

Phys 221.

Assignment #6. Solutions.

5.1.

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

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

$$\vec{U}$$

$$e$$



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

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

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

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

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

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

a6-2.

5.4 $N=20$

$I=0.5 A$

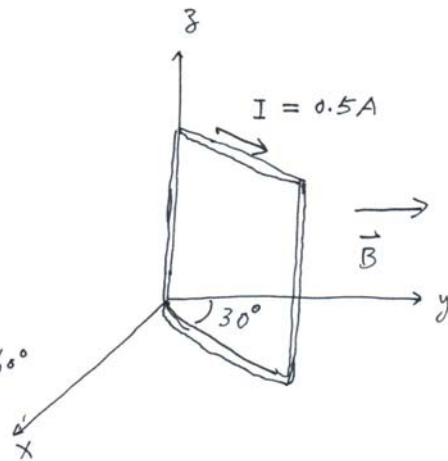
$\vec{B} = \hat{y} 1.2 T.$

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

$= -\hat{z} (NabI) \cdot B \cdot \sin 60^\circ$

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

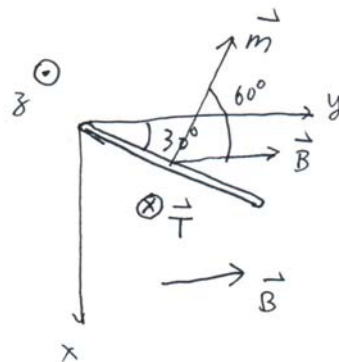
$= 0.83 (N \cdot m)$



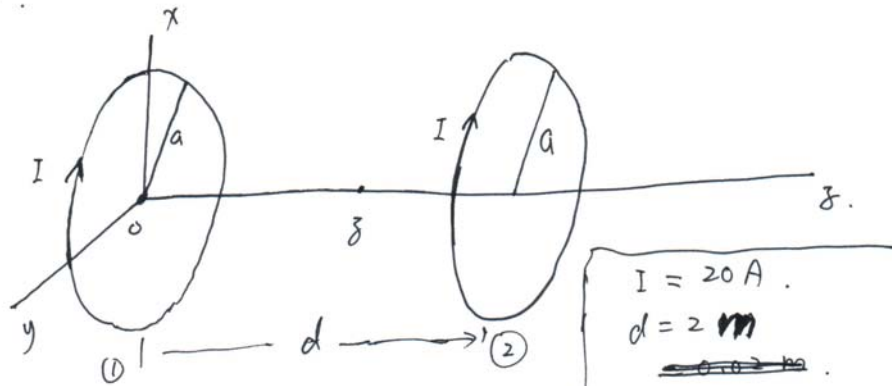
$\vec{T} = -\hat{z} (0.83) (N \cdot m).$

Direction : clockwise.

Top View



5.14.



$$I = 20 \text{ A}$$

$$d = 2 \text{ m}$$

$$a = 3 \text{ m}$$

$\vec{H}$ -field at z due to loop ①:

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

$\vec{H}$ -field at z due to loop ②:

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

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

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

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

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

5.17.

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

$$(B_y = B_z = 0)$$

$$dB_x = - \frac{\mu_0 \frac{I}{W} \cdot dx' \cdot \sin \theta}{2\pi (x'^2 + h^2)^{3/2}}$$

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

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

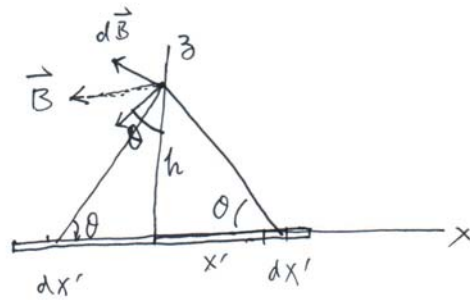
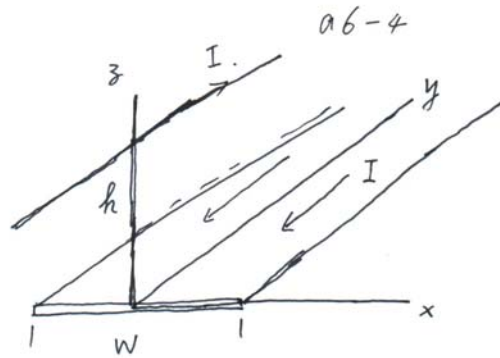
$$\therefore \vec{B} = -\hat{x} \frac{\mu_0 h I}{\pi W} \tan^{-1} \frac{W}{2h}$$

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

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

$$= \hat{z} \frac{I L B}{L}$$

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



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

