SN – 331

V Semester B.Sc. Examination, November/December 2017
(F+R) (CBCS/NS – Repeaters 2013-14 and Onwards)
PHYSICS – V
Quantum Statistical Physics, Quantum Mechanics – I and II

Time : 3 Hours Max. Marks : 70

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

PART – A

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

1. Derive Maxwell-Boltzmann distribution law. **8**

2. a) What are fermions and bosons ?

   b) Show that Bose-Einstein and Fermi-Dirac statistics approach to M – B statistics. **(2+6)**

3. Explain briefly the failure of classical theory in the explanation of :

   i) Balck body radiation

   ii) Photoelectric effect. **(4+4)**

4. a) What are matter waves ? Give any two characteristics.

   b) Deduce an expression for de Broglie wavelength. Hence, express it in terms of energy and temperature. **(3+5)**

5. Explain with a diagram Davisson and Germer experiment in the study of diffraction of electrons. Mention the result of the experiment. **8**

6. a) State and explain the three forms of Heisenberg's uncertainty principle.

   b) Show that electrons cannot remain inside a nucleus using uncertainty principle. **(6+2)**

7. a) Explain the term probability density.

   b) Arrive at Schrodinger's time dependent equation for a free particle in one dimension. Write the equation for three dimensions. **(2+6)**

8. Establish Schrodinger's equation for a linear harmonic oscillator. Mention the energy eigen value expression. Show that energy levels are equally spaced in harmonic oscillator. **8**

P.T.O.

PART – B

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

9. Consider two identical particles. Each particle can be in one of the three possible quantum states 0, E and 2E. Find the number of micro states of the system for M – B, B – E and F – D statistics. Also find the ratio of the probability that the two particles are found in different states in each of the three cases.
10. Consider a two particle system each of which exist in three states E_1, E_2 and E_3. What are the possible states if the particles are i) bosons and ii) fermions ?
11. The number of free electrons per C.C is 24.2×10^{22} in Beryllium and 0.91×10^{22} in Cesium. If the fermi energy of conduction electrons in Be is 14.44 eV, Calculate that in cesium.
12. A particle of mass $\frac{0.5}{C^2}$ SI units has a K.E. of 100eV. Calculate its de Broglie wavelength.
13. The de Broglie wavelength of a non-relativistic electron is 1.5 Å. Calculate its phase and group velocity.
14. An electron is confined to a box of length 10^{-8} m. Calculate the minimum uncertainty in its velocity and comment on the result. ($m_e = 9.1 \times 10^{-31}$ kg).
15. An electron is trapped inside a box of side 1nm. Calculate the first three eigen values in eV.
16. The energy of a linear harmonic oscillator in its third excited state is 0.1 eV. Calculate its frequency.

PART – C

Solve **any five** of the following questions. **Each** question carries **two** marks. **(5×2=10)**

17. a) Why do bosons and fermions have different distribution functions ? Explain.
    b) What is ultraviolet catastrophe ? Explain.
    c) Does the Bose temperature depend on number of particles ? Explain.
    d) Are de Broglie waves monochromatic in nature ? Explain.
    e) Can matter waves travel faster than light ? Explain.
    f) Why do we normalise a wave function ?
    g) Is zero point energy of a harmonic oscillator zero ? Explain.
    h) An electron and a neutron have the same de Broglie wave length. Which one will move faster ? Explain.