Quantum Computing and modern Physics (PH1004-1)

MCQs

Unit - II: Electrical Properties of Materials

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

   Ans: (a)

2. Which of the following statement correctly describes a metal based on band theory?
   (a) A material possessing moderate band gap
   (b) A material possessing a large band gap
   (c) A material with zero band gap
   (d) A material with infinite band gap

   Ans: (c)

3. The electrons in valence band are
   (a) Freely moving inside the solid
   (b) Tightly bonded inside the solid
   (c) Lies in the innermost orbits and cannot be made free
   (d) Lies in the outermost orbits and cannot be made free

   Ans: (a)

4. 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)

5. The probability of occupation of the electrons at any temperature is given as,

(a) $f(E) = \frac{1}{e^{(E+E_f)/k_B T}+1}$

(b) $f(E) = \frac{1}{e^{(E-E_f)/k_B T}-1}$

(c) $f(E) = \frac{1}{e^{(E-E_f)/k_B T}+1}$

(d) (iv)$f(E) = \frac{1}{e^{(E-E_f)/k_B}+1}$

Ans: (c)

6. 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)

7. 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)

8. A pure semiconductor behaves like an insulator at 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)

9. 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 all temperatures.

   (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)

10. Examples of Fermions are

    (a) Electrons

    (b) Photons

    (c) Phonons

    (d) Atoms

    Ans: (a)

11. 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)

12. An elemental semiconductor is formed by ……… bonds.
    (a) Covalent
    (b) Electrovalent
    (c) Co-ordinate
    (d) Ionic
    Ans: (a)

13. A semiconductor has ………… temperature coefficient of resistance.
    (a) Positive
    (b) Zero
    (c) Negative
    (d) Infinite
    Ans: (c)

14. The most commonly used semiconductor is ………..
(a) Gallium
(b) Silicon
(c) Carbon
(d) Arsenide
Ans: (b)

15. A semiconductor has generally ……………… valence electrons.
(a) 2
(b) 3
(c) 6
(d) 4
Ans : (d)

16. 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)

17. Addition of pentavalent impurity to a semiconductor creates ……..
(a) Donor electrons
(b) Holes
(c) Valence electrons
(d) Bound electrons
Ans : (a)

18. A pentavalent impurity has ………. valence electrons
(a) 3
(b) 5
(c) 4
(d) 6
Ans : (b)

19. An n-type semiconductor is ………
(a) Positively charged
(b) Negatively charged
(c) Electrically neutral
(d) None of the answers
Ans: (c)

20. A trivalent impurity has ….. valence electrons

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

Ans: (d)

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

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

Ans: (a)

22. 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)

23. 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)

24. 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)

25. When a pure semiconductor is heated, its resistance …………..

(a) Increases
(b) Decreases
(c) Remains the same
(d) Can’t say

Ans : (b)

26. 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)

27. 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)

28. 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)

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

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

Ans : (a)

30. Which of the following is a semiconductor

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

Ans: (d)

31. 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)

32. 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)

33. The forbidden gap for germanium is,

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

Ans: (b)

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

(a) Close to the valance band
(b) in the middle of the energy band gap
(c) close to the conduction band
(d) Can be any where

Ans: (c)

35. 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)

36. 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)

37. 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)

38. Hall Effect is clearly visible in _______________

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

Ans: (b)

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

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

Ans: (a)

40. Hall effect can be used to measure

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

Ans: (d)

41. Which of the following parameters can't be found with Hall Effect?

(a) Type of semiconductors (p or n type)
(b) Conductivity
(c) Carrier concentration
(d) Area of the device

Ans: (d)

42. In the Hall Effect, the electric field is in X direction and the velocity is in Y direction. Then the direction of the magnetic field is

(a) X
(b) Y
(c) Z
(d) XY plane

Ans: (c)

43. 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)

44. 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)

45. 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)

46. 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)

47. 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)

48. The compound gallium arsenide has an intrinsic conductivity of 10^{-6} ohm^{-1} m^{-1} at 20 ^{o}C. 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)

49. Measurement of Hall coefficient enables the determination of:

(a) Temperature coefficient and thermal conductivity
(b) Mobility and carrier concentration
(c) Fermi level and forbidden energy gap
(d) Area of the device

Ans: (b)

50. For a particular material, the Hall coefficient is found to be zero. The material is

(a) Intrinsic semiconductor
(b) Extrinsic semiconductor
(c) Metal
(d) Insulator

Ans: (d)

51. What happens to the Hall voltage in a conductor if the magnetic field is reversed (i.e., its direction is flipped)?

(a) The Hall voltage becomes zero.
(b) The Hall voltage changes direction but remains the same magnitude.
(c) The Hall voltage doubles in magnitude.
(d) The Hall voltage remains unchanged.

Ans: (b)

52. In which direction does the Hall voltage develop in a conductor when a magnetic field is applied perpendicular to the current?

(a) Parallel to the current direction
(b) Perpendicular to both the magnetic field and the current direction
(c) In the same direction as the magnetic field

(d) Opposite to the magnetic field direction

Ans: (b)

53. An intrinsic semiconductor, at the absolute zero temperature, behaves like which one of the following?

a) Insulator

b) Superconductor

c) n-type semiconductor

d) p-type semiconductor

Ans: a)

54. In intrinsic semiconductors, number of electrons is ____________ number of holes

a) equal to

b) greater than

c) less than

d) none of the above

Ans: a

55. When a pure semiconductor is heated, its resistance

a) goes up

b) goes down

c) remains the same

d) none of the above

Ans: b

56. Intrinsic semiconductor at room temperature will have ______available for conduction.

a) Electrons

b) Holes

c) Both electrons and holes

d) None of the above

Ans : c

57. The density of charge carriers in a pure semiconductor is proportional to

a) exp(-Eg/kT)

b) exp(-2Eg/kT)

c) exp ((-Eg/kT ^{2})

d) exp(-Eg/2kT)

Ans: d

58. In an intrinsic semiconductor

a) $\sigma = n\ e\ \mu_e\ e$

b) $\sigma = n\ h\ \mu_h\ e$

c) $\sigma = n_i\ e\ (\mu_e + \mu_h)$

d) $n_e\ \mu_e\ e > n_h\ \mu_h\ e$

Ans: c

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

A) 2

B) 3

C) 4

D) 5

Ans: c

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

A) Positive

B) Negative

C) Both positive and negative

D) Infinite

Ans. b

61. Which of the following statements about the Hall effect in is true?

A) The Hall effect cannot occur in semiconductors

B) The Hall effect occurs only in metals.

C) The Hall effect can provide information about the concentration and type of charge carriers

D) The Hall effect is observed only at very low temperatures

Ans. c

62. What is the primary function of a solar cell?

A) To store solar energy in chemical form

B) To reflect sunlight to solar heaters

C) To convert sunlight directly into electrical energy

D) To absorb and retain heat from sunlight

Ans: c

63. 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

64. 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

65. In superconductivity the conductivity of a material becomes

(a) Zero

(b) Finite

(c) Infinite

(d) None of the answers

Ans: c

66. 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

67. The superconducting state is perfectly _____ in nature.

(a) Diamagnetic
(b) Paramagnetic
(c) Ferromagnetic
(d) Ferrimagnetic
Ans: a

68. 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

69. The electron pairs in a superconductor are ______

(a) Bosons

(b) Leptons

(c) Hydrons

(d) Fermions

Ans: a

70. 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

71. The magnetic susceptibility (χ) in superconductor is

(a) positive

(b) zero

(c) negative

(d) infinity

Ans: c

72. 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

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