S. S. College. Jehanabad (Magadh University)

Department : Physics

Subject : Quantum Mechanics

Class : B.Sc(H) Physics Part III

Topic: One dimensional infinite potential square well.

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Thermodynamics Variables

The thermodynamic state of a substance is specified by properties like pressure, volume, temperature, internal energy and entropy. These properties change when the system passes from one state to another. These variables are known as thermodynamic variables. These are called macroscopic co-ordinates. They require a few measurable properties of the system to define them and do not require the knowledge of microscopic co-ordinates.

Extensive and Intensive Variables

An *extensive variable* of a system is a macroscopic co-ordinate, which describes a system in equilibrium and has a value equal to the sum of its values in each part of the system. It depends upon the mass or the size of the substance present in the system.

Examples are

Mass, volume, internal energy, entropy, length, area, heat capacity, magnetization etc.

An *intensive variable* of a substance is a microscopic co-ordinate which describes the system in equilibrium and has the same value in any part of the system. It is independent of mass or size of the system.

Examples are

Pressure, temperature, viscosity, refractive index, density, specific volume, surface tension, electromotive force etc.

Distinction between extensive and intensive variables

In a homogeneous system in equilibrium, Suppose the system is divided into many parts and the macroscopic, variable x of the system has the values $x1$, $x2$, $x3$, ….. in each of these parts of the system respectively, then

x is said to be extensive variable, if $x = x1 + x2 + x3 + ……..$, and

x is said to be intensive variable, if $x = x1 = x2 = x3 = ……$

An extensive variable may become an intensive variable by specifying unit amount of substance. Like heat capacity is extensive variable but specific heat is an intensive variable.

Maxwell's Thermodynamical Relations

Measurable quantities

How does one measure the entropy or chemical potential from experiments? These kinds of quantities are not usually directly accessible in the lab. What we can measure, typically, are mechanical quantities like pressure, bulk quantities like volume and density etc. thermal properties like temperature and heat flow (e.g., by slow heat exchange experiments where we can measure temperature changes in a coupled reference body). Of the thermodynamic variables that we have discussed thus far, the following are considered *measurable*:

Measurable thermodynamic variables

temperature

pressure

volume or

number of particles or

mass (related by the molecular weight)

and enthalpy (latent heat) of phase change.

There are also several readily-measured material properties that depend on derivatives of thermodynamic variables. These quantities measure the change in a parameter in response to an infinitesimally small perturbation, they are termed as *response functions*:

Measurable thermodynamic response functions

constant volume heat capacity

constant pressure heat capacity

isothermal compressibility

thermal expansivity / expansion coefficients.