MT-03, PHYS-205B, Spring 2017

Solutions

Prob. 1

(a) $\frac{1}{2} m v^2 = eV \quad \Rightarrow v = \sqrt{\frac{2eV}{m}} = \sqrt{\frac{2 \times 1.6\times10^{-19} \times 350}{9.1\times10^{-31}}} = 1.1\times10^{7} \frac{m}{s}$

(b) $\omega = \frac{q}{m} B = \frac{1.6\times10^{-19}}{9.1\times10^{-31}} \times 200\times10^{-3} T = 3.5\times10^{10} \frac{rad}{s}$

$R = \frac{v}{\omega} = \frac{1.1\times10^{7} \frac{m}{s}}{3.5\times10^{10} \frac{rad}{s}} = 0.31\times10^{-3} m = 0.31 mm.$

Prob. 2

$\vec{F}_E = q\vec{E} = \hat{x}\,(1.0\times10^{-6} C)\ 6.00\times10^{3} \frac{N}{C}$

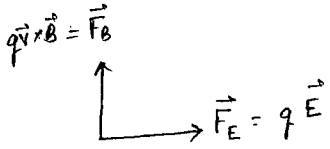
$= \hat{x}\ 6.0\times10^{-3} N$

$\vec{F}_B = q\vec{v}\times\vec{B} = \hat{y}\,(1.0\times10^{-6} C)\left(2.00\times10^{6} \frac{m}{s}\right)(1.50\times10^{-3} T)\sin 90$

$= \hat{y}\ 3.0\times10^{-3} N$

$\vec{F}_{tot} = \hat{x}\ 6.0 mN + \hat{y}\ 3.0 mN$

$|\vec{F}_{tot}| = \sqrt{(6.0 mN)^2 + (3.0 mN)^2} = 6.7 mN.$



Prob. 3

$F = I d B$

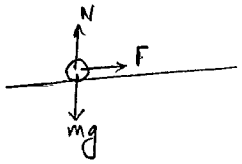
$a = \frac{I d B}{m}$ (using $F = ma$)

using kinematic equation we have

$2 a \Delta x = v_f^2 - v_i^2$

$2\left(\frac{I d B}{m}\right) L = v_f^2 - 0^2$

$v_f = \sqrt{\frac{2 I d B L}{m}}$



Prob. 4

Using $\frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi r}$

$$\frac{MLT^{-2}}{L} = [\mu_0] \frac{(cT^{-1})^2}{L}$$

$$[\mu_0] = \frac{M}{T^2} \frac{L}{c^2} T^2 = \frac{ML}{c^2}$$

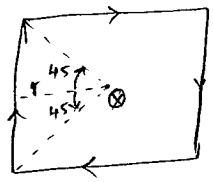
Prob. 5

$$|\vec{B}| = 4B$$

$$= 4 \frac{\mu_0 I}{4\pi r} (\sin\theta_1 - \sin\theta_2)$$

$$= 4 \frac{\mu_0 I}{4\pi (\frac{L}{2})} [\sin 45 - \sin(-45)]$$

$$= 8 \frac{\mu_0 I}{4\pi L} \left[\frac{2}{\sqrt{2}}\right] = \frac{\mu_0 I}{4\pi L} \frac{16}{\sqrt{2}}$$



direction: ⊗, into the page.

Prob. 6

$$\vec{B}_1 = \hat{x} \frac{\mu_0 I_1}{2\pi y} + 0\,\hat{y}$$

$$= \hat{x} \frac{4\pi \times 10^{-7} \times (1.0A)}{2\pi (4.0 \times 10^{-2} m)} = \hat{x}\, 5.0\,\mu T$$

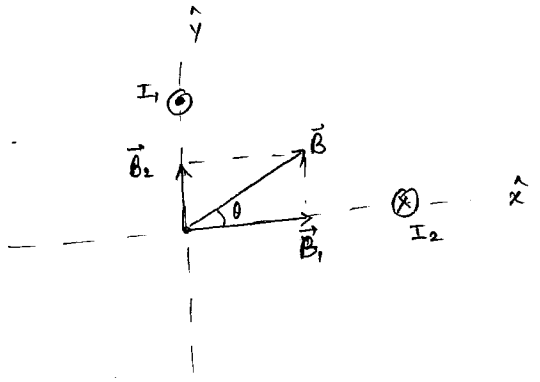
$$\vec{B}_2 = \hat{y} \frac{\mu_0 I_2}{2\pi x}$$

$$= \hat{y} \frac{4\pi \times 10^{-7} \times (2.0A)}{2\pi (6.0 \times 10^{-2} m)} = \hat{y}\, 6.7\,\mu T$$

$$\vec{B} = \hat{x}\, 5.0\mu T + \hat{y}\, 6.7\mu T$$

$$|\vec{B}| = \sqrt{(5.0\mu T)^2 + (6.7\mu T)^2}$$

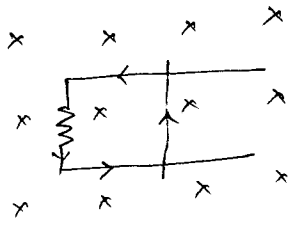
$$= 8.4\,\mu T \rightarrow \text{magnitude.}$$



direction: $\theta = \tan^{-1}\left(\frac{6.7\mu T}{5.0\mu T}\right)$

$= 53°$ clockwise w.r.t $\hat{x}$

Prob. 7



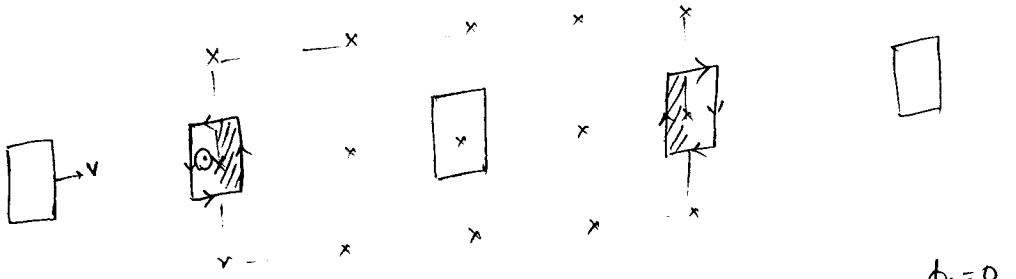
(a) increasing

(b) clockwise

(c) $I = \frac{BLv}{R} = \frac{(1.2\,T)(10\times10^{-2}\,m)(5.0\,m/s)}{(0.40\,\Omega)}$

$= 1.5\,A$

Prob. 8



$\Phi_B = 0$

$I = 0$

$\Phi_B \uparrow$

$\vec{B}_{in}$ ⊙

I: counter clockwise

$\Delta\Phi_B = 0$

$I = 0$

Φ_B decreasing

$\vec{B}_{in}$: ⊗

I: clockwise

$\Phi_B = 0$

$I = 0$