2015

OLD

Part I 3-Tier

ELECTRONICS

PAPER—II

(Honours)

Full Marks : 100

Time : 4 Hours

The figures in the right-hand margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

Group—A

Answer any *two* questions : 2×15

1. (a) Obtain the equation of motion of a particle falling from rest under the influence of gravity and a resistive force proportional to the square of velocity. Find the maximum possible velocity.

(b) Consider an elastic collision between two particles of equal mass one of which is initially at rest. Show that after the collision the particles move at right angles to each other.

(c) Find the M.I. of a rigid body about an axis whose direction cosines are l, m, n.

6+4+5

2. (a) Find co-ordination number, nearest neighbour distance, lattice constant, number of atoms per unit cell & packing factor of FCC and BCC lattices.

(b) What is a reciprocal lattice ? Find relation between direct and reciprocal lattice.

(c) If (3, 2, 6) are the Millar indices of a plane, find the intercepts made by the plane on three crystallographic axis.

8+5+2

3. (a) Define specific heat of solid. Deduce Einstein's equation for the specific heat of solid. What is the limitation of this model ?

(b) Explain how Debye model over come the limitation of Einstein model.

(2+6+1)+6

Group—B

Answer any *five* questions. 5×8

4. (a) Compare the salient features of the band theory and free electron theory. Discuss the merits and demerits of these theories.

(b) Find the Miller indices of a plane having intercepts of 8a, 4b and 2c on the a, b, c axes respectively.

5+3

5. (a) Discuss briefly the experiment of Davisson and Germer pointing out clearly how it demonstrates the existence of de-Broglie matter waves. What is wave-particle duality ?

(b) What is the physical significance of normalising wave function ?

6+2

6. (a) Explain wave-particle duality of particle.

(b) What is de-Broglie hypothesis ? Find the de-Broglie wave length of a particle in terms of its energy and temperature.

(c) Is it possible to find the de-Broglie wave length of a fast moving cricket ball ?

2+4+2

7. (a) Define phase and group velocity of a wave packet & find a relation between them.

   (b) Show that particle velocity is equal to the group velocity of the wave packet.

4+4

8. Discuss Kroning-Penney model. Using the model show that the energy spectrum of electron consists of a number of allowed energy bands separated by forbidden regions.

2+6

9. (a) Consider a photon gas enclosed in a cubical cavity of volume V (= c^3) and in equilibrium at temperature T. What is the chemical potential of the gas ? What is the number of photon states in the frequency interval $(\gamma,\ \gamma + d\gamma)$?

   (b) Using the Bose-Einstein distribution function, determine how the number of photons in the volume depends upon temperature.

   (c) What type of statistics — MB or FD should be used for electrons in metallic copper (atomic weight 63·5) at room temperature (300K) ? Give reasons for your answer.

4+2+2

10. (a) (i) Explain the origin of the sharp, the principal and the diffuse series in alkali spectra.

(ii) State the selection rules that govern the radiative transition between atomic states.

(iii) X-rays of wave length $\lambda = 0{\cdot}124\text{Å}$ is scattered from a block of graphite. What is the wavelength of the X-rays scattered in the backward direction ?

(b) Write down the time dependent and time independent Schrödinger equation and also discuss their significance.

6+2

11. (a) What is Raman effect ? Explain the origin of stokes and anti-stokes lines. Which lines are more intense and why ?

(b) Consider the $3P_{3/2}$ level of a sodium atom. What are the eigenvalues of J^2, L^2 and S^2 for this level ?

(2+2+2)+2

Group—C

Answer any *five* questions : 5×4

12. Show that rate of change of angular momentum of the system of particles is equal to total external torque. Hence find the conservation of angular momentum. 2+2

13. Explain the zero point energy. How does it reconcile with the classical viewpoint ? 2+2

14. Normalize the one-dimensional wave function given by :

$$\Psi(x) = A\sin\left(\frac{\pi x}{a}\right) \quad 0 < x < a$$
$$= 0 \quad \text{outside}$$

4

15. Prove the relation :

$$\frac{\partial P}{\partial T} + \vec{\nabla} . \vec{J} = 0$$

where $\vec{J}$ = Probability current density
P = Probability density. 4

16. Define conservative and non-conservative forces with suitable example. 4

17. Deduce an expression for the mean occupation number of an energy state ε_i assuming the particles to obey (i) BE (ii) FD statistics. 2+2

18. Assuming initial velocity of the rocket on earth's is zero and rate of loss of mass on the rocket to be constant. Find the height reached by the rocket in time t. 4

19. Draw the Fermi level in an intrinsic semiconductor. Draw neat diagrams showing the location of the Fermi level in n- and p-type semiconductors. What is degenerate semiconductor ? 1+1+1+1

[Internal Assessment — 10]

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