****

**JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES**

**UNIVERSITY EXAMINATION FOR THEDEGREE OF BACHELOR OF EDUCATION (SCIENCE)**

 **4TH YEAR 2ND SEMESTER**

**MAIN**

**REGULAR**

**COURSE CODE: SPH 402**

**COURSE TITLE: STATISTICAL MECHANICS**

**EXAM VENUE: STREAM: (BED SCI)**

**DATE: EXAM SESSION:**

**TIME: 2:00HRS**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Instructions:**

1. **Answer question 1 (Compulsory) and ANY other 2 questions.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

**Useful constants**



 



***QUESTION 1 (30 MARKS)***

(a) Define the following terms.

 (i) Statistical Physics  **(1 mark)**

 (ii) Canonical ensemble **(1 mark)**

 (iii) Grand canonical ensemble  **(1 mark)**

 (iv) Phase space  **(1 mark)**

(b) The Hamiltonian of a given system in phase space is given by 

 Determine the Hamiltonian canonical equations of motion. **(3 marks)**

(c) Two bosons are in an energy level with degeneracy of . Determine the number

 of microstates of these bosons.  **(3 marks)**

(d) State **TWO** features of particles obeying Maxwell-Boltzmann statistics.

  **(2 marks)**

(e) By using Helmholtz free energy, derive expressions for entropy, pressure and

 chemical potential. **(4 marks)**

(f) Derive the equation for the partition function of a spin- paramagnetic system.

 **(3 marks)**

(g) Explain the formation of Bose-Einstein condensate. **(2 marks)**

(h) Show that the average internal energy in a canonical ensemble is given by

  where each symbol has its usual meaning. **(3 marks)**

(i) Explain the term black body as used in Statistical Physics  **(2 marks)**

(j) Determine the percentage error in the use of Stirling’s formula to calculate 

 for a system of  particles.  **(4 marks)**

***Attempt any TWO questions in this section***

***QUESTION 2 (20 MARKS)***

(a) Show that the Maxwell-Boltzmann distribution function is given by

   **(12 marks)**

(b) Blackbody radiation in a box of volume and at temperature  has internal

 energy and pressure , where is the Stefan-Boltzmann

 constant. Determine the entropy and chemical potential in terms of .

 **(8 marks)**

***QUESTION 3 (20 MARKS)***

(a) Consider a system of particles that obey Fermi-Dirac statistics with a

 a degeneracy of in each energy level. Given that the energy levels are equally

 spaced and the total energy per macrostate is where ,  and so

 on, determine the statistical weight of the system. **(10 marks)**

(b) Obtain an expression for the entropy of a thermodynamic system in terms of

 the statistical weight.  **(10 marks)**

***QUESTION 4 (20 MARKS)***

(a) Show that the energy density in blackbody radiation is given by

 **(15 marks)**

(b) Show that the maximum value of the wavelength for which  obtained in

 4 (a) is maximum is obtained from   **(5 marks)**

***QUESTION 5 (20 MARKS)***

(a) Derive the average internal energy of a system of -independent particles

 in the form   **(7 marks)**

(b) Determine the conditions under which a composite isolated system C resulting

 interaction of two isolated systems A and B attains thermodynamic equilibrium.

 **(13 marks)**