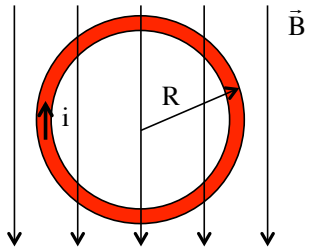
Problem 29.44



We know that

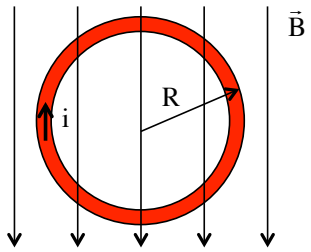
$$C = 2\pi R = 2 \text{ m}$$
$$\Rightarrow \quad R = .318 \text{ m}$$

a.) The magnetic moment, by definition, is:

$$\begin{aligned}\mu &= IA \\ &= I\left(\pi R^2\right) \\ &= \left(17\text{x}10^{-3} \text{ A}\right)\left[\pi\left(.318 \text{ m}\right)^2\right] \\ &= 5.41\text{x}10^{-3} \text{ A} \bullet \text{m}^2\end{aligned}$$

The direction of the magnetic moment is perpendicular to the face of the coil. Specifically, it is found by having the fingers of the right hand to curl around the coil along the direction of the current. The direction the thumb points is the direction of the magnetic moment. In this case, that would be into the page.

Put a little differently, the magnetic moment vector can be written in this case as:



$$\vec{\mu} = \left(5.41\text{x}10^{-3} \text{ A} \bullet \text{m}^2\right)\left(-\hat{k}\right)$$

b.) The magnitude of the torque on a current carrying coil in a magnetic field is:

$$\begin{aligned}\left|\vec{\Gamma}\right| &= \left|\vec{\mu}\text{x}\vec{B}\right| \\ &= \mu B \sin\theta \\ &= \left(5.41\text{x}10^{-3} \text{ A} \bullet \text{m}^2\right)\left(.8 \text{ T}\right)\sin 90^\circ \\ &= 4.33\text{x}10^{-3} \text{ N} \bullet \text{m}\end{aligned}$$

Note: The direction of the torque (remember, this is the direction of the axis *about which the rotation will occur*) is defined as the direction of $\vec{\mu}\text{x}\vec{B}$. Using the right-hand rule and just the unit vectors in the cross product, that direction is:

$$\begin{aligned}\vec{\Gamma} &= \vec{\mu} \text{ x } \vec{B} \\ &= \left(-\hat{k}\right)\text{x}\left(-\hat{j}\right) \\ &= -\hat{i}\end{aligned}$$