparency 2 (page 47)

Water Works

Transparency Teaching Tips

- This transparency may be used to introduce the nature of matter (solids, liquids, gases, and plasma) as well as the properties of liquids. Ask students to explain the processes at work that cause a shaken can of soda to bubble and explode when opened. This occurs because the shaking excites carbon dioxide dissolved in the liquid, causing it to change to its gaseous state. The more the can is shaken, the faster the carbon dioxide comes out of solution, building up pressure within the sealed can.
- Ask students to explain why an ice sculpture melts when placed in a banquet hall (at room temperature). You may also ask them why sand sculptures eventually crumble.

Content Background

- In ice, the water molecules can vibrate, but they can't really move about. When the temperature rises and the water molecules absorb enough energy, they begin to flow past one another. This is the melting point. At the boiling point, the water molecules absorb enough energy to overcome virtually all the intermolecular attractive forces. This energy allows individual atoms to break away, the water changing state from a liquid to a gas (steam).
- On a beach, energy from the Sun causes the water within a sand structure to evaporate. This, along with the wind, causes the structure to lose its form.
- Plasma is a high-temperature gas containing positive and negative electrons. Because of the speed and force with which they collide, some of the electrons are stripped from the atoms. All the stars, including the Sun, are composed of plasma. Plasma can also be found in lightning, fluorescent and neon tubes.

Answers to Student Worksheet

1. The motion of the water molecules increases, gradually gaining enough energy to flow and

cause the ice to change to water.
2. The snow melts because thermal energy from your hand is transferred to the snow. The energy allows it to change states, causing the water molecules in the solid to vibrate enough to break apart.
3. When water boils, the molecules have enough energy not only to flow, but to break free of one another entirely.

Section Focus Transparency 3 (page 48)

Steam Power

Transparency Teaching Tips

- This transparency introduces thermal energy transfer. Ask the students to explain how homes were heated during the halcyon days of railroad travel (wood, coal, or gas furnace).
- Point out that another way of heating a home, similar to that pictured on the transparency, was steam heating. In this system, a fuel, such as wood or coal, heats a furnace, which transfers heat to water. The hot water is carried by pipes to radiators, which heat individual rooms.
- Ask the students to explain how modern homes are heated using heat transfer (gas and electrical heating with forced-air systems: possibly a form of solar heating.)
- Explain that the steam locomotive shown converts steam into mechanical energy. Coal, oil, or wood burns in the locomotive's boiler. Inside the boiler, the heat changes water into steam, which expands greatly in volume. The steam is forced into a pipe system that delivers it to the piston system on both sides of the engine. The expanding steam pushes a piston within a cylinder in a reciprocating action. The piston is attached to a rod that connects to a flywheel. The push-pull motion causes the flywheel to revolve, thus causing the wheels to turn.

Content Background

- The steam engine was based on the ideas of two Englishmen, Thomas Savery and Thomas Newcomen, who received patents for their ideas in 1698 and 1712, respectively. James Watt improved on their ideas, receiving his patent in 1769. By the 1800s, high-pressure steam engines led to the creation of the first locomotive and modern railroads.
- The first steam locomotive was built in 1804 in Wales. The first such locomotive in the United States was built by John Stephens in Hoboken, New Jersey (1825). The first railroad was begun two years later.

Answers to Student Worksheet

1. Steam engines burn wood, coal, and oil.
2. The molecules in liquid water flow past one another, but most do not have enough energy to overcome intermolecular attractive forces. The application of heat excites the water molecules, making them move about until the water molecules escape from the liquid. Thus water turns from a liquid into a gas.
3. The piston changes the energy of steam into mechanical energy.

Section Focus Transparency 4 (page 49)

One Small Step

Transparency Teaching Tips

- This transparency introduces the behavior of gases. Point out that gas will increase in volume when temperature is increased. Likewise, the volume of a gas will shrink when temperature is decreased. Heat is transferred to the individual atoms in the gas, causing them to move faster, expanding outward as they do so. If heat is removed, the particles move slower and volume is reduced. This process is called Charles's Law, named after the French scientist who first stated this property.
- By cooling oxygen to −183°C (−297°F) and hydrogen to −253°C (−423°F), the gases turn to liquids. This occurs because the individual oxygen and hydrogen particles are slowed to where the gas changes states.
- Explain that liquid propellant rockets now utilize liquid oxygen and liquid hydrogen. The oxygen and hydrogen are stored in separate containers. They are mixed and ignited in the combustion chamber. The resulting explosive exhaust is funneled out a nozzle. This force powers the rocket. Since an element is more dense as a liquid than as a gas, more fuel can be squeezed into the rocket when hydrogen and oxygen are in the liquid state.

Content Background

- Goddard used liquid oxygen and gasoline to power his rockets. The space shuttle utilizes liquid oxygen and liquid hydrogen. These liquid gases must be loaded just prior to launch in order to maintain the required temperatures and pressures which keep the gases in the liquid state. If the liquids were to become gases, their volume would increase tremendously, resulting in a container explosion.
- Such liquid propellants are called cryogenic fuels
- Between 50 and 95 percent of a rocket's payload is propellant.
- Goddard's interest in rockets germinated after he read a serialized newspaper version of H.G. Wells's *War of the Worlds* in 1898.

Answers to Student Worksheet

1. When a liquid is heated, its particles absorb energy and move faster and further apart. Eventually it becomes a gas.
2. The gas will expand, too.
3. By liquefying them, the gases will contract and

take up less volume.

Teaching Transparency (page 51)

Structure of a Solid, Liquid, and Gas

Section 2

Transparency Teaching Tips

- Review the properties of each of the four states of matter. Demonstrate the characteristics of solids, liquids, and gases using ice and water as examples of a solid and a liquid and a balloon filled with air as an example of a gas. Place the balloon in a refrigerator to lower its temperature. Later, return the balloon to the classroom and have students observe how the size of the balloon changes as it warms. Point out that the molecules of air inside the balloon move more slowly and become more tightly packed when the temperature decreases. As the balloon warms, its molecules begin to move about, causing the balloon to reinflate. Explain that all stars, including the Sun, consist of plasma, the fourth state of matter. Plasma is a high temperature gas composed of positively and negatively charged particles.

Reteaching Suggestion

- Prepare a table on the chalkboard using the names of the four states of matter as headings. Below each head, list the properties that distinguish that state from the others.

Extensions

Activity: Have students heat a beaker containing 100 mL of water (to boiling) until the volume of water in the beaker decreases by 10 to 15 mL. Have each student write a laboratory report that explains his or her observations and a summary describing how and why the water molecules changed state.
Challenge: Challenge students to design an experiment that would demonstrate that gas has mass and volume and write a procedure for their experiment.

Answers to Student Worksheet

1. solid, liquid, gas, and plasma
2. The particles in a solid oscillate in place and have less energy than do the particles in a liquid.
3. heat of vaporization
4. melting point
5. As a liquid is cooled, its particles lose energy and move more slowly. As a result, the particles become more tightly held in place.
6. thermal energy
7. Heat of fusion is the amount of energy required to change a substance from the solid phase to the liquid phase.

Assessment Transparency (page 53)

Heat and States of Matter

Section 3

Answers

1. **A.** Students need to refer to the diagram in order to identify the correct answer. Students must evaluate the setup in the diagram and then decide what is being tested.
   Choice A: Yes, the experiment is designed to show how different metals conduct thermal energy.
   Choice B: No, the diagram does not agree with this, since the wax on the copper rod is melting the fastest.
   Choice C: No, this is not true and is not supported by the experiment.
   Choice D: No, although this may be true, there is no indication that different kinds of wax are being used.
2. **J.** Students need to refer to the diagram in order to identify the correct answer. The diagram shows that the wax at the end of the copper rod is melting fastest.
3. **D.** Students need to know something about the properties of metals in order to identify the correct answer.

Test-Taking Tip

Remind students to carefully read all answers before deciding on a final answer.