proprep

Workbook

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Time Dependent Fields

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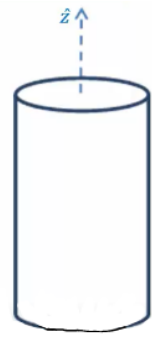
Questions

1) An infinite solid cylinder of radius R is spinning at an angular velocity $\omega = \alpha t$. The cylinder has charge density ρ.



a. Calculate the magnetic field.
b. Calculate the electric field.
c. What force acts on charge q?

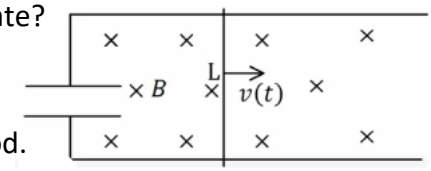
$$\oint \vec{E} \cdot \mathrm{d}\vec{l} = -\int\int \frac{\mathrm{d}\vec{B}}{\mathrm{d}t} \cdot \mathrm{d}\vec{s}$$

2) A parallel plate capacitor is given. Each plate is circular and has radius R, and the plates are a distance d from one another. A constant current, I, flows through the capacitor.

a. Calculate the charge on the capacitor, as a function of time, given that $q(t = 0) = 0$.
b. Calculate the electric field, as a function of time.
c. Calculate the magnet field.
d. Calculate the energy stored between the capacitor plates.
e. Calculate the Poynting vector on the edge of the capacitor. Find its flux through the Gaussian surface encasing the capacitor.

$$\oint \vec{B} \cdot \mathrm{d}\vec{l} = \mu_0 \int \vec{j} \cdot d\vec{s} + \mu_0 \int\int \varepsilon_0 \frac{\mathrm{d}\vec{E}}{\mathrm{d}t} \cdot \mathrm{d}\vec{s}$$

3) A parallel plate capacitor is given. Each plate is circular and has radius ,a, and the plates are a distance d from one another. The capacitor is connected to a conducting track (there is no resistance). A non-resistant rod of length $L$is placed on the track. The rod is pulled away from the capacitor at a velocity of $v(t) = At$. A uniform magnetic field B acts into the page.



a. Calculate the charge on the capacitor. Which is the positive plate?
b. Calculate the electric field inside the capacitor.
c. Calculate the magnet field both inside and outside the capacitor. Ignore the fields produced by the rod.
d. The rod is of mass M. Calculate the force required in order to move the rod at the same velocity.

*For the solutions go see the videos