Theoretical Discussion
In a brief paragraph, explain the concept of the electric potential field (a scalar field) contrasting it with the concept of the electric field (a vector field). Describe their interrelationship and how one can go from one to the other. Use the potential of a point charge as an example in your discussion. Introduce the next section with some sort of description of how you’ll demonstrate the concepts you just explained.

Methods
Describe the spreadsheet routine. Include a sketch or printout of the various parameter boxes and grids.

Presentation of Data
Present the printouts carefully describing all of the features of the graph. Discuss the limitations of your data in terms of finite grid spacing, etc.

Analysis of Data
Discuss the pattern of equipotential lines in terms of how they fit your theoretical expectations. E.g., the location of the zero potential lines, where the lines are closest together, furthest apart, etc.
Map the electric field lines on top of the equipotential lines using a different color pencil or pen. Be sure to include a legend on your figure which clearly points out which lines are which. Now, using the theoretical discussion from the first section, determine the magnitude and direction of an electric field vector somewhere on your diagram.

Conclusions
Briefly discuss how your models fit your theoretical expectations.
Background

In lecture we will develop the electric potential as an important concept used in analyzing electric fields and, hence, forces. The electric potential due to a point charge was found to be the following.

\[ V = k \cdot \frac{q}{r} \]

where “k” is a constant = \(8.99 \times 10^9\) Nm\(^2\)/C\(^2\), “q” is the magnitude of the point charge and “r” is the distance from the point charge to the point at which the potential is being calculated. The potential is a scalar field. As with all field equations, the potential at any position can be calculated by simply inputting the position information (in this case specified by “r”) into the field equation.

The Assignment

In this lab you’re required to write a program (actually a “spreadsheet routine”) in MS Excel™ that calculates the electric potential field around a grid corresponding to a single point charge at first and, later, a pair of point charges. Using printouts of the electric potential field, you will then calculate the Electric Field, itself (a vector field).

Getting Started

Open Excel from the network list and, then, open the Potential Lab template file from the x: drive. You’ll find a layout somewhat like that shown on page 2. It will consist of two boxes specifying point charge parameters (x,y position components and charge magnitude) and three grids. The grid closest to the charge parameter boxes is the equation grid. The other two are the y component and x component grids.

Important

Immediately “Save As” this file to your diskette (which will be on the “a:” drive).

Programming the Equation Grid

The equation grid is the one that will produce your potential field data. Note that the sides are labeled with x,y values. In the upper left hand box (y=10, x=1) input the potential equation for two point charges corresponding to the charge box parameters. (Note: keep “r” as variable as possible using absolute references to the charge box parameters and relative references to the x,y grids.

If you input the equation correctly you can then copy it and paste it into the remaining equation cells.

Graphing the Equation Grid

Graph the grid by selecting all the grid cells, going to the chart wizard, placing the chart box in a view that includes the charge parameter boxes, and selecting the 3-D surface option. Next select Format #4. Now, reverse the order of the “y” axis (for some reason, Excel inverts these in this type of plot). This will result in the generation of equipotential lines around the point charges. Using this graph, do the following:

1) Graph the potential around a single point charge. Play with the positions of the point charge and the contour intervals until the contours are smooth. Print out the plot and the associated equation grid.
2) Before changing the charge parameters, make a line graph directly through a charge. Use this later to calculate the magnitude of the electric field along this line.

3) Repeat 1) for the potential of an electric dipole (two charges of opposite sign).

4) Repeat 2) for the potential of an electric dipole (two charges of opposite sign).

Extra Stuff

Time permitting, play with

a) Format #1 under the 3-D surface option

b) The expanded template (a 50 X 50 grid already done for you).