

[lex96] Point charge in uniform motion I

A point charge is at rest at the origin of frame \mathcal{F}' , which moves with velocity $\mathbf{v} = v \hat{\mathbf{i}}$ relative to frame \mathcal{F} . In frame \mathcal{F}' , the point charge generates the electrostatic field,

$$\mathbf{E}'(\mathbf{x}') = \frac{q}{4\pi\epsilon_0} \frac{\mathbf{x}'}{|\mathbf{x}'|^3},$$

and no magnetic field: $\mathbf{B}'(\mathbf{x}') \equiv 0$.

(a) Use the Lorentz transform for the position and field vectors to determine the electric field $\mathbf{E}(\mathbf{x}, t)$ and magnetic field $\mathbf{B}(\mathbf{x}, t)$ observed in frame \mathcal{F} .

(b) Describe in words the direction, orientation, and shape of the electric and magnetic field lines in frame \mathcal{F} . Show graphical evidence for your description.

(c) Describe in words the shape of contour lines of electric and magnetic field strengths (i) in the yz -plane and (ii) in the xz -plane. Show graphical evidence for your description.

Solution: