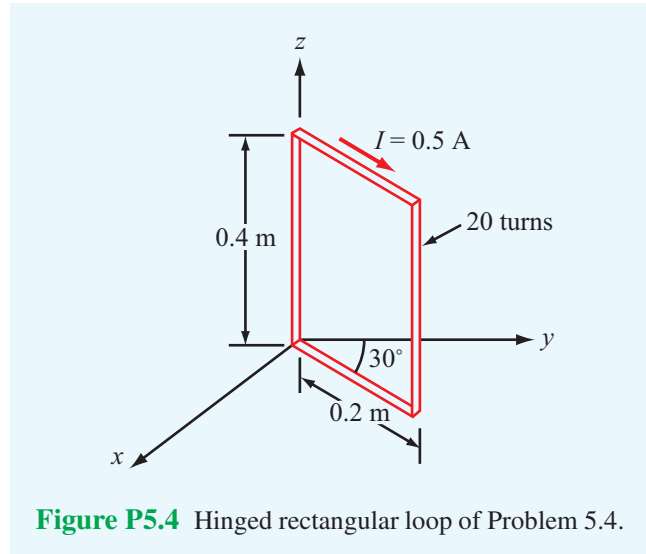


5.4 The rectangular loop shown in Fig. P5.4 consists of 20 closely wrapped turns and is hinged along the z -axis. The plane of the loop makes an angle of 30° with the y -axis, and the current in the windings is 0.5 A. What is the magnitude of the torque exerted on the loop in the presence of a uniform field $\mathbf{B} = \hat{y}2.4$ T? When viewed from above, is the expected direction of rotation clockwise or counterclockwise?



Solution: The magnetic torque on a loop is given by $\vec{T} = \vec{m} \times \vec{B}$ (Eq. (5.20)), where $\vec{m} = \hat{n}NIA$ (Eq. (5.19)). For this problem, it is given that $I = 0.5$ A, $N = 20$ turns, and $A = 0.2 \text{ m} \times 0.4 \text{ m} = 0.08 \text{ m}^2$. From the figure, $\hat{n} = -\hat{x} \cos 30^\circ + \hat{y} \sin 30^\circ$. Therefore, $\vec{m} = \hat{n}0.8 \text{ (A} \cdot \text{m}^2)$ and $\vec{T} = \hat{n}0.8 \text{ (A} \cdot \text{m}^2) \times \hat{y}2.4 \text{ T} = -\hat{z}1.66 \text{ (N} \cdot \text{m)}$. As the torque is negative, the direction of rotation is clockwise, looking from above.