



Answer the following questions based on the pictures above:

1. One way that bees control the temperature in their hive is by beating their wings vigorously. Explain what happens to:
 - a. The motion of the air particles in the hive.
 - b. The air temperature in the hive.
2. In a famous experiment, James Joule observed the temperature of water as he stirred it vigorously with a mechanical mixer. Explain what happened to:
 - a. The motion of the water.
 - b. The water temperature.
3. To start a fire, early people used a fire drill to twirl a stick pressed against a piece of wood.
 - a. What happened to the temperature at the pointed end of the drill?
 - b. What do you think caused the particles of wood to change temperature?

Review – Particle Theory

All matter is made of tiny particles that are in constant motion. Based on the discussion from above we can see that the more motion there is, the higher the temperature will be. The lower the temperature is, the less motion there would be.

Temperature and Thermal Energy

Temperature is the average kinetic energy of the particles in a substance.

Thermal energy is the total kinetic energy of the particles in a substance.

Because particles are so tiny, they are impossible to see. Their size also makes it impossible to track movement and energy of any individual particle. In any one substance the movement will vary from particle to particle. For this reason, scientists use temperature and thermal energy when looking at experimental data and discussing results.

Compare

If you think of 10-pin bowling, the bowler rolls the ball towards the stationary pins. At the moment of impact the kinetic energy from the ball is transferred to the pins. Some of the pins will move very quickly, and travel quite far, while others may only move slightly if they move at all. By watching the pins you would see overall how much movement was produced. If the ball is rolled hard, most likely there is a lot of overall movement. If the ball is rolled very gently, most likely there is not a lot of overall movement.

In this scenario:

The ball represents a substance at a high temperature (a lot of kinetic energy)

The pins represent a substance at a low temperature (low kinetic energy)

The impact represents heat (the transfer of energy due to temperature difference)

The overall movement of the pins represents the thermal energy (total kinetic energy)

What is energy?

Energy is not matter. You can not weigh energy, energy does not take up space. Energy is a quality of an object that gives it the ability to move, do work or cause change. Energy is measured in Joules. The quantity of energy determines how much movement, work or change can be made.

A mug of water can be heated easily to make hot chocolate, only a small amount of thermal energy is required. The heat transferred from a glass of ice tea to a few ice cubes is enough to keep the drink cool. Large scale heating and cooling is not as easy. It takes an enormous amount of heat to change the temperature of a lake, and once the lake has that thermal energy, it would take a long time for it to be released. This thought may be related to global warming. The Earth is absorbing extreme amounts of thermal energy, and storing all of that thermal energy is causing drastic changes to the world.

One of the most important laws of physics and nature is:

Energy cannot be created or destroyed. It can only be transformed from one type to another, or passed between objects.

Thermal Pollution and Cogeneration

Not all transfer of energy can be controlled. In vehicles the fuel is meant to be transferred into kinetic energy of the car, however only 25% of that chemical energy goes towards propelling the vehicle, the other 75% is lost to heat, sound and light, all of which end up heating the air surrounding the car. The same scenario occurs when buildings are heated or when factories produce goods. All of this heat is known as "*Thermal Pollution*" – *accidental warming of the environment*.

One thing that is being done to help reduce the affects of thermal pollution is what is called cogeneration. Cogeneration is the act of using waste heat, from one process, to work to the advantage of another process. For example, the cooling water used in industrial machinery on a factory floor can be used to provide heat to the furnace system in a joining office building.