Thermal Physics II

3$^{\mathrm{rd}}$ short test – 10 May 2013

given and surname :

university number :

course of study   :

marks obtained   :

total marks   :

comments   :

1. If Z_1 denotes the partition function for one particle, what is the partition function for a gas of N indistinguishable, noninteracting particles of this kind in volume V? What is Z_1 for a gas with $\Lambda_m^2 = h^2/(2\pi m k_B T)$?

2. Which ensemble allows the particle number and the energy to fluctuate?

3. Combine the first and second laws of thermodynamics for open systems.

4. Give the Boltzmann factor (left) and the Gibbs factor (right).

5. Quote the relation that connects the statistical description of **open** many-body systems with thermodynamics.

6. What is the difference between the density of states for a gas of Fermions compared to the density of states for a gas of Bosons?

7. Order the following particles into Fermions (left) and Bosons (right): ^{1}H, ^{2}D, ^{6}Li and ^{7}Li atoms; ^{7}Li$^+$ ions; oxygen O_2 molecules.
   Hint: the upper number to the left give the sum of protons and neutrons in the core. Hydrogen is the first, Lithium the third element in the periodic table. Oxygen has eight electrons per atom.

8. State the energy distribution function for Fermions and for Bosons.

9. Under which condition can a gas of Fermions be described classically? What can you say about the chemical potential μ in that case?

10. A gas has a chemical potential of $\mu = 10$ eV and a temperature such that $k_B T = 0.1\,\text{eV}$. What kind of particles is the gas made of?

11. Quote the condition when Bose-Einstein condensation starts.

12. How do the internal energy and the pressure of the radiation field inside a cavity scale with temperature?

E Using the fact that $dU = TdS - pdV + \mu dN$, derive the Maxwell-relation $(\partial T/\partial N)_{S,V} = (\partial \mu/\partial S)_{V,N}$.