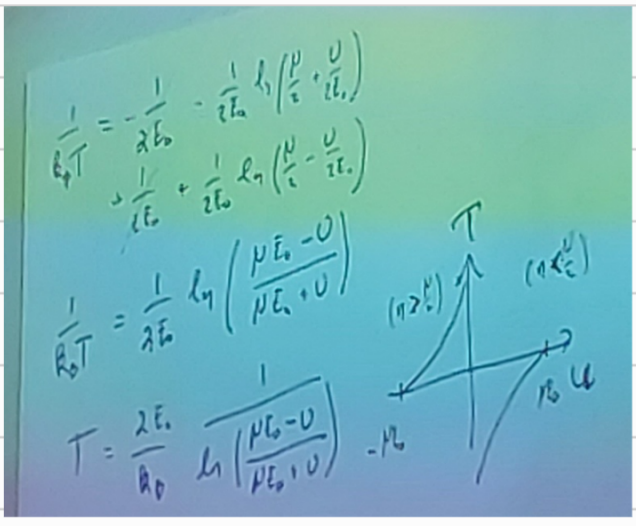
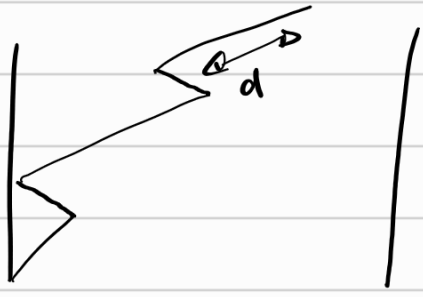
- U missed a lecture somewhere



L4 What is entropy?

1) Rubber elasticity



a - length of monomer
N - number of monomers

a - length l of polymer

Q: Tens° f(l)
(in the limit $N >> 1$, $l << Nd$)

Change E: $-pdV \Rightarrow -Fdl$
(ideal gas → this syst)

by analogy with gases

$dV = TdS - Fdl$ → work done

$dV = 0$ (assumption)

$F = T\frac{\partial S}{\partial l} = k_B T \frac{\partial \ln(W)}{\partial l}$ (using $S = k_B \ln(W)$)

n - number of right links

$W(n) = \frac{N!}{n!(N-n)!}$ (identical expression to two level systems)

n(l) to get W(l)

$l(n) = [n - (N-n)]\,d = [2n - N]\,d$

right left

$$F = \frac{k_B T}{2d} \ln\left(\frac{Nd - \ell}{Nd + \ell}\right)$$

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Limit $\ell \ll Nd$ (not extended)

$$F(\ell) = \frac{k_B T}{2d}\left\{\ln\left(1 - \frac{\ell}{Nd}\right) - \ln\left(1 + \frac{\ell}{Nd}\right)\right\}$$

$$\ln(1+x) \simeq x + \mathcal{O}(x^2)$$

$$F(\ell) \simeq \frac{k_B T}{2d}\left(-\frac{\ell}{Nd} - \frac{\ell}{Nd}\right) = -\frac{k_B T \ell}{Nd^2}$$

or $$S(\ell) = -\frac{1}{2}\frac{k_B \ell^2}{Nd^2}$$

exp I
1) Stretch $d\ell > 0$ ⟷
2) Heat up $dT = 0$ ⟷

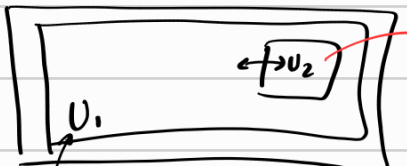
3) $\left(\frac{\partial F}{\partial T}\right)_\ell < 0$

exp II
1. Stretch at cnst T $d\ell > 0$
2. Measure ΔS
3. $\left(\frac{\partial S}{\partial \ell}\right)_T < 0$

$$\left(\frac{\partial S}{\partial P}\right)_T = \left(\frac{\partial F}{\partial T}\right)_\ell$$

Maxwell relation from thermodynamics

System at cnst T



small subsystem
Exchange heat
but not N, V

thermal bath
Heat Reservoir

$U_0 = U_1 + U_2 = \text{const}$

For our system, T, V, N const