Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	STATISTICAL PHYSICS
COURSE CODE	:	BWC 30103
PROGRAMME	:	3 BWC
EXAMINATION DATE	:	DECEMBER 2014/JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	A) ANSWER **ALL** QUESTIONS B) ALL CALCULATIONS AND ANSWERS MUST BE IN THREE (3) DECIMAL PLACES

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

Q1 (a) What is degree of freedom in Statistical Physics?

(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) Even though you have no symptoms, a doctor wishes to test you for a rare disease that only 1 in 10,000 people of your age contract. The test is 98% accurate which means that if you have the disease, 98% of the times the test will come out positive and 2% negative. It is also assume that if you do not have the disease, the test will come out negative 98% of the time and positive 2% of the time. You take the test and it comes out positive. What is the probability that you have the disease?

(8 marks)

Q2 (a) What is a probability distribution function?

(2 marks)

(b) Explain the word indistinguishable identical particles in quantum statistical physics.

(4 marks)

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

(6 marks)

(d) From the answer of **Q2**(c), find the standard deviation of classical coins and quantum coins.

(8 marks)

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

(4 marks)

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

(4 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.

(12 marks)

Q4 (a) The grand canonical ensemble of the entropy is given by

$$S = kT\left(\frac{\partial \ln(Z)}{\partial T}\right)_{z,V} - \langle N\rangle k\ln(z) + k\ln(Z)$$

where Z is the grand partition function and $\langle N\rangle$ is the expectation value of the total number of particles. Use the grand canonical ensemble to find the expression of the entropy for a gas of non-interacting particles obeying Bose-Einstein statistics and Fermi-Dirac statistics in terms of the mean occupaton number of a single-particle state with energy ε, $\langle n_\varepsilon\rangle$.

(10 marks)

(b) 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.

(i) Consider the system in the thermodynamic limit and discuss the $p = 0$ state.

(4 marks)

(ii) Show that there is no Bose-Einstein condensation at $T \neq 0$ for two dimensional ideal gas.

(6 marks)

Q5 (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, ε, for a Fermi gas at $T = 0$, given that ε_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)

- END OF QUESTION -