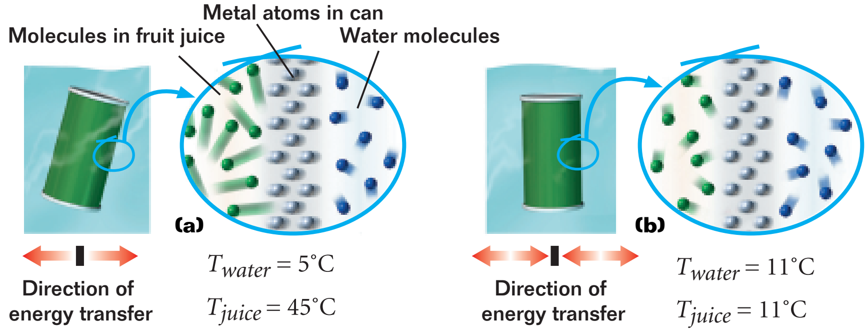

Figure 8
Energy is transferred as heat from the higher-energy particles to lower-energy particles **(a).** The net energy transferred is zero when thermal equilibrium is reached **(b).**

The direction in which energy travels as heat can be explained at the atomic level. Consider a warm can of fruit juice in ice water. At first, the molecules in the fruit juice have a higher average kinetic energy than do the water molecules that surround the can, as shown in **Figure 8(a).** This energy is transferred from the juice to the can by the juice molecules colliding with the metal atoms of the can. The atoms vibrate more because of their increased energy. This energy is then transferred to the surrounding water molecules, as shown in **Figure 8(b).**

As the energy of the water molecules gradually increases, the energy of the fruit juice's molecules and of the can's atoms decreases until all of the particles have, on the average, equal kinetic energies. In individual collisions, energy may be transferred from the lower-energy water molecules to the higher-energy metal atoms and fruit juice particles. That is, energy can be transferred in either direction. However, because the average kinetic energy of particles is higher in the object at higher temperature, more energy moves out of the object as heat than moves into it. Thus, the net transfer of energy as heat is in only one direction.

The transfer of energy as heat alters an object's temperature

Thermal equilibrium may be understood in terms of energy exchange between two objects at equal temperature. When the can of fruit juice and the surrounding water are at the same temperature, as depicted in **Figure 9,** the quantity of energy transferred from the can of fruit juice to the water is the same as the energy transferred from the water to the can of juice. The net energy transferred between the two objects is zero.

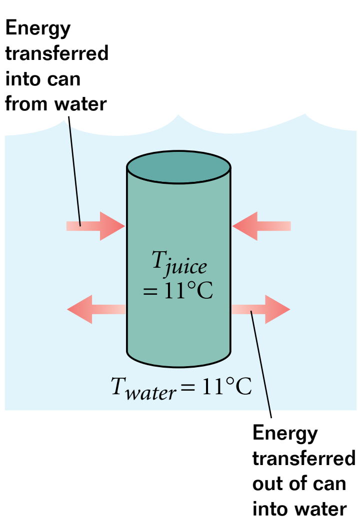

Figure 9
At thermal equilibrium, the net energy exchanged between two objects equals zero.

This reveals the difference between temperature and heat. The atoms of all objects are in continuous motion, so all objects have some internal energy. Because temperature is a measure of that energy, all objects have some temperature. Heat, on the other hand, is the energy transferred from one object to another because of the temperature difference between them. When there is no temperature difference between a substance and its surroundings, no net energy is transferred as heat.

Energy transfer as heat depends on the difference of the temperatures of the two objects. The greater the temperature difference is between two objects, the greater the rate of energy transfer between them as heat (other factors being the same).