PHYS 324 – Thermodynamics
Spring 2008

Homework 3: (due Feb 4th)

1. The bulk modulus, ***K***, of an isotropic linear elastic solid is defined by the dialation, $\frac{\Delta V}{V_0}$, response to hydrostatic pressure ***P***:

$$\frac{\Delta V}{V_0} = \frac{V - V_0}{V_0} = -\frac{P}{K}$$

   Typical values of ***K*** for an ionic crystal are about 100 GPa. The permittivity of vacuum, κ_0 is 8.85×10^{-12} C^2/Jm. Typical values of the dielectric susceptibility, χ ($\vec{P} = \kappa_0 \chi \vec{E}$), of an ionic crystal are about 50 (unitless). The permittivity of vacuum, μ_0, is $4\pi\cdot10^{-7}$ J/T^2m^3 (T is a tesla). The magnetic susceptibility, ψ ($\vec{I} = \mu_0 \psi \vec{H}$), of a typical paramagnetic ionic crystal is about 10 (unitless).

   Calculate all the ratios (meaning, in terms of V_0) of: stored elastic energy, stored polarization energy, and stored magnetic energy in a typical ionic crystal at 1 atm, 220 volts/m, and in the earth's magnetic field.

2. From the state function for an ideal gas (PV = NRT), derive an expression for a small change, *dn*, of the number of moles in a system in terms of appropriate thermodynamic variables.

3. Suppose that, in a desperate attempt to lower the temperature in your *adiabatically enclosed* dorm room, you prop open the door of your refrigerator. Your refrigerator operates at 110 volts and draws a constant 30 amperes.

   Draw two *schematic* curves of the temperature in your adiabatically enclosed room as a function of time. For one curve, plot the temperature versus time for the case that the refrigerator door is kept closed; for the other curve, plot the temperature versus time for the case that the refrigerator door is kept open. *A schematic plot is one that illustrates relevant physical aspects of the system, but need not be numerically quantitative.*

   Illustrate or annotate any relevant characteristics of your curves--and be sure to indicate which curve corresponds to each case.