25. (b) : According to radioactive decay law

$N = N_0 e^{-\lambda t}$

where N_0 = Number of radioactive nuclei at time $t = 0$

N = Number of radioactive nuclei left undecayed at any time t

λ = decay constant

At time $t_2, \frac{2}{3}$ of the sample had decayed

$\therefore \ N = \frac{1}{3}N_0$

$\therefore \ \frac{1}{3}N_0 = N_0 e^{-\lambda t_2}$ ...(i)

At time $t_1, \frac{1}{3}$ of the sample had decayed,

$\therefore \ N = \frac{2}{3}N_0$

$\therefore \ \frac{2}{3}N_0 = N_0 e^{-\lambda t_1}$ ...(ii)

Divide (i) by (ii), we get

$$\frac{1}{2} = \frac{e^{-\lambda t_2}}{e^{-\lambda t_1}} \Rightarrow \frac{1}{2} = e^{-\lambda(t_2 - t_1)}$$

$\lambda(t_2 - t_1) = \ln 2$

$$t_2 - t_1 = \frac{\ln 2}{\lambda} = \frac{\ln 2}{\left(\frac{\ln 2}{T_{1/2}}\right)} \quad \left(\because \lambda = \frac{\ln 2}{T_{1/2}}\right)$$

$= T_{1/2} = 50$ days

26. (d) : The wavelength of the first line of lyman series for hydrogen atom is

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$$

The wavelength of the second line of Balmer series for hydrogen like ion is

$$\frac{1}{\lambda'} = Z^2 R\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

According to question $\lambda = \lambda'$

$$\Rightarrow R\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = Z^2 R\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

or $\frac{3}{4} = \frac{3Z^2}{16}$ or $Z^2 = 4$ or $Z = 2$

27. (b) : $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$

where n is number of half lives

$\therefore \ \frac{1}{16} = \left(\frac{1}{2}\right)^n$ or $\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$ or $n = 4$

Let the age of rock be t years.

$\because \ n = \frac{t}{T_{1/2}}$

or $t = nT_{1/2} = 4 \times 50$ years $= 200$ years

28. (c) : According to Einstein's mass energy relation

$E = mc^2$ or $m = \frac{E}{c^2}$

Mass decay per second

$$= \frac{\Delta m}{\Delta t} = \frac{1}{c^2}\frac{\Delta E}{\Delta t} = \frac{P}{c^2} = \frac{1000 \times 10^3 \text{ W}}{(3 \times 10^8 \text{ m/s})^2}$$

$$= \frac{10^6}{9 \times 10^{16}} \text{ kg/s}$$

Mass decay per hour

$$= \frac{\Delta m}{\Delta t} \times 60 \times 60 = \left(\frac{10^6}{9 \times 10^{16}} \text{ kg/s}\right)(3600 \text{ s})$$

$= 4 \times 10^{-8}$ kg $= 40 \times 10^{-6}$ g $= 40$ μg

29. (b) : Momentum of emitted photon

$= p_{\text{photon}} = \frac{h\upsilon}{c}$

From the law of conservation of linear momentum,

Momentum of recoil nucleus

$= p_{\text{nucleus}} = p_{\text{photon}}$

$\therefore \ Mv = \frac{h\upsilon}{c}$

where v is the recoil speed of the nucleus

or $v = \frac{h\upsilon}{Mc}$ ...(i)

The recoil energy of the nucleus

$$= \frac{1}{2}Mv^2 = \frac{1}{2}M\left(\frac{h\upsilon}{Mc}\right)^2 = \frac{h^2\upsilon^2}{2Mc^2} \quad \text{(Using (i))}$$

30. (c) : When an alpha particle $\left({}^4_2\text{He}\right)$ is emitted, the mass number and the atomic number of the daughter nucleus decreases by four and two respectively. When a beta particle (β^-) is emitted, the atomic number of the daughter nucleus increases by one but the mass number remains the same.

$$\therefore \ {}^m_n X \xrightarrow{\alpha} {}^{m-4}_{n-2}Y \xrightarrow{2\beta^-} {}^{m-4}_{n}X$$

31. (c) : Extremely high temperature needed for fusion make kinetic energy large enough to overcome coulomb repulsion between nuclei.

32. (c) : Here, Stopping potential, $V_0 = 10$V

Work function, $W = 2.75$ eV
According to Einstein's photoelectric equation

$$eV_0 = h\upsilon - W \quad \text{or} \quad h\upsilon = eV_0 + W$$
$$= 10\text{ eV} + 2.75\text{ eV} = 12.75\text{ eV} \quad \text{...(i)}$$

When an electron in the hydrogen atom makes a transition from excited state n to the gound state (n=1), then the frequency (υ) of the emitted photon is given by

$$h\upsilon = E_n - E_1 \Rightarrow h\upsilon = -\frac{13.6}{n^2} - \left(-\frac{13.6}{1^2}\right)$$

$$\left[\because \text{ For hydrogen atom}, E_n = -\frac{13.6}{n^2}\text{eV}\right]$$

According to given problem

$$-\frac{13.6}{n^2} + 13.6 = 12.75 \qquad \text{(Using (i))}$$

$$\frac{13.6}{n^2} = 0.85 \Rightarrow n^2 = \frac{13.6}{0.85} = 16$$

or $n = 4$

33. (c) :

	P	Q
No. of nuclei, at $t = 0$	$4N_0$	N_0
Half- life	1 min	2 min
No. of nuclei after time t	N_P	N_Q

Let after t min the number of nuclei of P and Q are equal.

$$\therefore \quad N_P = 4N_0\left(\frac{1}{2}\right)^{t/1} \text{ and } N_Q = N_0\left(\frac{1}{2}\right)^{t/2}$$

As $N_P = N_Q$

$$\therefore \quad 4N_0\left(\frac{1}{2}\right)^{t/1} = N_0\left(\frac{1}{2}\right)^{t/2}$$

$$\frac{4}{2^{t/1}} = \frac{1}{2^{t/2}} \text{ or } 4 = \frac{2^t}{2^{t/2}}$$

or $4 = 2^{t/2}$ or $2^2 = 2^{t/2}$

or $\frac{t}{2} = 2$ or $t = 4$ min

After 4 minutes, both P and Q have equal number of nuclei.

$\therefore$ Number of nuclei of R

$$= \left(4N_0 - \frac{N_0}{4}\right) + \left(N_0 - \frac{N_0}{4}\right)$$

$$= \frac{15N_0}{4} + \frac{3N_0}{4} = \frac{9N_0}{2}$$

34. (c) : The energy of n^{th} orbit of hydrogen atom is given as

$$E_n = -\frac{13.6}{n^2}\text{ eV}$$

$$\therefore \quad E_1 = -13.6\text{ eV}; \; E_2 = -\frac{13.6}{2^2} = -3.4\text{ eV}$$

$$E_3 = -\frac{13.6}{3^2} = -1.5\text{ eV}; \; E_4 = -\frac{13.6}{4^2} = -0.85\text{ eV}$$

$$\therefore \quad E_3 - E_2 = -1.5 - (-3.4) = 1.9\text{ eV}$$
$$E_4 - E_3 = -0.85 - (-1.5) = 0.65\text{ eV}$$

35. (b) : For ${}^7_3$Li nucleus,
Mass defect, $\Delta M = 0.042$ u

$\because \quad 1\text{ u} = 931.5\text{ MeV}/c^2$

$\therefore \quad \Delta M = 0.042 \times 931.5\text{ MeV}/c^2 = 39.1\text{ MeV}/c^2$

Binding energy, $E_b = \Delta Mc^2$

$$= \left(39.1\frac{\text{MeV}}{c^2}\right)c^2 = 39.1\text{ MeV}$$

Binding energy per nucleon, $E_{bn} = \frac{E_b}{A} = \frac{39.1\text{ MeV}}{7}$
≈ 5.6 MeV

36. (d) : According to activity law

$$R = R_0 e^{-\lambda t} \qquad \text{...(i)}$$

According to given problem,

$R_0 = N_0$ counts per minute

$R = \frac{N_0}{e}$ counts per minute

$t = 5$ minutes

Substituting these values in equation (i), we get

$$\frac{N_0}{e} = N_0 e^{-5\lambda}$$

$$e^{-1} = e^{-5\lambda}$$

$$5\lambda = 1 \text{ or } \lambda = \frac{1}{5}\text{ per minute }1$$

At $t = T_{1/2}$, the activity R reduces to $\frac{R_0}{2}$.

where $T_{1/2}$ = half life of a radioactive sample

From equation (i), we get

$$\frac{R_0}{2} = R_0 e^{-\lambda T_{1/2}}$$

$$e^{\lambda T_{1/2}} = 2$$

Taking natural logarithms of both sides of above equation, we get

$$\lambda T_{1/2} = \log_e 2$$

or $T_{1/2} = \frac{\log_e 2}{\lambda} = \frac{\log_e 2}{\left(\frac{1}{5}\right)} = 5\log_e 2$ minutes

37. (a) **38. (c)**

39. (c) : $A_1 = \lambda N_1$ at time t_1

$A_2 = \lambda N_2$ at time t_2

Therefore, number of nuclei decayed during time interval $(t_1 - t_2)$ is

$$N_1 - N_2 = \frac{[A_1 - A_2]}{\lambda}$$

40. (a) : $_1H^2 + {_1H^2} \rightarrow {_2He^4} + \Delta E$
The binding energy per nucleon of a deuteron = 1.1 MeV
$\therefore$ Total binding energy = 2 × 1.1 = 2.2 MeV
The binding energy per nucleon of a helium nuclei = 7 MeV
$\therefore$ Total binding energy = 4 × 7 = 28 MeV
Hence, energy released

$$\Delta E = (28 - 2 \times 2.2) = 23.6 \text{ MeV}$$

41. (d) :

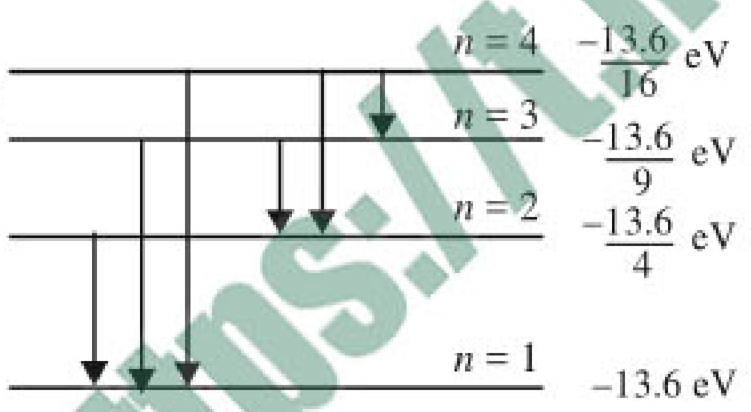
$$_Z^AX \xrightarrow{\beta^-} {_{Z+1}^{A}Y} \xrightarrow{\alpha} {_{Z-1}^{A-4}B^*} \xrightarrow{\gamma} {_{Z-1}^{A-4}B}$$

First X decays by β^- emission emitting $\bar{\upsilon}$, antineutrino simultaneously. Y emits α resulting in the excited level of B which in turn emits a γ ray.
$\therefore$ β^-, α, γ is the answer.

42. (c) : $_Z^AX \xrightarrow{2\beta^-} {_{Z+2}^{A}Y_1} \xrightarrow{\alpha} {_Z^{A-4}Y_2}$
The resultant daughter is an isotope of the original parent nucleus.

43. (a) : Energy of the projectile is the potential energy at closest approach, $\frac{1}{4\pi\varepsilon_0}\frac{z_1z_2}{r}$
Therefore energy $\propto z_1z_2$.

44. (c) :



The maximum wavelength emitted here corresponds to the transition $n = 4 \rightarrow n = 3$ (Paschen series 1st line)

45. (c) : $ZM_p + (A - Z)M_n - M(A, Z)$

$$= \text{mass effect} = \frac{B.E}{c^2}$$

$$\Rightarrow M(A, Z) = ZM_p + (A - Z)M_n - \frac{B.E}{c^2}$$

46. (b) : $A_1 : A_2 = 1 : 3$
Their radii will be in the ratio

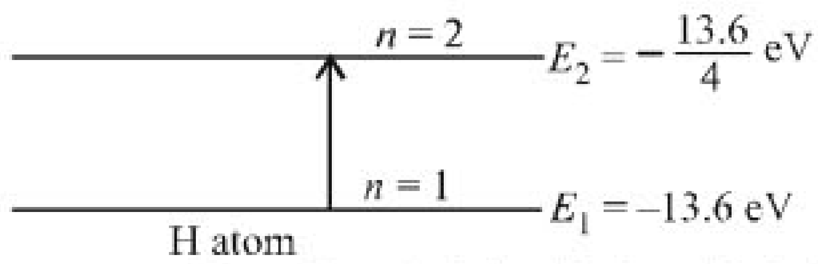
$$R_0A_1^{1/3} : R_0A_2^{1/3} = 1 : 3^{1/3}$$

$$\text{Density} = \frac{A}{\frac{4}{3}\pi R^3}$$

$$\therefore \rho_{A_1} : \rho_{A_2} = \frac{1}{\frac{4}{3}\pi R_0^3 \cdot 1^3} = \frac{3}{\frac{4}{3}\pi R_0^3 (3^{1/3})^3}$$

Their nuclear densities will be the same.

47. (a) :



1st excitation energy $E_{n2} - E_{n1} = (-3.4 + 13.6) = 10.2$ eV

48. (a) : $X_1 = N_0e^{-\lambda_1 t}$; $X_2 = N_0e^{-\lambda_2 t}$

$$\frac{X_1}{X_2} = e^{-1} = e^{(-\lambda_1+\lambda_2)t}\ ;\ e^{-1} = e^{-(\lambda_1-\lambda_2)t}$$

$$\therefore\ t = \left|\frac{1}{\lambda_1 - \lambda_2}\right| = \frac{1}{(5\lambda - \lambda)} = \frac{1}{4\lambda}$$

49. (c) : Given : $\lambda_A = 5\lambda$, $\lambda_B = \lambda$
At $t = 0$, $(N_0)_A = (N_0)_B$

$$\frac{N_A}{N_B} = \left(\frac{1}{e}\right)^2$$

According to radioactive decay, $\frac{N}{N_0} = e^{-\lambda t}$

$$\therefore\ \frac{N_A}{(N_0)_A} = e^{-\lambda_A t} \qquad \text{... (i)}$$

$$\frac{N_B}{(N_0)_B} = e^{-\lambda_B t} \qquad \text{... (ii)}$$

Divide (i) by (ii), we get

$$\frac{N_A}{N_B} = e^{-(\lambda_A - \lambda_B)t} \quad \text{or,} \quad \frac{N_A}{N_B} = e^{-(5\lambda-\lambda)t}$$

$$\text{or,}\ \left(\frac{1}{e}\right)^2 = e^{-4\lambda t} \quad \text{or,}\ \left(\frac{1}{e}\right)^2 = \left(\frac{1}{e}\right)^{4\lambda t}$$

$$\text{or,}\ 4\lambda t = 2 \Rightarrow t = \frac{2}{4\lambda} = \frac{1}{2\lambda}.$$

50. (a) : In beta minus decay (β^-), a neutron is transformed into a proton and an electron is emitted with the nucleus along with an antineutrino.

$$n \rightarrow p + e^- + \bar{\nu}$$

where $\bar{\nu}$ is the antineutrino.

51. (a) : In mass spectrometer when ions are accelerated through potential V,

$$\frac{1}{2}mv^2 = qV \qquad \text{... (i)}$$

where m is the mass of ion, q is the charge of the ion.
As the magnetic field curves the path of the ions in a semicircular orbit

$$\therefore\ Bqv = \frac{mv^2}{R} \Rightarrow v = \frac{BqR}{m} \qquad \text{... (ii)}$$

Substituting (ii) in (i), we get

$$\frac{1}{2}m\left[\frac{BqR}{m}\right]^2 = qV \quad \text{or,} \quad \frac{q}{m} = \frac{2V}{B^2R^2}$$

Since V, B are constants,

$$\frac{q}{m} \propto \frac{1}{R^2} \quad \text{or,} \quad \frac{\text{charge on the ion}}{\text{mass of the ion}} \propto \frac{1}{R^2}.$$

52. (a)

53. (d) : Nuclear radii $R = (R_0)A^{1/3}$
where A is the mass number.

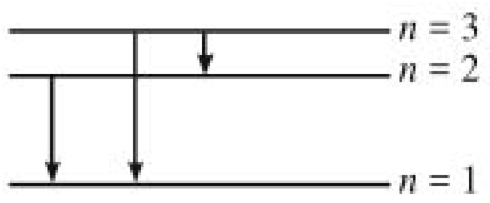
$$\therefore \frac{R_{Te}}{R_{Al}} = \left(\frac{A_{Te}}{A_{Al}}\right)^{1/3} = \left(\frac{125}{27}\right)^{1/3} = \left(\frac{5}{3}\right)$$

or, $R_{Te} = \frac{5}{3} \times R_{Al} = \frac{5}{3} \times 3.6 = 6$ fm.

(Given R_{Al} =3.6 fm)

54. (d) : Energy of n^{th} orbit of hydrogen atom is given by

$$E_n = \frac{-13.6}{n^2}\text{ eV}$$



For ground state, $n = 1$

$$\therefore E_1 = \frac{-13.6}{1^2} = -13.6 \text{ eV}$$

For first excited state, $n = 2$

$$\therefore E_2 = \frac{-13.6}{2^2} = -3.4 \text{ eV}$$

Kinetic energy of an electron in the first excited state is

$K = -E_2 = 3.4$ eV.

55. (c) : Ionisation potential of hydrogen atom is 13.6 eV.
Energy required for exciting the hydrogen atom in the ground state to orbit n is given by

$E = E_n - E_1$

$$i.e.\quad 12.1 = -\frac{13.6}{n^2} - \left(\frac{-13.6}{1^2}\right) = -\frac{13.6}{n^2} + 13.6$$

$$\text{or,}\quad -1.5 = \frac{-13.6}{n^2} \quad \text{or,}\quad n^2 = \frac{13.6}{1.5} = 9 \quad \text{or,}\quad n = 3$$

Number of spectral lines emitted

$$= \frac{n(n-1)}{2} = \frac{3 \times 2}{2} = 3.$$

56. (b) : According to activity law, $R = R_0 e^{-\lambda t}$

$\therefore$ $R_1 = R_0 e^{-\lambda t_1}$ and $R_2 = R_0 e^{-\lambda t_2}$

$$\therefore \frac{R_1}{R_2} = \frac{R_0 e^{-\lambda t_1}}{R_0 e^{-\lambda t_2}} = e^{-\lambda t_1} e^{\lambda t_2} = e^{-\lambda(t_1 - t_2)}$$

or, $R_1 = R_2 e^{-\lambda(t_1 - t_2)}$.

57. (c) : ${}_1^2\text{H} + {}_1^2\text{H} \rightarrow {}_2^4\text{He} + \text{energy}$

$\therefore$ Energy released = B.E. of ${}_2^4$He $-$ 2(B.E. of ${}_1^2$H)

$= 28 - 2(2.2) = 28 - 4.4 = 23.6$ MeV.

58. (a) : Nuclear radii $R = R_0(A)^{1/3}$,
where $R_0 \approx 1.2$ Fm
or $R \propto (A)^{1/3}$

$$\therefore \frac{R_{Be}}{R_{Ge}} = \frac{(9)^{1/3}}{(A)^{1/3}} \quad \text{or,} \quad \frac{R_{Be}}{2R_{Be}} = \frac{(9)^{1/3}}{(A)^{1/3}}$$

($\because$ given $R_{Ge} = 2R_{Be}$)

or, $(A)^{1/3} = 2 \times (9)^{1/3}$ or, $A = 2^3 \times 9 = 8 \times 9 = 72$.

$\therefore$ The number of nucleons in Ge is 72.

59. (c) : Energy released, $E = (\Delta m) \times 931$ MeV
Δm = mass of product $-$ mass of reactant
$\Delta m = c - a - b$
$E = (\Delta m) \times 931$ or, $E = (c - a - b)$.

60. (a) : K.E. $= \left|\frac{1}{2}\text{P.E.}\right|$

But P.E. is negative.

$\therefore$ Total energy

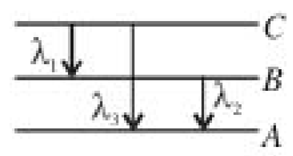
$$= \left|\frac{1}{2}\text{P.E.}\right| - \text{P.E.} = \frac{-P.E.}{2} = -3.4 \text{ eV}.$$

$\therefore$ K.E. = + 3.4 eV.

61. (a) : Isotones means number of neutron remains same.

62. (c)

63. (b) :



$$(E_C - E_A) = (E_C - E_B) + (E_B - E_A)$$

$$\frac{hc}{\lambda_3} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2} \quad \text{or} \quad \frac{1}{\lambda_3} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$$

$$\therefore \frac{1}{\lambda_3} = \frac{\lambda_1 + \lambda_2}{\lambda_1 \lambda_2} \quad \text{or} \quad \lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$

64. (d) : For nuclei having $A > 56$ binding energy per nucleon gradually decreases.

65. (b) : Z is number of protons and A is the total number of protons and neutrons.

66. (c) : In nuclear fusion the mass of end product or resultant is always less than the sum of initial product, the rest is liberated in the form of energy, like in Sun energy is liberated due to fusion of two hydrogen atoms.

67. (a)

68. (d) : Using $N = N_0\left(\frac{1}{2}\right)^n \Rightarrow \frac{N}{N_0} = \left(\frac{1}{2}\right)^n$

$$\Rightarrow \frac{25}{100} = \left(\frac{1}{2}\right)^n \Rightarrow n = 2.$$

The total time in which radium change to 25 g is $= 2 \times 1600 = 3200$ yr.

69. (d) : The charge on hydrogen nucleus $q_1 = +e$ charge on electron, $q_2 = -e$

Coulomb force, $F = K\frac{q_1q_2}{r^2} = K\frac{(+e)(-e)}{r^2}$

$= -\frac{Ke^2}{r^3}\vec{r} = -\frac{Ke^2}{r^2}\hat{r}$.

70. (c)

71. (d): $\frac{\text{Volume of atom}}{\text{Volume of nucleus}} = \frac{\frac{4}{3}\pi(10^{-10})^3}{\frac{4}{3}\pi(10^{-15})^3} = 10^{15}$.

72. (a) : Let, $t = 0$, $M_0 = 10$ g

$t = 2\tau = 2\left(\frac{1}{\lambda}\right)$ (given)

Then from, $M = M_0e^{-\lambda t} = 10e^{-\lambda\left(\frac{2}{\lambda}\right)}$

$= 10\left(\frac{1}{e}\right)^2 = 1.35$ g.

73. (a) : Radius of first orbit, $r \propto \frac{1}{Z}$,

for doubly ionized lithium Z (= 3) will be maximum, hence for doubly ionized lithium, r will be minimum.

74. (c) : Mass defect $= 2M_P + 2M_N - M_{He}$

$= 2\times1.0073 + 2\times1.0087 - 4.0015 = 0.0305$.

$\Rightarrow$ Binding energy = (931 × mass defect) MeV

$= 931 \times 0.0305$ MeV $= 28.4$ MeV

(1 amu = 931 Mev).

75. (c) : Mass number = atomic number + no. of neutrons

For hydrogen, number of neutrons = 0

So, mass number = Atomic number.

Hence mass number is sometimes equal to atomic number.

76. (a) : β-decay.

77. (a) : The nuclei of light elements have a lower binding energy than that for the elements of intermediate mass. They are therefore less stable; consequently the fusion of the light elements results in more stable nucleus.

78. (c) : Number of initial active nuclei $= 4 \times 10^{16}$

Number of decayed nuclei after 10 days (half life)

$= \frac{4\times10^{16}}{2} = 2\times10^{16}$.

Remaining number of nuclei after 10 days

$= 4 \times 10^{16} - 2 \times 10^{16} = 2 \times 10^{16}$.

∴ Number of decayed nuclei in next 10 days

$= \frac{2\times10^{16}}{2} = 1\times10^{16}$.

Similarly, number of decayed nuclei in next 10 days $= 0.5 \times 10^{16}$

∴ Total number of nuclei decayed after 30 days

$= 2 \times 10^{16} + 1 \times 10^{16} + 0.5 \times 10^{16} = 3.5 \times 10^{16}$.

79. (d) : The nuclear reaction is

$${}_8O^{16} + {}_1H^2 \rightarrow {}_7N^{14} + {}_2He^4$$

So when a deuteron is bombarded on ${}_8O^{16}$ nucleus then an α-particle (${}_2He^4$) is emitted and the product nucleus is ${}_7N^{14}$.

80. (a) : α-rays are positively charged particles.

81. (a) : ${}^{10}_{5}B + {}^{1}_{0}n \rightarrow {}^{4}_{2}He + {}^{7}_{3}Li$

82. (b) : $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$ $n \rightarrow$ no. of decays.

$\frac{1}{256} = \left(\frac{1}{2}\right)^8 = \left(\frac{1}{2}\right)^n$ ∴ $n = 8$

Time for 8 half life = 100 hours.

83. (b) : $2d\sin\phi = n\lambda$; $(\sin\phi)_{max} = 1$

i.e. $\lambda_{max} = 2d \Rightarrow \lambda_{max}$

$= 2 \times 2.8 \times 10^{-8} = 5.6 \times 10^{-8}$ m.

84. (a) : $E \propto \frac{Z^2}{n^2}$

85. (a) **86. (a)** **87. (c)**

88. (a) : $\upsilon \propto \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

89. (a) **90. (a)** **91. (a)**

92. (b) : Jump to second orbit leads to Balmer series. The jump from 4th orbit shall give rise to second line of Balmer series.

93. (d)

94. (b,d) : 1α reduce the mass number by 4 units and atomic number by 2 units, while 1β only increase the atomic number by 1 unit.

95. (c)

96. (c) : ${}_nX^m \xrightarrow{-1\alpha} {}_{n-2}Z^{m-4} \xrightarrow{-2\beta} {}_nX^{m-4}$.

97. (c) : Let ${}_5B^{10}$ be present as x%

and percentage of ${}_5B^{11} = (100 - x)$

∴ Average atomic coefficient $= \frac{10x + 11(100-x)}{100}$

$= 10.81$

$\Rightarrow x = 19$

∴ % of ${}_5B^{11}$ is $100 - 19 = 81$. Ratio is 19 : 81.

98. (a) : Centripetal force = force of attraction of nucleus on electron

$\frac{mv^2}{a_0} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{a_0^2}$; $v = \frac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$.

99. (d) : Energy = $h\upsilon$

$$= \frac{hc}{\lambda} = \frac{6.625\times10^{-34}\times3\times10^{8}}{21\times10^{-2}}$$

$= 0.9464 \times 10^{-24}$ J $\cong 1 \times 10^{-24}$ J.

100. (a) : For A, 80 min. = 4 half lives

No. of atoms left $= \frac{N_0}{16}$

For B, 80 min. $\cong$ 2 half lives

No. of atoms left $= \frac{N_0}{4}$. Ratio = 1 : 4.

101. (c)

102. (d) : In nuclear fission, the chain reaction is controlled in such way that only one neutron, produced in each fission, causes further fission. Therefore some moderator is used to slow down the neutrons. Heavy water is used for this purpose.

103. (c) : Energy of the ground electronic state of hydrogen atom $E = -13.6$ eV.

We know that energy of the first excited state for second orbit (where $n = 2$)

$$E_n = -\frac{13.6}{(n)^2} = -\frac{13.6}{(2)^2} = -3.4 \text{ eV}.$$

104. (b) : When a hydrogen atom is in its excited level, then $n = 2$. Therefore radius of hydrogen atom in its first excited level $(r) \propto n^2 r_0 \propto (2)^2 = 4r_0$.

105. (b) : γ-ray are most penetrating radiations.

106. (b) : By the law of photo-electric effect

$$\frac{hc}{\lambda} = eV \text{ or } \lambda = \frac{hc}{eV} \propto \frac{1}{V}.$$

107. (b) : Energy of hydrogen atom in ground state $= -13.6$ eV and quantum number $(n) = 2$.

We know that energy of hydrogen atom

$$(E_n) = -\frac{13.6}{n^2} = -\frac{13.6}{(2)^2} = -3.4 \text{ eV}.$$

108. (d) : According to Bohr's principle, radius of orbit $(r) = 4\pi\varepsilon_0 \times \frac{n^2h^2}{4\pi^2me^2} \propto n^2$. where n = principal quantum number.

109. (d) : Velocity ratio $(v_1 : v_2) = 2 : 1$.

Mass $(m) \propto$ Volume $\propto r^3$.

According to law of conservation of momentum,

$$m_1v_1 = m_2v_2$$

Therefore $\frac{v_1}{v_2} = \frac{m_2}{m_1} = \frac{r_2^3}{r_1^3}$

or $\frac{r_1}{r_2} = \left(\frac{v_2}{v_1}\right)^{1/3} = \left(\frac{1}{2}\right)^{1/3} = \frac{1}{2^{1/3}}$

or $r_1 : r_2 = 1 : 2^{1/3}$.

110. (b) : On emission of one α-particle, atomic number decreases by 2 units and atomic mass number decrease by 4 units.

Here, decrease in mass number = 200 – 168 = 32.

$\therefore$ Number of α-particles = 32/4 = 8.

While the emission of β-particle does not effect the mass number and atomic number increases by 1 unit.

$\therefore$ Number of β-particles = 16 – 10 = 6.

111. (b) : Number of nucleon on reactant side = 4

Binding energy for one nucleon = x_1

Binding energy for 4 nucleons = $4x_1$

Similarly on product side binding energy = $4x_2$

Now, Q = change in binding energy = $4(x_2 - x_1)$.

112. (a) : Half-life time = 30 minutes; Rate of decrease (N) = 5 per second and total time = 2 hours = 120 minutes. Relation for initial and final count rate $\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\text{time/half-life}} = \left(\frac{1}{2}\right)^{120/30} = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$.

Therefore $N_0 = 16 \times N = 16 \times 5 = 80$ s^{-1}.

113. (d) : Transition of hydrogen atom from orbit $n_1 = 4$ to $n_2 = 2$.

$$\text{Wave number} = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = R\left[\frac{1}{(2)^2} - \frac{1}{(4)^2}\right]$$

$$= R\left[\frac{1}{4} - \frac{1}{16}\right] = R\left[\frac{4-1}{16}\right] = \frac{3R}{16}$$

$\Rightarrow \lambda = 16/3R$.

114. (b) : P.E. $= -\frac{k\,Ze^2}{R}$ and K.E. $= \frac{1}{2}mv^2 = \frac{k\,Ze^2}{2R}$.

Therefore when a hydrogen atom is raised from the ground, it increases the value of the radius R. As a result of this, both K.E. and P.E. decrease.

115. (b)

116. (c) : Absorption spectrum involves only excitation of ground level to higher level. Therefore spectral lines 1, 2, 3 will occur in the absorption spectrum.

117. (b) : Mass number of helium $(A_{He}) = 4$ and mass number of sulphur $(A_S) = 32$.

Radius of nucleus, $r = r_0(A)^{1/3} \propto (A)^{1/3}$. Therefore

$$\frac{r_s}{r_{He}} = \left(\frac{A_s}{A_{He}}\right)^{1/3} = \left(\frac{32}{4}\right)^{1/3} = (8)^{1/3} = 2.$$

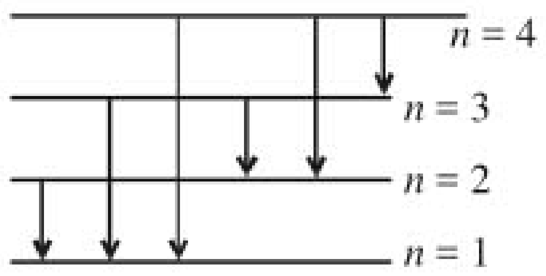
118. (b) : From binding energy curve, the curve reaches peak for $_{26}Fe^{56}$.

119. (b) : Neon street sign is a source of line emission spectrum.

120. (b) : Fission rate

$$= \frac{\text{total power}}{\dfrac{\text{energy}}{\text{fission}}} = \frac{5}{200 \times 1.6 \times 10^{-13}} = 1.56 \times 10^{11}\ \text{s}^{-1}$$

121. (b) :



No. of spectral lines $= \frac{n(n-1)}{2} = \frac{4(4-1)}{2} = 6$

122. (a) : As $r \propto n^2$, therefore, radius of 2nd Bohr's orbit $= 4a_0$

123. (a) : Fusion reaction.

124. (d) : $E = E_4 - E_3$

$$= -\frac{13.6}{4^2} - \left(-\frac{13.6}{3^2}\right) = -0.85 + 1.51 = 0.66\ \text{eV}$$

125. (c) : 1 a.m.u = 931 MeV

126. (a) : α-particle $= {}_2\text{He}^4$. It contains 2 p and 2 n. As some mass is converted into binding energy, therefore, mass of α particle is slightly less than sum of the masses of $2p$ and $2n$.

127. (d) : Clearly C and N^+ have same electronic configuration as they are isoelectronic.

128. (c) : The nuclear radius r varies with mass number A according to the relation

$r = r_0 A^{1/3} \Rightarrow r \propto A^{1/3}$ or $A \propto r^3$

Now density $= \frac{\text{mass}}{\text{volume}}$

Further mass $\propto A$ and volume $\propto r^3$

$\therefore \frac{\text{mass}}{\text{volume}} = \text{constant}$

129. (a) : Nucleus contains only neutrons and protons

130. (d) : $\frac{N}{N_0} = \left(\frac{1}{2}\right)^{6400/1600} = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$

131. (a) : $Z = 11$ *i.e.*, number of protons $= 11$, $A = 23$

$\therefore$ Number of neutrons $= A - Z = 12$

Number of electron = 0 (No electron in nucleus)

Therefore 11, 12, 0.

132. (a) : Second excited state corresponds to $n = 3$

$$\therefore E = \frac{13.6}{3^2}\ \text{eV} = 1.51\ \text{eV}$$

but one has to ionise only from ground state. Even if one has to excite an atom from $n = 3$, one has to excite from $n = 1$.

133. (c) : Nuclear force is the same between any two nucleons

134. (c) : For all first group elements, Na, K, Rb, Cs, Fr. They have one electron in the s subsell.

135. (d) : The circumference of an orbit in an atom in terms of wavelength of wave associated with electron is given by the relation,

Circumference $= n\lambda$

where $n = 1, 2, 3, \ldots$

136. (a) : As ${}_6\text{C}^{13}$ and ${}_7\text{N}^{14}$ have same no. of neutrons $(13 - 6 = 7$ for C and $14 - 7 = 7$ for N), they are isotones.

137. (c) : Nuclear forces are short range forces

138. (a) : $R \propto (A)^{1/3}$ from $R = R_0 A^{1/3}$.

$\therefore R_{\text{Al}} \propto (27)^{1/3}$ and $R_{\text{Te}} \propto (125)^{1/5}$

$$\therefore \frac{R_{\text{Al}}}{R_{\text{Te}}} = \frac{3}{5} = \frac{6}{10}$$

139. (b) : ${}_6\text{C}^{12} + {}_0n^1 \rightarrow {}_6\text{C}^{13} \rightarrow {}_7\text{N}^{13} + {}_{-1}\beta^0 + \text{Energy}$

140. (d) : Number of half lives, $n = \frac{t}{T} = \frac{6400}{800} = 8$

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^8 = \frac{1}{256}$$

141. (a) : From equation (ii), B has 2 units of charge more than C.

From equation (i), A loses 2 units of charge by emission of alpha particle. Hence, A and C are isotopes as their charge number is same.

142. (c) : Curie is a unit of radioactivity

143. (a) : Average binding energy/nucleon in nuclei is of the order of 8 MeV.

144. (b) : Bohr used quantisation of angular momentum. For stationary orbits, Angular momentum

$I\omega = \frac{nh}{2\pi}$ where $n = 1, 2, 3, \ldots$etc.

145. (d)

146. (d) : In two half lives, the activity becomes one fourth.

Activity on 1 - 8 - 91 was 2 micro curie

$\therefore$ Activity before two months,

4×2 micro-Curie = 8 micro curie

147. (d) : Two successive β decays increase the charge no. by 2.

148. (d) : $E \propto Z^2$ and Z for singly ionised helium is 2 (*i.e.*, 2 protons in the nucleus)

$\therefore (E)_{\text{He}} = 4 \times 13.6 = 54.4$ eV.

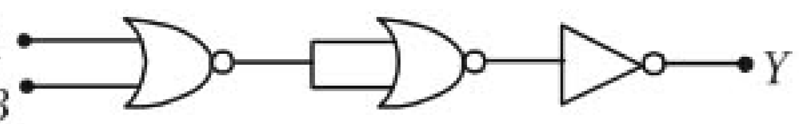
Chapter 21 Semiconductor Electronics : Materials, Devices and Simple Circuits

1. In a common emitter transistor amplifier the audio signal voltage across the collector is 3 V. The resistance of collector is 3 kΩ. If current gain is 100 and the base resistance is 2 kΩ, the voltage and power gain of the amplifier is

(a) 15 and 200 (b) 150 and 15000
(c) 20 and 2000 (d) 200 and 1000

(NEET 2017)

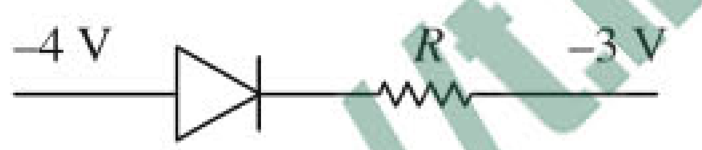
2. The given electrical network is equivalent to

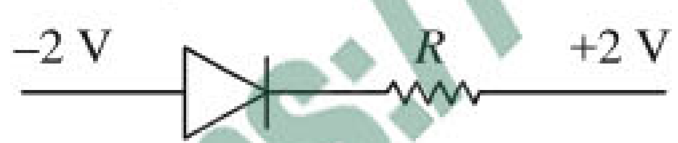


(a) OR gate (b) NOR gate
(c) NOT gate (d) AND gate

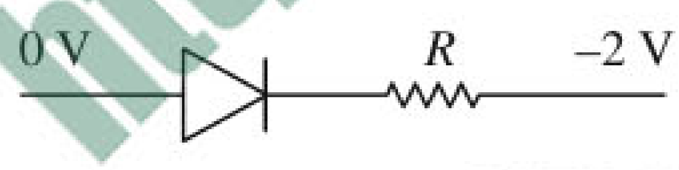
(NEET 2017)

3. Which one of the following represents forward bias diode?

(a)


(b)


(c)


(d)


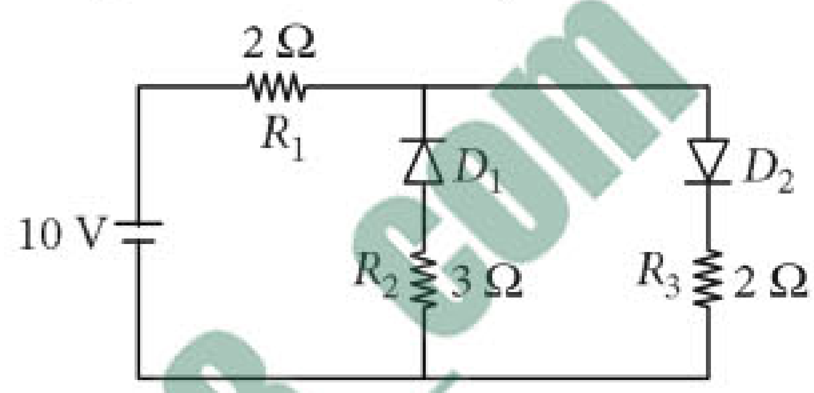
(NEET 2017, 2006)

4. For *CE* transistor amplifier, the audio signal voltage across the collector resistance of 2 kΩ is 4 V. If the current amplification factor of the transistor is 100 and the base resistance is 1 kΩ, then the input signal voltage is

(a) 10 mV (b) 20 mV
(c) 30 mV (d) 15 mV

(NEET-II 2016)

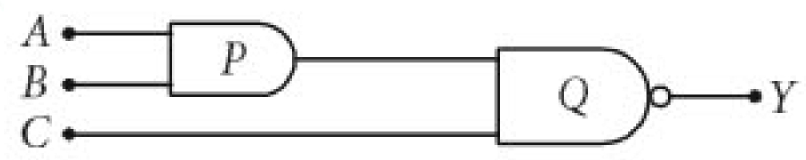
5. The given circuit has two ideal diodes connected as shown in the figure. The current flowing through the resistance R_1 will be



(a) 2.5 A (b) 10.0 A
(c) 1.43 A (d) 3.13 A

(NEET-II 2016)

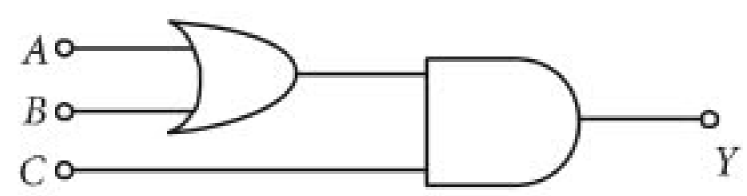
6. What is the output *Y* in the following circuit, when all the three inputs *A*, *B*, *C* are first 0 and then 1 ?



(a) 0, 1 (b) 0, 0
(c) 1, 0 (d) 1, 1

(NEET-II 2016)

7. To get output 1 for the following circuit, the correct choice for the input is



(a) $A = 1, B = 1, C = 0$
(b) $A = 1, B = 0, C = 1$
(c) $A = 0, B = 1, C = 0$
(d) $A = 1, B = 0, C = 0$

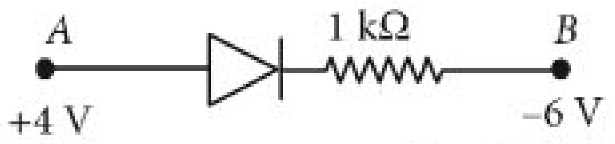
(NEET-I 2016)

8. A *npn* transistor is connected in common emitter configuration in a given amplifier. A load resistance of 800 Ω is connected in the collector circuit and the voltage drop across it is 0.8 V. If the current amplification factor is 0.96 and the input resistance of the circuit is 192 Ω, the voltage gain and the power gain of the amplifier will respectively be

(a) 4, 4 (b) 4, 3.69
(c) 4, 3.84 (d) 3.69, 3.84

(NEET-I 2016)

9. Consider the junction diode as ideal. The value of current flowing through AB is



(a) 10^{-1} A (b) 10^{-3} A
(c) 0 A (d) 10^{-2} A

(NEET-I 2016)

10. The input signal given to a CE amplifier having a voltage gain of 150 is $V_i = 2\cos\left(15t + \frac{\pi}{3}\right)$. The corresponding output signal will be

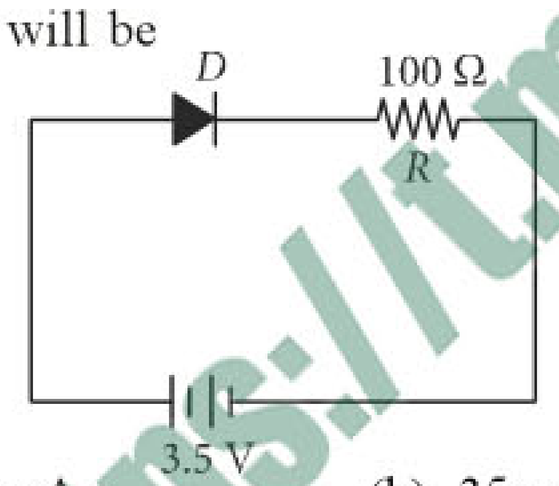
(a) $2\cos\left(15t + \frac{5\pi}{6}\right)$

(b) $300\cos\left(15t + \frac{4\pi}{3}\right)$

(c) $300\cos\left(15t + \frac{\pi}{3}\right)$

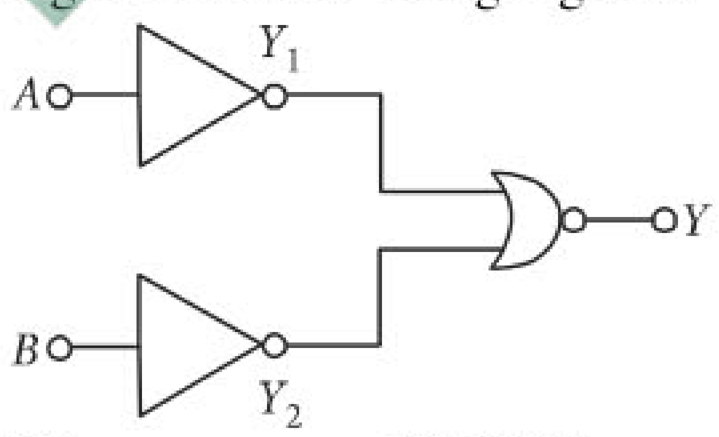
(d) $75\cos\left(15t + \frac{2\pi}{3}\right)$ *(2015)*

11. In the given figure, a diode D is connected to an external resistance R = 100 Ω and an e.m.f. of 3.5 V. If the barrier potential developed across the diode is 0.5 V, the current in the circuit will be



(a) 20 mA (b) 35 mA
(c) 30 mA (d) 40 mA *(2015)*

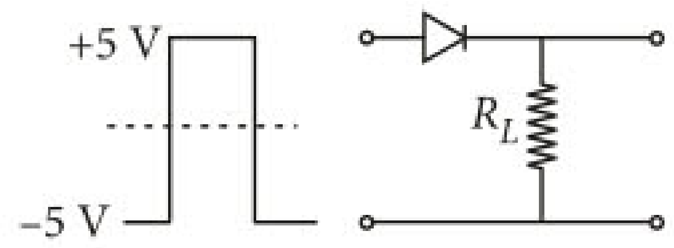
12. Which logic gate is represented by the following combination of logic gates?



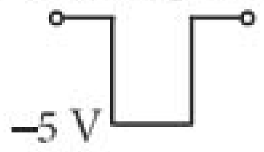
(a) AND (b) NOR
(c) OR (d) NAND

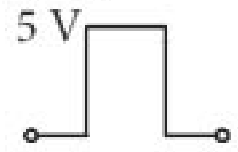
(2015 Cancelled)

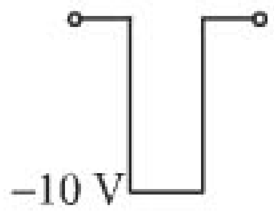
13. If in a p–n junction, a square input signal of 10 V is applied, as shown,

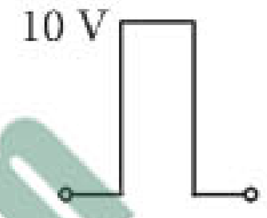


then the output across R_L will be

(a) 

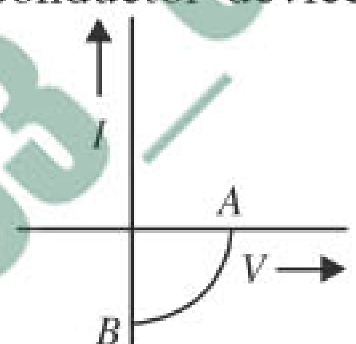
(b) 

(c) 

(d) 

(2015 Cancelled)

14. The given graph represents V-I characteristic for a semiconductor device.



Which of the following statement is correct?
(a) It is V-I characteristic for solar cell where, point A represents open circuit voltage and point B short circuit current.
(b) It is for a solar cell and points A and B represent open circuit voltage and current, respectively.
(c) It is for a photodiode and points A and B represent open circuit voltage and current, respectively.
(d) It is for a LED and points A and B represent open circuit voltage and short circuit current, respectively. *(2014)*

15. The barrier potential of a p-n junction depends on
(1) type of semiconductor material
(2) amount of doping
(3) temperature
Which one of the following is correct?
(a) (1) and (2) only (b) (2) only
(c) (2) and (3) only (d) (1), (2) and (3)

(2014)

16. In a common emitter (CE) amplifier having a voltage gain G, the transistor used has transconductance 0.03 mho and current gain 25. If the above transistor is replaced with another one with transconductance 0.02 mho and current gain 20, the voltage gain will be

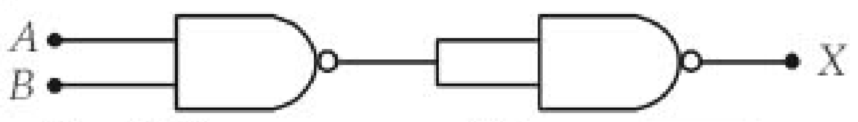
(a) $\frac{1}{3}G$ (b) $\frac{5}{4}G$

(c) $\frac{2}{3}G$ (d) 1.5G

(NEET 2013)

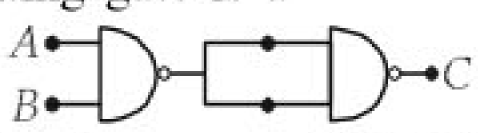
17. In a n-type semiconductor, which of the following statement is true.
(a) Holes are minority carriers and pentavalent atoms are dopants.
(b) Holes are majority carriers and trivalent atoms are dopants.
(c) Electrons are majority carriers and trivalent atoms are dopants.
(d) Electrons are minority carriers and pentavalent atoms are dopants.
(NEET 2013)

18. The output (X) of the logic circuit shown in figure will be



(a) $X = A.B$ (b) $X = \overline{A+B}$
(c) $X = \overline{\overline{A}}.\overline{\overline{B}}$ (d) $X = \overline{A.B}$
(NEET 2013)

19. The output from a NAND gate is divided into two in parallel and fed to another NAND gate. The resulting gate is a

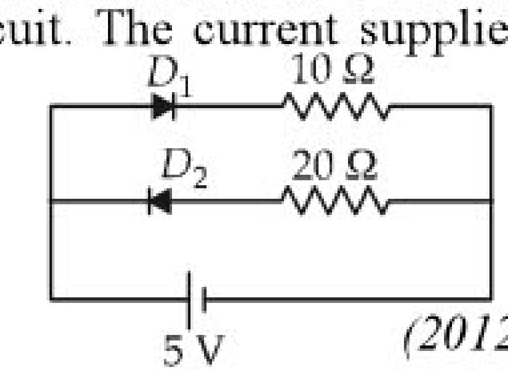


(a) AND gate (b) NOR gate
(c) OR gate (d) NOT gate
(Karnataka NEET 2013)

20. One way in which the operation of a n-p-n transistor differs from that of a p-n-p
(a) The emitter junction injects minority carriers into the base region of the p-n-p
(b) The emitter injects holes into the base of the p-n-p and electrons into the base region of n-p-n
(c) The emitter injects holes into the base of n-p-n
(d) The emitter junction is reversed biased in n-p-n *(Karnataka NEET 2013)*

21. In an unbiased p-n junction, holes diffuse from the p-region to n-region because of
(a) The attraction of free electrons of n-region.
(b) The higher hole concentration in p-region than that in n-region.
(c) The higher concentration of electrons in the n-region than that in the p-region.
(d) The potential difference across the p-n junction. *(Karnataka NEET 2013)*

22. Two ideal diodes are connected to a battery as shown in the circuit. The current supplied by the battery is
(a) 0.75 A
(b) zero
(c) 0.25 A
(d) 0.5 A

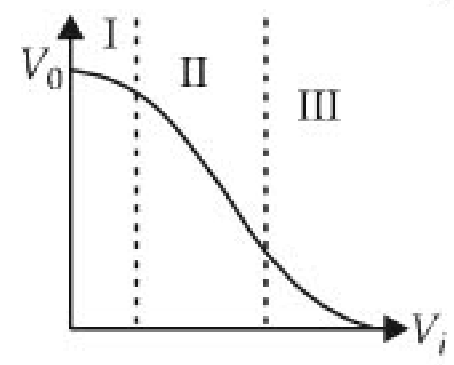


(2012)

23. In a CE transistor amplifier, the audio signal voltage across the collector resistance of 2 kΩ is 2 V. If the base resistance is 1 kΩ and the current amplification of the transistor is 100, the input signal voltage is
(a) 0.1 V (b) 1.0 V
(c) 1 mV (d) 10 mV *(2012)*

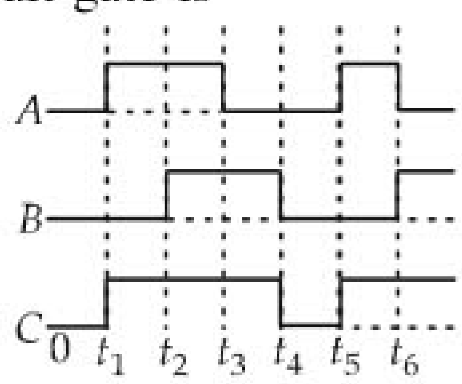
24. C and Si both have same lattice structure; having 4 bonding electrons in each. However, C is insulator where as Si is intrinsic semiconductor. This is because
(a) In case of C the valence band is not completely filled at absolute zero temperature.
(b) In case of C the conduction band is partly filled even at absolute zero temperature.
(c) The four bonding electrons in the case of C lie in the second orbit, whereas in the case of Si they lie in the third.
(d) The four bonding electrons in the case of C lie in the third orbit, whereas for Si they lie in the fourth orbit. *(2012)*

25. Transfer characteristics [output voltage (V_0) vs input voltage (V_i)] for a base biased transistor in CE configuration is as shown in the figure. For using transistor as a switch, it is used



(a) in region III
(b) both in region (I) and (III)
(c) in region II
(d) in region I *(2012)*

26. The figure shows a logic circuit with two inputs A and B and the output C. The voltage wave forms across A, B and C are as given. The logic circuit gate is

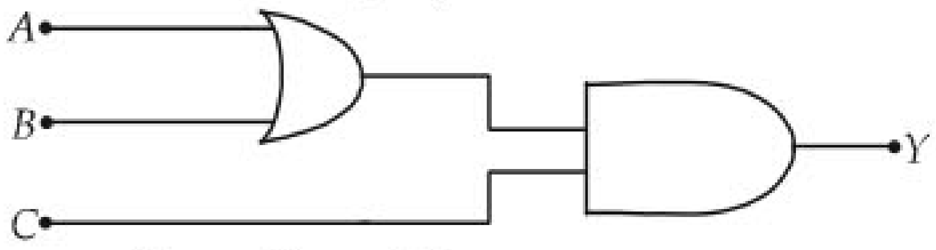


(a) OR gate (b) NOR gate
(c) AND gate (d) NAND gate
(2012)

27. The input resistance of a silicon transistor is 100 Ω. Base current is changed by 40 μA which results in a change in collector current by

2 mA. This transistor is used as a common emitter amplifier with a load resistance of 4 kΩ. The voltage gain of the amplifier is
(a) 2000 (b) 3000
(c) 4000 (d) 1000 *(Mains 2012)*

28. To get an output $Y = 1$ in given circuit which of the following input will be correct?



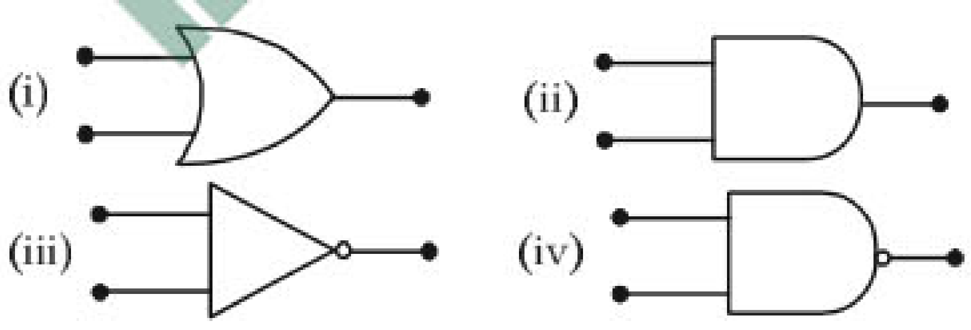
	A	B	C
(a)	1	0	0
(b)	1	0	1
(c)	1	1	0
(d)	0	1	0

(Mains 2012, 2010)

29. A transistor is operated in common emitter configuration at $V_C = 2$ V such that a change in the base current from 100 μA to 300 μA produces a change in the collector current from 10 mA to 20 mA. The current gain is
(a) 50 (b) 75
(c) 100 (d) 25 *(2011)*

30. In forward biasing of the p-n junction
(a) the positive terminal of the battery is connected to p-side and the depletion region becomes thick.
(b) the positive terminal of the battery is connected to n-side and the depletion region becomes thin.
(c) the positive terminal of the battery is connected to n-side and the depletion region becomes thick.
(d) the positive terminal of the battery is connected to p-side and the depletion region becomes thin. *(2011)*

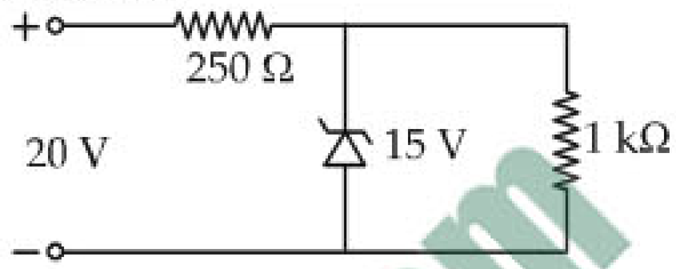
31. Symbolic representation of four logic gates are shown as



Pick out which ones are for AND, NAND and NOT gates, respectively
(a) (ii), (iii) and (iv) (b) (iii), (ii) and (i)
(c) (iii), (ii) and (iv) (d) (ii), (iv) and (iii) *(2011)*

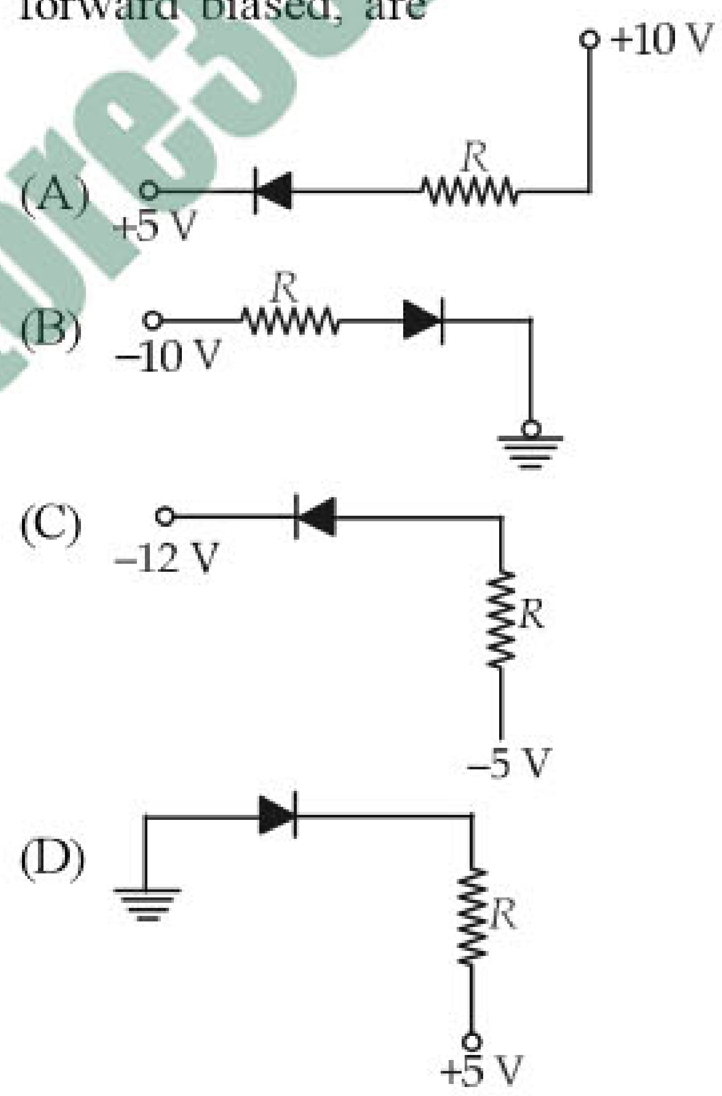
32. If a small amount of antimony is added to germanium crystal
(a) it becomes a p-type semiconductor
(b) the antimony becomes an acceptor atom
(c) there will be more free electrons than holes in the semiconductor
(d) its resistance is increased *(2011)*

33. A Zener diode, having breakdown voltage equal to 15V, is used in a voltage regulator circuit shown in figure. The current through the diode is



(a) 5 mA (b) 10 mA
(c) 15 mA (d) 20 mA *(Mains 2011)*

34. In the following figure, the diodes which are forward biased, are



(a) (A), (B) and (D) (b) (C) only
(c) (C) and (A) (d) (B) and (D) *(Mains 2011)*

35. Pure Si at 500 K has equal number of electron (n_e) and hole (n_h) concentrations of 1.5×10^{16} m^{-3}. Doping by indium increases n_h to 4.5×10^{22} m^{-3}. The doped semiconductor is of
(a) p-type having electron concentration $n_e = 5 \times 10^9$ m^{-3}
(b) n-type with electron concentration $n_e = 5 \times 10^{22}$ m^{-3}
(c) p-type with electron concentration $n_e = 2.5 \times 10^{10}$ m^{-3}
(d) n-type with electron concentration $n_e = 2.5 \times 10^{23}$ m^{-3} *(Mains 2011)*

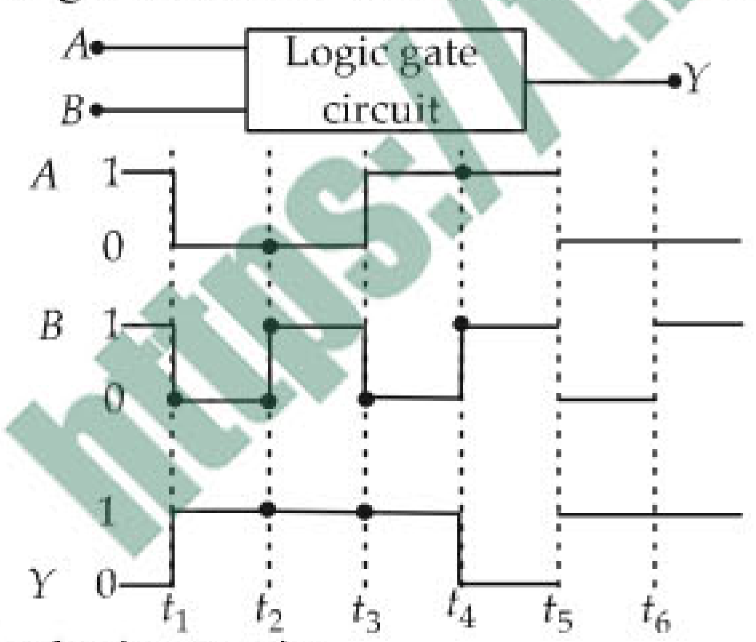
36. Which one of the following statement is false?
(a) Pure Si doped with trivalent impurities gives a *p*-type semiconductor.
(b) Majority carriers in a *n*-type semiconductor are holes.
(c) Minority carriers in a *p*-type semiconductor are electrons.
(d) The resistance of intrinisic semiconductor decreases with increase of temperature.
(2010)

37. Which one of the following bonds produces a solid that reflects light in the visible region and whose electrical conductivity decreases with temperature and has high melting point?
(a) metallic bonding
(b) van der Waal's bonding
(c) ionic bonding
(d) covalent bonding *(2010)*

38. The device that can act as a complete electronic circuit is
(a) junction diode (b) integrated circuit
(c) junction transistor (d) zener diode
(2010)

39. A common emitter amplifier has a voltage gain of 50, an input impedance of 100 Ω and an output impedance of 200 Ω. The power gain of the amplifier is
(a) 500 (b) 1000
(c) 1250 (d) 50 *(2010)*

40. The following figure shows a logic gate circuit with two inputs *A* and *B* and the output *Y*. The voltage waveforms of *A*, *B* and *Y* are as given.

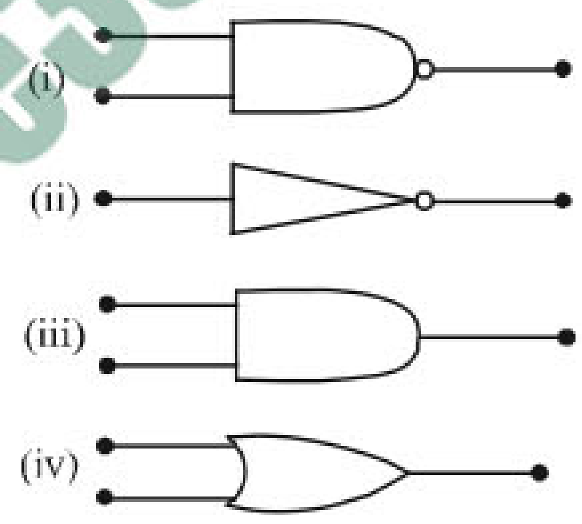


The logic gate is
(a) NOR gate (b) OR gate
(c) AND gate (d) NAND gate
(Mains 2010)

41. For transistor action
(1) Base, emitter and collector regions should have similar size and doping concentrations.
(2) The base region must be very thin and lightly doped.
(3) The emitter-base junction is forward biased and base-collector junction is reverse biased.
(4) Both the emitter-base junction as well as the base-collector junction are forward biased.
Which one of the following pairs of statements is correct?
(a) (4) and (1) (b) (1) and (2)
(c) (2) and (3) (d) (3) and (4)
(Mains 2010)

42. A *p-n* photodiode is fabricated from a semiconductor with a band gap of 2.5 eV. It can detect a signal of wavelength
(a) 4000 nm (b) 6000 nm
(c) 4000 Å (d) 6000 Å *(2009)*

43. The symbolic representation of four logic gates are given below



The logic symbols for OR, NOT and NAND gates are respectively
(a) (iv), (i), (iii) (b) (iv), (ii), (i)
(c) (i), (iii), (iv) (d) (iii), (iv), (ii)
(2009)

44. A transistor is operated in common-emitter configuration at $V_C = 2$ V such that a change in the base current from 100 μA to 200 μA produces a change in the collector current from 5 mA to10 mA. The current gain is
(a) 100 (b) 150
(c) 50 (d) 75 *(2009)*

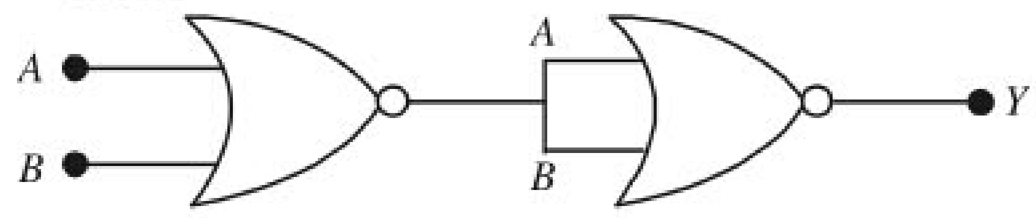
45. Sodium has body centred packing. Distance between two nearest atoms is 3.7 Å. The lattice parameter is
(a) 4.3 Å (b) 3.0 Å
(c) 8.6 Å (d) 6.8 Å *(2009)*

46. A *p-n* photodiode is made of a material with a band gap of 2.0 eV. The minimum frequency of the radiation that can be absorbed by the material is nearly
(a) 1×10^{14} Hz (b) 20×10^{14} Hz
(c) 10×10^{14} Hz (d) 5×10^{14} Hz
(2008)

47. If the lattice parameter for a crystalline structure is 3.6 Å, then the atomic radius in fcc crystal is
(a) 2.92 Å (b) 1.27 Å
(c) 1.81 Å (d) 2.10 Å *(2008)*

48. The voltage gain of an amplifier with 9% negative feedback is 10. The voltage gain without feedback will be
(a) 1.25 (b) 100
(c) 90 (d) 10 *(2008)*

49. In the following circuit, the output Y for all possible inputs A and B is expressed by the truth table.



(a)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

(b)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

(c)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

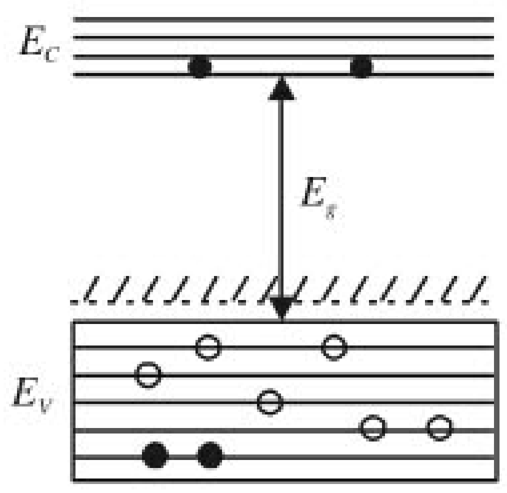
(d)

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

(2007)

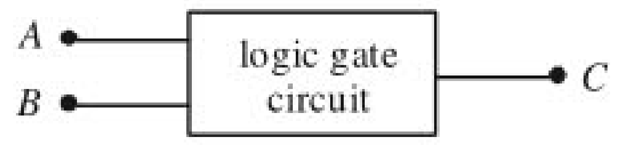
50. For a cubic crystal structure which one of the following relations indicating the cell characteristics is correct?
(a) $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90°$
(b) $a = b = c$ and $\alpha \neq \beta \neq \gamma = 90°$
(c) $a = b = c$ and $\alpha = \beta = \gamma = 90°$
(d) $a \neq b \neq c$ and $\alpha \neq \beta$ and $\gamma \neq 90°$. *(2007)*

51. In the energy band diagram of a material shown below, the open circles and filled circles denote holes and electrons respectively. The material is

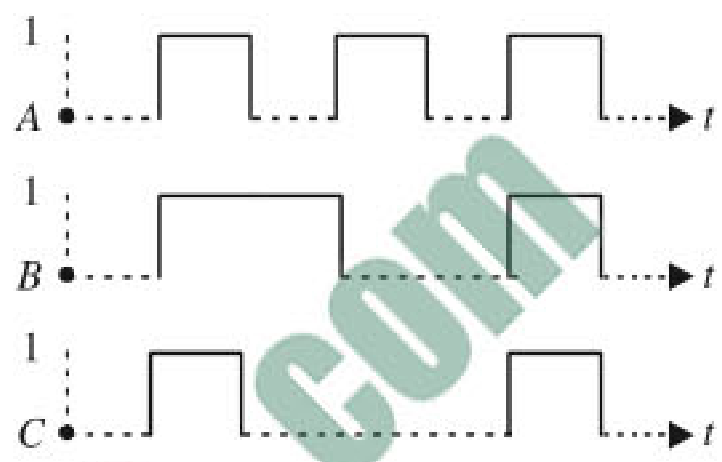


(a) an insulator (b) a metal
(c) an n-type semiconductor
(d) a p-type semiconductor. *(2007)*

52. The following figure shows a logic gate circuit with two inputs A and B and the output C.



The voltage waveforms of A, B and C are as shown below.



The logic circuit gate is
(a) OR gate (b) AND gate
(c) NAND gate (d) NOR gate. *(2006)*

53. A transistor is operated in common emitter configuration at constant collector voltage $V_C = 1.5$ V such that a change in the base current from 100 μA to 150 μA produces a change in the collector current from 5 mA to 10 mA. The current gain β is
(a) 50 (b) 67
(c) 75 (d) 100. *(2006)*

54. Choose the only false statement from the following.
(a) In conductors the valence and conduction bands overlap.
(b) Substances with energy gap of the order of 10 eV are insulators.
(c) The resistivity of a semiconductor increases with increase in temperature.
(d) The conductivity of a semiconductor increases with increase in temperature. *(2005)*

55. Zener diode is used for
(a) amplification (b) rectification
(c) stabilisation
(d) producing oscillations in an oscillator. *(2005)*

56. Application of a forward bias to a p-n junction
(a) widens the depletion zone
(b) increases the potential difference across the depletion zone

(c) increases the number of donors on the n side
(d) decreases the electric field in the depletion zone. *(2005)*

57. Carbon, silicon and germanium atoms have four valence electrons each. Their valence and conduction bands are separated by energy band gaps represented by $(E_g)_C$, $(E_g)_{Si}$ and $(E_g)_{Ge}$ respectively. Which one of the following relationships is true in their case?
(a) $(E_g)_C > (E_g)_{Si}$ (b) $(E_g)_C < (E_g)_{Si}$
(c) $(E_g)_C = (E_g)_{Si}$ (d) $(E_g)_C < (E_g)_{Ge}$. *(2005)*

58. Copper has face centered cubic (fcc) lattice with interatomic spacing equal to 2.54 Å. The value of lattice constant for this lattice is
(a) 2.54 Å (b) 3.59 Å
(c) 1.27 Å (d) 5.08 Å. *(2005)*

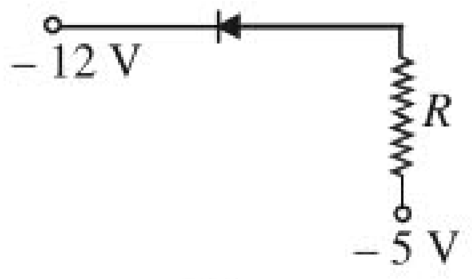
59. In a p-n junction photo cell, the value of the photo-electromotive force produced by monochromatic light is proportional to
(a) The barrier voltage at the p-n junction.
(b) The intensity of the light falling on the cell.
(c) The frequency of the light falling on the cell.
(d) The voltage applied at the p-n junction. *(2005)*

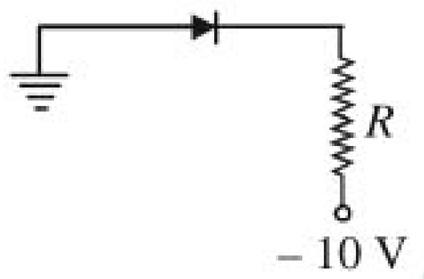
60. In semiconductors at a room temperature
(a) the valence band is partially empty and the conduction band is partially filled
(b) the valence band is completely filled and the conduction band is partially filled
(c) the valence band is completely filled
(d) the conduction band is completely empty *(2004)*

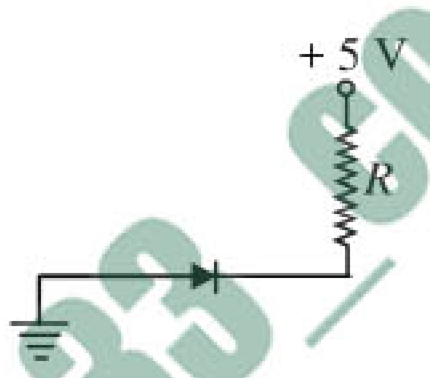
61. The peak voltage in the output of a half wave diode rectifier fed with a sinusoidal signal without filter is 10 V. The d.c. component of the output voltage is
(a) $10/\sqrt{2}$ V (b) $10/\pi$ V
(c) 10 V (d) $20/\pi$ V *(2004)*

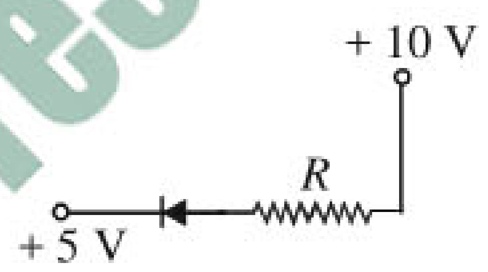
62. The output of OR gate is 1
(a) if both inputs are zero
(b) if either or both inputs are 1
(c) only if both inputs are 1
(d) if either input is zero *(2004)*

63. Of the diodes shown in the following diagrams, which one is reverse biased ?

(a)


(b)


(c)


(d)


(2004)

64. Reverse bias applied to a junction diode
(a) lowers the potential barrier
(b) raises the potential barrier
(c) increases the majority carrier current
(d) increases the minority carrier current *(2003)*

65. A n-p-n transistor conducts when
(a) both collector and emitter are positive with respect to the base
(b) collector is positive and emitter is negative with respect to the base
(c) collector is positive and emitter is at same potential as the base
(d) both collector and emitter are negative with respect to the base *(2003)*

66. If a full wave rectifier circuit is operating from 50 Hz mains, the fundamental frequency in the ripple will be
(a) 25 Hz (b) 50 Hz
(c) 70.7 Hz (d) 100 Hz *(2003)*

67. Barrier potential of a p-n junction diode does not depend on
(a) diode design (b) temperature
(c) forward bias (d) doping density *(2003)*

68. Number of atom per unit cell in B.C.C.
(a) 9 (b) 4
(c) 2 (d) 1. *(2002)*

69. For a transistor $\frac{I_C}{I_E} = 0.96$, then current gain for common emitter is
(a) 12 (b) 6
(c) 48 (d) 24. *(2002)*

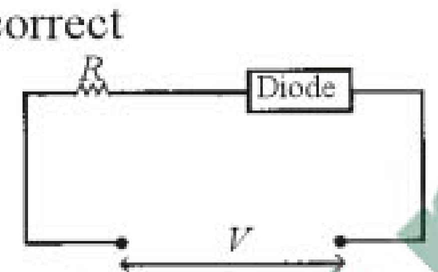
70. In a *pn* junction
(a) high potential at *n* side and low potential at *p* side
(b) high potential at *p* side and low potential at *n* side
(c) *p* and *n* both are at same potential
(d) undetermined. *(2002)*

71. The given truth table is for which logic gate

A	*B*	*Y*
1	1	0
0	1	1
1	0	1
0	0	1

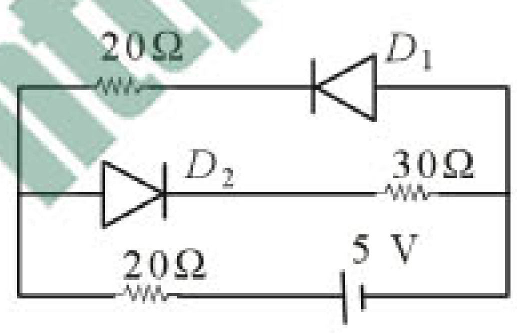
(a) NAND (b) XOR
(c) NOR (d) OR.
(2002, 2001, 1998, 1994)

72. For the given circuit of *p-n* junction diode which is correct



(a) in forward bias the voltage across *R* is *V*
(b) in reverse bias the voltage across *R* is *V*
(c) in forward bias the voltage across *R* is 2*V*
(d) in reverse bias the voltage across *R* is 2*V*. *(2002)*

73. The current in the circuit will be

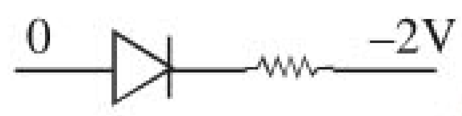


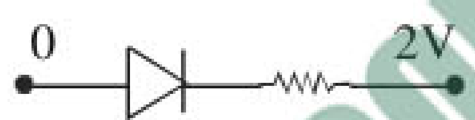
(a) 5/40 A (b) 5/50 A
(c) 5/10 A (d) 5/20. A *(2001)*

74. For a common base circuit if $\frac{I_C}{I_E} = 0.98$ then current gain for common emitter circuit will be
(a) 49 (b) 98
(c) 4.9 (d) 25.5. *(2001)*

75. The cations and anions are arranged in alternate form in
(a) metallic crystal
(b) ionic crystal
(c) covalent crystal
(d) semi-conductor crystal. *(2000)*

76. From the following diode circuit, which diode is in forward biased condition

(a) 

(b) 

(c) 

(d) 

(2000)

77. The correct relation for α, β for a transistor
(a) $\beta = \frac{1-\alpha}{\alpha}$ (b) $\beta = \frac{\alpha}{1-\alpha}$
(c) $\alpha = \frac{\beta - 1}{\beta}$ (d) $\alpha\beta = 1$. *(2000)*

78. A *p-n* junction diode can be used as
(a) condenser (b) regulator
(c) amplifier (d) rectifier *(1999)*

79. Sodium has body-centred packing. If the distance between two nearest atoms is 3.7 Å, then lattice parameter is
(a) 4.3 Å (b) 3.9 Å
(c) 3.3 Å (d) 4.8 Å *(1999)*

80. In a *p* type semiconductor, the majority carriers of current are
(a) protons (b) electrons
(c) holes (d) neutrons *(1999)*

81. In forward bias, the width of potential barrier in a *p-n* junction diode
(a) remains constant (b) decreases
(c) increases (d) first (a) then (b) *(1999)*

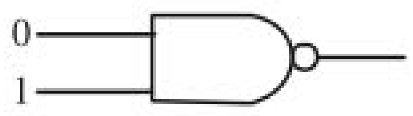
82. Depletion layer consists of
(a) mobile ions (b) protons
(c) electrons (d) immobile ions *(1999)*

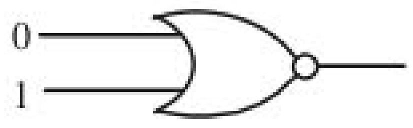
83. In a junction diode, the holes are due to
(a) extra electrons (b) neutrons
(c) protons
(d) missing of electrons *(1999)*

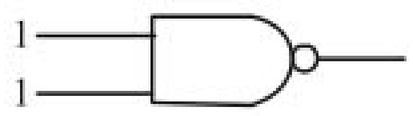
84. Which of the following, when added as an impurity into the silicon produces *n* type semiconductor?
(a) B (b) Al
(c) P (d) Mg *(1999)*

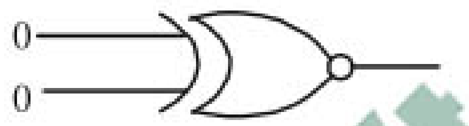
85. The cause of the potential barrier in a *p-n* diode is
(a) depletion of negative charges near the junction
(b) concentration of positive charges near the junction
(c) depletion of positive charges near the junction
(d) concentration of positive and negative charges near the junction *(1998)*

86. Which of the following gates will have an output of 1?

(a) 

(b) 

(c) 

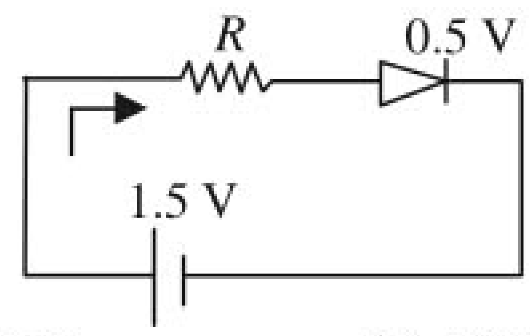
(d) 

(1998)

87. The transfer ratio β of a transistor is 50. The input resistance of the transistor when used in the common-emitter configuration is 1 kΩ. The peak value of the collector A.C. current for an A.C. input voltage of 0.01 V peak is
(a) 0.25 mA (b) 0.01 mA
(c) 100 μA (d) 500 μA *(1998)*

88. A semiconducting device is connected in a series circuit with a battery and a resistance. A current is found to pass through the circuit. If the polarity of the battery is reversed, the current drops to almost zero. The device may be
(a) a *p*-type semiconductor
(b) an intrinsic semiconductor
(c) a *p-n* junction
(d) an *n*-type semiconductor *(1998)*

89. The diode used in the circuit shown in the figure has a constant voltage drop at 0.5 V at all currents and a maximum power rating of 100 milli watts. What should be the value of the resistor *R*, connected in series with diode for obtaining maximum current?



(a) 6.76 Ω (b) 20 Ω
(c) 5 Ω (d) 5.6 Ω. *(1997)*

90. The correct relationship between the two current gains α and β in a transistor is
(a) $\alpha = \frac{\beta}{1+\beta}$ (b) $\alpha = \frac{1+\beta}{\beta}$
(c) $\beta = \frac{\alpha}{1+\alpha}$ (d) $\beta = \frac{\alpha}{\alpha-1}$. *(1997)*

91. The following truth-table belongs to which one of the following four gates?

A	*B*	*Y*
1	1	0
1	0	0
0	1	0
0	0	1

(a) XOR (b) NOR
(c) OR (d) NAND
(1997, 1995)

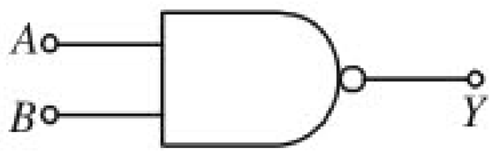
92. To obtain a *p*-type germanium semiconductor, it must be doped with
(a) indium (b) phosphorus
(c) arsenic (d) antimony. *(1997)*

93. When *npn* transistor is used as an amplifier, then
(a) electrons move from collector to base
(b) holes move from base to emitter
(c) electrons move from base to collector
(d) electrons move from emitter to base. *(1996)*

94. When arsenic is added as an impurity to silicon, the resulting material is
(a) *n*-type conductor
(b) *n*-type semiconductor
(c) *p*-type semiconductor
(d) none of these. *(1996)*

95. When using a triode, as an amplifier, the electrons are emitted by
(a) grid and collected by cathode only
(b) cathode and collected by the anode only
(c) anode and collected by cathode only
(d) anode and collected by the grid and by cathode. *(1996)*

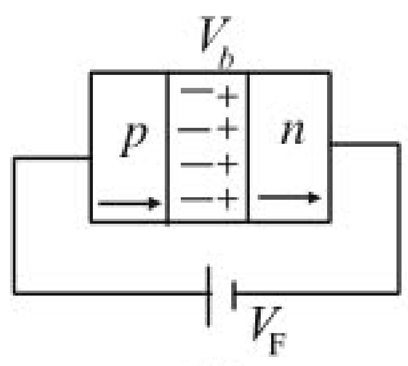
96. This symbol represents

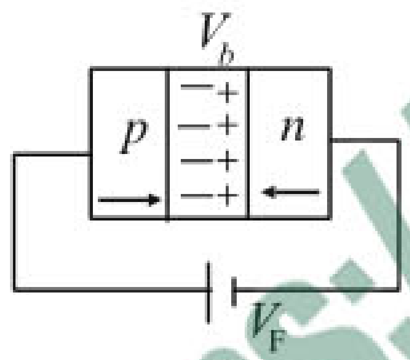


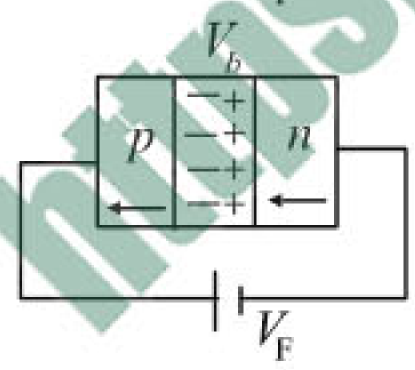
(a) AND gate (b) NOR gate
(c) NAND gate (d) OR gate. *(1996)*

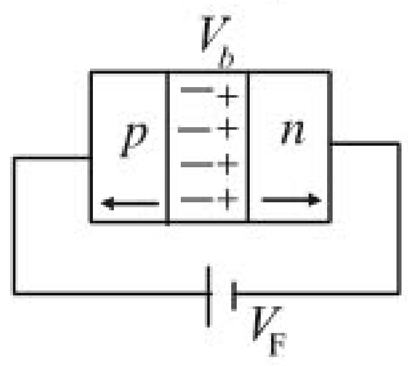
97. Distance between body centred atom and a corner atom in sodium (a = 4.225 Å) is
(a) 2.99 Å (b) 2.54 Å
(c) 3.66 Å (d) 3.17 Å. *(1995)*

98. In the case of forward biasing of p-n junction, which one of the following figures correctly depicts the direction of flow of carriers?

(a) 

(b) 

(c) 

(d) 

(1995)

99. Diamond is very hard because
(a) it is covalent solid
(b) it has large cohesive energy
(c) high melting point
(d) insoluble in all solvents *(1993)*

100. The part of the transistor which is heavily doped to produce large number of majority carriers is
(a) emitter (b) base
(c) collector
(d) any of the above depending upon the nature of transistor *(1993)*

101. Which one of the following is the weakest kind of the bonding in solids?
(a) ionic (b) metallic
(c) van der Waals (d) covalent *(1992)*

102. For amplification by a triode, the signal to be amplified is given to
(a) the cathode (b) the grid
(c) the glass envelope
(d) the anode *(1992)*

103. For an electronic valve, the plate current I and plate voltage V in the space charge limited region are related as
(a) I is proportional to $V^{3/2}$
(b) I is proportional to $V^{2/3}$
(c) I is proportional to V
(d) I is proportional to V^2 *(1992)*

104. A piece of copper and other of germanium are cooled from the room temperature to 80 K, then
(a) resistance of each will increase
(b) resistance of copper will decrease
(c) the resistance of copper will increase while that of germanium will decrease
(d) the resistance of copper will decrease while that of germanium will increase *(1992)*

105. The depletion layer in the p-n junction region is caused by
(a) drift of holes
(b) diffusion of charge carriers
(c) migration of impurity ions
(d) drift of electrons. *(1991)*

106. The following truth table corresponds to the logical gate

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(a) NAND (b) OR
(c) AND (d) XOR. *(1991)*

107. To use a transistor as an amplifier
(a) the emitter base junction is forward biased and the base collector junction is reversed biased

(b) no bias voltage is required
(c) both junction are forward biased
(d) both junction are reverse biased. *(1991)*

108. In a common base amplifier the phase difference between the input signal voltage and the output voltage is

(a) 0 (b) $\frac{\pi}{4}$
(c) $\frac{\pi}{2}$ (d) π. *(1990)*

109. When a triode is used as an amplifier the phase difference between the input signal voltage and the output is
(a) 0 (b) π
(c) $\pi/2$ (d) $\pi/4$. *(1990)*

110. When n type semiconductor is heated
(a) number of electrons increases while that of holes decreases
(b) number of holes increases while that of electrons decreases
(c) number of electrons and holes remain same
(d) number of electrons and holes increases equally. *(1989)*

111. Radiowaves of constant amplitude can be generated with
(a) FET (b) filter
(c) rectifier (d) oscillator. *(1989)*

112. p-n junction is said to be forward biased, when
(a) the positive pole of the battery is joined to the p-semiconductor and negative pole to the n-semiconductor
(b) the positive pole of the battery is joined to the n-semiconductor and p-semiconductor
(c) the positive pole of the battery is connected to n-semiconductor and p-semiconductor
(d) mechanical force is applied in the forward direction. *(1988)*

113. At absolute zero, Si acts as
(a) non metal (b) metal
(c) insulator (d) none of these. *(1988)*

Answer Key

1. (b)	**2.** (b)	**3.** (d)	**4.** (b)	**5.** (a)	**6.** (c)	**7.** (b)	**8.** (c)	**9.** (d)	**10.** (b)
11. (c)	**12.** (a)	**13.** (b)	**14.** (a)	**15.** (d)	**16.** (c)	**17.** (a)	**18.** (a)	**19.** (a)	**20.** (b)
21. (b)	**22.** (d)	**23.** (d)	**24.** (c)	**25.** (b)	**26.** (a)	**27.** (a)	**28.** (b)	**29.** (a)	**30.** (d)
31. (d)	**32.** (c)	**33** (a)	**34.** (c)	**35.** (a)	**36.** (b)	**37.** (a)	**38.** (b)	**39.** (c)	**40.** (d)
41. (c)	**42.** (c)	**43.** (b)	**44.** (c)	**45.** (a)	**46.** (d)	**47.** (b)	**48.** (b)	**49.** (c)	**50.** (c)
51. (d)	**52.** (b)	**53.** (d)	**54.** (c)	**55.** (c)	**56.** (d)	**57.** (a)	**58.** (b)	**59.** (b)	**60.** (a)
61. (b)	**62.** (b)	**63.** (c)	**64.** (b)	**65.** (b)	**66.** (d)	**67.** (a)	**68.** (c)	**69.** (d)	**70.** (a)
71. (a)	**72.** (a)	**73.** (b)	**74.** (a)	**75.** (b)	**76.** (a)	**77.** (b)	**78.** (d)	**79.** (a)	**80.** (c)
81. (b)	**82.** (d)	**83.** (d)	**84.** (c)	**85.** (d)	**86.** (a)	**87.** (d)	**88.** (c)	**89.** (c)	**90.** (a)
91. (b)	**92.** (a)	**93.** (c)	**94.** (b)	**95.** (b)	**96.** (c)	**97.** (c)	**98** (b)	**99.** (b)	**100.** (a)
101. (c)	**102.** (b)	**103.** (a)	**104.** (d)	**105.** (b)	**106.** (b)	**107.** (a)	**108.** (a)	**109.** (b)	**110.** (d)
111. (d)	**112.** (a)	**113.** (c)							

EXPLANATIONS

1. (b) : Given: $V_i = 3$ V, $R_C = 3$ kΩ, $R_B = 2$ kΩ, $\beta = 100$

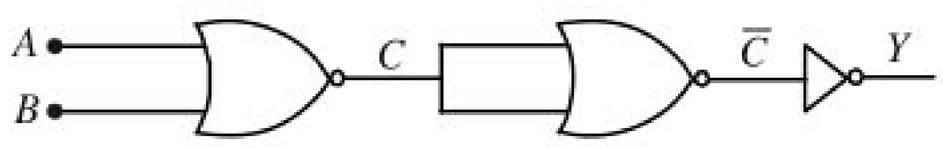
Voltage gain of the *CE* amplifier,

$$A_V = -\beta_{ac}\left(\frac{R_C}{R_B}\right) = -100\left(\frac{3}{2}\right) = -150$$

Power gain, $A_P = \beta \times A_V = 100 \times (-150)$
$= -15000$

Negative sign represents that output voltage is in opposite phase with the input voltage.

2. (b) :



A	B	C	$\bar{C}$	Output (Y)
0	0	1	0	1
0	1	0	1	0
1	0	0	1	0
1	1	0	1	0

At output, the truth table corresponds to NOR gate.

3. (d) : A diode is said to be forward biased if *p*-side is at higher potential than *n*-side of *p*-*n* junction.

4. (b) : Here, $R_C = 2$ kΩ = 2000 Ω, $V_0 = 4$ V
$\alpha = 100$, $R_B = 1$ kΩ = 1000 Ω, $V_i = ?$

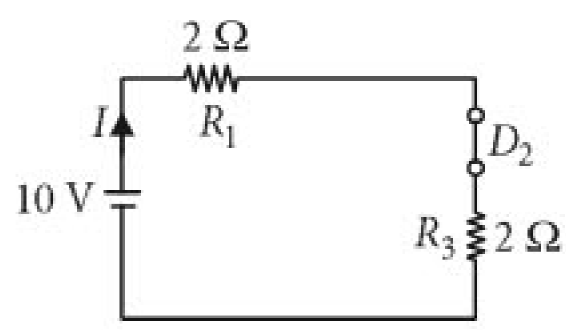
$$\text{Voltage gain, } A = \beta\frac{R_C}{R_B} = 100 \times \frac{2000}{1000} = 200$$

$$\text{Also, } A = \frac{V_0}{V_i} \text{ or } V_i = \frac{V_0}{A} = \frac{4}{200}$$

$$= \frac{2}{100}\text{ V} = 20 \text{ mV}$$

5. (a) : Diode D_1 is reverse biased so, it will block the current and diode D_2 is forward biased, so it will pass the current.

Hence, equivalent circuit becomes as shown in the figure.



Current in the circuit = Current flowing through the resistance

$$R_1 = \frac{10}{2+2} = 2.5 \text{ A}$$

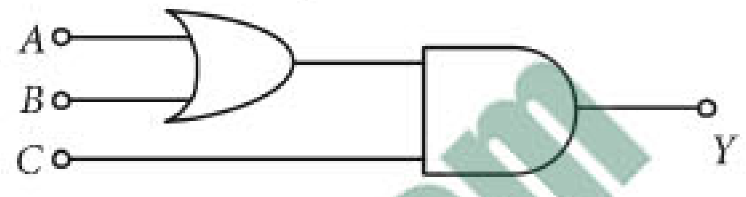
6. (c) :

$Y = \overline{(AB)C} = \overline{ABC}$

If $A = B = C = 0$ then $Y_0 = \bar{0} = 1$

If $A = B = C = 0$ then $Y_1 = \bar{1} = 0$

7. (b) :



Output of the circuit, $Y = (A + B)\cdot C$

$Y = 1$ if $C = 1$ and $A = 0$, $B = 1$

or $A = 1, B = 0$ or $A = B = 1$

8. (c) : Here, $R_0 = 800$ Ω, $R_i = 192$ Ω,
current gain, $\beta = 0.96$

Voltage gain = Current gain × Resistance gain

$$= 0.96 \times \frac{800}{192} = 4$$

Power gain = [Current gain] × [Voltage gain]
$= 0.96 \times 4 = 3.84$

9. (d) : Here, the *p*-*n* junction diode is forward biased, hence it offers zero resistance.

$$\therefore\ I_{AB} = \frac{V_A - V_B}{R_{AB}} = \frac{4\text{V} - (-6\text{V})}{1 \text{ k}\Omega} = \frac{10}{1000}\text{A} = 10^{-2}\text{A}$$

10. (b) : Here, Input signal, $V_i = 2\cos\left(15t + \frac{\pi}{3}\right)$

and voltage gain, $A_v = 150$

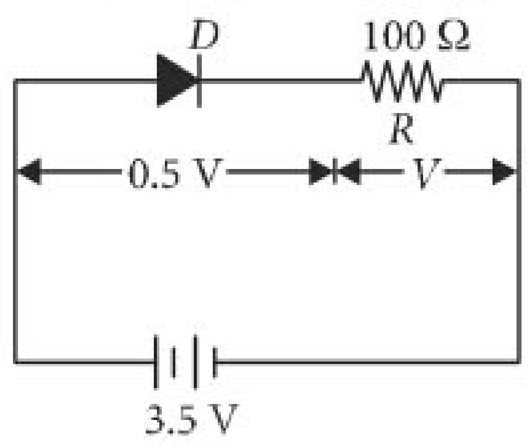
As $A_v = \dfrac{V_o}{V_i}$

$\therefore$ Output signal, $V_o = A_v V_i$

Since CE amplifier gives a phase difference of $\pi (=180°)$ between input and output signals,

$$\therefore\ V_o = 150\left[2\cos\left(15t + \frac{\pi}{3} + \pi\right)\right] = 300\cos\left(15t + \frac{4\pi}{3}\right)$$

11. (c) :



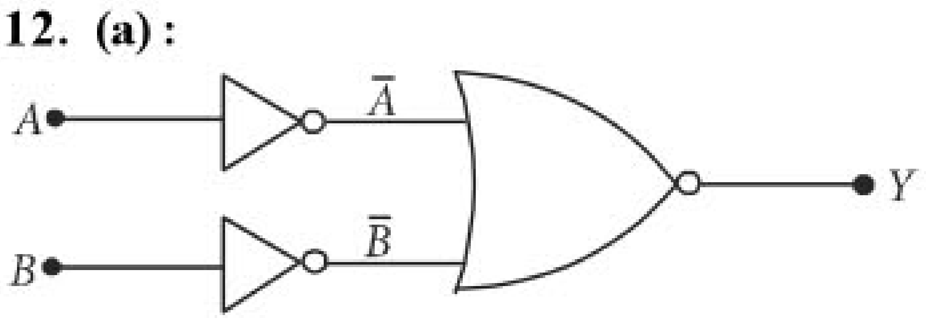
The potential difference across the resistance R is
$V = 3.5 \text{ V} - 0.5 \text{ V} = 3 \text{ V}$

By Ohm's law,

The current in the circuit is

$$I = \frac{V}{R} = \frac{3 \text{ V}}{100\ \Omega} = 3 \times 10^{-2} \text{ A} = 30 \times 10^{-3} \text{ A} = 30 \text{ mA}$$

12. (a) :

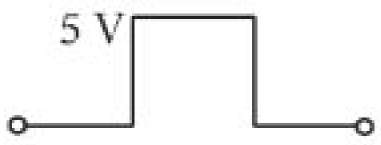


The Boolean expression of this arrangement is

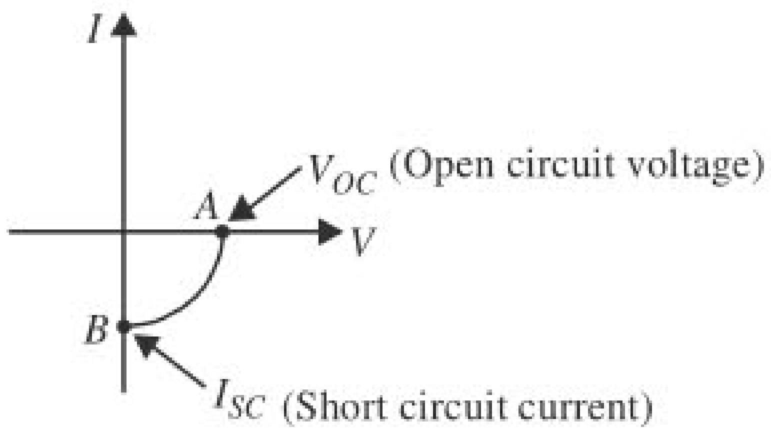
$$Y = \overline{\overline{A} + \overline{B}} = \overline{\overline{A}} \cdot \overline{\overline{B}} = A \cdot B$$

Thus, the combination represents AND gate.

13. (b) : Diode is forward bias for positive voltage *i.e.* $V > 0$, so output across R_L is given by



14. (a) : The *V-I* characteristic for a solar cell is as shown the figure.



15. (d) : The barrier potential depends on type of semiconductor (For Si, V_b = 0.7 V and for Ge, V_b = 0.3 V), amount of doping and also on the temperature.

16. (c) : Voltage gain = Current gain × Resistance gain

$$A_v = \beta \times \frac{R_{out}}{R_{in}}$$

Transconductance, $g_m = \frac{\beta}{R_{in}}$ or $R_{in} = \frac{\beta}{g_m}$

$\therefore \quad A_v = g_m R_{out}$

For first case, $A_v = G$, g_m = 0.03 mho, $\beta = 25$

$\therefore \quad G = 0.03 R_{out}$ ...(i)

For second case, $A_v = G'$, g_m = 0.02 mho, $\beta = 20$

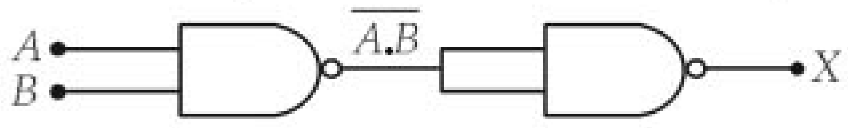
$\therefore \quad G' = 0.02 R_{out}$ ...(ii)

Divide (ii) by (i), we get

$$\frac{G'}{G} = \frac{2}{3} \text{ or } G' = \frac{2}{3} G$$

17. (a) : In *n*-type semiconductor, electrons are majority charge carriers and holes are minority charge carriers and pentavalent atoms are dopants.

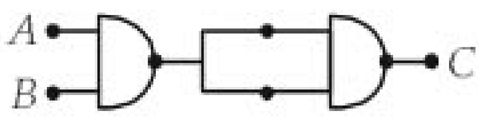
18. (a) :



The output of the given logic circuit is

$$X = \overline{\overline{A.B}} = A.B$$

19. (a) :



The output of the given logic gate is

$$C = \overline{\overline{A \cdot B}} = A \cdot B$$

It is the Boolean expression AND gate.

Hence, the resulting gate is a AND gate.

20. (b) : The emitter injects electrons into the base region of the *n-p-n* transistor and holes into the base region of *p-n-p* transistor.

21. (b) : The higher hole concentration is in *p*-region than that in *n*-region.

22. (d) : In the given circuit the upper diode D_1 is forward biased and the lower diode D_2 is reverse biased. So, the current supplied by the battery is

$$I = \frac{5\text{ V}}{10\ \Omega} = \frac{1}{2}\text{ A} = 0.5\text{ A}$$

23. (d) : Here, $R_C = 2\text{ k}\Omega = 2 \times 10^3\ \Omega$

$V_o = 2$ V, $R_B = 1\text{ k}\Omega = 1 \times 10^3\ \Omega$, $\beta = 100$

Output voltage, $V_o = I_C R_C$

$$\text{or} \quad I_C = \frac{V_o}{R_C} = \frac{2\text{ V}}{2 \times 10^3\ \Omega} = 10^{-3}\text{ A} = 1\text{ mA}$$

$$\text{As} \quad \beta = \frac{I_C}{I_B} \quad \text{or} \quad I_B = \frac{I_C}{\beta}$$

$$I_B = \frac{10^{-3}\text{A}}{100} = 10^{-5}\text{ A}$$

Input voltage, $V_i = I_B R_B = (10^{-5}\text{ A})(1 \times 10^3\ \Omega)$

$= 10^{-2}\text{ V} = 10\text{ mV}$

24. (c) : Electronic configuration of carbon (^{6}C) is $1s^2\ 2s^2\ 2p^2$. The electronic configuration of silicon ($_{14}$Si) is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$.

Hence, the four bonding electrons of C and Si respectively lie in second and third orbit.

25. (b) : In the given graph,

Region (I) – Cutoff region

Region (II) – Active region

Region (III) – Saturation region

Using transistor as a switch it is used in cutoff region or saturation region.

Using transistor as a amplifier it is used in active region.

26. (a) : The truth table of the given waveform is as shown in the table.

Time interval	Input A	Input B	Output C
0 to t_1	0	0	0
t_1 to t_2	1	0	1
t_2 to t_3	1	1	1
t_3 to t_4	0	1	1
t_4 to t_5	0	0	0
t_5 to t_6	1	0	1
$> t_6$	0	1	1

The logic circuit is OR gate.

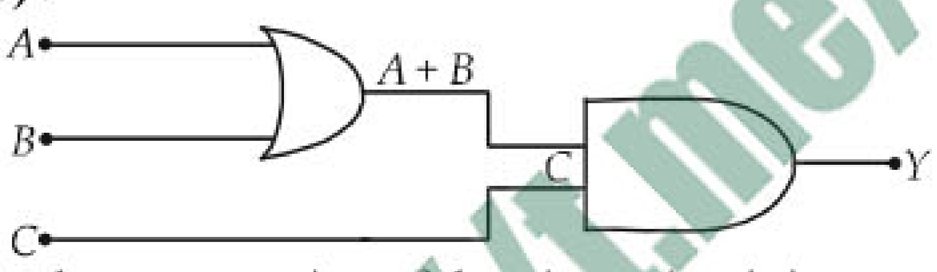
27. (a) : Here,
Input resistance, $R_i = 100\ \Omega$
Change in base current, $\Delta I_B = 40\ \mu A$
Change in collector current, $\Delta I_C = 2$ mA
Load resistance, $R_L = 4\ k\Omega = 4 \times 10^3\ \Omega$

$$\text{Current gain, } \beta = \frac{\Delta I_C}{\Delta I_B} = \frac{2\text{ mA}}{40\ \mu\text{A}} = \frac{2\times10^{-3}\text{ A}}{40\times10^{-6}\text{ A}} = 50$$

Voltage gain of the amplifier is

$$A_V = \beta\frac{R_L}{R_i} = 50\times\frac{4\times10^3}{100} = 2000$$

28. (b) :



The Boolean expression of the given circuit is
$Y = (A + B)\cdot C$
The table truth of the given inputs is as shown in the table.

Inputs			Output
A	B	C	$Y = (A + B)\cdot C$
1	0	0	0
1	0	1	1
1	1	0	0
0	1	0	0

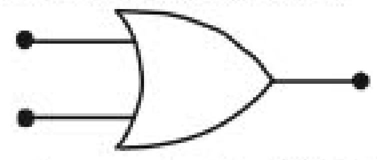
From the above truth table it is clear that $Y = 1$, when $A = 1$, $B = 0$ and $C = 1$

29. (a) : Current gain, $\beta = \dfrac{\Delta I_C}{\Delta I_B}$

$$= \frac{(20-10)\text{ mA}}{(300-100)\ \mu\text{A}} = \frac{10\times10^{-3}\text{ A}}{200\times10^{-6}\text{ A}} = 50$$

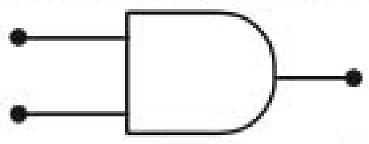
30. (d) : In forward biasing, the positive terminal of the battery is connected to p-side and the negative terminal to n-side of p-n junction. The forward bias voltage opposes the potential barrier. Due to it, the depletion region becomes thin.

31. (d) : (i)



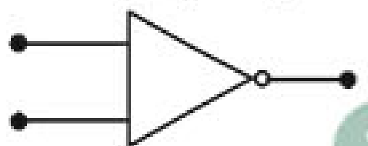
It represents logic symbol of OR gate.

(ii)



It represents logic symbol of AND gate.

(iii)



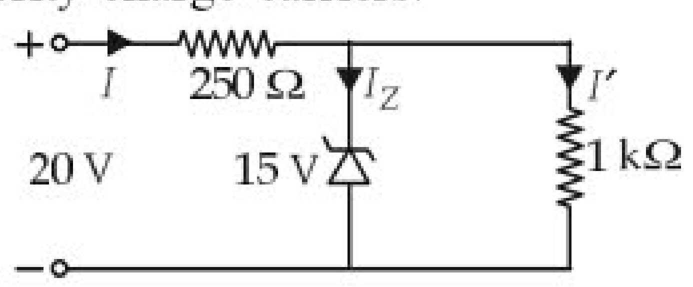
It represents the logic symbol of NOT gate.

(iv)

It represents the logic symbol of NAND gate.

32. (c) : When a small amount of antimony (pentavalent) is added to germanium (tetravalent) crystal, then crystal becomes n-type semiconductor. In n-type semiconductor electrons are the majority charge carriers and the holes are the minority charge carriers.

33. (a) :



The voltage drop across 1 kΩ = V_Z = 15 V
The current through 1 kΩ is

$$I' = \frac{15\text{ V}}{1\times10^3\ \Omega} = 15\times10^{-3}\text{ A} = 15\text{ mA}$$

The voltage drop across 250 Ω = 20 V – 15 V = 5V
The current through 250 Ω is

$$I = \frac{5\text{ V}}{250\ \Omega} = 0.02\text{ A} = 20\text{ mA}$$

The current through the zener diode is

$$I_Z = I - I' = (20-15)\text{mA} = 5\text{ mA}$$

34. (c) : p-n junction is said to be forward biased when p side is at high potential than n side. It is for circuit (A) and (C).

35. (a) : p-type semiconductor is obtained when Si or Ge is doped with a trivalent impurity like aluminium (Al), boron (B), indium (In) etc,
Here, $n_i = 1.5\times10^{16}\text{ m}^{-3}$, $n_h = 4.5\times10^{22}\text{ m}^{-3}$
As $n_e n_h = n_i^2$

$$n_e = \frac{n_i^2}{n_h} = \frac{(1.5\times10^{16}\text{ m}^{-3})^2}{4.5\times10^{22}\text{ m}^{-3}} = 5\times10^9\text{ m}^{-3}$$

36. (b) : In a *n*-type semiconductors, electrons are majority carriers and holes are minority carriers.

37. (a)

38. (b) : The device that can act as a complete circuit is integrated circuit (IC).

39. (c) : Here, Voltage gain = 50

Input resistance, R_i = 100 Ω

Output resistance, R_o = 200 Ω

$$\text{Resistance gain} = \frac{R_o}{R_i} = \frac{200\ \Omega}{100\ \Omega} = 2$$

$$\text{Power gain} = \frac{(\text{Voltage gain})^2}{\text{Resistance gain}} = \frac{50 \times 50}{2} = 1250$$

40. (d) : It is clear from given logic circuit, that out put Y is low when both the inputs are high, otherwise it is high. Thus logic circuit is NAND gate.

A	B	Y
1	1	0
0	0	1
0	1	1
1	0	1

41. (c)

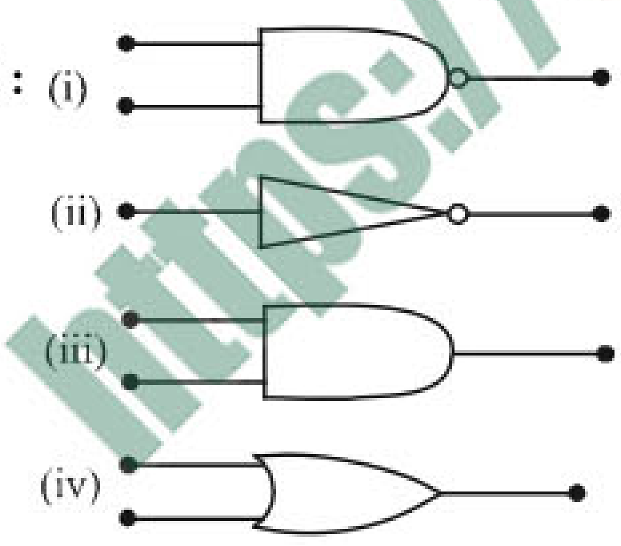
42. (c) : Band gap = 2.5 eV

The wavelength corresponding to 2.5 eV

$$= \frac{12400\ \text{eV Å}}{2.5\ \text{eV}} = 4960\ \text{Å}.$$

4000 Å can excite this.

43. (b) :



OR gate, NOT gate and NAND gates are (iv), (ii) and (i) respectively.

44. (c) : For common emitter, the current gain is

$$\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$$

i.e., at a given potential difference of *CE*

$$\beta = \frac{(10\times10^{-3} - 5\times10^{-3})\ \text{A}}{(200\times10^{-6} - 100\times10^{-6})\ \text{A}} = \frac{5\times10^{-3}}{100\times10^{-6}}$$
$$= 50.$$

45. (a) : Distance between nearest atoms in body centred cubic lattice (bcc), $d = \frac{\sqrt{3}}{2}a$

Given d = 3.7 Å,

$$a = \frac{3.7\times2}{\sqrt{3}} \simeq 4.3\ \text{Å}$$

46. (d) : Band gap = 2 eV.

Wavelength of radiation corresponding to this energy,

$$\lambda = \frac{hc}{E} = \frac{12400\ \text{eV Å}}{2\ \text{eV}} = 6200\ \text{Å}$$

The frequency of this radiation

$$= \frac{c}{\lambda} = \frac{3\times10^8\ \text{m/s}}{6200\times10^{-10}\ \text{m/s}}$$

$\Rightarrow$ $\upsilon = 5 \times 10^{14}$ Hz.

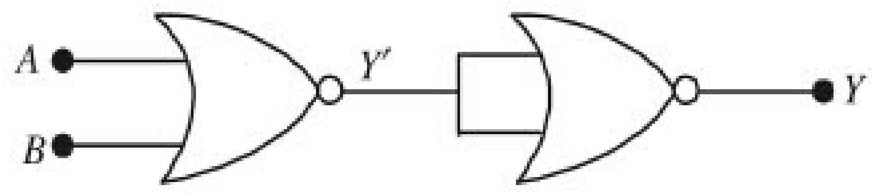
47. (b) : The atomic radius in a f.c.c. crystal is $\frac{a}{2\sqrt{2}}$

where a is the length of the edge of the crystal.

$$\therefore\ \text{Atomic radius} = \frac{3.6\ \text{Å}}{2\sqrt{2}} = 1.27\ \text{Å}$$

48. (b) : One applies negative feed-back, which reduces the output but makes it very stable. For voltage amplification amplifiers the value of output voltage without the negative feed-back could be very high. The value max shown here is 100.

49. (c) :



$$Y' = \overline{A+B} \qquad Y = \overline{\overline{A+B}} = A+B.$$

Truth table of the given circuit is given by

A	B	Y'	Y
0	0	1	0
0	1	0	1
1	0	0	1
1	1	0	1

50. (c) : In a cubic crystal structure
$a = b = c$, $\alpha = \beta = \gamma = 90°$.

51. (d) : *p*-type semiconductor.

52. (b) : The truth table corresponding to waveform is given by

A	B	C
1	1	1
0	1	0
1	0	0
0	0	0

$\therefore$ The given logic circuit gate is AND gate.

53. (d) : Current gain, $\beta = \Delta I_C/\Delta I_B$

$$= \frac{(10-5)\text{ mA}}{(150-100)\ \mu\text{A}} = \frac{5\times10^{-3}}{50\times10^{-6}} = 100.$$

54. (c) : Resistivity of a semiconductor decreases with increase in the temperature.

55. (c) : Zener diode is used for stabilisation while *p-n* junction diode is used for rectification.

56. (d)

57. (a) : Band gap of carbon is 5.5 eV while that of silicon is 1.1 eV.

$(E_g)_C > (E_g)_{Si}$

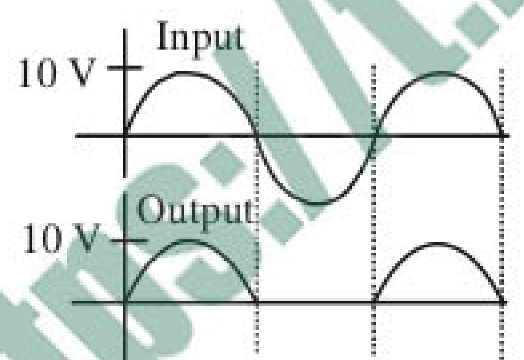
58. (b) : Lattice constant for (f.c.c.)

$= a =$ interatomic spacing $\times\ \sqrt{2}\ = 3.59$ Å.

59. (b) : In photocell, photoelectromotive force, is the force that stimulates the emission of an electric current when photovoltaic action creates a potential difference between two points and the electric current depends on the intensity of incident light.

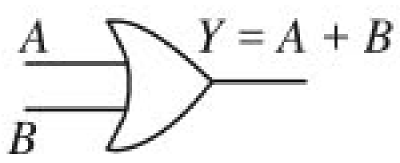
60. (a) : In semiconductors at room temperature the electrons get enough energy so that they are able to over come the forbidden gap. Thus at room temperature the valence band is partially empty and conduction band is partially filled. Conduction band in semiconductor is completely empty only at 0 K.

61. (b) : $V_{dc} = \frac{V_m}{\pi} = \frac{10}{\pi}$.



62. (b) : The truth table of OR gate is

A	*B*	*Y*
0	0	0
0	1	1
1	0	1
1	1	1



From truth table we can observe that if either of input is one then output is one. Also if both the inputs are one then also output is one.

63. (c) : A diode is said to be reverse biased if *p*-type semiconductor of *p-n* junction is at low potential with respect to *n*-type semiconductor of *p-n* junction. It is so for circuit (c).

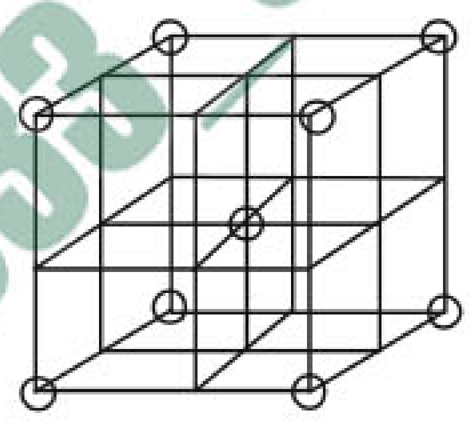
64. (b) : In reverse biasing, the conduction across the *p-n* junction takes place due to minority carriers, therefore the size of depletion region (potential barrier) rises.

65. (b) : A *n-p-n* transistor conducts when emitter-base junction is forward biased while collector-base junction is reverse biased.

66. (d) : In full wave rectifier the fundamental frequency in ripple is twice of input frequency.

67. (a) : Barrier potential depends upon temperature, doping density and forward biasing.

68. (c) : In body-centred cubic (b.c.c.) lattice there are eight atoms at the corners of the cube and one at the centre as shown in the figure.



b.c.c. structure

Therefore number of atom per unit cell

$= \frac{1}{8}\times 8 + 1 = 2$.

69. (d) : The current gain of a common emitter transistor (β) is defined as the ratio of collector current (I_C) to the base current (I_B).

Also, $I_E = I_B + I_C$; $\quad I_C/I_E = 0.96$ (given)

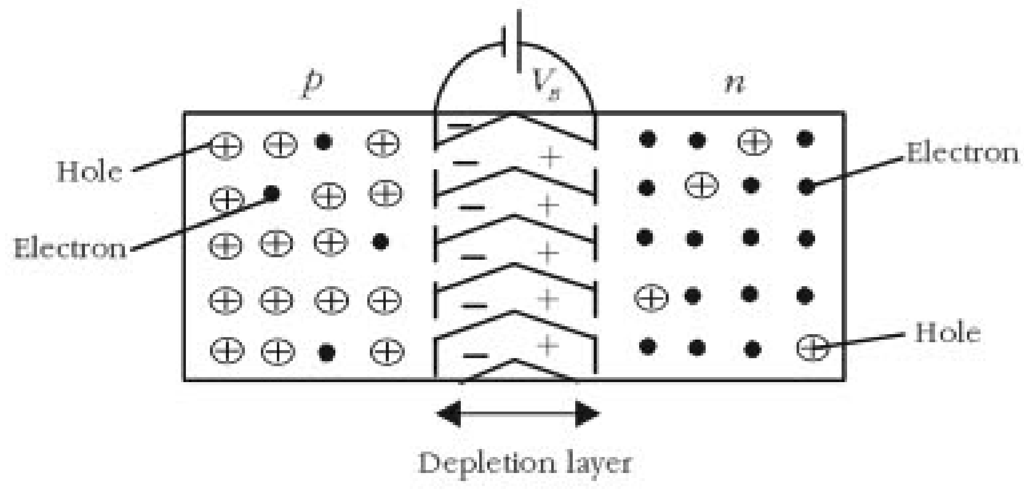
$$\therefore\ \beta = \frac{I_C}{I_B} = \frac{I_C}{I_E - I_C}$$

Now, $\frac{I_E}{I_C} = \frac{1}{0.96}$.

$$\therefore\ \frac{I_E - I_C}{I_C} = \frac{1}{0.96} - 1 = \frac{0.04}{0.96}$$

$$\therefore\ \beta = \frac{I_C}{I_E - I_C} = \frac{0.96}{0.04} = 24.$$

70. (a) :

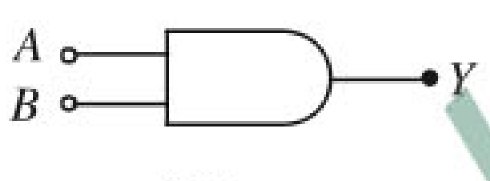


A *p-n* junction is shown in the figure. On account of difference in concentration of charge carriers in the two sections of *p-n* junction, the electrons from *n*-region diffuse through the junction into *p*-region and the holes from *p*-region diffuse into *n* region.

Since the hole is a vacancy of an electron, when an electron from *n* region diffuses into the *p*-region, the electron falls into the vacancy, *i.e.* it completes the covalent bond. Due to migration of charge carriers across the junction, the *n*-region of the junction will have its electrons neutralized by holes from the *p*-region, leaving only ionised donor atoms (positive charges) which are bound and cannot move. Similarly, the *p* region of the junction will have ionised acceptor atoms (negative charges) which are immobile.

The accumulation of electric charges of opposite polarities in the two regions of the junction gives rise to an electric field between these regions as if a fictitious battery is connected across the junction with its positive terminal connected to *n* region and negative terminal connected to *p* region. Therefore, in a *p-n* junction high potential is at N side and low potential is at P side.

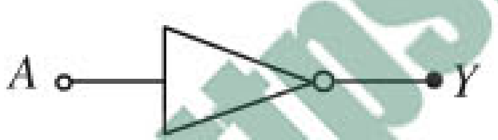
71. (a) : NAND gate is a combination of AND and NOT gate.



AND gate

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

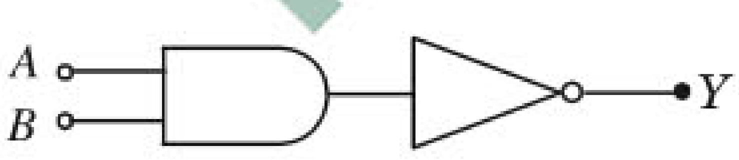
Truth table of AND gate



NOT gate

A	Y
0	1
1	0

Truth table of NOT gate



NAND gate

A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0

Truth table of NAND gate

Hence the given truth table is of a NAND gate.

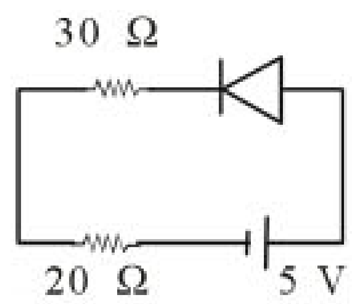
72. (a) : In forward biasing, the resistance of *p-n* junction diode is very low to the flow of current. So practically all the voltage will be dropped across the resistance R, *i.e.* voltage across R will be V.

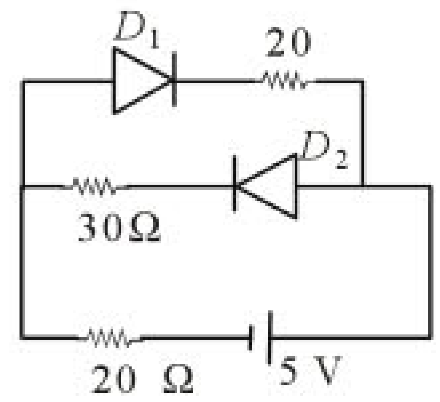
In reverse biasing, the resistance of *p-n* junction diode is very high. So the voltage drop across R is zero.

73. (b) : $D_1 \rightarrow$ reverse biased

& $D_2 \rightarrow$ forward biased.

Equivalent circuit is





$$I = \frac{5\text{ V}}{(30+20)\Omega} = \frac{5}{50}\text{ A.}$$

74. (a) : $\frac{I_C}{I_E} = \alpha = 0.98, \frac{I_C}{I_B} = \beta = \frac{\alpha}{1-\alpha} = 49$

75. (b)

76. (a) : A diode is said to be forward biased if *p*-type semiconductor of *p-n* junction is at positive potential with respect to *n*-type semiconductor of *p-n* junction. It is so for circuit (a).

77. (b) : $\beta = \frac{I_c}{I_b} = \frac{I_c}{I_e - I_c} = \frac{I_c/I_e}{1-(I_c/I_e)} = \frac{\alpha}{1-\alpha}.$

78. (d) : As a *p - n* junction diode conducts in forward bias and does not conduct in reverse bias (current is practically zero), thus undirectional property leads to application of diode in rectifiers.

79. (a) : Atomic radius for body centered cubic structure is $r = \frac{a\sqrt{3}}{4}$

or, $a = \frac{4r}{\sqrt{3}} = \frac{4(3.7/2)}{1.732} = 4.3\text{ Å}.$

80. (c)

81. (b) : In forward biasing, the conduction across *p-n* junction takes place due to migrations of majority carriers (*i.e.* electrons from *n*-side to *p*-side and holes from *p*-side to *n*-side), hence the size of depletion region decreases.

82. (d) **83. (d)**

84. (c) : Because P (phosphorus) is pentavalent.

85. (d) **86. (a)**

87. (d) : $I_b = \frac{V_{in}}{R_{in}} = \frac{0.01}{10^3}$

$$I_c = \beta I_b = 50\times\frac{0.01}{10^3} = 5\times10^{-4}\text{ A} = 500\,\mu\text{A}.$$

88. (c) : On reversing the polarity of the battery, the *p-n* junction is reverse biased. As a result of which its resistance becomes high and current through the junction drops to almost zero.

89. (c) : Voltage drop across diode (V_D) = 0.5 V; Maximum power rating of diode (P) = 100 mW $= 100 \times 10^{-3}$ W

and source voltage (V_s) = 1.5 V.

The resistance of diode (R_D)

$$= \frac{V_D^2}{P} = \frac{(0.5)^2}{100\times10^{-3}} = 2.5\ \Omega.$$

And current in diode (I_D) = $\frac{V_D}{R_D} = \frac{0.5}{2.5} = 0.2\ \Omega.$

Therefore total resistance in circuit (R)

$$= \frac{V_s}{I_D} = \frac{1.5}{0.2} = 7.5\ \Omega.$$

And the value of the series resistor

= Total resistance of the circuit – Resistance of diode

= 7.5 – 2.5 = 5 Ω.

90. (a) : Current gain (β) = $\frac{\alpha}{1-\alpha}$ or $\beta - \beta\alpha = \alpha$

or, $\beta = \alpha + \beta\alpha = \alpha(1+\beta)$ or $\alpha = \frac{\beta}{1+\beta}$.

91. (b) : For NOR gate, $Y = \overline{A+B}$. Therefore from the given truth table

A	B	$A + B$	$Y = \overline{A+B}$
1	1	1	0
1	0	1	0
0	1	1	0
0	0	0	1

92. (a) : In p type germanium semiconductor, it must be doped with a trivalent impurity atom. Since indium is a third group member, therefore germanium must be doped in indium.

93. (c) : In n-p-n transistor, the electrons are majority carriers in emitter, which move from base to collector while using n-p-n transistor as an amplifier.

94. (b) : Arsenic is pentavalent, therefore when added with silicon it leaves one electron as a free electron. In this case the conduction of electricity is due to motion of electrons, so the resulting material is n-type semiconductor.

95. (b)

96. (c) : According to figure $Y = \overline{A \cdot B}$. Therefore it is NAND gate.

97. (c) : a = 4.225 Å

For BCC cubic cell, $4r = \sqrt{3} \times a$.

Therefore $2r = \frac{\sqrt{3}\times a}{2} = \frac{1.732\times4.225}{2} = 3.66$ Å.

98. (b) : As soon as the p-n junction is formed, there is an immediate diffusion of the charge carrier across the junction due to thermal agitation. After diffusion, these charge carriers combine with their counterparts and neutralise each other. Therefore correct direction of flow carriers is depicted in figure (b).

99. (b) : Diamond is very hard due to large cohesive energy.

100. (a) : The function of emitter is to supply the majority carriers. So, it is heavily doped.

101. (c) : van der Waals bonding is the weakest bonding in solids.

102. (b) : The amplifying action of a triode is based on the fact that a small change in grid voltage causes a large change in plate current. The AC input signal which is to be amplified is superimposed on the grid potential.

103. (a) : According to Child's Law,

$I = KV^{3/2}$

Thus $I \propto V^{3/2}$

104. (d) : Copper is a conductor so its resistance decreases on decreasing temperature as thermal agitation decreases whereas germanium is semiconductor which on decreasing temperature resistance increases.

105. (b) : The depletion layer in the p-n junction region is caused by diffusion of charge carriers.

106. (b) : This truth table is of identity, $Y = A + B$, hence OR gate.

107. (a) : To use transistor as an amplifier the emitter base junction is forward bias while the collector base junction is reverse biased.

108. (a) : The phase difference between output voltage and input signal voltage in common base transistor or circuit is zero.

109. (b) : Voltage gain of an amplifier

$$= \frac{\text{Output voltage}}{\text{Input voltage}} = -\frac{\mu R_L}{R_L + r_P}$$

The negative sign indicates that the output voltage differs in phase from the input voltage by 180°(π). This holds for a pure resistive load.

110. (d) : Due to heating, when a free electron is produced than simultaneously a hole is also produced.

111. (d) : Radiowaves of constant amplitude can be produced by using oscillator with proper feedback.

112. (a) : For forward biasing of p-n junction, the positive terminal of external battery is to be connected to p semiconductor and negative terminal of battery to the n semiconductor.

113. (c) : Semiconductors are insulators at room temperature.