MIT Course 3.00 Fall 2002

Recitation #3

1. Review important concepts from last three class lectures.

First law of thermodynamics - work/heat equivalence

Heat, Internal energy - definitions, examples.

Types of systems and processes - terminology

Work : elastic, magnetic, electric .... - Isotropic, anisotropic responses.

(sign conventions : work done, heat flow)

1. Gas is confined in a chamber by a piston. In this closed system, a constant pressure of 10 atms is applied through the piston to reduce the volume of the gas from 3 m^3 to 2 m^3.

1. what is the workdone by the system?
2. what is the change in internal energy during this process?

2. Check the following statements : true or false? (and under what conditions?)

1. internal energy of a system is a state function.
2. internal energy is an intensive property.
3. in an adiabatic system, work done is a state function.
4. work done is a state function during isothermal process.

3. Gas is confined in a chamber by a piston clamped at certain height. A resistive coil with resistance 1kiloohms is used to provide heat to this chamber for 10 seconds (current = 15milliamps). Calculate the heat transferred and internal energy of the system. See Fig. 1.

1. in a closed system with chamber boundary as the system boundary.
2. in a adiabatic system with the above boundary.
3. in adiabatic system which includes the resistive coil (the walls of the container are thermally conducting).

4. what is the change in intenal energy of an isolated system when the volume increases by 50 % at constant pressure of 1atm.

5. (from a old problem set - 2000)

The bulk modulus, K, of an isotropic linear elastic solid is defined by the dialation,$\Delta V/V_0$, response to hydrostatic pressure P:

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

Typical values of K for an ionic crystal are about 100 GPa. (GPa = 1 Gigapascal, 1 atm $\approx 10^{-1}$ MPa)

The permittivity of vacuum, k_0 is 8.85x10^{-12}C$^2/J$ m. Typical values of the dielectric susceptibility, $\chi(\vec{P}=k_0\chi\vec{E})$, of an ionic crystal are about 50 (unitless).

The permittivity of vacuum,μ_0 , is 4x$10^{-7}T^2m^3/J$ (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 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.

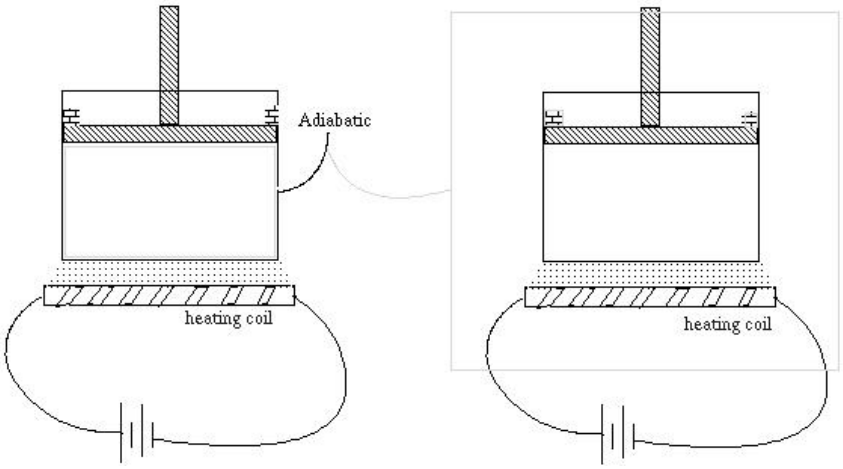

Figure 1.