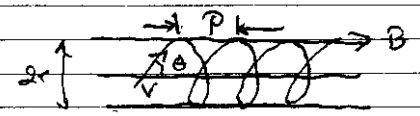
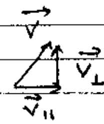
HW 8

27-29





$v = 3.0 \times 10^6 \frac{m}{s}$

$B = 0.23\ T$

$v_\perp = v_\parallel = \frac{v}{\sqrt{2}}$

$\theta = 45°$

Force $\vec{F} = q\vec{v} \times \vec{B}$ (p. 692)

Decompose $\vec{v} = \vec{v}_\perp + \vec{v}_\parallel$ ← parallel to $\vec{B}$

$\vec{F} = -e(\vec{v}_\perp + \vec{v}_\parallel) \times \vec{B}$

$\vec{v}_\parallel \times \vec{B} = v_\parallel B \sin 0° = 0$

$\vec{F} = -e\,\vec{v}_\perp \times \vec{B}$ always perp. to $\vec{v}_\perp$

Circular motion is just as on p. 693 with $v_\perp$ in place of v, so

radius: $r = \frac{m v_\perp}{eB} = \frac{(9.1 \times 10^{-31} kg)(3.0 \times 10^6 \frac{m}{s})\frac{1}{\sqrt{2}}}{(1.6 \times 10^{-19} C)(0.23\ T)}$

$= 52.5 \times 10^{-31+6+19}\ m$

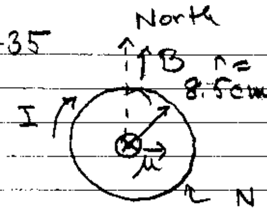
$= 5.25 \times 10^{-5}\ m$

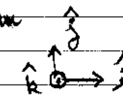
'pitch':

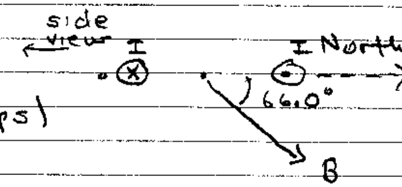
$P = \cancel{v_\parallel} \times \left(\frac{2\pi r}{\cancel{v_\perp}}\right) = 3.3 \times 10^{-4}\ m$ ← period

these are equal because $\theta = 45°$

27-35







$I = 7.10\ A$

a) Torque from $\vec{\tau} = \vec{\mu} \times \vec{B}$

$\vec{\mu} = N I A(-\hat{k})$ (down)

$= -(12)(7.10\ A)(\pi (0.085 m)^2)\ \hat{k}$

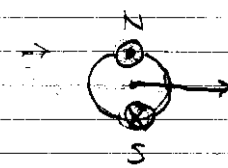
$= -1.93\ A \cdot m^2\ \hat{k}$

$\vec{B} = 5.50 \times 10^{-5}\ T \cdot (\hat{j} \cos 66.0° - \hat{k} \sin 66.0°)$

use $\hat{k} \times \hat{j} = -\hat{i}$, $\hat{k} \times \hat{k} = 0$

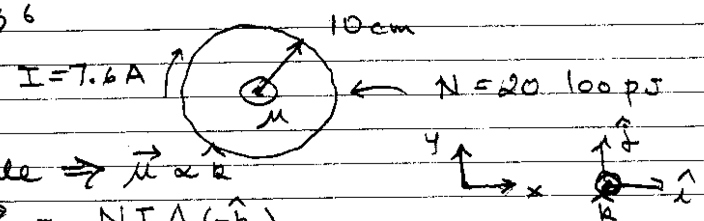
$\vec{\tau} = +4.33 \times 10^{-5}\ N m\ (+\hat{i})$ (East)

b)



$\vec{\tau}$ to right (E)
equivalent to lifting force at top (N)

27-36



a) RH rule $\Rightarrow \vec{\mu} \propto \hat{k}$

$$\vec{\mu} = NIA(-\hat{k})$$

$$= 20 \cdot (7.6\,A)\left(\pi(0.1\,m)^2\right)(-\hat{k})$$

$$= -4.8\ A\,m^2\,\hat{k}$$

b) $\vec{\tau} = \vec{\mu} \times \vec{B}$

$$= -(4.8\ A\,m^2)\,\hat{k} \times (0.80\hat{i} + 0.60\hat{j} - 0.65\hat{k})\,T$$

use $\hat{k} \times \hat{i} = \hat{j}$, $\hat{k} \times \hat{j} = -\hat{i}$, $\hat{k} \times \hat{k} = 0$

$$\vec{\tau} = -(3.84\hat{j} - 2.88\hat{i})\ N\cdot m$$

$$= (2.9\hat{i} - 3.8\hat{j})\ N\cdot m$$

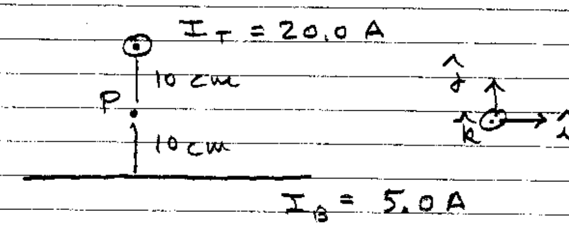
c) $U = -\vec{\mu} \cdot \vec{B}$ ($U=0$ for $\theta = \frac{\pi}{2}$ as on p. 696.)

$$= -(-4.8\,A\,m^2)\,\hat{k} \cdot (0.80\hat{i} + 0.60\hat{j} - 0.65\hat{k})\,T$$

use $\hat{k}\cdot\hat{i} = \hat{k}\cdot\hat{j} = 0$, $\hat{k}^2 = 1$:

$$= -3.1\ J$$

28-17



at P: $\vec{B} = \vec{B}_T + \vec{B}_B$

Magnitudes:

$$B_T = \frac{\mu_0}{2\pi}\frac{I_T}{0.1\,m}$$

$$= 2\times10^{-7}\ \frac{T\,m}{A}\ \frac{(20.0\,A)}{0.1\,m}$$

$$= 4.0\times10^{-5}\ T$$

$$B_B = 2.0\times10^{-7}\ \frac{T\,m}{A}\ \frac{(5.0\,A)}{0.1\,m}$$

$$= 1.0\times10^{-5}\ T$$

Directions (from RH rule)

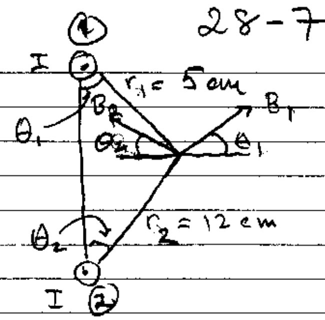
$\vec{B}_T \propto \hat{i}$, $\vec{B}_B \propto \hat{k}$

So $\vec{B} = (4.0\hat{i} + 1.0\hat{k})\times10^{-5}\ T$

Magnitude of total

$$B = \sqrt{4^2+1}\ \times10^{-5}\,T = 4.1\times10^{-5}\,T$$

28-7



$I = 25$ A

Need magnitudes of B_1 and B_2

And need θ_1 and θ_2. When we get these

$\vec{B} = \vec{B}_1 + \vec{B}_2$

$= B_1(\hat{i}\cos\theta_1 + \hat{j}\sin\theta_1)$

$+ B_2(-\hat{i}\cos\theta_2 + \hat{j}\sin\theta_2)$

Magnetudes:

$B_1 = \frac{\mu_0}{2\pi}\frac{I}{5\text{ cm}} = \left(2\cdot10^{-7}\frac{\text{Tm}}{\text{A}}\right)\frac{(25\text{ A})}{.05\text{ m}} = 1.00\times10^{-4}\text{ T}$

$B_2 = \left(2\cdot10^{-7}\frac{\text{Tm}}{\text{A}}\right)\frac{25\text{ A}}{.12\text{ m}} = 4.17\times10^{-5}\text{ T}$

Angles: θ_1 and θ_2 equal the angles marked on the triangle, to be found from "law of cosines"

$r_2^2 = d^2 + r_1^2 - 2r_1 d\cos\theta_1$

$r_1^2 = d^2 + r_2^2 - 2r_2 d\cos\theta_2$

for θ_1:

$144 = 225 + 25 - 2(15)5\cos\theta_1$

$150\cos\theta_1 = 106$

$\cos\theta_1 = 0.707$, $\sin\theta_1 = 0.707$

$\theta_1 = 45°$

for θ_2:

$25 = 225 + 144 - 2(12)15\cos\theta_2$

$360\cos\theta_2 = 344$

$\cos\theta_2 = 0.956$, $\sin\theta_1 = 0.294$

$\theta_2 = 17.1°$

Rest is substitution, then determine $B_{x,tot}$, $B_{y,tot}$ to get direction from

$\frac{B_{y,tot}}{B_{x,tot}} = \cancel{\tan\alpha}\ \tan\alpha$