Massachusetts Institute of Technology
Thermodynamics of Materials
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Problem Set 2: Due Tues. Sept. 24, Before 5PM in 13-5114

Exercise 2.1

A state function for a *Van der Waals* gas is given by an equation between thermodynamic variables that depend on model parameters A, B, and a physical constant R:

$$(P + \frac{AN^2}{V^2})(V - NB) = NRT \tag{1}$$

where AN^2/V^2 is referred to as the internal pressure due to the attraction between molecules and NB is an extra volume, sometimes associated with the the volume per molecule.

Write out a differential expression for dN in terms of differentials of the thermodynamic variables.

Exercise 2.2

Each day a certain amount of water evaporates from the oceans, lakes, and earth surface and forms water vapor and clouds in the atmosphere. Each day a certain amount of rain falls back to the earth. Make the reasonable assumption that, on the average, the energy consumed by evaporating and lifting the water is equal to the energy produced by condensation and rain falling back to earth.

To evaporate one mole of water, approximately 41090 joules of heat are required and an equivalent amount is expelled when a mole of water condenses.

Estimate the amount of work required each day to produce the rain that raineth. That is, the work to evaporate and lift the water.

You may need to find data to help make this estimate such as the average height of a rain cloud, state what those data are and from whence they came.

Discuss what is supplying this daily energy.

Compare this daily energy consumption with the energy produced each year in metropolitan Boston.

Exercise 2.3

Write your own sonnet to the first law. You may submit this as a group or individually.

If you would like to have your contribution published on the website (I hope you will!) please send your sonnet to ccarter@mit.edu. Also please send it as *plain text* and not as an attachment.

There are multiple types of sonnets. All sonnets have 14 lines with iambic pentameter (ten syllables in each line with every other syllable stressed).

The rhyme scheme can vary. Shakespearean sonnets rhyme ababcdcdefef gg. The final couplet might act as a summary of the previous 12 lines or is a resolution to the conflict laid out in the previous 12 lines.

Petrarchan sonnets (also known as Italian sonnets) rhyme abbaabba cdecde (or abbaabba cdcdcd) and the break between the octet and the sestet shows a change in the poet's point of view.

For more information, see http://www.sp.uconn.edu/~mwh95001/iambic.html

I'll be happy with ten syllables per line and don't care if you can make it rhyme or not—whether you are please with that is a different matter. Also, you need not restrict yourself to English!