5.50 Consider a gallium arsenide sample at $T = 300$ K. A Hall effect device has been fabricated with the following geometry: $d = 0.0\ 1$ cm, $W = 0.05$ cm, and $L = 0.5$ cm. The electrical parameters are: $I_x = 2.5$ mA, $V_x = 2.2$ V, and $B_z = 2.5 \times 10^{-2}$ tesla. The Hall voltage is $V_H = -4.5$ mV. Find: (*a*) the conductivity type, (*b*) the majority carrier concentration, (*c*) the mobility, and (*d*) the resistivity.

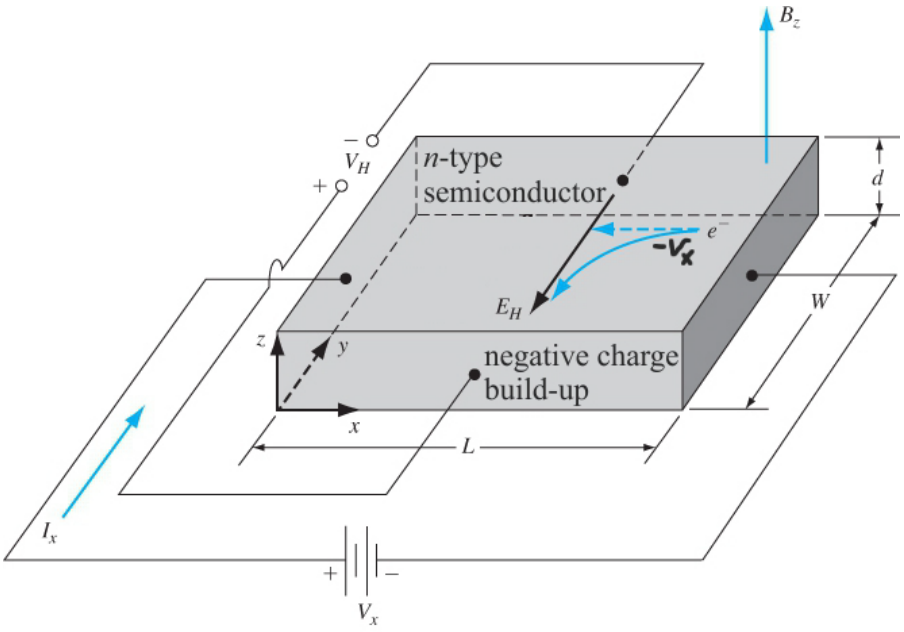

Figure 5.13 | Geometry for measuring the Hall effect.

a) Per page 181 of the text, since $V_H = -4.5\ \text{mV} < 0$ $\Rightarrow$ **n-type semiconductor**.

b) Use (5.56), $n = \dfrac{-I_x B_z}{ed V_H} = \dfrac{-2.5\times10^{-3}(2.5\times10^{-2})}{(1.6022\times10^{-19})0.01\times10^{-2}(-4.5\times10^{-3})}$

$\Rightarrow$ $n = 8.67\times10^{20}\ \#/\text{m}^3 = 8.67\times10^{14}\ \#/\text{cm}^3$

c) Use (5.60), $\mu_n = \dfrac{I_x L}{enV_x Wd} = \dfrac{2.5\times10^{-3}(0.5\times10^{-2})}{(1.6022\times10^{-19})(8.6686\times10^{20})2.2(0.05\times10^{-2})(0.01\times10^{-2})}$

$\Rightarrow$ $\mu_n = 0.8182\ \text{m}^2/\text{V-s} = 8182\ \text{cm}^2/\text{V-s}$

d) Per (5.20), $\rho = \dfrac{1}{e(\mu_n n + \mu_p p)}$. Assume $p \approx 0$.

$$\rho \simeq \frac{1}{e\mu_n n} = \frac{1}{(1.6022\times10^{-19})\,0.8182\,(8.6686\times10^{20})} \quad \Rightarrow \quad \rho = 0.0088\ \Omega\text{-m} = 0.88\ \Omega\text{-cm}$$