Physics 133 Homework 2
Gauss's Law and Intro to Electric Potential
Due Monday October 8

Note: for each problem (except number 6) there is a figure on the figure pages.

Problem 1.
A 9 mm square surface is placed in a uniform electric field. The magnitude of the electric field is 5 N/C, and points in a direction that is $35°$ from a line perpendicular to the surface.

What is the electric flux through the surface?

Problem 2.
Consider the 4 charges shown in the figures page. The magnitude of the charges are $2q$, q, $-q$, and $-2q$.

Draw these point charges on your paper, and sketch a surface through which the net electric flux is:

a) zero
b) $3q/\epsilon_0$
c) $-2q/\epsilon_0$

Problem 3.
A charge of magnitude q is located a distance $a/2$ directly above a square with sides a as shown on the figures page.

Find the electric flux through the square from the electric field due to the charge.

Problem 4.
Our friend Wolfram goes to his favorite delicatessen and buys an infinitely long sausage, which has a radius R. The sausage is uniformly charged with a charge density of ρ. See the picture on the figures page.

a) Find an expression for the electric field for points inside the charged sausage. (i.e. find an expression for $|\vec{E}|$ for values of $r < R$.

Problem 5. Consider a spherical conductor, with a spherical cavity centered about the center. That is, the conductor has an inner radius of a, and an outer radius of b, as shown in the figures page. Inside the cavity, a charge q is placed off center: The total net charge on the conductor is $+2q$.

Use Gauss' Law to find:

a) The total charge on the inner surface.
b) The total charge on the outer surface.
c) The electric field outside the conductor.

Problem 6.
In a hydrogen atom, the electron and proton are approximately 0.5×10^{-10} meters apart. What is the electric potential energy of the hydrogen atom? (Note: this is not the complete energy of the system, since one needs to add in the kinetic energy.)

Problem 7.
Three point particles, each with the same charge q and the same mass m, are located equidistant from each other a distance "a" apart. They are initially held in place at rest.

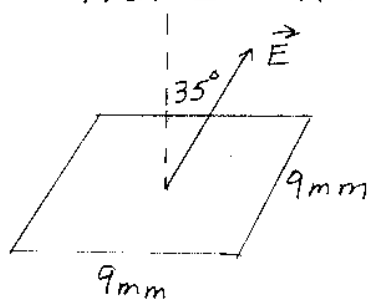a) What is the electrostatic potential energy of the system?

After they are released, they repel each other and fly apart.

b) When they are very far apart (i.e. at infinity), what speed does each point mass have? Express your answer in terms of q, m, k, and a.
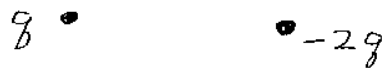
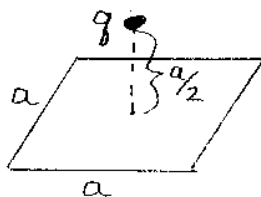*See the next two pages for the figures*
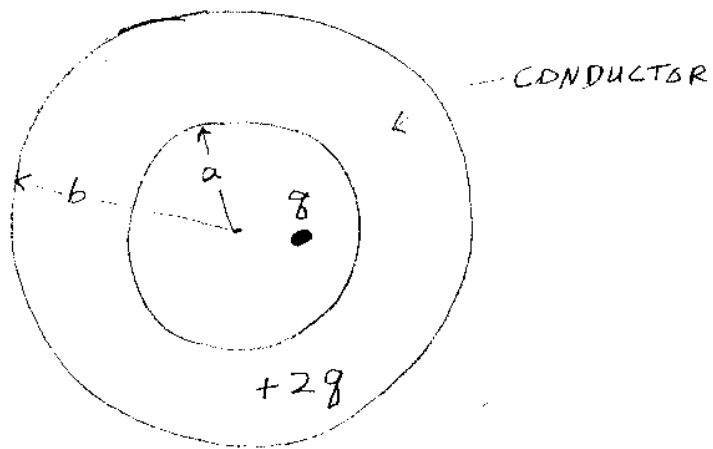
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Figures for PHY133
HOMEWORK #2

①

$\vec{E}$

$35°$

9mm

9mm

②

$2g$

$-g$

g

$-2g$

③

g

a

$\frac{a}{2}$

a

3

(4)

uniform charge density ρ

R

a

b

(5)

CONDUCTOR

a

b

q

+2q

(7)

q, m

a   a

q, m   a   q, m