

Experiment #3 Electric Fields Pre-lab Questions

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- Read the Background Information section of this lab and answer the following questions.
 - What is an electric field?

The presence of an electric charge produces a force on all other charges present.

$$\vec{F} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} \hat{r}$$

This is Coulomb's Law. The charges exert a force on one another by means of disturbances (propagated at the speed of light) that they generate in the space surrounding them. These disturbances are called electric fields.

Each electrically charged object generates an electric field which permeates the space around it, and exerts pushes or pulls whenever it comes “in contact” with other charged objects. The electric field generated by a set of charges can be measured by putting a point charge q at a given position. The test charge will feel an electric force. The electric field at the location of the point charge is defined as the force divided by the charge:

$$\vec{E} = \frac{\vec{F}}{q} = \frac{1}{4\pi\epsilon_0} \frac{q_1}{r^2} \hat{r}$$

- Why must the electric field be a vector?

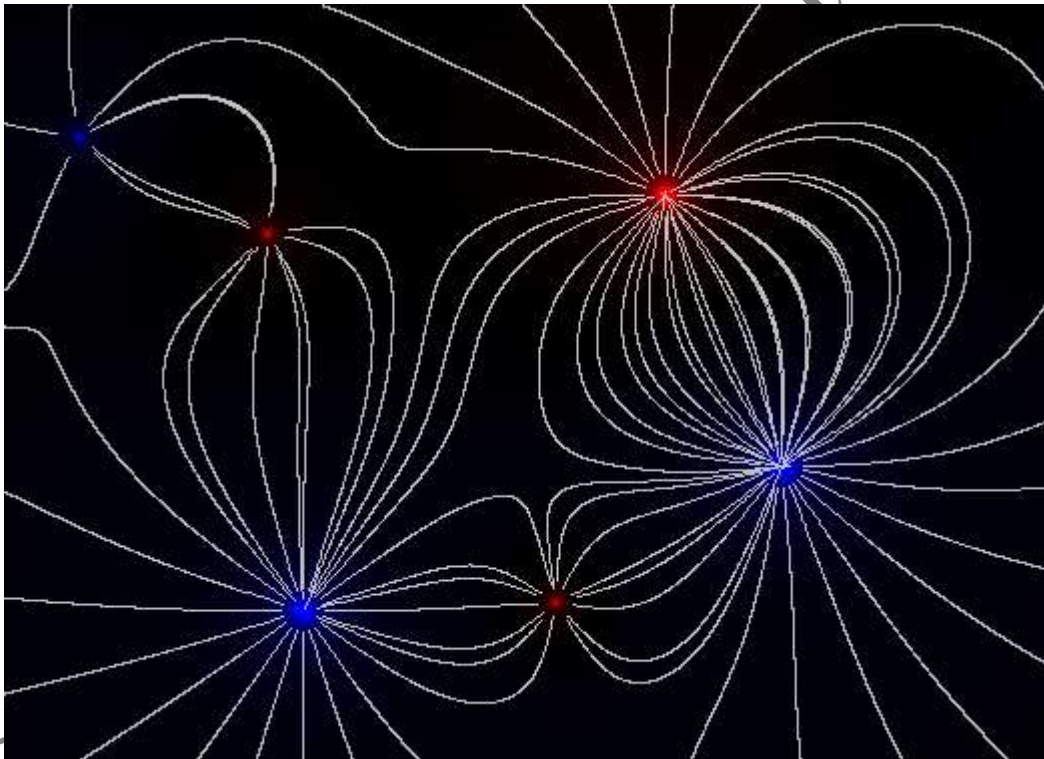
Since the electric force is a vector (it has both a magnitude and a direction [pointing radially away or radially toward a charge depending on the sign]), and the electric field is defined as the force divided by a test charge, then the electric field will also be a vector (it too will have both a magnitude and a direction [pointing radially away or radially toward a charge depending on the sign]).

- The electric field points in the same direction as the _____?

The electric field points in the same direction as the electric force. The direction of the electric field is the direction in which a positive test charge placed at some position (r) will move. For example, if the electric field is negative, a positive test charge will move toward the negative charge distribution generating the negative electric field. If the electric field is positive, a positive test charge will move away from the positive charge distribution generating the positive electric field.

○ **Under what conditions can two electric field lines cross?**

Two electric field lines can *never* cross. They will always begin on positive charges (or at infinity) and end on negative charges (or at infinity). If there is a larger positive charge than negative charge, the field lines will bend toward the negative charge, but will never cross. Examples of this are shown below. (Red charges are positive and blue charges are negative in the following example. Notice that the field lines (in white) NEVER cross.)



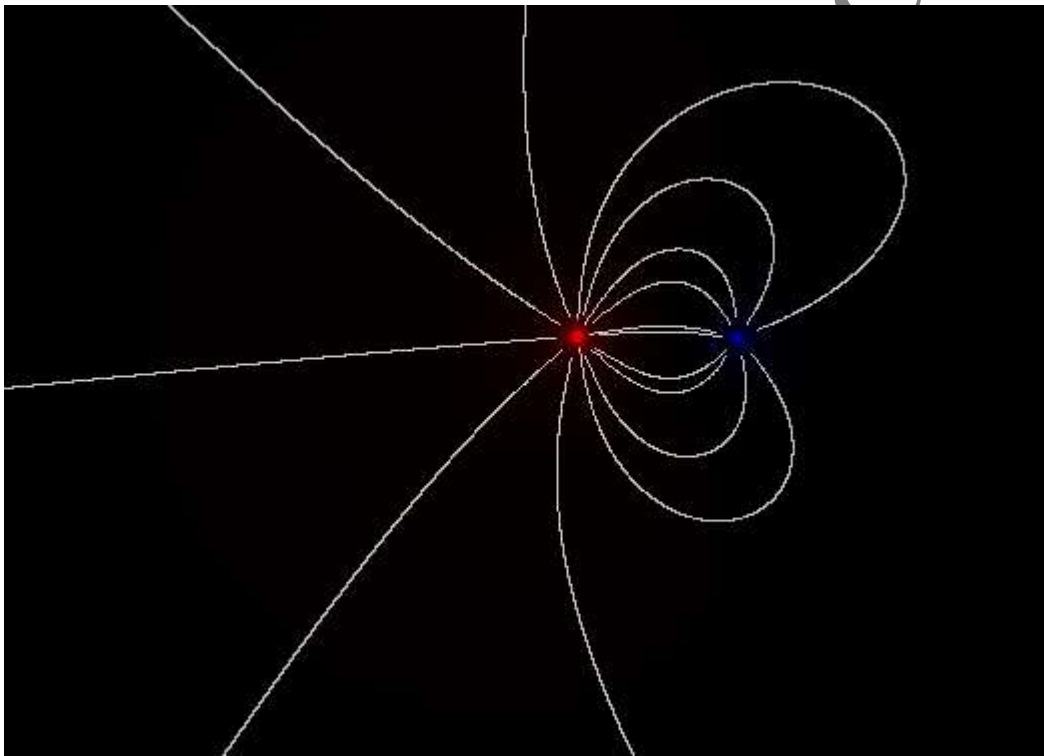
- Below are two circles representing point charges:



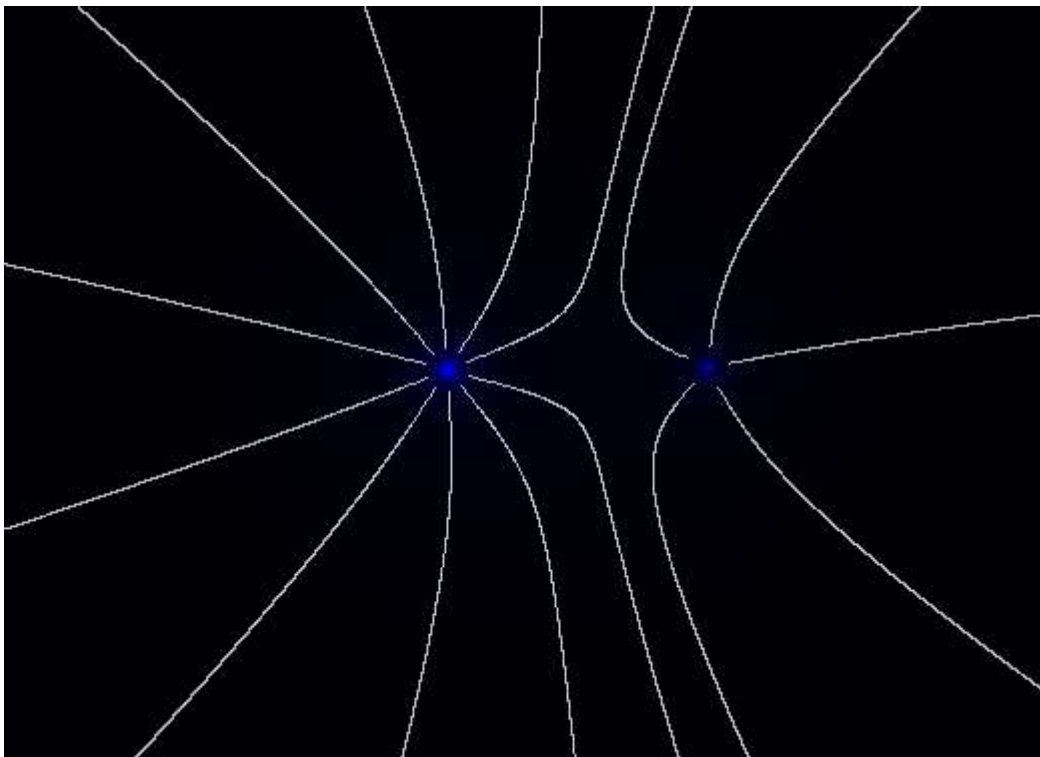
- The lines through the circles are the beginnings of E-field lines.
 - What is the relative magnitude of the two charges?

The relative magnitude of the two charges is 2x. That is, the charge on the left is two times the charge on the right. This is accomplished by counting the number of electric field lines emerging from the charges. The charge on the left has 12 lines emerging from it, and the charge on the right has 6 lines emerging from it. So, for example, if we measured the charge on the right to have a charge of 1 Coulomb, then the charge on the left would obviously be 2 Coulombs. If the charge on the right was 4.2 Coulombs, then the charge on the left would be 8.4 Coulombs. This is why we call it a “relative” magnitude – because the left charge will always be twice the right charge, but depends upon the initial magnitude of charge on the charges. * Phew *

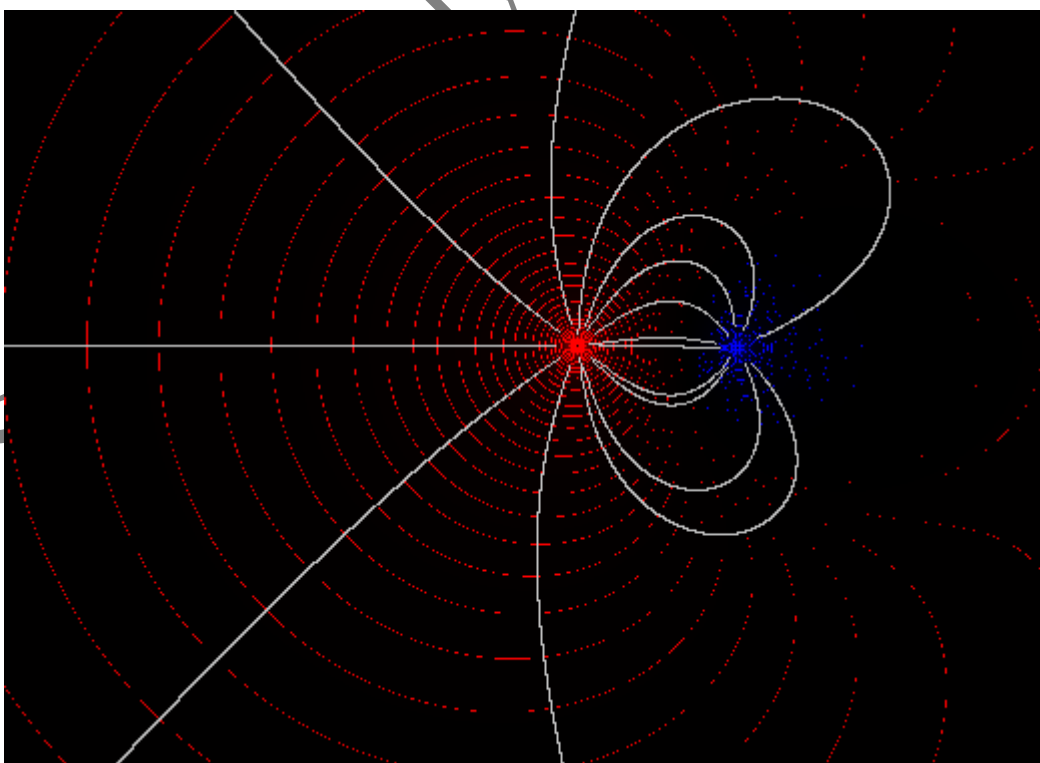
- **On a separate piece of paper, finish drawing the electric field lines by hand. Make the left charge positive and the right charge negative.**

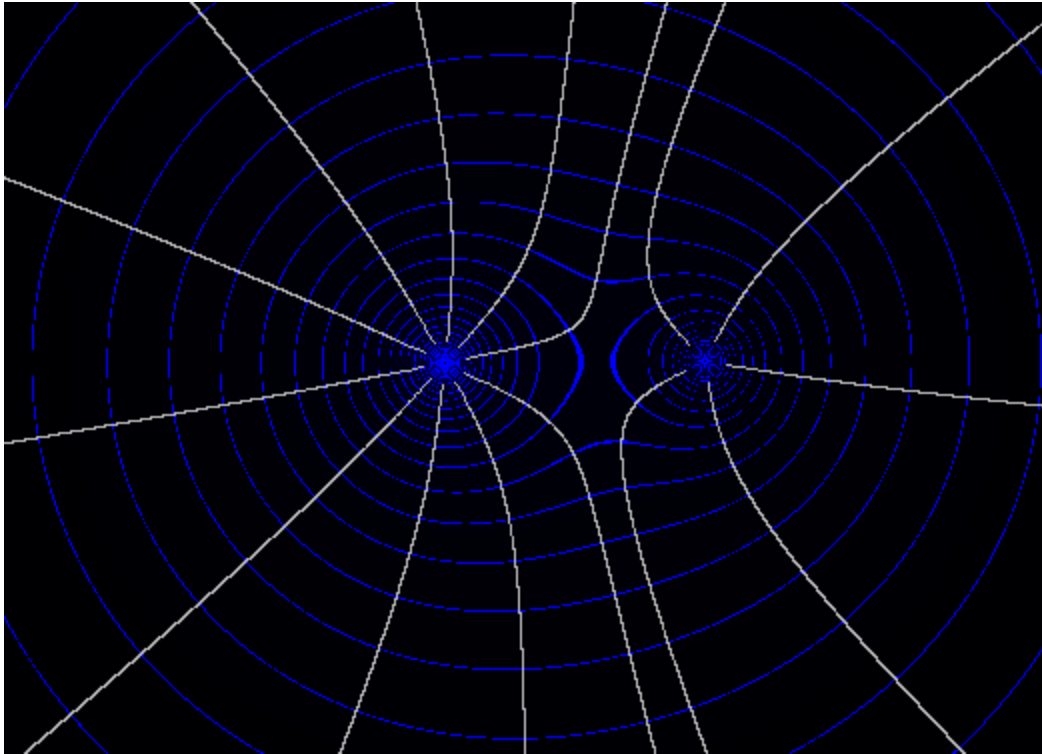


- **Repeat the part above for two negative charges.**



- On the same diagrams you drew in parts (b) and (c), draw the equipotential lines for these charges. Use the electric field lines to guide you.





The above images are taken from:

<http://www.cco.caltech.edu/~phys1/java/phys1/EField/EField.html>

This is an excellent website that you can use to determine the equipotentials and electric field lines for several charges in different configurations. Play with a few and check it out – it really is quite interesting.