Solutions PHYS-205B (Midterm Exam 03) 2021 Fall

Problem 1

Using $\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$

we have

$$[qE] = [qvB]$$

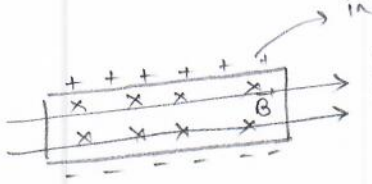
$$\Rightarrow \left[\frac{E}{B}\right] = [v] = \frac{L}{T} = LT^{-1}.$$

Problem 2

Circle.

Problem 3

A voltage is induced in a conductor in the presence perpendicular E and B.



Problem 4

The magnetic field from the two wires cancel at point P.

$$\vec{B} = 0.$$

Problem 5

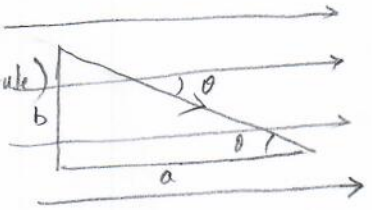
Flux is not changing. Thus, there is no current induced.

Problem 6

$$\frac{\omega_{electron}}{\omega_{proton}} = \frac{\frac{q_{electron}}{m_{electron}} B}{\frac{q_{proton}}{m_{proton}} B} = \frac{m_{proton}}{m_{electron}} = 1800$$

Problem 7

$$\vec{F}_3 = I L B \sin\theta \, \hat{z} \quad \text{(using right hand rule)}$$



$$= I \sqrt{a^2+b^2} \, B \frac{b}{\sqrt{a^2+b^2}} \hat{z}$$

$$\sin\theta = \frac{b}{\sqrt{a^2+b^2}}$$

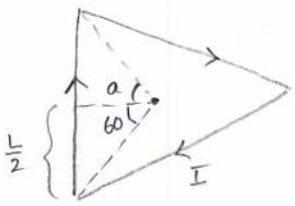
$$= I B b \hat{z} = (2.0)(0.30)(0.02)\hat{z} = \hat{z}\, 12 \text{ N}$$

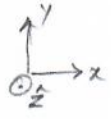
magnitude : 12 N

direction : along $\hat{z}$.

Problem 8

$$\vec{B} = -\hat{z}\, 3 \, \frac{\mu_0}{4\pi} \frac{I}{a} (\sin 60 + \sin 60) \quad \text{(three sides)}$$





$$= -\hat{z}\, 3 \, \frac{\mu_0}{4\pi} \frac{I}{\left(\frac{L}{2}\frac{1}{\sqrt{3}}\right)} \frac{\sqrt{3}}{2}$$

$$\sin 60 = \frac{\sqrt{3}}{2}$$

$$= -\hat{z} \, \frac{\mu_0}{4\pi} \frac{I}{L} \, 18$$

$$a = \frac{L}{2} \tan 30$$

$$= \frac{L}{2}\frac{1}{\sqrt{3}}$$

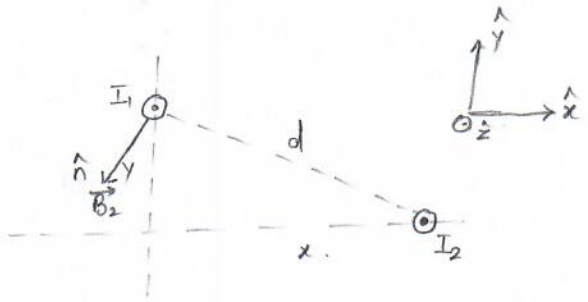
$$a = 18.$$

Problem 9

$$\vec{F}_{12} = I_1 \vec{L}_1 \times \vec{B}_2$$

on 1 by 2 ↙

$$= I_1 L_1 \hat{z} \times \hat{n} \frac{\mu_0}{4\pi} \frac{2 I_2}{d}$$



$$\frac{\vec{F}_{12}}{L_1} = \frac{\mu_0}{4\pi} \frac{2 I_1 I_2}{d} \hat{z} \times \hat{n}$$

$$= \frac{(4\pi \times 10^{-7})}{4\pi} \frac{2(1.0)(2.0)}{(0.14)} \hat{z} \times \hat{n}$$

$$= 2.9 \frac{\mu N}{m} \hat{z} \times \hat{n}$$

$$\vec{L}_1 = L_1 \hat{z}$$

$$\vec{B}_2 = B_2 \hat{n} = \frac{\mu_0}{4\pi} \frac{2 I_2}{d} \hat{n}$$

$$d = \sqrt{x^2 + y^2} = \sqrt{(0.12)^2 + (0.08)^2}$$

$$= 0.14 \text{ m}$$

magnitude : $2.9 \times 10^{-6} \frac{N}{m}$

direction : $\hat{z} \times \hat{n}$ (towards I_2, that is, attractive force)

Problem 10

(a) Rate of change of flux $= \frac{d}{dt} \Phi_B$

$$= \frac{d}{dt} BLx \cos(0) = BLV$$

$$= (1.2)(0.10)(5.0)$$

$$= 0.60 \text{ Volt.}$$

(b) $$I = \frac{\left| -\frac{d\Phi_B}{dt} \right|}{R} = \frac{0.60}{0.40} = 1.5 \text{ A}$$