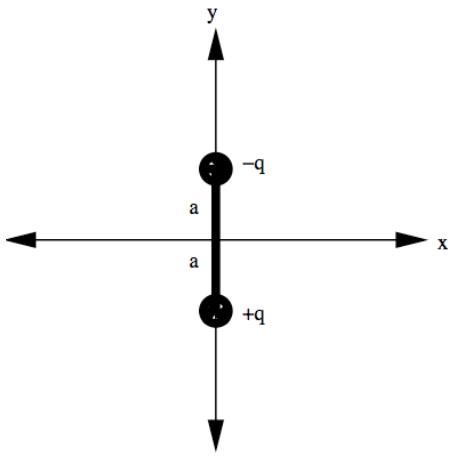
Physics 008 **Problem Set #1** **Fall 2008**

My Lectures from : Purcell Chapter 1
Web Notes : Lecture Notes #1(Workshop #1) and #2
Other Notes: Fields; Coulomb Law; Gauss Law

Purcell Problems:

1.05 Field due to a semicircle
1.09 Potential energy of a sphere of charge
1.11 2 charges on the x-axis
1.16 Sphere of charge with a spherical hollow
1.17 Flux through a cube
1.18 2 infinite sheets of charge
1.19 Infinite plane + infinite layer
1.24 Electric field due to a rod
1.29 Hole in a spherical shell
1.30 Energy stored in two concentric shells

1. Electric field from an electric dipole - A pair of charges lie in the x-y plane. The +q charge is a (0,-a) and the -q charge is at (0,a) as in figure below:



(a) Evaluate the electric field (magnitude and direction) at a point (d,0). Show that for $d >> a, \left|\vec{E}\right| \propto d^{-3}$. What is the direction in this limit? Assume $d > 0$.

(b) Evaluate the electric field (magnitude and direction) at a point (0,d). Find the magnitude and direction when $d >> a$. Assume $d > 0$.

(c) How much work is required to move a particle with charge q' from (d,0) to (0,d)? Do not assume that $d >> a$.

2. Partial Derivatives - For all parts of this problem use the function:

$$f(x,y,z) = \tanh\left(x^2 + y^2 + z^2\right) \quad with \quad \tanh(u) = \frac{\sinh(u)}{\cosh(u)} = \frac{e^u - e^{-u}}{e^u + e^{-u}}$$

(a) Compute the partial derivatives

$$\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}, \frac{\partial f}{\partial z}$$

(b) Define the radial displacement vector as $\vec{r} = x\hat{x} + y\hat{y} + z\hat{z}$.

Calculate the following quantity for f given above and then express in terms of $\vec{r}$.

$$\nabla f = \frac{\partial f}{\partial x}\hat{x} + \frac{\partial f}{\partial y}\hat{y} + \frac{\partial f}{\partial z}\hat{z}$$