

# Heat Transfer

## **Heat Energy**

Particles that make up substances are always moving and always have energy. This energy can be transferred from one object to another by three means—*conduction*, *convection*, and *radiation*.

There is a difference between heat and temperature. *Heat* is the energy that the object has because the particles are moving. *Temperature* is a way of measuring heat energy. Two scales that are commonly used to measure heat are the *metric system* and the *standard system*. The metric system uses *Celsius* and the standard system uses *Fahrenheit* to measure heat. The measurement of temperature gives the average amount of energy contained in the substance.

Heat always travels from hotter to cooler objects. It may seem that when you are holding an ice cube, the ice cube is causing your hand to feel colder. However, the real physics behind this heat transference is that the feeling of coldness in your hand is caused by the heat flowing away from your hand and into the ice cube. The energy from the faster moving (hotter) particles transfer to the slower moving (colder) particles. The transfer of energy goes on until all the particles in both objects are all moving at about the same speed. When the amount of heat energy of each object is the same, both objects will have the same temperature.

## **Conduction**

When two objects come into contact with each other, the heat energy moves between them because the particles in one object collide with the particles in the other object. Transferred heat resulting from the collision of particles is call *conduction*.

Conduction works best through solids. In a hot solid touching a cold solid, fast-moving particles touch slow-moving particles and the heat is transferred. This causes slower particles to speed up and faster particles to slow down. You can demonstrate this by rubbing your hands together very fast for 30 seconds. Now touch them to your ears. Can you feel the heat transfer from your hands to your ears? As your ears warm, your hands will cool until the particles in each are moving at the same speed.

Examples of everyday conduction heat transfer are frying an egg, making pancakes on a grill, boiling water in a pan on the stove, ironing a shirt, walking on pavement in the summertime, curling your hair with a curling iron, and a person sitting down on a chair making the chair warm.

## **Convection**

Heat energy transferred by the movement of a liquid or gas is called *convection*. When particles are heated, they move faster, move apart from each other (expand), become less dense (lighter in weight) and the particles rise. As the heated substance rises, the cooler, heavier substance moves down. As a liquid or gas cools, the particles move slower, move in toward each other (contract), become more dense (heavier in weight) and the particles sink. These currents exchange heat through this movement.

This movement of heating, expanding, cooling, contracting, and sinking is a continuous one. An example is to observe the amount of wind in the early morning compared to the afternoon. As air heats up during the day, the hot air rises. Cold air is heavy and comes in and takes the place of the rising hot air and causes wind. Wind is an example of convection process in motion.

You can observe convection in a simple experiment. Get two baby food jars. Fill one with hot water and a drop of red food coloring. Fill the other with cold water and a drop of blue food coloring. Place a card over the mouth of the cold water jar and turn it upside down on the top of the warm water jar. Carefully pull out the card. You should see warm, red water rising and cold blue water sinking.

Examples of everyday convection heat transfer are hot air balloons, air currents, ocean currents, continental drift, hot air near the ceiling and the cooler air near the floor, a pinwheel over a heating unit, convection ovens for better cooking, dust devils, and even tornadoes.

## **Radiation**

Conduction and convection need a medium to transfer heat energy. However, radiation does not. *Radiation* uses electromagnetic waves such as ultraviolet, visible, infrared, and microwaves to move. These invisible waves carry energy through empty space, as well as through solids, liquids, and gases. All objects give off electromagnetic radiation, which means warm object emit more radiation than cool objects.

The heat from we receive from the Sun is radiant heat. This radiant heat travels as waves through space. Heat waves hit Earth and cause warming. Your house gets warms when the Sun's waves travel through the windows and walls. This heat gets trapped warming it up inside.

Examples of everyday radiation heat transfer are feeling the warmth of a fire while roasting marshmallows, heat going though the sides of you car or house to make it extremely hot inside, a toaster, space heater, radiator, microwave oven, and anything that you are standing next to, but not touching, where you can feel the heat from that object.