

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 per unit length 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: $\frac{k\pi^2 R^5}{4\pi\epsilon_0 48z^3}$),
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.