(b) Number of Gas Particles

The probability of a particle having energy E is $p(E) \propto e^{-E/kT}$. Taking the ratio of probabilities for the first two states:

$$\frac{p(E_2)}{p(E_1)} = \frac{e^{-E_2/kT}}{e^{-E_1/kT}} = e^{-(E_2-E_1)/kT}$$

$$\frac{0.23}{0.63} = e^{-(0.0129-0.0043)/kT} = e^{-0.0086/kT}$$

$$\ln\left(\frac{0.23}{0.63}\right) = -1.0076 = -\frac{0.0086}{kT}$$

$$kT = \frac{0.0086}{1.0076} \approx 0.008535\,\text{eV}$$

Now find the probability for the third state, $p(E_3)$:

$$\frac{p(E_3)}{p(E_1)} = e^{-(E_3-E_1)/kT}$$

$$p(E_3) = p(E_1)e^{-(0.0215-0.0043)/kT} = 0.63 \cdot e^{-0.0172/0.008535}$$

$$p(E_3) = 0.63 \cdot e^{-2.015} \approx 0.63 \times 0.1333 \approx 0.0840$$

For 1 mole of gas, $N_{total} = N_A = 6.02 \times 10^{23}$ particles.

$$N_3 = N_{total} \cdot p(E_3) = (6.02 \times 10^{23})(0.0840) \approx 5.06 \times 10^{22}$$

Answer: The number of particles is approximately $\mathbf{5.06 \times 10^{22}}$.
