Date
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Sem III, Unit V

Third law of thermodynamics

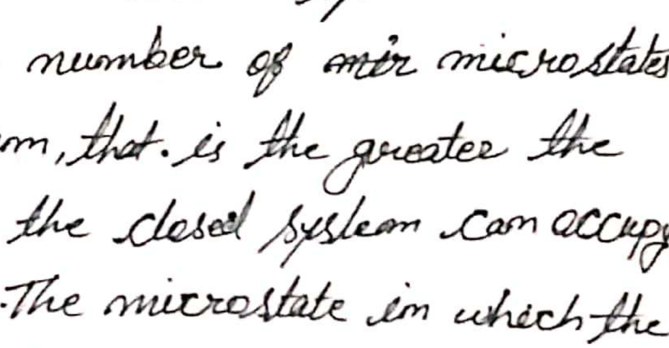
The third law of thermodynamics states that the entropy of a perfect crystal at a temperature of zero Kelvin ($-273^{\circ}C$ approx) is equal to zero.

Entropy, denoted by 'S' is a measure of the disorder (randomness) in a closed system. It is directly related to the number of ~~mir~~ microstates accessible by the system, that is the greater the number of microstates the closed system can occupy, the greater its entropy. The microstate in which the energy of the system is at its minimum is called the ground state of the system.

At a temperature of absolute zero ($-273^{\circ}C$) the following phenomena can be observed in a closed system.

=> The system does not contain any heat.

=> All the atoms and molecules in the system are at their lowest energy points.



Therefore a system at absolute zero has only one accessible microstate (a fixed microscopic state that can be occupied by a system) its ground state. As the third law of thermodynamic the entropy of such a system is exactly zero.

Mathematical enplanation of the third leuo → The entropy of a System can be enpressed the f equation.

$$S - S_0 = K_B \ln \Omega$$ where

→ S is the entriopy of the System

S_0 is the initial entropy

K_B is the Boltzman constant. and.

Ω refers to the total number of the micro-States that are consistant with the Systems microscopic configuration.

A perfact crystal that has enactly one unique ground state. $\Omega = 1$ there, the equation

$$S - S_0 = K_B \ln(1) = 0 \; [\text{because } \ln(1) = 0]$$

When the initial entropy of the system is selected as zero(0), the following value of 'S' can be obtained

$$S - 0 = 0 \Rightarrow S = 0$$

Thus the entropy of the a perfect crystal at absolute zero is zero.