[tex112] Maxwell-Boltzmann gas in $\mathcal{D}$ dimensions

From the expression,

$$\Omega(T, V, \mu) = -k_B T \sum_k e^{-\beta(\epsilon_k - \mu)},$$

for the grand potential of the Maxwell-Boltzmann gas and the density of energy levels obtained in [tex111] for (a) the nonrelativistic case and (b) the ultrarelativistic case, derive the familiar results for the equation of state, $pV = \mathcal{N} k_{\rm B} T$, the heat capacity C_V, and the adiabate in the form $pV^\gamma = \text{const}$ at fixed $\mathcal{N}$. Check the results against those obtained in [tex76] and [tex94] for the nonrelativistic classical ideal gas and in [tex77] and [tex169] for the ultrarelativistic classical ideal gas.

Solution: