EXAM I Physics 208 SPRING 2010

Name.....Section Number.....

USEFUL INFORMATION

For two point particles

$$\vec{F} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}\hat{r}$$

$$Volume \quad of \quad a \quad sphere = \frac{4}{3}\pi r^3$$

$$Area \quad of \quad a \quad sphere = 4\pi r^2$$

$$d\vec{r} = dx\vec{i}_x + dy\vec{i}_y$$

$$d\vec{r} = dr\vec{i}_r + rd\theta\vec{i}_\theta$$

PLEASE DO NOT SPEND TIME DOING NON-TRIVIAL INTEGRALS

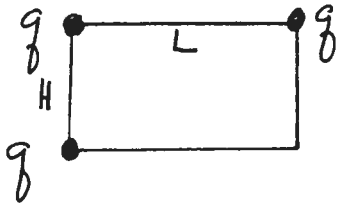
1.

2.

3.

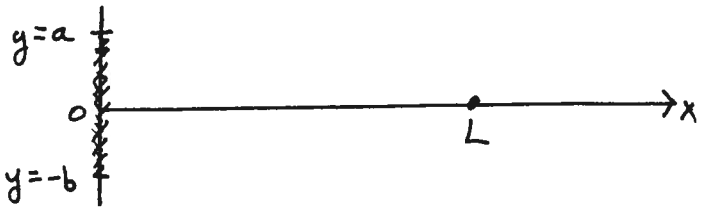
4.

1. (25 points) Three equal charges are fixed at the three corners of a rectangle. What charge would have to be placed at the fourth corner in order for the total force on the upper left charge to be zero?



What must be the relationship between H and L for this to be possible?

2. (25 points)An amount of charge Q is distributed along the y axis from $y = -b$ to $y = +a$.

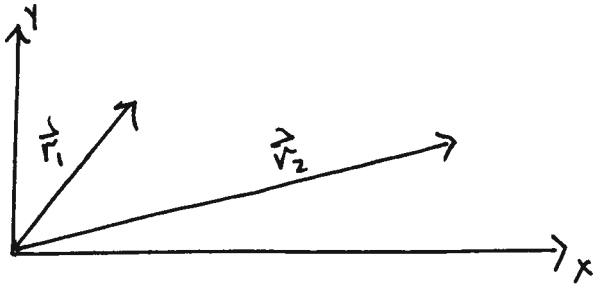


a. (20 points) Find the electric field at a point on the x axis at $x = L$ if the charge is uniformly distributed.

b. (3 points) Find the electric field at a point on the x axis at $x = L$ if the charge is distributed so that the charge per unit length is given by $\lambda(y) = \lambda_0(1 + \frac{y}{a})$.

c. (2 points) What does λ_0 have to be for the total charge to be Q?

3. (25 points)



a. Find the difference in the electric potential between the two points

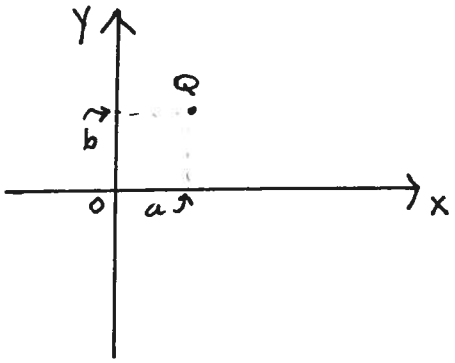
$$\vec{r}_1 = x_1\vec{i}_x + y_1\vec{i}_y = r_1\vec{i}_r \qquad \textit{and} \qquad \vec{r}_2 = x_2\vec{i}_x + y_2\vec{i}_y = r_2\vec{i}_r$$

if $\vec{E} = \alpha x\vec{i}_x + \beta y\vec{i}_y$, where α and β are known constants.

b. Find the difference in the electric potential between the two points

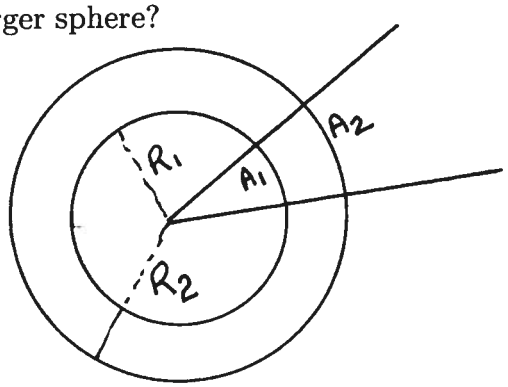
$$\vec{r}_1 = x_1\vec{i}_x + y_1\vec{i}_y = r_1\vec{i}_r \qquad \textit{and} \qquad \vec{r}_2 = x_2\vec{i}_x + y_2\vec{i}_y = r_2\vec{i}_r$$

if, instead, the electric field, $\vec{E}$ was produced by a point charge Q located at the point $x = a, y = b$.

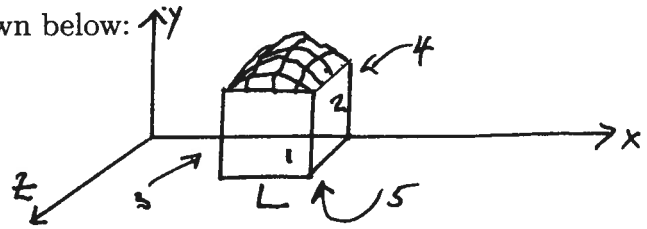


4. (25 points)

a. (5 points) Two concentric spheres have radii R_1 and R_2. A cone with vertex at the center of the spheres intersects an area A_1 on the smaller sphere. What area does it intersect on the larger sphere?



b. (15 points) Consider the surface shown below:



The surface is a cube except for the top which has a weird shape. There is no charge contained within this surface. If there were an electric field given by

$$\vec{E} = a_1\vec{i}_x + a_2\vec{i}_y + a_3\vec{i}_z,$$

where a_1, a_2, and a_3 are known constants, evaluate the flux of $\vec{E}$ through each of the five flat surfaces separately.

c. (5 points) What is the flux of $\vec{E}$ through the weird shaped top?