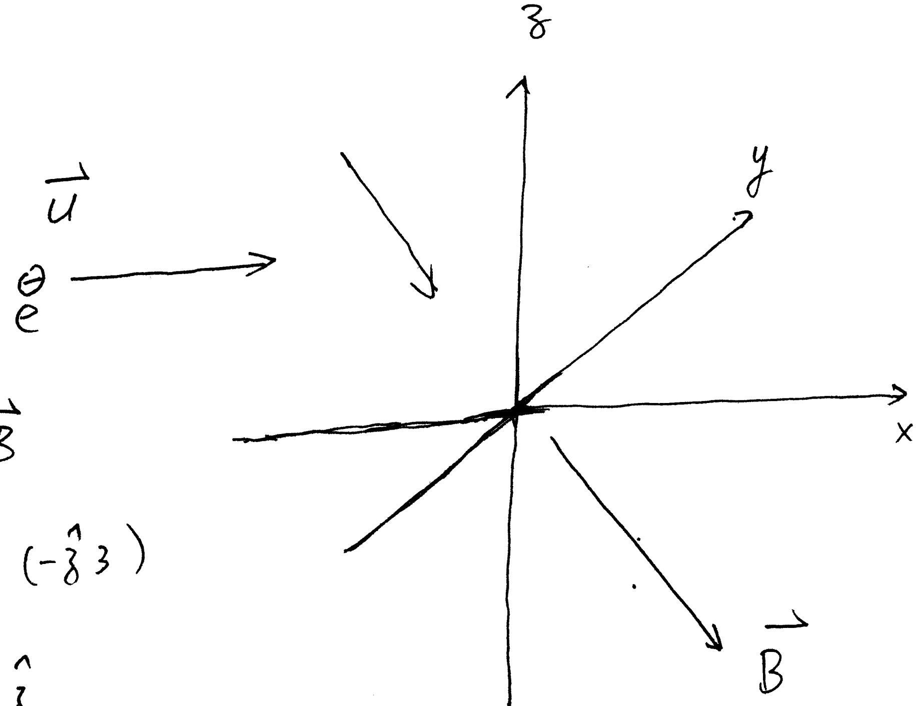
Phys 221.

Assignment #6. Solutions.

5.1.

$\vec{u} = \hat{x} \cdot u.$

$\vec{B} = \hat{x}2 - \hat{z}3.$



$$\vec{F} = -e\vec{u} \times \vec{B}$$

$$= -eu\,\hat{x} \times (-\hat{z}3)$$

$$= 3eu\,\hat{x} \times \hat{z}$$

$$= -\hat{y}\,3eu$$

$$\vec{a} = \frac{\vec{F}}{m_e} = -\hat{y}\,\frac{3eu}{m_e} = -\hat{y}\,\frac{3 \times 1.6 \times 10^{-19} \times 4 \times 10^{6}}{9.1 \times 10^{-31}}$$

$$= -\hat{y}\,(2.1 \times 10^{18})\ m/s^2$$

5.4 $N = 20$

$I = 0.5\ A$

$\vec{B} = \hat{y}\ 1.2\ T.$

$\vec{T} = \vec{m} \times \vec{B}$

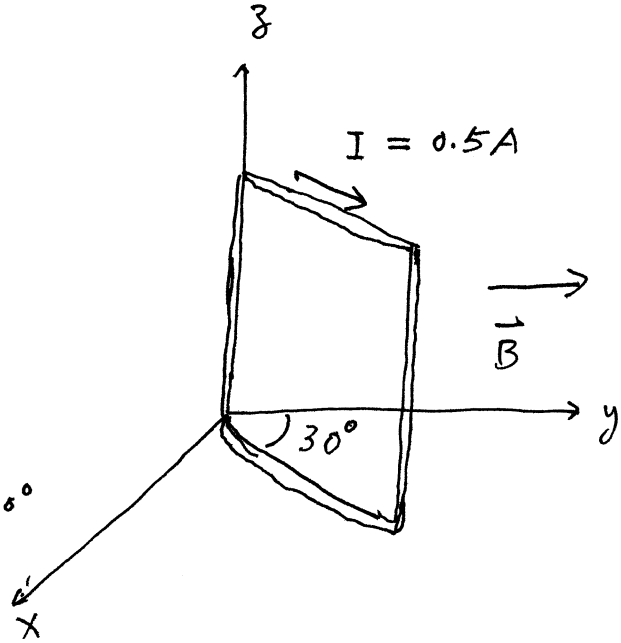
$= -\hat{z}\,(NabI)\cdot B \cdot \sin 60°$

$T = (20)(0.2)(0.4)(0.5)(1.2)\cdot \sin 60°$

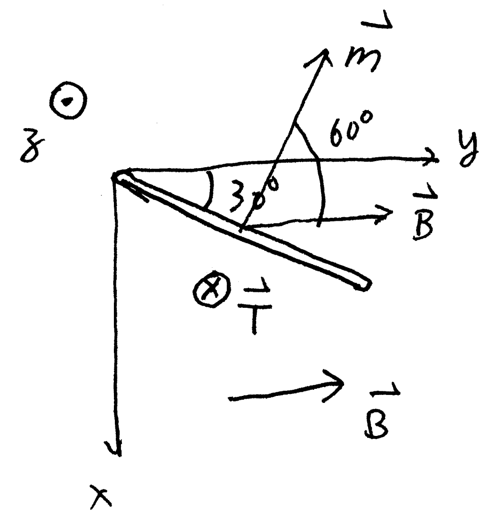
$= 0.83\ (N\cdot m)$

$\vec{T} = -\hat{z}\,(0.83)\ \ (N\cdot m)$.

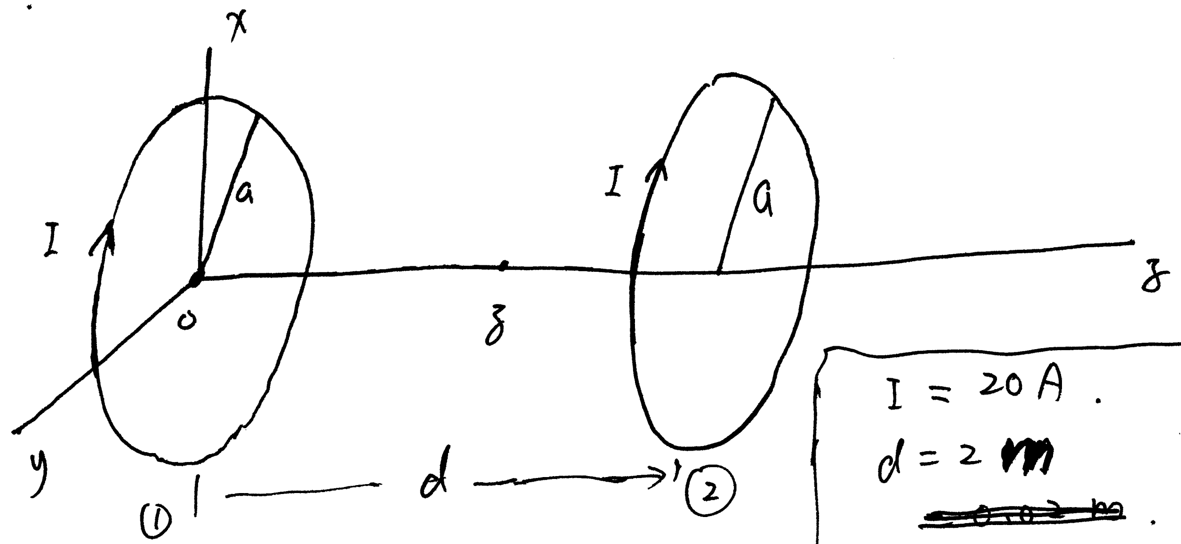
Direction : clockwise.



Top View



5.14.



$I = 20\,A$.
$d = 2\,m$
~~0.02 m~~.
$a = 3\,m$.

~~H~~ field at z due to loop ①:

$$\vec{H}_1 = -\hat{z}\,\frac{I a^2}{2(a^2+z^2)^{3/2}}$$

$\vec{H}$-field at z due to loop ②:

$$\vec{H}_2 = -\hat{z}\,\frac{I a^2}{2[a^2+(d-z)^2]^{3/2}}$$

Total $\vec{H}$-field at z: $\vec{H} = -\hat{z}\,\frac{Ia^2}{2}\left[\frac{1}{(a^2+z^2)^{3/2}} + \frac{1}{[a^2+(d-z)^2]^{3/2}}\right]$

(a) $z = 0$: $\vec{H} = -\hat{z}\,\frac{Ia^2}{2}\left(\frac{1}{a^3} + \frac{1}{(a^2+d^2)^{3/2}}\right) = -\hat{z}\,5.25\ A/m$

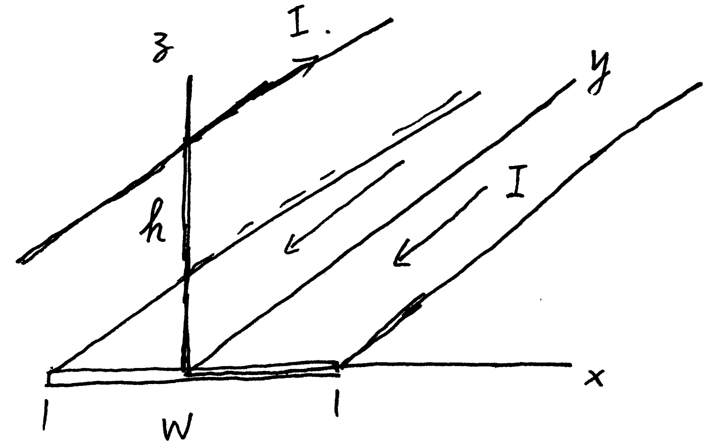
(b) $z = 1\,m$: $\vec{H} = -\hat{z}\,\frac{Ia^2}{2}\left(\frac{1}{(3^2+1^2)^{3/2}} + \frac{1}{(3^2+(1)^2)^{3/2}}\right) = -\hat{z}\,5.69\ A/m$

(c) $z = 2\,m$: $\vec{H} = -\hat{z}\,\frac{Ia^2}{2}\left(\frac{1}{(3^2+2^2)^{3/2}} + \frac{1}{(3^2)^{3/2}}\right) = -\hat{z}\,5.25\ A/m$.

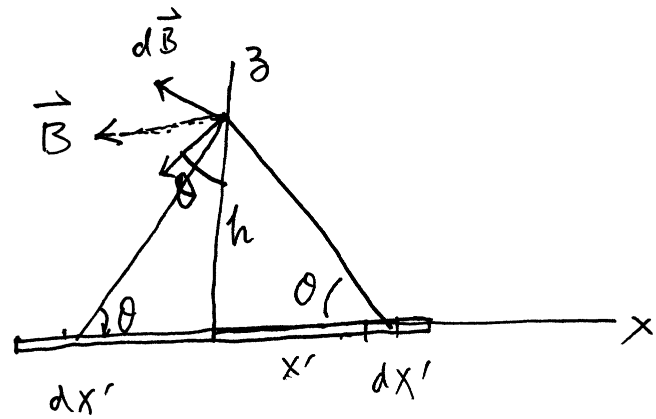
5.17.

(a) By symmetry, $\vec{B} = \hat{x} B_x$

$(B_y = B_z = 0)$.



$$dB_x = -\frac{\mu_0 \frac{I}{W} \cdot dx' \cdot \sin\theta}{2\pi (x'^2 + h^2)^{1/2}}$$



$$B_x = -\frac{2\mu_0 I}{2\pi W} \int_0^{\frac{W}{2}} \frac{h\, dx'}{x'^2 + h^2}$$

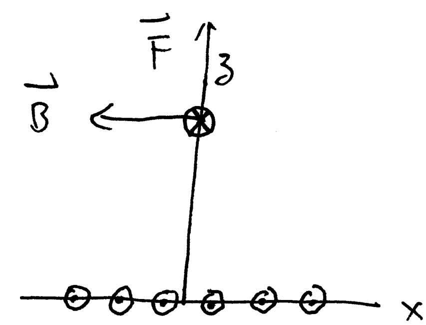
$$= -\frac{\mu_0 I}{\pi W} \cdot \tan^{-1} \frac{W}{2h}$$

$$\therefore \vec{B} = -\hat{x} \frac{\mu_0 I}{\pi W} \tan^{-1} \frac{W}{2h}.$$

$$\vec{H} = -\hat{x} \frac{I}{\pi W} \tan^{-1} \frac{W}{2h}.$$

$$\sin\theta = \frac{h}{(h^2 + x'^2)^{1/2}}$$

(b). $\vec{F} = \int_0^L I d\vec{\ell} \times \vec{B} \Big/ L$



$$= \hat{z} \frac{ILB}{L}$$

$$= \hat{z} \frac{\mu_0 I^2}{\pi W} \tan^{-1} \frac{W}{2h}. \quad (N)$$