Phys. 807 — Statistical Mechanics

HW3 due Tue Sept. 27 at 4 p.m. in my mailbox.

Problem 1:
Show that the relations

$$p = \alpha\sqrt{2p'}\cos q' \quad ; \quad q = \frac{1}{\alpha}\sqrt{2p'}\sin q'$$

represent a canonical transformation $(p, q) \leftrightarrow (p', q')$. Expressing the hamiltonian $H = p^2/2m + m\omega^2 q^2/2$ as a function of p' and q', show that it can be made independent of q' by suitable choice of α, and use this form of the hamiltonian to determine its mean value E at the temperature T according to classical statistical mechanics.

Problem 2:
For an ideal gas of particles with rest mass m_0 and kinetic energy $c\sqrt{p^2 + (m_0 c)^2} - m_0 c^2$ determine the energy ϵ and the specific heat c_v per mole

a) For $\delta \equiv k_B T/m_0 c^2 \ll 1$, including terms linear in δ

b) For $\gamma \equiv m_0 c^2/k_B T \ll 1$, including linear and quadratic terms in γ.

Problem 3:
What is the probability density and specific heat of a mole of an ideal gas at temperature T contained in a volume V if each molecule is subject to the same constant force in the x-direction?