Engineering Physics (PH1001-1)

MCQ Questions

Unit-II Semiconductors and Superconductors

1. Solids with high value of conductivity are called:
   (a) Conductors
   (b) Non-metal
   (c) Insulator
   (d) Semi-conductor

   Ans: (a)

2. Fermi level for a metal is
   (a) Highest energy level occupied by electrons at 0^0C
   (b) Average value of all available energy levels
   (c) Highest energy level occupied by electrons at 0 K
   (d) Addition of energy of all available electron energy levels

   Ans: (c)

3. The probability of occupation of the electrons at any temperature is given as,
   (a) $f(E) = \frac{1}{e^{(E+E_f)/k_BT}+1}$
   (b) $f(E) = \frac{1}{e^{(E-E_f)/k_BT}-1}$
   (c) $f(E) = \frac{1}{e^{(E-E_f)/k_BT}+1}$
   (d) (iv)$f(E) = \frac{1}{e^{(E-E_f)/k_B}+1}$

   Ans: (c)

4. The relationship between current density J and electric field E is
   (a) J = σE
   (b) J = σ / E
   (c) J = σ/2E
   (d) J = 1/ σ E

   Ans: (a)

5. Intrinsic semiconductors are those

(a) Which are made of semiconductor material in its purest form

(b) Which have zero energy gap

(c) Which have more electrons than holes

(d) Which are available locally

Ans: (a)

6. A pure semiconductor behaves like an insulator at 0^0 K because

(a) There is no recombination of electrons with holes

(b) Drift velocity of free electrons is very small

(c) Free electrons are not available for current conduction

(d) Energy possessed by electrons at that low temperature is almost zero

Ans: (c)

7. Which of the following about Fermi-Dirac distribution is false?

(a) When $E = E_F$, the probability of finding an electron with energy equal to the Fermi energy in a metal is ½ at any temperature.

(b) At T = 0 K all the energy level up to E_F are occupied and all the energy levels above E_F are empty.

(c) When T > 0 K, some levels above E_F are partially filled while some levels below E_F are partially empty.

(d) When T = 0 K, some levels above E_F are partially filled while some levels below E_F are empty.

Ans: (d)

8. Examples of Fermions are

(a) Electrons

(b) Photons

(c) Phonons

(d) Atoms

Ans: (a)

9. Using Fermi distribution function, the value of f(E) for $(E – E_F)$ = 0.01 eV at 200 K is

(a) 0.36

(b) 0.64

(c) 0.45

(d) 0.55

Ans: (a)

10. The magnetic lines of force cannot penetrate the body of a superconductor, a phenomenon is known as

(a) Isotopic effect

(b) BCS theory

(c) Meissner effect

(d) Silsbee's effect

Ans: (c)

11. The minimum amount of current passed through the body of superconductor in order to destroy the superconductivity is called

(a) Induced current
(b) Critical current
(c) Eddy current
(d) Hall current

Ans: (b)

12. In superconductivity the conductivity of a material becomes

(a) Zero

(b) Finite

(c) Infinite

(d) None of the answers

Ans: (c)

13. In superconductors the temperature at which conductivity of a material becomes infinite is called

(a) Critical temperature

(b) Absolute temperature

(c) Mean temperature

(d) Crystallization temperature

Ans: (a)

14. The superconducting state is perfectly _____ in nature.
   (a) Diamagnetic
   (b) Paramagnetic
   (c) Ferromagnetic
   (d) Ferrimagnetic

   Ans: (a)

15. The binding energy of a Cooper pair is of the order of _______
   (a) 10^{-3} eV
   (b) 10^{3} eV
   (c) 10^{-3} J
   (d) 10^{3} J

   Ans: (a)

16. The electron pairs in a superconductor are ______
   (a) Bosons
   (b) Leptons
   (c) Hydrons
   (d) Fermions

   Ans: (a)

17. The transition to normal state occurs abruptly at a critical magnetic field (H_c) in
   (a) Type-I superconductor
   (b) Type-II superconductor
   (c) Both Type-I and Type-II superconductors
   (d) Conductors

   Ans: (a)

18. The magnetic susceptibility (χ) in superconductor is
   (a) positive
   (b) zero
   (c) negative
   (d) infinity

   Ans: (c)

19. Hard superconductors are also called as ___________

(a) Type-I superconductor

(b) Type-II superconductor

(c) Both Type-I and Type-II superconductors

(d) Conductors

Ans: (b)

20. Silsbee's rule gives the relation between

(a) current and critical temperature

(b) current and critical magnetic field

(c) current and isotopic mass

(d) critical current and critical magnetic field.

Ans: (d)

21. The critical temperature and critical magnetic field for superconducting lead are 7.2 K and 800 Gauss respectively. What will be the temperature up to which lead will be in superconducting state in a magnetic field of 400 gauss?

(a) 1.5 K

(b) 0.5 K

(c) 15 K

(d) 5.09 K

Ans: (d)

22. Superconducting tin has a critical magnetic field of 217 gauss at 2 K. If the critical temperature for superconducting transition for tin is 3.7 K, find the critical magnetic field at 3 K.

(a) 105 Gauss

(b) 10.5 Gauss

(c) 1.05 Gauss

(d) 150 Gauss

Ans: (a)

23. A semiconductor is formed by ……… bonds.

(a) Covalent
(b) Electrovalent
(c) Co-ordinate
(d) Ionic

Ans: (a)

24. A semiconductor has ………… temperature coefficient of resistance.

(a) Positive
(b) Zero
(c) Negative
(d) Infinite

Ans : (c)

25. The most commonly used semiconductor is ………..

(a) Gallium
(b) Silicon
(c) Carbon
(d) Arsenide

Ans : (b)

26. A semiconductor has generally ……………… valence electrons.

(a) 2
(b) 3
(c) 6
(d) 4

Ans : (d)

27. When a pentavalent impurity is added to a pure semiconductor, it becomes ………

(a) An insulator
(b) An intrinsic semiconductor
(c) p-type semiconductor
(d) n-type semiconductor

Ans : (d)

28. Addition of pentavalent impurity to a semiconductor creates ……..

(a) Donor electrons
(b) Holes
(c) Valence electrons
(d) Bound electrons

Ans : (a)

29. A pentavalent impurity has ………. valence electrons

(a) 3
(b) 5
(c) 4
(d) 6

Ans : (b)

30. An n-type semiconductor is ………

(a) Positively charged
(b) Negatively charged
(c) Electrically neutral
(d) None of the answers

Ans : (c)

31. A trivalent impurity has ….. valence electrons

(a) 4
(b) 5
(c) 6
(d) 3

Ans : (d)

32. Addition of trivalent impurity to a semiconductor creates ……..

(a) Holes
(b) Donor electrons
(c) Valence electrons
(d) Bound electrons

Ans : (a)

33. A hole in a semiconductor is defined as …………….

(a) A free electron
(b) Electron vacancy
(c) A free proton
(d) A free neutron

Ans : (b)

34. As the doping to a pure semiconductor increases, the bulk resistance of the semiconductor ………..

(a) Remains the same
(b) Increases
(c) Decreases
(d) Becomes zero

Ans : (c)

35. A hole and electron in close proximity would tend to ……….
(a) Repel each other
(b) Attract each other
(c) Have no effect on each other
(d) None of the answers
Ans : (b)

36. In an intrinsic semiconductor, current conduction is due to ……..
(a) Only holes
(b) Only electrons
(c) Both holes and electrons
(d) None of the answers
Ans : (c)

37. When a pure semiconductor is heated, its resistance …………..
(a) Increases
(b) Decreases
(c) Remains the same
(d) Can't say
Ans : (b)

38. In an intrinsic semiconductor, the number of free electrons ………
(a) Equals the number of holes
(b) Is greater than the number of holes
(c) Is less than the number of holes
(d) None of the answers

Ans (a)

39. At room temperature, an intrinsic semiconductor has ……….
(a) Holes only
(b) Electrons and holes
(c) Electrons only
(d) No holes and no electrons
Ans : (b)

40. At absolute temperature, an intrinsic semiconductor has ……….
(a) A few free electrons
(b) Many holes
(c) Many free electrons
(d) No holes and no free electrons
Ans : (d)

41. Which of the following is known as indirect band gap semiconductors?

(a) Germanium
(b) GaAs
(c) GaAsP
(d) Carbon

Ans : (a)

42. Which of the following is a semiconductor

(a) Diamond
(b) Arsenic
(c) Phosphorous
(d) Gallium arsenide

Ans : (d)

43. In an intrinsic semiconductor, the Fermi level

(a) Lies at the middle of the forbidden energy gap.
(b) Is near the conduction band.
(c) Is near the valence band.
(d) May be anywhere in the forbidden energy gap.

Ans : (a)

44. For silicon, the energy gap at 300 K is

(a) 0.7 J
(b) 1.1 J
(c) 1.1 eV
(d) 0.7 eV

Ans : (c)

45. The forbidden gap for germanium is,

(a) 0.7 J
(b) 0.7 eV
(c) 1.1 eV
(d) 1.1 J

Ans: (b)

46. In a N-type semiconductor, the position of Fermi-level

(a) Is below the middle of the energy gap
(b) Is at the middle of the energy gap
(c) Is above the middle of the energy gap
(d) Can be any where

Ans : (c)

47. The mobility of electrons in a material is expressed in unit of:

(a) V/s
(b) m^2 /V-s
(c) m^2 /s
(d) J/K

Ans : (b)

48. The energy gap in a semiconductor

(a) Increases with temperature
(b) Does not change with temperature
(c) Decreases with temperature
(d) Is zero

Ans : (b)

49. Donor impurity atoms in semiconducting material results a new

(a) Wide energy band
(b) Narrow energy band
(c) Discrete energy level just below conduction band
(d) Discrete energy level just above valance band

Ans : (c)

50. Hall Effect is clearly visible in ________________

(a) Insulators
(b) Semiconductors
(c) Super conductors
(d) Non metals

Ans : (b)

51. Which of the following represents correct expression for Lorentz force?

(a) BeV
(b) BV
(c) eV
(d) B

Ans : (a)

52. Hall effect can be used to measure

(a) Magnetic field intensity
(b) Mobility
(c) Carrier concentration
(d) All the answers

Ans : (d)

53. Which of the following parameters can’t be found with Hall Effect?
   (a) Polarity
   (b) Conductivity
   (c) Carrier concentration
   (d) Area of the device

Ans : (d)

54. In the Hall Effect, the electric field is in X direction and the velocity is in Y direction. What is the direction of the magnetic field?
   (a) X
   (b) Y
   (c) Z
   (d) XY plane

Ans : (c)

55. The number of electrons in a semiconductor is 10^{20}. Then the Hall coefficient is
   (a) 0.625
   (b) 0.0625
   (c) 6.25
   (d) 62.5

Ans : (b)

56. Calculate the conductivity of silicon doped with 10^{21} atoms m^{-3} of boron if the mobility of holes is 0.048 $m^2v^{-1}s^{-1}$.
   (a) 76.8/Ωm
   (b) 7.68/Ωm
   (c) 7.68 Ωm
   (d) 0.768/Ωm

Ans : (b)

57. Calculate the resistivity of intrinsic germanium if the intrinsic carrier density is 2.5 x 10^{19} m^{-3} assuming electron and hole mobilities of 0.38 and 0.18 $m^2v^{-1}s^{-1}$ respectively.
   (a) 0.45/Ωm
   (b) 0.045 Ωm
   (c) 0.45 Ωm
   (d) 4.50 Ωm

Ans : (c)

58. A semiconductor sample of thickness 1.2 x 10^{-4}m is placed in a magnetic field of 0.2T acting perpendicular to its thickness. The Hall voltage generated when a current of 100 mA passes through it is (Assume the carrier concentration to be 10^{23} m^{-3})

(a) 0.123 V
(b) 0.0123 V
(c) 1.23 V
(d) 0.0012 V

Ans : (b)

59. Intrinsic silicon has a carrier concentration of 1.1 x 10^{16} m^{-3}. If the mobilities of electrons and holes are 0.17 and 0.035 $m^2v^{-1}s^{-1}$ respectively at room temperature, the resistivity of silicon is

(a) 0.277x10^3 Ωm
(b) 27.7x10^3 Ωm
(c) 2.77x10^3 Ωm
(d) 0.0277x10^3 Ωm

Ans : (c)

60. The compound gallium arsenide has an intrinsic conductivity of 10^{-6} ohm^{-1} m^{-1} at 20 ^oC. How many electrons have jumped the forbidden energy gap? [Given: μ_e = 0.88 $m^2V^{-1}s^{-1}$ and μ_h = 0.04 $m^2V^{-1}s^{-1}$]

(a) 6.79 x10^3 m^{-3}
(b) 0.679 x10^3 m^{-3}
(c) 67.9 x10^3 m^{-3}
(d) 0.0679 x10^3 m^{-3}

Ans : (a)