

58. Consider two levels, labeled 1 and 2, with $E_2 > E_1$. Since $T = -|T| < 0$,

$$\frac{N_2}{N_1} = e^{-(E_2 - E_1)/kT} = e^{-|E_2 - E_1|/(-k|T|)} = e^{|E_2 - E_1|/k|T|} > 1 .$$

Thus, $N_2 > N_1$; this is population inversion. We solve for T :

$$T = -|T| = -\frac{E_2 - E_1}{k \ln(N_2/N_1)} = -\frac{2.26 \text{ eV}}{(8.62 \times 10^{-5} \text{ eV/K}) \ln(1 + 0.100)} = -2.75 \times 10^5 \text{ K} .$$