

# Physics 380-001

## Homework #4

### Practice Problems:

We have listed problems from the textbook that involve related skills and concepts; answers to these problems may be found in the back of the text. You should use these extra problems for practice and review, but they do *not* need to be turned in. Selected Practice Problems from Griffiths: 3.3, 3.8, 3.9

**1. Earnshaw's Theorem (2 pts):** Do problem 3.2 in textbook

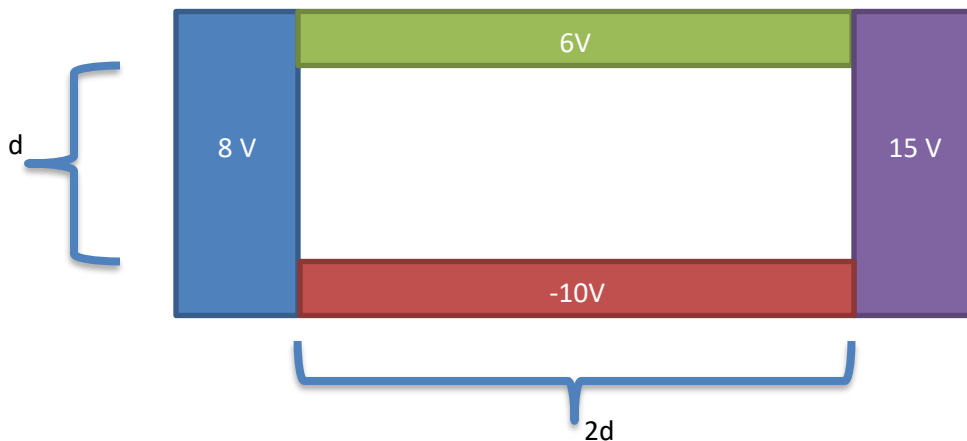
**2. Mirror Mirror (2 pts):** Do problem 3.7 in textbook

**3. Exclamation points are never good (6 pts):** Do problem 3.10 in textbook



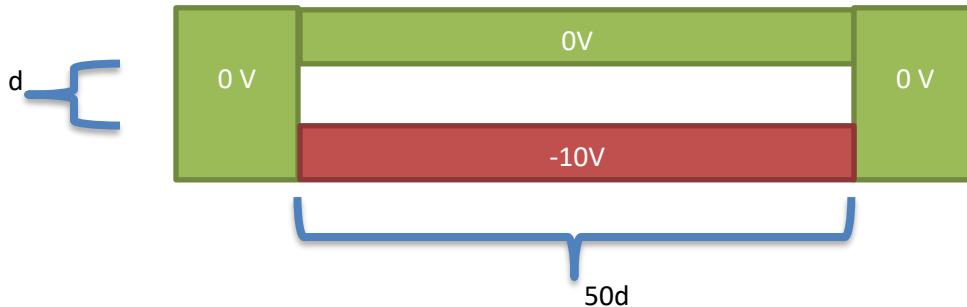
**4. You've got "numerical" problems (4 pts):** Use the method we discussed in class to find the potential in Excel.

- a) Four plates form a box in 2-D. Each plate has a different potential as shown in the picture below. Determine the potential inside. (Please include at least a grid of 20 X 10)



- b) Make a plot of the potential inside (your choice of plot).

- c) In another configuration, four different plates form a box in 2-D. Each plate has a different potential as shown in the picture below. Determine the potential inside. (Please include at least a grid of 10 X 1000), (Hint: make sure you have the number of iterations set correctly)



- d) Make a 2D plot of the potential you calculated in part c, in the line down the center (i.e.,  $y(x, d/2)$  vs  $x$ ).

**5.) Not too formal for me (6 pts):** We have been developing all kinds of equations in class. Things with point charges, line charges, surface area charges, etc. But remember, I said that using the uniform charge density was the most fundamental description of the electric field or the potential. For example:

$$V(\mathbf{r}) = \frac{1}{4\pi\epsilon_0} \int \frac{\rho}{r} d^3x$$

- a) Show, in Cartesian coordinates, that the charge density for a uniform continuous string of charge is given by: (Hint: it's okay to use the equations given in the book, for linear charge density)

$$\rho(\mathbf{r}) = \lambda \delta(y - 0) \delta(z - 0)$$

- b) Show, in Spherical coordinates that the charge density for a continuous area of charge is given by:

$$\rho(\mathbf{r}) = \sigma \delta(r - R)$$

- c) What is  $\rho$  for a point charge at the origin in Cartesian coordinates?

**6. Now I'm stuck in a pipe (10 pts):** Solve Laplace's equation for cylindrical symmetric potentials. Assume that the potential doesn't have any dependence in the z-direction.

**7. Strange pipe (2 pts):** Find the potential inside a pipe where the potential obeys the following equation:

$$V(R, \varphi) = \begin{cases} V & 0 \leq \varphi < \pi \\ -V & \pi \leq \varphi < 2\pi \end{cases}$$

**8. Now a pipe with charge density (2 pts):** Charge density:

$$\sigma = a \sin 2\varphi$$

Where a is constant is glued over the surface of an infinite cylinder of radius R. Find the potential inside and outside the cylinder.