EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE - 2008/2009

SECOND SEMESTER (Special Repeat)

(January 2012)

PH 305 FUNDAMENTALS OF STATISTICAL PHYSICS

Time: 01 hour.

Answer ALL Questions

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1. Specify macrostates and microstates in a statistical system.

Define *free energy* and outline the condition for thermodynamic equilibrium of a statistical system.

The entropy of a system of N non-interacting classical particles having constant total energy is given by $S = k_B \ln\left(N! \prod_{j=1}^{n} \frac{(g_j)^{N_j}}{N_j!} \right)$, where N_j is the number of particles in the j^{th} energy level E_j with degeneracy g_j. If the system is in thermodynamic equilibrium, derive an expression for the distribution function in the case of classical statistics.

2. Outline the conditions for the three types of statistics used for classical and quantum systems. Give an example for each case.

Consider a perfect gas of N free electrons in a solid of volume V, which obey the Fermi-Dirac distribution $f(E) = \frac{n(E)}{g(E)} = \frac{1}{\exp[(E-\mu)/k_B T]+1}$, where the density of electron states is given by $g(E) = 4\pi V \left(\frac{2m_e}{h^2} \right)^{3/2} E^{1/2}$ and the symbols have their usual meaning. Show that the Fermi energy at absolute zero (T=0) is given by $E_f = \frac{h^2}{8m_e} \left(\frac{3N}{\pi V} \right)^{2/3}$.

Find the Fermi energy in copper on the assumption that each copper atom contributes one free electron to the electron gas. The density of copper is 8.94×10^3 kg m^{-3} and its atomic mass is 63.5 a.m.u.

The following values may be useful: Avergadro number 6.023×10^{23} mol^{-1}, Plank's constant (h) = 6.64×10^{-34} J s and mass of electron (m_e)= 9.1×10^{-31} kg.