PhET Electric Potential and Field

The mathematical relationship between the electric potential and the electric field may be the single most important concept you learn this semester.

Part 1: Visualizing the relationship between potential and field

Start here:

https://phet.colorado.edu/sims/html/charges-and-fields/latest/charges-and-fields_en.html

Unclick the "Electric Field" box in the upper right hand part of the screen, and then click on the "Voltage", "Values" and "Grid" boxes.

Place a positive 1 nC charge and a negative 1 nC charge at the same vertical position but separated horizontally by 6.0 m.

Use the "Equipotential" meter (from the right side of the screen) to find a location in the screen that has a potential of 10.0 V. When you do, click on the pencil on the equipotential meter, and it will draw an equipotential line. Do the same for potentials of 8.0 V, 6.0 V, 4.0 V, 2.0 V, 0.0 V, -2.0 V, -4.0 V, -6.0 V, -8.0 V and -10.0 V.

For four locations on the line connecting the two charges, measure the distance between two adjacent equipotential lines. For each location, estimate the derivative of the potential with respect to the position by dividing the change in the potential by the distance between the equipotential lines. Drag an electric field sensor to the location and compare the magnitude of the electric field you measure to the derivative of the potential. Are they close? Keep in mind that the potentials are continuously changing, so dividing the change in potential by the change in the distance is really just a rough estimate of the derivative of the potential. Now consider the direction of the electric field. In which direction is the derivative of the potential? To the left or to the right? In which direction is the electric field pointed? In the same direction as the derivative or in the opposite direction?

Now do the same thing – and answer the same questions - for a location vertically above the positive charge and another location vertically above the negative charge.

Part 2: Potential and field of an electric dipole

Place a negative charge at the center of the screen on the major grid line closest to the box on the bottom of the screen where the charges are stored. Then place a positive charge 0.5 m directly above the negative charge.

Use the equipotential line finder to draw the 1.0 V equipotential line. Do the same for the equipotential lines for 0.9 V, 0.8 V, 0.7 V, 0.6 V, 0.5 V, 0.4 V, 0.3 V, 0.2 V and 0.1 V.

Open a spreadsheet and set up two columns – the one on the left for the distance of the equipotential line above the center of the line connecting the two charges and the column on the right for the potential. Once you have done this, make a plot of the points, and then fit a power law trendline to the points. Print the equation for the trendline in your plot. Then take a screen shot of your plot and paste it into your Word document.

Now measure the electric field strength and direction at each equipotential line (on the vertical line above the charges). Answer this question in your Word document: Is the electric field strength reproduced by the derivative of the potential function?

Convert your Word document to pdf and submit it via Canvas.