Assignment 6
PHGN361

Homework due Feb. 22

1. Generate a graph in Mathematica which displays the potential energy of a positive test charge constrained to move in the xy plane placed between at least 4 other positive charges also located in the xy plane. This is meant to show a different approach to solving 3.2.

2. Derive the solution to the diffusion equation ($\nabla^2 T = \frac{1}{\kappa}\partial T/\partial t$) by separation of variables in spherical coordinates assuming that the boundary conditions have spherical symmetry. Hint: assume R(r) = f/r where f is a function of r to be determined.

3. A "infinite" cylindrical steam pipe of radius a is surrounded by cylindrical insulation out to radius b. Find an expression for the rate at which heat (thermal energy) is lost by the pipe if the temperature at radius a is T_1 and at radius b is T_2. Assume thermostatics ($\kappa\nabla^2 T = c_v \partial T/\partial t$ where c_v is the heat capacity per unit volume per unit mass and κ is the thermal conductivity of the material.)

4. Chapter 3 problems 26 (ans/hint quadrupole term: $\frac{k\pi^2 R^5}{4\pi\epsilon_0 48 z^3}$),

   28 (ans/hint part b: $\frac{kR^3\cos\theta}{3\epsilon_0 r^2}$),

   29 (V_{oct} is proportional to $(5\cos^3\theta - 3\cos\theta)$),

   31 (check limits as a goes to infinity, dipole moment goes to zero, etc),

   33, 34.