Exercises in Statistical Mechanics

Based on course by Doron Cohen, has to be proofed
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===== [Exercise 5040]

Virial coeff - ideal Bose/Fermi

For a single quantum particle of mass m, spectra $p^2/2m$ in a volume V the partition function is $Z_1(m) = gV/\lambda^3$ with $\lambda = h/\sqrt{2\pi m k_B T}$. The particle has a spin degeneracy g ($g = 2s + 1$ for spin s).

(a) Calculate the partition function of two such particles if they are either bosons or fermions.

(b) Calculate the corrections to the energy E, and the heat capacity C, due to Bose or Fermi statistics.

(c) Find the second virial coefficient a_2, defined as $PV = NkT[1 + a_2 n\lambda^3]$ to leading order in the small parameter $n\lambda^3$.