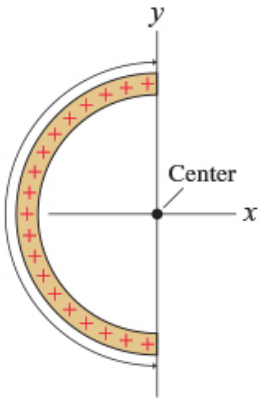
In-class problems, Thu Feb 20, 2020

22.4 22.5, E due to a line of charge, charged disk

1. *from yesterday...*

   Consider a half circle. It has a total charge of Q and a radius a. Determine the electric field at the circle's center.



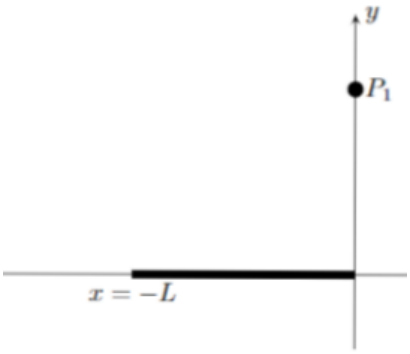
   (a) Sketch what this looks like. Include a couple of dq's, the distance r, and any angle θ that might be helpful.

   (b) Sketch $d\vec{E}$'s from your two dq's. What component(s) of the resulting $\vec{E}$ do you need to calculate? You'll have to choose the dq's wisely

   (c) Write your integral and substitute in the appropriate dq. Since this is an arc stay in polar coordinates (r, θ), and use $ds = rd\theta$ (which comes from $s = r\theta$). Don't change to rectangular coordinates (x, y) so that means keeping $\cos\theta$ or $\sin\theta$ as is.

   (c) Calculate E. You'll be able to do the integral.

2. A straight wire of length L has a uniform charge density λ. Determine the electric field at point P_1, a point somewhere along the y-axis.



   (a) Sketch what this looks like. Include a dq, the distance r, and any angle θ that might be helpful.

   (b) Sketch $d\vec{E}$ from your dq. What component(s) of $\vec{dE}$ do you need to calculate?

   (b) Calculate $\vec{E}$. You're welcome to leave your answer as integrals, but include limits, and simplify as much as possible (in particular, move all constants out of the integral).

3. A ring of radius a and total charge Q, has an electric field of

$$E = \frac{kQx}{(x^2 + a^2)^{3/2}}$$

   along its axis (that is, down the middle).

   (a) Determine the electric field at the center of the ring.

   (b) Determine E in the limit that $x \gg a$. Provide an expression (that is, an equation with some kind of dependence on x).

4. You design an apparatus in which a uniformly charged disk of radius R and total charge Q_{disk} produces an electric field. The field is important at P, a distance $2R$ above the center of the disk. Cost analysis suggests that you switch to a ring with the same radius.

   Calculate the amount of charge the rings needs, Q_{ring}, that would lead to the same electric field at P.

Due Mon Feb 24, 2020, beginning of class

22-6, 22-7 point charges and dipoles in E

Read 22-6, 22-7.

1. (a) Write down equation 22-28.

   Describe what this equation says about what happens to a point charge q when it's in an electric field $\vec{E}$.

   (b) Use words.

   (c) Use a sketch. Sketch a uniform electric field. Place a positive point charge in the field. Sketch the force. Repeat for a negative point charge.

2. Describe what happens to a dipole in a uniform electric field. Use words. You're welcome to use straightforward language. You don't have to use words like torque or center of mass,