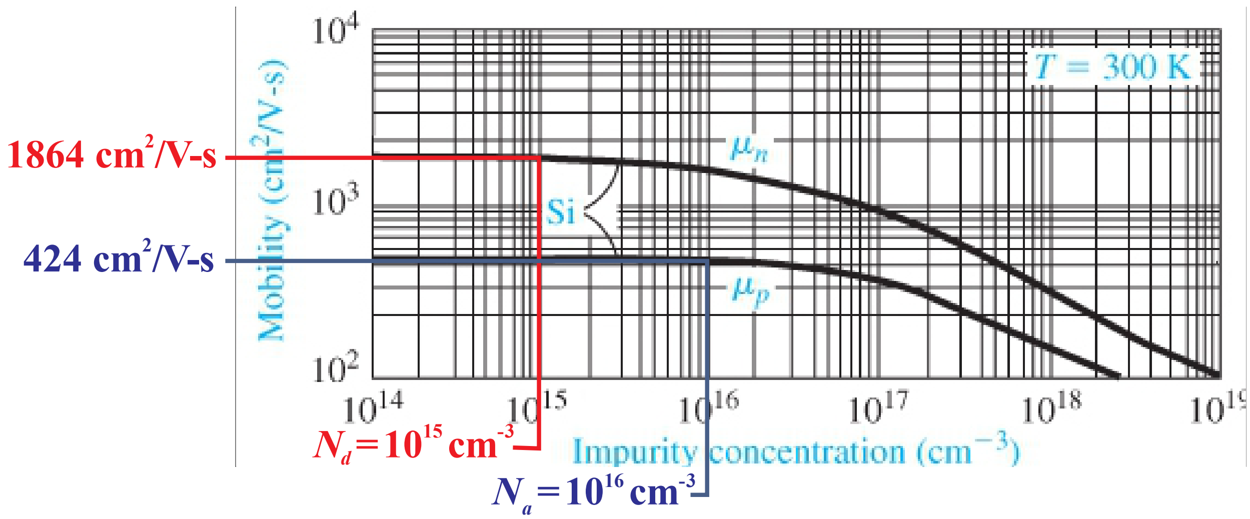
8.43 A silicon pn junction diode at $T = 300$ K has a cross-sectional area of 10^{-2} cm^2. The length of the p region is 0.2 cm and the length of the n region is 0.1 cm. The doping concentrations are $N_d = 10^{15}$ cm^{-3} and $N_a = 10^{16}$ cm^{-3}. Determine (*a*) approximately the series resistance of the diode and (*b*) the current through the diode that will produce a 0.1 V drop across this series resistance.

- First, use Figure 5.3 to get mobilities for each region. Second, use Einstein relation to get the diffusion coefficients. Third, calculate conductivities for each region.



From Fig. 5.3, read the mobilities to be **μ_n = 1864 cm²/V·s** and **μ_p = 424 cm²/V·s.**

Using (5.47), $\dfrac{D_n}{\mu_n} = \dfrac{D_p}{\mu_p} = \dfrac{k_B T}{e} = \dfrac{8.617333\times10^{-5}(300)}{e} = 0.025852$ V.

Now, we can calculate the diffusion coefficients to be-

$D_n = 0.025852(1864) \Rightarrow$ **D_n = 48.19 cm²/s** and $D_p = 0.025852(424) \Rightarrow$ **D_p = 10.96 cm²/s.**

Using (5.23) $\sigma = e(\mu_n n + \mu_p p)$, we can calculate the conductivities for the two regions-

p-region $\sigma_p \approx e\,\mu_p p \approx e\,\mu_p N_a = 1.602176634\times10^{-19}(0.0424)10^{22} \Rightarrow$ **σ_p = 67.932 S/m.**

n-region $\sigma_n \approx e\,\mu_n n \approx e\,\mu_n N_d = 1.602176634\times10^{-19}(0.1864)10^{21} \Rightarrow$ **σ_n = 29.865 S/m.**

a) $r_{\text{series}} \cong r_{\text{p-region}} + r_{\text{n-region}}$. Per (5.22b), $R = L/\sigma A$ for a conductive material. Working in MKS units-

$r_{\text{series}} \cong L_{\text{p-region}}/(\sigma_p A) + L_{\text{n-region}}/(\sigma_n A) = 0.002/[67.932(10^{-6})] + 0.001/[29.865(10^{-6})]$

$= 29.441 + 33.484 \Rightarrow$ **r_{series} = 62.925 Ω.**

b) Use Ohm's Law, $V = IR$ to get I = V/R = 0.1/62.925 $\Rightarrow$ **I = 1.589 mA.**