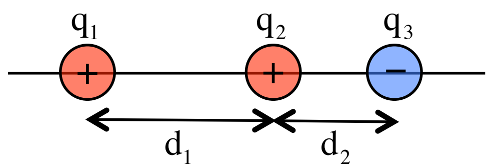
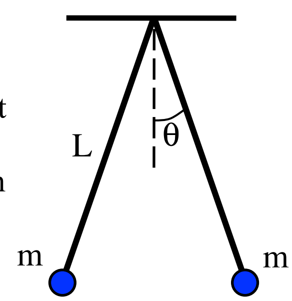
23-Series Problem

23.4) Two people stood apart at arms-length. If each had 1% more electrons than protons, the electric force between them would be great enough to lift a weight equal to the weight of the earth. (This hypothetical was first put forth by Nobel Laureate Richard Feinman of Caltech, whose daughter happens to work at Poly.) Show this assertion is true to an order of magnitude (that is, within a factor of 10).



23.8) Given the sketch of charges to the right, and noting that $q_1 = 6.00\ \mu C$, $q_2 = 1.50\ \mu Cs$ and $q_3 = -2.00\ \mu C$, with $d_1 = 3.00$ cm and $d_2 = 2.00$ cm, determine the net force (as a vector) on:

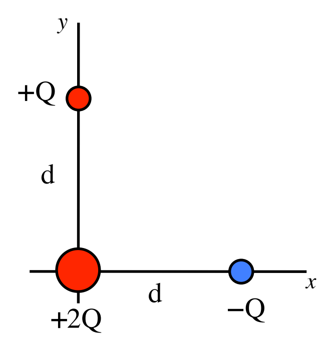
a.) q_1;
b.) q_2;
c.) q_3;



23.10) Two light strings of unknown length L are suspended from a common point with two 0.200 gram masses attached to their free ends. Each mass is given a 7.2 nC charge. The repulsion motivates the two masses to swing out to an equilibrium position at an angle of $\theta = 5^\circ$ with the vertical, as shown. Determine the length L of the strings.

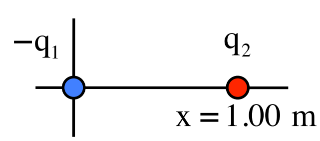
23.15) The Bohr model for the hydrogen atom has an electron orbiting in a circular path at radius $5.29\text{x}10^{-11}$ meters out from a central proton. If the charge on each particle is $1.6\text{x}10^{-19}\text{C}$ and the mass of the electron is $9.1\text{x}10^{-31}$ kg:

a.) Determine the magnitude of the electric force between the two charged particles.
b.) If the force is wholly centripetal, what does the model predict for the speed of the electron?

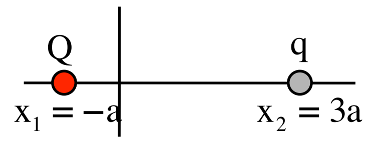


23.17) With reference to the sketch to the right, derive an algebraic expression for the net force acting on $+Q$ located up the *y-axis*.

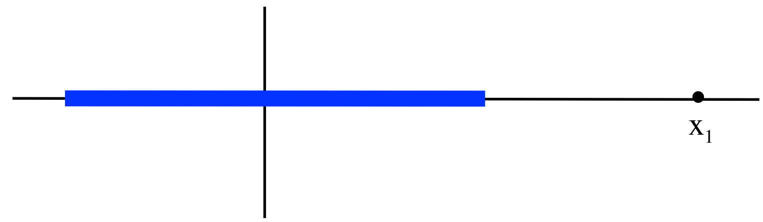
23.21) Where, other than infinity, is the electric field *zero* in the sketch to the right?



23.24) Two charges, one known (Q) and one unknown (q), are located as shown in the sketch. It is known that at the origin, the magnitude of the electric field is equal to $2k\frac{Q}{a^2}$. What are the possible values for the unknown charge?



23.29) A uniformly charged rod of length L is negatively charged and is centered on the origin of a coordinate axis.

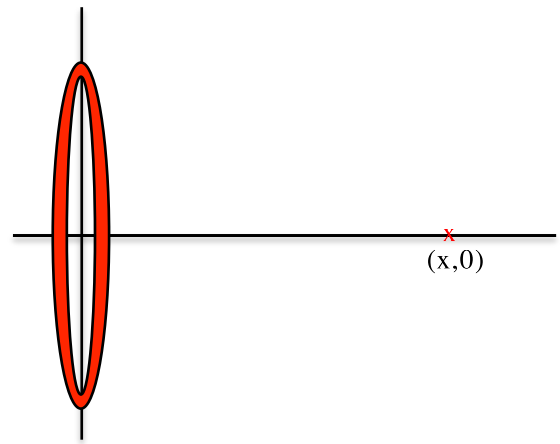


a.) Derive an expression for the magnitude of the electric field a distance *x* units down the *x-axis*. Once derived, determine the field's value assuming $L = 14.0\text{ cm}$, the total charge is $-22.0\ \mu C$ and $x_1 = 36.0\text{ cm}$.

b.) What is the field's direction?

23.31) A 10.0 cm radius ring that is uniformly charged has a net charge of $75.0\ \mu C$ on it. Derive an expression for the electric field down the central axis of the ring, then evaluate it for:

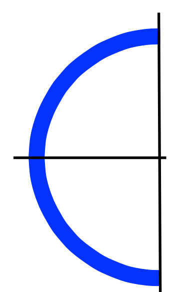
a.) x = 1.00 cm
b.) x = 5.00 cm
c.) x = 30.0 cm
d.) x = 100. cm



23.35) Consider the sketch to the right:

a.) Derive an expression for the magnitude of the electric field at the center of the semi-circular charged rod of length L with a negative charge on it, then use L = 14.0 cm and a charge $-7.50\ \mu C$ to determine a numeric value for that field.

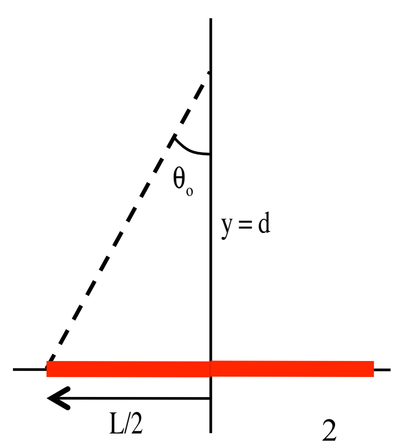
b.) What is the direction of the E-fld at the center?



23.37) A uniformly charge rod of length L and charge density λ is symmetrically placed on the *x-axis*.

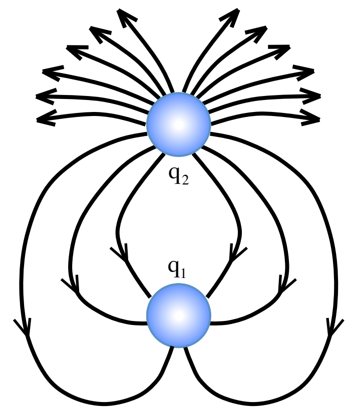
a.) Derive an expression for the electric field *d units* up the *y-axis*? Is there an *x-component* for that field? Show that this field can be written as $E = \frac{2k\lambda}{d}\sin\theta_o$, where θ_o is as defined in the sketch.

b.) Use *Part a* to determine the field for an infinitely long rod.



23.40) A disk with area charge density σ is viewed from the edge. What will the electric field lines look like from that perspective?

23.41) Consider the charge distribution and electric field lines for the two charges shown to the right.



a.) What is the charge ratio q_1/q_2 ?

b.) Determine the signs of each charge.

23.43) An electron and proton are released from rest in an electric field of magnitude 520 N/C. How fast will each be moving after traveling 48.0 ns?

23.45) A proton sits in an electric field of magnitude 640 N/C. It accelerates from rest. Shortly thereafter, its speed is $1.20\text{x}10^6$ m/s. Ignoring relativistic effects (which would be small in this case):

a.) What is the proton's acceleration?

b.) How long did it take for the proton to reach this speed?

c.) Over what distance does the proton move during this interval?

23.47) A particle beam is comprised of electrons each of which have kinetic energy K.

a.) If you wanted to stop these electrons in a distance *d*, how large an electric field would you need?

b.) In what direction would this field need to be?

23.49) An electric field found in space (i.e., no gravity) is observed to be $\vec{E} = \left(9.60\text{x}10^3 \text{N/C}\right)\hat{j}$.

a.) How long would it take for a proton moving at $\vec{v} = \left(4.50\text{x}10^5 \text{m/s}\right)\hat{i}$ to move 5.00 cm horizontally?

b.) What would its vertical displacement be during the time it took to move 5.00 cm horizontally?

c.) What would its velocity, as a vector, be after traveling that 5.00 horizontal cm?