

In the name of God

Department of Physics
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ADVANCED STATISTICAL MECHANICS I

Exercise Set 3

(Due Date: 1400/09/12)

1. Ultra-relativistic Gas. Suppose that the energy of one-particle is $\epsilon = \sqrt{\vec{p}^2 c^2 + m_0^2 c^4}$ and for ultra-relativistic regime, we can ignore the rest mass energy and in this case we have $\epsilon = |\vec{p}|c$. For N -particle system in 3-dimension, compute the volume of phase space, Σ and accordingly, compute Ω when $U = cts$. Then compute the Entropy, $U(S, V, N)$ and μ .
2. For N classical distinguishable harmonic oscillators, with frequency ω in one-dimension, calculate the thermodynamical properties (S , U , P , μ and Heat capacities). Suppose the hamiltonian is given by
$$\mathcal{H} = \sum_{i=1}^N \left[\frac{p_i^2}{2m} + \frac{1}{2}\omega^2 q_i^2 \right]$$

Good luck, Movahed
