Section 1: Temperature, Thermal Energy, and Heat

CHAPTER 5

MAINIDEA

The atoms and molecules that make up matter are in continuous, random motion.

Essential Questions

- What is temperature?
- How are thermal energy and temperature related?
- What is the difference between thermal energy and heat?
- How can you calculate changes in thermal energy?

Temperature

Matter in Motion

Matter in Motion

Matter is made of tiny particles—atoms and molecules.

- Particles are in constant, random motion
- Faster = More KINETIC energy
- Particles in hot objects move faster than cooler objects.

Temperature

Temperature

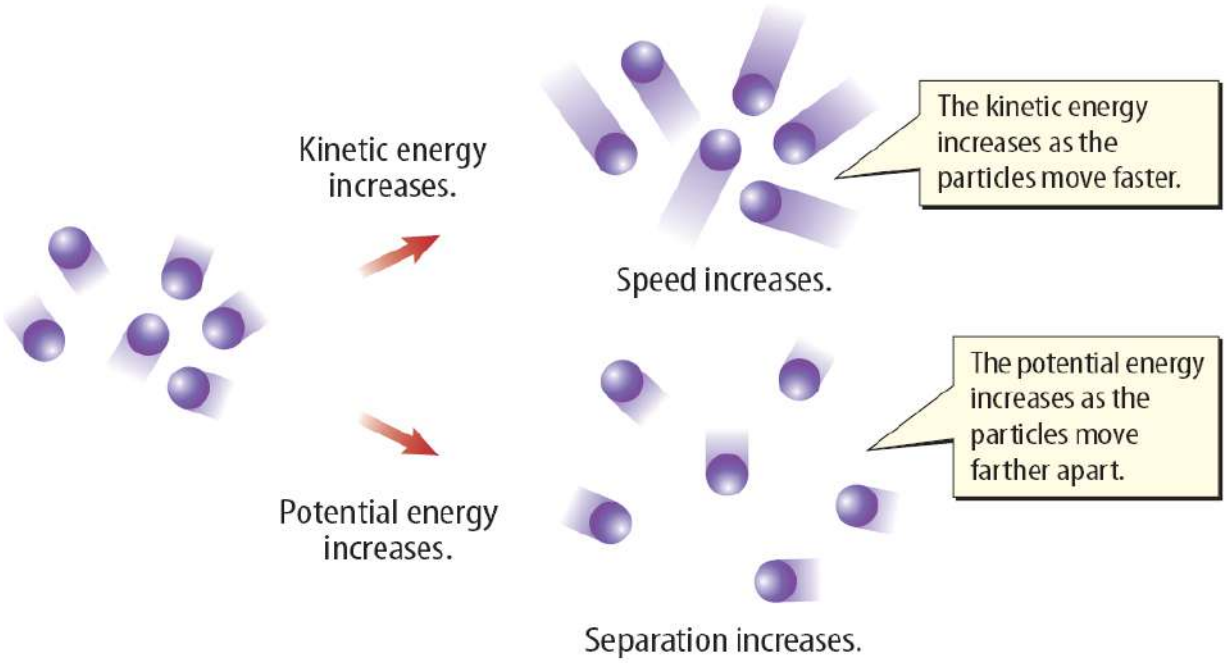
The **temperature** of an object is a measure of the average kinetic energy of the particles that make up that object.

- temperature of an object increases = average speed of the particles increases.
- In SI units, temperature is measured in kelvins (K).
- Celsius scale more common
- One kelvin = one degree Celsius.

Thermal Energy

Thermal Energy

Kinetic energy + potential energy of an object = **thermal energy** of that object.



Thermal Energy and Temperature

Thermal Energy and Temperature

- Thermal energy of the object increases when the average kinetic energy of its particles increases.

Heat

Heat

Heat is thermal energy transferred from something at a higher temperature to something at a lower temperature.

- **Heat** is a ***transfer*** of **energy**

Specific Heat

Specific Heat

…is the amount of heat needed to raise the temperature of 1 kg of a substance by 1°C

As a substance absorbs thermal energy, temperature change depends on

- nature of the substance
- amount of thermal energy added.

Water as Coolant

Water as Coolant

A coolant is a substance that is used to absorb thermal energy.

Water can absorb thermal energy without a large change in temperature

- Compared with the other common materials in the table, water has the highest specific heat.
- The specific heat of water is high because water molecules are strongly attracted to each other.

Table 1 Comparison of Specific Heats*

Substance	Specific Heat [J/(kg • °C)]
Water	4,200
Wood	1,700
Sand	830
Carbon (graphite)	710
Iron	450

*Values have been rounded.

Changes in Thermal Energy

The thermal energy of an object changes when thermal energy is transferred into or out of the object.

- If Q is the change in thermal energy and C is specific heat, the change in thermal energy can be calculated from the following equation:

Thermal Energy Equation

change in thermal energy (J) =

mass (kg) · **temperature change**(°C) · **specific heat** $\left(\frac{\text{J}}{\text{kg} \cdot \text{°C}}\right)$

$$Q = m(T_f - T_i)C$$

Measuring Specific Heat

Measuring Specific Heat

The specific heat of a material can be measured using a device called a calorimeter.