

Assess Your Understanding

Temperature, Thermal Energy, and Heat

What Determines the Temperature of an Object?

got it?.....

I get it! Now I know that temperature is related to _____

I need extra help with _____

What Is Thermal Energy?

1a. LIST What are two factors that determine an object's thermal energy? _____

b. **CHALLENGE** Object A has less thermal energy than Object B, but heat flows from Object A to Object B. What conditions would make this possible? _____

got it?.....

I get it! Now I know that the thermal energy in an object is defined as _____

I need extra help with _____

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

Key Concept Summaries

Temperature, Thermal Energy, and Heat

What Determines the Temperature of an Object?

Temperature is a measure of how hot or cold something is with respect to a reference point. Matter is made up of tiny particles that are always moving, so these particles have kinetic energy. **Temperature is related to the average kinetic energy of the particles in an object.** As an object heats up, its particles move faster. As a result, both the average kinetic energy of the particles and the temperature increase.

scale is most common; water freezes at 32°F and boils at 212°F. Most other countries use the **Celsius** scale; water freezes at 0°C and boils at 100°F. Scientists usually use either the Celsius scale or the **Kelvin** scale. The Kelvin scale is divided into kelvins (K). A temperature change of 1 K is the same temperature change as 1°C. **Absolute zero** is the lowest temperature possible; it is 0 K. At absolute zero, the kinetic energy of individual particles is zero.

There are three common scales for measuring temperature. In the United States, the **Fahrenheit**

What Is Thermal Energy?

Temperature, thermal energy, and heat are closely related, but they are not the same thing. **Thermal energy is the total energy of all the particles in an object.** Thermal energy depends on the temperature of an object, the number of particles in the object, and how those particles are arranged. Thermal energy can transfer from one object to another; it always moves from a warmer object to a cooler object. The transfer of thermal energy is called **heat**. Heat is measured in the unit of energy—joules.

On a separate sheet of paper, compare and contrast melting 10 kg of ice with freezing 1 kg of water. Be sure to address temperature, heat flow, and thermal energy.

Lesson Quiz

Temperature, Thermal Energy, and Heat

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

1. _____ At the freezing point, the particles in an object have no kinetic energy.
2. _____ On the Celsius temperature scale, there are no negative numbers.
3. _____ The more particles an object has at a given temperature, the more thermal energy it has.
4. _____ Object A is much larger than Object B, but both are made of the same material. If both objects are at the same temperature, the thermal energy of Object A is the same as the thermal energy of Object B.
5. _____ When heat is absorbed by an object, the speed of the particles in the object is unchanged.

Fill in the blank to complete each statement.


6. The transfer of thermal energy from a warmer object to a cooler object is called _____.
7. _____ is a measure of the average kinetic energy of the individual particles in an object.
8. Most of the world uses the _____ temperature scale.
9. On the _____ temperature scale, water boils at 212°.
10. The amount of thermal energy in an object depends on its _____, the number of particles in it, and how those particles are arranged.

Assess Your Understanding

The Transfer of Heat

How Is Heat Transferred?

1a. **CLASSIFY** What type of heat transfer occurs when eggs cook in a hot pan? Before toasters, people toasted bread by holding it over a fire. What type of heat transfer occurred then? Name the third type of heat transfer and an example of food cooked by it. _____

b. **ANSWER**  How does heat flow from one object to another? _____

got it?

I get it! Now I know that the three methods of heat transfer are _____

I need extra help with _____

Key Concept Summary

The Transfer of Heat

How Is Heat Transferred?

Whenever the temperature of an object or substance changes, heat is being transferred. It travels only in one direction and by three different methods. **Heat is transferred from warmer areas to cooler areas by conduction, convection, and radiation.**

Conduction is the transfer of heat from one particle of matter to another without the matter moving. The fast-moving particles in a warm object collide with the slow-moving particles in a cooler object, and the particles in the cooler object speed up. Objects or particles must be in direct contact for conduction to occur.

Convection occurs only in fluids, such as water and air. As the fluid is heated, its particles speed up and move farther apart, so it becomes less dense and rises. Cooler fluid flows into its place, is also heated, and rises. Meanwhile, the previously heated fluid cools down, sinks, and the cycle repeats. This flow creates a circular motion called a **convection current**.

Radiation is the transfer of energy by electromagnetic waves. It is the only form of heat transfer that does not require matter. Energy from the sun travels through empty space to Earth in the form of radiation.

On a separate sheet of paper, explain all of the heat transfer that occurs when a pot of soup on a metal grill is heated over a campfire and gets close to boiling. Be sure to mention convection currents.

Lesson Quiz

The Transfer of Heat

Write the letter of the correct answer on the line at the left.

1. ____ Water bubbles up through a hot spring at Yellowstone National Park. What method of heat transfer is this?
A conduction
B convection
C radiation
D specific heat
2. ____ On a sunny day, you return to your car after a ball game. The inside of the car is very hot. How did the car get so warm?
A conduction
B convection
C radiation
D specific heat
3. ____ The inside window pane in your house feels very cold to touch on a winter night. Why does it feel cold?
A The cold from the outside is flowing in by convection.
B The warm from the inside is flowing out by convection.
C The cold from the outside is being conducted to the inside.
D The warm from the inside is being conducted to the outside.
4. ____ Malia burned herself when she picked up a hot iron skillet from the stove. What method of heat transfer caused the burn?
A conduction
B convection
C radiation
D specific heat

Fill in the blank to complete each statement.

5. Heat is transferred directly from one particle of matter to another by the process of _____.
6. A circular flow of warmer fluid and cooler fluid is called a(n) _____.
7. Heat is always transferred from _____ areas.
8. _____ is the transfer of energy by electromagnetic waves.
9. Heat that is transferred by the movement of currents within a fluid is called _____.
10. The only form of heat transfer that does not require matter is _____.

Assess Your Understanding

Thermal Properties

How Do Different Materials Respond to Heat?

1a. CLASSIFY Foam picnic coolers keep food cold on a hot day. Is foam a conductor or an insulator? Explain. _____

b. CALCULATE The specific heat of foam is about $1,200 \text{ J}/(\text{kg} \times \text{K})$. How much heat does it take to raise the temperature of 1 kg of foam by 2 K? _____

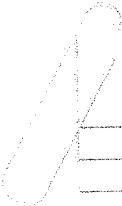
got it?

I get it! Now I know that the way a material responds to heat depends on _____

I need extra help with _____

Key Concept Summaries

Thermal Properties



How Do Different Materials Respond to Heat?

The thermal properties of an object determine how it will respond to heat. **Some materials conduct heat well, while other materials do not.** A material that conducts heat well is called a **conductor**; most metals are conductors. **Insulators** are materials that do not conduct heat well; some good insulators are air and wool.

specific heat. It is measured in joules per kilogram-kelvin, or J/(kg·K). A material with high specific heat can absorb a great deal of thermal energy without a great change in temperature. There is a formula for calculating thermal energy change.

$$\text{Energy Change} = \text{Mass} \times \text{Specific Heat} \times \text{Temperature Change}$$

When an object is heated, its temperature rises. But the temperature does not rise at the same rate for all objects. **To change the temperature of different objects by the same amount, different amounts of thermal energy are required.** The amount of energy required to raise the temperature of 1 kilogram of a material by 1 kelvin is called its

As the thermal energy of matter increases, its particles usually spread out, causing the substance to expand. The expanding of matter when it is heated is known as **thermal expansion.** When matter is cooled, it usually contracts. Different materials expand and contract at different rates.

On a separate sheet of paper, explain why when you have a metal lid stuck tightly on a glass jar, holding the sealed jar under a stream of hot water will often help loosen the lid. In your explanation, discuss heat conduction, specific heat, thermal energy, and thermal expansion.

Lesson Quiz

Thermal Properties

Fill in the blank to complete each statement.

1. A material with a(n) _____ specific heat can absorb a great deal of thermal energy without a great change in temperature.
2. As the thermal energy of matter _____, its particles usually spread out.
3. If two objects of the same mass require different amounts of heat to raise their temperatures 10 kelvin, the objects have different _____.
4. To keep food warm or cool, coolers are made out of materials that are _____.
5. Water has a specific heat of $4,186 \text{ J}/(\text{kg}\cdot\text{K})$. To raise the temperature of a bathtub of water (220 kg) by 3 kelvin, it takes _____ Joules of energy.

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

6. _____ Specific heat is measured in joules.
7. _____ Most metals are good conductors of heat.
8. _____ The amount of energy required to raise 1 kg of material by 1 kelvin is called thermal energy.
9. _____ On a hot summer day, a metal door in a wood frame may stick and be hard to open due to specific heat.
10. _____ Insulators do not conduct heat well.