14. Assertion : Two *P-N* junction diodes placed back to back, will work as a *NPN* transistor.

Reason : The *P*-region of two *PN* junction diodes back to back will form the base of *NPN* transistor.

15. Assertion : In transistor common emitter mode as an amplifier is preferred over common base mode.

Reason : In common emitter mode the input signal is connected in series with the voltage applied to the base emitter function.

16. Assertion : The dominant mechanism for motion of charge carriers in forward and reverse biased silicon *P-N* junction are drift in both forward and reverse bias.

Reason : In reverse biasing, no current flow through the junction.

17. Assertion : A transistor is a voltage-operating device.

Reason : Base current is greater than the collector current.

18. Assertion : NAND or NOR gates are called digital building blocks.

Reason : The repeated use of NAND (or NOR) gates can produce all the basic or complicated gates.

19. Assertion : At 0 *K* Germanium is a superconductor.

Reason : At 0 *K* Germanium offers zero resistance.

20. Assertion : Base in a transistor is made very thin as compared to collector and emitter regions.

Reason : Due to thin base power gain and voltage gain is obtained by a transistor.

21. Assertion : The current gain in common base circuit is always less than one.

Reason : At constant collector voltage the change in collector current is more than the change in emitter current.

22. Assertion : *V-i* characteristic of *P-N* junction diode is same as that of any other conductor.

Reason : *P-N* junction diode behave as conductor at room temperature.

23. Assertion : Zener diode works on a principle of breakdown voltage.

Reason : Current increases suddenly after breakdown voltage.

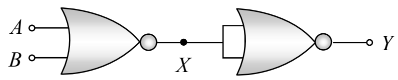
24. Assertion : NOT gate is also called inverter circuit.

Reason : NOT gate inverts the input order.

25. Assertion : In vacuum tubes (valves), vacuum is necessary for the movement of electrons between electrodes otherwise electrons collide with air particle and loses their energy.

Reason : In semiconductors devices, external heating or vacuum is not required.

26. Assertion : The following circuit represents 'OR' gate



Reason : For the above circuit $Y = \overline{X} = \overline{\overline{A+B}} = A+B$

27. Assertion : A *P-N* photodiode is made from a semiconductor for which E_g = 2.8 *eV*. This photo diode will not detect the wavelength of 6000 *nm*.

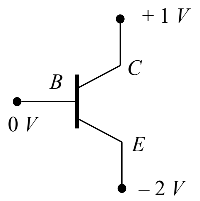
Reason : A *PN* photodiode detect wavelength λ if $\frac{hc}{\lambda} > E_g$.

28. Assertion : 29 is the equivalent decimal number of binary number 11101.

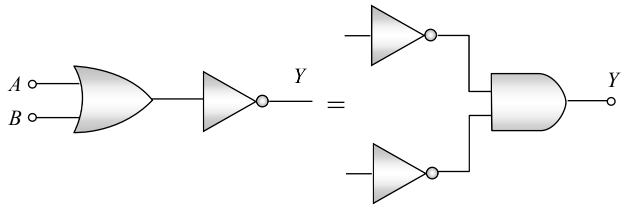
Reason : $(11101)_2 = (1 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0)_{10}$
$= (16 + 8 + 4 + 0 + 1)_{10} = (29)_{10}$

29. Assertion : When *PN*-junction is forward biased then motion of charge carriers at junction is due to diffusion. In reverse biasing. The cause of motion of charge is drifting.

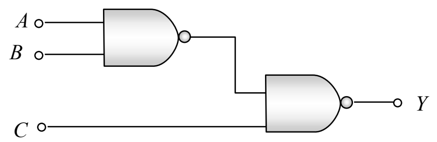
Reason : In the following circuit emitter is reverse biased and collector is forward biased.



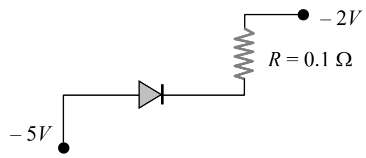
30. Assertion : De-morgan's theorem $\overline{A+B}=\overline{A}\cdot\overline{B}$ may be explained by the following circuit



Reason : In the following circuit, for output inputs *ABC* are 101



31. Assertion : In the following circuit the potential drop across the resistance is zero.



Reason : The given resistance has low value.

Answers

Solids and Crystals

1	d	2	d	3	d	4	a	5	a
6	a	7	a	8	b	9	a	10	c
11	d	12	c	13	b	14	a	15	a
16	a	17	d	18	b	19	c	20	c
21	b	22	a	23	b	24	a	25	d
26	d	27	d	28	d				

Semiconductors

1	c	2	b	3	d	4	b	5	b
6	b	7	b	8	c	9	d	10	a
11	b	12	a	13	a	14	d	15	c
16	b	17	b	18	b	19	c	20	c
21	d	22	b	23	ac	24	d	25	b
26	c	27	d	28	c	29	c	30	b
31	d	32	a	33	b	34	a	35	c
36	d	37	c	38	b	39	d	40	a
41	d	42	c	43	b	44	c	45	d
46	b	47	a	48	b	49	a	50	d
51	d	52	b	53	b	54	a	55	c
56	d	57	b	58	d	59	a	60	a
61	b	62	a	63	c	64	a	65	b
66	a	67	c	68	c	69	c	70	c
71	b	72	b	73	a	74	b	75	c
76	b	77	c	78	a	79	d	80	a
81	a	82	a	83	b	84	d	85	c
86	d	87	a	88	c	89	b	90	c
91	a	92	b	93	d	94	d	95	d
96	d	97	d	98	a	99	b	100	a
101	b								

Semiconductor Diode

1	b	2	a	3	b	4	b	5	c
6	b	7	a	8	b	9	a	10	a
11	b	12	b	13	b	14	c	15	d
16	c	17	c	18	bc	19	c	20	d
21	d	22	b	23	d	24	c	25	c
26	b	27	b	28	b	29	c	30	b
31	b	32	c	33	d	34	c	35	d
36	a	37	b	38	b	39	d	40	a
41	b	42	a	43	b	44	a	45	a
46	b	47	b	48	a	49	c	50	d
51	d	52	a	53	c	54	c	55	b
56	d	57	a	58	a	59	c	60	a
61	b	62	c	63	a	64	c	65	a
66	b	67	c	68	c	69	d	70	a
71	c	72	a	73	d	74	d	75	c
76	a	77	c	78	c	79	c		

Junction Transistor

1	a	2	c	3	a	4	d	5	d
6	b	7	d	8	b	9	b	10	b
11	c	12	d	13	d	14	a	15	b
16	b	17	d	18	b	19	ac	20	a
21	c	22	a	23	b	24	b	25	b
26	c	27	a	28	b	29	b	30	d
31	b	32	b	33	a	34	b	35	b
36	a	37	a	38	a	39	b	40	a
41	b	42	d	43	d	44	b		

Digital Electronics

1	b	2	c	3	b	4	a	5	b
6	c	7	d	8	b	9	a	10	a
11	d	12	b	13	c	14	a	15	c
16	a	17	b	18	b	19	a	20	a
21	b	22	c	23	b	24	c	25	b
26	c	27	b	28	a	29	a	30	d
31	d								

Valve Electronics

1	c	2	c	3	a	4	b	5	b
6	b	7	c	8	b	9	a	10	a
11	c	12	b	13	b	14	c	15	d
16	b	17	b	18	c	19	c	20	c
21	b	22	b	23	b	24	c	25	a
26	c	27	d	28	a	29	a	30	ad
31	d	32	c	33	c	34	a	35	a
36	c	37	b	38	d	39	b	40	c
41	c	42	b	43	d	44	b	45	c
46	c	47	b	48	b	49	a	50	c
51	a	52	b	53	b	54	a	55	c
56	a	57	a	58	d				

Critical Thinking Questions

1	c	2	a	3	c	4	c	5	abd
6	a	7	a	8	c	9	b	10	b
11	d	12	c	13	a	14	b	15	a
16	d	17	b	18	a	19	a	20	c
21	b	22	a	23	d	24	d	25	a
26	b	27	b	28	d	29	c	30	a
31	b	32	c	33	d	34	b	35	c
36	b	37	d	38	d	39	d	40	b
41	c	42	a	43	a	44	b	45	a
46	c	47	a	48	a	49	b	50	b

Graphical Questions

1	c	2	b	3	c	4	c	5	a
6	b	7	b	8	c	9	b	10	a
11	b	12	a	13	d	14	a	15	d
16	a	17	c	18	c	19	a	20	c
21	c	22	c	23	a	24	b	25	c
26	c	27	b	28	c	29	a	30	d

Assertion and Reason

1	d	2	a	3	c	4	a	5	d
6	a	7	b	8	a	9	b	10	a
11	c	12	e	13	e	14	d	15	b
16	d	17	d	18	a	19	d	20	a
21	c	22	d	23	a	24	a	25	b
26	a	27	a	28	a	29	b	30	c
31	b								

AS Answers and Solutions

Solids and Crystals

1. (d) Ionic bonds cone into being when atoms that have low ionization energies, and hence lose electrons rapidly, interact with other atoms that and to acquire excess electrons. The former atoms give up electrons to the latter and they there upon become positive and negative ions respectively.
2. (d) For tetragonal, cubic and orthorhombic system $\alpha = \beta = \gamma = 90°$.
3. (d) Tourmaline crystal is biaxial.
4. (a) The temperature co-efficient of resistance of conductor is positive.
5. (a) Density $\rho = \dfrac{nA}{N(a)^3}$

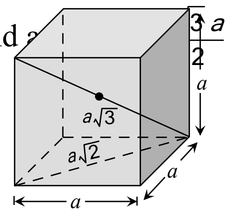
   where $n = 2$ for bcc structure , $A = 39 \times 10^{-3}$ *kg*,

$N = 6.02 \times 10^{23}$, $a = \frac{2}{\sqrt{3}} d = \frac{2}{\sqrt{3}} \times (4.525 \times 10^{-10}) m$

(d = nearest neighbour distance = distance between centres of two neighbouring atoms $= \frac{a}{\sqrt{2}}$)

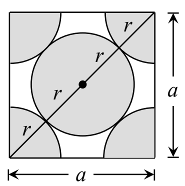
On putting the values we get $\rho = 907$

6. (a) The highest energy level which an electron can occupy in the valence band at 0 *K,* is called Fermi energy level.
7. (a) In a triclinic crystal $a \neq b \neq c$ and $\alpha \neq \beta \neq \gamma \neq 90°$
8. (b) Metallic solids are opaque because incident light is absorbed by the free electrons in a metal.
9. (a) In ionic bonding electrons are transferred from one type of atoms to the other type creating positive and negative ions. For example in *NaCl*, *Na* loses one electrons and *Cl* gains one so that Na^+ and Cl^- ions have a stable shell structure.
10. (c) Wood is non-crystalline.
11. (d) *Cu* has *fcc* structure, for *fcc* structure co-ordination number = 12
12. (c) Vander Waal force is weak dipole-dipole interaction.
13. (b)
14. (a) The sodium chloride crystal structure has a *fcc* lattice with one chloride ion at each lattice point and one sodium ion half a cube length above it.
15. (a) In *NaCl* crystal Na^+ ion is surrounded by $6\,Cl^-$ ion, therefore coordination number of Na^+ is 6.
16. (a) Sodium has *bcc* structure. The distance between body centre and a



$= \frac{\sqrt{3} \times 4.225}{2} = 3.66\,Å$

17. (d)
18. (b) For the *fcc* structure



$4r = (a^2 + a^2)^{1/2} = a\sqrt{2}$

$\Rightarrow r = \frac{a\sqrt{2}}{4} = \frac{a}{2\sqrt{2}}$

19. (c) Metals reflects incident light by the vibrations of free electrons under the influence of electric field of incident wave. The conductivity of metals decreases with increase of temperature due to increase in random motion of free electrons. The bonding is therefore metallic.
20. (c)
21. (b) The nearest distance between two atoms in a *bcc* lattice = 2 (atomic radius) $= 2 \times \left(\frac{\sqrt{3}\,a}{4}\right) = \frac{\sqrt{3}a}{2}$
22. (a) The net force on electron placed at the centre of *bcc* structure is zero. (By the principle of superposition of couloumb forces)
23. (b) For *bcc* packing, distance between two nearest atoms $d = 2r = 2\left(\frac{\sqrt{3}\,a}{4}\right)$

    $\Rightarrow$ Lattice constant $a = \frac{2d}{\sqrt{3}} = \frac{2 \times 3.7}{\sqrt{3}} = 4.3\,Å$
24. (a)
25. (d) $\sqrt{2}\,a = 4r \Rightarrow a = \frac{4r}{\sqrt{2}} = \sqrt{2}(2r) = \sqrt{2} \times 2.54 = 3.59\,Å$
26. (d)
27. (d) Covalent bonding exists in semi-conductor.
28. (d) In H_2O covalent bonding is present.

Semiconductors

1. (c) In *P*-type semiconductors, holes are the majority charge carriers
2. (b) *Ga* has a valancy of 3.
3. (d) [Ge] + [Trivalent impurity] → [*P*- type semiconductor]
4. (b) Since $n_e > n_h$; the semiconductor is *N*-type.
5. (b) Absence of one electron, creates the positive charge of magnitude equal to that of electronic charge.
6. (b) [Ge] + [Pantavalent impurity] → [*N*- type semiconductor]
7. (b) Impurity increases the conductivity.

8. (c) Intrinsic semiconductor → Conductivity is due to the breaking of covalent bond

Extrisnsic semiconductor → Conductivity is due to the breaking of covalent bond and excess of charge carriers due to impurity.

9. (d) Resistance of conductors (*Cu*) decreases with decrease in temperature while that of semi-conductors (*Ge*) increases with decrease in temperature.

10. (a) Aluminum is trivalent impurity.

11. (b) With temperature rise conductivity of semiconductors increases.

12. (a)

13. (a) Similar to Q. 11

14. (d) In insulators, the forbidden energy gap is largest and it is of the order of 6 *eV*.

15. (c) *N*-type semiconductors are neutral because neutral atoms are added during doping.

16. (b)

17. (b) In insulators, the forbidden energy gap is very large, in case of semiconductor it is moderate and in conductors the energy gap is zero.

18. (b) Similar to Q. 15.

19. (c) Phosphorus is pentavalent.

20. (c) In intrinsic semiconductors, the creation or liberation of one free electron by the thermal energy has created one hole. Thus in intrinsic semiconductors $n_e = n_h$

21. (d) Conductor has positive temperature coefficient of resistance but semiconductor has negative temperature coefficient of resistance.

22. (b) Boron is trivalent.

23. (a, c) In intrinsic semiconductors, electrons and holes both are charge carriers. In *P*-type semiconductors (Extrinsic semiconductors) holes are majority charge carriers.

24. (d)

25. (b)

26. (c) $\Delta E_{g(Germanium)} = 0.67\ eV$

27. (d) In *P*-type semiconductors, holes are majority charge carrier and electrons are minority charge carriers.

28. (c) At zero Kelvin, there is no thermal agitation and therefore no electrons from valence band are able to shift to conduction band.

29. (c) Antimony is a fifth group impurity and is therefore a donor of electrons.

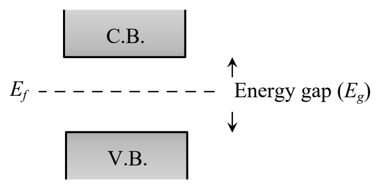
30. (b) Resistance of semiconductor $\propto \frac{1}{\text{Temperature}}$

31. (d) Extrinsic S.C. → $P-\text{Type}(n_p >> n_e)$; → $N-\text{Type}(n_e >> n_p)$

32. (a) At room temperature the number of electrons and holes are equal in the intrinsic semiconductor.

33. (b) Indium is trivalent, hence on doping with it, the intrinsic semiconductor becomes *P*-type semiconductor.

34. (a)



35. (c) In semiconductors, Forbidden energy gap is of the order of 1 *eV*.

36. (d) At 0*K* temperature semiconductor behaves as an insulator, because at very low temperature electrons cannot jump from the valence band to conduction band.

37. (c) Antimony is pentavalent.

38. (b) At 0*K* semiconductor behaves as insulator so it's resistance is infinite.

39. (d) The conduction and valence bands in the conductors merge into each other.

40. (a) For *N*-type semiconductor, the impurity should be pentavalent.

41. (d) When a free electron is produced, simultaneously a hole is also produced.

42. (c) For $P-$type semiconductor the doping impurity should be trivalent.

43. (b) The temperature co-efficient of resistance of a semiconductor is always negative.
44. (c) The resistance of semiconductor decreases with the increase in temperature.
45. (d) At absolute zero temperature, semiconductor.
46. (b) Formation of energy bands in solids are due to Pauli's exclusion principle.
47. (a) In *P*-type semiconductors, holes are majority charge carriers.
48. (b)
49. (a) Conductivity of semiconductors increases with rise in temperature.
50. (d) All are trivalent in nature.
51. (d) In *N*-type semiconductors, electrons are majority charge corners.
52. (b) When a strong current passes through the semiconductor it heats up the crystal and covalent bond are broken. Hence because of excess number of free electrons it behaves like a conductor.
53. (b)
54. (a) Phosphorus is a pentavalent impurity so $n_e > n_h$.
55. (c) Phosphorus is pentavalent while Indium is trivalent.
56. (d) Phosphorus and Arsenic both are pentavalent.
57. (b)
58. (d)
59. (a) For Ge, $E_g = 0.7\, eV = 0.7 \times 1.6 \times 10^{-19}\, J = 1.12 \times 10^{-19}\, J$
60. (a) At room temperature some covalent bond breaks and semiconductor behaves slightly as a conductor.
61. (b)
62. (a)
63. (c) Because boron is a trivalent impurity.
64. (a) In *P*-type semi conductor, holes are majority charge carriers.
65. (b) In intrinsic semiconductors, at room temperature $n_e = n_h$.
66. (a) In conductors valence band and conduction band overlaps.
67. (c) Because As is pentavalent impurity.
68. (c) At 0 K semiconductor behaves as an insulator.
69. (c)
70. (c)
71. (b) Antimony and phosphorous both are pentavalent.
72. (b) Gallium is trivalent impurity.
73. (a)
74. (b) One atom of pentavalent impurity, donates one electron.
75. (c)
76. (b) The charge on hole is positive.
77. (c) Phosphorus is pentavalent impurity.
78. (a) $n_i^2 = n_h n_e \Rightarrow (10^{19})^2 = 10^{21} \times n_e \Rightarrow n_e = 10^{17} / m^3$.
79. (d) Temperature co-efficient of semiconductor is negative.
80. (a) Copper, Aluminum, Iron are conductors, while Ge is semiconductor.
81. (a) At room temperature, few bonds breaks and electron hole pair generates inside the semiconductor.
82. (a)
83. (b) With rise in temperature, conductivity of semiconductor increases while resistance decreases.
84. (d) Gallium, boron and aluminum are trivalent.
85. (c) Because with rise in temperature, resistance of semiconductor decreases, hence overall resistance of the circuit increases, which in turn increases the current in the circuit.
86. (d) Extrinsic semiconductor (*N*-type or *P*-type) are neutral.
87. (a) Because $v_d = \frac{i}{(n_e)eA}$
88. (c)
89. (b) Resistivity is the intrinsic property, it doesn't depend upon length and shape of the semiconductors.
90. (c)
91. (a) $\lambda_{\max} = \frac{hc}{E} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{1.14 \times 1.6 \times 10^{-19}} = 10888 \mathring{A}$
92. (b) In *N*-type semiconductor impurity energy level lies just below the conduction band.
93. (d)
94. (d)

95. (d) $\sigma = en_e\mu_e$ $\Rightarrow$

$$n_e = \frac{\sigma}{e\mu_e} = \frac{6.24}{1.6 \times 10^{-19 \times 3900}} = 10^{16} / cm^3$$

96. (d) In semiconductors, the forbidden energy gap between the valence band and conduction band is very small, almost equal to kT. Moreover, valence band is completely filled where as conduction band is empty.

97. (d) In sample x no impurity level seen, so it is undoped. In sample y impurity energy level lies below the conduction bond so it is doped with fifth group impurity.

In sample z, impurity energy level lies above the valence band so it is doped with third group impurity.

98. (a) Forbidden energy gap for carbon is greater than that of silicon.

99. (b)

100. (a) Because electrons needed less energy to move.

101. (b)