792.

Problem 53.6 (RHK)

We have to calculate the probability that a state 0.0730 eV *above the Fermi energy is occupied at* (a) $T = 0$ K *and* (b) $T = 320$ K.

Solution:

For a gas of fermions the probability for occupation of a state of energy E at temperature T is given by the function

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

where E_F is the Fermi energy.

(a)

At $T = 0$ K the probability $p = 1$ for $E < E_F$, and $p = 0$ for $E > E_F$. Therefore, the probability that a state 0.0730 eV above the Fermi energy is occupied at $T = 0$ K will be zero.

(b)

And, the probability that a state 0.0730 eV above the Fermi energy is occupied at $T = 320$ K will be

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

$$= \frac{1}{\exp\left(0.073\ \text{eV}/\left(8.62\times10^{-5}\ \text{eV K}^{-1}\right)\times 320\ \text{K}\right)+1}$$

$$= \frac{1}{\exp\left(2.646\right)+1} = \frac{1}{14.09+1} = 0.066.$$