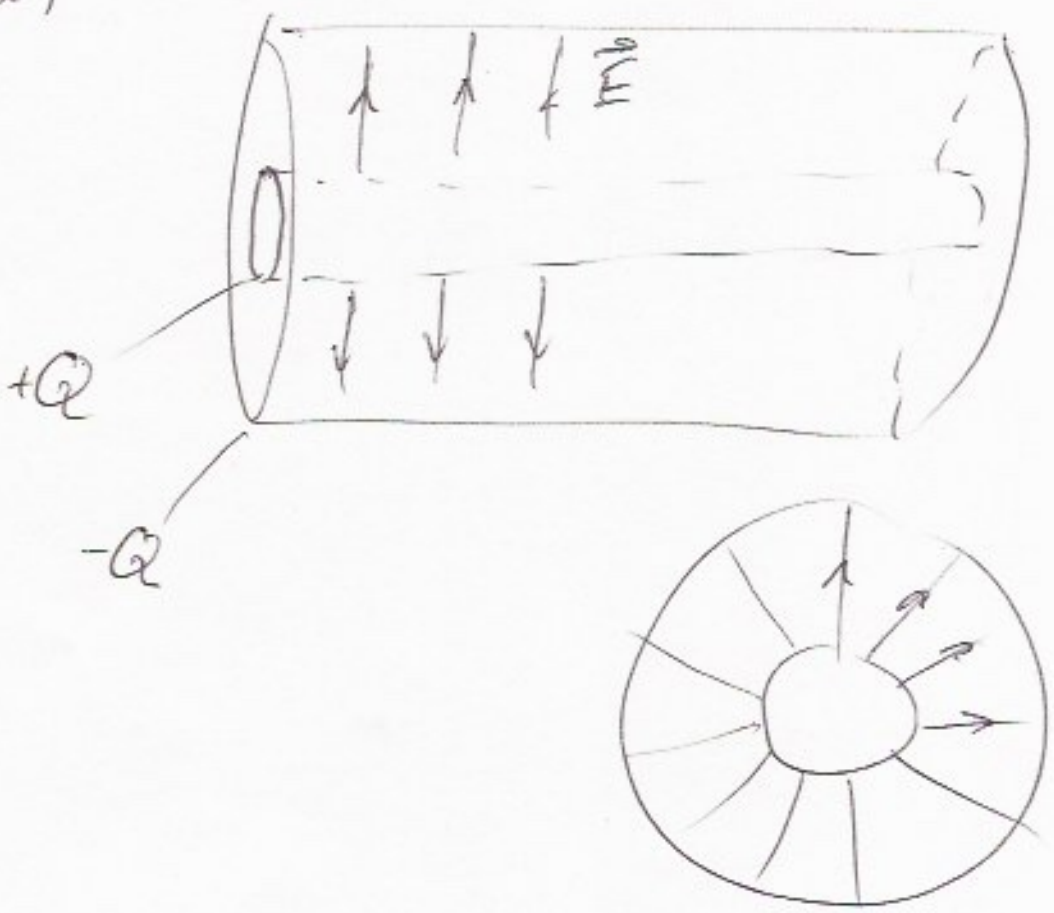
Prelim 2 Solutions

1. (a)

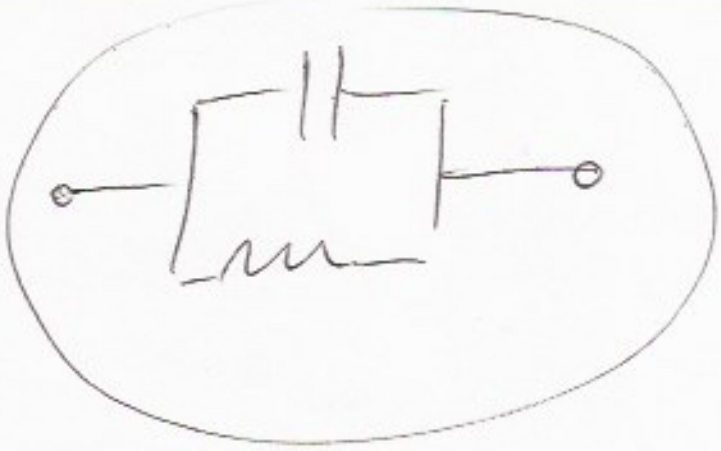


(b) $\vec{E} = \frac{Q/L}{2\pi\epsilon_0} \frac{\hat{r}}{r}$

(c) $\Phi = -\frac{Q/L}{2\pi\epsilon_0} \log r$

$V = \frac{Q/L}{2\pi\epsilon_0} \log b/a$, $C = \frac{Q}{V} = \frac{2\pi\epsilon_0 L}{\log b/a}$

2. (a)



(b) $C = \epsilon_0 \frac{A}{d}$, $R = \rho \frac{d}{A}$

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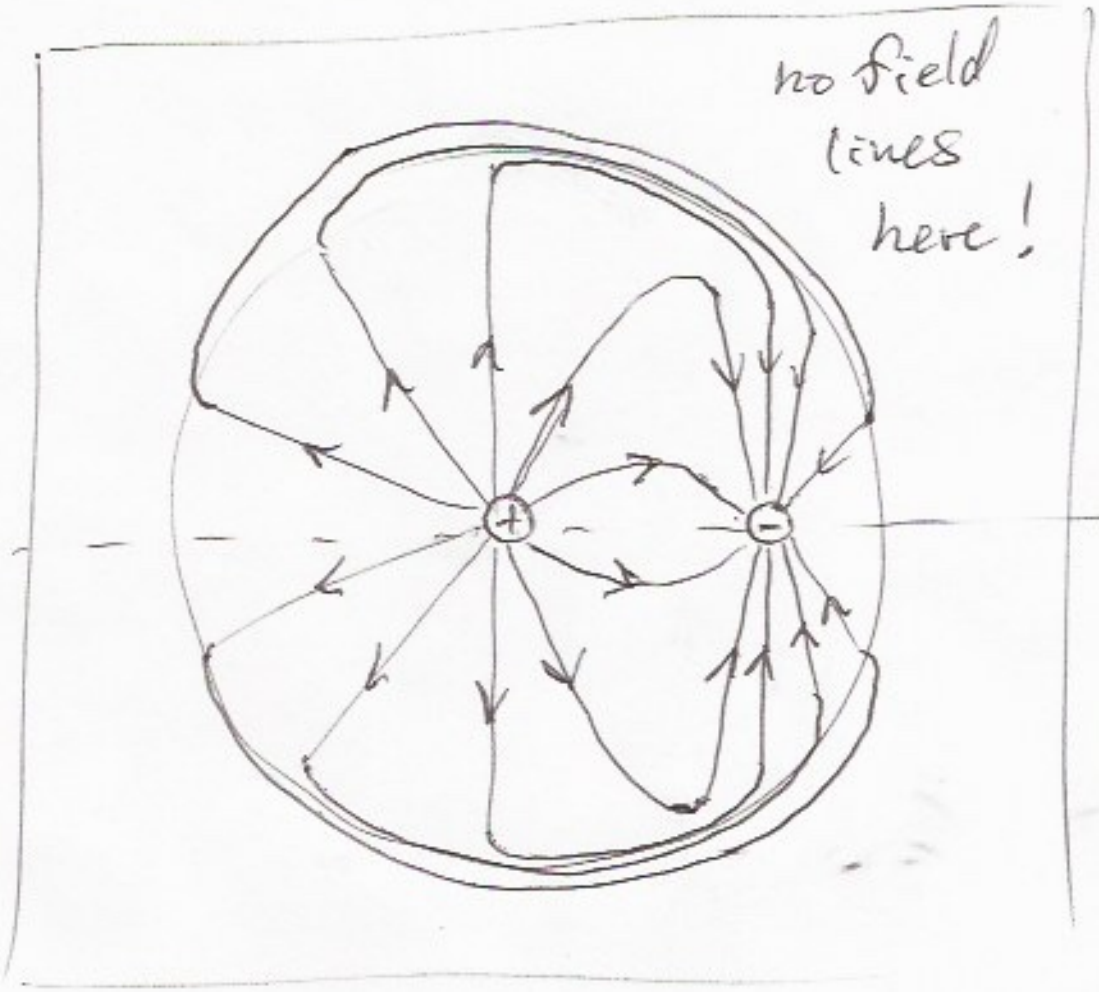
3. $\vec{E} = \frac{E}{2}(\hat{x}+\hat{y}) + \frac{E}{2}(\hat{x}-\hat{y})$

$$\gamma = \frac{1}{\sqrt{1-\frac{1}{2}}} = \sqrt{2}$$

$$\vec{E}' = \frac{E}{2}(\hat{x}+\hat{y}) + \sqrt{2}\,\frac{E}{2}(\hat{x}-\hat{y})$$

$$= E\left(\left(\tfrac{1}{2}+\tfrac{1}{\sqrt{2}}\right)\hat{x} + \left(\tfrac{1}{2}-\tfrac{1}{\sqrt{2}}\right)\hat{y}\right)$$

4.



- isotropic near ⊕
- more concentrated ⊥ to axis for ⊖
- connected dipole pattern (no field line termination)

5. The force law for $\vec{X}$ should give zero force when the charge is at rest. When we derived $\vec{E}' = \gamma \vec{E}$ we transformed to the rest frame of the charge, and the force was explained purely in terms of the electric force due to a modified electric field ($\vec{E}'$). There is consistency if forces due to $\vec{X}'$ are zero when the charge is at rest (which it is in that frame).