SN – 237

V Semester B.Sc. Examination, November/December 2014
(2013-14 & Onwards) (Semester Scheme) (NS)
PHYSICS – V
Quantum Statistical Physics, Quantum Mechanics – I and II

me : 3 Hours　　　　Max. Marks : 70

Instruction : *Answer **five** questions from each **Part**.*

PART – A

nswer **any five** of the following questions. **Each** question carries **eight** marks. **(5×8=40)**

Derive the Bose-Einstein distribution law for bosons. **8**

What are fermions ? Derive an expression for the probability distribution of particles governed by Fermi-Dirac statistics. **8**

Explain briefly the failure of classical physics in the explanation of atomic spectra. How does quantum mechanics explain the same ? **8**

With relevant theory, explain Davisson and Germer experiment to demonstrate de Broglie hypothesis. **8**

a) Explain group velocity and phase velocity for a matter wave.

b) Derive the relation between group velocity and particle velocity. **(3+5)**

Arrive at Schrödinger's time independent equation for a free particle in one dimension. Write the equation for three dimensions. **8**

a) Derive an expression for energy eigen values of a particle trapped in one dimensional box of infinite depth.

b) Derive an expression for normalised wave function. **(6+2)**

Develop the Schrödinger's equation for a linear harmonic oscillator. Mention the energy value and eigen function of the oscillator. **8**

PART – B

olve **any five** of the following problems. **Each** problem carries **four** marks. **(5×4=20)**

Three particles are to be distributed in 5 energy levels a, b, c, d and e. Calculate all possible ways of distribution when particles are i) bosons and ii) classical particles with one particle in one energy level.

P.T.O.

10. A system has only two particles. Show with diagrams how these particles can be arranged in three quantum states 1, 2, 3 using i) Maxwell-Boltzmann and ii) Fermi-Dirac statistics.

11. A system has 5 particles arranged in two compartments. The first compartment has 6 cells and the second compartment has 10 cells. All cells are of equal size. Calculate the number of microstates in the macrostate (4, 1) when the particles obey Fermi-Dirac statistics.

12. Ultraviolet radiation of wavelength 260 nm is incident on silver whose threshold wavelength is 380 nm. Calculate the maximum velocity of photoelectrons.

13. Calculate the de Broglie wavelength of neutron of energy 28.8 eV.

Given : Mass of neutron = 1.67×10^{-27} kg, h = 6.63×10^{-34} Js.

14. The average time that an atom retains excess excitation energy before reemitting it in the form of electromagnetic radiation is 10^{-8} s. Calculate the limit of accuracy with which the excitation energy of the emitted radiation can be determined.

15. An eigen value of an electron confined to a one dimensional box of length 0.2 nm is 151 eV. What is the order of the excited state ?

Given : Mass of electron = 9.1×10^{-31} kg.

16. Calculate the zero point energy in eV and the spacing of energy levels in eV is a one dimensional oscillator of frequency 2.5 kHz.

PART – C

17. Answer **any five** of the following questions. **Each** question carries **two** marks. (5×2=

a) Can Maxwell-Boltzmann statistics be applied to electron gas ? Explain.

b) Does the number of photons inside a container remain constant ? Explain.

c) Do particles like electron, proton and neutron obey Pauli's exclusion principle ? Explain.

d) Does each photon necessarily eject a photoelectron ? Explain.

e) The concept of trajectory has no meaning in quantum mechanics. Explain.

f) Can matter waves move faster than light ? Explain.

g) Can one eigen value have many eigen functions ? If so, what are they called ?

h) Why do we normalise a wave function ?
