B.Sc. DEGREE EXAMINATION NOVEMBER 2023
BRANCH III - PHYSICS
FIFTH SEMESTER

COURSE   : MAJOR – CORE
PAPER   : SOLID STATE PHYSICS
SUBJECT CODE : 19PH/MC/SS54
TIME   :3 HOURS   MAX. MARKS :100

SECTION – A

ANSWER ALL QUESTIONS: **25 marks**

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

1. As the number of covalent bonds between two atoms increases, the distance between the atoms _____ and the strength of the bond between them _____
   a) increases, increases   b) decreases, decreases
   c) increases, decreases   d) decreases, increases

2. In NaCl, the Na ions are positively charged and chlorine ions are negatively charged. Inspite of the coulomb attraction between them, why do the two ions not collapse?
   a) Because of the presence of free electrons.   b) Because of its low melting point.
   c) Because of its high specific heat.   d) Because of short range repulsive forces.

3. If a dislocation is caused by inserting an extra plane of atoms below the dislocation line in the crystal it is called as
   a) screw dislocation   b) positive edge dislocation
   c) negative edge dislocation   d) Frenkel defect

4. The loop obtained by proceeding one atomic distance at a time along the translation vector is called
   a) Burger's circuit   b) Burger's vector   c) Costa's loop   d) Atomic loop

5. If the mobility of electrons in a metal increases, the resistivity
   a) decreases   b) increases   c) remains constant   d) zero

6. If e, p and n respectively represent the charge, mobility and concentration of electrons respectively, then the electrical conductivity of the metal is given by
   a) $n/\mu e$ b)$\mu e/n$ c) ne   d)neμ

7. The transition temperature of most superconducting elements lie in the range
   a) zero to 10 K   b) 10 K to 20 K   c) 20 K to 50 K   d) above 50 K

8. The coherence length of the paired electrons is
   a) 0.25 nm   b) 250 nm   c) 0.01 nm   d) 0.001 nm

9. In a ferromagnetic material, susceptibility is
   a) very small and positive   b) very small and negative
   c) very large and positive   d) very large and negative

10. The susceptibility of a diamagnetic material is essentially independent of temperature
    a) Under all circumstances
    b) If the electronic structure is independent of temperature
    c) At very low temperatures of the order of 10 K
    d) At very high temperatures

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

11. The nature of binding for a crystal with alternate and evenly spaced positive and negative ions is _____

12. Properties of materials that are greatly affected by the changes in crystal structure due to defects are called as _____

13. The unit of Hall coefficient is _____

14. The units of magnetic permeability are _____

15. Soft superconductors observe _____

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

16. What is Madelung constant?
17. What is meant by crystal imperfection?
18. State Wiedemann-Franz law.
19. What is the cause for magnetism in materials?
20. Define critical magnetic field.

SECTION – B

Answer any Five Questions: **(5 x 6 = 30)**

21. Show that the potential energy of two particles in the stable configuration is equal to $-\left[\frac{a}{r_{02}}\right]\left(\frac{4}{5}\right)$ for m=2 and n=10.

22. What is the condition for hydrogen bonding? Discuss the properties of hydrogen bonding.

23. Explain Schottky and Frenkel defects in solids.

24. A uniform silver wire has a resistivity of 1.54×10^{-8} Ω m at room temperature. For an electric field along the wire of 1 volt cm^{-1}, compute the average drift velocity of electron assuming that there is 5.8×10^{28} conduction electrons /m^3. Also calculate the mobility.

25. The thermal conductivity of a material is 4.00 W/m/K and the electrical conductivity of the material is given by 6.32×10^7 m^{-1} at a temperature of 200K. Find the Lorentz number for the given material.

26. Nickel is a ferromagnetic metal with density 8.90 g/cm^3. Given that Avogadro's number $N_A = 6.02 \times 10^{23}$ atoms/mol and the atomic weight of Ni is 58.7, calculate the number of atoms of Ni per cubic metre. If one atom of Ni has a magnetic moment of 0.6 Bohr magnetons, deduce the saturation magnetization M_s and the saturation magnetic induction B_s for Ni.

27. A given superconductor has a critical field of 2.3 x 10^5 and 6.8 x 10^5 A/m at 10 K and 8 K, respectively. Calculate its transition temperature and critical field for 4.2 K.

SECTION – C

Answer any Three Questions: **(3 x1 5 = 45)**

28. Explain the different types of bondings in solids. Find an expression for the equilibrium potential energy of an ionic solid.

29. Describe with suitable diagrams edge dislocations and screw dislocations in crystal lattice.

30. Explain the terms "mobility of charge carriers" and "Hall effect". Obtain an expression for the Hall coefficient in terms of the density of conduction electrons and explain how it is used to determine the mobility of a charge carriers.

31. Discuss Langevin's theory for a paramagnetic gas and obtain an expression for the paramagnetic Susceptibility of the gas. What are the main drawbacks of this theory?

32. Derive the London equations and explain the term coherence length.

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