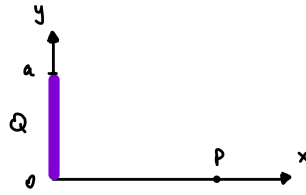


Problem set 9 (due May 22)

1. Positive charge Q is distributed uniformly along the positive y -axis between $y = 0$ and $y = a$.



- (a) (2pt) Calculate the x and y -components of the electric field produced by the charge distribution Q at the point P on the positive x -axis.
- (b) (1pt) Compute the leading contribution to the norm of the electric field in the limit $x \gg a$. Does the result fit your expectations? Explain why.
2. The electric field of a point particle in two dimensions is (for a particle located at the origin)

$$\vec{E}(\vec{r}) = \frac{kq}{r} \hat{r}$$

- (a) (1pts) Consider a test particle of charge q_0 at a location \vec{r} . What is the potential energy of the system? How much work does it take to move the test particle to infinity?
- (b) (2pts) Compute the electric field of an infinite long line. How does this result compare to the electric field of an infinite long plane in three dimensions?
3. Let $f(x, y, z) = x^2y^2 + y^2z^2 + z^2x^2$.
- (a) (2pt) Compute the vector field $\vec{F} = \vec{\nabla} f$. Sketch the vector field on the xy -plane with $z = 0$.
- (b) (1pt) Compute the divergence and the curl of \vec{F} .
- (c) (1pt) Consider an arbitrary scalar field $\Phi(x, y, z)$. Show that the curl of the gradient of Φ vanishes.