SECTION 1

Temperature and Thermal Equilibrium

SECTION OBJECTIVES

- **Relate temperature to the kinetic energy of atoms and molecules.**
- **Describe the changes in the temperatures of two objects reaching thermal equilibrium.**
- **Identify the various temperature scales, and convert from one scale to another.**

DEFINING TEMPERATURE

When you hold a glass of lemonade with ice, such as that shown in **Figure 1,** you feel a sharp sensation in your hand that we describe as "cold." Likewise, you experience a "hot" feeling when you touch a cup of hot chocolate. We often associate temperature with how hot or cold an object feels when we touch it. Our sense of touch serves as a qualitative indicator of temperature. However, this sensation of hot or cold also depends on the temperature of the skin and therefore can be misleading. The same object may feel warm or cool, depending on the properties of the object and on the conditions of your body.

Determining an object's temperature with precision requires a standard definition of temperature and a procedure for making measurements that establish how "hot" or "cold" objects are.

Figure 1
Objects at low temperatures feel cold to the touch, while objects at high temperatures feel hot. However, the sensation of hot and cold can be misleading.

Adding or removing energy usually changes temperature

Consider what happens when you use an electric range to cook food. By turning the dial that controls the electric current delivered to the heating element, you can adjust the element's temperature. As the current is increased, the temperature of the element increases. Similarly, as the current is reduced, the temperature of the element decreases. In general, energy must be either added to or removed from a substance to change its temperature.

Quick Lab

Sensing Temperature

MATERIALS LIST

- **3 identical basins**
- **hot and cold tap water**
- **ice**

SAFETY

Use only hot tap water. The temperature of the hot water must not exceed 50°C (122°F).

Fill one basin with hot tap water. Fill another with cold tap water, and add ice until about one-third of the mixture is ice. Fill the third basin with an equal mixture of hot and cold tap water.

Place your left hand in the hot water and your right hand in the cold water for 15 s. Then place both hands in the basin of lukewarm water for 15 s. Describe whether the water feels hot or cold to either of your hands.