B. Sc. Part (I) Physics (Hons.)

- Paper I
  - Group (A): Special theory of relativity
  - Group (B): Mechanics & Properties of matter
- Paper II
  - Group (A): Heat
  - Group (B): Thermodynamics

Laws of thermodynamics :→

First law : (Law of conservation of Energy) :→ Energy can neither be created nor destroyed, although it can be transformed from one form to another form.

Second law :→ Heat cannot be transferred by any continuous, self-sustaining process from a colder to hotter body, or stated in terms of Entropy : The Entropy of a closed system increases with time.

Third law :→ At the absolute zero temperature, the entropy of ~~energy~~ every substance may become zero and it does become zero in the case of a perfectly crystalline structure. The consequence of this law is that absolute zero of temperature can never be attained.

Zeroth law of thermodynamics → If two bodies are in thermal equilibrium separately with a third body, they are in thermal equilibrium with each other.

→ Explanation of the first law of thermodynamics :→ The first law of thermodynamics is simply the principle of conservation of energy applied to a thermodynamic system undergoing some change. It states that – " The amount of heat related to system equals the sum of the increase in the system internal energy and the workdone the system against its surroundings.

Internal energy :→ A body always has certain amount of energy within itself. We call this energy as the Internal energy (U). In general, the internal energy of gas or a liquid or a solid consists of two components :

(i) K.E. due to the translational, rotational or vibrational motion of the molecules, all of which depend only on the temp.

(ii) P.E. due to the intermolecular forces, this depends on the separation of the molecules i.e. the volume.

In an ideal gas, the kinetic component is present. and the kinetic theory shows that the translational part of its equals $\frac{3RT}{2}$ per mole. For real gases, its components are present with the kinetic form predominating and their internal energy depends on the temperature and the volume of the gas. In a solid K.E. and P.E. are present in roughly equal amounts.

An isolated body has constant internal energy. A change in the internal energy can occur only if any transfer of energy between the body and its surrounding is allowed. This can take place by (a) performance of work (b) by heat transfer.

The changes in the U, when the system changes from one state to another depends only on the initial and final states of the system. For instance, consider gas enclosed in a cylinder with a moving piston. Let the piston be pushed by doing some work. The gas gets compressed and its temperature rises. If the walls of the system are thermally insulated no heat will be transferred i.e. the process will be adiabatic. In this process, the mechanical work done on the system increases the internal energy of the system from U_1 to U_2 such that:

$$\therefore W = U_1 - U_2$$

where W = Workdone on the system.

Whenever work-flow is completely converted into heat or vice-versa, one is proportional to the other.

$$W = JH$$

$$dQ = dU + dW$$

If heat is supplied to a system which is capable of doing work, then the quantity of heat absorbed by the system will be equal to the sum of the increase in the internal energy of the system and the external work done by system.

The first law of Thermodynamics is not a seperate law but is a special case of the general law known as the Universal law of conservation of Energy. It may be called the conservation law of energy applied to the case of the mutual transformation of heat energy and mechanical energy. The first law of thermodynamics is applies to all states of matter, solid, liquid and gas.

Physical significance of 1st law :→ The first law of Thermodynamics establishes the relation between heat and work. According to this law heat can be produced only by the expenditure of energy in some form or the other. Hence it follows directly from this law that it is impossible to make a perpetual motion machine or to derive work without any expenditure of energy.

It doesnot however, specify the condition under which a body can use its heat energy to produce a supply of work nor does it say that how much of the heat energy of the body can be converted into useful work.

In the more elaborated from it introduces a neer state variable called internal energy whose change will simply depend on the initial and final state and not on the process by which it is taken from the former to the later. Note that this second form is reduced to the first form when $dW = 0$, that is when there is complete conversion of work into heat and vice-versa.

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