

CC-12
SOLID STATE PHYSICS

Q.1 (1 Mark)

1. The temperature at which conductivity of a material becomes infinite is called_____.
2. The binding energy for a cooper pair is_____.
3. In superconductivity the conductivity of a material becomes_____.
4. In superconductivity, the electrical resistance of material becomes_____.
5. The temperature at which conductivity of a material becomes infinite is called_____.
6. In superconductors, the Fermi energy level is_____.
7. The superconducting state is perfectly _____ in nature.
8. The minimum amount of current passed through the body of superconductor in order to destroy the superconductivity is called_____.
9. Which can be used for generation of laser pulse_____.(Ruby laser/Nd-YAG laser)which is an example of optical pumping_____.(Ruby/Helium laser)
10. Which is a unique property of laser_____.(Coherence/wavelength)
11. How many types of sources of optical light are available?
12. The radiation emission process (emission of a proton at frequency) can occur in _____ ways.
13. Which process gives the laser its special properties as an optical source?
14. The lower energy level contains more atoms than upper level under the conditions of _____.(thermal equilibrium/population inversion)
15. Dielectrics which show spontaneous polarization are called as_____.
16. What is the relation between ϵ_r and χ ?
17. Electrical counterpart of bar magnets is called as_____.
18. Ceramics cannot be_____.(Oxides/Sulfides)
19. Which of the following has a non-crystalline structure_____.(Iron/Silica glass)
20. Which one of the following is least symmetrical_____.(triclinic/monoclinic)
21. With an increase in temperature, magnetic susceptibility ferromagnetic material_____.
22. Magnetic Bubbles are used as_____.

Q.2 (1.5 Marks)

1. What is a Crystal? (or) What are crystalline materials? Give examples.
2. What is an amorphous solid? Give example. (or) Non-Crystalline materials.
3. What is meant by Crystallography?
4. What is a single crystal?
5. What is a poly crystal? Give example.

6. What are the differences between crystalline and non-crystalline materials?
7. What is meant by crystallization and X-ray crystallography?
8. Define Lattice.
9. Define space lattice (or) crystal lattice.
10. Define lattice points.
11. Define Basis (or) Motif.
12. What is meant by structure?
13. Define lattice planes?
14. Define unit cell.
15. What is called as crystallographic axis?
16. What is unit cell parameter (or) lattice parameters?
17. What are primitives (or) Characteristic intercepts?
18. What is primitive cell.
19. Which are called Non-Primitive cell.
20. Name of the seven crystal system.
21. What are Bravais lattices?
22. What is known number of atoms per unit cell (or) effective number?
23. What are lattice vibrations and phonons?
24. Give the qualitative description of phonons.
25. What do you mean by linear monoatomic and diatomic chains?
26. What are acoustical and optical branches in lattice vibrations?
27. State Dulong and Petit's law.
28. Explain the classification of magnetic materials.
29. Define the terms magnetic permeability, magnetic susceptibility
30. Moment of a magnetic dipole.
31. Explain why electronic orbits behave like a magnetic
32. Explain diamagnetic action is an induced phenomenon
33. All substances should exhibit diamagnetism.
34. What do you mean by lasers?
35. Explain spontaneous emission and stimulated emission.
36. Differentiate between spontaneous emission and stimulated emission.
37. What are Einstein's coefficients A and B?
38. What is pumping action?
39. What is superconductivity?
40. Explain some experimental results of superconductivity.
41. Define critical temperature.
42. Define critical magnetic field.
43. What is Meissner effect?
44. Describe Type-I and Type-II superconductors.
45. Explain the concept of band theory. 2. Explain Bloch theorem.

Q.3 (2.5 Marks)

46. Copper has FCC structure and its atomic radius is 1.273 \AA , find the lattice parameter and the density of copper. (i) Atomic weight of copper = 63.5 gm (ii) Avogadro's number = 6.023×10^{23} atoms/Kilomole.
47. α -iron of atomic weight 55.85 solidifies into BCC structure and has a density of 7860 kg m^{-3} . Calculate the radius of an atom.
48. Copper crystalline in the FCC structure. The Density and atomic weight of copper are 8960 kg m^{-3} and 63.54 respectively. Calculate its lattice constant.
49. Calculate the value of d-spacing for (100) planes in a rock salt crystal $a = 2.814 \text{ \AA}$.
50. Calculate the interplanar distance for (321) plane in simple cubic lattice with interatomic spacing equal to 4.12 \AA .
51. Calculate the inter-planar spacing for (101) and (221) planes in a simple cubic lattice whose lattice is 0.42 nm .
52. Discuss Brillouin zones.
53. What do you mean by X-ray diffraction of crystals?
54. State and explain Bragg's law.
55. Derive Bragg's law of X-ray diffraction. 14. Define a reciprocal lattice.
56. Explain atomic factor and Geometrical factor. Explain different types of bonding.
57. What is ionic bonding? Give characteristics of ionic solids.
58. Explain the basic ideas behind Einstein model for specific heat of solids.
59. Explain the basic idea of Debye model for specific heat of solids
60. Compare the assumptions of Einstein and Debye theories.
61. Compare the results of Einstein and Debye theories.
62. Explain Debye T law.
63. Distinguish between para, dia and ferro-magnetic magnet.
64. What are domains?
65. Discuss domain theory of ferromagnetism.
66. What is Curie temperature?
67. What is a hysteresis curve?
68. What is hysteresis loss?
69. Explain the basic principle of laser in the following terms
70. Explain the main components of a laser.
71. Describe the principle and working of a three level system.
72. Describe the principle of four level laser system.
73. Describe the construction and action of a Ruby laser
74. Describe the construction and working of He-Ne laser.
75. Explain the formation of discrete energy levels in solids using Kronig-Penney model.
76. Classify conductors, insulators and semiconductors based on diagrams. energy level
77. What do you understand by semiconductors? Differentiate between and extrinsic semiconductors. intrinsic

78. Discuss P and N type semiconductors.
79. What do you mean by conductivity and mobility of semiconductors?
80. Define Hall effect.
81. Explain Hall coefficient.
82. Write short notes on
 - (i) Band theory of solids and (ii) Hall effect.

Q.4 (5 Marks)

1. What are symmetry operations? Describe the principal symmetry operations applicable to a three-dimensional lattice. Show that the fivefold rotational axis is not permissible in case of lattice.
2. What are point group and space group? Give their number for two and three dimensional lattice. List all the point groups of a two dimensional lattice.
3. Determine the interplanar spacing between two parallel plane with Miller indices (h,k,l) in a cubic crystal of side a.
4. Which is the most densely packed structure amongst the various cubic structures? Determine the packing fraction and porosity of this structure. Can the porosity be reduced by some means? What type of solids generally exhibit this type of structure and why?
5. Draw a plan view of sodium chloride structure? In how many ways can this structure be interpreted?
6. Draw plan view of hcp unit cell and give co-ordinates of all the atoms. Are all the atoms located at equivalent sites? Discuss implications of your answer.
7. Derive dispersion relationship for a one dimensional atomic crystal and discuss the nature of acoustic and optical modes. Show that the group velocity vanishes at the zone boundary. Give physical interpretation of the result.
8. Deduce vibration modes of a finite one-dimensional monatomic lattice. How does this knowledge help in calculating the specific heat?
9. Describe inelastic scattering of photons by phonons. Obtain an expression for the frequency of phonons generated when a photon is scattered in elastically at an angle θ .
10. Describe the classical theory of lattice heat capacity and obtain the value of molar heat capacity for metals.
11. Describe the Einstein model of lattice heat capacity. Discuss the success and failure of this model.
12. Discuss the Debye model of lattice heat capacity. What is Debye T^3 law?
13. Calculate the density of normal modes for a linear chain of atoms assuming the dispersion relation

$\omega = \omega_m \left| \sin \frac{1}{2} Ka \right|$ where a is the spacing and ω_m is the maximum frequency. What will be its value in Debye approximation?

14. What is paramagnetic material and discuss Langevin's theory for a paramagnetic gas and obtain an expression for the paramagnetic susceptibility of the gas.
15. Explain the different contributions for the formation of domains in ferromagnetic material and show how the hysteresis curve is explained on the basis of the domain theory.
16. Give an account of Weiss theory of ferromagnetism. On the basis of this theory, how will you explain hysteresis and Curie point? Explain clearly the basic difference between paramagnetic and ferromagnetic substances.
17. Describe the Weiss molecular field theory of ferromagnetism and derive the Curie – Weiss law.
18. What is meant by local field in a solid dielectric? Deduce an expression for the local field for structures possessing cubic symmetry.
19. Obtain Clausius- Mosotti equation and explain how it can be used to determine the dipole moment of a polar molecule from the dielectric constant measurements.
20. What is meant by local field in a dielectric and how is it calculated for a cubic structure? Deduce Clausius-Mosotti relation and explain its use in predicting the dielectric constant of solids.
21. Explain electronic polarisability