5 Thermal Energy

BIGIDEA

Write the Big Idea for this chapter.

Thermal energy is a form of energy that can be transferred as well as converted into other forms of energy.

Use the "What I Know" column to list the things you know about the Big Idea. Then list the questions you have about the Big Idea in the "What I Want to Find Out" column. As you read the chapter, fill in the "What I Learned" column.

K *What I Know*	W *What I Want to Find Out*	L *What I Learned*

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5 Thermal Energy

1 Temperature, Thermal Energy, and Heat

TEKS 4(A), 5(A)

MAIN IDEA

Write the Main Idea for this lesson.

The atoms and molecules that make up matter are in continuous, random motion.

REVIEW VOCABULARY

energy

Recall the definition of the Review Vocabulary term.

energy the ability to cause change or do work

NEW VOCABULARY

temperature

thermal energy

heat

specific heat

Use your book or a dictionary to define the following key terms.

temperature a measure of the average kinetic energy of the particles in an object

thermal energy the sum of the kinetic and potential energy of all the particles in an object

heat thermal energy that flows from something at a higher temperature to something at a lower temperature

specific heat the amount of heat needed to raise the temperature of 1 kg of a substance by 1˚C

ACADEMIC VOCABULARY

random

Look up the word *random* in a dictionary. Then use the definition to describe the phrase *random motion*.

random lacking a definite plan, purpose, or pattern

Random motion is motion with no pattern or predictability.

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1 Temperature, Thermal Energy, and Heat (continued)

Student Edition, pp. 138–141
Reading Essentials, pp. 74–77

Compare the motion of hot atoms or molecules to cold atoms or molecules.

Accept all reasonable responses. In a hot substance, they move very quickly. In a cool substance, they move more slowly.

Analyze how each of the three actions in the table increases the kinetic, potential, or total thermal energy of a substance.

Actions that Increase Thermal Energy	Explanation
raise the temperature of the object	increases the kinetic energy of the atoms or molecules
pull atoms or molecules that attract one another farther apart	increases the potential energy of the atoms or molecules
add mass to the object, without changing its temperature	more molecules at the same level of energy means more total energy in the object

Model the flow of heat from a hot object to a cold one. Show the heat flow and some particles in the hot and cold objects.

Accept all reasonable responses. Particles in a hot object should be shown as having more motion than particles in a cold object and the hot particles would be farther apart.

Compare and contrast what happens in a metal to what happens to a mass of water when each is heated.

Accept all reasonable responses. A metal heats up quickly because the electrons are already free to move faster when heat is added. In water, strong bonds between molecules must be broken before the molecules can move faster.

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1 Temperature, Thermal Energy, and Heat (continued)

Student Edition, pp. 141–143
Reading Essentials, pp. 77–78

GET IT? **Define** specific heat.

the amount of heat that is needed to raise the temperature of 1 kg of a substance by 1°C.

Evaluate the amount of thermal energy lost from a 0.5 kg glass casserole dish when it is placed in water. The dish's temperature changes from 110˚C to 50˚C.

Hints:
1. Start by writing the equation for the change in thermal energy of an object.
2. Find the specific heat for glass in the table in your book.

Energy lost by dish: $Q = m(T_f - T_i)C$

$= (0.5\ \text{kg})(110^\circ\text{C} - 50^\circ\text{C})[664\ \text{J/(kg} \cdot {}^\circ\text{C)}]$

$= 19{,}920\ \text{J}$

Sequence steps to use a calorimeter to find the specific heat of a material. Include steps for measurement and steps for calculation.
Accept all reasonable responses.

1. An object that has been heated is placed in a calorimeter.
2. It transfers heat to a known mass of water and the water heats up as the object cools until they are the same temperature.
3. The energy absorbed by the water can be calculated by measuring its temperature change. The thermal energy released by the object is the same as the thermal energy absorbed by the water.

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CONNECT IT

Describe 3 or 4 processes in nature or daily life that depend on the high specific heat of water.

Accept all reasonable responses. Water in the radiator of a car cools the engine. A cold glass of water brings relief on a hot day. A rubber bag filled with hot water provides heat to cold or sore feet for a long time. Oceans take a long time to heat up, then carry heat from the equator to cooler parts of the world.

1 Temperature, Thermal Energy, and Heat (continued)

REVIEW IT!

4. **MAIN**IDEA **Describe** how the motions of the particles that make up an object change when the object's temperature increases.

   The particles that make up an object move faster as that object's temperature increases.

5. **Describe** the energy transfer when you touch a block of ice with your hand.

   When you touch a block of ice with your hand, thermal energy is transferred from your hand to the block of ice.

6. **Infer** When one object heats another, does the temperature increase of one object always equal the temperature decrease of the other object? Explain.

   No, one object could have a greater specific heat than the other object.

7. **Explain** why water is often used as a coolant.

   Water has a high specific heat.

8. **Think Critically** Explain whether the following statement is true: For any two objects, the one with the higher temperature always has more thermal energy.

   False. Student explanations will vary. A cup of hot cocoa is at a higher temperature than a swimming pool. However, because the swimming pool has a much larger mass, the swimming pool has far more thermal energy.

9. **Estimate** the change in the thermal energy of water in a pond with a mass of 1,000 kg and a specific heat of 4,200 J/(kg · °C) if the water cools by 1°C.

   The water loses approximately 4 million J of thermal energy.

10. **Calculate** the specific heat of a metal if 0.3 kg of the metal absorb 9,000 J of heat as the metal warms by 10°C.

    3,000 J/(kg · °C)

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