B24

$V, \quad \varepsilon_p = \frac{p^2}{2m} + mc^2 \quad mc^2 = 1000\,\text{MeV}$

a) no conservation law: $\mu = 0 \rightarrow z = 1$

$$\ln \mathcal{L} = \sum_i \ln(1 + z e^{-\beta\varepsilon_i}) = \sum_i \ln(1 + e^{-\beta\varepsilon_i})$$

$$\ln \mathcal{L} = \frac{Vg}{\lambda^3} f_{5/2}(e^{-\beta mc^2}) = \frac{PV}{kT}$$

b) $$\langle n \rangle = \sum_i \frac{1}{\frac{1}{z} e^{\beta\varepsilon_i} + 1} = \frac{g}{\lambda^3} f_{3/2}(e^{-\beta mc^2})$$

$$E = \sum_i \frac{\varepsilon_i}{\frac{1}{z} e^{\beta\varepsilon_i} + 1} = 4\pi \int \frac{\frac{p^2}{2m} \cdot p^2 dp}{e^{\beta \frac{p^2}{2m}} \cdot e^{\beta mc^2} + 1} + 4\pi \int \frac{mc^2 \cdot p^2 dp}{e^{\beta \frac{p^2}{2m}} e^{\beta mc^2} + 1}$$

$$\boxed{\frac{E}{V} = \frac{3}{2} \cdot \frac{g}{\lambda^3} f_{5/2}(e^{-\beta mc^2}) + \frac{mc^2 g}{\lambda^3} f_{3/2}(e^{-\beta mc^2})}$$

c) at room temp $kT \approx \frac{1}{40}\,\text{eV} \rightarrow \beta \approx 40 \frac{1}{\text{eV}}$

$\rightarrow \frac{mc^2}{kT} \approx 4 \times 10^7$ very large!

$\rightarrow e^{-\frac{mc^2}{kT}} \rightarrow 0$

all functions will go to 0 if no. of particles is not conserved.