

**Physics 133 Homework 3**  
**Voltage, Capacitance and Resistance**  
**Due Friday October 23**

**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  $\int \vec{E} \cdot d\vec{r}$ .)

**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.

includegraphics[width=14cm]fig3.png

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?