

Thermal Energy

We have discussed kinetic energy at great length. Kinetic energy is energy associated with motion.

See example in the book: When you move a baked potato from the oven to a plate on the kitchen countertop, the potato



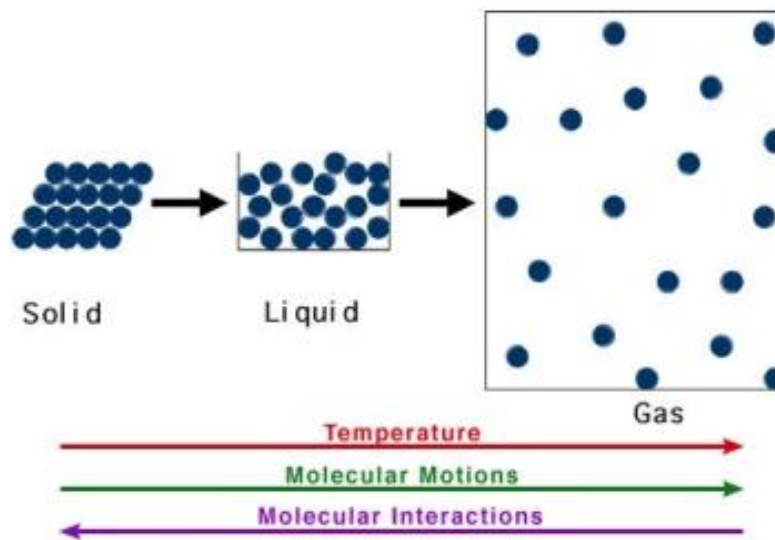
has kinetic energy because it is moving.

However, once you set the potato down on the plate, it still has kinetic energy inside of it. The molecules and atoms that make up the potato are always in motion. Each moving atom has a certain amount of kinetic energy. This energy is **Thermal Energy**.

Thermal Energy is the total of all the kinetic & potential energy of the atoms in an object.

When any object gets hotter, the kinetic energy of the molecules of the object increases. This increase in movement/kinetic energy of the molecules increases the object's thermal energy.

Let's look at solids, liquids, and gases to illustrate this concept of moving molecules and thermal energy.



When H_2O is a **solid**, it is ice. The molecules are tightly packed. The bonds between the molecules are close. There is very little movement/kinetic energy within the atoms.

When ice melts into **liquid** water, the temperature has increased (IT HAS GAINED THERMAL ENERGY) and the molecules are moving more. They spread out more and the bonds between them are not as tight.

When water is heated (IT HAS GAINED THERMAL ENERGY), it can evaporate into a **gas**. The molecules become very agitated. The movement/kinetic energy of the atoms is frantic. The molecules spread out.

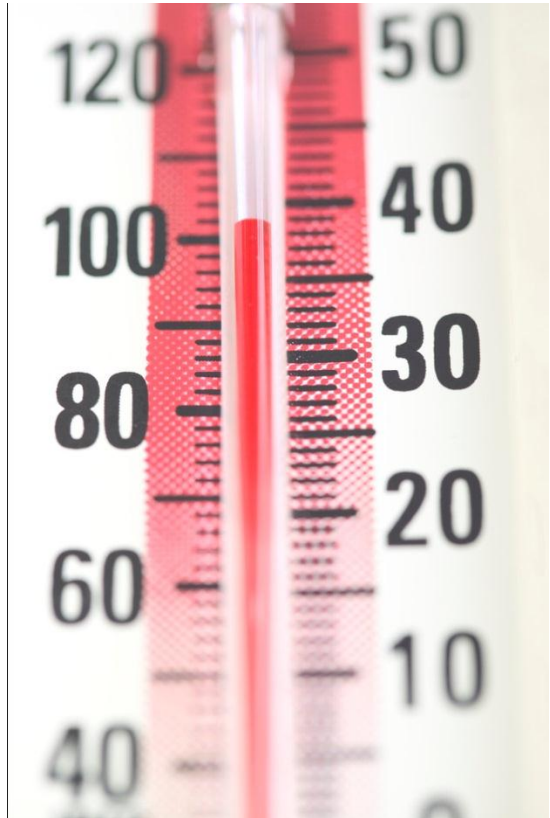
**In which substance do the particles move the fastest?
Ice? Hot Chocolate? Apple Juice? Why?**

Let's look at the pictures on pages 462-463.

Temperature is a measure of thermal energy.

Temperature is measured with a thermometer.

Most thermometers contain a liquid, such as mercury or alcohol. As thermal energy increases, there is heat. This causes the molecules in the liquid to move more and spread out. The liquid expands up the tube in response.



CRITICAL THINKING

QUESTIONS: What is the difference between thermal energy and temperature? _____

_____.

How are water molecules different at 10° C and 40°C?

_____.

Heat Transfer

- Thermal energy flows between materials that have different temperatures.
- Think about stepping into a warm bath. Your body gets warmer. Think about holding an ice cube. Your hands get colder.

Thermal energy naturally flows from **WARMER** substances to **COOLER** ones. When people refer to the transfer of thermal energy, they often use the word **HEAT**.


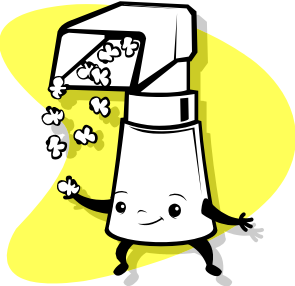
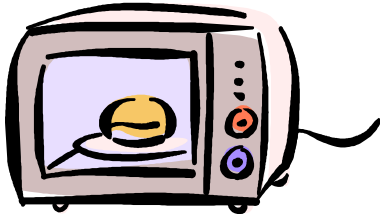
There are three main ways that heat can move:

- *Conduction*
- *Convection*
- *Radiation*

When something increases its temperature, its particles increase their kinetic energy. Some of this kinetic energy can be passed on to other particles.

Kinetic energy of the fast-moving particles in the warmer object transfers some of their energy to the slower-moving particles of the cooler object. The temperature of the warm object decreases↓ as the temperature of the cool object increases↑.

THE HEAT OR THERMAL ENERGY FLOWS UNTIL THE OBJECTS HAVE THE SAME TEMPERATURE.

Conduction	Convection	Radiation
The flow of heat of heat between objects that are touching.	The movement of warm liquids or gases to cooler areas.	Movement of energy by electromagnetic waves.
Heat from a stove warms a pan.	Warm water currents heat other water in the fish tank.	Radiation from the sun heats a greenhouse or solar panels.
 Popcorn	 Popcorn	 Popcorn