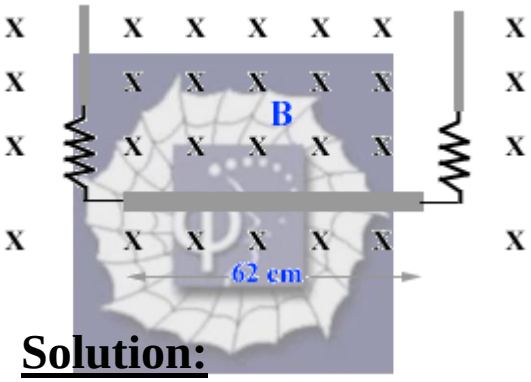
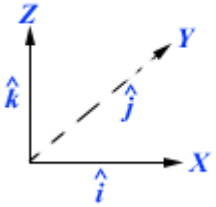
444.

Problem 34.41 (RHK)

A wire of length 62.0 cm *and mass* 13.0 g *is suspended by a pair of flexible leads in a magnetic field of* 440 mT. *We have to find the magnitude and the direction of the current in the wire required to remove the tension in the supporting leads.*



Solution:



We fix a coordinate system as shown in the figure. Mass of the wire is 13.0 g. The force due to gravitational pull of the Earth on the wire will be

$$\vec{F}_g = -13\times10^{-3}\times9.81\hat{k}\ \text{N} = -0.128\hat{k}\ \text{N}.$$

Magnetic field acting on the wire is

$$\vec{B} = 0.440\,\hat{j}\ \text{T}.$$

Force on a wire of length, L, carrying current $\vec{i}$ (A) in magnetic field, $\vec{B}$, is

$$\vec{F}_{mag} = L\vec{i} \times \vec{B}.$$

Length of the wire is

$$L = 0.62 \text{ m}.$$

Therefore,

$$\vec{F}_{mag} = 0.62\vec{i} \times 0.44\hat{j} \text{ N} = 0.273\vec{i} \times \hat{j} \text{ N}.$$

The direction and magnitude of the current is so arranged that there is no tension in the supporting leads. That is

$$\vec{F}_g + \vec{F}_{mag} = 0.$$

We note from the property of the cross-products that this condition determines the direction of the current. We have

$$\vec{i} = i\hat{i}.$$

And the magnitude of the current

$$i = \frac{0.128}{0.273} \text{ A} = 0.468 \text{ A} = 468 \text{ mA}.$$

The current flows from left-to-right, that is along the *X*-axis of the coordinate system shown in the figure.