

## FIRST LAW OF THERMODYNAMICS

"When a certain amount of heat  $Q$  is supplied which does external work  $W$  in passing from state 1 to state 2, the amount of heat is equal to sum of the increase in the internal energy of the system & the external work done by the system.

$$Q = (U_2 - U_1) + W \quad \text{--- (1)}$$

$$\delta Q = dU + \delta W \quad \text{--- (2)}$$

where  $\delta Q$  &  $\delta W$  are not perfect differentials but  $dU$  is a perfect differential because  $U$  is a function of the state of the system.

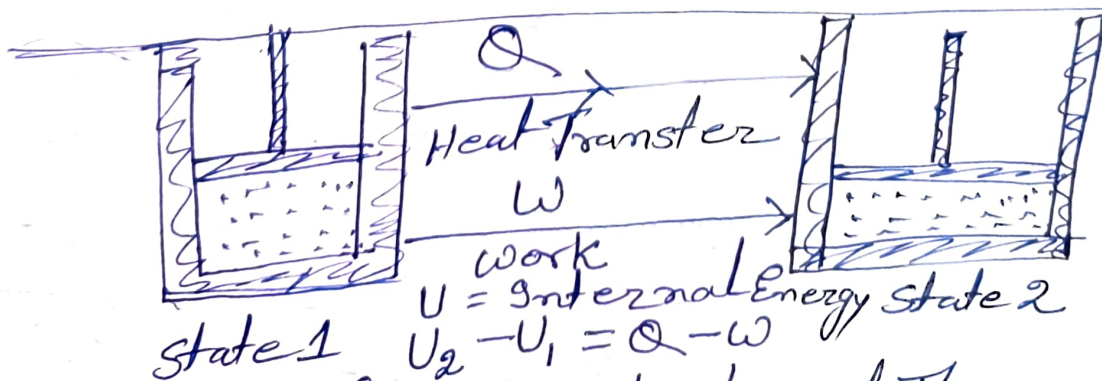


Fig. (1) First Law of Thermodynamics

It should be remembered that all the eqn ① & ② must be expressed in unit of energy. The amount of heat  $Q$  or  $\delta Q$  is taken positive if heat is supplied to the system, and negative if heat is removed from it. Similarly, the work  $W$  or  $\delta W$  is positive when the external work is done by the system in expansion and negative if the work is done on it, in compression.

Any thermodynamic system in an equilibrium state possesses state variable called the internal energy ( $U$ ). Between any two equilibrium states, the change in internal energy is equal to the difference of the heat transferred into the system and work done by the system, shown in fig. ①.

~~physical significance~~  
Physical significance of first law:

The first law of thermodynamics is based on the principle of conservation of energy of a system, in its most general energy of the system all forms

It speaks about transfer of energy through either work or heat. It includes in the internal energy of the system all forms of energy due to ordered as well as disordered motion of the particles of the system. Work is the macroscopic displacement of a body and represents ordered kinetic and potential energy. Heat (or thermal energy) on the other hand measures energy of disordered motion of the particles of the system arising from a temperature difference or in another words: -

"In all transformations the energy due to heat supplied to the system must be balanced by the external work done plus the increase in internal energy."

Limitation of the first law :-

The first law of thermodynamics is based on the principle of conservation of energy of a system though it is applicable to every process

in nature between the equilibrium states,  
it does not specify the condition under  
which a system can use its heat  
energy to produce a supply of  
mechanical work. It also does not  
say how much of the heat energy  
can be converted into work.

