Our goal is to gather background information through a reading on heat and how it moves.

reading from the glencoe textbook new york science- grade 6

weather watch

investigation 4 – heat transfer

name _____ class ___

team ___ seat ___ date ___

Glencoe Science

section 2

PS 4.2a: Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature. Also covered: 4.2b.

Heat

What You'll Learn

- **Explain** the difference between thermal energy and heat.
- **Describe** three ways heat is transferred.
- **Identify** materials that are insulators or conductors.

Why It's Important

To keep you comfortable, the flow of heat into and out of your house must be controlled.

Review Vocabulary

electromagnetic wave: a wave produced by vibrating electric charges that can travel in matter and empty space

New Vocabulary

- heat
- conduction
- radiation
- convection
- conductor
- specific heat
- thermal pollution

Heat and Thermal Energy

It's the heat of the day. Heat the oven to 375°F. A heat wave has hit the Midwest. You've often heard the word *heat*, but what is it? Is it something you can see? Can an object have heat? Is heat anything like thermal energy? **Heat** is thermal energy that is transferred from one object to another when the objects are at different temperatures. The amount of heat that is transferred when two objects are brought into contact depends on the difference in temperature between the objects.

For example, no heat is transferred when two pots of boiling water are touching, because the water in both pots is at the same temperature. However, heat is transferred from the pot of hot water in **Figure 5** that is touching a pot of cold water. The hot water cools down and the cold water gets hotter. Heat continues to be transferred until both objects are the same temperature.

Transfer of Heat When heat is transferred, thermal energy always moves from warmer to cooler objects. Heat never flows from a cooler object to a warmer object. The warmer object loses thermal energy and becomes cooler as the cooler object gains thermal energy and becomes warmer. This process of heat transfer can occur in three ways—by conduction, radiation, or convection.

Figure 5 Heat is transferred only when two objects are at different temperatures. Heat always moves from the warmer object to the cooler object.

Conduction

When you eat hot pizza, you experience conduction. As the hot pizza touches your mouth, heat moves from the pizza to your mouth. This transfer of heat by direct contact is called conduction. **Conduction** occurs when the particles in a material collide with neighboring particles.

Imagine holding an ice cube in your hand, as in **Figure 6.** The faster-moving molecules in your warm hand bump against the slower-moving molecules in the cold ice. In these collisions, energy is passed from molecule to molecule. Heat flows from your warmer hand to the colder ice, and the slow-moving molecules in the ice move faster. As a result, the ice becomes warmer and its temperature increases. Molecules in your hand move more slowly as they lose thermal energy, and your hand becomes cooler.

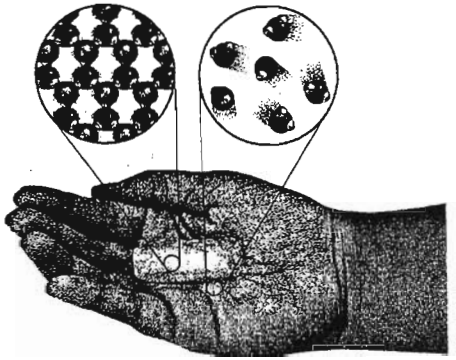

Figure 6 An ice cube in your hand melts because of conduction. The solid ice melts, becoming liquid water. Molecules in the water move faster than molecules in the ice.
Explain *how the thermal energy of the ice cube changes.*

Conduction usually occurs most easily in solids and liquids, where atoms and molecules are close together. Then atoms and molecules need to move only a short distance before they bump into one another and transfer energy. As a result, heat is transferred more rapidly by conduction in solids and liquids than in gases.

Reading Check *Why does conduction occur more easily in solids and liquids than in gases?*

Radiation

On a beautiful, clear day, you walk outside and notice the warmth of the Sun. You know that the Sun heats Earth, but how does this transfer of thermal energy occur? Heat transfer does not occur by conduction because almost no matter exists between the Sun and Earth. Instead, heat is transferred from the Sun to Earth by radiation. Heat transfer by **radiation** occurs when energy is transferred by electromagnetic waves. These waves carry energy through empty space, as well as through matter. The transfer of thermal energy by radiation can occur in empty space, as well as in solids, liquids, and gases.

The Sun is not the only source of radiation. All objects emit electromagnetic radiation, although warm objects emit more radiation than cool objects. The warmth you feel when you sit next to a fireplace is due to heat transferred by radiation from the fire to your skin.

Physical Setting

4.2a, 4.2b: Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature. **Explain** how this statement is true for conduction, radiation, and convection. Provide examples to support your responses.

bob Standard S5f, S7c, S7e

Thermal Conductors

Why are cooking pans usually made of metal? Why does the handle of a metal spoon in a bowl of hot soup become warm? The answer to both questions is that metal is a good conductor. A **conductor** is any material that easily transfers heat. Some materials are good conductors because of the types of atoms or chemical compounds they are made up of.

Reading Check *What is a conductor?*

Remember that an atom has a nucleus surrounded by one or more electrons. Certain materials, such as metals, have some electrons that are not held tightly by the nucleus and are freer to move around. These loosely held electrons can bump into other atoms and help transfer thermal energy. The best conductors of heat are metals such as gold and copper.

Thermal Insulators

If you're cooking food, you want the pan to conduct heat easily from the stove to your food, but you do not want the heat to move easily to the handle of the pan. An insulator is a material in which heat doesn't flow easily. Most pans have handles that are made from insulators. Liquids and gases are usually better insulators than solids are. Air is a good insulator, and many insulating materials contain air spaces that reduce the transfer of heat by conduction within the material. Materials that are good conductors, such as metals, are poor insulators, and poor conductors are good insulators.

Houses and buildings are made with insulating materials to reduce heat conduction between the inside and outside. Fluffy insulation like that shown in **Figure 9** is put in the walls. Some windows have double layers of glass that sandwich a layer of air or other insulating gas. This reduces the outward flow of heat in the winter and the inward flow of heat in the summer.

Heat Absorption

On a hot day, you can walk barefoot across the lawn, but the asphalt pavement of a street is too hot to walk on. Why is the pavement hotter than the grass? The change in temperature of an object as it absorbs heat depends on the material it is made of.

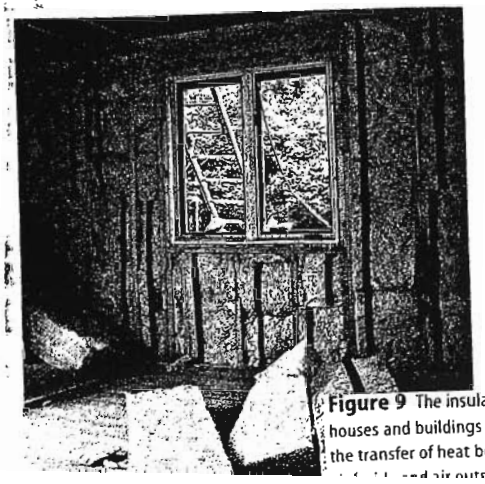

Figure 9 The insulation in houses and buildings helps reduce the transfer of heat between the

Specific Heat The amount of heat needed to change the temperature of a substance is related to its specific heat. The **specific heat** of a substance is the amount of heat needed to raise the temperature of 1 kg of that substance by 1°C.

More heat is needed to change the temperature of a material with a high specific heat than one with a low specific heat. For example, the sand on a beach has a lower specific heat than water. When you're at the beach during the day, the sand feels much warmer than the water does. Radiation from the Sun warms the sand and the water. Because of its lower specific heat, the sand heats up faster than the water. At night, however, the sand feels cool and the water feels warmer. The temperature of the water changes more slowly than the temperature of the sand as they both lose thermal energy to the cooler night air.

What is heat?

What is specific heat?

compare conduction and radiation

specific to conduction	They are similar in these ways	specific to radiation

Why does conduction occur more easily in solids and liquids than in gases?

bob