Statistical Physics

May 1, 2025

14-1 (a) Calculate the entropy S and the Helmholtz function F for an assembly of *distinguishable* particles.

(b) Show that the total energy U and the pressure P are the same for distinguishable particles as for molecules of an ideal gas while S is different. Explain why this makes sense.

14-3 (a) Show that for an ideal gas of N molecules,

$$\frac{g_j}{N_j} = \frac{Z}{N} e^{\varepsilon_j / k_B T},$$

where

$$\frac{Z}{N} = \frac{(k_B T)^{5/2}}{P} \left(\frac{2\pi m}{h^2} \right)^{3/2}.$$

(b) For $\varepsilon_j = (3/2) k_B T$, $T = 300\,\mathrm{K}$, $P = 10^3\,\mathrm{Pa}$, and $m = 10^{-26}\,\mathrm{kg}$, calculate g_j/N_j.

14-6 A tank contains one kilomole of argon gas at 1 atm and 300 K. The mass of an argon atom is $6.63 \times 10^{-26}\,\mathrm{kg}$.

(a) What is the internal energy of the gas in joules? What is the average energy of a molecule in eV?

(b) What is the partition function Z?

(c) What is the chemical potential μ in eV?

(d) What is N_j/g_j