Physics 133
Homework 1 (Due Friday September 28)
Coulomb's Law and Principle of Superposition

Problem 1.
An electron and a proton are located a distanced of 10^{-10} meters from each other and are both momentarily at rest. At this moment,

a)What electrostatic force does the electron feel due to the proton?
b)What electrostatic force does the proton feel due to the electron?

Consider the following simple picture of a hydrogen atom:
The electron orbits the proton in a circular motion with a constant speed. The proton is very heavy compared to the electron and can be considered fixed in space. The radius of the electron's orbit is 10^{-10} meters.

c) What is the speed of the electron in this model? How does this speed conpare to the speed of light, 3×10^8 m/s? **Hint**: The force needed for circular motion is mv^2/r and is supplied by the electrostatic force.

Problem 2.
Consider an equilateral triangle with sides of length a. Two of the corners have a point charge of magnitude q. See the figure on the last page.

What is the magnitude and direction of the electric field at the top corner of the triangle due to the two charges? Express your answer in terms of a, q, and k.

Problem 3.
Andres has three charges. He places one charge, of magnitude $-3q$, on the x-axis a distance $3a$ right of the origin $(3a, 0)$. He places a second charge, of magnitude $-2q$, on the x-axis a distance $2a$ left of the origin $(-2a, 0)$. He places a third charge, of magnitude $4q$, a distance $2a$ on the y-axis $(0, 2a)$. What is the value of the electric field at the origin? Express your answer in terms of q, a, and k. See the figure on the last page.

Question 4.
A line of charge starts at x_0 and extends to infinity in the $+x$ direction. The linear

charge density is not uniform, but has the form $\lambda = C/x$. See the figure on the last page. Determine the electric field at the origin. Express your answer in terms of C, k, and x_0.

Question 5.
A line of positive charge is formed in the shape of a semi-circle of radius R. The total charge on the semi-circle of charge is Q. What is the value of the electric field at the center of the semi-circle? See the figure on the last page.

Problem 6.
Consider 4 point charges located at the corners of a square with sides of length a. The amount of the charge on diagonally opposite corners are equal. We label them as q_1 for one set of opposite corners and and q_2 for the other set of opposite corners. See the figure on the last page.

What should the ratio q_1/q_2 be so that the charges q_2 experience zero net force?

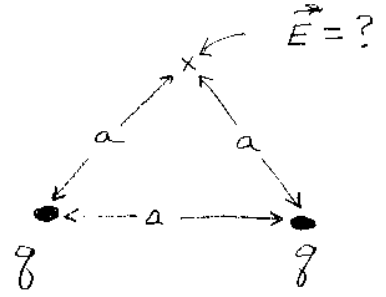
Question 7.
Four point particles are located at the corners of a square of side L. The center of the square is at the origin, and the square lies in the x-y plane as shown in the figure on the last page. Each particle has a charge of $q > 0$. A fifth point particle, also of charge q, is confined to move along the z-axis. Gravity acts in the $-z$ direction.

a) For what value of z does the charge on the z-axis feel the greatest electrostatic force?
b) What is the largest mass, m, that the fifth charge can have so that the 4 charges on the square can "hold up" the fifth charge?

See the next two pages for the figures

FIGURES FOR HOMEWORK 1

(2)



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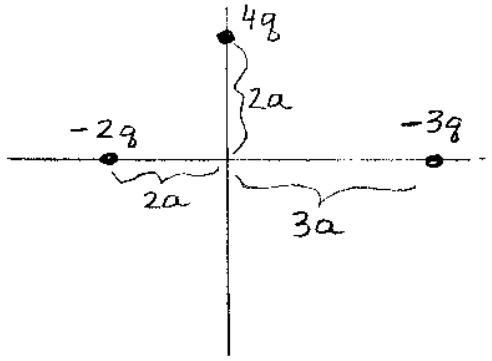

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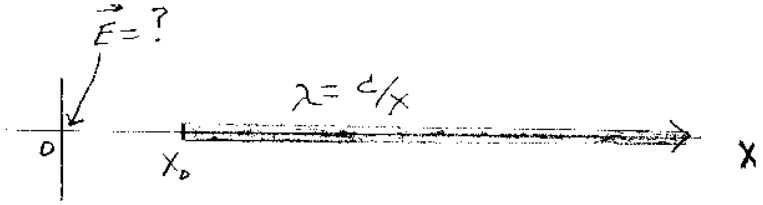

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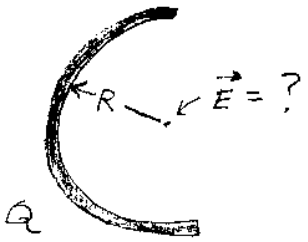

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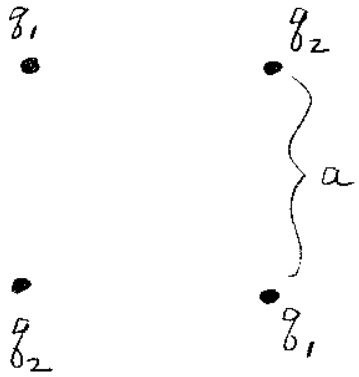
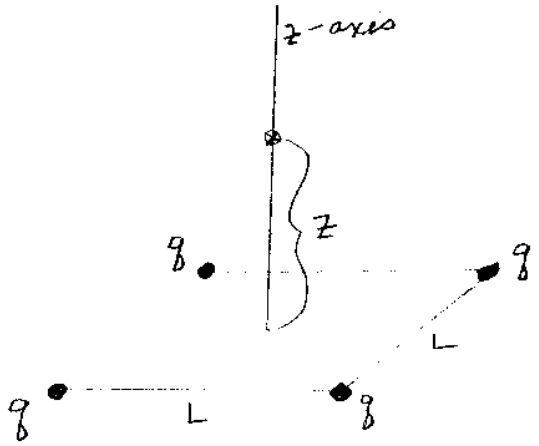
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