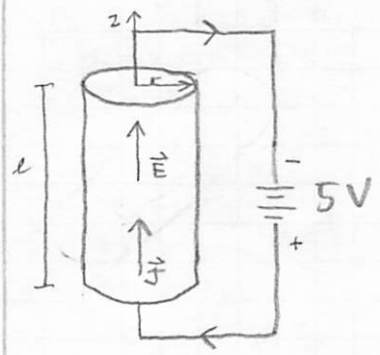
4.41 A cylindrical bar of si has radius 4 mm and length 8 cm. If 5V is applied between the ends of the bar and $\mu_e = 0.13\ m^2/V{\cdot}s$, $\mu_h = 0.05\ m^2/V{\cdot}s$, $N_e = 1.5 \times 10^{16}\ m^{-3}$, $N_h = N_e$.



$r = 0.004\ m \qquad \ell = 0.08\ m$

a) $\sigma = (N_e \mu_e + N_h \mu_h)\, e \quad S/m \quad (4.65)$

$= (N_e \mu_e + N_e \mu_h)\, e$

$= (\mu_e + \mu_h) N_e e$

$= (0.13 + 0.05)\, 1.5 \times 10^{16} \cdot 1.6 \times 10^{-19}$

$= 432 \times 10^{-6}\ S/m$

b) $J = \sigma E = 432 \times 10^{-6} \cdot \frac{5}{0.08} = 27 \times 10^{-3}\ A/m$

$I = JA = 27 \times 10^{-3} \cdot \pi\, 0.004^2 = 432\pi \times 10^{-9} \simeq 1.36\ \mu A$

c) $u_e = -\mu_e E = -0.13 \cdot \frac{5}{0.08} = -8.125$

$\vec{u}_e = -\hat{z}\ 8.125\ m/s$

$u_h = \mu_h E = 0.05 \cdot \frac{5}{0.08} = 3.125$

$\vec{u}_h = \hat{z}\ 3.125\ m/s$

d) $R = V/I = 5/1.36 \times 10^{-6} = 3.68\ M\Omega$

e) $P = IV = 1.36 \times 10^{-6} \cdot 5 = 6.8\ \mu W$