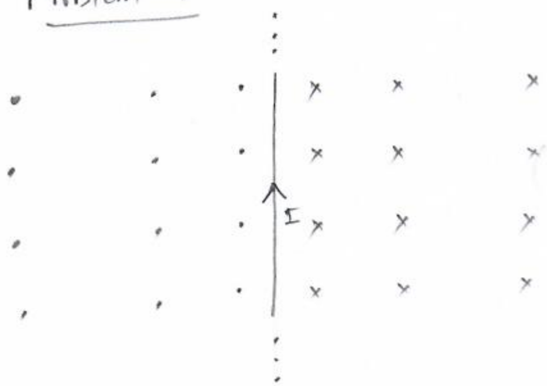
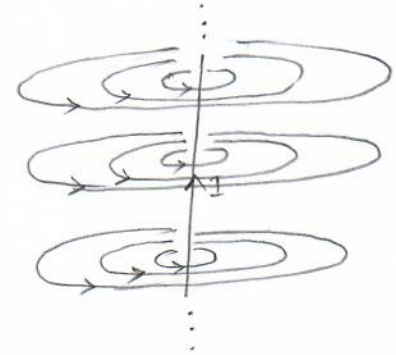
Solutions

PHYS - 2038-001 (Midterm Exam 03) Spring 2022

Problem 1



(OR)



Problem 2

The negative sign signifies that the induced voltage opposes what the external flux is doing.

Problem 3

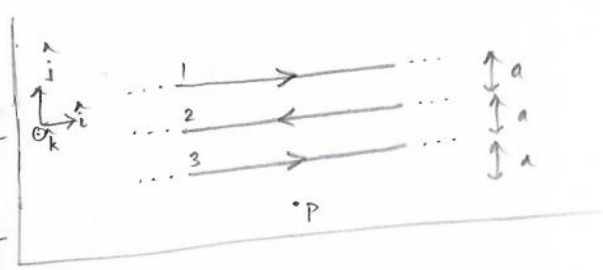
radio wave

Problem 4

$\vec{F}_e = q\vec{E}$ $\Rightarrow$ $\frac{E}{B}$ has units of speed, $\frac{m}{s}$.

$\vec{F}_m = q\,\vec{v}\times\vec{B}$ $\Rightarrow$ dimension of $\frac{E}{B}$ is $\frac{\text{length}}{\text{time}}$ or $\frac{L}{T}$.

Problem 5



$$\vec{B}_1 = -\hat{k}\frac{\mu_0 I}{2\pi(3a)} = -\hat{k}\frac{(4\pi\times10^{-7})(1.0)}{2\pi\,3(0.10)} = -\hat{k}\,0.67\,\mu T$$

$$\vec{B}_2 = +\hat{k}\frac{\mu_0 I}{2\pi(2a)} = +\hat{k}\frac{(4\pi\times10^{-7})(1.0)}{2\pi\,2(0.10)} = +\hat{k}\,1.0\,\mu T$$

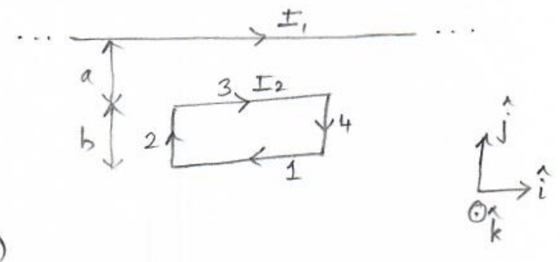
$$\vec{B}_3 = -\hat{k}\frac{\mu_0 I}{2\pi a} = -\hat{k}\frac{4\pi\times10^{-7}(1.0)}{2\pi(0.10)} = -\hat{k}\,2.0\,\mu T$$

$$\vec{B}_{tot} = \vec{B}_1 + \vec{B}_2 + \vec{B}_3 = -\hat{k}(2.0 - 1.0 + 0.67)\,\mu T = -\hat{k}\,1.7\,\mu T$$

magnitude: $1.7\,\mu T$

direction: into the page.

Problem 6



$\vec{B}_1$: magnetic field due to I_1 at the side '1' of loop.

$$\vec{B}_1 = -\hat{k}\,\frac{\mu_0 I_1}{2\pi(a+b)} = -\hat{k}\,\frac{(4\pi\times10^{-7})(1.0)}{2\pi\,(0.020+0.030)}$$

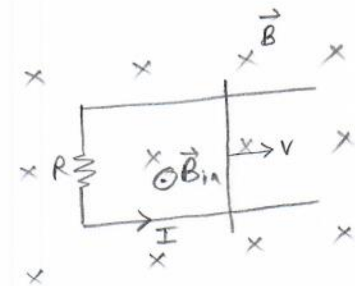
$$= -\hat{k}\;4.0\;\mu T$$

$$\vec{F}_{21} = I_2\,\vec{L}_2\times\vec{B}_1$$

$$= (5.0)(0.05)\,(-\hat{i})\times(-\hat{k})\;4.0\times10^{-6}$$

$$= -\hat{j}\;1.0\;\mu N$$

Problem 7



→ flux is increasing

→ induced $\vec{B}_{in}$ is coming out of paper

→ induced current is counterclockwise.

$$V_{eff} = -N\,B\,L\,v\,\cos(0)$$

$$= -(1)(1.0\times10^{-3})(0.050)(7.0)(1.0)$$

$$= -\,0.35\;mV$$

$$I = \frac{|V_{eff}|}{R} = \frac{0.35\times10^{-3}}{25\,\Omega}$$

$$= 14\;\mu A$$

counter clockwise in loop.

Problem 8

$$\frac{\lambda}{T} = c \qquad T = \frac{\lambda}{c} = \frac{540\times10^{-9}\;m}{3.0\times10^{8}\;\frac{m}{s}} = 1.8\times10^{-15}\;s$$