NKT/KS/17/5170

Bachelor of Science (B.Sc.) Semester—V (C.B.S.) Examination

PHYSICS

(Atomic Physics, Free Electron Theory and Statistical Physics)

Paper–1

Time : Three Hours] [Maximum Marks : 50

N.B. :— (1) **All** questions are compulsory.

(2) Draw neat diagrams wherever necessary.

EITHER

1. (A) Explain normal and Anomalous Zeeman effect. Obtain an expression for Zeeman shift. 5

(B) (i) State and explain the quantum numbers associated with an atom. 3

(ii) Calculate the two possible orientations of spin vector S with respect to a magnetic field direction. 2

OR

(C) What is Bohr's atomic model ? Give its drawbacks. 2½

(D) Describe the experimental arrangement of Stern-Gerlach experiment. 2½

(E) What are the possible quantum numbers of electrons in the L shell of an atom ? 2½

(F) Calculate the value of Bohr Magneton from the following data :

Given : $e = 1.6 \times 10^{-19}$ c, $\dot{\hbar} = 1.055 \times 10^{-34}$ J.s.

$m_e = 9.1 \times 10^{-31}$ kg. 2½

EITHER

2. (A) What is Hall effect ? Derive an expression for Hall voltage and Hall co-efficient in a semiconductor. 5

(B) (i) Derive an expression for electrical conductivity of metal on the basis of free electron theory. 3

(ii) Calculate the conductivity of copper if the collision time is 10^{-15} sec. Assume that copper has simple cubic structure with lattice parameter $4A^0$. 2

OR

(C) Explain the concept of 'hole' in a semiconductor. 2½

(D) Derive an expression for density of states for a free electron gas in one dimension. 2½

(E) Discuss the periodic nature of potential in a crystal. State Bloch theorem. 2½

(F) Calculate Fermi energy for sodium if there are 2.5×10^{28} free electrons per cubic meter. 2½

EITHER

3. (A) Derive Maxwell-Boltzmann distribution law and hence show that :

$$n(E)dE = \frac{2\pi N}{(\pi kT)^{3/2}} . E^{1/2} . e^{-E/kT} dE$$

where n(E) dE is the number of molecules with energies between E and E + dE. 5

(B) (i) Deduce Boltzmann's entropy-probability relation $S = k \log_e W$. 3

(ii) Calculate the probability that we get three heads and two tails in tossing a coin 5 times. 2

OR

(C) Write a short note on Macrostates and Microstates. 2½

(D) Obtain an expression for r.m.s. speed of gas molecules by using M-B distribution law. 2½

(E) State the fundamental postulates of statistical mechanics. 2½

(F) Calculate the value of r.m.s. speed of hydrogen at N.T.P. The Boltzmann's constant is 1.38×10^{-16} erg per degree and Avogadro's number is 6×10^{23} gm/mol. 2½

EITHER

4. (A) Derive an expression for most probable distribution by using Fermi-Dirac statistics. 5

(B) (i) Explain Bose-Einstein condensation. 3

(ii) Fermi energy of conduction electrons in silver is 5.48 eV. Calculate the number of electrons per cm^3.

Given : h = 6.62×10^{-27} erg. sec. and iev = 1.62×10^{-12} erg. 2

OR

(C) What are basic postulates of B-E statistics ? 2½

(D) What is Fermi function ? Give its importance. 2½

(E) Distinguish between classical statistics and quantum statistics. 2½

(F) Five bosons are distributed in two compartments, the first having 3 cells and second 4 cells. Find the thermodynamic probability for the macrostate (5, 0). 2½

5. Attempt any **ten** questions (**1** mark each) :

(i) What is Stark effect ?

(ii) Find the possible values of j for states in which $\ell = 3$ and s = ½.

(iii) Write the selection rules for the spectral lines.

(iv) Define mean free path of free electron.

(v) Define Fermi temperature.

(vi) State importance of Hall effect.

(vii) Explain phase space.

(viii) Calculate the r.m.s. velocity of H_2 at 27°C.

Given : K = 1.38×10^{-23} joule/degree, $m_H = 3.34 \times 10^{-27}$ kg.

(ix) State the principle of a priori probability.

(x) What is occupation index ?

(xi) What are fermions ?

(xii) The Fermi energy of a free electron in silver is 5.51 eV. Calculate the Fermi temperature.

Given : Boltzman's constant K = 1.38×10^{-23} J/K. 1×10=10