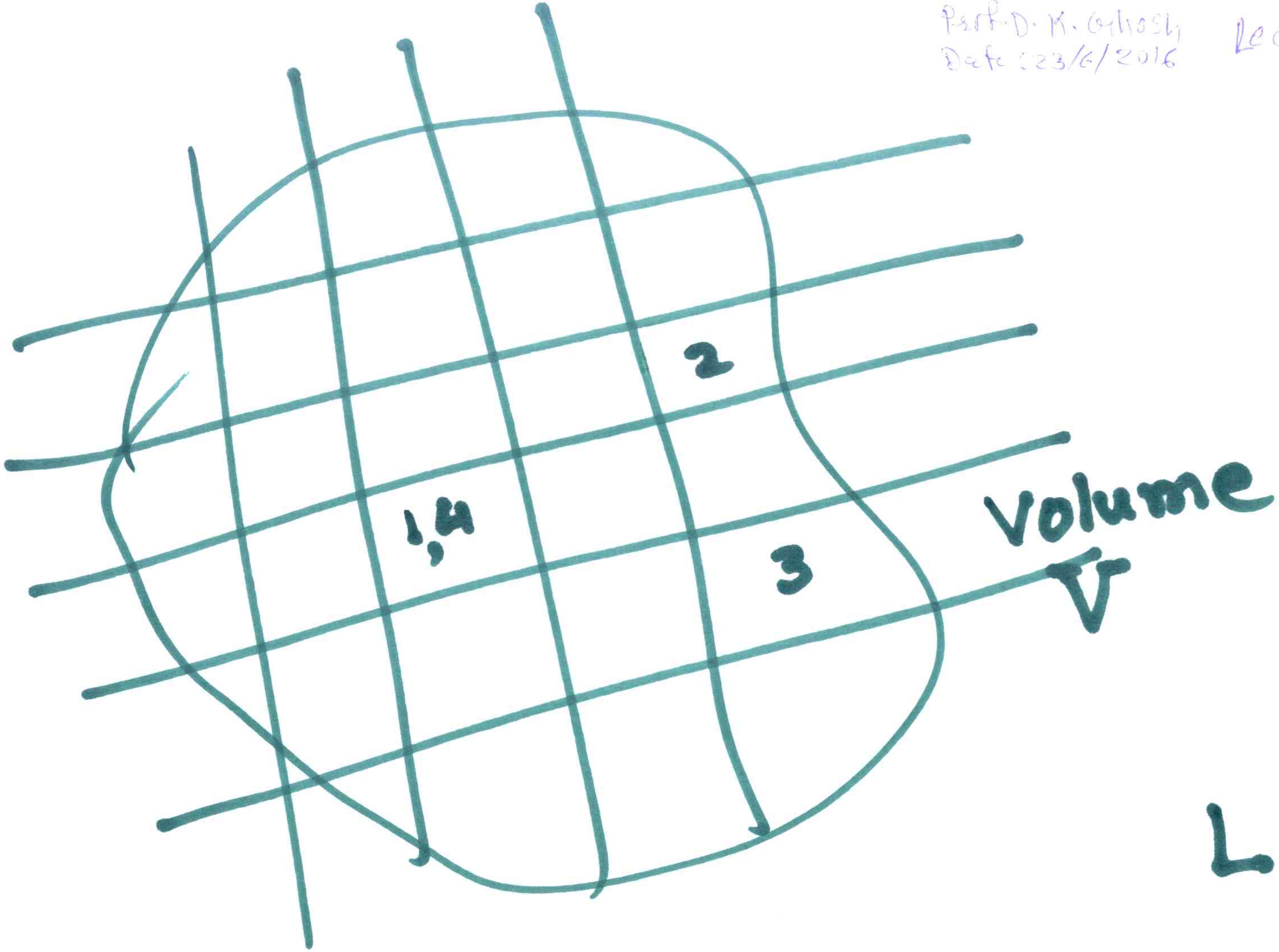
2
1,4
3
Volume
V
L

W = Number of microstates associated with a given macrostate

n_1 : Cell 1

n_2 : Cell 2

$\vdots$

n_L : Cell L

$$= \frac{N!}{n_1!\, n_2! \cdots n_L!} \qquad \sum_i n_i = N$$

Stirling approximation

$$\log N! \cong N \log N - N.$$

$\Sigma_i n_i = N$

$$W = \frac{N!}{n_1!\, n_2! \cdots n_L!}$$

$$\log W = (N \log N - N) - \sum_i (n_i \log n_i - n_i)$$

$$= N \log N - \sum_i n_i \log n_i$$

$$p_i = \frac{n_i}{N}$$

$$\begin{aligned}
\log W &= N \log N - \sum_i n_i \log n_i \\
&= N \log N - \sum_i (N p_i) \log (N p_i) \\
&= N \log N - \sum_i (N p_i) [\underline{\underline{\log N}} + \log p_i] \\
&= N \log N - N \log N \underbrace{\sum_i p_i} - N \sum_i p_i \log p_i \\
&= -N \sum_i p_i \log p_i
\end{aligned}$$

Average entropy

$$S = -\sum_i p_i \log p_i$$

Let $L \approx 10^6$ $\quad p_i = 1$ for a particular i

$= 0$ for all others.

$$S = 0$$

No. of configuration (for equal population in 2 cells)

$$\frac{10^6!}{2!\,(10^6-2)!} = \frac{10^6(10^6-1)}{2}$$

$$\approx 5\times 10^{11}$$

$$\frac{5\times 10^{11}}{10^6+5\times 10^{11}} \approx 1-10^{-5}.$$

A = 00 — 40%.

C = 01 — 30%.

G = 10 — 15%.

T = 11 — 15%.

2 bits per letter on average.

A = 0 – 40%

C = 10 – 30%

G = 110 – 15%

T = 1110 – 15%

$$0.4 \times 1 + 0.3 \times 2 + 0.15 \times 3 + 0.15 \times 4$$

= 1.9 bits per letter.

A	0.4
C	0.3
T	0.15
G	0.15

$$-\sum_i p_i \log_2 p_i$$

$$= -0.4 \log_2(0.4) - 0.3 \log_2(0.3)$$
$$- 0.3 \log_2(0.15)$$

$$= 1.871$$