38. (a) At the bottom of the conduction band $E = 0.67\,\text{eV}$. Also $E_F = 0.67\,\text{eV}/2 = 0.335\,\text{eV}$. So the probability that the bottom of the conduction band is occupied is

$$\begin{aligned} P(E) &= \frac{1}{e^{(E-E_F)/kT}+1} = \frac{1}{e^{(0.67\,\text{eV}-0.335\,\text{eV})/[(8.62\times10^{-5}\,\text{eV/K})(290\,\text{K})]}+1} \\ &= 1.5\times10^{-6}\,. \end{aligned}$$

(b) At the top of the valence band $E = 0$, so the probability that the state is *unoccupied* is given by

$$\begin{aligned} 1-P(E) &= 1-\frac{1}{e^{(E-E_F)/kT}+1} = \frac{1}{e^{-(E-E_F)/kT}+1} \\ &= \frac{1}{e^{-(0-0.335\,\text{eV})/[(8.62\times10^{-5}\,\text{eV/K})(290\,\text{K})]}+1} \\ &= 1.5\times10^{-6}\,. \end{aligned}$$