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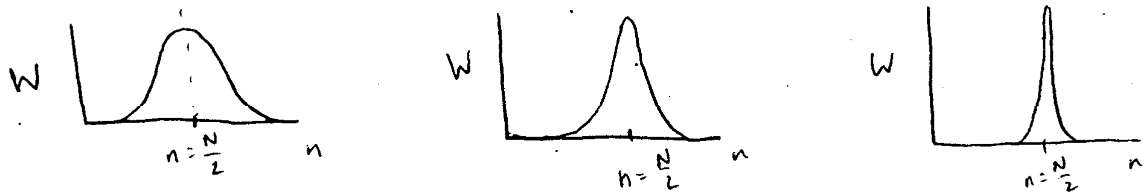
Course 565/665 Lecture Number ____ Date 2/3/03

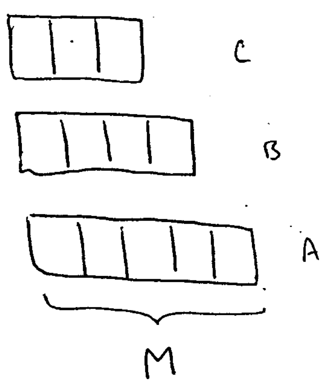
Lecturer Dr. Silvia Cavagnero Note Taker Eric Fulmer

Last Time:



Complex systems tend to populate states which maximize W.

Origins of Pressure



$W_A = 10$ $W_B = 4$

$W_C = 1$

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Given that there are 2 possibilities, occupied ⊡ and unoccupied □

If in the case of A, let us presume that only the 1st 3 spaces are available to occupy. The final two spaces exist, but they are not available for occupation.

$$P_C = p_{⊡}^{n} \, p_{□}^{(M-n)} \cdot W_C = \left(\tfrac{1}{2}\right)^3 \left(\tfrac{1}{2}\right)^2 (1) = \frac{1}{32}$$

$$P_B = \;\; '' \;\; \cdot W_B = \left(\tfrac{1}{2}\right)^3 \left(\tfrac{1}{2}\right)^2 (4) = \frac{4}{32}$$

$$P_c = \;\; '' \;\; \cdot W_c = \left(\tfrac{1}{2}\right)^3 \left(\tfrac{1}{2}\right)^2 (10) = \frac{10}{32}$$

However, the above probabilities are not normalized. If normalized, $\sum_i p_i = 1$.

To normalize,

$$P_{c,\text{normalized}} = \frac{p_c}{p_A + p_B + p_C} = \frac{\left(\tfrac{1}{2}\right)^5 W_c}{\left(\tfrac{1}{2}\right)^5 \left[W_A + W_B + W_C\right]}$$

$$= \frac{1}{10+4+1} = \frac{1}{15}$$

$$p_B = \frac{4}{15}$$

$$p_c = \frac{10}{15}$$

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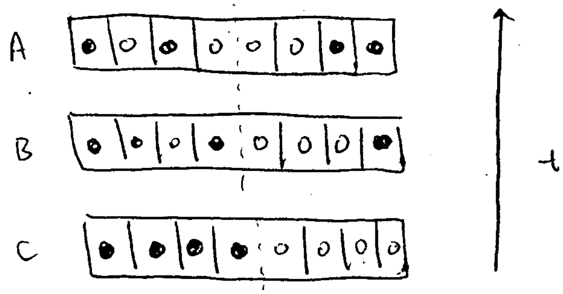
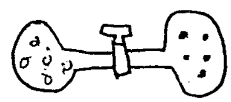
Why do molecules diffuse? (Example 2)



Particles are free to go back and forth between the two sides, like an open 2 chamber system.



● = Helium
o = Argon
(something like this)

$$W_{total} = W_L W_R$$

Case C: (t = 0)

$$W_L = \frac{4!}{0!\,4!} = \frac{N!}{n_o!\,n_\bullet!} = 1$$

$$W_R = \frac{N!}{n_\bullet!\,n_o!} = \frac{4!}{0!\,4!} = 1$$

$$W_{c,total} = W_L \cdot W_R = 1 \cdot 1 = 1$$

Case B: (t = t')

$$W_L = \frac{4!}{1!\,3!} = 4$$

$$W_R = \frac{4!}{3!\,1!} = 4$$

$$W_{B,total} = 4 \cdot 4 = 16$$

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Case A: $(t = t_{final})$ $\quad W_L = \frac{4!}{2!\,2!} = W_R = \frac{4 \cdot 3 \cdot \cancel{2 \cdot 1}}{(2 \cdot 1)\cdot \cancel{(2 \cdot 1)}} = 6$

$$W_{A,total} = 6 \cdot 6 = 36$$

If there are no significant barriers for diffusion or mixing, then the particles tend to be found in the most probable state. Finding a particular state (such as A or C) is equally likely, but there are so many more states ~~that~~ possible that can be described by A (it has a very large multiplicity) that one tends to find configurations with the highest multiplicity, especially for large N.

Example 3:
- Why are rubber bands elastic?
- Why do proteins fold (partial explanation, only).

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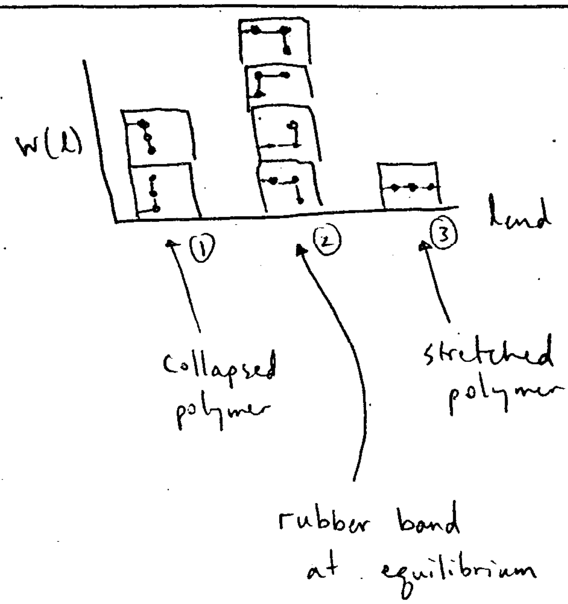

* 3-box 1D lattice space

- l ≡ lattice layer number
- l_{end} ≡ lattice layer # where the polymer chain evolves.
- 3 molecule polymer.

Chapter 3 - Heat, Energy, and Work

- Conservation of Particular Quantities; Thermodynamics.
- Work started in this field in the 18th Century.

Conserved Quantities

- Energy
- Mass
- Momentum (mass × velocity).