Physics 5524
Statistical Mechanics
Problem Set 4
Due: Wednesday, February 18 (in class)

4.1: Consider 3 dimensional ideal Bose gas at volume V, temperature T, and with N particles, where N is fixed and thermodynamically large. Assuming the parameters are such that Bose-Einstein condensation has not occurred, use numerical methods to plot the $U/(Nk_BT)$ vs $2\pi^2 \frac{N}{V}\left(\frac{\hbar^2}{2mk_BT}\right)^{3/2}$. When do you recover the result familiar from the classical ideal gas law? Discuss the consequences of your finding for the Joule experiment.

4.2: Consider 3 dimensional ideal Bose gas at volume V, temperature T, and with N particles, where N is fixed and thermodynamically large. Assume that the temperature is fixed and that the conditions for the Bose-Einstein condensation are satisfied. Assume also that the energy of the single particle ground state, into which the particles condense, does not depend on the volume V. Determine the pressure as a function of volume. How does it compare with pressure dependence of the classical ideal gas at fixed temperature. Discuss the reasons for the difference.

4.3: Consider a 2 dimensional ideal Bose gas of area A, temperature T, and with N particles, where N is fixed and thermodynamically large. The single particle dispersion is $\epsilon = \hbar^2(k_x^2 + k_y^2)/2m$. Can such gas undergo a Bose-Einstein condensation at finite temperature? If yes, determine the temperature. If no, explain why.