EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE - 2004/2005 (March/April 2006)

REPEAT

PH 305 FUNDAMENTALS OF STATISTICAL PHYSICS

Answer ALL questions.

Time: 1 hour

---

01. (a) State the conditions for a system to obey Maxwell-Boltzmann statistics and derive an expression for the Maxwell-Boltzmann distribution function in terms of the partition function of the system.

(b) Derive the relation between the thermal average energy and the single particle partition function for a system of N non-interacting particles.
A system of N non-interacting identical particles is in thermal equilibrium with a large reservoir at absolute temperature T. Each particle can take energies either ε_1 or ε_2.

i. Write down an expression for the partition function for a single particle.
ii. What is the average thermal energy of a single particle?
iii. Obtain an expression for the heat capacity at constant volume, C_V of the system.

You may use the following information useful:

The thermodynamic probability of Maxwell-Boltzmann statistics is given by $\Omega = N!\prod_{j=1}^{N}\frac{g_j^{N_j}}{N_j!}$.

02. State the conditions under which a system of particles obeys Fermi-Dirac statistics. Derive an expression for Fermi-Dirac distribution law and state under what condition will it reduces to the classical distribution.

Show that for a perfect gas of electron obeying Fermi-Dirac statistics, the Fermi energy of a free electron gas at $T = 0K$ is $E_F = \frac{h^2}{8m}\left(\frac{3N}{\pi V}\right)^{\frac{2}{3}}$, where the symbols have their usual meanings.

You may use the following information useful:

The thermodynamic probability of Fermi-Dirac statistics is given by $\Omega = \prod_{j=1}^{N}\frac{g_j!}{(g_j - N_j)!N_j!}$.

The number of quantum energy states between energy range E and $E + dE$ is $g(E)dE = 4\pi V\left(\frac{2m}{h^2}\right)^{\frac{3}{2}}E^{\frac{1}{2}}dE$.