Homework 1 Solution

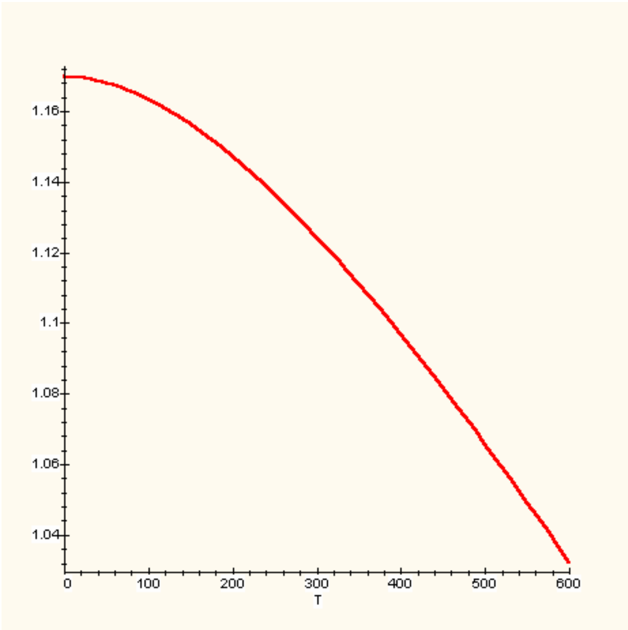
1.5

a. a=5.43A. From figure 1.3d $r = a\sqrt{3}/4 = 2.35A$

b. $N = 8/a^3 = 5\times10^{22}cm^{-3}$

c. $\rho = \frac{N \cdot At.Wt}{N_A} = \frac{5\times10^{22}cm^{-3}\times28.09}{6.02\times10^{23}} = 2.33g/cm^3$

3.12



3.15 Points A,B $\frac{\partial E}{\partial k} < 0$ velocity is in –x direction

Points C,D $\frac{\partial E}{\partial k} > 0$ velocity is in +x direction

Points A,D $\frac{\partial^2 E}{\partial k^2} < 0$ negative effective mass

Points B,C $\frac{\partial^2 E}{\partial k^2} > 0$ positive effective mass

3.17

$$E_v - E = \frac{\hbar^2 k^2}{2m_v} = \frac{\hbar^2}{2m_0}\frac{m_0}{m_v}k^2 = 3.81eV\cdot A\frac{m_0}{m_v}k^2$$

$$\frac{m_v}{m_0} = \frac{3.81eV\cdot A}{E_v - E}k^2$$

For the first curve: $\frac{m_v}{m_0} = \frac{3.81 eV \cdot A^2}{0.08 eV} 0.01 A^{-2} = 0.476$

For the second curve: $\frac{m_v}{m_0} = \frac{3.81 eV \cdot A^2}{0.4 eV} 0.01 A^{-2} = 0.953$

3.18

$$\nu = \frac{E}{h} = \frac{1.42 eV}{4.136 \cdot 10^{15} eV \cdot s} = 3.43 \cdot 10^{14} Hz = 343 THz$$

$$\lambda = \frac{c}{\nu} = \frac{300 \mu m \cdot THz}{343 THYz} = 0.875 \mu m$$

3.20

$$m = \frac{\hbar^2}{\frac{\partial^2 E}{\partial k^2}} = \frac{\hbar^2}{E_1 \alpha^2}$$

3.23

$$N = \int_{E_c}^{E_c + kT} g_c(E) dE = 4\pi \left(\frac{2 m_c}{h^2} \right)^{3/2} \int_{E_c}^{E_c + kT} (E - E_c)^{1/2} dE =$$

$$\frac{8}{3} \pi \left(\frac{2 m_c kT}{h^2} \right)^{3/2} = 3.28 \cdot 10^{17} cm^{-3}$$

3.32 $f_F(E) = \frac{1}{1 + \exp \frac{E - E_F}{kT}} = \frac{1}{1 + \exp \frac{E + 0.25 eV}{kT}}$