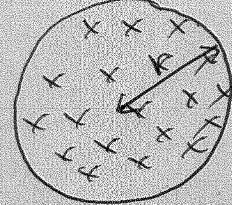
Ch. 13 Prob 52

$B_0 = 1.0\,T$

$B_f = 0\,T$

$\Delta t = 20\,s$

$r = 20\,cm$



$$\mathcal{E} = \oint \vec{E} \cdot d\vec{l} = -\frac{d\Phi_m}{dt}$$

Normally we think of Faradays law as

$$\mathcal{E} = -\frac{d\Phi_m}{dt} = -\frac{d\,A \cdot B}{dt} = -A\frac{dB}{dt}$$

The area is $A = \pi r^2$

so $\mathcal{E} = -\pi r^2 \frac{dB}{dt}$

from the provided information

$$\frac{dB}{dt} = \frac{\Delta B}{\Delta T} = \frac{B_f - B_0}{\Delta T} = \frac{(0T - 1.0T)}{20s} = -0.050\,\frac{T}{s}$$

and $\mathcal{E} = -\pi r^2 \left(-0.050\,\frac{T}{s}\right)$ (units overall are volts)

But $\mathcal{E} = \oint \vec{E} d\vec{l} = E \int dl = E \cdot 2\pi r$

so $E\,2\pi r = \pi r^2 (0.050)$

$$E = \frac{\pi r^2 (0.050)}{2\pi r} = 0.025\,r$$

By Lenz Law current flows counter-clockwise to make up for the lost B field

@ $r = 0.20m$ $E = 0.005\,\frac{V}{m}$

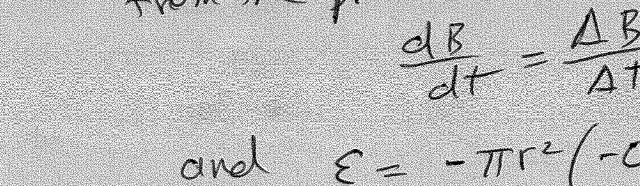
Beyond 20cm the flux doesn't change

so $\mathcal{E} = -\pi (0.20_m)^2 \left(-0.050\,\frac{T}{s}\right)$

$\mathcal{E} = 6.28 \times 10^{-3}\,V$

But $\mathcal{E} = 2\pi r E$

so $E = \frac{\mathcal{E}}{2\pi r} = \frac{6.28 \times 10^{-3}\,V}{2\pi\,r} = \boxed{\frac{1.0 \times 10^{-3}\,V}{r}}$



E is c.c.w.

$E = 0.025\,r$

$E = \frac{1.0 \times 10^{-3}}{r}\,V$