EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE - 2002/2003

(MARCH/APRIL 2004)

REPEAT

PH 305 STATISTICAL PHYSICS

Time: 01 hour.

Answer ALL Questions

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1. What do you understand by the term "partition function" as used in Statistical Physics?

State the conditions for a system to obey Maxwell-Boltzmann(M-B) statistics and write down the expression for the M-B distribution law in terms of the partition function of the system.

An ideal gas composed of monatomic molecules can be described according to Maxwell-Boltzmann statistics. Given that the number of molecular states of the ideal gas in the energy range between E and $E + dE$ is

$$g(E)dE = \frac{2\pi V(2m)^{\frac{3}{2}}E^{\frac{1}{2}}}{h^3}dE.$$

Show that the partition function of the ideal gas is given by

$$Z = \frac{V(2\pi mkT)^{\frac{3}{2}}}{h^3},$$

where the symbols have their usual meanings.

Hence find

(a) the most probable energy,

(b) the most probable velocity,

(c) the average velocity

in terms of m, T and k of the gas molecules.

You may use the following integrals

$$\int_0^{\infty} x^{\frac{1}{2}}e^{-x}dx = \frac{\sqrt{\pi}}{2} \qquad \text{and}$$

$$\int_0^{\infty} v^3 e^{-\frac{mv^2}{2kT}}dv = \frac{1}{2}\left(\frac{2kT}{m}\right)^2$$

2. State the conditions under which a system of particles obeys the Fermi-Dirac distribution law and derive an expression for the corresponding distribution.

Under which condition will the distribution reduces to the classical distribution.

Prove that for a perfect gas of electron obeying Fermi-Dirac statistics, the Fermi energy of a free electron gas at absolute zero 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

The thermodynamic probability of Fermi-Dirac distribution is

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

and the number of quantum energy states between energy range E and $E + dE$ is

$$g(E)dE = \frac{4\pi V(2m)^{\frac{3}{2}} E^{\frac{1}{2}}}{h^3} dE.$$