



UNIVERSITY OF EMBU

2016/2017 ACADEMIC YEAR
SECOND SEMESTER EXAMINATION

FIRST YEAR EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE IN
PHYSICS

SPH 602: STATISTICAL MECHANICS

DATE: APRIL 7, 2017

TIME: 2:00-5:00PM

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions.

Constants:

QUESTION ONE (30 MARKS)

- Differentiate between micro canonical ensemble, canonical ensemble and grand canonical ensemble. (3 marks)
- Describe the properties a system of gases must have to be treated as ideal classical gases. (2 marks)
- What are the challenges observed with systems considered as ideal gases in nature? (3 marks)
- Explain the difference between bosons and fermions. (4 marks)
- Find the fluctuations of the given thermodynamic quantities given that they are independent of V and T . (4 marks)
- Describe the contributions of Johnson-Nyquist noise. (3 marks)
- Describe the short noise experimental procedure. (3 marks)
- Describe two examples of single Hilbert space. (4 marks)
- Describe the origin of black body spectra. (4 marks)

QUESTION TWO (20 MARKS)

- a) Discuss the non-interacting Bose and Fermi gas second quantization. (20 marks)

QUESTION THREE (20 MARKS)

- a) Show that Einstein relation for viscous friction of a Brownian particle related to the diffusion constant of the particle is given by:

$$\mu = \frac{1}{m\gamma} = \frac{D}{KT} = 1/KT \int_0^{\infty} \langle u(t_0) u(t_0 + t) \rangle dt$$

(10 marks)

- b) Show that for bound electrons to a magnetic field the magnetic paramagnetic susceptibility X is given by:

$$X = \left(\frac{3}{2}\right) \frac{n\mu\mu^2 B}{KBT^2}$$

(10 marks)

QUESTION FOUR (20 MARKS)

- a) Discuss the difference between superfluid helium and ideal Bose condensate. (10 marks)
- b) Construct a grand canonical ensemble where all possible states of the system are represented, all possible values of N and all possible energy states $E_s(N)$ for a given N are shown. Obtain Gibbs free energy for each particle. (10 marks)

QUESTION FIVE (20 MARKS)

- a) Discuss the symmetry properties of Bosons and Fermions. (12 marks)
- b) Explain the relationship between emitted radiation and radiation inside the cavity. (5 marks)
- c) Show that the partition functions of a gas with N non-interacting identical particles is given by:

$$\bar{m}_i = \frac{\sum n_1 n_2 \dots n_i e^{-B(n_1 E_1 + n_2 E_2 + \dots)}}{\sum n_1 n_2 \dots e^{-B(n_1 E_1 + n_2 E_2 + \dots)}}$$

(3 marks)

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