Classical Distribution Law

(a) Microstates and Macrostates :-

An ensemble consisting of a large number of independent systems or a gas consisting of a large number of molecules in phase space. The state of an individual system or molecules may be represented in phase space by a point known as phase point or ~~representative~~ representative point. The phase ~~my~~ space may be divided into cells 1, 2, 3 -- -- i. A phase ~~too~~ point for any system or molecule may be reside in one of these cells.

"Each arrangement of specified system or molecules with their representative points in particular cells is called a microstate. In other words a Microstate of the ensemble may be defined by the specification of the individual position of phase points for each system of molecules of the system". Thus system or molecule in a microstate we have to state to which cell each system or molecule belongs temporarily

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The gross observable properties of macroscopic behaviour that occupying by the specific cells.

A ~~macroscopic~~ macrostate of the ensemble may be defined by the specification of phase point in each cell i.e by ~~specify~~ specifying the numbers only and over looking the identities of the systems of molecules.

A change of phase points between two cells in phase space shifts the position of unit cell because the microstate changes. But macroscopic point of view the exchange makes no difference because it is ~~xxx~~ immaterial which of the molecules are in a particular cell specified by numbers 1, 2, ... etc

Thus many different microstates which may corresponding to form macrostate.

Let there are cell 1, cell 2, cell 3 ... ~~etc~~ cell i in phase space

$n_1=4$	$n_2=3$	$n_3=1$	$n_i=2$
abcd	efg	h	jk
cell-1	cell-2	cell-3	cell-i

Suppose ~~three~~ there four phase points abcd in cell-1 three ~~in~~ phase points ~~in~~ efg in cell-2, one phase point h in cell-3, and two phase points jk in cell i

The macrostate of figure is specified by

merely giving the phase points $x_1 = 4, x_2 = 3$
-- $x_i = 2$ of different cells. This also constitute individual microstate in cell-1, cell-2 and so on.

Now if the two phase points a & e from different cells are interchanged, then the microstate is changed because the position of two phase points are changed, while the macrostate remain constant. Similarly, with the same macrostate we can consider different microstate.

The microstate which are allowed under given restriction are called accessible microstate. One of the most fundamental postulate of St. mechanics is that all accessible microstates corresponding to possible microstate are equally probable.

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* STIRLING'S APPROXIMATION :-

The calculation of $n!$ becomes very laborious for large values of n. The Stirling's formula gives the approximate value of $\log n!$, when n is given large.

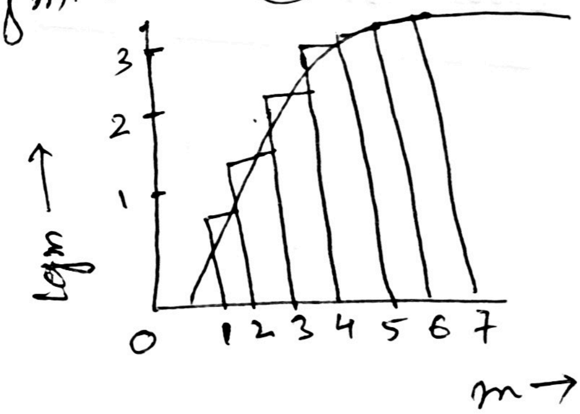
$$\log n! = n\log n - n \qquad (1)$$

By the definition of $n!$, we have

$$n! = 1\times 2\times 3\times \cdots \times (n-1)\times n.$$

$$\therefore \log n! = \log 1 + \log 2 + \cdots + \log n$$

$$= \sum_{m=1}^{n} \log m \qquad (2)$$



Now we plot a graph with $y = \log m$ and draw ordinates to it for values of $m = 1, 2, 3 \ldots n$. One can approximate this sum by an to integral. This replacement by an integral is increasingly good in the range where m is large, since $\log m$ varies only slightly when m is increased by unity. With this approximation, equation (1) becomes

$$\log n! \approx \int_1^n 1.\log x \, dx \longrightarrow (B)$$

Integrating By parts

$$\log n! \approx (x \log x)\Big|_1^n - \int_1^n \frac{1}{x}\, x \, dx$$

$$\approx n \log n - n + 1$$

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$$\log n! \approx n \log n - n$$

This is simplified as Stirling's theorem

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