Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	STATISTICAL PHYSICS
COURSE CODE	:	BWC 30103
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **THREE (3)** PAGES

Q1 (a) State **ONE (1)** purpose of a particle detector. With the aid of a diagram, briefly explain the general working principle of particle detector.

(6 marks)

(b) Draw the Standard Model of particle physics. Describe **ONE (1)** reason why the Standard Model equation is written in the form of Lagrangian equation and state the meaning of the first line in this mathematical equation. State **ONE (1)** fundamental physical phenomena in nature that the Standard Model works without explaining it.

(6 marks)

(c) Your roommate is majoring in chemistry. They know all about protons, neutrons, and electrons, and they see them in action every day in the laboratory. However, they are shocked when you tell them about positrons, quarks, muons, and neutrinos. Explain to them whether these particles play any role in chemistry.

(8 marks)

Q2 (a) Three coins are flipped, labeled 1, 2, and 3. List down the **THREE (3)** different ways in which they could land with two heads and one tail? Calculate is the probability of this to happen.

(6 marks)

(b) Consider five air molecules in an otherwise empty room. Calculate is the probability that exactly two of them are in the front third of the room.

(4 marks)

(c) Sketch the graph of relative frequency of occurrence versus the fraction of the flipped coins that land heads, for systems of 10, 100, and 1000 coins. Describe the distribution.

(6 marks)

(d) Explain the Stirling's approximation formula. Discuss the importance of this formula in Statistical Physics?

(4 marks)

Q3 (a) Explain the random walk problem. State the formula.

(4 marks)

(b) Provide the meaning of macrostate and microstate in Statistical Physics.

(4 marks)

(c) For Maxwell-Boltzmann statistics,

(i) calculate the expected number of particles.
(ii) derive the average speed of a single particle.
(iii) plot the speed distribution function. Briefly explain the plot.

(12 marks)

Q4 (a) Write down 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. Explain the graph briefly.

(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, construct 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) Write down 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 high and low temperature.

(6 marks)

(c) Explain Bose-Einstein condensation.

(4 marks)

(d) In the case of bosons, the low-lying states have larger occupation numbers than the classical prediction, so that the total internal energy of a boson system is correspondingly low. Clarify this statement.

(8 marks)

– END OF QUESTIONS –