1. Consider the following statements about p-n junctions:

1) p-n junction behaves as a capacitor when forward biased.

2) p-n junction has p and n types semiconductors with depletion layer in between.

3) p-n junction has a wider depletion layer as compared to a Zener diode.

Which of these statements are correct?

A. 1, 2 and 3 B. 1 and 2

C. 2 and 3 D. 1 and 3

Ans. C

Sol. PN juction also behave as a caacitor when reverse biased but value of capacitor is less. Zeneer diode is heavily doed so thin depletion layer.

2. Consider the following statements

Magnetic susceptibility

1) depends on the nature of the magnetic material

2) is not dependent on the relative permeability of the medium

3) cannot be determined by measuring the force susceptibility depends on exerted on a magnetic material when placed in a magnetic field.

4) can be determined from M-H curve.

Which of these statements is/are correct ?

A. 1, 2, 3 and 4 B. 1 only

C. 1 and 4 only D. 2 only

Ans. C

Sol. Magnetic susceptibility depends on

1) Nature of material

2) Permeability of medium

3.What is the commercial name of Kevlar?

A. Glass fiber B. Carbon fiber

C. Aramid fibers D. Cermet's

Ans. C

Sol. Aramid fibers is the commercial name of Kevlar

4. The resistivity of hard drawn copper at 20 °C is $1.9\times10^{-6}\Omega cm.$ The resistivity of annealed copper compared to hard drawn copper is

A. lesser B. slightly larger

C. same D. much larger

Ans. A

Sol. Localised strains produced by mechanical treatment of copper increases its resistivity. Hence, a hard drawn copper wire has higher resistivity than annealed copper. ie. the resistivity of annealed copper compared to hard drawn copper is lesser.

5. The principle used in the designing of thermocouple is:

A. Skin effect B. Seeback effect

C. Peltier effect D. Hall effect

Ans. B

Sol. When two dissimilar metals are joined at their ends and kept at different temperatures then an emf is developed across the junctions, this effect is called Seeback effect. This principle is used in the designing of thermocouple.

6. Which defect is explained by pressing of crystal structure?

A. vacancy
B. interstitial
C. edge dislocation
D. grain boundary

Ans. D

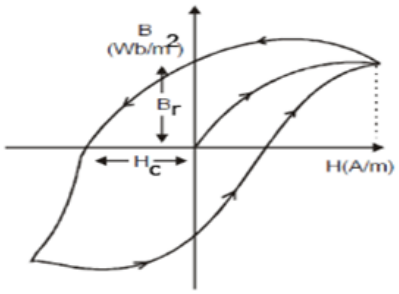
Sol. Among the following defects found in metal structure, grain boundary defect shows pressing of crystal structure against each other in two regions having different orientations.

7. The magnetic field required to reduce the residual magnetization to zero is called

A. retentivity
B. coercivity
C. hysteresis
D. saturation

Ans. B

Sol. The magnetic field required to reduce the residual magnetization to zero is called 'coercivity' This magnetic field is applied externally in the opposite direction.



In the B-H curve shown above, B_r is residual magnetization and H_C is coercivity.

8. Consider the following statements :

Secondary (or Molecular) bonds are

1) The attraction forces exist between atoms or molecules.
2) Stronger than primary bonds.
3) Can be divided as electrostatic bonds.
4) Weaker than primary bonds.

Which of the above statements is/are correct?

A. 1 only
B. 2 and 3 only
C. 1 and 4 only
D. 1, 2, 3 and 4

Ans. C

Sol. Secondary or molecular bonds are either iondipole interaction, dipole-dipole interaction or vanderwalls are weaker than primary bonds (ionic, covalent).

9. Paramagnetic susceptibility of a material

A. Increase linearly with temperature
B. Decrease linearly with temperature
C. Increase linearly with $\left(\frac{1}{T}\right)$
D. Decrease linearly with $\left(\frac{1}{T}\right)$

Ans. C

Sol. For paramagnetic material,

Magnetic susceptibility

$$\chi_m = \frac{C}{T}$$

θ is curie temperature

$$\chi_m \propto \frac{1}{T}$$

So increase with 1/T

10. Match List-Iwith List-II and select the correct answer using the code given below the lists:

List-I

A) Porcelain

B) Steatite

C) Mica

D) Rutile

List-II

1) Used for high frequency applications

2) Used in capacitors to be operated at high frequencies

3) Used for insulators

4) Releases water when heated

A. A-3; B-1; C-4; D-2

B. A-1; B-2; C-4; D-3

C. A-3; B-4; C-2; D-1

D. A-1; B-4; C-2; D-3

Ans. C

Sol. Porcelain: is a ceramic material and used for insulator.

Mica: used in capacitors to be operated at high frequencies. So, option (c) is correct.

11. Magnetostriction is a phenomenon of

A. generation of electricity in ferro-magnetic material

B. generation of magnetism in conductors

C. change in permeability of ferrro-magnetic materials during magnetization

D. change in physical dimensions ferro-magnetic materials during magnetization

Ans. D

Sol. Magnetostriction is phenomenon of charge in dimension of ferromagnetic material due to magnetization Reverse of this effect is called as vellori effect.

12. When BCC iron is heated it changed to FCC iron resulting in

A. expansion in volume of unit cell

B. contraction in volume of unit cell

C. no change in volume

D. Damage of material

Ans. B

Sol. ⇒ As we know that atomic packing fraction is inversely proportional to volume of unit cell.

⇒ APF of BCC = 68%

⇒ APF of FCC = 74%

⇒ APF of FCC ↑ so volume of unit cell ↓

13. Which among the following platinum metals are not used in electrical contacts?

i. Osmium

ii. Iridium

iii. Palladium

iv. Ruthenium

A. both i and ii
B. both ii and iii
C. both iii and iv
D. both i and iv

Ans. A

Sol. Osmium is used as powder and in alloying component. Iridium powder is used as alloying component in limited amounts as sheet. Palladium are used as Sheet, strip, tubing, wire, rivets and coatings. Ruthenium powder is used in sheet form, coatings and wires as alloying component.

14. Which among the following metals has maximum Curie temperature?

A. Nickel
B. Iron
C. Gadolinium
D. Dysprosium

Ans. B

Sol. Among the following metals, Iron has maximum curie temperature of around 1043 k. Nickel is another amorphous transition metal with curie temperature 627 k. Gadolinium is silvery-white, highly ductile rare earth metal with curie temperature of 292 k while Dysprosium has curie temperature of 88 k.

15. Neel temperature is associated with

A. Ferromagnetic materials
B. Anti-ferromagnetic materials
C. Ferrimagnetic materials
D. Diamagnetic materials

Ans. B

Sol. Anti-ferromagnetic materials are anti-ferro up to a critical temperature called Neel temperature. Above Neel temperature they behave like paramagnetic.

16. The total magnetic moment

1) is called saturation magnetization.

2) depends on the number of magnetic dipoles per unit volume, the instant electric current and the area of the current loop.

Which of the above statements is/are correct?

A. 1 only
B. 2 only
C. Both 1 and 2
D. Neither 1 nor 2

Ans. B

Sol. Total magnetic moment is the sum of the moments of all the magnetic dipoles and the atomic magnetic moments due to orbital motion of electrons.

Saturation magnetization is the magnetic moment per unit volume of the specimen.

The total magnetic moment depends on the number of magnetic dipoles per unit volume, the instant electric current and the area of the current loop.

17. Which of the following statement are true for metal?

(i) Valence band overlaps with conduction bands.

(ii) The gap between valence band and conduction band is negligible.

(iii) The gap between valence band and conduction band cannot be determined.

(iv) Valence band may remain partially filled.

A. (i), (ii)
B. (i), (ii), (iii)
C. (i), (ii), (iv)
D. (ii), (iii), (iv)

Ans. C

Sol. Statements (i), (ii), (iv) are correct

18. The Fermi level in an n-type semi-conductor at zero degree kelvin lies

A. Below the donor level

B. Half-way between the conduction band and the donor level

C. Half-way between the conduction band and the valence level

D. Close to the valence band

Ans. B

Sol.

Since in N-type donar type impurity added to intrinsic semiconductor so that initially ND state in conduction Band will be filled.

EF must be closer to the conduction band when most of the energy state in the conduction band are filled by the donar electrons & very few hole exist in Valance band.

19.In general, for a superconductor, which of the following statements is true?

A. A superconductor is a perfect paramagnetic material with the magnetic susceptibility equals to positive unity

B. A superconductor is a perfect diamagneticmaterial with the magnetic susceptibility equals to negative one

C. A superconductor is a perfect ferromagnetic material with the magnetic susceptibility equals to positive one

D. A superconductor is a perfect piezoelectric material with the magnetic susceptibility equals to negative unity

Ans. B

Sol.

$$B = \mu_0(H+M)$$

In case of superconductors

$$B = 0,\ H = -M$$
$$\Rightarrow XH = H$$
$$\Rightarrow X = -L$$

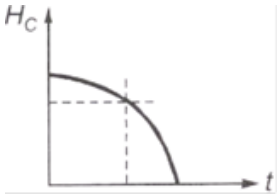
So, material is diamagnetic.

20. In a superconductor, if the temperature is decrease below is critical temperature, the value of critical magnetic field will

A. Increase
B. Decrease
C. Not change
D. Increase or decrease depending on the superconductor material

Ans. A

Sol.



21. The percentage composition of oxygen in electrolytic tough pitch copper will be around:

A. 10.25 to 25%
B. 8.5 to 12%
C. 2.5 to 5.0%
D. 0.02 to 0.04%

Ans. D

Sol. The main grade of copper which is used for electrical applications is electrolytic tough pitch copper. This is the pure copper with 99.90% purity and has electrical conductivity of 101% IACS. Such copper contains small percentage of oxygen of around 0.02% to 0.04%.

22. Consider the following statement regarding Teflon

1) It is formed by addition polymerization.
2) It is hydrophobic is nature.
3) It is used as non-stick coating for cookware.

Which of the above statements are true?

A. 1 and 2
B. 2 and 3
C. 1 and 3
D. 1, 2 and 3

Ans. D

Sol. Teflon is a brand name for polytetrafluoroethylene (PTEE) which is formed by addition of polymerization.

PTEE is hydrophobic, neither water nor water containing substances can wet PTEE

It has very low coefficient of friction, so it is also used as lubricant.

It is used as non-stick coating for pans and other cookware.

23. **Statement (I):**

The inorganic materials are used to manufacture suspension insulators for high-volrage overhead lines and bushings on high-voltage transformers and switchgear.

Statement (II):

The ceramic and glass materials are formed into a series of flanged discs to decrease the creepage distance along the surface of the complete insulator.

A. Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).

B. Both Statement (I) and Statement (II) are individually true, but Statement (II) is **not** the correct explanation of Statement (I).

C. Statement (I) is true, but Statement (II) is false.

D. Statement (I) is false, but Statement (II) is true.

Ans. C

Sol. The ceramic and glass materials are formed into a series of flanged discs to increase the creepage distance (not to decrease it).

24. In Face-Centred Cubic structure (FCC), what number of atoms is present in each unit cell?

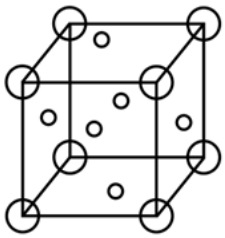
A. 18 B. 16

C. 14 D. 12

Ans. C

Sol.

Face-centred cubic structure (FCC)



In FCC structure, eight atoms are present in all eight corners of the unit cell and six atoms are present in centre of all six faces of unit cell.

So, total number of atoms in an unit cell

= 8 + 6 = 14

Note : Effective numbers of atoms present in an unit cell

$$= \left(\frac{1}{8} \times 8\right) + \left(\frac{1}{2} \times 6\right) = 1 + 3 = 4$$

25. For intrinsic gallium arsenide, conductivity at room temperature is $\mathbf{10^{-6}(\Omega\text{-}m)^{-1}}$. the electron and hole mobilities are, respectively **0.85** and **0.04 $\mathbf{m^2/V\text{-}s}$**. The intrinsic carrier concentration at room temperature is

A. 7.0×10^{10} m^{-3} B. 7.0×10^{12} m^{-3}

C. 7.0×10^{13} m^{-3} D. 8.0×10^{14} m^{-3}

Ans. B

Sol. $\sigma = 10^{-6}(\Omega\text{-m})^{-1}$

$[\mu_n + \mu_p] = [0.85+0.04] = 0.89$; $q = 1.6 \times 10^{-19}$

$\sigma = qn_i [\mu_n + \mu_p]$

$n_i = \sigma / [\mu_n + \mu_p] = 7.0 \times 10^{12}\ m^{-3}$

26. Which of the following exhibit electric hysteresis?

A. Ferromagnetic materials only

B. Ferroelectric materials only

C. Ferrielectric materials only

D. Both ferroelectric and ferrielectric materials

Ans. B

Sol. There is no ferrielectric material and ferroelectric exhibit hysteresis, as like ferromagnetic and ferromagnetic.

27. Consider the following statements:

1) Nano means 10^{-9} so that nano materials have an order of dimension higher than the size of atom and come in the form of rods, tubes, spheres or even thin sheets/films

2) Nano materials have enchanced of changed structural property

3) Nano elements lend themselves to mechanical processing like rolling, twisting, positioning

4) Nano elements show important electrical, magnetic and optical characteristics that are useful in electrical inductry

Which of the above statements are correct?

A. 1, 2 and 3 only

B. 1, 2, 3 and 4

C. 3 and 4 only

D. 1, 2 and 4 only

Ans. B

Sol. All the statements are correct.

28. A superconductor may be used for generating

A. Voltage

B. Pressure

C. Temperature

D. Magnetic field

Ans. D

Sol. A superconductor may be used for generation of magnetic field.

29. Which one of the following is the Fermi function f(E)?

A. $\frac{1}{1+e^{(E-E_F)/(kT)}}$

B. $\frac{1}{1-e^{(E-E_F)/(kT)}}$

C. $\frac{1}{1+e^{(E_F-E)/(kT)}}$

D. $\frac{1}{1-e^{(E_F-E)/(kT)}}$

Ans. A

Sol. Fermi function i.e. probability of finding a e^- in a available energy state E is given by

$$f(E) = \frac{1}{1 + \exp[(E - E_F)/KT]}$$

$K \rightarrow$ Boltzman constant $\left(\frac{ev}{k}\right)$

T $\rightarrow$ Temp. in Kelvin

$E_F \rightarrow$ Fermi level in eV

30. An iron rod of $10^{-3}m^3$ volume and relative permeability of 1150 is placed inside a long solenoid wound with 5 turns/cm. If a current of 0.5 A is allowed to pass through the solenoid, the magnetic moment of the rod is

A. 2.87×10^4 A .m^2 B. 2.87×10^3 A .m^2

C. 2.87×10^2 A .m^2 D. 2.87×10^1 A .m^2

Ans. C

Sol. Since, $\chi_m = \frac{M}{H}$

$\Rightarrow \mu_r - 1 = \frac{M}{H}$

$\Rightarrow M = (\mu_r - 1)H = (\mu_r - 1)ni$

$= (1150 - 1) \times \frac{5}{10^{-2}} \times 0.5$

$= 1149 \times 5 \times 50$ A / m

Now,

Magnetic moment = Magnetisation × Volume

⇒ m = M × V

= 1149 × 5 × 50 × 10^{-3}

= 28725 × 10^{-2} A.m^2

31. Soft magnetic materials should have

A. Large saturation magnetization and large permeability

B. Low saturation magnetization and large permeability

C. Large saturation magnetization and low permeability

D. Low saturation magnetization and low permeability

Ans. A

Sol. Soft magnetic material would have zero coercivity (Hc), a very large saturation magnetization, zero remanent magnetization (Br), zero hysteresis loss.

32. If (n) is lattice points per unit cell of the cubic system, (N) and (M) are the Avogadro's number and atomic weight, respectively, and (ρ) is the density of the element, then the lattice constant A . is

A. $\left(\frac{M\rho}{nM}\right)^{\frac{1}{3}}$

B. $\left(\frac{NM}{n\rho}\right)^{\frac{1}{3}}$

C. $\left(\frac{nM}{N\rho}\right)^{\frac{1}{3}}$

D. $\left(\frac{N\rho}{nM}\right)^{\frac{1}{3}}$

Ans. C

Sol.

$$\text{Density } (\rho) = \frac{n \times M}{a^3 \times N_A}$$

$$\therefore a^3 = \frac{nM}{\rho N}$$

$$\therefore a = \left(\frac{nM}{\rho N}\right)^{\frac{1}{3}}$$

33. If μ_I and μ_p represent the impurity scattering and phonon scattering limited values of mobility of a semiconductor, the overall mobility would be

A. μ_I and μ_p

B. $\mu_I + \mu_p/2$

C. $\sqrt{\mu_I}$

D. $\frac{\mu_l \mu_p}{\mu_l + \mu_p}$

Ans. D

Sol. Overall mobility

$$= \frac{\mu_l \mu_p}{\mu_l + \mu_p}$$

34. Consider the following statements:

In a Hall effect experiment, the sign of Hall voltage will change if

1) Direction of applied is changed.

2) Direction of applied mangnetic field is changed.

3) Direction of both applied electric and magnetic fields are changed.

4) Direction of current is changed.

Which of these statements is/are correct?

A. 1, 2 and 3

B. 3 only

C. 1, 2 and 4

D. 3 and 4

Ans. C

Sol. Hall voltage (incduce voltage) given by

$$V_H = \frac{BI}{\rho W}$$

$\rho \longrightarrow$ Charge density

W $\longrightarrow$ width of sample

B $\longrightarrow$ Magnetic field applied

I $\longrightarrow$ Currnet flowig through sample

So if direction of B is changed sign of V_H will be changed and if direction of I is changed keeping B as it is the direction of V_H will be changed.

35. The magnetic moments of diamagnetic materials are mainly due to

A. Electron spin angular momentum
B. Nuclear spin angular momentum
C. Orbital angular momentum of the electrons
D. Centrifugal angular momentum

Ans. C

Sol. The magnetic moments of diamagnetic materials are mainly due to orbital angular momentum of the electrons.

Without the presence of an external applied magnetic field (H) diamagnetic materials have no net magnetic moment. As an external magnetic field is applied to a diamagnetic natural, the spinning electrons experience a motion, producing electrical current and hence magnetization.

36. Match elements with their correct crystal structure?

A. Titanium	1. Body-centered cubic
B. Gamma iron	2. Hexagonal closed packed
C. Sulfur	3. Face Centered Orthorhombic
D. Vanadium	4. Face-centered cubic

A. A-3, B-2, C-4, D-1
B. A-4, B-1, C-3, D-2
C. A-2, B-4, C-3, D-1
D. A-3, B-1, C-4, D-2

Ans. C

Sol. Sulfur is a Face Centered Orthorhombic structure, Vanadium is Body Centered Cubic structure, Titanium is Hexagonal Close Packing structural element while Gamma iron is face-centered cubic structure.

37. Which of the following machine used for the preparation of nano particles of alumina –

A. Grinding machine
B. Welding machine
C. Vending machine
D. Attrition mill

Ans. D

Sol. ⇒ Attrition mill is used for preparation of nano particles.

38. What is the packing fraction of a BCC (body-centered cubic) unit cell?

A. $\frac{\sqrt{3}\pi}{16}$
B. $\frac{\sqrt{3}\pi}{8}$
C. $\frac{\sqrt{3}\pi}{12}$
D. $\frac{\sqrt{2}\pi}{8}$

Ans. B

Sol. Packing fraction of BCC

$$= \frac{\sqrt{3}\pi}{8} = 0.68.$$

39. High permittivity ceramic is used for capacitors of

A. A few pF to a few hundred pF
B. A few μF to a few hundred μF
C. A few nF to a few hundred nF
D. A few mF to a few hundred mF

Ans. B

Sol. High permittivity ceramic is used for capacitors of a few μF to few hundred μF

- These *ceramic* materials are sintered in an atmosphere of low oxygen to yield a *high* resistivity (10^{12} Ω-cm).
- A *high dielectric constant* **(7,000~9,000)**, and a low dissipation factor of less than **2.5%**.
- The monolithic *capacitors* of these *ceramics* with nickel electrode are as reliable as those with precise metal electrode.

40. What is a material with equal, anti-parallel atomic magnetic moments, known as?

A. Ferrimagnetic
B. Ferrite
C. Ferromagnetic
D. Anti-ferromagnetic

Ans. D

Sol. Dipole moment for antiferromagnetic

equal and antiparallel.

41. Consider the following statements: Characteristics of a good insulating material are

1) Should give uniform electric and thermal properties.
2) High permittivity.
3) Low dissipation factor.
4) Low insulating resistance.

Which of the above statements are correct?

A. 1 and 4 only
B. 2 and 4 only
C. 1 and 3 only
D. 1, 2, 3 and 4

Ans. C

Sol. Good insulating materials possess high insulating resistance. So, (c) is correct.

42. Behaviour of conductors, semicondurctors and insulators is explained on the basis of

A. atomic structure
B. molecular structure
C. energy band structure
D. all of the above

Ans. C

Sol. Based on energy band structure conductors. Semiconductor and insulator is classified.

43. Defects in ionic crystals are:

A. Point defects
B. Line defects
C. Planar defects
D. Bulk defects

Ans. A

Sol. Point defects occur only around single lattice point that involves extra or missing atoms. Many point defects, occurs in ionic crystals known as centers where vacancy in ionic solids is luminescence center which is known as F-center.

44. The hardness of nanomaterial increases linearly with:

A. increase of grain size
B. decrease of particle size
C. decrease of strength
D. increase in strength

Ans. B

Sol. Generally, hardness of metal increases linearly with increase of grain size, but in case of nano-material, the hardness of the nano-metal increases linearly with decrease in particle size.

45. The Hall voltage, V_H, for a thin copper plate of 0.1 mm carrying a current of 100 A with the flux density in the z-direction, B_z = 1 Wb/m^2 and the Hall coefficient, $R_H = 7.4 \times 10^{-11}$ m^3/ C, is

A. $148\,\mu V$
B. $111\,\mu V$
C. $74\,\mu V$
D. $37\,\mu V$

Ans. C

Sol.

$$\text{Hall voltage, } V_H = R_H \frac{IB}{t}$$

where, R_H is Hall coefficient,

I is current flowing in the material, B is applied magnetic flux density, and t is thickness of material.

So,

$$V_H = 7.4\times10^{-11} \times \frac{100\times1}{0.1\times10^{-3}} volt$$

$$= 7.4\times10^{-5}\, volt$$

$$= 74\,\mu V.$$

46. Choose the correct option related to Bearing metal?

1) It is also called Babbitt metal.
2) It reduces the bearing resistance.
3) It provides anti-friction.

A. 1 & 2
B. 2 & 3
C. 1 & 3
D. 1, 2 & 3

Ans. C

Sol. In order to provide the bearing surface, Babbitt metal also known as bearing metal is used. Its main role is to provide the anti-friction properties 90% Sn, 10% Cu is one popular bearing metal used.

47. Which effect is the converse of Peltier effect?

A. Seebeck effect
B. Thomson effect
C. Hall effect
D. Joule effect

Ans. A

Sol. Seebeck effect is converse of peltier effect.

48. Pearlite in iron-carbon system is_____of ferrite and cementite at room temperature.

A. phase
B. mechanical mixture
C. eutectic mixture
D. none of above

Ans. B

Sol. Since the chemical separation occurs entirely within crystalline solids, the resultant structure is a five mechanical mixture of ferrite & cementite. Pearlite is a eutectoid mixture of ferrite and cementite.

49. Which among the following magnetic materials has the highest energy-product to make it a permanent magnet?

A. Alnico
B. Ferrite
C. Samarium cobalt
D. Cobalt-Iron-alloy

Ans. A

Sol. In magnetic materials Alnico having maximum energy product used for making permanent magnet.

50. What type of defect causes F-centers in a crystal?

A. Stoichiometric defect
B. Metal excess defect due to anion vacancies
C. Metal excess defect due to extra cations
D. Frenkel defect

Ans. B

Sol. An F-center, FARBE center or color center (from the original German Farbzentrum; Farbe means color, and zentrum center) is a type of crystallographic defect in which an anionic vacancy in a crystal is filled by one or more unpaired electrons. Electrons in such a vacancy tend to absorb light in the visible spectrum such that a material that is usually transparent becomes colored. This is used to identify many compounds, especially zinc oxide (yellow).

51. What is the general name for the class of structures made of rolled up carbon lattices?

A. Nanorods
B. Nanosheets
C. Fullerrods
D. Nanotubes

Ans. D

Sol. Carbon nanotubes (CNT) have the structure which consists of single sheet of graphite rolled into a tube and ends of CNT are capped with C_{60} hemispheres.

52. Orbital magnetic moment of an electron, in an atom, is of the order of

A. 0.1 Bohr magneton
B. 1.0 Bohr magneton
C. 10 Bohr magneton
D. 100 Bohr magneton

Ans. B

Sol. The net magnetic moment for an atom containing several atoms is basically net sum of these two contributions.

$$\mu_{net} = \mu_{orbit}^{net} + \mu_{spin}^{net}$$

And net magnetic moments of electrons are of the order of 1.0 Bohr magneton.

53. Which material possesses the following properties?

1) Shining white color with lustre

2) Soft, malleable and can be drawn into wires

3) Poor in conductivity and tensile strength

4) Used in making alloys with lead and copper

5) Used for fuses and cable sheathing

A. Silver

B. Tin

C. Nickel

D. Aluminium

Ans. C

Sol. The properties of the materials are:

1) Silver:

• Silver is lustrous

• Silver is soft

• Ductile and malleable metal

• Does not oxidize in air

2) Tin:

• Tin is soft

• Silvery white metal

• Does not oxidize in air and resists corrosion

3) Nickel:

• Shining white color with lustre

• Soft, malleable and can be drawn into wires

• Poor in conductivity and tensile strength

• Used in making alloys with lead and copper

• Used for fuses and cable sheathing

4) Aluminium:

• Light weight

• Corrosion resistance

• Good electrical and thermal conductivity

• Ductile and impermeable

54. Consider the following statements regarding characteristics of superconductors.

1. Resistivity of superconductors is zero.

2. Magnetic flux density in superconductors is zero.

3. The relative permeability of superconductors is zero.

4. Transition from superconducting to normal state under influence of magnetic fields is irreversible.

5. A superconductor has bound electron pairs within it.

Which of the following above statement is/are correct?

A. 1, 2, 3 and 4 only
B. 1, 2, 3 and 5 only
C. 1, 4 and 5 only
D. 1, 3, 4 and 5 only

Ans. B

Sol. For a superconductor,

$\chi_m = -1$

$\mu_r = 0$

55. In a piezoelectric crystal oscillator, the oscillation or tuning frequency is linearly proportional to the

A. mass of the crystal
B. square root of the mass of the crystal
C. square of the mass of the crystal
D. inverse of the square root of the mass of the crystal

Ans. D

Sol. Since,

Either series or parallel.

Piezoelectric in electrical equivalent in series

56. Which among the following material does not exhibit superconductivity?

i. gold
ii. silver
iii. lead
iv. aluminium

A. both i and ii
B. both ii and iii
C. both iii and iv
D. only iv

Ans. A

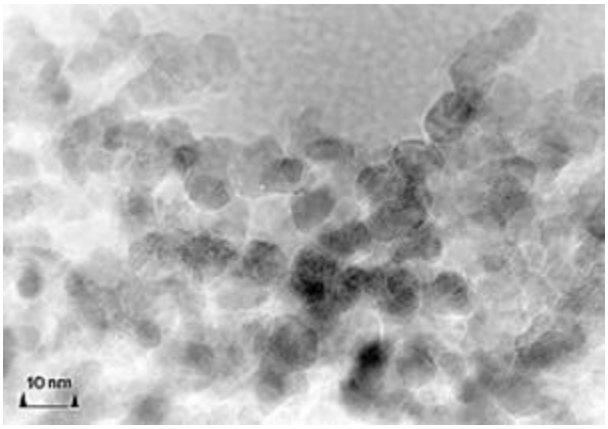
Sol. Superconductivity occurs in a wide variety of materials, including simple elements like tin and aluminium, various metallic alloys and some heavily-doped semiconductors. Superconductivity does not occur in noble metals like gold and silver, nor in pure samples of ferromagnetic metals.

57. The grain size of Fe_2O_3 nano-particle is:

A. 85 nm
B. 8 nm
C. 55 nm
D. 100nm

Ans. B

Sol. Nanomaterials are those that has grain size below 100 nm. In case of Fe_2O_3 nano-particles, the grain size of the particles is 8 nm.



58. The value of hall coefficient is positive for

1) Intrinsic semiconductor

2) Metals

3) P-type semiconductor

4) N-type semiconductor

A. 3 only

B. 1 and 3

C. 4 only

D. 1, 2 and 4

Ans. A

Sol. Majority charge carries in P-type semiconductor are holes. Therefore, it shows positive hall voltage coefficient. Metals and N-type semiconductor have electrons as majority charge carriers. Therefore, they show negative hall coefficient.

Intrinsic semiconductors show zero or small negative hall coefficient.

59. Consider the following statements :

The coercive force can be increased by

1) Adding Cobalt because it is ferro-magnetic material.

2) Adding Gold because it is a diamagnetic material.

3) Adding Super alloy

4) Space charge polarizing

Which of the above statements is/are correct?

A. 1, 2, 3 and 4

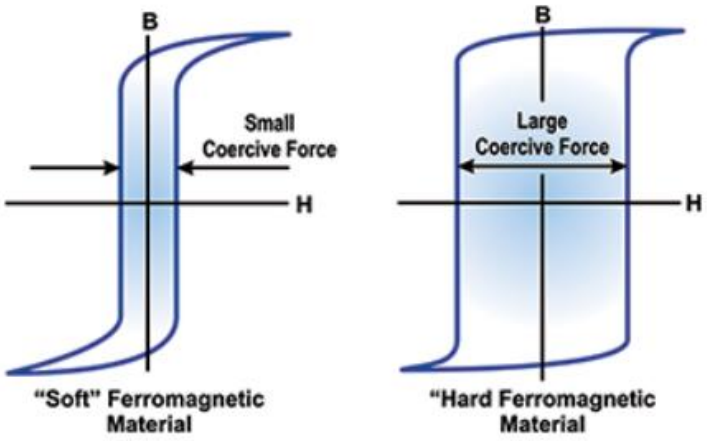
B. 1 only

C. 2 only

D. 1 and 3 only

Ans. B

Sol. **Hard Magnetic Material:** These magnetic materials retain their magnetism in absence of magnetic field and also known as permanent magnets. Alloys composed of iron, cobalt, and aluminum are generally acted as hard magnetic materials.



60. The current flow in a semiconductor is due to

1) Drift current

2) Displacement current

3) Diffusion current

A. 1, 2 and 3 B. 1 and 2 only

C. 1 and 3 only D. 2 and 3 only

Ans. C

Sol. In SC current flow due to frift and diffusion, displacement current flows in a dielectric or (conductor not perfect) under alternative field.

61. Match List-I with List-II and select the correct answer using the code givrn below the lists:

List-I

A) Antiferromagnetic

B) Ferrimagnetism

C) Diamagnetic

D) Ferromagnetic

List-II

1) Permanet magnetic dipoles

2) Dipoles interact or line up in parallel

3) Neighbouring magnetic moments are aligned anti-parallel with equal magnitudes

4) Neighbouring magnetic moments are aligned anti-parallel with unequal magnitudes

A. A-4; B-3; C-1; D-2 B. A-2; B-3; C-1; D-4

C. A-4; B-1; C-3; D-2 D. A-2; B-1; C-3; D-4

Sol. . Antiferromagnetic $\rightarrow \uparrow\downarrow\uparrow\downarrow$

. Ferromagnetic $\rightarrow \uparrow\uparrow\uparrow\uparrow$

. Ferrimagnetism $\rightarrow \uparrow\downarrow\uparrow\downarrow$

A B C D

3 4 2 1

62. From the following alloy wires, which pair option is known as Eutectic Alloy Fuse Wire?

A. lead-tin alloy
B. zinc-tin alloy
C. zinc-lead alloy
D. copper-tin alloy

Ans. A

Sol. For least current interruption, lead–tin alloy fuse wire been used in past. The most preferred lead – tin alloy for fuse wire has 37% lead and 63% tin. Such type of alloy fuse wire is Eutectic Alloy Fuse Wire having specific characteristics for which, it is preferred as fuse wire.

63. What is the line energy of dislocations on BCC iron ? The Burgers' vector in iron is of the $1/2 < 111 >$ type. The shear modulus of iron is $80 \cdot 2\mathrm{GN/m^2}$. Given that the lattice parameters of BCC iron, $a = 2 \cdot 87\text{Å}$

A. 1.40 × 10^{-9}J/m
B. 3.12 × 10^{-9}J/m
C. 2.476 × 10^{-9}J/m
D. 6.544 × 10^{-9}J/m

Ans. C

Sol.

Line energy $= \frac{ab^2}{2}$

$$b = \frac{a}{2} < 111 >$$

$$b = \frac{2.87}{2}\sqrt{3}\text{Å} = 2 \cdot 485\text{iÅ}$$

Line energy $= \frac{80.2\times10^9\times(2.485\times10^{-10})^2}{2}$ = 2.476 × 10^{-9} J/m

Hence option C

64. Which of the following may be the reason of imperfection in solids?

i) Thermal fluctuations
ii) Quick cooling from high temperature
iii) Deformation by forging
iv) Bombardment of high energy particles on atoms

A. i, ii, and iii
B. ii, iii, and iv
C. i, ii, and iv
D. i, ii, iii, and iv

Ans. D

Sol. All the given reasons are true for creating imperfections or vacancies in solids.
Depending on the vacancies and number of cations and anions displaced, imperfections are further categorized.

65. Materials in superconducting state have the property of

A. Absorbing magnetic field
B. Repelling magnetic field
C. Absorbing electric field
D. Repelling electric field

Ans. B

Sol. In superconductivity phase material show perfect diamagnetism i.e. $\mu_r = 0 \Rightarrow X_m = -1$ since X_m is –ve so they repel magnetic field.

66. If the domain walls in a magnetic materials can easily be moved, the material displays

A. high flux density

B. high permeability

C. Permanent magnetic behaviour

D. High permittivity

Ans. B

Sol. Domain walls in magnetic material can be easily moved in case of ferromagnetic materials which has high value of permeability.

67. A semiconductor differs from a conductor in that it has

A. Only one path for the free electrons in the valence band

B. Only one path for holes in the conduction band

C. Two paths followed by free electrons and holes, one an ordinary path in the conduction band and the other one an extraordinary path in the valence band, respectively

D. Two paths followed by free electrons and holed, one an extraordinary path in the conduction band and the other one an ordinary path in valence band, respectively

Ans. C

Sol. In a semiconductor, conduction band and valence band are separated by energy gap. At room temperature, some of the e^- in V.B. gains enough energy to overcome the energy gap and move into C.B. leaving behind an empty space in V.B which is called as Hole. An e^- in the V.B. may fill the hole, leaving another hole in its place. In this way, a hole appears to move.

In the presence of electric field e^- move in one direction and holes appear to move in the opposite direction and both contribute to conductivity of the material.

Hence, e^- moves in ordinary path in C.B. and holes move in extra-ordinary path in V.B.

68. Which of the following statements regarding superconducting materials correct, when a large number of metals become superconducting below a temperature?

1) The resistivity ρ of the superconductor is zero.

2) The magnetic flux density B vanishes through the substance.

3) Ferromagnetic and Antiferromagnetic metals and good examples of superconducting materials.

A. 1, 2 and 3

B. 1 and 3 only

C. 1 and 2 only

D. 2 and 3 only

Ans. C

Sol. 1) he resistivity ρ of the superconductor is zero.

2) he magnetic flux density B vanishes through the substance.

69. The magnetic field at which a super-conductor remains in its superconducting state at a temperature less than the transition temperature is

A. Zero

B. Greater than the critical field corresponding to the given temperature

C. Less than the critical field corresponding to the given temperature

D. Equal to the critical field corresponding to the transition temperature

Ans. C

Sol. If a magnetic field H is applied, the material remains supercoducting until a critical field H_C is reached such that for $H>H_C$, the material is in the normal state at a certain temperature as temperature require H will be less.

70. Annealing is:

A. Heat treatment process

B. Cutting process

C. Metal casting process

D. None of the above

Ans. A

Sol. The term annealing refers to a heat treatment in which a material is exposed to an elevated temperature for an extended time period and then slowly cooled. Ordinarily, annealing is carried out to (1) relieve stresses; (2) increase softness, ductility, and toughness; and/or (3) produce a specific microstructure. A variety of annealing heat treatments are possible; they are characterized by the changes that are induced, which many times are microstructural and are responsible for the alteration of the mechanical properties. Any annealing process consists of three stages: (1) heating to the desired temperature, (2) holding or "soaking" at that temperature, and (3) cooling, usually to room temperature.

71. Which of the following statement is not true for direct band gap semiconductor?

A. Carrier life time is shorter than indirect band gap semiconductor .

B. No need of recombination agent.

C. When electron makes transition from conduction band to valence band, then energy is released in the form of heat.

D. These are used in LED's.

Ans. C

Sol. During transition from conduction band to valence band, no change in momentum vector takes place and energy is released in the form of light.

72. A permeable substance is one

A. Which is strong magnetic

B. Which is weak magnetic

C. Which is good conductor

D. Through which magnetic lines of force can pass easily

Ans. D

Sol. A permeable substance means having a high value of permeability means through which magnetic lines of force can pass easily.

73. **Assertion (A):** Ionic bonds and covalent bonds are higher than metallic bonds.
Reason (R): Ionic and covalent bonds are generally lower than other primary bonds.
A. both A and R are true and R is the correct explanation of A
B. both A and R are true but R is not a correct explanation of A
C. A is true but R is false
D. A is false but R is true

Ans. C

Sol.

- In **covalent bonding**, the electrons are shared between the two atoms in question. Appears in **non-metals** such as those that fall after the group four(included).
- Ionic bonding is when there is a **full transfer of electrons from one atom to the next**. This results in formation of **oppositely charged ions which attract each othe**r. Common between metals and non-metals.
- A **metallic bond** has valence electrons free to move throughout the structure, leaving behind positive metal cations - this makes the metal malleable and conductive. They are formed by the attraction of a metallic cation with a mobile electron.

Ionic bonds are formed due to **electrostatic attraction** between two cation and anion whereas **covalent bonds** are the result of **electron cloud overlap** between two atom.
Now the cloud overlap's dissociation energy is greater than electrostatic attraction's dissociation energy
so covalent bonds are relatively more stronger.
Ionic and metallic bonds are weaker than **covalent bonds**.

74. When an alternating voltage of a given frequency is applied to a dielectric material, dissipation of energy occurs due to
1) Continual change in the orbital paths of the electrons in the atomic structure.
2) A small conduction current through the dielectric
3) Eddy currents Which of the above statements are correct?
A. 1, 2 and 3
B. 1 and 2 only
C. 1 and 3 only
D. 2 and 3 only

Ans. B

Sol. Â When an alternating voltage is applied to a dielectric material, dissipation of energy occurs due to movement or, rotation of atoms or, molecules in an alternating electric field.
Â However, the conduction current in a dielectric is, in fact, the main source of dielectric losses.

75. Einsteing relation is referred between
A. the diffusion constant and the mobility
B. the conduction and diffusion currents
C. the conduction and diffusion voltages
D. none of the above

Ans. A

Sol. The equation which relates the mobility μ (of electrons or holes) and the diffusion coefficient (of electrons D_n or holes D_p) is known as Einstein Relationship.

$$\frac{D_p}{\mu_p} = \frac{D_n}{\mu_n} = V_T$$

Where,

D_p = Diffusion coefficient of holes

D_n = Diffusion coefficient of electrons

μ_p = Mobility of holes

μ_n = Mobility of electrons

V_T is called voltage equivalent of temperature and it can be expressed as

$V_T = KT/q = T/11600$

V_T = 26 mV at 300 K

76. Match List-I with List-II and select the correct answer using the code given below the lists:

List-I

A) Carbon (Diamond)

B) Silicon

C) Tin (Grey)

D) Lead

List-II

1) Conducting

2) Semiconducting

3) Insulating

A. A-3; B-2; C-1; D-1

B. A-1; B-2; C-1; D-3

C. A-3; B-1; C-2; D-1

D. A-1; B-1; C-2; D-3

Ans. A

Sol. In the given list Tin (grey) and lead are the conducting materials.

Carbon (diamond) is a insulating materials and silicon a simiconducting material hence option (a) is correct.

77. Some magnetic materials may be classified on the basis of

1) Susceptibility

2) Saturation

3) Spin arrangement

4) Nature of hysteresis loop

5) Domain structure

6) Critical temperature above which it behaves as a paramagnetic material.

Which of these can be used to distinguish between Ferri and ferromagnetic materials?

A. 1, 3 and 4 only

B. 2, 3 and 6 only

C. 3, 4 and 5 only

D. 1, 2, 3, 4, 5 and 6

Ans. A

Sol. Since Saturation and Domain structure is used to define the properties of ferromagnetic materials and Critical Temperature is a property of a paramagnetic material such that above that critical point it is converted to the ferromagnetic material.

78. As temperature falls below the transition temperature, the value of critical magnetic field of a superconductor

A. Remains unchanged

B. Increases

C. Decreases

D. First increases, reaches a peak and then decreases

Ans. B

Sol. Critical field required for destroying superconductivity is zero above transition temperature as above transition temperature material is in normal state. And below transition temperature critical field required is

$$H_c = H_0\left[1-\left(\frac{T}{T_c}\right)^2\right]$$

H_0 critical field required at as $T = 0^\circ K\,(\max.)$ fall below T_C, H_C increases.

79. Consider the following statements about superconductors :

1) The temperature at which the conductor becomes a super conductor is called transition temperature.

2) Superconductors repel magnetic flux lines.

3) All superconductors are paramagnetic materials.

4) Superconductors become normal when placed in a magnetic field of certain critical value.

Which of the above statements are correct?

A. 1 and 2 only

B. 2 and 4 only

C. 1, 2 and 4 only

D. 1, 2, 3 and 4

Ans. C

Sol.

$$B = \mu_0(H+M)$$

Super conductor repel the magnetic flux

So, $B = 0$

$$0 = \mu_0(H+M)$$

$$M = -H$$

$$M = X_m H$$

So, $X_m = -1$

Condition for perfect dimagnetic

80. Above the Curie temperature, ferro-magnetic materials behave like

A. Paramagnetic
B. Diamagnetic
C. Anti-ferromagnetic
D. Ferrrimagnetic

Ans. A

Sol. Above the Curie temperature, ferro-magnetic materials behave like Paramagnetic.

81. Match List-I (Material) with List-II (Properties) and select the correct answer using the code given below the lists:

List-I

A) Superconductor at very low temperatures
B) Ferric chloride
C) Diamond
D) Manganese oxide

List-II

1) Susceptibility +ve
2) Very small -ve susceptibility
3) Very high -ve susceptibility
4) Susceptibility inversely proportional to *T* -e (Here Tis temperature of the material in Kelvin, eis a constant for a material)

A. A-2; B-4; C-3; D-1
B. A-3; B-1; C-2; D-4
C. A-2; B-1; C-3; D-4
D. A-3; B-4; C-2; D-1

Ans. C

Sol. Superconductor is diamagnetic so very small negative susceptibility. Ferric chloride is paramagnetic so susceptibility is positive. MnO is Antiferro so follow curie Weiss law after Neel temperature.

82. Consider the following statements regarding Type-II superconductors.

1) These are ideal or soft superconductor having high critical field and critical temperature.
2) They exhibit complete Meissner's effect and Silsbee effect.

Which of the above statement is/are correct?

A. 1 only
B. 2 only
C. Both 1 and 2
D. Neither 1 and 2

Ans. D

Sol.

- Type-II super conductors are non-ideal and hard superconductors.
- These have high value of critical field and critical temperatures. The change of state from superconducting state to normal state and vice-versa is gradual. These exhibits incomplete Meissner's effect and Silsbee effect.

83. Bohr magneton is unit of

A. Magnetic energy
B. Permanent dipole moment due to spin
C. Polarisability
D. Hysteresis loss

Ans. B

Sol. Bohr magnetron= $\frac{eh}{4\pi m}$ is unit of permanent dipole moment due to spin of e^{-s} in orbital.

84. Choose the correct option(s) related to XRD:

1. It is used to determine crystal structure.
2. It is based on Bragg's law.

A. 1 Only
B. 2 Only
C. Both A and B
D. Neither A nor B

Ans. C

Sol. Historically, much of our understanding regarding the atomic and molecular arrangements in solids has resulted from x-ray diffraction investigations; furthermore, x-rays are still very important in developing new materials. We will now give a brief overview of the diffraction phenomenon and how, using x-rays, atomic interplanar distances and crystal structures are deduced. So, X-Ray diffraction (XRD) technique is used. So, statement 1 is correct.

X-rays are a form of electromagnetic radiation that have high energies and short wavelengths—wavelengths on the order of the atomic spacings for solids. When a beam of x-rays impinges on a solid material, a portion of this beam will be scattered in all directions by the electrons associated with each atom or ion that lies within the beam's path. The mathematical relation is given by Bragg's law, So, statement 2 is also correct.

85. The number of degrees of freedom of eutectic point in binary system as per Gibbs' rule is:

A. 0
B. 2
C. 1
D. 3

Ans. C

Sol. As per Gibb's rule, no of degree of freedom:

F = C - P + 2

where,

C = number of components

P = number of phases

For binary system

C = 2 and for entectic point, P = 3

F = 2- 3 + 2 = 1

86. The energy gap of a superconductor

A. is independent of temperature
B. increases with temperature
C. is maximum at a critical temperature
D. is minimum at a critical temperature

Ans. D

Sol. Energy gap of superconductor is minimum at critical temperature as it inters in infinite conductive stage.

87. The co-ordination number & no of atom per unit cell of BCC structure is

A. 8, 2
B. 8, 8
C. 2, 8
D. 6, 2

Ans. A

Sol.

Structure	Coordination no	No. of atom per unit cell
SCC	6	1
BCC	8	2
FCC	12	4
HCP	12	6

88. Choose the correct option related to silicon,

1. It forms covalent bond.
2. The nature is having hardness.
3. It is semiconductor.

A. 1, 2, 3 B. 1, 3

C. 1, 2 D. None of the above

Ans. A

Sol. Si is an example of covalent bond these materials have every high melting point, they are hard and brittle also.

89. Consider the following statements about electrostriction

1) Some material gets strained when an electric field is applied across them.
2) Reversal of electric field reverses the direction of deformation.

Which of the above statements is/are correct?

A. 1 only B. 2 only

C. Both 1 and 2 D. Neither 1 and 2

Ans. A

Sol. Electrostriction is a property of dielectrics that causes them to change their shape under the application of electric field. The strain resulting from electrostriction is proportional to the square of applied electric field. Therefore, reversal of the electric field does not reverse the direction of deformation.

90. Materials, whose resistivity at very low temperature plunges from a finite value to zero and remains there upon further cooling,are known as

A. ferromagnetic materials B. high energy hard magnetic materials

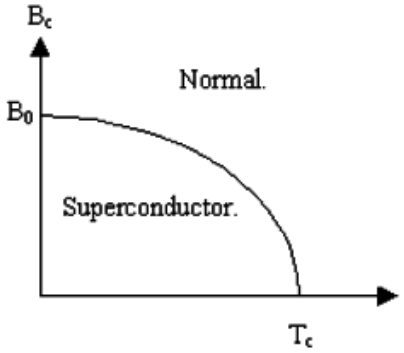
C. superconductors D. ferrimagnetic materials

Ans. C

Sol. In a superconductor, below a temperature called the "critical temperature", the electric resistance very suddenly falls to zero.

At zero resistance, the material conducts current perfectly.

This is incomprehensible because the flaws and vibrations of the atoms should cause resistance in the material when the electrons flow through it. However, in a superconductor, the electric resistance is equal to zero although the flaws and vibrations still exist.



91. Quantum dot materials are

A. Zero dimensional
B. 1 –D
C. 2 – D
D. 3 – D

Ans. A

Sol. Quantum dots are zero dimensional materials.
Ex) Dendrimers, fullerene

92. Which kind of semiconductor is used in fabrication of BJT:

A. Direct bandgap semiconductor
B. Narrow bandgap semiconductor
C. Wide bandgap semiconductor
D. Indirect bandgap semiconductor

Ans. D

Sol. For fabrication of BJT indirect bandgap semiconductor are used whereas direct bandgap semiconductors are used in LED and LASERs.

93. The maximum allowed temperature for Class E insulation materials are:

A. 120C, 248F
B. 155C, 311F
C. 180C, 356F
D. 105C, 221F

Ans. A

Sol. Class E insulation has materials or combinations of materials which by testing, capable of operation at Class E temperature where maximum allowed temperature is 120C, 248F.

94. Controlled addition of group III element to an elemental semiconductor results in the formation of

A. Intrinsic semicondurtor
B. n-type semiconductor
C. p-type semiconductor
D. Degenerate semiconductor

Ans. C

Sol. 3rd group element like B are accepters so addition of these to SC like Si or Ge result in p-type SC.

95. The presence of one of the following materials,in iron or steel for use as a magnetic material, tends to reduce the hysteresis loss

A. Carbon
B. Sulphur
C. Phosphorus
D. Silicon

Ans. D

Sol. On addition of silicon in iron or steel the hysteresis loop becomes narrow therefore hysteresis loss decrease.

96. Thermal conductivity _____ and Entropy _____ in superconducting state.

A. Increases, Decreases
B. Decreases, Increases
C. Increases, Increases
D. Decreases, Decreases

Ans. D

Sol. In superconducting state both thermal conductivity and entropy decreases.

97. The Hall effect coefficient of the material is R_H = 2 .5 × 10^{-5} m^3 /C and resistivity ρ= 5 × 10^{-4} Ω-m, then the value of mobility (m^2 /v-s) is:

A. 20
B. 12 .5
C. 0.05
D. 0.8

Ans. C

Sol. $R_H = 2.5 \times 10^{-5}\ m^3/C$; $\rho = 5 \times 10^{-4}\ \Omega$-m

We know that mobility is

$$\mu = \sigma R_H$$

$$\because \sigma = \frac{1}{\rho}$$

$$\therefore \mu = \frac{R_H}{\rho}$$

$$\mu = \frac{2.5\times10^{-5}\ m^3/C}{5\times10^{-4}\ \Omega\text{-}m} = 0.05\ m^2/v\text{-}s$$

98. A semiconductor has a band gap of 2 eV. The wavelength of radiation emitted from the semiconductor when electrons and holes recombine is

A. 620 nm
B. 525 cm
C. 425 mm
D. 625 Angstrom

Ans. A

Sol.

$$\lambda(\mu m) = \frac{1024}{E_g(eV)} = \frac{1.24}{2}\mu m$$

$$\lambda = 620nm$$

99. Which of the following is a characteristic of hard magnetic material?

A. low coercivity
B. low hysteresis loss
C. hight coercivity
D. smaller area enclosed their hysteresis loop

Ans. C

Sol. ⇒ Hard magnetic materials have high coercivity and retentivity.

⇒ When magnetization is removed then they also contain residual magnetism that's why they are also used for making permanent magnet.

⇒ Hard magnetic materials have larger loop area, more hysteresis loss.

100. Ferrites have:

1) Low eddy current loss

2) High resistivity

3) Higher specific gravity than that of iron.

Which of the above statement is/are correct?

A. 1, 2 and 3 B. 2 and 3 only

C. 1 and 2 only D. 1 and 3 only

Ans. C

Sol. Ferrites have high resistivity and low eddy current losses. Iron generally has higher specific gravity then ferrites.

****