STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2019-2020 and thereafter)

SUBJECT CODE :19PH/MC/SS54

B.Sc. DEGREE EXAMINATION NOVEMBER 2022
BRANCH III - PHYSICS
FIFTH SEMESTER

COURSE : MAJOR – CORE
PAPER : SOLID STATE PHYSICS
TIME : 3 HOURS **MAX. MARKS :100**

SECTION – A

ANSWER ALL QUESTIONS: **25 marks**

Choose the correct answer: **(10 x 1 = 10)**

1. Inert gases generally have _____type of bond.
   a) covalent b) metallic c) hydrogen d) Vander Waals
2. Which of the following is a secondary bond?
   a) Covalent bond b) ionic bond c) hydrogen bond d) metallic bond
3. Which of the following is a zero-dimensional crystal defect?
   a) Point imperfection b) line imperfection c) surface imperfection d) Volume imperfection
4. _____, being thermodynamically unstable, increases the free energy of the crystal.
   a) Schottky imperfection b) Frenkel imperfection
   c) electronic defects d) Dislocation
5. For impure metals, electrical conductivity is proportional to _____, where T is the absolute temperature.
   a) T^2 b) $\sqrt{T}$ c) $1/\sqrt{T}$ d) T
6. Unit of Lorentz number L is _____.
   a) Watt $Ohm^{-1}deg^2$ b) Watt Ohm deg^2 c) Watt Ohm deg^{-2} d) Watt deg^{-2}
7. _____ is found in materials where the atoms, ions or molecules in them have permanent magnetic dipole moment.
   a) Diamagnetism b) Paramagnetism c) Ferromagnetic d) Ferrimagnetic
8. In an anti-ferromagnet the susceptibility above the Neel Temperature θ_N is given by ____.
   a) C/T b) $C/(T - \theta_N)$ c) $C/(T+\theta_N)$ d) $C/(\theta_N)$
9. The specific heat of a superconductor shows an abrupt change at T ____.
   a) $= T_c$ b) $< T_c$ c) $> T_c$ d) $\leq T_c$
10. The isotope effect co-efficient is _____
    a) zero b) generally in the range 0.4 to 0.6
    c) generally in the range 0.5 to 1 d) generally greater than 1.

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Fill in the blanks: **(5 x 1 = 5)**

11. Crystals which exhibit hydrogen bonding have cohesive energy in the range _____.
12. The modulus of Burgers vector is called _____.
13. Measurement of Hall voltage gives information about the _____ of the charge carrier.
14. Ferrimagnetic substance exhibit spontaneous magnetisation below _____ temperature.
15. The effect because of which a superconductor does not have flux density even when a magnetic field is applied is called _____ effect.

Answer briefly: **(5 x 2 = 10)**

16. Differentiate between covalent bonding and metallic bonding.
17. What is Frenkel defect.
18. List the successes and failures of Free Electron Theory of metals.
19. State the Curie-Weiss Law.
20. Differentiate Type –I and Type II superconductors.

SECTION – B

Answer any Five Questions: **(5x6=30)**

21. Assume the mutual interaction energy of two particles in each other's field is given as: $U_R = -a/r + b/r^8$. Here, a and b are constants and r is the distance between the centre of the particles. Show that if the particles are pulled apart, the molecule will break when $r = (36b/a)^{1/2} = r_0(4.5)^{1/7}$.
22. The average energy required to create a Frenkel defect in an ionic crystal $A^{2+}B^{2-}$, is 1.4eV. Calculate the ratio of Frenkel defects at 300 K and 600 K in 1g of crystal.
23. Discuss the Langevin's theory of diamagnetism.
24. Obtain expressions for electrical and thermal conductivities for a conductor. Use these expressions to obtain the expression for Wiedmann-Franz law.
25. A magnetic substance has 10^{28} atom/m^3. The magnetic moment of each atom is 1.8×10^{-23} Am^2. Calculate the paramagnetic susceptibility at 300 K. What would be the dipole moment of a bar made of this material 0.1 m long and 1 sq.cm.cross-section placed in a field of 8×10^4Am. (Given: $\mu_0 = 4\pi \times 10^{-7}$ H/m, $\mu_m = 1.8 \times 10^{-23}$ Am^2).
26. For a superconducting specimen, the critical fields are respectively 1.4×10^5 and 4.2×10^5 A/m for 14 K and 13 K. Determine the superconducting transition temperature and the critical field at 0K.
27. The following are data given for copper:
    a) Density = 8.92×10^3 kg/m^3
    b) Resistivity = 1.73×10^{-8} ohm m
    c) Atomic weight = 63.5 u

    Calculate the mobility, average time of collision of electrons in copper obeying classical laws

SECTION – C

Answer any Three Questions: **(3x15=45)**

28. Discuss the properties of the following types of bonds briefly:
    a. Metallic bonding (10 marks)
    b. Van der Waals bonding (5 marks)
29. Discuss in detail the two types of line defects with the help of appropriate diagrams.
30. Explain Hall Effect. Derive the expressions for various parameters associated with the effect, like Hall Coefficient, Hall Voltage and Hall angle.
31. Derive an expression for the equilibrium concentration of Schottky defects in ionic crystals.
32. Discuss the thermodynamics of superconductors. Derive the expression for Gibbs free energy, entropy and specific heat.

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