

Phase Transition

Phase transition is when a substance changes from a solid, liquid or gas state to a different state.

Every element and substance can transition from one phase to another at a specific combination of temperature and pressure.

Thus a phase transition is the transformation of a thermodynamic system from ^{heat} transfer. The term is most commonly used to describe transition between solid, liquid and gaseous states of matter and, in rare cases plasma, from one phase to another phase by heat transfer.

A phase of thermodynamic system and the states of matter have intorm physical properties. During a phase transition of a given medium certain properties of the medium change, often discontinuously, as a result of the change of some external condition, such as temperature, pressure or others.

First and second order of phase transitions :-

Several substances undergo phase transitions under change of temperature and pressure.

There are two-types of phase transitions :-

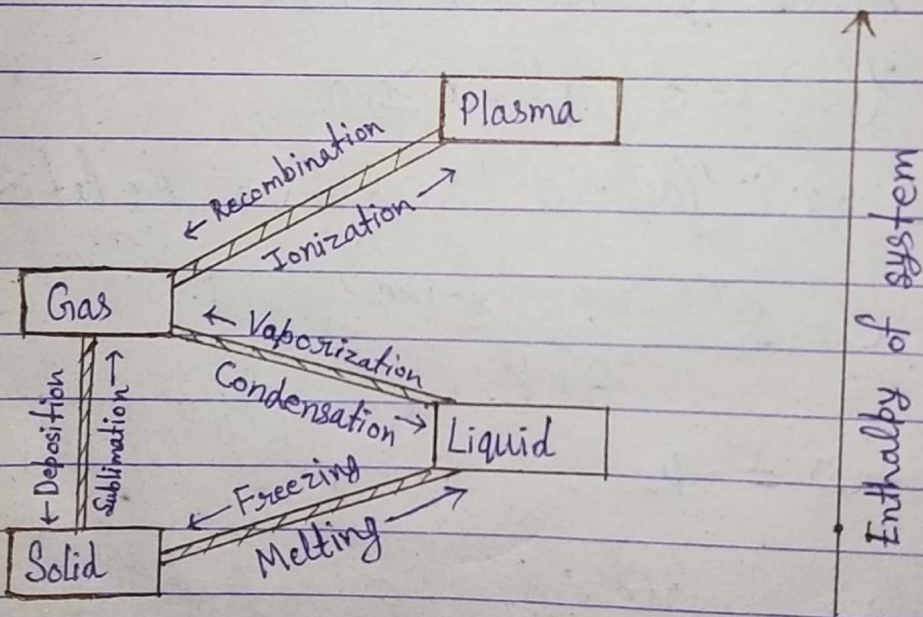


Fig: - Shows the nomenclature for the different phase transitions.

1) First order Phase transitions: - The changes of phase, which take place at constant temperature and pressure and in which heat is either absorbed or evolved during change of phase are called first order phase transitions. In first order phase transitions, the entropy and density (or volume) change. In first order phase transitions, the Gibb's function G remains constant in both phases, while its first derivative with respect to temperature and pressure is discontinuous at transition point.

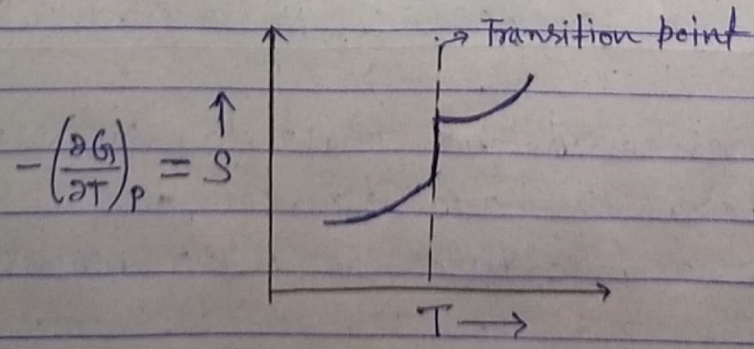
Gibb's eqn ,

$$G = H - TS$$

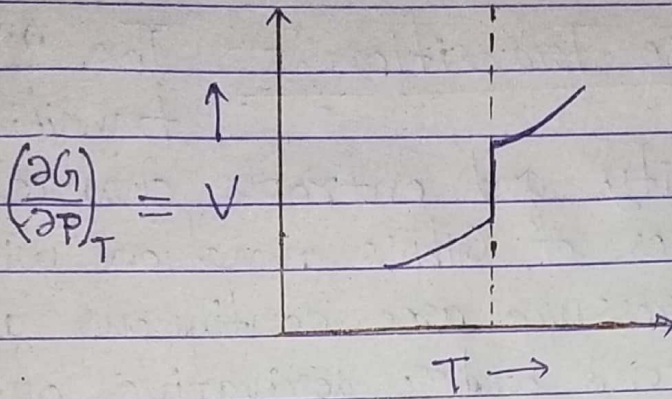
where,

$$V = \left(\frac{\partial G}{\partial P} \right)_T \quad \text{and} \quad S = - \left(\frac{\partial G}{\partial T} \right)_P$$

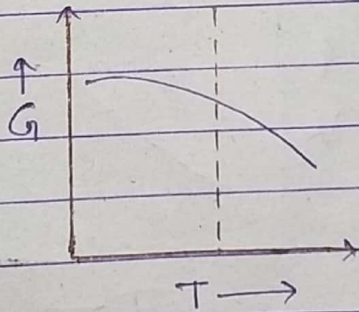
Entropy (S) :- changes discontinuously



Volume (V) :- Changes discontinuously



Gibb's Free Energy (G) :- doesn't change discontinuously, It means, we find a continuously graph

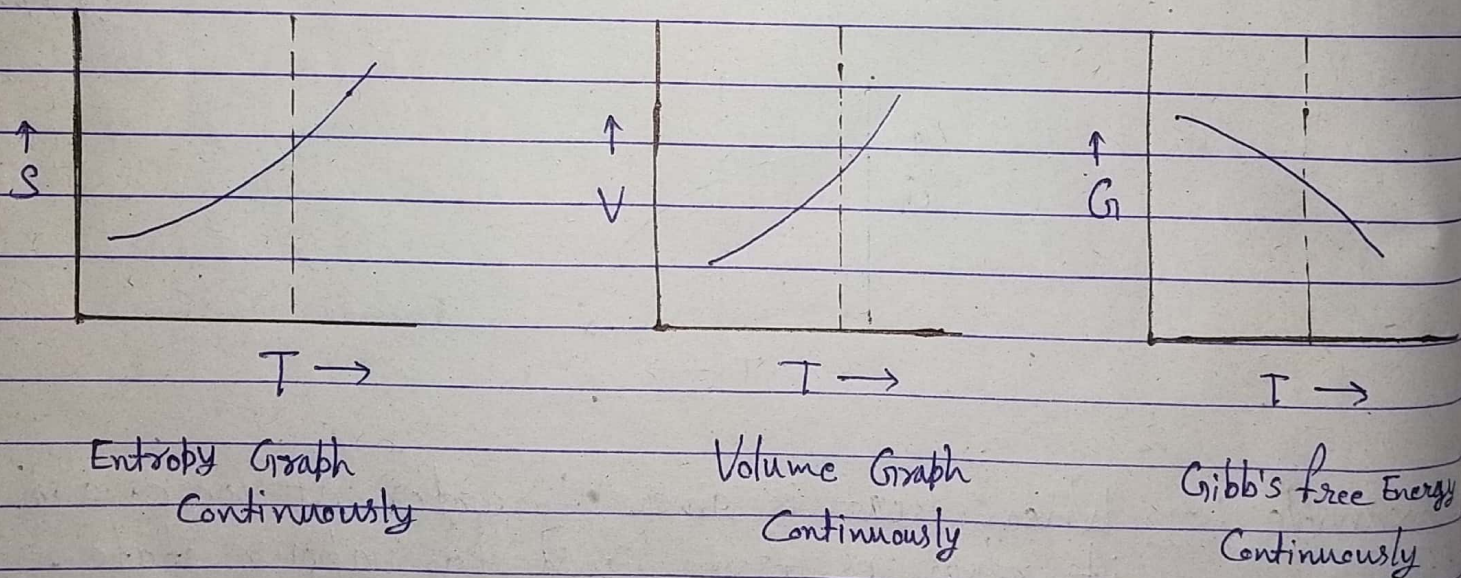


Example :- When heat is given to water at 100°C and 1atm , it changes from liquid to vapour state. The density of water is 1000 kg/m^3 ; while that of vapour is 0.6 kg/m^3 . Therefore the transformation of water into vapour at constant temperature and volume is first order phase transition. Similarly, the transformation of ice into water at 0°C and 1 atmospheric pressure is the example.

of first order phase transition.

2) Second Order Phase Transition :- The 2nd order phase transitions are those in which the density and entropy change slowly; and the first derivatives of Gibb's function with respect to temperature and pressure are continuous at transition point, while the second order derivative of Gibb's function becomes discontinuous at transition point.

Here,



Example :- The transformation of liquid helium I to liquid helium II at a point (2.19K) is second order phase transition. In this transition there is no evolution or absorption of latent heat during

change of states and the densities of liquid helium I and II are same.

Similarly, transformation of ferromagnetic substance into paramagnetic substance at "curie temp." is second order phase transition.