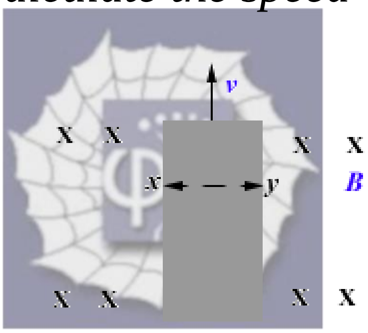
442.

<u>Problem 34.39 (RHK)</u>

As shown in the figure, a metal strip, 6.5 cm *long,* 0.88 cm *wide, and* 0.76 cm *thick, moves with constant velocity* $\vec{v}$ *through a magnetic field* $B = 1.2\ \text{mT}$ *perpendicular to the strip. A potential difference of* $3.9\ \mu\text{V}$ *is measured between points x and y across the strip. We have to calculate the speed v.*



<u>Solution:</u>

Let n be the volume density of conduction charge carriers inside the metal strip. As the strip is being pulled with velocity $\vec{v}$, the charge carriers also move with velocity $\vec{v}$ in the laboratory frame in which the magnetic field is static and uniform. The Hall electric field, *E*, is related to the potential difference, *V*, measured across the strip and the width of the strip, *w*.

$$E = \frac{V}{w}.$$

Also, when the Hall voltage becomes constant, the net Lorentz force on the conduction charge carriers will be zero. That is

$$vB = E,$$

and

$$v = \frac{E}{B} = \frac{V}{Bw}.$$

From the data of the problem, we note that

$$V = 3.9\ \mu\text{V} = 3.9 \times 10^{-6}\ \text{V},$$

$$w = 0.88 \times 10^{-2}\ \text{m}.$$

Therefore, the speed v with which the strip is being pulled is

$$v = \frac{3.9 \times 10^{-6}}{0.88 \times 10^{-2} \times 1.2 \times 10^{-3}}\ \text{m s}^{-1} = 36.9 \times 10^{-2}\ \text{m s}^{-1} = 36.9\ \text{cm s}^{-1}.$$