EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE - 2005/2006

SECOND SEMESTER (PROPER/REPEAT)

(MARCH/APRIL 2008)

PH 305 FUNDAMENTALS OF STATISTICAL PHYSICS

Time: 01 hour.

Answer ALL Questions

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1. Derive the relation between the thermal average energy and the single particle partition function for a system of N non-interacting, distinguishable particles.

A system at temperature T consists of N non-interacting distinguishable identical particles each of which can be in either $+\varepsilon$ or $-\varepsilon$ energy states, but the particles do not have any translational kinetic energy.

i. Write down the partition function for a single particle.

ii. Find the thermal average energy of the system.

iii. Given that the total energy of the system is U, show that the absolute temperature is:

$$\frac{1}{T} = \frac{k}{2\varepsilon} \ln \left[\frac{N - \left(\frac{U}{\varepsilon} \right)}{N + \left(\frac{U}{\varepsilon} \right)} \right].$$

iv. Obtain an expression for heat capacity C_V of the system.

2. Derive the expressions for thermodynamic probability and the distribution function in the case of Bose-Einstein statistics. Hence explain how the classical result can be obtained from Bose-Einstein statistics.

Show that for an ideal gas, the partition function Z can be written as

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

You may use the following identity

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