Electromagnetic Theory I

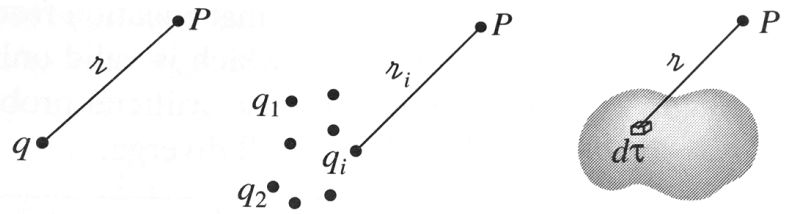
Problem Set #2

Due: 10-9-2015

1. (Adapted from Griffiths) The following Eqs are used in this problem:

$$V(\mathbf{r}) = \frac{1}{4\pi\epsilon_0}\sum_{i=1}^{n}\frac{q_i}{\mathcal{r}_i}, \qquad V(\mathbf{r}) = \frac{1}{4\pi\epsilon_0}\int\frac{\rho(\mathbf{r}')}{\mathcal{r}}\,d\tau'.$$

where **r** points the observation point P. Script r is the distance between P and an element of charge:



Consider the following 3 charge distributions:

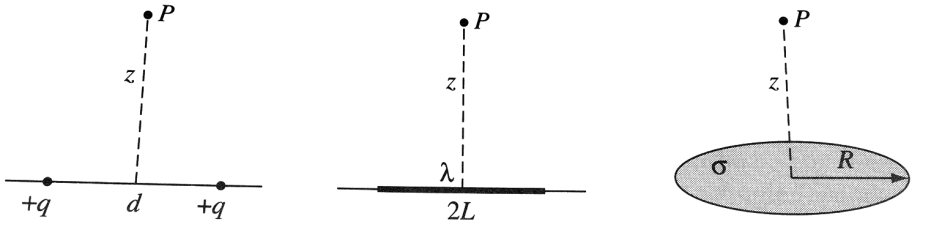


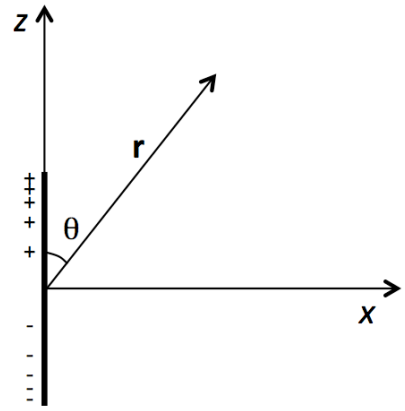
FIGURE 2.34

a) Use the appropriate equation to find the potential at point P for each of the 3 charge distributions shown in Fig. 2.34. The point P is a distance *z* above the center of each charge distribution.

b) For each charge distribution, compute the z component of the electric field at the P.

c) Consider Fig 2.34a. Change the right-hand charge to –q. What is the potential at point P? What is the electric field, **E**, at point P?

2.



$\lambda(z) = \lambda_0 \sin(\pi z/2a)$ for $-a < z < a$

A rod of length $2a$ points along the z direction and is centered at the origin. The charge per unit length on the rod is given by $\lambda(z) = \lambda_0 \sin(\pi z/2a)$. Find the electric potential in the space around the rod in terms of the coordinates r and θ. Express your answer as a definite integral that could be handed over to a mathematician (the variables in the integrand must either r, θ, or a variable of integration).