Physics 3410 Homework #7

4 problems

Due by March 21

▷ **1.**

For the following four partial derivatives, write an equivalent derivative or ratio of thermodynamic variables. One of them is a Maxwell relation, one is a reciprocal Maxwell relation, and one involves the Gibbs-Duhem relation.

(a) $\left(\frac{\partial \mu}{\partial P}\right)_T$ (b) $\left(\frac{\partial \mu}{\partial P}\right)_{N,S}$ (c) $\left(\frac{\partial N}{\partial V}\right)_{F,T}$ (d) $\left(\frac{\partial N}{\partial V}\right)_{P,T}$

▷ **2.**

Given one mole of diamond vs one mole of graphite,

	G	S	V
1 mol Graphite	0 J	5.74 J/K	5.30 cm^3
1 mol Diamond	2900 J	2.38 J/K	3.42 cm^3

(Assume S and V are constant over the temperatures and pressures we're considering, which is a reasonable approximation.)

(a) At room temperature 300 K, at what pressure does diamond become more stable?

(b) At standard pressure 10^5 Pa, at what temperature does diamond become more stable?

▷ **3.**

The fictional compound *hillonium* has two different solid phases, miranite and kevinite. At standard temperature and pressure,

- 1 mole of miranite has $G = 0\,\text{J}$, entropy $S = 3\,\text{J/K}$, and volume $V = 4\,\text{cm}^3$
- 1 mole of kevinite has $G = 500\,\text{J}$, entropy $S = 5\,\text{J/K}$, and volume $V = 3\,\text{cm}^3$

(a) Which is more stable at room temperature? That is, which one is more common?

(b) At what temperature does the other compound become stable?

▷ **4.**

Use the Clausius-Clapeyron relation to find the slope of the liquid-gas phase transition line at the natural boiling point of water (i.e. $P = 10^5\,\text{Pa}$, $T = 373\,\text{K}$). Assume that the water vapor is an ideal gas, and that the water has mass density $\rho = 958\,\text{kg/m}^3$. (You'll also need that each molecule of water has mass $m = 3 \times 10^{-26}\,\text{kg}$.)