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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 Fe Dirac distribution law and derive an expression for the correspon distribution.

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

Prove that for a perfect gas of electron obeying Fermi-Dirac statis 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 $E + dE$ is

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