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Reg. No. : .....

Code No. : 6393 **Sub. Code : ZPHM 33**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Third Semester

Physics – Core

CONDENSED MATTER PHYSICS

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. If a crystal lattice has 6 closed-pack spheres, what the number of tetrahedral voids in the lattice?
   (a) 12 (b) 6
   (c) 36 (d) 3

2. Which of the following possess anisotropic nature within their structure?
   (a) Hair wax (b) Snowflakes
   (c) Polythene (d) Crystal glass

3. Consider a one-dimensional solid with a lattice spacing of 0.32 nm. What is the value for the wavevector k at the zone boundary of the first Brillouin zone?
   (a) 8.17 nm^{-1} (b) 9.82 nm^{-1}
   (c) 10.43 nm^{-1} (d) 21.63 nm^{-1}

4. Which of the experimental methods below is the best choice for determining phonon dispersion curves?
   (a) Inelastic neutron scattering
   (b) Transmission electron microscopy
   (c) X-ray diffraction
   (d) Scanning tunnel microscopy

5. When the temperature of either n-type or p-type increases, determine the movement of the position of the Fermi energy level?
   (a) Towards up of energy gap
   (b) Towards down of energy gap
   (c) Towards center of energy gap
   (d) Towards out of page

6. Consider a bar of silicon having carrier concentration n0 = 1015 cm^{-3} and ni = 1010 cm^{-3}. Assume the excess carrier concentrations to be n = 1013 cm^{-3}, calculate the quasi - fermi energy level at T = 300K?
   (a) 0.2982 eV (b) 0.2984 eV
   (c) 0.5971 eV (d) 1 Ev

7. The temperature below which certain materials are antiferromagnetic and above which they are paramagnetic is called

(a) Weiss temperature (b) Curie temperature

(c) Neel temperature (d) None of the above

8. In a piezoelectric crystal, the application of mechanical force will cause

(a) Plastic deformation of crystal

(b) Magnetic dipoles in the crystal

(c) Electrical polarization in the crystal

(d) Shift in Fermi level

9. There are three important lengths which enter the theory of superconductivity except

(a) London penetration length

(b) Intrinsic coherence length

(c) Normal electron mean free length

(d) Mean path length

10. The phenomena of superconductivity was first discovered by ————

(a) Kammerlingh Onnes

(b) Richard Smalley

(c) Otto Lehman

(d) Neils Bohr

PART B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) For a certain BCC crystal the (110) plane has a separation of 1.1817 A°. These planes are indicated with X-rays of wavelength 1.540 A°. How many order of Bragg's reflections can be observed in this case?

Or

(b) Discuss in detail Fourier analysis of the basis.

12. (a) Explain the umklapp processes.

Or

(b) Explain the Debye model for density of states.

13. (a) Evaluate the value of Fermi distribution function for an energy KT above the Fermi energy at that temperature and give some comments on your answer.

Or

(b) Explain free electron gas in three dimensions.

14. (a) Dy^{3+} has outer electronic configuration of $4f^{9}6s^{0}$. Calculate the magnetic susceptibility for a salt containing one kg mole of Dy^{3+} ions at 300 k.

Or

(b) Explain the nuclear magnetic resonance.

15. (a) Explain the dielectric constant and polarizability.

Or

(b) Explain the concept of SQUID.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b)

16. (a) An x-ray tube operates at a potential difference of 24800 v and has a copper target. The first order glancing angle for NaCl crystal for Kα line at $\lambda = 1.54$ A° is 15.8°. Calculate (i) the grating spacing for NaCl crystal and (ii) the glancing angle for minimum wavelength of the continuous spectrum.

Or

(b) Discuss in detail analysis of elastic strains.

17. (a) Describe the Einstein model of lattice heat capacity. Discuss the success and failures of this model.

Or

(b) Explain the thermal resistivity of phonon gas.

18. (a) The Hall coefficient of a certain silicon specimen was found to be $-7.35 \times 10^{-5} m^3 c^{-1}$ from 100 to 400 k. Determine the nature of the semiconductor. If the conductivity was found to be 200 $m^{-1}\Omega^{-1}$, calculate the density and mobility of the charge carrier.

Or

(b) Explain the DeHass - Van Alphen effect.

19. (a) A paramagnetic material has bcc structure with a cube edge of 2.5 A°. If the saturation value of magnetization is 1.8×10^6 Am^{-1}. Calculate the average magnetization contributed per atom in Bohr magnetons.

Or

(b) Explain quantum theory of paramagnetism.

20. (a) Derive the London equations and explain the term coherence length.

Or

(b) Discuss d.c. and a.c. Josephson's effects and explain their importance.