#1 from chapter 3:
Theoretically speaking and using the data provided in appendix F of the text.

$$\rho = \frac{1}{q(n\cdot\mu_n + p\cdot\mu_p)}$$

$$n = p = n_i$$

+

For Si:

$$n_i := 9.65\cdot10^{9}\,cm^{-3}$$

$$\mu_n := 1450\,\frac{cm^2}{V\cdot s} \qquad \mu_p := 505\,\frac{cm^2}{V\cdot s}$$

$$\rho := \frac{1}{1.6\cdot10^{-19}C\cdot n_i\cdot(\mu_n + \mu_p)} \qquad \rho = 3.313\times10^{5}\,\Omega\cdot cm$$

For GaAs

$$n_i := 2.25\cdot10^{6}\,cm^{-3}$$

$$\mu_n := 9200\,\frac{cm^2}{V\cdot s} \qquad \mu_p := 320\,\frac{cm^2}{V\cdot s}$$

$$\rho := \frac{1}{1.6\cdot10^{-19}C\cdot n_i\cdot(\mu_n + \mu_p)} \qquad \rho = 2.918\times10^{8}\,\Omega\cdot cm$$

Practically speaking the real measured data provided in Fig7 on page 55 we see that for Si the resistivity is more on the order of104 and GaAs depending on the predominate carrier is higher than that. Intrinsic semiconductors are hard to manufacture and test. Semi-Insulating GaAas are doped with Si to make the resistivity high.

Problem 2:

$$T := 200K$$

$$\mu_n := 1300 \cdot \frac{T^{-1.5}}{(300K)^{-1.5}}$$

$$\mu_n = 2.388 \times 10^3$$

$$T := 400K$$

$$\mu_n := 1300 \cdot \frac{T^{-1.5}}{(300K)^{-1.5}}$$

$$\mu_n = 844.375$$

Problem 3:

$$\mu := \left(\frac{1}{250} + \frac{1}{500}\right)^{-1} \qquad \mu = 166.667$$

Problem 22:

$$E := 2V \quad V_0 := 20V \quad d := 3 \cdot 10^{-10} m$$

$$m_n := 9.1094 \cdot 10^{-31} kg \qquad h\_bar := 1.05457 \cdot 10^{-34} J \cdot s$$

$$\beta := \sqrt{2 \cdot m_n \cdot \frac{1.6 \cdot 10^{-19} C \cdot (V_0 - E)}{h\_bar^2}} \qquad \beta = 2.172 \times 10^{10} \frac{1}{m}$$

$$T := \left[1 + \frac{(V_0 \cdot \sinh(\beta \cdot d))^2}{4 \cdot E \cdot (V_0 - E)}\right]^{-1} \qquad \sinh(\beta \cdot d) = 338.04$$

$$\sinh(40) = 1.177 \times 10^{17}$$

$$T = 3.15 \times 10^{-6}$$

Problem 20:

If the ntype semiconductor is doped heavily enough then the Fermi level will be almost the same energy at the conduction band, in this case the barriers would be The metal work function (4.2eV) minus the electron affinity (4ev) or .2eV because the Fermi levels have to align.

Problem 25:

$$m_0 := 9.1094 \cdot 10^{-31} \mathrm{kg}$$

$$k := 1.38066 \cdot 10^{-23} \frac{J}{K}$$

$$T := 1K$$

This is at only 1K!!!

$$T := 300K$$

$$E_{th} := k \cdot T$$

$$v_{th} := \sqrt{\frac{2 \cdot E_{th}}{m_0}}$$

$$v_{th} = 9.536 \times 10^{6} \frac{1}{s} \mathrm{cm}$$

$$v_n := 1350 \frac{\mathrm{cm}^2}{V \cdot s} \cdot 100 \frac{V}{\mathrm{cm}} \qquad v_n = 1.35 \times 10^{5} \frac{1}{s} \mathrm{cm}$$

$$v_n := 1350 \frac{\mathrm{cm}^2}{V \cdot s} \cdot 10^{4} \frac{V}{\mathrm{cm}} \qquad v_n = 1.35 \times 10^{7} \frac{1}{s} \mathrm{cm}$$

Bottom line is that the thermal velocity of an electron can be greater than the actual drift velocity. If we look at the true velocity from lattice scattering is 10^6cm/2, and even at room temperature the thermal velocity is greater.