

Bachelor of Science (T.Y.B.Sc.) Fifth Semester
B.Sc.3534 : 5S-PHY501-Physics Paper-I (Statistical Physics And Relativity)

P. Pages : 3

Time : Three Hours



GUG/W/18/1320

Max. Marks : 50

- Notes : 1. All the questions are compulsory.
2. Draw the neat labelled diagram wherever necessary.

Either:-

1. A) i) Explain the term microstate and macrostate with the help of an example. 4
ii) What is meant by thermodynamic probability of a macrostate? How it is related to probability of occurrence of that state? Distinguish between mathematical probability and thermodynamic probability. 4
iii) Calculate the probability that in tossing a coin 10 times, We get 5 heads and 5 tails. 2

OR

- B) i) Derive Maxwell-Boltzmann's law of distribution of velocities of the molecules of ideal gas. 5
ii) Assuming Maxwell's law of distribution of molecular speeds, derive an expression for the most probable speed. 3
iii) At what temperature will the average speed of hydrogen molecules be the same as that of nitrogen molecules at 35°C. Molecular weight of N₂ = 28 and that of H₂ = 2. 2

Either:

2. A) i) What are Bose-Einstein's statistics? and give its basic postulates. 3
ii) Derive an expression 5
$$\eta_i = \frac{g_i}{e^{\alpha + \beta E_i - 1}}$$
 for the most probable distribution of the particles of a system obeying B.E. statistics.
iii) Find the number of ways in which three bosons may be distributed in four cells. 2

OR

- B) i) What are the postulates of special theory of relativity? 2
ii) Derive the formula for the relativistic variation of mass with velocity. Explain its significance. 6
iii) What would be the speed of a particle if its mass is equal to four times to its rest mass? 2

Either:-

3. a) Explain Bridge with macroscopic physics. 2½
- b) Assuming MB distribution of molecular speeds, show that the mean speed for the molecules of an ideal gas is given by 2½
- $$\bar{v} = \sqrt{\frac{8KT}{\pi m}}$$
- c) How does FD statistics differ from BE statistics? 2½
- d) The length of a rocket ship is 100m on the earth. When it is moving with velocity v , its length observed is 99m. Calculate its velocity. 2½

OR

- e) Derive the condition of equilibrium between two systems in thermal contact. 2½
- f) Find the most probable speed of nitrogen at 27°C. Molecular weight of $M_2 = 28 \times 10^{-3}$ kg/mol, the gas constant $R = 8.314$ J/mol °K. 2½
- g) Distinguish between classical and quantum statistics. 2½
- h) On the basis of Lorentz transformation discuss length contraction. 2½

Either:-

4. a) State and explain the principle of equal a priori probability. 2½
- b) Assuming M.B. distribution of molecular speeds, show that the rms speed is given by 2½
- $$V_{\text{rms}} = \sqrt{\frac{3kT}{m}}$$
- c) Define Fermi energy. Explain the significance of the Fermi energy. 2½
- d) The length of a rod is found to be half its length when at rest. What is the speed of the rod relative to the observer? 2½

OR

- e) In a system of 8 distinguishable particles distributed in two equal sized compartments, calculate the probability of the macrostate (3,5) and (4,4). 2½
- f) What are the limitations of Maxwell. Boltzmann statistics? 2½
- g) Derive the expression for Fermi energy of electron in a metal at absolute temperature. 2½
- h) Derive $E = mc^2$, Einstein's mass-energy relation. 2½

5. Attempt **any ten** of the followings.

- a) What is μ -space? 1
- b) Distinguish between accessible and inaccessible states. 1
- c) Define probability. 1
- d) Draw the graph showing mean, r.m.s. and most probable velocity. 1
- e) What is partition function for system of gas? 1
- f) Define root mean square velocity of the gas molecules. 1
- g) What are Bosons? Give its examples. 1
- h) What are Fermions? Give its examples. 1
- i) Write Fermi-Dirac distribution law for assembly of fermions. 1
- j) Write Inverse Lorentz transformations equations. 1
- k) What is meant by time dilation? 1
- l) Define proper time? 1
