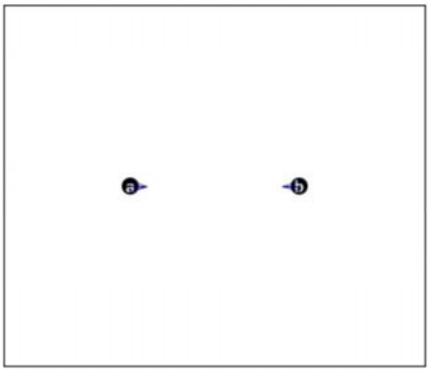
Lab 6: Electrostatics

Lab 6: Electrostatics (see website)

Like and Unlike Charges



Description:

Two unknown charges are shown on the screen along with vectors representing the net force on each charge. If you hold the mouse down on the charge you see its x and y position along with the magnitude of the force on it caused by the other particle and you can move the charges around.

Drag the charges around with the mouse and note the magnitude and direction of the force at various locations.

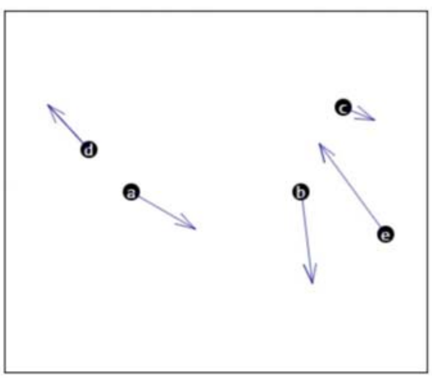
Question 1:

Is there any way to tell from this simulation which charge is positive and which is negative? Explain.

Question 2:

Is there any way to tell from this simulation which charge has the larger magnitude? Explain.

Five Charges



Description:

Five unknown charges are shown on the screen along with vectors representing the net forces on each. The length of the vector is proportional to the magnitude of the force. You can click-drag on any charge to change its position.

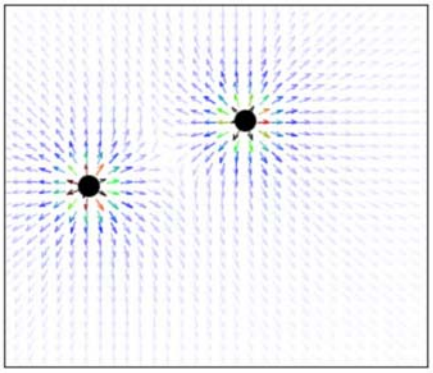
Question 3:

Which charges have like signs? How did you arrive at your answer?

Questions 4:

Move charges a and b to the far left of the window and the other three charges to the far right. What can you say about the force on charge a as compared to the force on charge b (is Newton's third law obeyed)? Now move one of the other three charges closer to the pair on the left. Why are the forces on a and b no longer equal and opposite?

Electrostatic Fields



Add Reset x=-1 y=0 q=1

Description:

This simulation shows the electric field vectors; the colors indicate the relative strength of the field at that point. You can drag the charges around to see the change in the electric field due to the changes in charge position. If you overlap two charges, their charge values will add and you will see the field due to the combined charges.

Question 5:

- Click on the Reset button.
- Click on the add button to add a positive charge.
- Click on the add button again to add a second positive charge.

With two positive charges describe the electric field around each charge. What happens if you lay a positive charge exactly on top of a positive charge of the same magnitude?

Question 6:

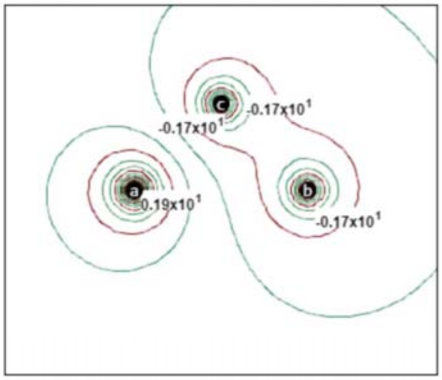
- Click on the Reset button.
- Click on the add button to add a positive charge.
- Change q to be -1 and add a negative charge.

With a positive and a negative charge showing describe the electric field around each charge. What happens if you lay a positive charge exactly on top of a negative charge of the same magnitude? Both charges are still there so why you don't you see a field?

Question 7:

In this simulation there is a way to tell *from the picture* which charge is negative and which is positive. Expain how.

Electric Potential



Description:

Three charged particles are shown in the animation along with their electric potential. You can click drag any of these particles. Holding the mouse down on any location shows the x and y position of that location and the potential,V, at that location in a box at the bottom of the simulation. Double clicking in any location draws the equipotential surface through that location.

Click on the charges to get the equipotential lines to appear. Double click in several different locations on the screen to see more eqipotential surfaces.

Question 8:

Hold the mouse button down so you can see the value of the potential, V (in volts), at the bottom of the screen and carefully trace one of the equipotential lines. What is an equipotential line?

Question 9:

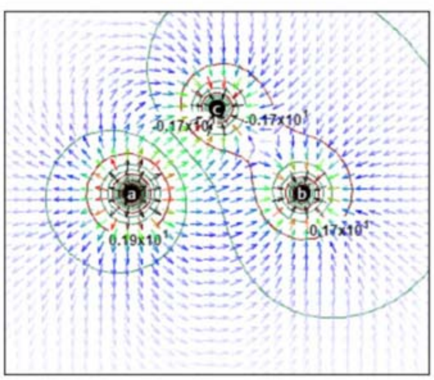
Hold the mouse down NEAR (but not on) charge *a* and drag towards charge *b* while noticing the potential in the box at the bottom of the screen. What happens to the potential as you drag the mouse from charge *a* to charge *b*? From *b* to *c*? From *c* to *a*?

Questions 10:

Which charges are positive and which are negative? How do you know?

List the chages in descending order of magnitude. How did you determine this?

Potential Lines



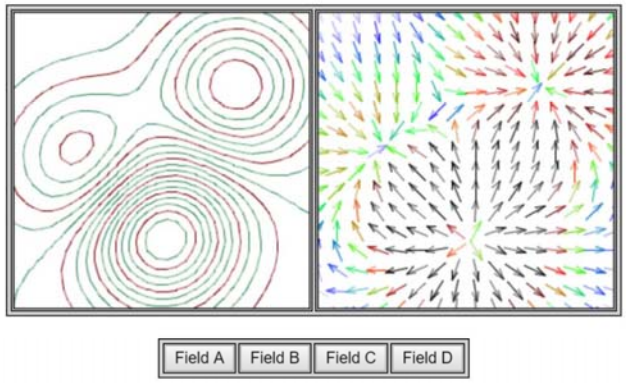
Description:

Three charged particles are shown in the animation along with their electric field and their electric potential. Double clicking in any location draws the equipotential surface through that location. You can click drag any of these particles. Holding the mouse down on any location shows the x and y position of that location and the potential,V in volts, at that location in a box at the bottom of the simulation.

Question 11:

Double click in several different locations on the screen to see more eqipotential surfaces. Move the charges around. What is the relationship between an equipotential surface and the electric field vectors at that location?

Comparing Field to Potential



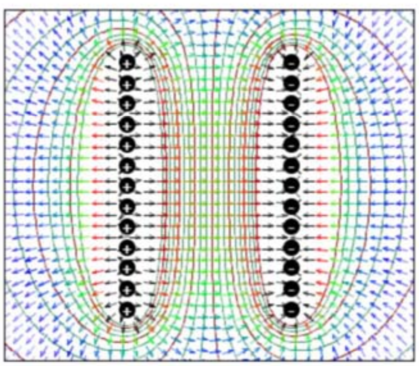
Description:

A set of potential lines around three point charges are shown on the left. You can click-drag in the left hand display to measure the potential at any point. Four choices of electric field lines can be shown on the right (click on one of the choices Field A etc. to display the electric field plot). The arrows in the field plot represent the direction and the colors represent the magnitude of the electric field.

Question 12:

Which electric field plot (on the right) best corresponds to the potential plot on the left hand side? How did you determine this?

Electrostatic Fields



Description:

This simulation shows the electric field vectors and the electric potential for a configuration of parallel charges (this is similar to the example of a parallel plate capacitor). Holding the mouse down gives the potential at that point in a box at the bottom of the simulation. Double clicking in any location draws the equipotential surface through that location. The colors of the electric field vectors indicates the strength.

A uniform electric field is one that has the same magnitude and direction everywhere.

Question 13:

In which region(s) is the electric field uniform or very nearly uniform (where do the vectors have the same color and direction)?

In which region(s) is the electric field non-uniform?

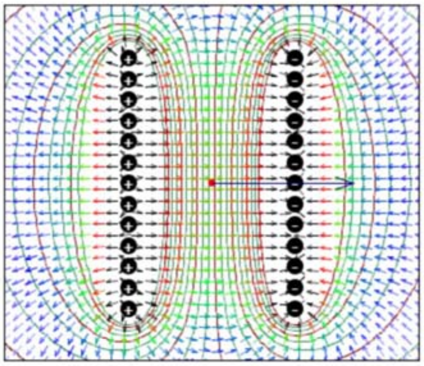
Question 14:

In the region between the plates, hold the mouse down and drag it around, noticing the value of the potential, V at the bottom of the simulation. In which direction can you move the mouse so the potential increases? Decreases? Remains constant?

Question 15:

Describe the equipotential in the region where the electric field is (nearly) uniform.

Uniform Field



Description:

The simulation shows a charge distribution between which there is a (nearly) uniform electric field (like the field between the plates of a capacitor) and a test charge (the small red dot in between the two rows of charge). The field vectors and equipotential lines are drawn for this case. The test charge shows a vector with the net force acting on it.

Move the test charge around and note the direction of the force acting on the test charge.

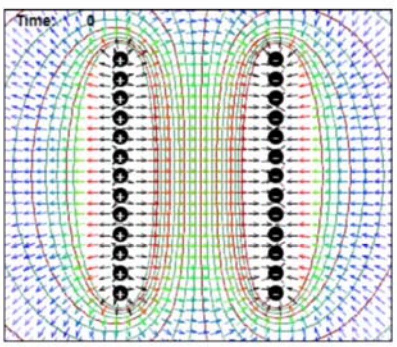
Question 16:

Which direction does the force on the test charge point relative to the electric field vectors?

Question 17:

Which direction does the force on the test charge point relative to the electric equipotential lines?

Test Charge



Description:

The simulation shows a charge distribution between which there is a (nearly) uniform electric field (like the field between the plates of a capacitor). The equipotential lines are drawn for this case. When you click on the start button below a small test charge is released at the location you specify in the box (x=0, y=0 is the center of the simulation) with an initial y velocity (v_y) you specify.

x=0 y=2 v_y=0 Start

Question 18:

Start the test charge with the default values of at x=0, y=2, v_y=0. Describe the motion. How does the direction the test charge travels compare with the direction of the force on the test charge?

Question 19:

Run the simulation several times with x=0, y=2 and the y velocity (v_y) set to different negative values between -1 and -5 and describe the motion. How does the direction the test charge travels compare with the direction of the force on the test charge?

Question 20:

In simulation H you found that the force on a test charge is in the same direction as the electric field and perpendicular to the eqipotential surfaces. In the previous question, then, why doesn't the test charge move in the direction the electric field vectors point (and perpendicularly across the equipotential surfaces) in these cases? Explain.