Heat Energy

Heat energy is given off when the molecules in a substance vibrate:

Internal energy is all of the energy belonging to a system while it is stationary.

Thermal energy is portion of internal energy that changes when the temperature of system changes. Thermal energy transfer is the transfer of thermal energy caused by a temperature difference between the system and its surroundings. Heat is used to mean both.

Calorie – amount of heat necessary to raise the temperature of 1 g of water one degree Celsius.

$$1 \text{ cal} = 4.186 \text{ J}$$

Example: ret hot poker, the molecules are vibrating at the end of the poker, which can be seen through the red glow. If you hold the poker in a fire, the heat spreads higher and higher up the poker – temperature of the metal in your hand increases. Thermal energy reaches your hand through conduction. Initially: before the rod is inserted into the flame, the metal atoms and electrons are vibrating about their equilibrium positions. As the flame heats the rod, those atoms and electrons near the flame begin to vibrate with larger and larger amplitudes. These, in turn, collide with their neighbors and transfer some of their energy in collision. Slowly, metal atoms and electrons farther down the rod increase their amplitude of vibration, until the vibrations arrive at the end being held – effect of increased vibration is increase in temperature.

Metals are good conductors of thermal energy because they contain large numbers of electron that are relatively free to move through the metal and can transport energy from one region to another.

Plastics are back because they have complicated molecules which cannot move easily so heat travels slowly through them.

Thermal energy transfer can be viewed on an atomic scale as an exchange of kinetic energy between molecules, where the less energetic particles gain energy by colliding with the more energetic particles - **conduction**

Convection currents thermal energy transferred by the movement of a heated substance: heater. Warm air from the convector heater rises to replace the colder air above. The colder air settles in turn to be heated and then rise – the air directly above the flame is heated and expands, as a result the density of the air decreases and the air rises. Movement results from differences in density (natural convection), heat substance is force to move by fan or pump (hot-air/hot-water heating system) called forced convection.

Ex. 1) As water is heated in teakettle, the lower layers are warmed first. These heated regions expand and rise to the top because their density is lowered. The denser cool water replaces the warm water at the bottom of the kettle that it can be heated.

2) Radiator: the radiator warms the air in the lower regions of the room. The warm air expands the rises to the ceiling because of its lower density. The denser regions of cooler air form above replace the warm air, setting up the continuous air current pattern.

Radiation heat travels directly through the air, it hits and warms objects in its path

All objects radiate energy continuously in the from of electromagnetic waves (rays of heat energy) which are usually infrared. Don't notice it unless the object is really hot.

Example: radiant energy from the Sun affects our existence in number of ways. It influences the Earth's average temperature, ocean currents, agriculture, rain patterns, and so on. If there is a cloud cover above the Earth, the water vapor in the clouds reflects back a part of the infrared radiation emitted by the Earth and temperature remains at moderate levels. In the absence of this cloud cover, there is nothing to prevent this radiation from escaping into space, thus temperature drops more on a clear night than when it is cloudy.

Solid has definite volume and shape

Molecules can vibrate but cannot move from basic position, they are tightly packed together

Liquid has definite volume but takes up the shape of its container

The molecules are free to move around, but are still fairly tightly packed together

Gas has neither definite volume nor definite shape

Molecules are a long way apart and are free to move around

When heat energy is applied to an ice block, the molecules gain sufficient energy to overcome the forces holding them in position and a liquid if formed. Similarly, if sufficient heat is applied to the liquid water, the molecules gain enough energy to move much further apart and escape through the surface to form a gas. Energy must be removed to change the steam back to liquid water and then to ice.

Melting and freezing both happen at the melting/freezing point of a substance.

"Physics for scientists and engineers," 4th edition, Vol.1, Raymond A. Serway, Saunders College Publishing, 1996.