Kasap example 4.7

a) $E_{center} \approx 5eV$, then

$$g(E_{center}) = 8\pi\sqrt{2}\left(\frac{m_e}{h^2}\right)^{3/2} E_{center}^{1/2} = 8\pi\sqrt{2}\left[\frac{9.11\times10^{-31}\,kg}{(6.626\times10^{-34}\,Js)^2}\right]^{3/2}\left(5eV\times\frac{1.6\times10^{-19}\,J}{eV}\right)^{1/2} =$$

$$= 9.5\times10^{46}/Jm^3 \times \frac{1.6\times10^{-19}\,J}{eV} \times \frac{1m^3}{10^6\,cm^3} = 1.52\times10^{22}/eV\,cm^3$$

b) $kT \simeq 0.026\,eV$ @ $T = 300\,K$

$$E_{kT} = E_{center} - kT = 5eV - 0.026\,eV = 4.974\,eV$$

$$g(E_{kT}) = 8\pi\sqrt{2}\left[\frac{9.11\times10^{-31}\,kg}{(6.626\times10^{-34}\,Js)^2}\right]^{3/2}\left(4.974\,eV\times\frac{1.6\times10^{-19}\,J}{1\,eV}\right)^{1/2} =$$

$$= 9.48\times10^{46}/Jm^3 = 1.516\times10^{22}/eV\,cm^3$$

since kT is small compared to E_{center}, we see that the densities of states are similar, so we can approximate the number of states by

$$g(E)\cdot\delta E = (1.52\times10^{22}/eV\,cm^3)(0.026\,eV) = 3.94\times10^{20}\,states/cm^3$$

or, doing the exact calculation:

$$\int_{E_{center}-kT}^{E_{center}} g(E)\,dE = 8\pi\sqrt{2}\left(\frac{m_e}{h^2}\right)^{3/2}\frac{2}{3}E^{3/2}\Big|_{E_{center}-kT}^{E_{center}} =$$

$$= 8\pi\sqrt{2}\left[\frac{9.11\times10^{-31}\,kg}{(6.626\times10^{-34}\,Js)^2}\right]^{3/2}\cdot\frac{2}{3}\left[\left(5eV\times\frac{1.6\times10^{-19}\,J}{eV}\right)^{3/2} - \left(4.974eV\times\frac{1.6\times10^{-19}\,J}{eV}\right)^{3/2}\right]$$

$$= 3.95\times10^{26}/m^3 \times \frac{1m^3}{10^6\,cm^3} = 3.95\times10^{20}/cm^3$$

which is very similar to the answer above c)

$$g(E=0.026\,eV) = 8\pi\sqrt{2}\left[\frac{9.11\times10^{-31}\,kg}{(6.626\times10^{-34}\,Js)^2}\right]^{3/2}\left(0.026\,eV\times\frac{1.6\times10^{-19}\,J}{eV}\right)^{1/2} =$$

$$= 6.84\times10^{45}/Jm^3 = 1.1\times10^{21}/eV\,cm^3$$

d) the number of states per unit volume:

$$g(E=0.026\,eV)\cdot\delta E = (1.1\times10^{21}/eV\,cm^3)(0.026\,eV) = 2.8\times10^{19}/cm^3$$