21. (a) We evaluate $P(E) = 1/\left(e^{(E-E_F)/kT} + 1\right)$ for the given value of E, using

$$kT = \frac{(1.381 \times 10^{-23}\,\text{J/K})(273\,\text{K})}{1.602 \times 10^{-19}\,\text{J/eV}} = 0.02353 \text{ eV} .$$

For $E = 4.4\,\text{eV}$, $(E - E_F)/kT = (4.4\,\text{eV} - 5.5\,\text{eV})/(0.02353\,\text{eV}) = -46.25$ and

$$P(E) = \frac{1}{e^{-46.25} + 1} = 1.00 .$$

Similarly, for $E = 5.4\,\text{eV}$, $P(E) = 0.986$, for $E = 5.5\,\text{eV}$, $P(E) = 0.500$, for $E = 5.6\,\text{eV}$, $P(E) = 0.0141$, and for $E = 6.4\,\text{eV}$, $P(E) = 2.57 \times 10^{-17}$.

(b) Solving $P = 1/\left(e^{\Delta E/kT} + 1\right)$ for $e^{\Delta E/kT}$, we get

$$e^{\Delta E/kT} = \frac{1}{P} - 1 .$$

Now, we take the natural logarithm of both sides and solve for T. The result is

$$T = \frac{\Delta E}{k \ln\left(\frac{1}{P} - 1\right)} = \frac{(5.6\,\text{eV} - 5.5\,\text{eV})(1.602 \times 10^{-19}\,\text{J/eV})}{(1.381 \times 10^{-23}\,\text{J/K}) \ln\left(\frac{1}{0.16} - 1\right)} = 699 \text{ K} .$$