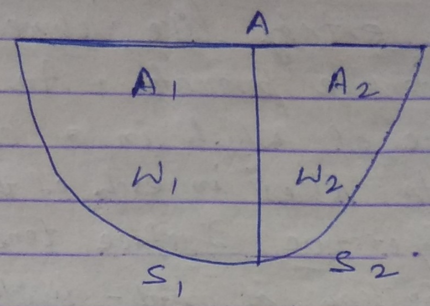
ADDITIVE NATURE OF ENTROPY →



Where

System A ⇒ having entropy S corresponding to a thermodynamic probability W. Let us divide the system into two sub-systems

Sub-system A_1 → entropy S_1 and thermodynamic probability W_1.

Sub-system A_2 → entropy S_2 and thermodynamic probability W_2.

According to the law of probability, combined probability for A_1 and A_2

$$W = W_1 \times W_2$$

Now,

$$S = K \log W$$

$$S_1 = K \log W_1$$

$$S_2 = K \log W_2$$

or,

$$S_1 + S_2 = K \log W_1 + K \log W_2$$

$$= K \log (W_1 \times W_2)$$

$$= K \log W = S$$

$$\therefore \boxed{S_1 + S_2 = S}$$

This argument can be extended to a system consisting of more than two sub-system in equilibrium.

$$S = S_1 + S_2 + S_3 + \cdots$$

Hence, the entropy of the system is equal to the sum of the entropies of its system.

In other words entropy like volume, area and internal energy is an extensive parameter.

In other words entropy like volume, area and internal energy is an extensive parameter. An extensive parameter is a quantity the value of which in a composite system is equal to the sum of its values in each of the sub-systems. Quantities like pressure, temperature, surface tension etc. which remain unchanged if the system is sub-divided are known as intensive parameters.

Change of Entropy :→ The Entropy change is defined as the ratio of the infinitesimally small amount of heat supplied to the system divided by the above temp. μ and volume (v) of the system constant. The relation $Kd(\log W) = dS = \frac{dQ}{T}$ gives the relation between probability, a statistical quantity and entropy, a thermodynamic quantity. Now entropy $S = K \log W$. Therefore, Entropy being proportional to W is also related to disorder in the system. Entropy is taken to be a measure of disorder. According to the law of increase of entropy, the entropy of every natural system tends to increase. The same can be stated as follows:

Every system tends to produced the state of maximum disorder.

Principle of increase of Entropy :→ Since, when the system is in equilibrium entropy (S) has its maximum value: That is $\Delta S = 0$ for the equilibrium state of the system. When the System moves from a state of lowest probability (state of inequilibrium) to the state of maximum probability (equilibrium state) there is in increase in entropy. As this process is irreversible, we have $\Delta S > 0$

Thus, the entropy of an isolated system remains constant or increases according as the changes it undergoes are reversible or irreversible.

Entropy :→ Criterion for a Physical or Chemical Change:

The result $\Delta S \geq 0$ is of great significance.

The process in which $\Delta S > 0$, that is, there is increase in entropy of the universe, is irreversible and the one in which $\Delta S = 0$, that is, entropy remains constant, irreversible. This, too, gives basis for any process to occur. In this Universe all natural processes are taking place irreversibly and hence by all processes going around us the entropy of the Universe is ever increasing. The natural direction of any physical or chemical change is therefore towards irreversibility. Thus 2nd law of thermodynamics in terms of Entropy can be stated as :

"A physical or chemical process will proceed in the direction that causes the entropy of the Universe to increase." This is also called the principle of entropy of the Universe.

Thermal equilibrium → If all the parts of the system are at the same temperature it is said to be in thermal equilibrium i.e., it is in the state of maximum thermodynamic probability.

Order and Disorder → When complete and definite information is known for all the particles of a system, it is said to be in perfect order.

The uncertainty or loss of information about the state of a system is called disorder.

→ Entropy and Availability of heat energy for work : →

Unavaible work due to conduction = $T \cdot \Delta S$. Hence the increase of unavailable energy is equal to the increase of entropy multiplied by the lowest temperature available. Thus entropy is a measure of the unavailability of energy, and the law of entropy implies that the available energy in the world tends to zero. This is also known as the principle of degradation or 'running downhill' of energy. Thus unavailability of work from heat is dereasing since entropy increases in all processes. In other words, availability is decreasing, we ~~see~~ are heading towards heat death.

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