EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE 2005/2006 (AUG-SEP. 2007)

FIRST SEMESTER

REPEAT

PH 305 – FUNDAMENTALS OF STATISTICAL PHYSICS

Time: 01 hour.
Answer ALL Questions.

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1. What do you understand by the terms macrostate, microstate and thermodynamic probability of a system. For a system obeying Maxwell Boltzman statistics, show that

   a) $E = \dfrac{Nk_BT^2}{Z}\dfrac{\partial Z}{\partial T}$

   b) $S = Nk_B \ln Z + \dfrac{Nk_BT}{Z}\dfrac{\partial Z}{\partial T}$

   c) $F = -Nk_BT \ln Z$

   Where the symbols have their usual meaning.

2. The thermodynamics probability of an assembly of Fermions can be written as

$$\Omega = \Pi \frac{g_j!}{N_j!(g_j - N_j)!}$$

   a) If the system is in equilibrium, prove that

$$\sum_j \ln\left(\frac{N_j}{g_j - N_j}\right) dN_j = 0$$

   b) Also show that

$$\sum_j dN_j = 0 \text{ and}$$

$$\sum_j \varepsilon_j dN_j = 0$$

   c) Using the results in (a) and (b), obtain the Fermi-Dirac distribution function

   d) For a degenerate, spin $\frac{1}{2}$, non-interacting Fermi gas at zero temperature, show that the energy of a system of N such particles confined to a volume V can be written as

$$E = \frac{3N\varepsilon_F}{5}$$

   Where the symbols have their usual meanings.