Problem set 1

1. Show that the number of quantum states of an electron moving in a volume V with the momentum in the interval $(\mathbf{p},\, \mathbf{p} + d\mathbf{p})$ is

$$d\tau = 2V \frac{d^3\mathbf{p}}{(2\pi\hbar)^3}$$

2. Find the distribution function of fictitious particles, which have the following property: No more than N particles $(1 < N < \infty)$ can occupy a single quantum state. Such particles do not exist in nature, but it should not stop you from solving the problem.

3. Find the Fermi momentum in a two and four dimensional Fermi gas.

4. Estimate the Fermi energy of electrons in a typical three-dimensional metal. Should the electron gas be considered quantum (degenerate) or classical at room temperature?

5. Calculate quantum corrections to Clapeyron's equation ($PV = NT$) in the limit of high temperature. Consider ideal Bose and Fermi gases.

Due Thursday, September 1 (in class)