**PROBLEM SET 6**

Physics 219A, Spring 2014

Due Wednesday, June 11

**[1.]** For a system of non–interacting one–dimensional classical particles in a harmonic oscillator potential:

**a.** Calculate the grand potential.

**b.** Obtain $\langle N \rangle$ and $\langle E \rangle$ and show they obey the equipartition theorem.

**[2.]** Massless particles have energy–momentum relationship $E = cp$. For a system of spinless one–dimensional Fermi–Dirac massless particles, determine the relationships between $\langle N \rangle$, $\langle E \rangle$, $\mu$, and $T$.

**[3.]** Consider a gas of $He^3$ atoms at pressure $P$ and temperature $T$ in equilibrium with an adsorbed surface layer of $He^3$ atoms. The surface $He^3$ atoms have their translational degrees of freedom, as well as spin, and are bound with an energy $\epsilon_0$. Find the dependence of the surface density of $He^3$ as a function of $P$ and $T$ in

**a.** the classical limit.

**b.** in a limit where the gas is classical and the adsorbed layer is not.

**[4.]** Write down the path integral expression for the *quantum* partition function for the $d = 1$ Ising model in a transverse field

$$\hat{H} = -J \sum_{i=1}^{N} \hat{\sigma}_i^z \hat{\sigma}_{i+1}^z - \Gamma \sum_{i=1}^{N} \hat{\sigma}_i^x$$

and show it is identical to that of the $d = 2$ *classical* Ising model (with anisotropic coupling $J_x \neq J_y$).