your name_____

Physics 831 Quiz #2 - Friday, Sep. 13

1. (10 pts) Beginning with the fundamental thermodynamic relation,

$$dS = \beta dE - \beta\mu dQ + \beta P dV,$$

derive the following Maxwell relation

$$\left.\frac{\partial E}{\partial S}\right|_{\mu,V} = T - \mu \left.\frac{\partial T}{\partial \mu}\right|_{S,V}.$$

2. (10 pts, extra credit) In Sec. 1.9 of the lecture notes, we showed the force acting on a particle,

$$f = -\left.\frac{\partial E}{\partial x}\right|_{N,S,V},$$

could equivalently be written as

$$f = -\left.\frac{\partial F}{\partial x}\right|_{N,T,V}.$$

where $F = E - TS$ was the Helmholtz free energy. Show that one can extend this to

$$-\left.\frac{\partial F}{\partial x}\right|_{N,T,V} = -\left.\frac{\partial (E - TS - \mu N)}{\partial x}\right|_{\mu,T,V}.$$

You may wish to remember that

$$\mu = \frac{\partial F(N,T,V)}{\partial N}.$$

Just as an aside, $E - TS = -T \ln Z_{\text{can.}}$, and $E - TS - \mu N = -T \ln Z_{\text{G.C.}}$