Studio PY106 Electric Fields and Potentials Lab **Name: ______________________** **Table: ____**

For this lab we will continue to study some general characteristics of the electric field and electric potential and voltage produced by configurations of point charges. We will be using the PhET that you've seen before, available at *https://phet.colorado.edu/en/simulation/charges-and-fields*

Part 1: Examining the electric field and equipotential lines produced by a single point charge.

Begin by putting a single positive point charge into the simulation area. Turn on the *grid* feature of the simulation. For convenience, try to center the point charge on one of the major grid lines.

Equipotential Lines: We will first examine the equipotential lines produced by this point charge. Use the voltage cursor tool to plot equipotential lines in 2V increments starting at +16V and working your way to +6V. Move the voltage tool to the point you want and then click the pencil to create "equipotential" lines.

1. What shapes do the equipotential lines of this single point charge make? Please sketch them below

2. How does the spacing between the equipotential lines change as you get farther from the charge? Why?

Electric Field: Now let's see how the new concept of electric potential relates to the electric field. Click and drag a yellow "Sensor" into the simulation space.

3. Recalling that the brightness of the arrows indicates the magnitude of the electric field, describe the correlation between the electric field magnitude and the spacing of equipotential lines for the single point charge.

Now we will examine the position dependence of both the electric potential and electric field. Place the positive point charge far to the left side of the grid, midway up, again centered on a major grid line. Measure the electric potential along the horizontal axis passing through the charge using the voltage tool at 8 equally spaced locations. Do the same for the electric field strength using the e-field sensors.

4. Plot both the electric field strength and electric potential versus distance on the grids below (use labels!).

Which quantity, the electric field strength or the electric potential, decreases faster with increasing distance? Is this consistent with the formulas we've studied for the electric field and electric potential?

Part 2:. Now replace the single point charge with two negative point charges, roughly in the center of the screen and 1 m (two large grid lines) apart on a horizontal line. Use the cursor tool to plot 6 or 7 equipotential lines in 10V intervals starting near the charges.

5. What is the sign of the voltage near your negative point charges? Why is it different than part 1 above?

6. What shapes do the equipotential lines make? Sketch them here:

7. What do you observe about the equipotential lines very near the charges and very far away from them?

Now replace the charge on the left with a positive charge. This pair of charges (one + charge and an equal-magnitude – charge) is called an electric dipole. Use the cursor tool to plot equipotential lines for -10V to 10V in 2V intervals.

8. What shapes do these equipotential lines make? Draw some of them below.

9. Now sketch the electric field lines for this situation. Electric field lines are lines that start at one charge (Which charge do they start at?) and follow the electric field direction and ultimately end at the other charge (Which charge do they end at?).

Questions

Consult with your groups to answer these questions.

1. What does it imply about the electric field when the electric potential is zero?

2. Did you observe two field or equipotential lines crossing each other?
   Is this possible according to the definitions of the lines? Explain.

3. Using the standard definition that $V = 0$ infinitely far from a charge, in the case of a single positive point charge is it ever possible to find a location where the electric potential is negative?

4. The simulation only shows two spatial dimensions whereas we live in a world with three. What do you think the shapes of the equipotential *surfaces* of a single point charge are in three dimensions?

5. In 3D, what are the equipotential surfaces of a pair of positive point charges separated by a distance d ? Choose three positions,

   (a) far away, $r >> d$;

   (b) close in on one charge, $r << d$;

   (c) midway, $r \sim d$.