Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2015/2016

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|---|---|---|
| COURSE NAME | : | STATISTICAL PHYSICS |
| COURSE CODE | : | BWC 30103 |
| PROGRAMME | : | 3 BWC |
| EXAMINATION DATE | : | DECEMBER 2015 / JANUARY 2016 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWERS **ALL** QUESTIONS |

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

**Q1** (a) What is a probability distribution function?
(4 marks)

(b) Explain the word ensemble.
(4 marks)

(c) Find the mean value, the variance and the standard deviation for the value of a single throw of a dice.
(4 marks)

(d) Consider flipping two coins. Find the distribution function of head occurs on both classical coins and quantum coins.
(8 marks)

**Q2** (a) Give the meaning of the words multiplicity, distinguishable and non-interacting.
(3 marks)

(b) Describe Maxwell-Boltzmann statistics. What is the expected number of particles for Maxwell-Boltzmann statistics.
(6 marks)

(c) Derive the average speed of a single particle using Maxwell-Boltzmann statistics.
(8 marks)

(d) Plot the speed distribution function of Maxwell-Boltzmann statistics.
(3 marks)

**Q3** (a) Explain the word partition function. Write down the average energy in terms of partition function.

(6 marks)

(b) Using the answer from **Q3(a)**, find the standard deviation for fluctuations in energy.

(6 marks)

(c) Given a pair of identical. Using partition function for a single quantum particle of mass $m$ in a volume $V$, calculate the partition function of two such particles, if they are bosons and also if they are fermions.

(8 marks)

**Q4** (a) State the Fermi-Dirac distribution function.

(2 marks)

(b) Sketch the energy distribution function at two different temperatures for a system of free particles govern by Fermi-Dirac statistics. Indicate which curve corresponds to the higher temperature.

(4 marks)

(c) Calculate the average energy per particle, $\varepsilon$, for a Fermi gas at $T = 0$, given that $\varepsilon_F$ is the Fermi energy.

(8 marks)

(d) For a degenarate, spin $\frac{1}{2}$, non-interacting Fermi gas at zero temperature, find an expression for the energy of a system of $N$ such particles confined to a volume $V$. Assume the particles are non-relativistic.

(6 marks)

**Q5** (a) State the Bose-Einstein distribution function.

(2 marks)

(b) Sketch the energy distribution function at two different temperatures for a system of free particles govern by Bose-Einstein statistics. Indicate which curve corresponds to the higher and low temperature.

(4 marks)

(c) What is Bose-Einstein condensation?

(4 marks)

(d) Consider a two-dimensional ideal Bose gas. Let $V = L^2$ be the area available to the system. The number of particles (which is conserved is given by

$$N = z\frac{\partial}{\partial z}\ln[Z(z,V,T)] = \sum_p \left[z^{-1}\exp(\beta\varepsilon_p) - 1\right]^{-1}$$

where $Z$ is the grand partition function. Show that there is no Bose-Einstein condensation at $T \neq 0$ for two dimensional ideal gas.

(10 marks)

**- END OF QUESTION -**