Homework 5, PHY 7500, Fall 2008 (due October 7, 2008)

1. Show that for a system in the grand canonical ensemble

$$\overline{NE} - \bar{N}\bar{E} = \left(\frac{\partial \bar{E}}{\partial N}\right)_{T,V} (\Delta N)^2. \tag{1}$$

   Evaluate the correlation for an ideal gas.

2. For an ultrarelativistic gas at temperature T, find

   - Fraction of particles with energies $\varepsilon > T$
   - Chemical potential as function of pressure, $\mu(P, T)$

3. Starting directly from a Bose distribution (probability to find n particles at a given energy level ε):

$$p_n = q^n(1-q) \tag{2}$$

   calculate $\langle n \rangle$ and $\langle n^2 \rangle$ in terms of parameter q.