

Statistical Physics: Weekly Problem 2 (SP2)

A system has single-particle states k , with energy $\epsilon_k = k\epsilon$, where $k = 0, 1, 2, \dots$

- (a) Derive the partition function Z for the system of particles in thermal equilibrium at temperature $k_B T = 1/\beta$. (Hint: think ‘sum on geometric series’ and also for simplicity, use expressions in terms of β .) [4 marks]
- (b) Using the Boltzmann distribution and the partition function, Z , you derived in (a)
 - (i) what is the probability, p_k , that a particle will be in state k ,
 - (ii) what is the energy per particle (U/N),
 - (iii) what is the free energy per particle (F/N)
 - (iv) and what is the entropy per particle (S/N)?

[6 marks]