

Interactive Problem Set 4, SP212 Spring 2013

Topic: 22.6 - 22.7 The Electric Field

NOTE: charge per unit length is denoted λ and carries units of C/m; charge per unit area is denoted σ and carries units of C/m²; charge per unit volume is denoted ρ and carries units of C/m³.

IPS 4.1 (in-class) A charged line lies on the x axis stretching from $(-a, 0)$ to $(+a, 0)$. A total charge q is spread uniformly across this length. What is the electric field at position $(0, b)$? *Reflect on your answer in the limit that $b \gg a$, does your answer work correctly in this limit?*

IPS 4.2 (in-class) A similar problem as above but let's bend the line into an arc. Suppose that the arc is of radius R with its center at the origin. Charge q is spread uniformly along this arc. The arc sits symmetrically about the y axis residing below in the 3rd and 4th quadrants. The angular spread is $\pm\theta_{\max}$ to either side of the $-y$ axis. What is the electric field at the origin?

IPS 4.3 (homework) A circle of charge with radius R lies in the xy plane centered on the origin. A total charge q is spread uniformly around the circle. What is the electric field produced $(0, 0, z)$? *Reflect on your answer in the limit that $z \gg R$, does your answer work correctly in this limit?*

IPS 4.4 (homework) Imagine the situation from the previous problem, but instead of a ring, the charge is spread over the area defined by the circle. Conceptually, will this produce an electric field at $(0, 0, z)$ that is stronger or weaker than the ring case?

IPS 4.5 (challenge problem, optional) Now setup the integral and grind out the calculation. This is a double integral, and there are a few ways to set it up. I would suggest though a straight up double integral using the area element you are familiar with, bumping out dr and sweeping an arc $r d\theta$. *Reflect on your answer in the limit that $z \gg R$, does your answer work correctly in this limit?*

Reading for next class: We will complete chapter 22 next class, so reread chapters 21 and 22 from the WPC and maybe spend sometime browsing through the text, particularly looking for interesting figures to spend a few minutes thinking about.