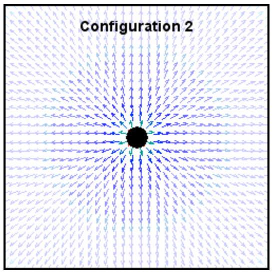
Worksheet for Exploration 24.4: Application of Gauss's Law



A point charge has radial (spherical) symmetry about the center of the charge while a line charge has cylindrical symmetry about the center of the wire **(position is given in meters and electric field strength is given in N/C)**. However, a two-dimensional view of both can look the same. Restart.

Consider the two configurations. One is a point charge and one is a line of charge (pointing into and out of the screen). Which is which? The electric field is different for the two cases (and you use two different Gaussian surfaces).

a. As a function of the distance away from the charge (as a function of r), what is the electric field of a point charge?
   i. That is, give the theoretical formula for magnitude of the electric field for the special case of a point charge.

$E_{point}=$

b. Therefore, if you measure the electric field at some point and then measure it twice as far away, how much should the electric field be decreased?
   i. Prediction.

   ii. Go ahead and make measurements for each configuration.

r=_______ 2r=_______

Configuration 1

E(r)=_______ E(2r)=_______

Configuration 2

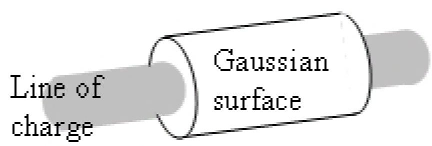
E(r)=_______ E(2r)=_______

c. Which configuration, then, is a point charge?

d. Use Gauss's law to find an analytic expression for the electric field around a line of charge. You may find the following diagram useful:
   i. To use Gauss's law for the line charge you must consider the electric field direction for a line charge (consider it positive). Describe the direction of the E field.

   ii. Next you should write out both sides of Gauss's law (net flux on one side, charge enclosed on the other). The charge density is a linear charge density usually called λ (which means charge per unit length). Consider the length of the Gaussian can L and radius r. The total charge in the can is then λL.

   iii. The flux side of Gauss's law has three parts in this particular case. The end face of the cylindrical can near you, the end face away from you, (both of those are the flat surfaces) and the curved surface of the can. Write out the total flux as the sum of those three contributions. Then determine how to write out the flux through each surface (two should be really easy due to the orientations of E and the normals). The last surface should also be easy. You should now be able to solve and obtain an expression for E_{line}.



E_{Line}=___________

e. If you measure the electric field at some point and then move twice as far away, how should the field drop off from a line of charge?

f. Does the electric field of the other configuration agree with this?
   i. Remember you have measurements above to check this.