EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE - 2007/2008

SECOND SEMESTER (SPECIAL REPEAT)

(February 2010)

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 which obeys Maxwell Boltzman statistics, show that:

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

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

   c) $F = -Nk_B T \ln Z$

   Where the symbols have their usual meanings.

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 the 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.