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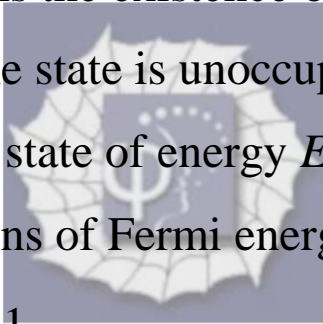
Problem 53.17 (RHK)

We have to show that the probability p_h that a hole exists at a state of energy E is given by

$$p_h = \frac{1}{\exp(-(E - E_F)/kT) + 1} .$$

Solution:

In a sea of electrons the existence of a hole in an energy state means that the state is unoccupied. The probability of occupation of a state of energy E in a gas of conduction electrons of Fermi energy E_F is given by


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

Therefore, the probability that this state is unoccupied is $(1 - p(E))$. We note that

$$\begin{aligned}(1 - p(E)) &= 1 - \frac{1}{\exp((E - E_F)/kT) + 1} \\ &= \frac{\exp((E - E_F)/kT)}{\exp((E - E_F)/kT) + 1} \\ &= \frac{1}{\exp(-(E - E_F)/kT) + 1} .\end{aligned}$$

Or

$$p_h = \frac{1}{\exp(-(E - E_F)/kT) + 1} .$$

