798.

Problem 53.14 (RHK)

The Fermi energy of copper is 7.06 eV. *For copper at* 1050 K *we have to find* (a) *the energy at which the occupation probability is* 0.910. *For this energy, we have to evaluate* (b) *the density of states and* (c) *the density of occupied states.*

Solution:

(a)

The Fermi-Dirac probability function is

$$p(E) = \frac{1}{\exp\left((E - E_F)/kT\right) + 1},$$

where E_F is the Fermi energy.

The Fermi energy of copper is

$$E_F = 7.06 \text{ eV}.$$

For copper at 1050 K we have to find the energy $E(\text{eV})$ at which the occupation probability is 0.910. We solve the equation

$$p(E) = \frac{1}{\exp\left((E - E_F)/kT\right) + 1},$$

or

$$\exp\left((E - 7.06)\Big/\left(8.62\times10^{-5}\times1050\right)\right) + 1 = \frac{1}{0.910},$$

or

$$\exp\left((E - 7.06)/0.0905\right) = 9.89\times10^{-2},$$

or

$$(E - 7.06)/0.0905 = -2.314$$

$$E = 6.85 \text{ eV}.$$

(b)

We recall from problem **788**. **Problem 53.1 (RHK)** that the density of states for quantum electron gas is given by the relation

$$n(E) = CE^{1/2},$$

where $C = 6.80\times10^{27}\ \text{m}^{-3}\ \text{eV}^{-3/2}$.

Therefore, the density of states at $E = 6.85$ eV will be

$$n(6.85 \text{ eV}) = 6.80\times10^{27}\times(6.85)^{1/2}\ \text{m}^{-3}\ \text{eV}^{-1}$$

$$= 1.78\times10^{28}\,\text{m}^{-3}\ \text{eV}^{-1}.$$

(c)

The density of occupied states will be

$$n_o(6.85\ \text{eV}) = n(6.85\ \text{eV}) \times p(6.85\ \text{eV})$$

$$= 1.78 \times 10^{28} \times 0.910\ \text{m}^{-3}\ \text{eV}^{-1}$$

$$= 1.62 \times 10^{28}\,\text{m}^{-3}\ \text{eV}^{-1}.$$