

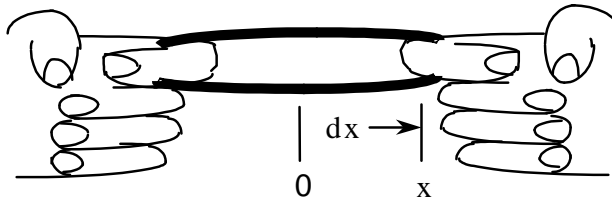
Handin Homework 9 : Free Energy

1. In an isothermal expansion of an ideal gas $\Delta U=0$. The value is **not** zero for a real gas. Using the Van der Waal's equation of state, find ΔU for an isothermal expansion from V_1 to V_2 .

Hints: Van der Waal's: $P = \frac{nRT}{(V-nb)} - a \frac{n^2}{V^2}$ and remember $\left(\frac{\partial U}{\partial V}\right)_T = -P + T \left(\frac{\partial P}{\partial T}\right)_V$

2. Hooke's Law holds for the extension of a rubber band: $F = kx$, where F is the restoring force. The work for the system in stretching the rubber band is $w_{\text{net}} = F dx$. Remember that at constant temperature and pressure, $\Delta G = w_{\text{net}}$, where w_{net} is the non-PV work. So the total change in Gibb's Free energy for any process involving stretching a rubber band is

$$dG = -S dT + V dP + F dx.$$



k ="stretchiness"
 x = extension

- a. Under what conditions is ΔG be a good spontaneity criterion (i.e when what is held constant)?
- b. Now define a new state function: $R = G - F x$. What are the independent variables for R ?

3. Given that $dU = TdS - PdV$ and for an ideal gas $dS = \frac{C_v}{T} dT + \frac{nR}{V} dV$ show that $dU = C_v dT$ for any process for an ideal gas. (At first it doesn't look like $dU=TdS-PdV$ will give just $C_v dT$, does it?)