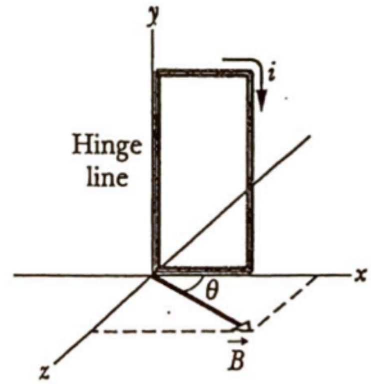
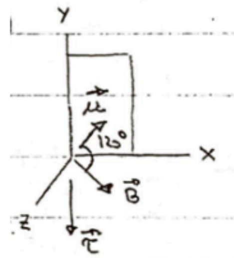
NAME and ID: ____ SCORE: _____ /4 points

PHY 274 PROBLEM SOLVING WORKSHOP VIII

1. The figure to the right shows a rectangular 20-turn coil of wire, of dimensions 10 cm by 5 cm. It carries a current of 0.10 A and is hinged along one long side. It is mounted in the xy plane, at an angle of $\theta = 30°$ to the direction of a uniform magnetic field of magnitude 0.50 T. In unit-vector notation, what is the torque acting on the coil about the hinge line?





$n = 20$, $A = 5\times10^{-3}\,m^2$

$I = 0.1A$, $B = 0.5T$

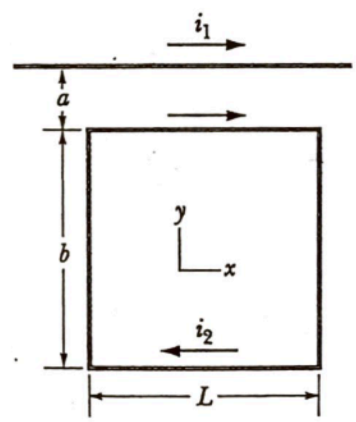
$\vec{\tau} = \vec{\mu}\times\vec{B}$

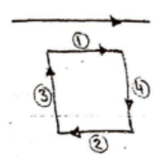
$\tau = \mu B \sin 120°$, $\mu = nIA$

$\Rightarrow \tau = nIAB\sin 120° = 4.33\times10^{-3}\,Nm$

$\vec{\tau} = -4.33\times10^{-3}\,Nm\,\hat{j}$

2. In the figure to the right, a long straight wire carries a current $i_1 = 30.0$ A and a rectangular loop carries current $i_2 = 20.0$ A. Take $a = 1.00$ cm, $b = 8.00$ cm, and $L = 30.0$ cm. In unit-vector notation, what is the net force on the loop due to i_1?





$I_1 = 30A$, $I_2 = 20A$

$L = 0.3m$, $a = 0.01m$

$b = 0.08m$

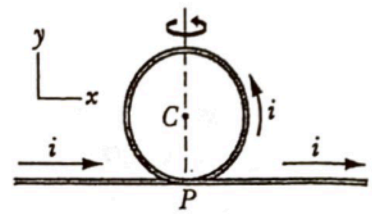
$\vec{F}_{③} = -\vec{F}_{④}$, $\vec{F} = F_{①}\hat{j} - F_{②}\hat{j}$

$F_{①} = L\frac{\mu_0}{2\pi}\frac{I_1 I_2}{a} = 3.6\times10^{-3}\,N$

$F_{②} = L\frac{\mu_0}{2\pi}\frac{I_1 I_2}{a+b} = 0.4\times10^{-3}\,N$

$\vec{F} = 3.2\times10^{-3}\,N\,\hat{j}$

3. In the figure to the right, part of a long insulated wire carrying current $i = 5.78\,\mathrm{mA}$ is bent into a circular section of radius $R = 1.89\,\mathrm{cm}$. In unit-vector notation, what is the magnetic field at the center of curvature (point C) if the circular section (lies in the plane of the page, as is shown), and (b) is perpendicular to the plane of the page after being rotated 90° clockwise as indicated?



1) $I = 5.78 \times 10^{-3}\,\mathrm{A}$, $R = 1.89 \times 10^{-2}\,\mathrm{m}$

$$B_c = \frac{\mu_0 I}{2R}, \quad B_s = \frac{\mu_0 I}{2\pi R}$$

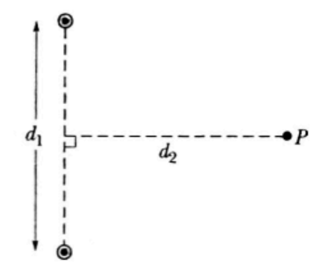
(a) $\vec{B} = B_c \hat{k} + B_s \hat{k}$

$= 1.92 \times 10^{-7}\,\mathrm{T}\,\hat{k} + 0.61 \times 10^{-7}\,\mathrm{T}\,\hat{k}$

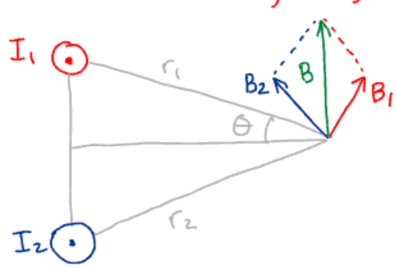
$= 2.53 \times 10^{-7}\,\mathrm{T}\,\hat{k}$

(b) $\vec{B} = B_c \hat{i} + B_s \hat{k} = 1.92 \times 10^{-7}\,\mathrm{T}\,\hat{i} + 0.61 \times 10^{-7}\,\mathrm{T}\,\hat{k}$.

4. The figure to the right shows two very long straight wires (in cross section) that each carry a current of 4.00 A directly out of the page. Distance $d_1 = 6.00\,\mathrm{m}$ and distance $d_2 = 4.00\,\mathrm{m}$. What is the magnitude of the net magnetic field at point P?



For a sufficiently long wire $B = \dfrac{\mu_0 I}{2\pi r}$



Since $I_1 = I_2$ and $r_1 = r_2$:

$$B_1 = B_2 = \frac{\mu_0 I}{2\pi r}$$

$$B_{1,2} = 1.6 \times 10^{7}\,\mathrm{T}$$

Net result from fig $B = 2 B_{1,2} \cos\theta = 2.56 \times 10^{7}\,\mathrm{T}$