The temperature of a system may be defined as the property that determines whether or not the system is in thermal equilibrium with the neighbouring systems.

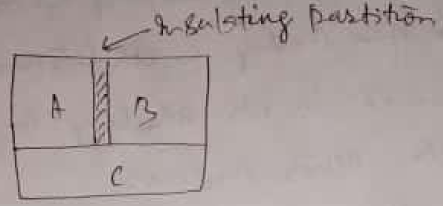
The first law of thermodynamics -

The law of conservation of energy, in specific form, may be stated as - whenever work is converted into heat, a definite amount of heat is produced for every part of work so converted. Similarly, when heat is expended to produce work same amount of heat is used up for every unit of work so produced. In terms of Joule's principle of heat equivalence - when work is converted into heat, a definite amount of work produces a definite quantity of heat. Mathematically this is represented as,

$$W \propto Q$$

the third one, are also in thermal equilibrium with each other.

Explanation -



Let us consider two systems A and B insulated from each other but in good thermal contact with the common system C. Systems A and B ~~with~~ will attain thermal equilibrium with the third C. Now the insulating partition is removed and systems A and B are brought into thermal contact. We find that there is no further change. This means that the systems A and B are also in thermal equilibrium with another. This is known as zeroth law of thermodynamics. A

All the three systems can be said to possess a property that ensures their being in thermal equilibrium with each other. This property is called temperature and (3i) The remaining heat energy is spent in expanding the system against the external pressure i.e in doing external work.

Let dU_k is the change in the internal kinetic energy, dU_p is the change in the potential energy and dw is the external work done, then since energy can neither be created nor ~~destroyed~~ distroyed but only converted from one form to another, we have.

$$dQ = dU_k + dU_p + dw$$

$$\text{or } dQ = dU + dw.$$

where, $dU = dU_k + dU_p$

It should be remembered that all the quantities must be expressed in unit of energy. (i.e. Joules or calories).

<u>Significance of the first law :-</u>

The first law of thermodynamics is important because—

(1) It is applicable to any process by

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DP I; Lecture No. ②

Internal or intrinsic Energy – When a System apparently shows no mechanical energy, but is still capable of doing work, it is said to possess internal energy or intrinsic energy. As we know matter is made up of large number of tiny particles called molecules, which are in a state of constant rapid motion and hence possess kinetic energy. It is due to translational, rotational and vibrational motion of the molecules, all of which depend only on temperature. While the internal potential arising due to inter molecular attraction and it is called internal potential energy, which depends on the separation between the molecules.
We know, electrons are spinning and revo

or, $W = JQ$

where, Q is the heat,
W is work.

and J is called the Joule's mechanical equivalent of heat.

This relation is known as the first law of thermodynamics.

The first law of thermodynamics is the statement of the principle of conservation of energy.

Let us consider a quantity dQ of heat is supplied to a system. This heat energy is spent in three ways—

① Partially it is spent in raising the temperature of the body which is equivalent of increasing its internal kinetic energy.

② A part of it is spent in doing internal work against molecular attraction which is equivalent to increase the internal potential energy of the system.

where U_1 is the internal energy in state 1 and U_2 the internal energy in state 2.

or, $dU = dQ - dw$.

or, $dU = dQ - P dv$.

where workdone, $dw = P.dv$,

<u>Heat</u> – we may regard heat as the physical cause of the sensation of hotness and coldness. Heat is defined as the energy in transit, which tries to maintain same thermal level, the temperature, between bodies that are in thermal contact. As it is not possible to speak of work in a body, it is also not possible to speak of heat in a body. Work is either done on a body or by a body. Similarly heat can flow from a body or to a body. If a body is at a constant temperature, it has both mechanical and thermal energies due to the molecular agitations and it is

level and heat as the energy that flows as a result of the difference in thermal levels (the temperature difference) of two bodies. The temperature of a body is its thermal state with reference to its ability to communicate heat to other bodies.

Thus we may call heat as the energy in transit which tries to maintain same thermal level, the temperature, between bodies that are in thermal contact.

Zeroth law of Thermodynamics:-

Let us first learn, thermal equilibrium - when a hot body A is brought in thermal contact with a cold body B, heat ~~from~~ flows from A to B. After some time the flow stops. The bodies A and A are then said to be in thermal equilibrium with each other.

Statement - If two systems are individually in thermal equilibrium with and revolving which possess kinetic energy.

So the internal energy of the system is the sum of kinetic energy, potential energy and energy of electrons and nuclei. It is denoted by U. In practice, it is not possible to measure the total energy of the system in any given state. Only change in its value can be measured. When a system passes from one state to the other change in the internal energy is independent of the path followed between the two states, but depends only on the initial and final states.

If the state of the system is changed from an initial state 1 to a final state 2, by supplying heat Q to the system and if W is the work done by the system during the change, then increase in the internal energy of the system is given by

$$U_2 - U_1 = Q - W.$$

which a system undergoes a physical or chemical change.

and. ② It introduces the concept of the internal energy.

Limitations of the first law of thermodynamics

The first law of thermodynamics is based on the principle of conservation of energy. 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.

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not possible to separate them. So, in this case, we cannot talk of heat energy. Here it is clear that if the flow of heat stops, the word heat cannot be used. It is only used when there is transfer of energy between two or more systems.

<u>Temperature</u> – It is the degree of hotness or coldness. We may understand the heat and temperature one familiar hydrostatic analogy. We know that a liquid flows only from higher to a lower level until a common level is attained. If we replace quantity of liquid by quantity of heat and its level by temperature, we have, heat flows from a body at a higher temperature to the one at a lower temperature, irrespective of the quantities of heat in the two bodies. This heat flows continuously until the two bodies attain a common temperature. For this reason the temperature is often referred to as thermal