Answer on Question #83665 – Physics – Molecular Physics – Thermodynamics

A system of particles occupying single-particle levels and obeying Maxwell–Boltzmann statistics is in thermal contact with a heat reservoir at temperature $T$. If the population distribution in the non-degenerate energy levels with energies $21.5\times10^{-3}$ eV, $12.9\times10^{-3}$ eV and $4.3\times10^{-3}$ eV are 8.5%, 23% and 63%, respectively, what is the average temperature of the system?

**Solution:**

Denote the energy levels by $E_1 = 21.5\times10^{-3}$ eV, $E_2 = 12.9\times10^{-3}$ eV and $E_3 = 4.3\times10^{-3}$ eV, and the corresponding populations by $P_1 = 8.5\%$, $P_2 = 23\%$ and $P_3 = 63\%$. In thermal distribution with Maxwell–Boltzmann statistics, the populations $P_i$ and $P_j$ on the respective levels $E_i$ and $E_j$ are related as

$$\frac{P_i}{P_j} = e^{\frac{E_j - E_i}{kT}},$$

where $k = 8.6\times10^{-5}$ eV/K is the Boltzmann constant. Taking the logarithm of this relation, we obtain $(E_j - E_i)/(kT) = log(P_i/P_j)$, whence $T = (E_j - E_i)/\left(klog(P_i/P_j)\right)$. Substituting for $i$ and $j$ any pair of numbers from {1, 2, 3}, we obtain the sought answer. Thus, $T = (E_1 - E_2)/\left(klog(P_2/P_1)\right) \approx 100K$.

**Answer:** 100 K.