energy state is occupied by two electrons. Consequently, there are 2×10^{21} electrons in that band.
(a) What is wrong with that argument?
(b) Why is the answer, after all, not too far from the correct numerical value?

7. Assuming the electrons to be free, calculate the total number of states below $E = 5$ eV in a volume of 10^{-5} m^3.

8. (a) Calculate the number of free electrons per cubic centimeter in copper, assuming that the maximum energy of these electrons equals the Fermi energy ($m^* = m_0$).
(b) How does this result compare with that determined directly from the density and the atomic mass of copper? Hint: Consider equation (7.5)
(c) How can we correct for the discrepancy?
(d) Does using the effective mass decrease the discrepancy?

9. What fraction of the 3*s*-electrons of sodium is found within an energy $k_B T$ below the Fermi level? (Take room temperature, i.e., $T = 300$ K.)

10. Calculate the Fermi distribution function for a metal at the Fermi level for $T \neq 0$.

11. Explain why, in a simple model, a bivalent material could be considered to be an insulator. Also explain why this simple argument is not true.

12. We stated in the text that the Fermi distribution function can be approximated by classical Boltzmann statistics if the exponential factor in the Fermi distribution function is significantly larger than one.
(a) Calculate $E - E_F = nk_B T$ for various values of *n* and state at which value for *n*,

$$\exp\left(\frac{E - E_F}{k_B T}\right)$$

can be considered to be "significantly larger" than 1 (assume $T = 300$ K). (*Hint*: Calculate the error in F(E) for neglecting "1" in the denominator.)
(b) For what *energy* can we use Boltzmann statistics? (Assume $E_F = 5$ eV and $E - E_F = 4k_B T$.)

Suggestions for Further Reading (Part I)

N.W. Ashcroft and N.D. Mermin, *Solid State Physics*, Holt, Rinehart and Winston, New York (1976).
D.R. Askeland and P.P. Phulé, *The Science and Engineering of Materials,* 4th edn., Brooks/Cole, Pacific Grove/Ca (2003).
L.V. Azároff and J.J. Brophy, *Electronic Processes in Materials*, McGraw-Hill, New York (1963).
J.S. Blakemore, *Solid State Physics*, W.B. Saunders, Philadelphia, PA (1969).
R.H. Bube, *Electronic Properties of Crystalline Solids*, Academic Press, New York (1974).
R.H. Bube, *Electrons in Solids*, 3rd edn., Academic Press, New York (1992).
S. Datta, *Quantum Phenomena*, Vol. VIII of Modular Series on Solid State Devices, Addison-Wesley, Reading, MA (1989).
R.E. Hummel, *Understanding Materials Science-History, Properties, Applications,* 2nd edn., Springer-Verlag, New York (2004).