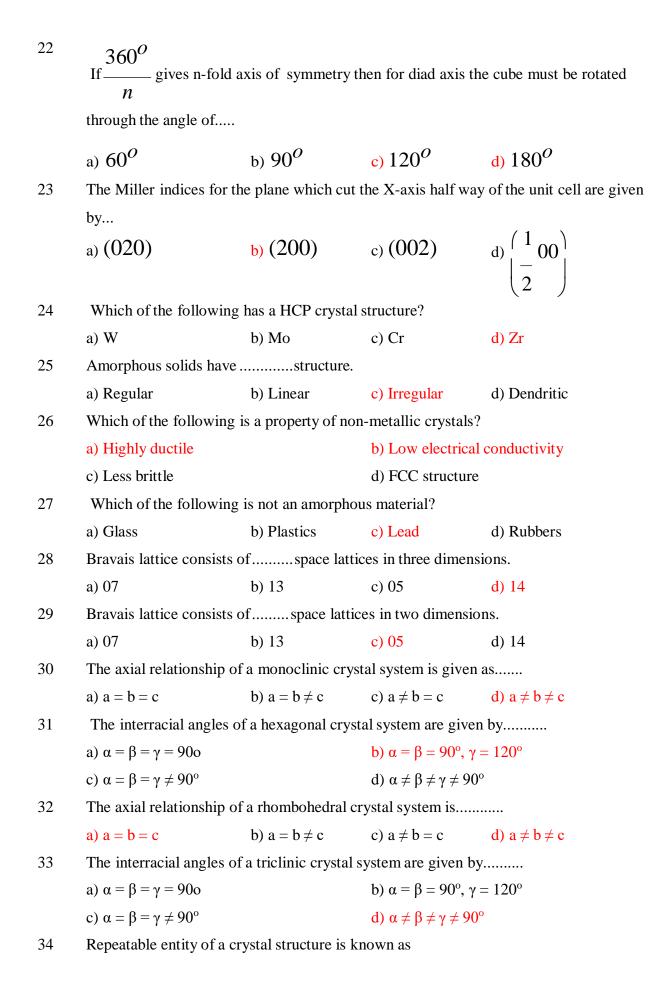Department of Physics

Question Bank

Paper **XIV**- DSE-F2 **Solid State Physics**

Class: **B.Sc. III**

Unit I- Chapter I- Crystal Structure

- **Multiple Choice Questions (Correct answer is shown in red color)**

1   The number of point group and space lattice structure in three dimensions are….

   a) 7,14   b) 32,14   c) 4,7   d) 14,32

2   The Miller index for the plane which does not cut the crystallographic axes

   a) 0 b) 1 c) $\bar{1}$ d) ∞

3   The close packed structure are

   a) SC and FCC   b) BCC and FCC

   c) HCP and FCC   d) BCC and HCP

4   The interplanar distance for plane (221) in case of cubic crystal lattice is....

   a) $\dfrac{a}{5}$ b) $\dfrac{a}{9}$ c) $\dfrac{a}{3}$ d) $\dfrac{a}{6}$

5   Primitive unit cell contains…. number of atoms

   a) 1 b) 2 c) 3 d) 4

6   The packing fraction for FCC crystal structure

   a) $\dfrac{\pi}{6}$ b) $\dfrac{3\pi}{8}$ c) $\dfrac{\pi}{3\sqrt{2}}$ d) $\dfrac{\pi}{\sqrt{2}}$

7   The atomic radius of HCP lattice is

   a) $\dfrac{a}{2\sqrt{2}}$ b) $\dfrac{a}{2\sqrt{2}}$ $\dfrac{3}{4}$ d) $\dfrac{a}{2}$

8   The coordination number for SC lattice

   a) 8   b) 6   c) 12   d) 10

9   The packing fraction for SC crystal structure

a) 0.52 b) 0.68 c) 0.74 d) 0.34

10 The atomic radius of BCC lattice is

a) $\dfrac{a}{2}$ $\dfrac{a}{2\sqrt{2}}$ $\dfrac{\sqrt{3}}{4}$ d) $\dfrac{a}{\sqrt{2}}$

11 The coordination number for FCC lattice

a) 6 b) 8 c) 12 d) 10

12 The packing fraction for BCC crystal structure

a) 0.52 b) 0.68 c) 0.74 d) 0.34

13 The atomic radius of simple cubic lattice is

a) $\dfrac{a}{2}$ $\dfrac{a}{2\sqrt{2}}$ $\dfrac{\sqrt{3}}{4}$ d) $\dfrac{a}{\sqrt{2}}$

14 The coordination number for HCP lattice

a) 6 b) 8 c) 12 d) 10

15 The packing fraction for HCP crystal structure

a) 0.52 b) 0.68 c) 0.34 d) 0.74

16 The atomic radius of FCC lattice is

a) $\dfrac{a}{2}$ $\dfrac{a}{2\sqrt{2}}$ $\dfrac{\sqrt{3}}{4}$ d) $\dfrac{a}{\sqrt{2}}$

17 The coordination number for BCC lattice

a) 6 b) 8 c) 12 d) 10

18 The number of lattice points per unit cell for non primitive cell is

a) equal to one b) greater than one

c) less than one d) equal to zero

19 The Miller index for the plane parallel to crystallographic axes....

a) 0 b) 1 c) $\overline{1}$ d) ∞

20 The sequence of atoms in hexagonal close packed crystal structure is

a) ABCABC b) ABAB c) random d) ABCDABCD...

21 The Miller index for the plane which cuts the X-axis at $\dfrac{1}{3}\overline{a}$ is....

a) 3 b) 1 c) $\overline{3}$ d) $\overline{1}$

22   If $\dfrac{360^O}{n}$ gives n-fold axis of symmetry then for diad axis the cube must be rotated

through the angle of.....

a) 60° b) 90° c) 120° d) 180°

23   The Miller indices for the plane which cut the X-axis half way of the unit cell are given

by...

a) (020)   b) (200)   c) (002)   d) $\left(\dfrac{1}{2}00\right)$

24   Which of the following has a HCP crystal structure?

a) W   b) Mo   c) Cr   d) Zr

25   Amorphous solids have ....structure.

a) Regular   b) Linear   c) Irregular   d) Dendritic

26   Which of the following is a property of non-metallic crystals?

a) Highly ductile   b) Low electrical conductivity

c) Less brittle   d) FCC structure

27   Which of the following is not an amorphous material?

a) Glass   b) Plastics   c) Lead   d) Rubbers

28   Bravais lattice consists of..........space lattices in three dimensions.

a) 07   b) 13   c) 05   d) 14

29   Bravais lattice consists of.........space lattices in two dimensions.

a) 07   b) 13   c) 05   d) 14

30   The axial relationship of a monoclinic crystal system is given as.......

a) $a = b = c$ b) $a = b \neq c$ c) $a \neq b = c$ d) $a \neq b \neq c$

31   The interracial angles of a hexagonal crystal system are given by...........

a) $\alpha = \beta = \gamma = 90o$ b) $\alpha = \beta = 90^o, \gamma = 120^o$

c) $\alpha = \beta = \gamma \neq 90^o$ d) $\alpha \neq \beta \neq \gamma \neq 90^o$

32   The axial relationship of a rhombohedral crystal system is............

a) $a = b = c$ b) $a = b \neq c$ c) $a \neq b = c$ d) $a \neq b \neq c$

33   The interracial angles of a triclinic crystal system are given by..........

a) $\alpha = \beta = \gamma = 90o$ b) $\alpha = \beta = 90^o, \gamma = 120^o$

c) $\alpha = \beta = \gamma \neq 90^o$ d) $\alpha \neq \beta \neq \gamma \neq 90^o$

34   Repeatable entity of a crystal structure is known as

a) Crystal   b) Lattice   c) Unit cell   d) Miller indices

35   Every point of space lattice has .... surroundings.

a) Atoms   b) element   c) Lattice   d) Identical

36   ....is a system of notation of planes within a crystal of space lattice

a) Space lattice   b) Crystalline   c) Miller indices   d) identical

37   Atomic packing fraction is maximum for.........

a) plastic   b) SC   c) BCC   d) FCC

38   If $\dfrac{360^O}{n}$ gives n-fold axis of symmetry then for triad axis the cube must be rotated through the angle of.....

a) 60° b) 90° c) 120° c) 180°

39   The interracial angles of a Hexagonal crystal system are given by..........

a) $\alpha = \beta = \gamma = 90$o   b) $\alpha = \beta = 90^o$, $\gamma = 120^o$

c) $\alpha = \beta = \gamma \neq 90^o$ d) $\alpha \neq \beta \neq \gamma \neq 90^o$

40   If $\dfrac{360^O}{n}$ gives n-fold axis of symmetry then for tetrad axis the cube must be rotated through the angle of.....

a) 60° b) 90° c) 120° c) 180°

41   Co-ordination no. & Atomic packing fraction of HCP structure is same as that of the............

a) SC   b) FCC   c) BCC   d) Rubber

42   The angle between [111] and [11−2] directions in a cubic crystal is (in degrees)

a) 0   b) 45   c) 90   d) 120

43   Atomic packing factor is

a) Distance between two adjacent atoms

b) Projected area fraction of atoms on a plane

c) Volume fraction of atoms in cell

d) Distance between two adjacent planes

44   Which unit cell has eight atoms located in the corners, has sides that are all the same length, and has angles of only 90° ?

a) SC b) FCC c) BCC d) triclinic

45   Intercepts of a plane in crystal is given by a, b/2, 3c in a simple cubic unit cell, Miller indices are,

a) (1 3 2) b) (2 6 1) c) (1 2 3) d) (3 6 1)

46   The sequence of atoms in FCC crystal structure is

a) ABCABC b) ABAB

c) random d) ABCDABCD..

47   A Cube has .....elements of symmetry

a) 13 b) 01 c) 09 d) 23

48   A Cube has .....rotation axes of symmetry

a) 13 b) 01 c) 09 d) 23

49   A Cube has .....planes of symmetry

a) 13 b) 01 c) 09 d) 23

50   c/a ratio in HCP crystal structure is

a) $\sqrt{\dfrac{8}{3}}$ b) $\sqrt{\dfrac{3}{8}}$ c) $\sqrt{\dfrac{4}{3}}$ d) $\sqrt{\dfrac{3}{2}}$

- **Short Answer Questions**

1.   Explain the concept of reciprocal lattice.
2.   Give construction of two dimensional reciprocal lattice.
3.   State and explain the properties of reciprocal lattice.
4.   Show that the volume of unit cell of reciprocal lattice is inversely proportional to the volume of the unit cell in the direct lattice.
5.   Show that reciprocal lattice to bcc lattice is fcc lattice.
6.   Find the reciprocal lattice to fcc lattice.
7.   Derive Bragg's law for X-ray diffraction
8.   What is Ewald's construction? Derive Bragg's law in reciprocal lattice.
9.   Obtain the vector form of Bragg's law using the concept of reciprocal lattice.
10.   What are Brillouin zones? Discuss the construction of first two Brillouin zones for a square lattice.
11.   Explain analysis of cubic crystal by powder method.

12. Explain diffraction of X-rays by crystal.

- **Long Answer Questions**

1. Describe Laue's method of X-ray diffraction.

2. Describe Rotating Crystal method of X-ray diffraction.

3. Describe powder method of X-ray diffraction.

4. What is reciprocal lattice? Derive relations for primitive translation vectors of the reciprocal lattice in terms of those of the direct lattice.

Unit II- Chapter I- Magnetic Properties of Matter

- **Multiple Choice Questions (Correct answer is shown in red color)**

1. Magnetic susceptibility χ is.....

A) dipole moment per unit volume

B) torque per unit area

C) magnetization for unit magnetic field intensity

D) none of these

2. One Bohr magneton is….

A) $9.27 \times 10^{-24} amp.m^2$ B) $2.27 \times 10^{-24} amp.m^2$

C) $6.67 \times 10^{-24} amp.m^2$ D) $9.27 \times 10^{-9} amp.m^2$

3. Magnetic susceptibility χ of a material is given by......

A) $\chi = \left(\mu_r - 1 \right)$ B) $\chi = \dfrac{M}{H}$ C) $\chi = \left(\dfrac{\mu - \mu_o}{\mu_o} \right)$ D) All
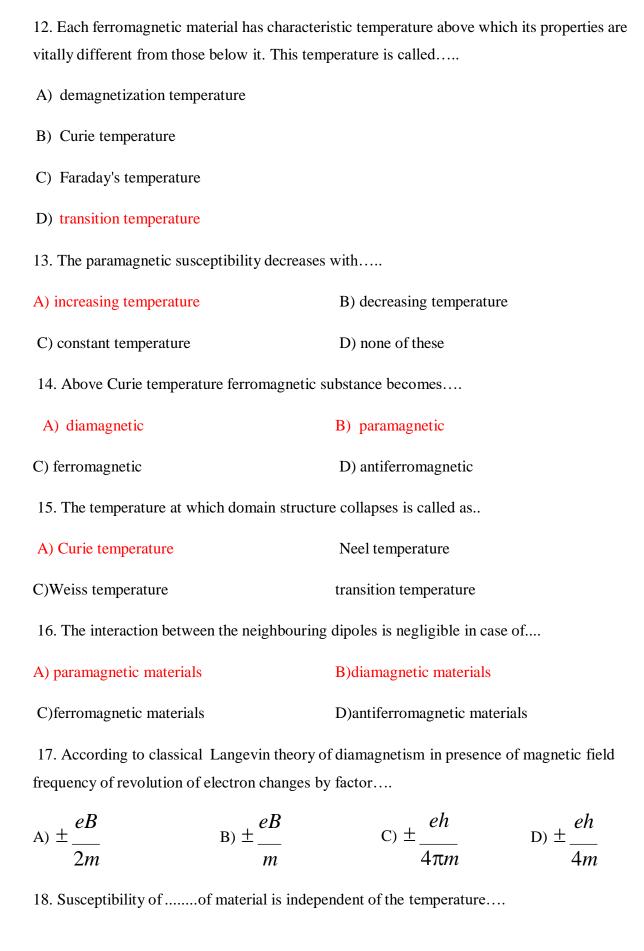
4. The magnetic materials in which permanent magnetic dipoles are already aligned due to bonding forces are known as.....

A) paramagnetic materials   B) ferromagnetic materials

C) diamagnetic materials   D) antiferromagnetic materials

5. In ferromagnetic material, susceptibility is......

A)very large and negative

 B)very small and negative

C) very large and positive

 D)very small and positive

6. Which of the following material does not have permanent magnetic dipole

 A) paramagnetic   B) diamagnetic

C) ferrimagnetic   D) antiferromagnetic

7. Diamagnetic material possesses…….

A) induced dipole moment

 B) permanent magnetic dipoles

C) no permanent magnetic dipoles

 D) none of these

8. The susceptibility of diamagnetic material is about......

A) 10^{-6} B) 10^{7} C) 10^{5} D) 10^{-5}

9. The Ferromagnetic Curie temperature of iron……

A) 922 K   B) 631 K   C) 1043K   D) 1428 K

10.Curie -Weiss law is

A) $\chi = \dfrac{C}{T}$ B) $\chi = \dfrac{C}{\theta}$ C) $\chi = \dfrac{C}{\theta - T}$ D) $\chi = \dfrac{C}{T - \theta}$

11. At Curie temperature, the spontaneous magnetization for ferromagnetic material is…….

A) ∞ B) 0   C) 1   D) -1

12. Each ferromagnetic material has characteristic temperature above which its properties are vitally different from those below it. This temperature is called…..

A) demagnetization temperature

B) Curie temperature

C) Faraday's temperature

D) transition temperature

13. The paramagnetic susceptibility decreases with…..

A) increasing temperature   B) decreasing temperature

C) constant temperature   D) none of these

14. Above Curie temperature ferromagnetic substance becomes….

A) diamagnetic   B) paramagnetic

C) ferromagnetic   D) antiferromagnetic

15. The temperature at which domain structure collapses is called as..

A) Curie temperature   Neel temperature

C)Weiss temperature   transition temperature

16. The interaction between the neighbouring dipoles is negligible in case of....

A) paramagnetic materials   B)diamagnetic materials

C)ferromagnetic materials   D)antiferromagnetic materials

17. According to classical Langevin theory of diamagnetism in presence of magnetic field frequency of revolution of electron changes by factor….

A) $\pm \dfrac{eB}{2m}$ B) $\pm \dfrac{eB}{m}$ C) $\pm \dfrac{eh}{4\pi m}$ D) $\pm \dfrac{eh}{4m}$

18. Susceptibility of ....of material is independent of the temperature….

A) diamagnetic   B) paramagnetic

C) ferromagnetic   D) ferrimagnetic

19. Curie law for paramagnetic material is..

A) $\chi = \dfrac{C}{\theta}$ B) $\chi = \dfrac{C}{T}$ C) $\chi = \dfrac{C}{\theta - T}$ D) $\chi = \dfrac{C}{T - \theta}$

20. Saturation magnetization in paramagnetic materials is observed at….

A) high temperature and high magnetic field

B) at high temperature and low magnetic field

C) low temperature and low magnetic field

D) low temperature and high magnetic field

21. The effective number of bar magnet on each P_{eff} is.....

A) $g\sqrt{(J+1)}$ B) $g\sqrt{J(J-1)}$ C) $g\sqrt{J(J+1)}$ D) gJ

22. Quantum theory of paramagnetism approaches to the classical Langevin theory of paramagnetism when…..

A) $J \rightarrow 0$ B) $J \rightarrow \infty$ C) $J = -\dfrac{1}{2}$ D) $J = \dfrac{1}{2}$

23. The Curie law of paramagnetism holds good for.

A) $\mu B >> kT$ B) $\mu B = kT$ C) $\mu B = \dfrac{1}{kT}$ D) $\mu B << kT$

24. Saturation magnetization in paramagnetism is Ms = ...

A) $N\mu$ B) $\dfrac{N}{\mu}$ C) $N\mu L(x)$ D) $N^2\mu$

25. .... Materials have large and positive value of susceptibility

  B) diamagnetic

B) paramagnetic

C) ferromagnetic

D) antiferromagnetic

26. The lagging intensity of magnetisation behind the magnetising field is called as

 A) hysteresis

B) Spontaneous magnetization

C) saturation magnetization

D) wall displacement

27. The value of magnetisation which remains even after magnetising field is reduced to zero

 A) hysteresis

B) retentivity

C) coercivity

D) saturation magnetization

28. Energy loss during hystersis is the area of

A) $\chi - T$ B) $B - H$ C) $M - B$ D) $\chi - H$

29. The magnetic field B_E is proportional

  A) Magnetization of domain

B) Applied magnetic field

  C) magnetic induction

D) area off domain

30. The susceptibility of diamagnetic materials is........... to the atomic number.

A) inversely proportional

B) directly proportional

C) equal

D) independent

- **Short Answer Questions**

1. State and explain Curie law in paramagnetism.
2. Explain how and why are the ferromagnetic domains formed?
3. Draw a typical B-H curve and describe the different magnetization processes.
4. Explain the hysteresis in ferromagnetic material. What is retaintivity and coercivity?
5. Show that energy loss in hysteresis is the area of B-H curve.
6. Why diamagnetic materials have negative susceptibility?

7. Explain the following terms briefly. (a) hysteresis, (b) coercivity, (c) remanence
8. Distinguish between diamagnetic, paramagnetic and ferromagnetic materials.
9. 8. Derive Curie Weiss law.

- **Long Answer Questions**
1. Explain classical Langevin's theory of diamagnetism and obtain an expression for diamagnetic susceptibility.
2. Explain classical Langevin's theory of paramagnetism. Obtain an expression for paramagnetic susceptibility.
3 Obtain an expression for diamagnetic susceptibility using the Langevin's theory. 6. Given an account of quantum theory of paramagnetism and discuss low and high temperature cases.
4 Give an account of Weiss theory of ferromagnetism. Discuss the temperature variation of saturation magnetization.
5 Explain the cause of hysteresis phenomenon in the ferromagnetic material. What does area of B-H loop signify?

Unit II- Chapter II- Band Theory of Solids

- **Multiple Choice Questions (Correct answer is shown in red color)**

1. The density of electron states is proportional to ....

A) E   B) $1/_E$ C) $E^{1/2}$ D) $E^{-1/2}$

2. In Kronig-Penny model period of one dimensional periodic potential is….

A) a   B) a+b   C) a-b   D) b

3. According to Kronig-Penny model width of allowed energy band with increase inenergy.

A) increases   B)decreases

C)remains constant   D)either increase or decrease

4. In Kronig-Penny model if P→ 0, then it leads to…

A) tight binding model   B) intermediate model

C) free electron model   D) can't say anything

5. The first Brillouin zone lies between the values of k =

A) $-\frac{\pi}{a} \, to + \frac{\pi}{a}$ B) $0 \, to + \frac{\pi}{a}$ C) $-\frac{\pi}{a} \, to \, 0$ D) $-\frac{\pi}{2a} \, to + \frac{\pi}{2a}$

6. The velocity of an electron in one dimensional periodic potential is v.

A) $\frac{dE}{dK}$ B) $\frac{1}{\hbar}\frac{dE}{dK}$ C) $\frac{1}{\hbar}\frac{d^2E}{dK^2}$ D) $\frac{d^2E}{dK^2}$

7. The effective mass of an electron is m*=

A) $\frac{d^2E}{dk^2}$ B) $\frac{\frac{d^2E}{dK^2}}{\hbar^2}$ C) $\frac{1}{\hbar}\frac{dE}{dK}$ D) $\frac{\hbar^2}{\frac{d^2E}{dK^2}}$

8. In lower half of energy band of E-k curve the effective mass of an electron is

A) zero   B) infinite   C) negative   D) positive

9. Band gap energy of silicon is.. …eV

A) 1.12   B) 0.72   C) 7   D) 0.5

10. Band gap energy of germanium is.. … eV

A) 1.12   B) 0.72   C) 7   D) 0.5

11.In semiconductors forbidden energy gap Eg is of the order of ...... ev

A) 0   B) 1   C) 7   D) ∞

12. The conduction band of insulators is…….

A) completely empty   B) completely filled

C) constant temperature   D) none of these

13. The conductivity of the semiconductor........with increase in temperature.

A) decreases   B) increases

C) remains constant   D) either increase or decrease

14. In Hall effect if the current is flowing due to motion of holes, then Hall coefficient is..........

A) positive   B) negative

C) either positive or negative   D) zero

15. The Hall coefficient of the n-type semiconductor material is given as R_H

A) $-\left[\dfrac{3\pi}{8} \cdot \dfrac{1}{\rho}\right]$ B) $+\left[\dfrac{3\pi}{8} \cdot \dfrac{1}{\rho}\right]$ C) $-\dfrac{1}{\rho}$ D) $+\dfrac{1}{\rho}$

16. In Hall effect, if the current flowing through the material is in x-direction, applied magnetic field is in z-direction then Hall voltage will be produced in…..

A) x-direction   B) y-direction

C) z-direction   D) x and y direction

17. The effective number of free electrons that is $N_{eff} = 0$ for…..

A) metals   B) metals and semiconductors

C) semiconductors   D) insulators

- **Short Answer Questions**

1. Explain the concept of density of state.
2. State Bloch function.
3. Write a note on Effective mass of an electron.
4. Define valence band, conduction band and forbidden energy gap.

- **Long Answer Questions**

1. Discuss the formation of allowed and forbidden energy bands on the basis of Kronig-Penny model.
2. Obtain an expression for velocity of an electron as predicted by band theory. Hence explain variation of velocity of electrons with wave vector.
3. Show that effective mass of an electron is inversely proportional to $\dfrac{d^2}{dK^2}$. Explain its significance.
4. Obtain an expression for effective number of free electrons in an energy band
5. Define Hall Effect. Obtain an expression for Hall voltage and Hall coefficient.
6. Explain variation of effective mass of an electron with a wave vector.
7. Explain how energy gap is formed between allowed energy bands.
8. Distinguish between metal, semiconductor and insulator on the basis of their energy band structure.