

D 52342

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Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2018

(CUCSS—PG)

Physics

PHY 3C 11—SOLID STATE PHYSICS

(2017 Syllabus Year)

Time : Three Hours

Maximum : 36 Weightage

Part A

Answer all questions.

Each question carries 1 weightage.

1. Mention the 14 Bravais lattices and specify the restrictions on lattice parameters and angles on each case.
2. What is a reciprocal lattice ? What is its importance in x-ray diffraction ?
3. Plot the dispersion curves for lattice vibrations of a crystal with one and two atoms in the primitive cell.
4. Explain the concept of phonons.
5. What is Hall effect ? Give the expression for Hall co-efficient as predicted by free electron theory.
6. Describe how to calculate the number of orbitals in an energy band.
7. Distinguish between direct and indirect bandgap semiconductors. Give examples.
8. Define electric polarization. Give the relation connecting macroscopic electric field with polarization vector.
9. Distinguish between pyroelectric and piezoelectric materials.
10. State Hund's rules to obtain the ground state of an atom.
11. Explain the concept of Cooper pairs in superconductors.
12. What is the importance of high temperature superconductors ? Give one example with transition temperature.

(12 × 1 = 12 weightage)

Turn over

Part B

Answer any **two** questions.

Each question carries 6 weightage.

13. Describe various kinds of bonding in crystals.
14. Obtain the dispersion relation for vibrations of monatomic lattices. Show that the group velocity is zero at zone boundary.
15. Derive the expression for intrinsic carrier density in semiconductors.
16. What is a Josephson junction ? Derive expressions for (i) dc and (ii) ac Josephson effects.

(2 × 6 = 12 weightage)

Part C

Answer any **four** questions.

Each question carries 3 weightage.

17. Calculate the energy required for a beam of (i) x -rays, (ii) neutrons and (iii) electrons in a scattering experiment to determine the crystal structure if the wavelength of the beam is 5\AA .
18. Specific heat capacity for Cu at 300K is 1688 J/mol-K. Calculate the Debye temperature for Cu. (given $k_B = 1.38 \times 10^{-23}\text{JK}^{-1}$, $N = 6.02 \times 10^{23}$ atoms/mole).
19. Valence electron density for monovalent potassium is, $N/V = 1.402 \times 10^{28}\text{m}^{-3}$. Calculate the Fermi energy and Fermi temperature of electrons in potassium.
20. Estimate Curie constant for Fe ($N = 9 \times 10^{28}\text{m}^{-3}$, $\mu_B = 9.27 \times 10^{-24}\text{JT}^{-1}$).
21. Show that energy level for a single electron with no orbital angular momentum splits to $\pm \mu_B B$ in a magnetic field directed along the positive z -axis.
22. Show that London equation leads to Meissner effect.

(4 × 3 = 12 weightage)