COIN TOSSING

Before moving to the practical let's see the basic terms and definition for proper understanding:

Macrostate:

It refers to a set of macroscopic properties that describe the system, such as temperature (T), volume (V), and total energy (E). It is the specification of the number of particles in each compartment of a system. It can be calculated by the following formula:

$$\Omega_{macro} = n + 1$$

Where:
- Ω_{macro} is the number of microstates.
- n is the number of particles.

For example, while tossing two coins, the total number of microstates will be two where we can arrange the outcomes such as head and tail.

Microstate:

A microstate refers to a specific microscopic configuration of the individual particles (atoms, molecules, etc.) that make up a system. It describes the precise arrangement of positions and momenta of all particles at a given instant for a particular macrostate. It helps us to calculate the entropy of the system as

$$S = k_B \ln \Omega$$

Where:
- S is the entropy of the system,
- k_B is the Boltzmann constant,
- Ω is the total number of microstates of the system.

Thermodynamic Probability:

It provides the likelihood of different microscopic configurations (microstates) within a given macroscopic state (macrostate) of a system. It helps predict how particles distribute themselves in terms of energy, position, and momentum. It can be calculated by the given formula

$$W = \frac{n!}{n_1! \cdot n_2! \cdot \ldots \cdot n_k!}$$

Where:
- n is the total number of particles,
- $n_1, n_2, \ldots, n_k$ are the number of particles in each microstate.
- k is the number of microstates.

Total Probability:

Total probability of a microstate is given by the formula

$$P = \frac{W}{k^n}$$

Where
- P is the total probability
- W is the thermodynamic probability
- k is the total number of microstate
- n is the total number of particles

Example:

Let we have to arrange **four particles** in **two compartments** so

Macrostates	Microstates Compartment 1	Microstates Compartment 2	Thermodynamic Probability	Total Probability
(0,4)	-	ABCD	$\frac{4!}{0!4!} = 1$	$\frac{1}{2^4} = 0.0625$
(1,3)	D A B C	ABC BCD CDA DAB	$\frac{4!}{1!3!} = 4$	$\frac{4}{2^4} = 0.25$
(2,2)	AB BC CD DA AC BD	CD DA AB BC BD AC	$\frac{4!}{2!2!} = 6$	$\frac{6}{2^4} = 0.375$
(3,1)	ABC BCD CDA DAB	D A B C	$\frac{4!}{3!1!} = 4$	$\frac{4}{2^4} = 0.25$
(4,0)	ABCD	-	$\frac{4!}{4!0!} = 1$	$\frac{1}{2^4} = 0.0625$

EXPERIMENT 4

AIM: Find the probability of various macrostates of coin tossing of coin tossing (two level system) vs no heads for 4, 8, 16 coins.

CODE:

```
clc;clear;clf;

n = input("Enter the number of coins:") // Enter the no of coins
nm = 2^n; //microstates
disp("n(h) P(h)");
for j= 0:1:n
    ns = factorial(n)/(factorial(j)*factorial(n-j)); //finding probability
    P(j+1)=ns/nm;
    h(j+1)=j;  //no of heads
    disp([h(j+1) P(j+1)]);
end
plot(h,P,'o-','linewidth',4); //plotting the graph
title("Number of coins:"+string(n),'fontsize',4);
xlabel("No of heads,n(h)",'fontsize',4);
ylabel("Probability,P(h)",'fontsize',4);
```

OUTPUT: