

First law of Thermodynamics

Q. What is thermodynamics? State the first law of thermodynamics and discuss its physical significance.

Ans.- Thermodynamics: It is the science that discusses the relation of heat to mechanical work. It establishes the equivalence between the work done and the heat produced. The principles of thermodynamics are very general and give the relation of heat to other forms of energy e.g, electrical, light etc.

Mechanical equivalent of heat: Whenever work is transformed into heat or heat into work, the quantity of work is mechanically equivalent to the quantity of heat.

$$W \propto H$$

$$\text{or } W = JH$$

where J is a constant known as Joule's mechanical equivalent of heat. The value of J is 4.186 Joules/Calorie or 4.186×10^7 ergs per calorie.

First law of thermodynamics: Whenever heat is imparted to a body, a part of it is used to increase its internal energy i.e, to raise its temp. and the rest is doing external work.

If δQ is the heat energy absorbed by a system δU the increase in its internal energy and δW the external work done by it, then provided all the quantities are measured in units of work, we have

$$\delta Q = \delta U + \delta W$$

This equation is known as the first law of thermodynamics.

Differential form of first law of thermodynamics:

When an infinitesimal small amount of heat dQ is added to the system so that it causes an increase dU in internal energy and in addition performs an external work dW , then according to the principle of conservation of energy

$$dQ = dU + dW$$

This is the differential form of the first law of thermodynamics. If the pressure remains constant at P and a change in volume dV takes place, then $dW = P dV$.

$$dQ = dU + P dV.$$