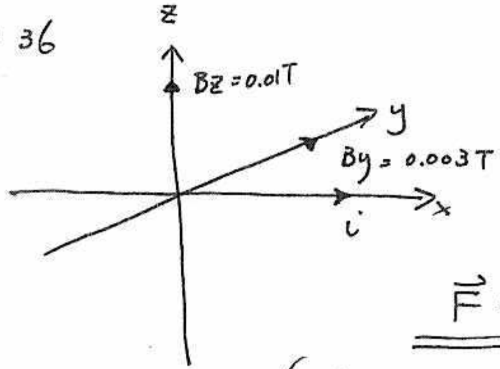
Ch 28 # 36, 45, 55, 57, 82

\# 36



Use Left hand Rule

$F_x = 0$

$F_y = i\ell \times B_z = -0.5 \times 0.5 \times 0.01 = -0.25 \times 10^{-3} N$

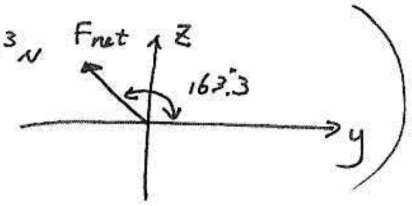
$F_z = i\ell \times B_y = 0.5 \times 0.5 \times 0.003 = 7.5 \times 10^{-4} N$

$$\underline{\underline{\vec{F} = 0\,\hat{i} - 0.25 \times 10^{-3} N\,\hat{j} + 7.5 \times 10^{-4} N\,\hat{k}}}$$

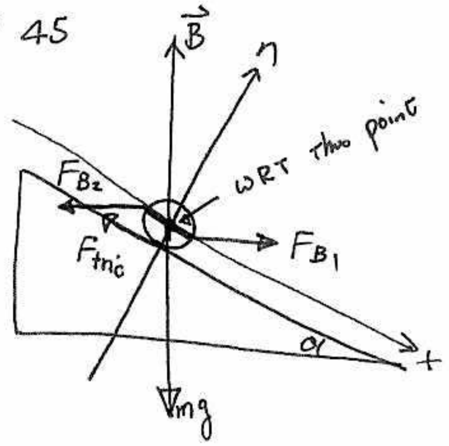
(Also,

$|F| = \sqrt{(F_x)^2 + (F_y)^2 + (F_z)^2} = 2.61 \times 10^{-3} N$

$\theta = \tan \frac{F_z}{F_y} = 163.°30$)



\# 45



Linear Motion

x axis

$F_{B1} \cos\theta + mg \sin\theta - F_{tric} - F_{B2} \cos\theta = 0$ ——— ①

y axis

$F_{B1} \sin\theta + n - mg\cos\theta - F_{B2} \sin\theta = 0$

$|F_{B1}| = |F_{B2}| = N(i\ell B)$

∴ eqn ① becomes

$mg \sin\theta - F_{tric} = 0$ ——— ①′

Rotational Motion

$\vec{r} \times \vec{F}_{tric} + \vec{r} \times \vec{F}_{B1} + \vec{r} \times \vec{F}_{B2} = 0$

$r F_{tric} - r F_{B1} \sin\theta - r F_{B2} \sin\theta = 0$

$r F_{tric} - 2r F_B \sin\theta = 0$

$\therefore F_{tric} = 2F_B \sin\theta$ ——— ②

①′ ← ②

$mg \sin\theta - 2F_B \sin\theta = 0$

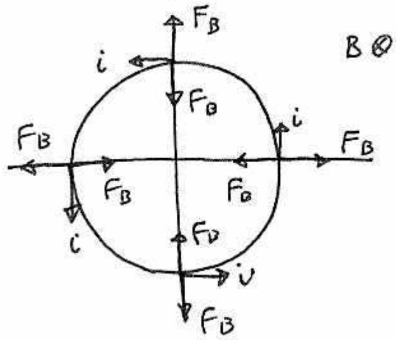
$mg \sin\theta = 2F_B \sin\theta$

$mg = 2N(i\ell B)$

$$\therefore i = \frac{mg}{2N\ell B} = \underline{\underline{2.4525 \text{ amp}}}$$

55.

(a) Case 1. If B is $\perp$ to the loop.

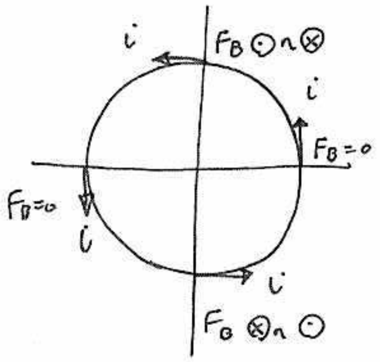


$B \otimes$ or $\odot$

As you can see, $\vec{F}_B \parallel \vec{r}$.

$\therefore \ \tau = 0$.

Case 2 If B is $\parallel$ to the loop

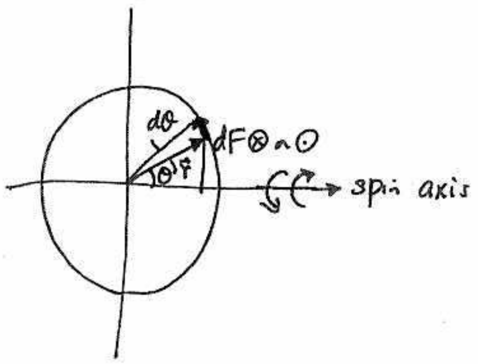


$\uparrow \vec{B}$ or $\downarrow$

As you can see there is some net τ.

$\therefore$ $\underline{\underline{\vec{B} \parallel \text{the loop}}}$

(b) We don't need a dipole eqn : you can derive it (of course!)



$$d\tau = \vec{r} \times d\vec{F}$$

$$d\vec{F} = i \, d\vec{S} \times \vec{B}$$

$$= i \, R d\theta \cdot \sin\theta \cdot B$$

$$= R\sin\theta \cdot i R d\theta \sin\theta \cdot B$$

$$= R^2 \sin^2\theta \ i \ B \ d\theta$$

$$\tau = 4 \times \int_0^{\pi/2} R^2 i B \sin^2\theta \cdot d\theta$$

$$= 4R^2 iB \int_0^{\pi/2} \sin^2\theta \, d\theta$$

$$= 4R^2 iB \int_0^{\pi/2} \frac{1 - \cos 2\theta}{2} \, d\theta$$

$$= 4R^2 iB \ \left. \frac{1}{2}\theta - \frac{1}{4}\sin 2\theta \right|_0^{\pi/2}$$

$$= 4R^2 iB \ \frac{\pi}{4}$$

$$= \pi R^2 i B$$

$$= A i B$$

$$\sin^2\theta = 1 - \cos^2\theta$$

Also,

$$\cos 2\theta = \cos^2\theta - \sin^2\theta$$

$$\therefore \ \cos^2\theta = \cos 2\theta + \sin^2\theta$$

$$\therefore \ \sin^2\theta = 1 - (\cos 2\theta + \sin^2\theta)$$

$$\sin^2\theta = 1 - \cos 2\theta - \sin^2\theta$$

$$2\sin^2\theta = 1 - \cos 2\theta$$

$$\therefore \ \sin^2\theta = \frac{1 - \cos 2\theta}{2}$$

$\therefore \tau_{Total} = NAiB$

N : # of turns $= \dfrac{L}{2\pi r}$

L : total length
r : radius of each circle
A : Area of a circle $= \pi r^2$

$$= \frac{L}{2\pi r} \cdot (\pi r^2)\, i\, B$$

$$= \frac{L}{2} r\, i\, B$$

$\therefore \tau \propto r$ For max τ, choose max $r \rightarrow N = 1$

(c) when $N = 1$

$$\tau = 1 \cdot \pi r^2 \cdot iB$$

$L = 2\pi r$

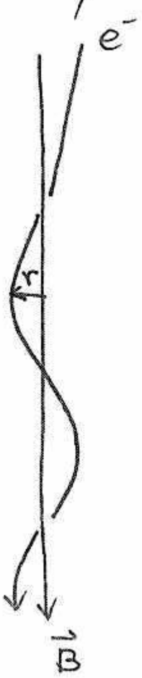
$r = \dfrac{L}{2\pi}$

$$= 1 \cdot \pi \left(\frac{L}{2\pi}\right)^2 i B$$

$$= \frac{L^2 i B}{4\pi} = \frac{(0.25)^2 \cdot (4.51\times10^{-3})(5.71\times10^{-3})}{4\pi}$$

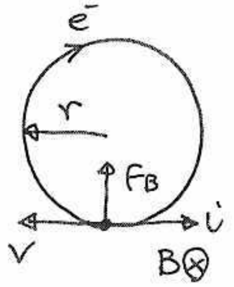
$$= \underline{\underline{1.28084378\times10^{-7}\ N\cdot m}}$$

57



seen From the above

$m_e = 9.11\times10^{-31}$ kg
$e = 1.6\times10^{-19}$ C
$V = 1.5\times10^{7}$ m/sec
$B = 1\times10^{-3}$ T



We need perpendicular comp. of V w.R.T. B
($V\sin 10°$)

$$F_B = q\vec{V}\times\vec{B} = F_{centri} = m\frac{V^2}{r}$$

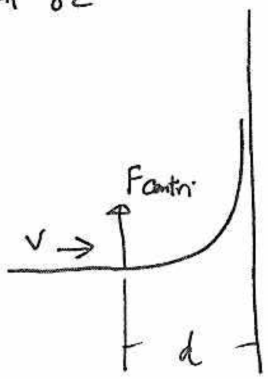
$$\therefore r = \frac{m(V\sin 10°)^2}{qBV\sin 10°} = \frac{mV\sin 10°}{qB}$$

P (Time needed for e^- to make 1 rev.)

$$= \frac{2\pi r}{V_\perp} = \frac{2\pi\left(\frac{mV\sin 10°}{qB}\right)}{V\sin 10°} = \frac{2\pi m}{qB}$$

$\therefore d = (V\cos 10°)\cdot P = \underline{\underline{0.528470781 5\,m}}$

82



$$F_{centri} = m\frac{v^2}{r} = m\frac{v^2}{d} \quad (\text{in this case})$$

$$= F_B = evB$$

$$\therefore \quad m\frac{v^2}{d} = evB$$

$$B = \frac{mv}{ed} \quad \text{——— ①}$$

Also

$$KE = \frac{1}{2}mv^2 = K$$

$$v = \sqrt{\frac{2K}{m}} \quad \text{——— ②}$$

① ← ②

$$B = \frac{m\sqrt{\frac{2K}{m}}}{ed}$$

$$= \sqrt{\frac{2Km}{e^2d^2}}$$

As long as B is stronger than this, the particle will not hit.