

PH421 - Thermal and Statistical Physics

Assignment 5 - Jan 30, 2008

1. Quantum partition function of a simple harmonic oscillator.

A simple harmonic oscillator (SHO) has its energy eigenvalues given by

$$\epsilon_r = \left(r + \frac{1}{2}\right)\hbar\omega \quad (1)$$

where $r = 0, 1, 2, \dots$

(a) Derive the partition function of a SHO in thermal equilibrium at temperature T .

(b) Find what is the probability that the SHO is in the ground state when $\hbar\omega \gg kT$ (limit of low temperature)

(c) Using the result of part (a), calculate the entropy of the SHO in thermal equilibrium at temperature T . Show that, in the limit of T that tends to 0, the entropy tends to $S \rightarrow 0$. Explain this result in terms of the result from part (b).

2. Problem 2.3 from textbook

3. Problem 2.5 from textbook

4. Problem 2.6 from textbook

5. Problem 2.7 from textbook