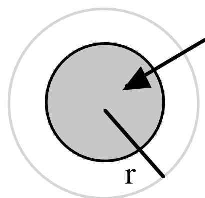
Chapter 32

32. 5 The induced magnetic field at radial distance 6.0 mm from the central axis of a circular parallel plate capacitor is $2.0 \times 10^{-7} T$. The plates have radius 3.0mm. At what rate $d\vec{E}/dt$ is the electric field between the plates changing?



$$\oint \vec{B} \cdot d\vec{r} = \mu_0 i_{enc} + \mu_0 \varepsilon_0 \frac{d\varphi_E}{dt}$$

$$B \cdot 2\pi r = 0 + \mu_0 \varepsilon_0 \frac{d(EA)}{dt}$$

$$\frac{dE}{dt} = \frac{B \cdot 2\pi r}{\mu_0 \varepsilon_0 A} = \frac{2.0 \times 10^{-7} T \cdot 2\pi \cdot 6 \times 10^{-3} m}{\mu_0 \varepsilon_0 \pi \cdot (3 \times 10^{-3} m)^2}$$

$$= 2.4 \times 10^{13} V/m/s$$

32.14 A Parallel plate capacitor with circular plates of radius 0.10m is being discharged. A circular loop of radius 0.20m is concentric with the capacitor and halfway between the plates. The displacement current through the loop is 2.0 A. At what rate is the electric field between the plates changing.

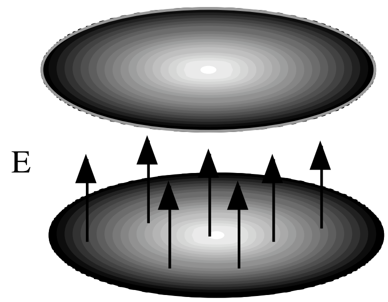
We compute the change in flux using the area of the plates since the field outside the plates is zero. This means that the area for the flux calculation is the area of the plates.

$$i_d = \varepsilon_0 \frac{d\varphi_E}{dt} = \varepsilon_0 \frac{d(EA)}{dt} = \varepsilon_0 A \frac{dE}{dt}$$

$$\frac{dE}{dt} = \frac{i_d}{\varepsilon_0 A} = \frac{2A}{\varepsilon_0 \pi \cdot (0.1m)^2} = 7.19 \times 10^{12} V/m/s$$

32.18 The magnitude of the electric field between the two circular parallel plates in Fig. 32-31 is $E = 4.0\times10^5 - 6.0\times10^4 t$. At t=0, E is upward. The plate area is $4.0\times10^{-2} m^2$. For t >0, what are the (a) magnitude and (b) direction of the displacement current between the plates and (c) is the direction of the induced magnetic field clockwise or counterclockwise.

To get the direction, we'll write the E vector and then take the derivative. We can see that the current points downward. The B field would be in the clockwise direction as viewed from above.



$$E = 4.0\times10^5 - 6.0\times10^4 t$$

$$\vec{E} = (4.0\times10^5 - 6.0\times10^4 t)\hat{k}$$

$$i_d = \frac{d\vec{E}}{dt} = -6.0\times10^4 \hat{k}$$