8.46 (*a*) An ideal silicon pn junction diode at $T = 300$ K is forward biased at $V_a = +20$ mV. The reverse-saturation current is $I_s = 10^{-13}$ A. Calculate the small-signal diffusion resistance. (*b*) Repeat part (*a*) for an applied reverse-biased voltage of $V_a = -20$ mV.

a) Per (8.67), $g_d = \left(\frac{e}{k_B T}\right) I_S e^{V_0/(k_B T/e)} \Big|_{V_a = V_0}$

$$r_d = \frac{1}{g_d} = \frac{8.617333\times10^{-5}\ \text{eV/K}\,(300\text{K})}{e} \frac{1}{10^{-13}} e^{\frac{-0.02}{8.617333\times10^{-5}(300)}}$$

$$r_d = 1.1926 \times 10^{11}\ \Omega$$

b) $$r_d = 8.617333\times10^{-5}(300) \frac{1}{10^{-13}} e^{\frac{+0.02}{8.617333\times10^{-5}(300)}}$$

$$r_d = 5.6038 \times 10^{11}\ \Omega$$