* Entropy of Mixing and Gibbs paradox. (part(2))

- Gibbs Paradox

a paradoxical situation arises while employing Entrop Mixing equation.

For Example: If we consider the two gases to be identical, obviously $x_1 = x_2 = x$, and hence the entropy of mixing becomes NON zero - an incorrect result since the Entropy of Mixing of two identical gases should be zero. This anomaly is known as the gibbs paradox which can be resolved by invoking the indistinguishability of the particles and resorting to the statistical definition of the entropy.

If the gases are identical, they are indistinguishable and the correct expression for Entropy Change using statistical mechanical considerations can be obtained as follows

$$\Delta S_{\text{Mixing}} = \left\{ (N_1 + N_2) K_B \ln\left[\frac{V_1+V_2}{N_1+N_2}\right] - N_1 K_B \ln\left[\frac{V_1}{N_1}\right] - N_2 K_B \ln\left[\frac{V_2}{N_2}\right] \right\}$$

The first term represents the

Entropy of the final state (after Mixing)
the second and third terms denote
the Entropy of the two gases,
their respective volumes being
V_1 and V_2, the corresponding number
of molecules being N_1 and N_2,
K_B denote the Boltzman constant $\left[= \frac{R}{N}\right]$
Thus gas simplified as:

$$\Delta S_{\text{Mixing}} = N_1 K_B \ln\left[\frac{VN_1}{V_1 N}\right] + N_2 K_B \ln\left[\frac{VN_2}{V_2 N}\right]$$

This equation holds good even
when the gases are identical.
for the Mixing of two identical
gases.