THERMODYNAMICS

Topic: 1

Concepts of thermodynamics with definitions, First law of thermodynamics, derivation of mathematical equation of First Law and its applications

VERY SHORT ANSWER QUESTIONS

1. Explain "System" and "Surroundings".

System: A small part of the universe chosen for thermodynamic study is called system.

Surroundings: The remaining part of the universe in contact with the system is known as surroundings.

Universe = System + Surroundings..

2. Name three intensive properties.

Ans. Intensive properties: Properties of a system which are independent of the amount of the material in the system.

Ex: Density pressure, temperature, boiling point, etc.,

3. **Name three extensive properties**.

Ans. Extensive properties: Properties of a system which depend on the total amount of the material present in the system.

Ex: Mass, volume, internal energy, Gibbs energy etc,.

SHORT ANSWER QUESTIONS

1. State first law of thermodynamics.

First law of thermodynamics: The law of conservation of energy is taken as the first law of thermodynamics**.**

Statements:

i) "Energy can neither be created nor destroyed, although it can be transformed from one form to another"

ii) "It is impossible to construct perpetual motion machine of first kind"

iii) "The total energy of the system and surroundings is constant"

2. Give the mathematical formulation of first law of thermodynamics.

Mathematical form of 1 law of thermodynamics:

Let a system in state "A" of internal energy E_A absorb form the surroundings a certain amount of heat (Q) and undergo a change in its to "B" let the internal energy in the state 'B' is E_B. If 'W' is the work done by the system in the process, the increase in internal energy (ΔE) of the system is given by the equation,

$$\Delta E = E_B - E_A$$

From first law, net gain of energy (Q – W) must be equal to ΔE

$$\Delta E = (E_B - E_A) = (Q - W)$$

(or) $Q = \Delta E + W$

For infinitesimally small changes $q = \Delta E + W$

This is mathematical form of I law of thermodynamics.

LONG ANSWER QUESTIONS

1. State and explain first law of thermodynamics.

Ans. First law of thermodynamics:

The law of conservation of energy is taken as the first law of thermodynamics.

Statements:

i) "Energy can neither be created nor destroyed, although it can be transformed from one form to another".

ii) "it is impossible to construct a perpetual motion machine of first kind (which Producework without consuming energy)".

iii) "the total energy of the system and surroundings is constant".

Mathematical form:

Let a system in state "A", of internal energy E_A absorb from the surroundings acertain amount of heat (Q) and undergo a change in its state to B. Let the internal energy in the state

B is E_B. If "W" is the work done by the system in the process, the increase in internal energy ΔE of the system is given by the equation, $\Delta E = E_B - E_A$.

$$\text{System - (A)}, E_A \xrightarrow{Q} \text{System - (A)}, E_B$$

From first law, net gain of energy (Q-W) must be equal to ΔE

$$\Delta E = (E_B - E_A). = (Q-W)$$

(or) $Q = \Delta E + W$

For infinitesimally small changes $\boxed{q = \Delta E + W}$

$\therefore$ q = increase in internal energy + energy used in doing work.

Above equation is mathematical form of I law of thermodynamics.

2. What are extensive and intensive properties? Give examples.

Ans. Measurable (or) macroscopic properties such as mass, pressure, volume, temperature, surface tension, viscosity etc., can be subdivided into two categories as below:

i) **Extensive properties:** The properties whose magnitude depends upon the quantity of matter present in the system are called extensive properties. Examples of such properties are mass, volume, heat capacity, internal energy, entropy, heat content, Gibbs free energy etc. These properties change with quantity of matter present in the system. These properties are additive in nature.

ii) **Intensive properties**: The properties which do not depend upon the quantity of matter present in the system are called intensive properties.

Examples of such properties are density, molar volume, molar entropy, molar heat capacity surface tension, viscosity, specific heat, refractive index, pressure, temperature, boiling point, freezing point, vapour pressure etc. These properties depend only on the nature of the substance.