Heat and Thermal Energy

Suppose you place an ice cube in a bowl on a table. At first, the bowl and the ice cube have different temperatures. However, the ice cube melts, and the water that comes from the ice will eventually have the same temperature as the bowl. This temperature will be lower than the original temperature of the bowl but higher than the original temperature of the ice cube. The water and the bowl end up at the same temperature because the particles in the ice cube and the particles in the bowl continually bump into each other and energy is transferred from the bowl to the ice.

Heat is always the transfer of energy from an object at a higher temperature to an object at a lower temperature. So energy flows from the particles in the warmer bowl to the particles in the cold ice and, later, the cooler water. If energy flowed in the opposite direction—from cooler to warmer—the ice would get colder and the bowl would get hotter, and you know that never happens.

In which direction does heat always transfer energy?

When energy flows from a warmer object to a cooler object, the thermal energy of both of the objects changes. Thermal energy is the total random kinetic energy of particles in an object. Note that temperature and thermal energy are different from each other. Temperature is an average and thermal energy is a total. A glass of water can have the same temperature as Lake Superior, but the lake has far more thermal energy because the lake contains many more water molecules.

Another example of how energy is transferred through heat is shown on the right. Soon after you put ice cubes into a pitcher of lemonade, energy is transferred from the warmer lemonade to the colder ice. The lemonade’s thermal energy decreases and the ice’s thermal energy increases. Because the particles in the lemonade have transferred some of their energy to the particles in the ice, the average kinetic energy of the particles in the lemonade decreases. As a result, the temperature of the lemonade decreases.

How are heat and thermal energy related to each other?