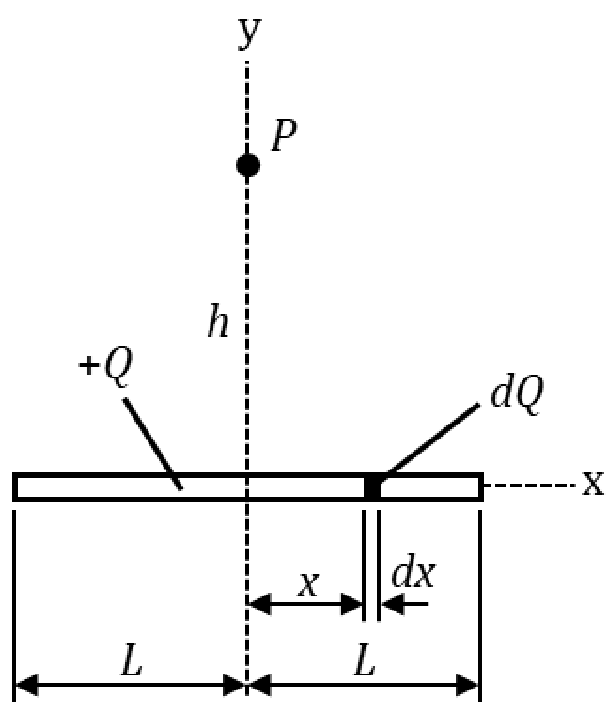
APPC, E & M: Unit A HW 2

Name: ______________________________
Hr: ___ Due at beg of hr on: __________

UA, HW2, P1
Reference Video: "The Electric Field Due to a Line of Charge (Part I)"
YouTube, lasseviren1, ELECTROSTATICS playlist

A line of charge (of length 2*L and total charge* +*Q) lies on the x-axis and is centered on the y-axis, as shown.*



A. Draw three vectors originating at Point *P*, which represent the electric field at that location due to the tiny amount of charge shown, *dQ*. The three vectors should be:

i. $d\vec{E}$ and...
ii. ...the components of $d\vec{E}$, namely $d\overrightarrow{E_x}$ and $d\overrightarrow{E_y}$

B. If you start with your first *dQ* element at the origin and then progress along the +*x*-axis, how do the magnitudes of the $d\overrightarrow{E_y}$ components due to each successive *dQ* element change?

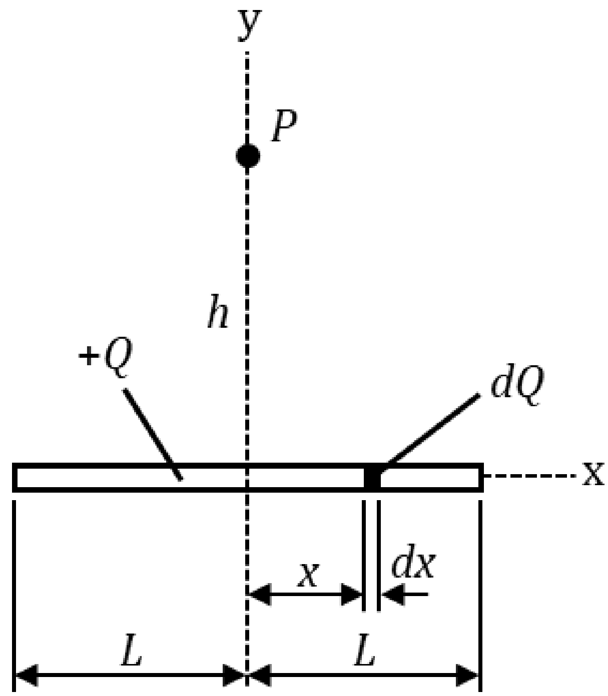
C. For a *dQ* element at the origin, what is $d\overrightarrow{E_x}$ at Point *P*, due to that *dQ* element?

D. In what direction is the net electric field at Point *P*, due to the entire line of charge?

E. Explain VERY briefly your answer to Part D. Mention both component vectors $d\overrightarrow{E_x}$ and $d\overrightarrow{E_y}$ for the many *dQ* elements that lie along the entire length of the line of charge.

UA, HW2, P2
Reference Video: "The Electric Field Due to a Line of Charge (Part II)"
YouTube, lasseviren1, ELECTROSTATICS playlist

Based on the figure you used in Problem 1, your task now is to determine an expression for the electric field at Point *P*, in the following way…



A. In terms of *k*, *Q*, *L*, *x*, *dx*, and *h*, write an expression for the *y*-component of the differential contribution to the electric field at Point P due to *dQ*, i.e., $d\overrightarrow{E_y}$ = ?.

Hint: You will need to define an angle θ first, then use an appropriate trig function, and finally get rid of the trig function using the dimensions of the right triangle that came into being when you defined θ.

B. Use a proportion to help you get *dQ* in terms of *dx*. Your answer should have "*dQ* = " on the left side of an equation and everything else on the right, one of which is *dx*.

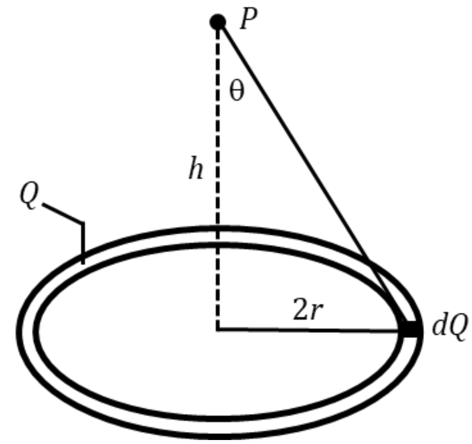
C. Take the next step by writing out the integral that must be solved when you sum up all of the various $d\overrightarrow{E_y}$ "bits" from Part A, i.e., $\vec{E}_y$ = ? First, take your answer from Part B and substitute it into your answer to Part A. Then, make sure you have an integral sign (with limits), and any constants pulled outside the integral. For the limits of integration: You may use either the limits based on the coordinate system shown in the figure OR by using the symmetry argument mentioned in the video.

D. From either the video or from a table of integrals, write here the integral pattern that applies to the expression you wrote in Part C.

E. Use your answer to Part D to solve the integral of Part C; this will give you an expression for the net electric field at Point *P*, i.e., $\vec{E}_y$ = ? in terms of the quantities given. Be sure to put the limits (i.e., the stuff with *L*) into the expression for *x*, i.e., there should be NO *x* terms in your final answer.

UA, HW2, P3
Reference Video: "The Electric Field Due to a Ring of Charge"
YouTube, lasseviren1, ELECTROSTATICS playlist

A. At Point *P*, draw $d\vec{E}$ due to the dQ shown. Also, draw the one component of $d\vec{E}$ that cannot be canceled on the basis of symmetry arguments. Invent a label of your choice so that this not-canceled component can be distinguished from $d\vec{E}$.



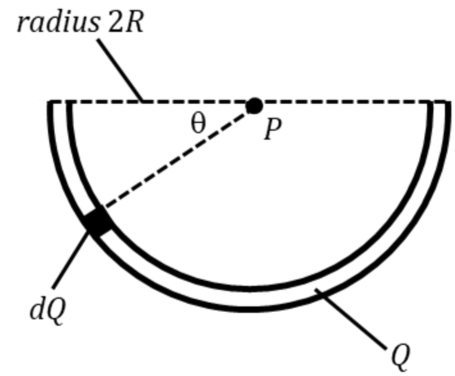
B. At Point *P*, in what direction does the net electric field point?

C. Now, write an expression for the differential component of the electric field (due to dQ) for which you invented a label in Part A. Your expression should be in terms of k, r, dQ, and h.

D. Integrate your expression from Part C to obtain a final expression for the net electric field at Point *P*.

UA, HW2, P4
Reference Video: "The Electric Field at the Center of a Semicircular Ring of Charge"
YouTube, lasseviren1, ELECTROSTATICS playlist

A. In the figure, at Point P, draw $d\vec{E}$, $d\overrightarrow{E_x}$, and $d\overrightarrow{E_y}$ vectors due to dQ. Based on what is already shown in the figure, write another θ in the correct place, in the vicinity of your dE vectors.



B. i. For this distribution, which dE component will be completely canceled out?

ii. Based on your answer to Part Bi, the net electric field at Point P will point in which direciton?

C. In terms of R, k, dQ, and θ, write an expression for dE_y.

D. Add whatever is necessary to the figure on the previous page to show what is meant by the differential angle $d\theta$. Clearly label $d\theta$ on the diagram.

E. Use a proportion to help you get dQ in terms of $d\theta$. Your answer should have "$dQ =$ " on the left side of an equation and everything else should be on the right, one of which is $d\theta$.

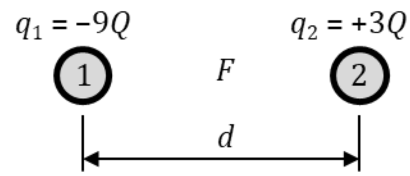
F. Substitute your answer from Part E into your answer from Part C to obtain a new expression for dE_y.

G. Integrate your Part F expression. Since θ is measured relative to the x-axis (see the figure), you can simply integrate from $\theta = 0$ to $\theta = \pi$. Your final answer should be $E_y = ?$

UA, HW2, P5
Reference Video: "Review of Electrostatics (Part I)"
YouTube, lasseviren1, ELECTROSTATICS playlist

The electric force between two charged, identical metal spheres has the magnitude *F*.

A. Is $\vec{F}$ attractive or repulsive? Explain.



B. In terms of *F*, what will the force be if the distance is reduced to $^1/_3$ d?

C. i. If we want the force to become ½ *F*, does the distance between the spheres need to increase or decrease, compared to *d*?

ii. With regard to Part Ci: By what factor should *d* change?

D. If we bring the spheres together so they touch, and then move them apart again to a distance *d*, how much charge (in terms of *Q*) will reside on… ...Sphere 1? ...Sphere 2?

E. At this point, will the force between the spheres be attractive or repulsive?

F. In terms of the original *F*, what will be the magnitude of the new force between the spheres?