EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE - 2005/2006

FIRST SEMESTER (SPECIAL REPEAT)

PH 305 FUNDAMENTALS OF STATISTICAL PHYSICS

Time: 01 hour.

Answer ALL Questions

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1. Briefly explain Bose-Einstein Statistics and derive an expression for its distribution function.
   (a) Show that the chemical potential in the Bose-Einstein distribution increases as the temperature decreases
   (b) Show that the temperature at which the chemical potential vanishes will be:

$$T_c = \frac{h^2}{2\pi mk}\left(\frac{N}{2.612\,V}\right)^{\frac{2}{3}}$$

You may assume the integral

$$\int_0^{\infty} \frac{x^{1/2}}{e^x - 1} dx = 1.306\,\pi^{1/2}$$

(c) Show that for $T < T_c$ the number of particles in the ground state n_0 is given by:

$$n_0 = N\left[1 - \left(\frac{T}{T_c}\right)\right]^{\frac{3}{2}}$$

2. What do you understand by the terms macro state, micro state and thermodynamic probability of a system. For a system obeying Maxwell Boltzmann statistics, show that

$$F = -NK_B T \ln Z$$

(a) Use the following thermodynamic relation to calculate the pressure of a blackbody radiation in volume v and its relation to the mean energy

$$P = -\left(\frac{\partial F}{\partial V}\right)_T .$$

where the density of modes is: $g(\nu) = \frac{V 8\pi\nu^2}{c^3}$

(b) The compressibility is defined as

$$K = -V\left(\frac{\partial P}{\partial V}\right)_T$$

Discuss the difficulties in compressing a fluid or gas. Calculate K for the radiation of the gas and compare it with an ideal gas.