TEMPERATURE AND MOLECULAR MOTION

Temperature and temperature scales:

When we talk about the temperature of some object, we refer to that object's "hotness" or "coldness". Because humans tend to have different ideas as to what is hot or cold, we have to have some sort of scale on which temperatures can be measured relative to some standard everyone can agree on. Three scales are in common use:

- The Celsius scale. On this scale, melting ice (in equilibrium with water vapour at one atmosphere pressure) has a temperature of 0.0 ºC, and boiling water (at normal atmospheric pressure) has a temperature of 100.0 ºC.
- the Farenheit scale, on which melting ice has a temperature of 32 ºF and boiling water a temperature of 212 ºF.

$$^{o}F = \frac{9}{5}{}^{o}C + 32 \qquad {}^{o}C = \frac{5}{9}({}^{o}F - 32)$$

- The Kelvin scale, used in scientific work. On this scale, melting ice (in equilibrium with water vapour at one atmosphere pressure) has a temperature of 273.16 ºC. $T(^{0}C)=T(K)+273.16$. The temperature of 0.0 K is known as the ABSOLUTE ZERO, the lowest temperature which can be obtained.

The sizes of the degree Celsius and degree Kelvin are the same, and therefore, temperature differences are the same on both scales.

Temperature and molecular motion:

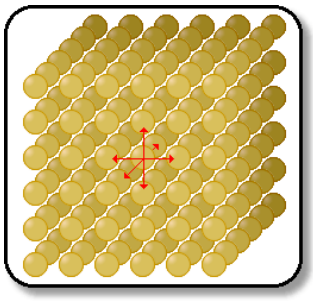
In order to understand the nature of heat and temperature, it is necessary to appreciate the fact that matter consists of moving particles (atoms or molecules) which can interact more or less strongly with one another. This forms the basis of the kinetic theory (later).

The motion of the particles is increased by raising the temperature. Conversely, the motion of the particles is reduced by lowering the temperature, until, at the absolute zero (0 K), the motion of the particles ceases altogether.

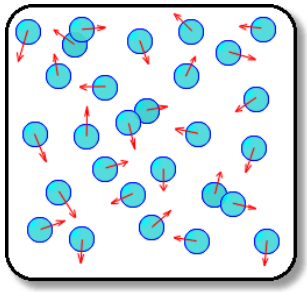
Because the particles are in motion, they will have kinetic energy. The particles will not all have the same energy, and the energy of the particles is constantly changing as they undergo changes in speed. Thus, for a given sample of matter, we can only talk about the average kinetic energy of the particles.

Temperature is a measure of the average kinetic energy of the particles.

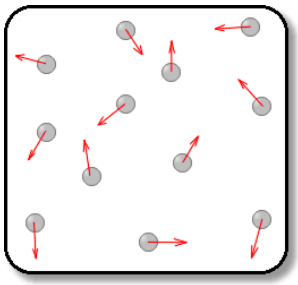
We can look at three different phases of matter:



In a solid, a metal for example, the particles are atoms, arranged in an orderly array. The atoms are relatively close to one another, and the motion of each atom is restricted by its interaction with other atoms.



In a liquid, the atoms or molecules, are further apart than in a solid, and are not arranged in any special order. There is less interaction between the molecules, and they are free to move in any direction, but as interactions between the molecules are still present, most molecules are confined to the volume occupied by the liquid sample.



In a gas, the atoms or molecules are further apart and have little interaction with one another. The motion of these particles is confined by the walls of the containing vessels.

Temperature and Heat

Heat is related to temperature and describes the process of energy transfer from one object to another. That is, **heat** is *the net energy transferred from one object to another because of a temperature difference.* Thus, heat is energy in transit, so to speak. Once transferred, the energy becomes part of the total energy to the molecules of the object or system, its **internal energy**. So heat (energy) transfers between objects can result in internal energy changes.