Electric Fields: U. P. II Lab #5
M.L. West

Objective: to use software to simulate electric fields, to explore graphically the electric fields produced by various spatial distributions of charges, and to investigate their potential surfaces.

Preparation: Start, All Programs, EM Field 6, EMField
Authors: ________________________________

Define: Electric field:

For a single charge, strength of the electric field = $E(r) = \ldots$

Equi-potential line:

I. Single Point Charge
a) We will investigate a single positive charge and its electric field lines.
Prediction of field lines:

Make the window full screen.
Pull down Sources, 3D Point Charges.
Now drag a charge of +1 onto the stage (playing field).
Pull down Field and Potential, Field Lines
Click at many various points around your charge.
Sketch the program’s field lines:

Compare your prediction and the program’s result:

Select Display, Clean up screen

b) We will investigate a single positive charge and its electric field vectors.
Select Field and Potential, Field Vectors
Click at various points around your charge.
Sketch of program’s electric field vectors:

c) We will investigate a single positive charge and its electric directional arrows.
Field and Potential, Directional arrows:
Click at various points around your charge.
Sketch of program’s electric directional arrows:
Describe the differences between electric field lines, vectors, and directional arrows:

d) Now we will investigate a single negative charge and its electric field vectors. Prediction of field vectors:

Clean up the display, and place the charge.
Select Field and Potential, Field Vectors
Click at various points around your charge.
Sketch of program’s field vectors:

Try a larger negative charge:

Describe how the field vectors of a negative charge are different from those of a positive charge.

II. Two charges on the stage
Display, Clean Up Screen
Investigate one positive charge = 1, and one negative charge = -1,
a few centimeters apart.
Prediction of field vectors:

Sketch of program’s field vectors:

Try click and hold and drag.
Then add field lines also.
Comment on the relationship of field lines and field vectors:

b) Try charges +1, +1
Prediction of field lines:
Sketch of program’s field lines:
III. Three Charges on the stage
a) Investigate +1, +1, +2 in a straight line
Prediction of electric field lines:

Sketch of program’s electric field lines:

b) Try +1, -1, +2 in a straight line
Prediction of field lines:

Put a few vectors, then lots of field lines.
Sketch of program’s field lines:

c) Drag one of the charges to another position on the stage, off the straight line.
Prediction of field vectors:

Sketch of program’s field vectors:
Isn't this fun?

IV. Equipotential Surfaces
What is the relationship of equipotential surfaces to field lines?

a) Single Point Charge
Prediction of equipotentials:
Select Field and Potential, Field lines, and place some field lines.
Field and Potential, Equipotentials
Click at various points around your charge to place the equipotential lines.
Sketch of program’s equipotentials:
b) Now let’s get quantitative. Display, Clean up screen.
Show grid. Place a charge of +6 on a grid point.

We want to find out how equipotential values depend on distance from a charge.
Select Field and Potential, Equipotentials with numbers.
Think. Use the grid, and click intelligently.
Print the program’s graphic of equipotentials with numbers (one copy for your team).
Record your data of distance from the charge, and equipotential values in a spreadsheet.
In particular, what is the value of the potential at a distance of one grid point? ________
From the textbook state the equation for electric potential as a function of distance from a charge:

So, what is the value of $k$ in this computer program? ________

Make a scatter point graph of potential value vs. distance (x axis).
Is this relationship monotonic? ________ Is it linear? ________
Try fitting various trendlines. For each type of trendline record the statistical R squared value. Higher numbers of R squared indicate a better fit of the trendline to the data. Make a small table in your spreadsheet for the type of trendline (linear, exponential, logarithmic, polynomial, power law) and its R squared value. Choose the best trendline and leave it on the graph, while deleting the other trendlines.
Write the best equation:

After using print preview, print the spreadsheet with its small embedded graph.

V. Ready to test what you have learned? Get ready for a challenge!
Select Sources, 3D point charges
Option, Challenge game
a) Find one hidden charge by clicking to expose electric field vectors.
When you are confident that you have located a charge, drag a marker to its position.
Challenge, Estimate amount of charge. (Hint: think about the length of the electric field vector at a specific distance from a charge.)
Click on the marker and type your magnitude estimate.
Challenge, Judge.
Describe your method:

b) Option, Challenge game
Find two hidden charges
Can you find three?

Conclusions