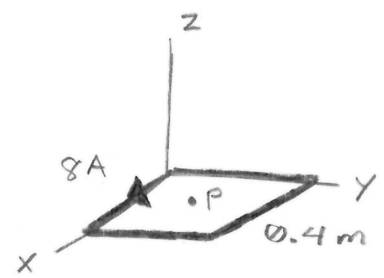
1



using result (5.27) in the textbook...

$$\vec{H} = \hat{\phi}\,\frac{I}{4\pi r}\left(\cos\theta_1 - \cos\theta_2\right) \quad \text{for 1 conductor}$$

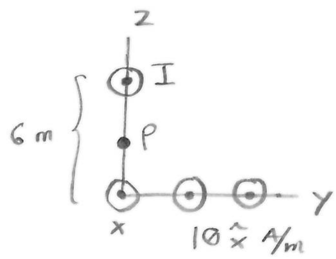
$$\theta_1 = 45°, \quad \theta_2 = 135°$$

$$\vec{H}_{1\text{ side}} = \hat{z}\,\frac{8}{4\pi(.2)}\left[\cos 45° - \cos 135°\right]$$

$$= \hat{z}\,\frac{10}{\pi}\left[\sqrt{2}\right]$$

$$\vec{H}_{4\text{ sides}} = \hat{z}\,\frac{40\sqrt{2}}{\pi} \approx \boxed{18\,\hat{z}\ \text{A/m}}$$

(2)



for a sheet of current, $\vec{H} = -\frac{J_s}{2}\hat{y}$

$$\vec{H}_{sheet} = -5\hat{y} \quad \text{for } z > 0$$

for a thin filament of current, $\vec{H} = \hat{\phi}\frac{I}{2\pi r}$

$$\vec{H}_{filament} = \hat{y}\frac{I}{2\pi(3)} = \hat{y}\frac{I}{6\pi}$$

for the total field to → zero,

$$-5\hat{y} + \frac{I}{6\pi}\hat{y} = 0$$

$$I = 30\pi \approx \boxed{94.2\text{ A}}$$

3 $\vec{J} = \frac{J_0}{r}\hat{z}$ Ampere's Law (because of symmetry)

$$\oint \vec{H}\cdot d\vec{\ell} = \iint_S \vec{J}\cdot d\vec{s} \qquad \vec{H} = H_\phi \hat{\phi}$$

$r \leq a$: $$\int_0^{2\pi} H_\phi \hat{\phi}\cdot\hat{\phi}\, r\, d\phi = \int_{\phi=0}^{2\pi}\int_{r=0}^{r} \frac{J_0}{r} r\, dr\, d\phi$$

$$2\pi \cdot H_\phi \cdot r = 2\pi \cdot J_0 \cdot r$$

$$H_\phi = J_0$$

$$\vec{H} = J_0 \hat{\phi}$$

$r \geq a$: $$\int_0^{2\pi} H_\phi \hat{\phi}\cdot\hat{\phi}\, r\, d\phi = \int_0^{2\pi}\int_0^{a} \frac{J_0}{r} r\, dr\, d\phi$$

$$2\pi \cdot H_\phi \cdot r = 2\pi \cdot J_0 \cdot a$$

$$H_\phi = J_0 a / r \Rightarrow \vec{H} = \frac{J_0 a}{r}\hat{\phi}$$

$$\boxed{\vec{H} = \begin{cases} J_0 \hat{\phi}, & r \leq a \\ \frac{J_0 a}{r}\hat{\phi}, & r \geq a \end{cases}}$$

4

$$\vec{B} = 4\hat{x} - 8\hat{z}$$

$$\overset{+}{\longrightarrow} \quad x \; y \; z \quad \underset{-}{\longleftarrow}$$

$$\vec{F} = I \int d\vec{l} \times \vec{B}$$

$$d\vec{l} = -\hat{y}\,dy \,, \quad I = 2\,A$$

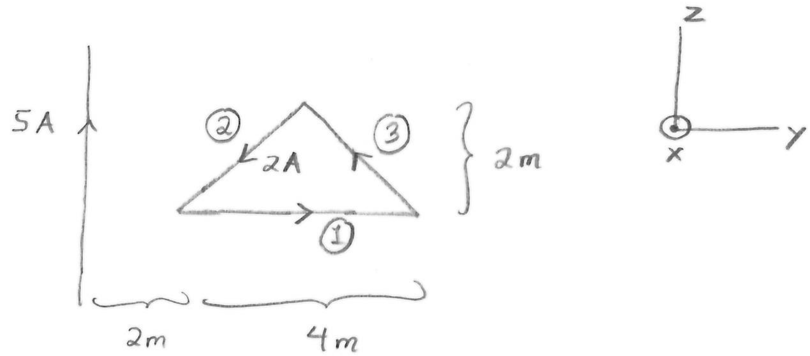
$$\vec{F} = (2) \int_{0}^{.2} (-\hat{y}\,dy) \times (4\hat{x} - 8\hat{z})$$

$$= (.4)\left[4\hat{z} + 8\hat{x} \right]$$

$$= 1.6\hat{z} + 3.2\hat{x}$$

$$= \boxed{3.2\hat{x} + 1.6\hat{z} \quad N}$$

5



(a)

$$\vec{F}_1 = I_1 \int d\vec{\ell}_1 \times \vec{B} \qquad \vec{B} = -\hat{x}\,\frac{\mu_0 I_2}{2\pi y}$$

$$d\vec{\ell}_1 = \hat{y}\,dy$$

$$= I_1 \int_{y=2}^{y=6} (\hat{y}\,dy) \times \left(-\hat{x}\,\frac{\mu_0 I_2}{2\pi y}\right)$$

$$= \frac{I_1 I_2 \mu_0}{2\pi}\,\hat{z} \int_2^6 \frac{1}{y}\,dy$$

$$= \frac{(5)(2)(4\pi \times 10^{-7})}{2\pi} \ln\left(\frac{6}{2}\right) \hat{z} \approx \boxed{2.2\ \mu N\ \hat{z}}$$

(b) [next page]

(b) $d\vec{\ell}_2 = \hat{y}\, dy + \hat{z}\, dz$

where $z = y - 2$

$dz = dy$

$$\vec{F}_2 = I_1 \int_{y=4}^{y=2} (\hat{y}\, dy + \hat{z}\, dy) \times \left(-\hat{x} \frac{\mu_0 I_2}{2\pi y}\right)$$

$$= \frac{\mu_0 I_1 I_2}{2\pi} \int_4^2 \hat{z} \frac{dy}{y} - \hat{y} \frac{dy}{y}$$

$$= \frac{(4\pi \times 10^{-7})(2)(5)}{2\pi} \left[\hat{z} \ln\left(\frac{2}{4}\right) - \hat{y} \ln\left(\frac{2}{4}\right) \right]$$

$$= -1.39\, \hat{z} + 1.39\, \hat{y} \quad \mu N$$

$d\vec{\ell}_3 = \hat{y}\, dy + \hat{z}\, dy$

where $z = -y + 6$

$dz = -dy$

$$\vec{F}_3 = I_1 \int_{y=6}^{y=4} (\hat{y}\, dy - \hat{z}\, dy) \times \left(-\hat{x} \frac{\mu_0 I_2}{2\pi y}\right)$$

$$= \frac{\mu_0 I_1 I_2}{2\pi} \int_6^4 \hat{z} \frac{dy}{y} + \hat{y} \frac{dy}{y}$$

(b) $$\vec{F}_3 = \frac{(4\pi \times 10^{-7})(2)(5)}{2\pi}\left[\hat{z}\ \ln\left(\frac{4}{6}\right) + \hat{y}\ \ln\left(\frac{4}{6}\right)\right]$$

$$= -0.81\,\hat{z} - 0.81\,\hat{y} \quad \mu N$$

$$\vec{F}_{total} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$$

$$= 2.2\,\hat{z}$$
$$- 1.39\,\hat{z} + 1.39\,\hat{y}$$
$$- 0.81\,\hat{z} - 0.81\,\hat{y} \quad \mu N$$

$$= \boxed{0.58\,\hat{y} \quad \mu N}$$