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.

SN – 332

V Semester B.Sc. Examination, November/December 2017
(2013 – 2014 and Onwards)
(CBCS – F+R/NS – Repeaters)
PHYSICS – VI
Astrophysics, Solid State Physics and Semiconductor Physics

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 an expression for gravitational potential energy of a star. **8**

2. a) Write a note on H-R diagram.
   b) Derive an expression for the radius of a neutron star. Express it in terms of solar mass. **(3+5)**

3. Give the theory of compton effect. **8**

4. Deduce an expression for the electrical conductivity of a metal based on free electron theory. Hence arrive at Ohm's law. **8**

5. Give a detailed account of any four properties of superconductivity. **8**

6. Derive an expression for the hoie concentration in the conduction band of intrinsic semiconductor. **8**

7. a) Explain the principle and working of a solar cell.
   b) With a circuit diagram, explain the working of zener diode as a voltage regulator. **(4+4)**

8. With a neat circuit diagram, explain the working of a CE amplifier. Explain the method of drawing a.c. load line. **8**

PART – B

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

9. If the apparent and absolute magnitude of Aldebaran are + 0.87 and – 0.63 respectively, calculate its distance from the earth.
   Given : 1 Parsec = 3.2616 light years.

P.T.O.

10. Calculate the average pressure of the sun. Given : $R_{\odot} = 6.96 \times 10^{8}$m, $M_{\odot} = 1.989 \times 10^{30}$ kg and $G = 6.67 \times 10^{-11} Nm^2kg^{-2}$.

11. In the orion constellation the luminosity of the star is 10000 times that of sun and its surface temperature is about 3000K. How much larger is the radius of the star compared to that of the sun ? Given : Temperature of the sun is 6000K.

12. Find the interplanar spacing for the lattice planes of Miller indices (3 2 1), (2 1 0) and (1 1 1) for cubic lattice (a = 5.62Å).

13. Fermi energy for gold and silver are 5.54 eV and 5.51 eV respectively. Calculate their Fermi temperatures. Given : $K = 1.38 \times 10^{-23} JK^{-1}$.

14. A magnetic field of 0.7 T is applied on a germanium crystal of 0.5 mm thick. Calculate the Hall voltage developed, if the current density is 250 Am^{-2} and electron density 2×10^{23} m^{-3}

15. Calculate the drift velocity of free electrons in a metal of area of cross section 2×10^{-4} m^2 in which a current of 100 A is flowing. The density of free electrons in a metal is 7.23×10^{28} m^{-3}.

16. For a transistor amplifier in CE – mode, $R_S = R_L = 1$ KΩ, $h_{ie} = 1.1$KΩ, $h_{re} = 2.5 \times 10^{-4}$, $h_{fe} = 50$ and $h_{oe} = 25 \times 10^{-6}$ mhos. Calculate (i) Current gain and (ii) Voltage gain.

PART – C

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

17. a) The more massive a star, the shorter its life time. Justify.

    b) What is the order of the density of a neutron star ? What happens if it continues to contract further ?

    c) A hot star has radiations of shorter wavelength compared to that of a cooler star. Why ?

    d) Visible light is not preferred for crystal diffraction. Why ?

    e) In metals, as the temperature increases, the conductivity decreases. Explain.

    f) Why is $\beta > \alpha$ in a transistor ?

    g) Pure germanium and silicon at 0°K are insulators. Why ?

    h) Does the rate of generation of electron-hole pair is equal to the rate of recombination at a given temperature ? Explain.