Physics 133 Homework 3
Voltage, Capacitance and Resistance
Due Friday October 19

Problem 1.
Consider two point charges that are placed on the y-axis. One has a charge of $+Q$ and is located at (0,3a), and the other also has a charge of $+Q$ and is located at (0,-3a).

Find the electrical potential difference between the point (4a,0) and the origin (0,0).

Problem 2. Consider a uniformly charged non-conducting sphere. Let the total charge be Q and the radius of the sphere be R. Find the voltage difference between the center of the sphere and a point on the surface of the sphere. (Hint: First find the electric field inside the sphere, then integrate $\int \vec{E} \cdot \vec{dr}$.)

Problem 3.
Consider a point located on the axis of a thin non-conducting rod. The rod has a length of L and a total charge Q.

a) Find the electric potential a distance x from the end of the rod. (Hint: Divide the rod up into little pieces and integrate over the rod using the electric potential due to a point charge.) See the figure on the figures page.

b) Take the derivative of the potential of part a) and show that it is equal to (-) the electric field at the point.

Problem 4.
Consider the capacitor circuit shown on the figures page.

a) What is the equivalent capacitance of the circuit?
b) If 12 volts are connected across points a and b, find the charges on each capacitor.

Problem 5.
Wolfram sets up two capacitors as shown on the figures page.

When the switch is open, the $6F$ capacitor has $+4$ Coulombs on one side and -4 Coulombs on the other plate. When the switch is closed, what is the final charge on the capacitors?

Problem 6.
You have several $4 \ \mu F$ capacitors, each capable of withstanding 250 Volts without breaking down. You need to assemble some of these together such that the capacitance of the combination of capacitors is

a) $1 \ \mu F$
b) $2 \ \mu F$

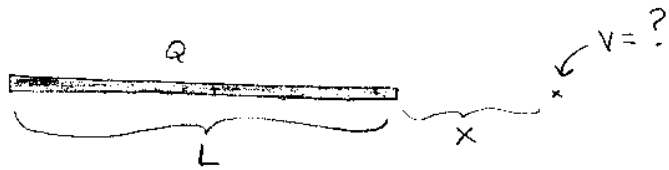and each combination is capable of withstanding 1000 Volts across it.

Problem 7.
Determine the capacitance of two concentric spherical conducting metal shells. Let the inner shell have a radius of a, and the outer shell a radius of b. See the figure on the last page.
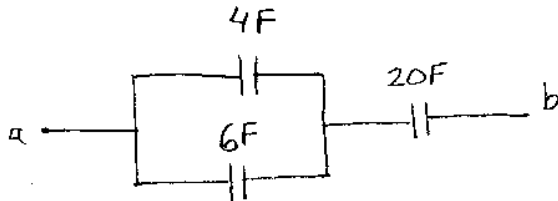
Problem 8.
A certain wire has a resistance R. What is the resistance of a second wire, made of the same material, that is half as long and has half the diameter?
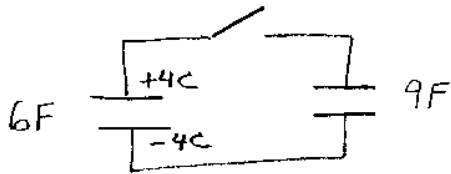
FIGURES FOR HWK3

(3)

Q

V = ?

L

X

(4)

4F

20F

b

a

6F

(5)

6F

+4c

9F

−4c

(7)

−Q

+Q

a

b

3