6.5.1 Internal Energy

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The internal energy of an object is determined by the motion and arrangement of its constituent molecules. Temperature is a measure of the mean kinetic energy of the molecules. This is usually referred to as the thermal energy. In a material in which there is molecular attraction, energy is required to increase the separation of the molecules. Increasing the separation of the molecules increases the potential energy of the system.

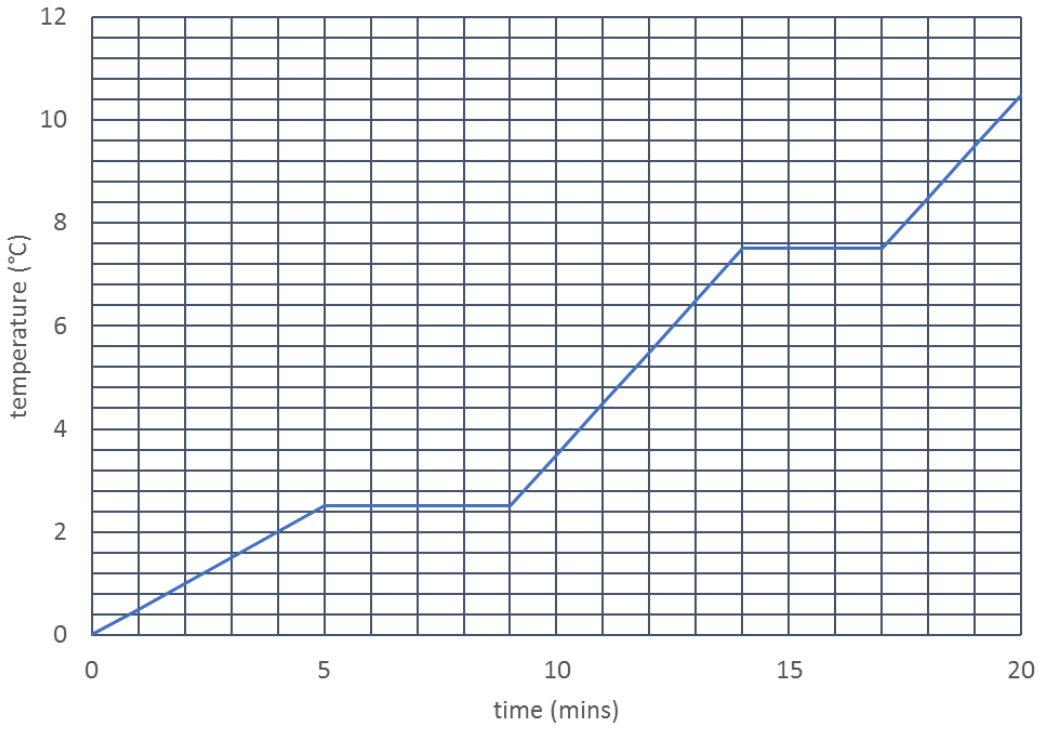
The internal energy of an object is defined as:

"the sum of the random distribution of the kinetic and potential energies of its constituent molecules."

Heating materials often increases both the thermal energy and the potential energy of the molecules.

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

Let us consider a graph of temperature versus time for 1kg of a material being heated from its solid state:



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

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

The power of the heater is 1000W, which means that it transfers 1000 joules of energy per second to the material.

(3)✍ Why is the temperature increasing from 0 to 5 minutes? (Explain in terms of molecules.)

(4)✍ Why does the temperature remain constant from 5 to 9 mins? (Explain in terms of molecules.)

(5)✍ Why is the temperature increasing from 9 to 14 mins? (Explain in terms of molecules.)

(6)✍ Why does the temperature remain constant from 14 to 17 mins? (Explain in terms of molecules.)

(7)✍ Why does the temperature increase above 17 mins? (Explain in terms of molecules.)

(8)✍ The specific heat capacity of a material is the energy required to increase 1kg of the material by 1°C. Calculate the specific heat capacity of the material above when it is: i) a solid, ii) a liquid.

(9)✍ The specific latent heat of fusion is the energy needed to change 1kg of a material from a solid to a liquid. Calculate the specific latent heat of fusion for the material.

(10)✍ The specific latent heat of vaporisation is the energy needed to change 1kg of a material from a liquid to a gas. Calculate the specific latent heat of vaporisation for the material.

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