Phys 971 Stat Mech: Homework 1

due 9/10/13

1

Pathria 1.2: Assuming that the entropy S and the statistical number Ω of a physical system are related through an arbitrary functional form

$$S = f(\Omega)$$

show that the additive character of S and the multiplicative character of Ω necessarily require that the function $f(\Omega)$ be of the form $[f = k \ln(\Omega)]$.

$\mathbf{2}$

Pathria 1.11: Four moles of nitrogen and one mole of oxygen at P = 1 atm and T = 300K are mixed together to form air at the same pressure and temperature. Calculate the entropy of mixing per mole of the air formed.

3

Pathria 1.16: Establish thermodynamically the formulae

$$V\left(\frac{\partial P}{\partial T}\right)_{\mu} = S$$
$$V\left(\frac{\partial P}{\partial \mu}\right)_{T} = N.$$

Now express the pressure P of an ideal gas in terms of the variables μ and T and verify the above formulae.

4

Compute the entropy of a set of N one-dimensional harmonic oscillators, the energy eigenvalues of the oscillators being $(n + 1/2)\hbar\omega$; n = 0, 1, 2, ..., as a function of the total energy E.

Four distinguishable particles can each occupy energy levels 0, ϵ , 2ϵ , and 4ϵ . Calculate the entropy of the system if the total energy is a) 3ϵ , b) 4ϵ , c) 8ϵ , d) 12ϵ , e) 16ϵ . (note: part b was a question from the 2012 midterm)



Figure 1: One possible configuration for $E = 4\epsilon$.