Homework 32.7

Fig. 32-30 shows a circular region of radius R = 3.00 cm in which a uniform electric flux is directed out of the page. The total electric flux through the region is given by Φ = (3.00 mV•m/s)t, where t is in seconds. What is the magnitude of the magnetic field at radial distances (a) 2.00 cm and (b) 5.00 cm?

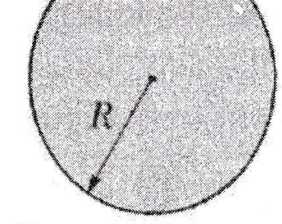

Figure 32.30

$$\phi_{MAX} = 3 \times 10^{-3} t$$

$$\frac{d\phi_{max}}{dt} = 3 \times 10^{-3}$$

$$\oint B \cdot dl = \mu_0 \epsilon_0 \frac{d\phi_E}{dt} = 2\pi r B$$

$$\phi_E = \left(\frac{r}{R}\right)^2 \Phi_{max} \qquad \left(\frac{r}{R}\right)^2 \quad \frac{\text{Area inside } r}{\text{Total Area}}$$

$$2\pi r B = \mu_0 \epsilon_0 \left(\frac{r}{R}\right)^2 3 \times 10^{-3}$$

$$B = \frac{4\pi \times 10^{-7}\ 8.854 \times 10^{-12} (.02) \times 3 \times 10^{-3}}{2\pi\ (.03)^2}$$

a) $B = 1.18 \times 10^{-19}$ T

b) $\oint B \cdot dl = \mu_0 \epsilon_0 \frac{d\Phi_{max}}{dt} = \mu_0 \epsilon_0 3 \times 10^{-3}$

$$\oint B \cdot dl = B \times 2\pi r = B\, 2\pi \times (.05) = \mu_0 \epsilon_0 3 \times 10^{-3}$$

$$B = \frac{4\pi \times 10^{-7}\ 8.854 \times 10^{-12} \times 3 \times 10^{-3}}{2\pi\ (.05)}$$

$$B = \frac{2 \times 8.854 \times 3}{.05} \times 10^{-22} = 1.06 \times 10^{-19}\ T$$

Homework 32.13

At what rate must the potential difference between the plates of a parallel-plate capacitor with a 2.0 μF capacitance be changed to produce a displacement current of 1.5 A?

$$I_{disp} = \epsilon_0 \frac{\partial \Phi_E}{\partial t}$$

$$\Phi_E = E A$$

$$E = \frac{V}{d} \qquad C = \frac{\epsilon_0 A}{d}$$

$$\epsilon_0 \Phi_E = \frac{\epsilon_0 A V}{d} = C V$$

$$I_{dis} = C \frac{dV}{dt}$$

$$\frac{dV}{dt} = \frac{I_{dis}}{C} = \frac{1.5}{2 \times 10^{-6}} = 0.75 \times 10^{6}$$

$$\frac{dV}{dt} = 7.5 \times 10^{5} \text{ V/s}$$

Homework 32.41

A magnet in the form of a cylindrical rod has a length of 5.00 cm and a diameter of 1.00 cm. It has a uniform magnetization of 5.30 x 10^3 A/m. What is its magnetic moment?

$M = 5.30 \times 10^{3}$ A/m

= Magnetic Moment / Volume

Volume $= 0.05 \times \pi \times \left(\frac{0.01}{2}\right)^2$

$= \frac{5}{4}\pi \times 10^{-6}$

$\mu =$ Magnetic Moment $= 5.30 \times 10^{3} \times \frac{5}{4}\pi \times 10^{-6}$

$\mu = 20.8 \times 10^{-3}$ J/T

Problem 4 Solution

Write Maxwell's four equations,

1. What is each equation called?
2. Write each equation in English words,
3. and in integral form

1.

a. Gauss' Law

b. The electric flux through a closed surface is equal to the charge enclosed within the surface divided by the permittivity of free space..

c. $$\oint E \cdot ds = \frac{1}{\epsilon_o} \int \rho dv$$

2.

a. Gauss' Law for magnetic fields

b. The magnetic flux through a closed surface is equal to zero

c. $$\oint B \cdot ds = 0$$

3.

a. Faraday's Law

b. The emf induced in a closed loop is equal to the negative of the rate of change of the magnetic flux passing through the loop.

c. $$\oint E \cdot dl = -\frac{\partial}{\partial t} \int B \cdot ds$$

4.

a. Ampere's Law

b. The integral of the magnetic field around a closed loop is equal to the current flowing through the loop and the displacement current flowing through the loop multiplied by the permeability of free space.

c. $$\oint B \cdot dl = \mu_o \int \left(J + \epsilon_o \frac{\partial E}{\partial t} \right) \cdot ds$$