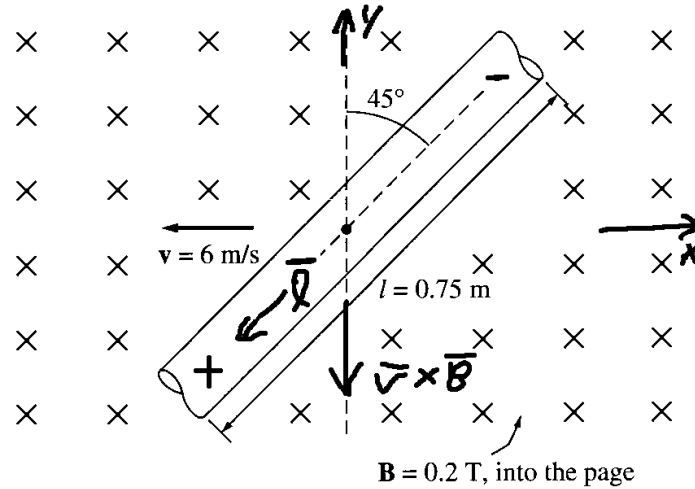


- 1-10** The wire shown in Figure P1-7 is moving in the presence of a magnetic field. With the information given in the figure, determine the magnitude and direction of the induced voltage in the wire.

Figure P1-7 | A wire moving in a magnetic field (Problem 1-10).



Per (1-45), $e_{\text{ind}} = (\bar{v} \times \bar{B}) \cdot \bar{\ell}$.

Method 1

Superimpose the Cartesian axes on the problem figure.

Then, the velocity is $\bar{v} = -\hat{a}_x 6 \text{ m/s}$, the magnetic flux density is $\bar{B} = -\hat{a}_z 0.2 \text{ T}$, and $\bar{v} \times \bar{B} = -\hat{a}_x 6 \times -\hat{a}_z 0.2 = -\hat{a}_y 1.2$.

The length vector $\bar{\ell}$ points in the direction of the wire axis making the smallest angle with $\bar{v} \times \bar{B}$ (and toward the positive '+' polarity wire end). It is

$$\bar{\ell} = \hat{a}_{\ell} 0.75 = \frac{(-\hat{a}_x - \hat{a}_y)}{\sqrt{1^2 + 1^2}} 0.75 = \frac{(-\hat{a}_x - \hat{a}_y)}{\sqrt{2}} 0.75 \text{ m}.$$

$$\text{So, } e_{\text{ind}} = -\hat{a}_y 1.2 \cdot \frac{(-\hat{a}_x - \hat{a}_y)}{\sqrt{2}} 0.75 = \frac{0 + 1(1.2)}{\sqrt{2}} 0.75 \Rightarrow \boxed{e_{\text{ind}} = 0.6364 \text{ V}}.$$

Method 2

By RHR, the vector $\bar{v} \times \bar{B}$ points down and has magnitude $(0.2)6 = 1.2$.

The length vector $\bar{\ell}$ points in the direction of the wire axis making the smallest angle (45° by inspection) with $\bar{v} \times \bar{B}$ (and toward the positive '+' polarity wire end), i.e., down and left, and has a magnitude of 0.75 m.

Using the definition of the scalar product,

$$e_{\text{ind}} = (\bar{v} \times \bar{B}) \cdot \bar{\ell} = |\bar{v} \times \bar{B}| |\bar{\ell}| \cos \theta = 1.2(0.75) \cos 45^\circ \Rightarrow \boxed{e_{\text{ind}} = 0.6364 \text{ V}}.$$