Study Guide

Interactive Textbook

- Complete student edition
- Section and chapter self-assessment
- Assessment reports for teachers

Help Students Read

Building Vocabulary

Paraphrasing Have students rewrite the boldface sentences from Thermal Energy and States of Matter in their own words. Have the students use their rewritten statements when they review the section content.

Word/Part Analysis Tell students that the suffix *-tion* changes a verb into a noun. For example, the word *vaporize* means "to turn into a gas." The word *vaporization* thus means "the process of turning into a gas." Have students apply this concept to the words *evaporation* and *condensation.*

Connecting Concepts

Concept Maps Help students develop a concept map to show how the information in this chapter is related. Thermal energy, temperature, and heat are related to the energy in particles in matter, can be used to explain energy transfer and changes of state, and are applied in the design of heat engines and cooling systems. Have students brainstorm to identify the key concepts, key terms, details, and examples. Then, write each one on a self-sticking note and attach it at random on chart paper or on the board.

Tell students that this concept map will be organized in hierarchical order and to begin at the top with the key concepts. Ask students these questions to guide them to categorize the information on the self-sticking notes: **How are temperature, thermal energy, and heat related? What are the three ways in which heat is transferred? How does thermal energy relate to an object's state of matter? What are some common uses of heat?** Prompt students to use connecting words or phrases, such as "are related to," and "can be used to explain," to indicate the basis for the connections in the map. The phrases should form a sentence between or among a set of concepts.

Answer

Accept logical presentations by students.

Chapter Study Guide

1 Temperature, Thermal Energy, and Heat

Key Concepts

- The three common scales for measuring temperature are the Fahrenheit, Celsius, and Kelvin scales.
- Heat is thermal energy moving from a warmer object to a cooler object.
- A material with a high specific heat can absorb a great deal of thermal energy without a great change in temperature.
- Change in energy = Mass × Specific heat × Change in temperature

Key Terms

temperature
Fahrenheit scale
Celsius scale
Kelvin scale
absolute zero
heat
specific heat

2 The Transfer of Heat

Key Concepts

- Heat is transferred by conduction, convection, and radiation.
- If two objects have different temperatures, heat will flow from the warmer object to the colder one.
- A conductor transfers thermal energy well. An insulator does not transfer thermal energy well.

Key Terms

conduction
convection
convection current
radiation
conductor
insulator

3 Thermal Energy and States of Matter

Key Concepts

- Most matter on Earth can exist in three states—solid, liquid, and gas.
- Matter can change from one state to another when thermal energy is absorbed or released.
- As the thermal energy of a substance increases, its particles spread out and the substance expands.

Key Terms

state
change of state
melting
freezing
evaporation
boiling
condensation
thermal expansion

4 Uses of Heat

Key Concepts

- Heat engines transform thermal energy to mechanical energy.
- A refrigerator is a device that transfers thermal energy from inside the refrigerator to the room outside.

Key Terms

heat engine
external combustion engine
internal combustion engine
refrigerant

All in One Teaching Resources

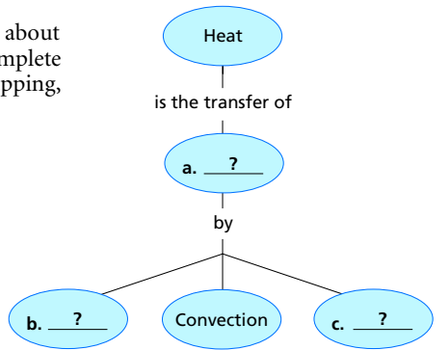
- Key Terms Review: *Thermal Energy and Heat*
- Connecting Concepts: *Thermal Energy and Heat*

Review and Assessment

Go Online PHSchool.com
For: Self-Assessment
Visit: PHSchool.com
Web Code: cga-3060

Organizing Information

Concept Mapping Copy the concept map about heat onto a separate sheet of paper. Then complete it and add a title. (For more on Concept Mapping, see the Skills Handbook.)



Reviewing Key Terms

Choose the letter of the best answer.

1. A measure of the average kinetic energy of the particles of an object is its
   a. heat.
   b. temperature.
   c. specific heat.
   d. thermal energy.
2. If you want to know the amount of heat needed to raise the temperature of 2 kg of steel by 10°C, you need to know steel's
   a. temperature. **b.** thermal energy.
   c. state. **d.** specific heat.
3. The process by which heat moves from one particle of matter to another without the movement of matter itself is called
   a. convection.
   b. conduction.
   c. radiation.
   d. thermal expansion.
4. Vaporization that occurs below the surface of a liquid is called
   a. evaporation. **b.** melting.
   c. boiling. **d.** freezing.
5. The process of burning a fuel is called
   a. combustion.
   b. thermal expansion.
   c. radiation.
   d. boiling.

If the statement is true, write *true*. If it is false, change the underlined word or words to make the statement true.

6. A temperature reading of zero on the Celsius scale is equal to absolute zero.
7. A convection current is a circular motion caused by the rising of heated fluid.
8. An insulator conducts heat well.
9. When a substance is freezing, the thermal energy of the substance decreases.
10. In an external combustion engine, the fuel is burned inside the engine.

Writing in Science

Proposed Solution You have been asked to design a bridge for an area that is quite hot in the summer and cold in the winter. Propose a design plan for the bridge. Include in your plan how expansion joints will help the bridge react in hot and cold temperatures.

Discovery Channel SCHOOL
Thermal Energy and Heat
Video Preview
Video Field Trip
Video Assessment

Go Online PHSchool.com
For: Self-Assessment
Visit: PHSchool.com
Web Code: cga-3060

Students can take a practice test online that is automatically scored.

All in One Teaching Resources

- Transparency M60
- Chapter Test
- Performance Assessment Teacher Notes
- Performance Assessment Student Worksheet
- Performance Assessment Scoring Rubric

ExamView® Computer Test Bank CD-ROM

Review and Assessment

Organizing Information

a. Thermal energy
b. Conduction or radiation
c. Radiation or conduction

Reviewing Key Terms

1. b **2.** d **3.** b **4.** c **5.** a
6. Kelvin scale
7. true
8. conductor
9. true
10. internal combustion engine

Discovery Channel SCHOOL Video Assessment

Thermal Energy and Heat

Show the Video Assessment to review chapter content and as a prompt for the writing assignment. Discussion questions: **What are the three ways in which heat is transferred?** *(The three ways in which heat is transferred are conduction, convection, and radiation.)* **How does heat transfer affect bridge structures?** *(Heat transfer affects bridge structures by causing expansion and contraction of the materials.)*

Writing in Science

Writing Mode Exposition/Problem-solution

Scoring Rubric

4 Exceeds criteria; includes a detailed plan and an extensive description of how the expansion joints will function
3 Meets criteria
2 Includes few details and/or some incorrect information
1 Fails to correctly explain how expansion joints are important to the bridge design

Review and Assessment

Checking Concepts

11. What happens to the particles of a solid as the thermal energy of the solid increases?

12. During a summer night, the air temperature drops by 10°C. Will the temperature of the water in a nearby lake change by the same amount? Explain why or why not.

13. When you heat a pot of water on the stove, a convection current is formed. Explain how this happens.

14. How can you add thermal energy to a substance without increasing its temperature?

15. When molten steel becomes solid, is energy absorbed or released by the steel? Explain.

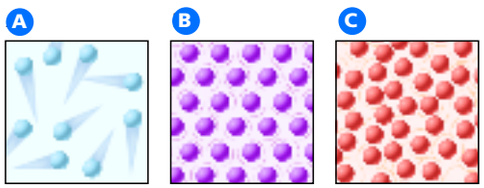
16. Describe how a thermostat controls the temperature in a building.

Thinking Critically

17. **Relating Cause and Effect** Why is the air pressure in a car's tires different before and after the car has been driven for an hour?

18. **Applying Concepts** When they are hung, telephone lines are allowed to sag. Can you think of a reason why?

19. **Interpreting Diagrams** The three illustrations below represent the molecules in three different materials. Which is a solid? A liquid? A gas?



20. **Developing Hypotheses** A refrigerator is running in a small room. The refrigerator door is open, but the room does not grow any cooler. Use the law of conservation of energy to explain why the temperature does not drop.

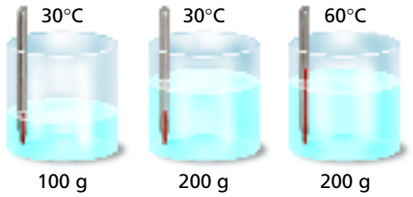
Math Practice

21. **Converting Units** A recipe says to preheat your oven to 275°F. What is this temperature in degrees Celsius?

22. **Converting Units** The temperature in a greenhouse is 86°F. Convert this temperature to degrees Celsius.

Applying Skills

Use the illustration of three containers of water to answer Questions 21–23.



23. **Interpreting Data** Compare the average motion of the molecules in the three containers. Explain your answer.

24. **Drawing Conclusions** Compare the total amount of thermal energy in the three containers. Explain your answer.

25. **Calculating** Which container would need the least amount of thermal energy to raise its temperature by 1 K? The specific heat of water is 4,180 J/(kg·K).

Lab zone Chapter Project

Performance Assessment Talk with your classmates about their container designs. When you've had a chance to look them over, predict the final water temperature for each container. Record the starting temperature for each one, including your own. Record the final temperatures at the end of each demonstration. Which insulating materials seemed to work the best? Describe how you could improve your container, based on what you learned.

Checking Concepts

11. The particles remain in fairly fixed positions until sufficient thermal energy has been absorbed to break down the solid's structure. At that point, melting takes place and the particles become freer to move around.

12. No. Air has a much lower specific heat than water. Loss of the same amount of thermal energy by the water will result in a smaller temperature drop.

13. The water near the heat source is warmed. The warm water expands and rises while cool water sinks to take its place. The circular flow is a convection current.

14. You could add more particles of the substance at the same temperature. Also, during some changes of state, thermal energy increases while temperature stays the same.

15. Thermal energy is released when a substance changes phase from a liquid to a solid.

16. The metals in a bimetallic strip inside the thermostat expand and contract by different amounts as the temperature changes. This causes the strip to curve, and allows it to control a switch connected to the heating or cooling system.

Thinking Critically

17. The air in the tires gets warmer as the car is driven. The increase in temperature causes the air particles to move faster and hit the inside of the tire with greater average force, which produces greater air pressure.

18. The lines expand in the summer and contract in the winter. If they did not sag, they would contract and pull away from the poles during cold winters.

19. Solid: B; liquid: C; gas: A

20. Inside the open refrigerator, the system is transferring thermal energy from the air to the refrigerant. Outside the open refrigerator, the system is transferring that same amount of thermal energy from the refrigerant back to the room.

Math Practice

21. 135°C

22. 30°C

Lab zone Chapter Project

L3

Performance Assessment Students' predictions should be based on what they have learned in the chapter. Students should explain how their experimental results affected their design and choice of materials. While the class is waiting for final temperatures, predictions can be posted. Ask students to explain the reasoning behind their predictions. Encourage students to compare their designs to the best-insulated design in the class.

Standardized Test Prep

Test-Taking Tip

Using Formulas

For some questions, you will need to use a formula to find the correct answer. It is important to know which formula to use. Look for key words in the question to help you decide which formula will help you answer the question. Then substitute the values provided to make your calculations.

Sample Question

The specific heat of iron is 450 J/(kg·K). How much heat must be transferred to 15 kg of iron to raise its temperature by 4.0 K?

A 450 J
B 2,700 J
C 5,400 J
D 27,000 J

Answer

The question deals with the amount of heat needed to change the temperature of a material. The specific heat of that material, iron, is provided. You need to use the formula for calculating thermal energy changes.

Change in energy =
Mass × Specific heat × Change in temperature

Change in energy = 15 kg × 450 J/(kg·K) × 4.0 K
Change in energy = 27,000 J

The correct answer is **D.**

Choose the letter of the best answer.

1. When cold, dry air passes over a much warmer body of water, a type of fog called sea smoke is produced. Which process explains why this occurs?
A melting
B condensation
C boiling
D freezing

2. The table below shows the specific heat of four metals. If 1,540 J of heat is transferred to 4 kg of each metal, which metal will increase in temperature by 1 K?

Specific Heat of Metals

Metal	Specific Heat (J/(kg·K))
Silver	235
Iron	450
Copper	385
Aluminum	903

F Silver
G Copper
H Iron
J Aluminum

3. A student wants to measure the temperature at which several different liquids freeze. In the student's experiment, temperature is the
A hypothesis.
B responding variable.
C manipulated variable.
D operational definition.

4. Two solid metal blocks are placed in a container. If there is a transfer of heat between the blocks, then they must have different
F boiling points.
G melting points.
H specific heats.
J temperatures.

5. A thermometer measures
A temperature.
B thermal energy.
C heat.
D specific heat.

Constructed Response

6. Explain how heat is transferred by conduction, convection, and radiation. Give an example of each.

Applying Skills

23. The average motion of the molecules is greater at higher temperatures. The average motion is the same for the two containers on the left and at the center, and greater for the container on the right.

24. The total thermal energy in the middle container is twice the thermal energy in the container on the left because it has twice as many particles at the same temperature. The thermal energy in the container on the right is greater than the middle container. It has the same number of particles, but the average energy of each particle is greater.

25. The left container would require the least amount of thermal energy (418 J) to raise its temperature by 1K because it has the least mass.

Standardized Test Prep

1. B **2.** G **3.** B **4.** J **5.** A

6. In conduction, heat is transferred from one particle to another without the movement of the matter itself. If you leave an iron poker in the fireplace while a fire is burning, the poker will get hot. This is an example of conduction. Convection is movement within a fluid that transfers heat. For example, when hot air rises, cool air descends to take its place. Hawks take advantage of convection to soar upward. In radiation, energy is transferred by electromagnetic waves. Matter is not required to transfer the energy. A microwave oven cooks food by radiation.