Chapter 32

32.9 *Uniform electric flux*. Figure 32-30 shows a circular region of radius R=3.00 cm in which a uniform electric flux is directed out of the plane of the page. The total electric flux through the region is given by $\Phi_E = (3.0\ mV \cdot m/s)t$, where t is in seconds. What is the magnitude of the magnetic field that is induced at radial distances (a) 2.00 cm and (b) 5.00 cm.

We can start by writing the B field in terms of the flux. We will need to be careful to find the change in flux for the particular path we choose. The flux that we have been given is for the entire circular area.

$$\oint \vec{B} \cdot d\vec{r} = \mu_0 \varepsilon_0 \frac{d\Phi_E}{dt}$$
$$B \cdot 2\pi r = \mu_0 \varepsilon_0 \frac{d\Phi_E}{dt}$$
$$B = \frac{\mu_0 \varepsilon_0 \frac{d\Phi_E}{dt}}{2\pi r}$$

At 2 cm, we only see a portion of the flux, so we correct for that by using the ratio of the area of our circle with radius of 2 cm to the area of the entire circle.

$$B = \frac{\mu_0 \varepsilon_0 \frac{d\Phi_E}{dt}}{2\pi r} = \frac{\mu_0 \varepsilon_0 (3.0 \times 10^{-3} \cdot m/s) \cdot \frac{\pi \cdot (2.0 \times 10^{-2})^2}{\pi \cdot (3.0 \times 10^{-2})^2}}{2\pi \cdot 2.0 \times 10^{-2}}$$
$$B = 1.18 \times 10^{-19} T$$

At 5 cm, we see the entire flux change.

$$B = \frac{\mu_0 \varepsilon_0 \frac{d\Phi_E}{dt}}{2\pi r} = \frac{\mu_0 \varepsilon_0 (3.0 \times 10^{-3} \cdot m/s)}{2\pi \cdot 5.0 \times 10^{-2}}$$
$$B = 1.06 \times 10^{-19} T$$

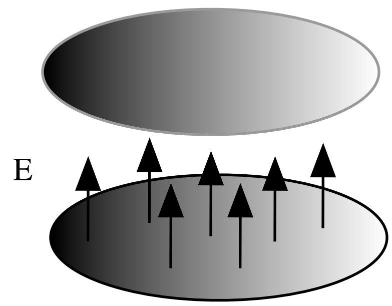
32.14 (Not assigned) A Parallel plate capacitor with circular plates of radius 0.10m is being discharged. A circular loop of radius 0.20m is concentric with the capacitor and halfway between the plates. The displacement current through the loop is 2.0 A. At what rate is the electric field between the 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 $E = 4.0 \times 10^5 - 6.0 \times 10^4 t$. At t=0, E is upward. The plate area is $4.0 \times 10^{-2} m^2$. 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.



$$E = 4.0 \times 10^5 - 6.0 \times 10^4 t$$

$$\vec{E} = (4.0 \times 10^5 - 6.0 \times 10^4 t)\hat{k}$$

$$i_d = \frac{d\vec{E}}{dt} = -6.0 \times 10^4 \hat{k}$$