Name _____Partner_____ Date _____

EM Fields: E&M Lab #4

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Objective: to use software to simulate electromagnetic fields and to explore graphically the electric fields from various spatial distributions of charges, and to investigate Gauss's law.

Preparation: Start, All Programs, EMFields6, EMField
Authors:
Define E(r):
Define algorithm:

I. Single Point Charges

a) A single positive charge, electric field vectors
Select Sources, 3D Point Charges
Drag a charge of +1 onto the stage (playing field)
Prediction of field vectors:

Field and Potential, Field Vectors
Click at various points around your charge.
Sketch of program's field vectors:

Comment on comparison of your prediction and the program's result:

Display, Clean up screen

b) A single positive charge, electric field lines
Prediction of electric field lines:

Select Field and Potential, Field Lines
Click at various points around your charge.
Sketch of program's lines:

Display, Clean up screen.

c) A single positive charge, directional arrows
Field and Potential, Directional arrows
Click at various points around your charge.

Describe the difference between electric field vectors, electric lines, and directional unit arrows:

d) A single negative charge
Sources, 3D Point Charges
Drag a charge of -1 onto the stage.
Prediction of field vectors:

Click at various points
Sketch of program's field vectors:

Larger negative charge:
Prediction of field vectors:

Sketch of program's field vectors:

II. Two charges on the stage
a) Positive 1, negative 1
Prediction of field vectors:

Sketch of program's field vectors:

Field vectors. Drag and hold and put one vector down. Then add field lines
Comment

b) +1, +1
Prediction of field vectors:

Sketch of program's field vectors:

III. Three Charges
a) +1, +1, +2 in a straight line
Prediction of electric field lines:

Sketch of program's field lines:

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

Sketch of program's field lines:

State an algorithm for drawing field lines:

c) Drag one of the charges to another position on a 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:

What unit is electric potential measured in?
a) Single Point Charge
Prediction of equipotentials:

Sketch of program's equipotentials:

Field and Potential, Field lines
Field and Potential, Equipotentials (sketch)

Let's get more quantitative now. Display, show grid
Field and Potential, Equipotentials with numbers.
Pick evenly distributed distances around a charge of +6 located on a grid point.
Prediction of equipotentials:

Sketch of program's equipotentials (print this):

Use Excel to list and plot electric potential vs. distance from this charge. Try fitting trendlines of various forms. Record their equations and R-squared values. Which is the best function to describe Potential (distance) ? Print your data table and the plot with the best trendline.

V. Charged Rods (infinitely long, coming out of the screen)
a) Sources, 2D Charged Rods
+1, +2
State Gauss's Law:

Field and Potential, Flux and Gauss's Law
Drag "a circle" (a closed curve not crossing itself) around one of the rods. This is a gaussian cylinder. Drag another closed curve around the other rod. Drag another curve around both rods. Drag another curve around empty space.
Describe the display:

b) Sources, 2D charged rods
+2, -2
Drag the four curves and describe:

VI. Line Currents
Electric currents in wires cause magnetic fields. Prediction:

Display, Show grid.
Display, Constrain to grid.
a) sources, +1 amp current

Drag to see the magnetic field vectors
Sketch:

b) +1 amp, +1 amp currents
Sketch of program's magnetic field lines:

VII. Ready to test what you have learned?
Sources, 3D point charges
Option, Challenge game
a) Find one hidden charge by clicking to expose electric field vectors.
(Recall page 1.)
When you are confident that you have located a charge, drag the open circle marker there.
Challenge, estimate amount of charge.
Click on the marker and type the number of the charge.
Challenge, judge.

Discuss your method:

b) If there is time, find two hidden charges. Put markers, guess magnitudes.
Discuss your method:

VIII. Conclusions: