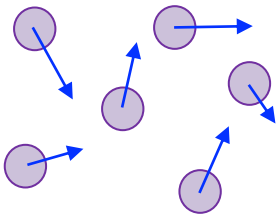
3.2.1 Internal Energy

videos

Energy is stored inside a system in the energy of the particles (atoms or molecules) that make up the system.

Energy is stored in the movement of particles. This is kinetic energy. Temperature is related to the kinetic energy of the particles. Increasing the speed of movement of particles, increases the kinetic energy of the system. The kinetic energy is often referred to as thermal energy.



Arrows show the velocity of particles.

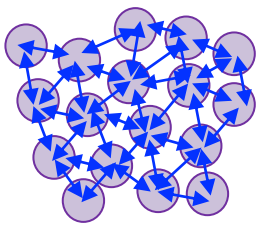
Particles moving around, or vibrating have kinetic energy.

Particles in a solid vibrate around fixed positions.
(1) What happens to the movement of particles in a solid when they are heated?

Particles in a liquid slide past each other and move around.
(2) What happens to the movement of particles in a liquid when they are heated?

Particles in a gas move around quickly and with minimal interaction.
(3) What happens to the movement of particles in a gas when they are heated?

Energy is also stored in the force of attraction between particles. This is called potential energy. Increasing the separation of particles and breaking bonds increases the potential energy of the system.



Arrows show the force of attraction between particles.

Forces of attraction between particles leads to energy being stored as potential energy.

(4)✎ Particles in a gaseous state have more potential energy than the same particles in a liquid state. Why?

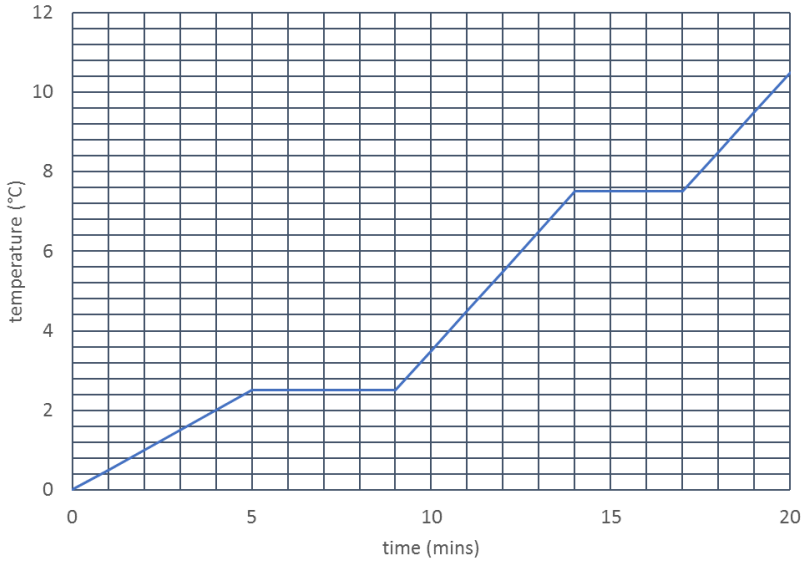
The internal energy of a system is just the sum of these two energies for all the particles in the system.

$$internal\ energy = sum\ of\ kinetic\ energies + sum\ of\ potential\ energies$$

Heating materials often increases both the kinetic energy and the potential energy of the particles in the material.

(5)✎ When a metal rod is heated, its temperature increases and it expands. How we can tell that the kinetic (thermal) energy of the metal rod has increased? How we can tell that its potential energy has increased?

Consider a graph of temperature versus time for a material being heated from its solid state:



Heat energy is being supplied to the material at a constant rate.

(6)✎ Put the following labels on the graph: ***liquid heating up, gas heating up, solid heating up, solid melting, liquid boiling, boiling point, melting point***

Where we see an increase in temperature, on a heating graph (such as the one above), we know that the mean kinetic energy of particles is increasing.

Where we see no change of temperature (even though the material is being heated), we know that the mean potential energy of particles is increasing.

(7) Why is the temperature increasing from 0 to 5 minutes? (Explain in terms of what is happening to the particles.)

(8) Why does the temperature remain constant from 5 to 9 mins? (Explain in terms of what is happening to the particles.)

(9) Why is the temperature increasing from 9 to 14 mins? (Explain in terms of what is happening to the particles.)

(10) Why does the temperature remain constant from 14 to 17 mins? (Explain in terms of what is happening to the particles.)

(11) Why does the temperature increase above 17 mins? (Explain in terms of what is happening to the particles.)