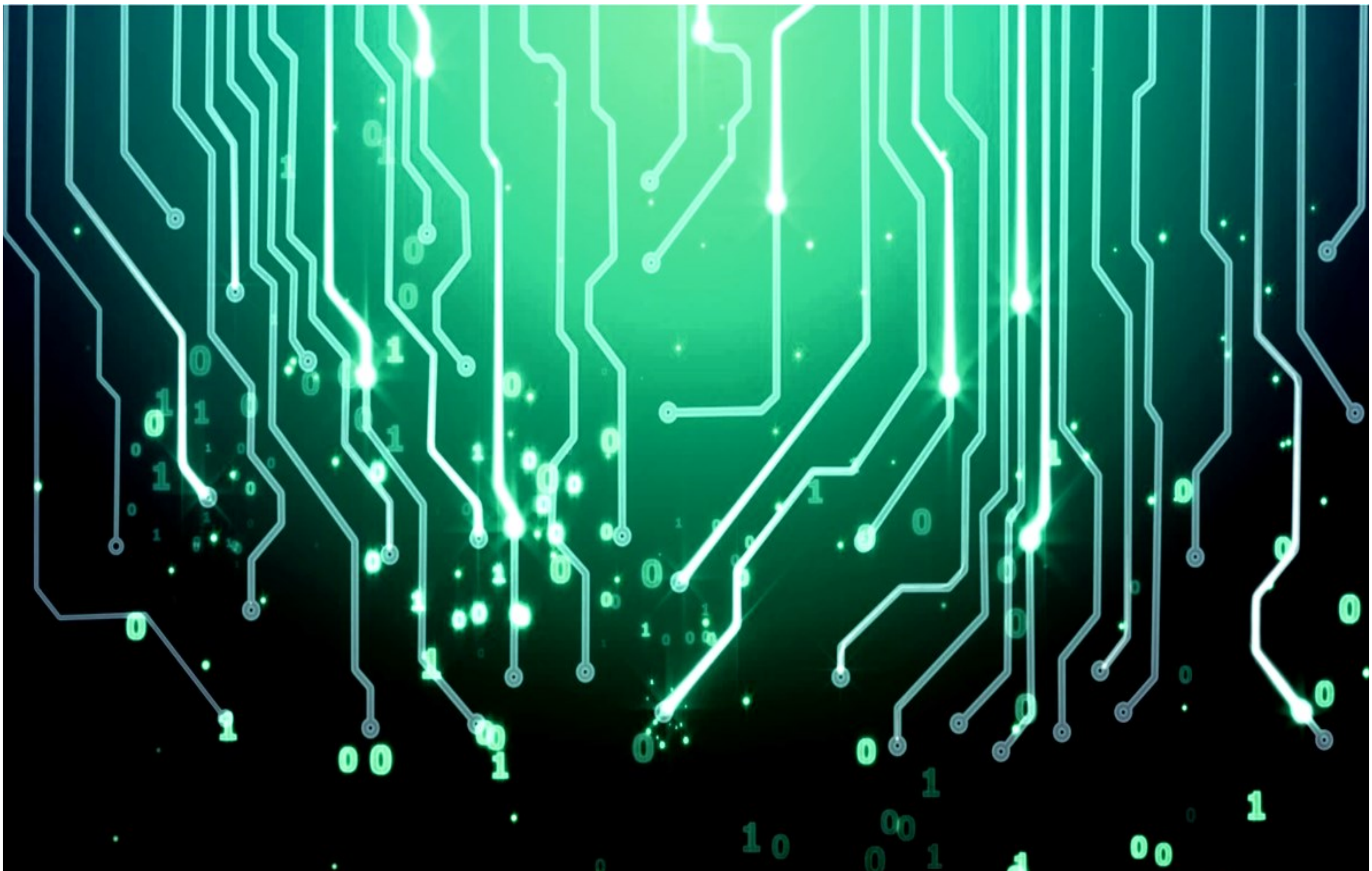

INDIA'S FIRST COLOUR SMART BOOK

PHYSICS XII

ELECTRONIC DEVICES

Key Features

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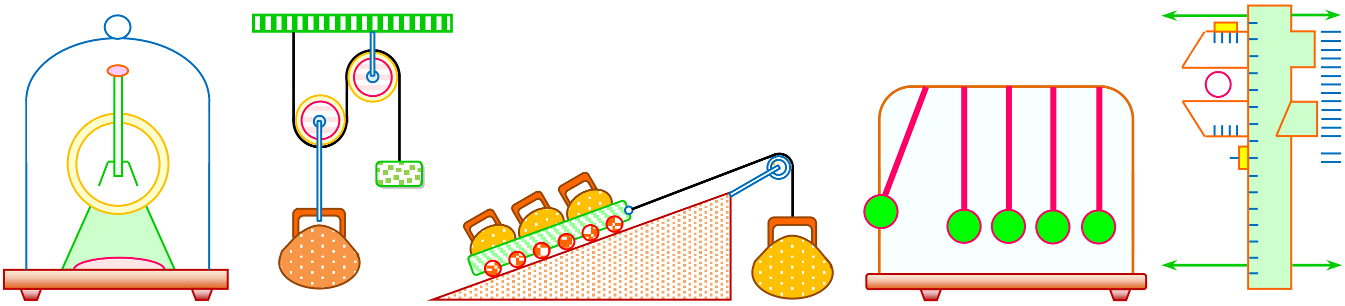


PHYSICS BOOKLET FOR JEE NEET & BOARDS

India's First Colour Smart Book

ELECTRONIC DEVICES: SOLID AND SEMICONDUCTOR DEVICES

1 SOLID STATE ELECTRONICS (SEMICONDUCTORS)

(A) Energy bands in solids:

(i) *In solids, the group of closely lying energy levels is known as energy band.*

(ii) *In solids the energy bands are analogous to energy levels in an atom.*

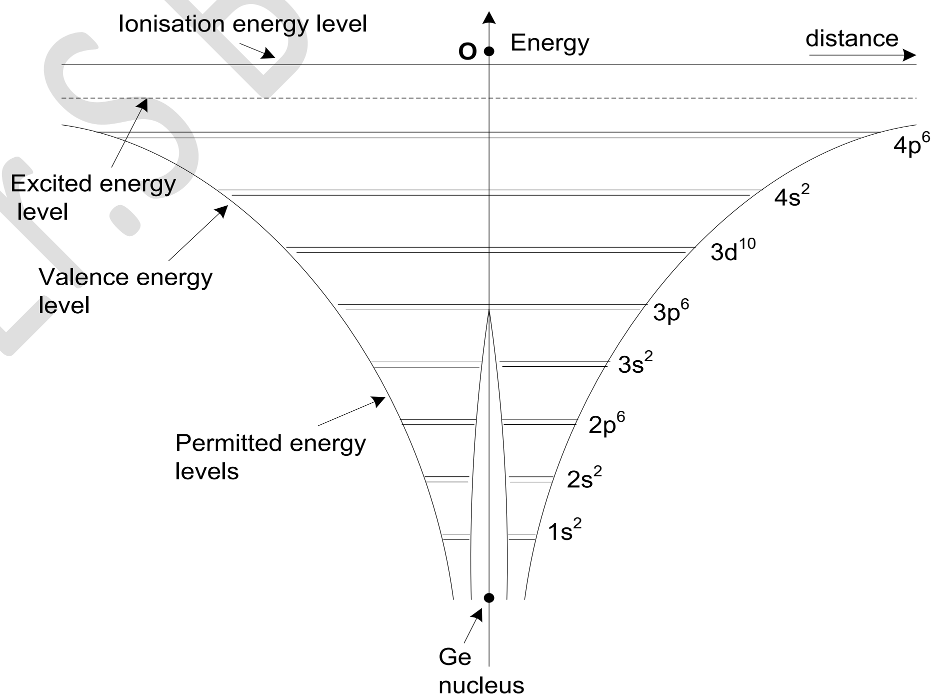
(iii) *In solids the atoms are arranged very close to each other. In these atoms there are discrete energy levels of electrons. For the formation of crystal these atoms come close together, then due to nucleus-nucleus, electron-electron and electron-nucleus interactions the discrete energy levels of atom distort and consequently each energy level spits into a large number of closely lying energy levels.*

(iv) *The number of split energy levels is proportional to the number of atoms interacting with each other. If two atoms interact then each energy level splits into two out of which one will be somewhat above and another will be somewhat below the main energy level. In solids the number of atoms is very large ($\approx 10^{23}$). Hence each energy level splits into large number of closely lying energy levels. Being very close to each other these energy levels assume the shape of a band.*

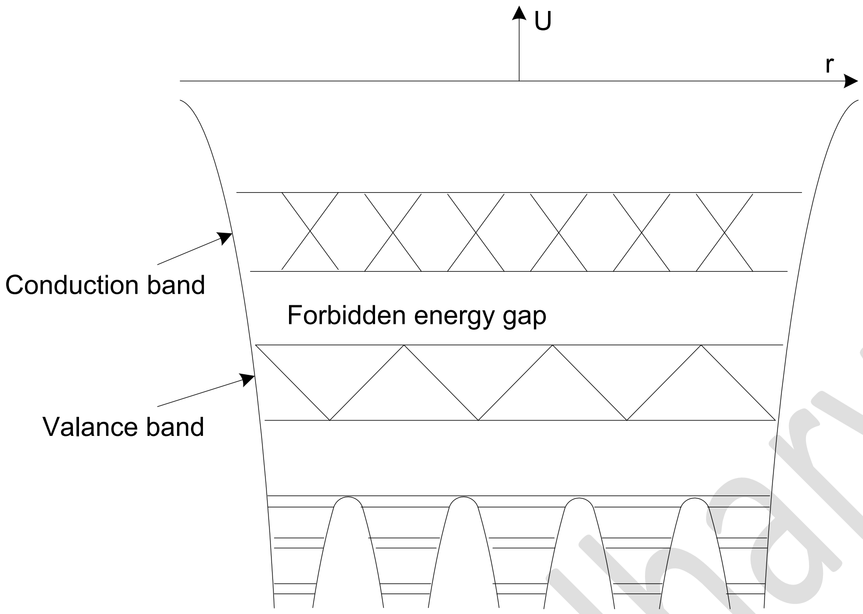
(v) *In an energy band there are 10^{23} energy levels with energy difference of 10^{-23} ev.*

(vi) *Curve between energy and distance i.e. U-r curve*

(a) When two atoms are interacting



(b) When 10^{23} atoms are mutually interacting



(vii) The are three types of energy bands in a solid viz.

(a) Valence energy band

(b) Conduction energy band

(c) Forbidden energy gap.

(viii) Difference between valence, forbidden and conduction energy bands.

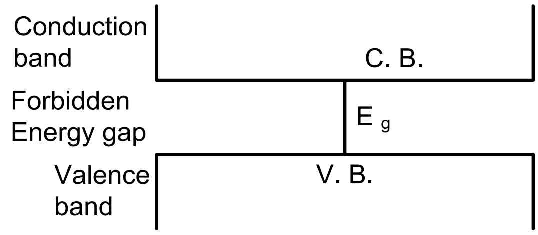
Valance Energy Band	Forbidden Energy Band	Conduction Energy Band
In this band there are valence electrons.	No electrons are found in this band	In this band the electrons are rarely found
This band may be partially or completely filled with electrons.	This band is completely empty.	This band is either empty or partially filled with electrons.
In this band the electrons are not capable of gaining energy from external electric field.		In this band the electrons can gain energy from electric field.
The electrons in this band do not contribute to electric current.		Electrons in this band contribute in this band contribute to electric current.
In this band there are electrons of outermost orbit of atom which contribute in band formation.		In this band there are electrons which are obtained on breaking the covalent bands.
This is the band of maximum energy in which the electrons are always present.		This is the band of minimum energy which is empty.
This band can never be empty.		This band can be empty.

(ix) The conduction band is also known as first permitted energy band or first band.

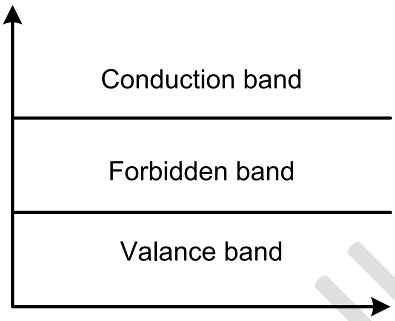
(x) Energy gap or Band gap (E_g):

(a) The minimum energy which is necessary for shifting electrons from valence band to conduction band is defined as band gap (E_g)

(b) The forbidden energy gap between the valence band and the conduction band is known as band gap (E_g). i.e. $E_g = E_c - E_v$



(xi) *As there are energy levels f electrons in an atom, similarly there are three specific energy bands for the electrons in the crystal formed by these atoms as shown in the figure*



(xii) *Completely filled energy bands: The energy band, in which maximum possible number of electrons are present according to capacity is known as completely filled bank.*

(xiii) *Partially filled energy bands: The energy band, in which number of electrons present is less than the capacity of the band, is known as partially filled energy band.*

(xiv) *Electric conduction is possible only in those solids which have empty energy band or partially filled energy band.*

2 VARIOUS TYPES OF SOLIDS

(i) On the basis of band structure of crystals, solids are divided in three categories.

(a) Insulators
(b) Semi-conductors
(c) Conductors.

(ii) Difference between Conductors, Semi-conductors and Insulators

S.No.	Property	Conductors	Semi-conductors	Insulators
1.	Electrical conductivity and its value	Very high 10^{-7} mho/m	Between those of conductors and insulators i.e. 10^{-7} mho/m to 10^{-13} mho/m	Negligible 10^{-13} mho/m
2.	Resistivity and its value	Negligible Less than 10^{-5} Ω-m	Between those of conductors and insulators i.e. 10^{-5} Ω-m to 10^{5} Ω-m	Very high more than 10^{5} Ω-m
3.	Energy gap and its value	Zero or very small	More that in con-ductors but less than that in insu-lators e.g. in Ge, ΔE_g =0.72 eV is Si, ΔE_g =1.1 eV in Ga As ΔE_g =1.3 eV	Very large e.g. in diamond ΔE_g = 7 eV

4.	Current carriers and current flow	Due to free electrons and very high	Due to free electrons and holes more than that in insulators	Due to free electrons but negligible.
5.	Number of current carriers (electrons or holes) at ordinary temperature	Very high	very low	negligible
6.	Condition of valence band and conduction band at ordinary temperature	The valence and conduction bands are completely filled or conduction band is some what empty (e.g. in Na)	Valence band in somewhat empty and conduction band is somewhat filled	Valence band is completely filled and conduction band is completely empty.
7.	Behaviour at 0 K	Behaves like a superconductor.	Behaves like an insulator	Behaves like an insulator
8.	Temperature coefficient of resistance (α)	Positive	Negative	Negative
9.	Effects of temperature on conductivity	Conductivity decreases	Conductivity increases	Conductivity increases
10.	On increasing temperature the number of current carriers	Decreases	Increases	Increases
11.	On mixing impurities their resistance	Increases	Decreases	Remains unchanged
12.	Current flow in these takes place	Easily	Very slow	Does not take place
13.	Examples	Cu, Ag, Au, Na, Pt, Hg etc.	Ge, Si, Ga, As etc.	Wood, plastic, mica, diamond, glass etc.

(iii) **Other properties of semiconductors:**

(a) Semi conducting elements are tetravalent i.e. there are four electrons in their outermost orbit.

(b) Their lattice is face centered cubic (F.C.C.)

(c) The number of electrons or cotters is given by

$$n_i = p_i = AT^{3/2}e^{-E_g/2kT}$$

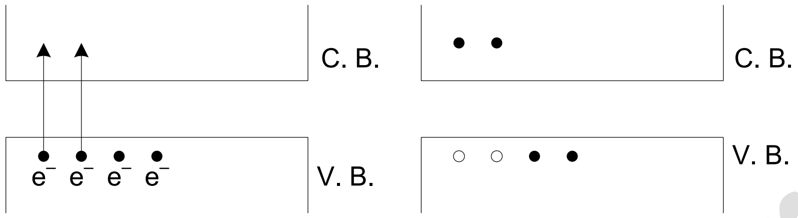
i.e. on increasing temperature, the number of current carriers increases.

(d) There are uncharged

(iv) **Holes or cotters:**

(a) The deficiency of electrons in covalent band formation in the valence band in defined as hole or cotter.

(b) These are positively charged. The value of positive charge on them is equal to the electron charge.
(c) Their effective mass is less than that of electrons.
(d) In an external electric field, holes move in a direction opposite to that of electrons i.e. they move from positive to negative terminal.
(e) They contribute to current flow.
(f) Holes are produced when covalent bonds in valence band break.



3 TYPES OF SEMICONDUCTORS AND DIFFERENCE BETWEEN THEM

(i) The semiconductors are of two types.
(a) Intrinsic or pure semiconductors
(b) Extrinsic or dopes semiconductors

(ii) **Difference between intrinsic and extrinsic semiconductors:**

S.No.	Intrinsic semiconductors	Extrinsic semiconductors
1.	Pure Ge or Si is known as intrinsic semiconductor	The semiconductor, resulting from mixing impurity in it, is known as extrinsic semiconductors.
2.	Their conductivity is low (because only one electron in 10^9 contribute)	Their conductivity is high
3.	The number of free electrons (n_i in conduction band is equal to the number of holes p_i in valence band.)	In these $n_i \neq p_i$
4.	These are not practically used	These are practically used
5.	In these the energy gap is very small	In these the energy gap is more than that in pure semiconductors.
6.	In these the Fermi energy level lies in the middle of valence band and conduction	In these the Fermi level shifts towards valence or conduction energy bands.

(iii) **Properties of intrinsic semiconductors:**
(a) At absolute zero temperature (0 K) there are no free electrons in them.
(b) At room temperature, the electron-hole pair in sufficient number are produced.
(c) Electric conduction takes place via both electrons and holes.
(d) The drift velocities of electrons and holes are different.
(e) The drift velocity of electrons (V_{dn}) is greater than that of holes (V_{dp}).
(f) The total current is $I = I_n + I_p$
(g) In connecting wires the current flows only via electrons.
(h) The current density is given by

$$J = nqV_{dn} + pqV_{dp}$$

$$\vec{J} = nq\mu_n E + pq\mu_p E = \sigma \vec{E}$$

Where V_{dn} = drift velocity of electrons
μ_n = mobility of electrons
V_{dp} = drift velocity of holes
μ_p = mobility of holes

(i) The electric conductivity is given by $\sigma = nq(\mu_n + \mu_p)$

(j) Mobility of electron $\mu_n = V_{dn}/E$

(k) Mobility of holes $\mu_p = V_{dp}/E$

(l) At room temperature $\sigma_{Ge} > \sigma_{Si}$ because $n_{Ge} > n_{Si}$

where $n_{Ge} = 2.5 \times 10^{13}/cm^3$ and $n_{Si} = 1.4 \times 10^{10}/cm^3$

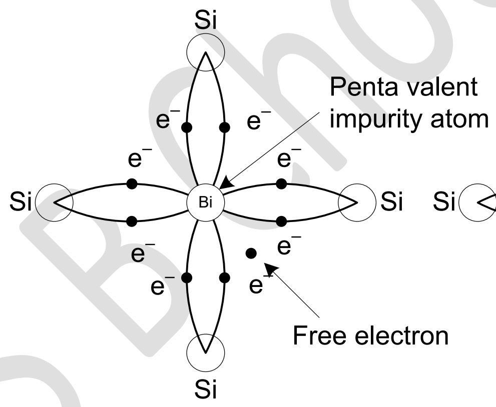
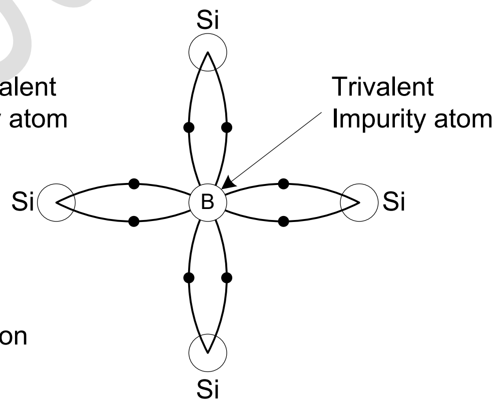
(iv) **Extrinsic semiconductors:**

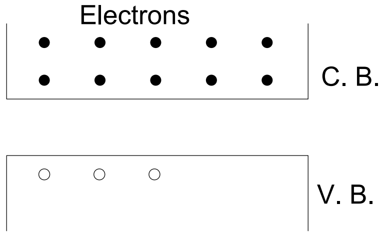
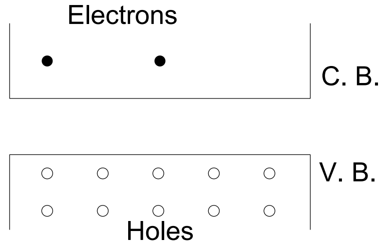
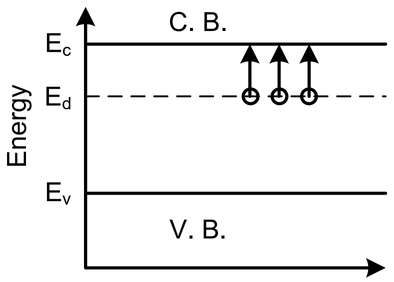
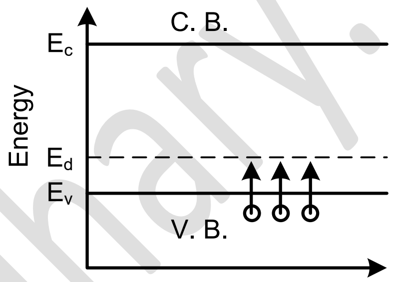
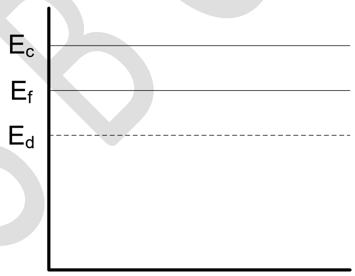
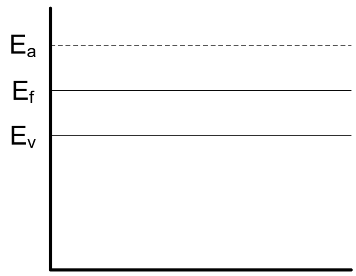
(a) **Doping:** The process of mixing impurities of other elements in pure semiconductors is known as doping.

(b) **Extrinsic semiconductors:** the semiconductors, in which trivalent and pentavalent elements are mixed as impurities, are known as extrinsic semiconductors.

(c) The extrinsic semiconductors are of two types
(i) N-type semiconductors (ii) P-type semiconductors.

(d) **Difference between N-type and P-type semiconductors**

S.No.	N-type semiconductors	P-type semiconductors
1.	In these the impurity of some pentavalent element like P, As, Sb, Bi, etc. is mixed	In these, the impurity of some trivalent element like b, Al, In, Ga etc. is mixed
2.		
3.	In these the impurity atom donates one electrons, hence these are known as donor type semiconductors	In these, the impurity atom can accept one electron, hence these are known as acceptor type semiconductors.
4.	In these the electrons are majority current carriers and holes are minority current carriers. (i.e. the electron density is more than hole density $n_n >> n_p$)	In these the holes are majority current carriers and electrons are minority current carriers i.e. $n_p >> n_n$
5.	In these there is majority of negative particles (electrons) and hence are known as N-type semiconductors	In these there is majority of positive particles (cotters) and hence are known as P-type semiconductors.

		
6.	In these the donor energy level is close to the conduction band and far away from valence band. 	In these the acceptor energy level is close to the valence band and far away from conduction band. 
7.	Current density $J_n = nq\,V_{dn}$	$J_p = pq\,V_{dp}$
8.	Electric conductivity $\sigma_n = nq\mu_n$ $\approx n_d\,q\mu_n$ Where nd = number of donor atoms / cm^3.	$\sigma_p = nq\mu_p$ $\approx n_p\,q\mu_p$ Where np = number of acceptor atoms / cm^3.
9.	The Fermi energy level lies close to conduction band (i.e. the Fermi energy level lies in between the donor energy level and conduction band)	The Fermi energy level lies close to the valence band (i.e. the Fermi energy level lies in between the acceptor energy level and valence band)
		

(v) **Conductivity formulae:**

(a) $\frac{\sigma_n}{\sigma_p} = \frac{n\mu_h}{p\mu_p}$

(b) $\frac{\sigma_n}{\sigma_p} = \frac{\mu_h}{\mu_p}$ if $n = p$

(c) $\frac{\sigma_n}{\sigma_p} = \frac{n_d\,\mu_h}{n_a\,\mu_p}$

(d) $\frac{\sigma_{ext}}{\sigma_{int}} = \frac{n_d}{n_i}$

(vi) **Resistivity formulae:**

(a) $r_i = \dfrac{1}{qn_i(m_n + m_p)}$

(b) $r_n = \dfrac{1}{m_n q_n}$

(c) $r_p = \dfrac{1}{m_p qp}$

(d) $\dfrac{r_n}{r_p} = \dfrac{m_p P}{m_n n}$

(e) $\dfrac{r_n}{r_p} = \dfrac{m_p}{m_n}$

(f) $\dfrac{r_1}{r_2} = \dfrac{s_1}{s_2}$

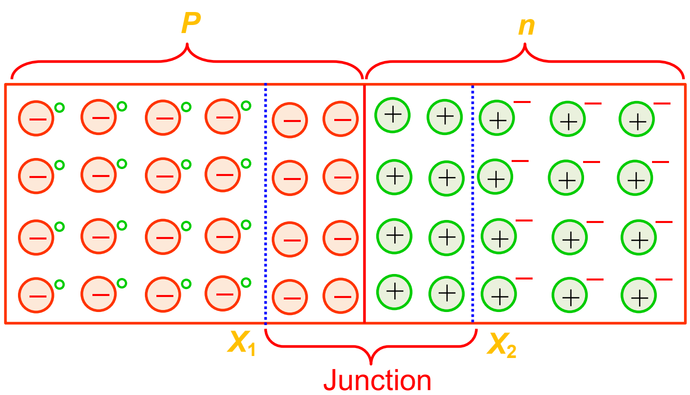
(vii) **Characterizes Si and Ge at 300 K**

Characteristics	Ge	Si
Energy gap	0.7 (eV)	1.1 (eV)
Electron mobility (μ_n)	0.39 ($M^2V^{-1}S^{-1}$)	0.135 ($M^2V^{-1}S^{-1}$)
Cotter mobility (μ_p)	0.19 ($M^2V^{-1}S^{-1}$)	0.048 ($M^2V^{-1}S^{-1}$)
Intrinsic current concentration	$n_i = 2.4 \times 10^{19}$ cm^{-3}	$n_i = 1.5 \times 10^{16}$ cm^{-3}
Resistivity	0.46 Ω-m	2300 Ω-m
Potential barrier	0.3 V	0.7 V

4 SEMICONDUCTOR DIODE OR P-N JUNCTION, CONDUCTION IN P-N JUNCTION, DEPLETION LAYER AND BARRIER ENERGY

P-N Junction

(a) The device formed by joining atomically a wafer of P-type semiconductor to the wafer of N-type semiconductor is known as P-N junction.



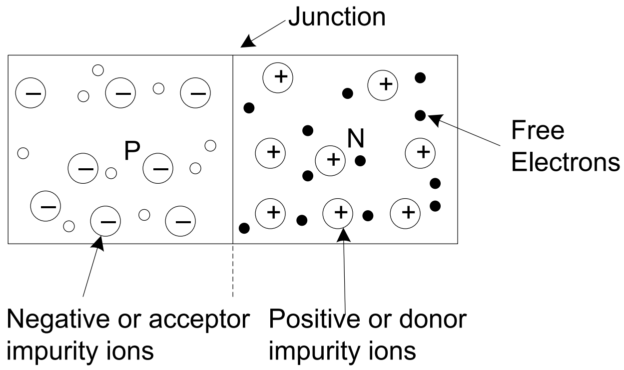
(a)

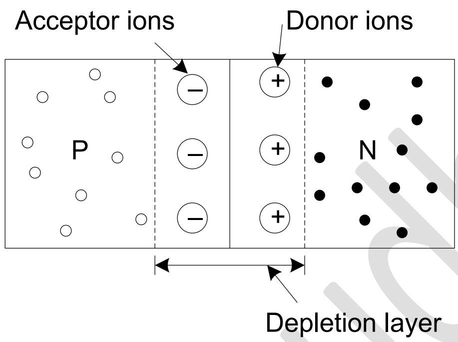
(b) There are three processes of making junctions

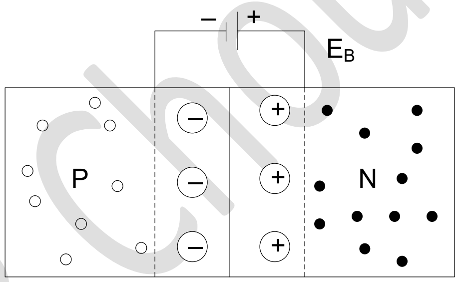
(i) Diffusion (ii) Alloying (iii) Growth

In majority of cases P-N junction is formed by diffusion process. The impurity concentration is maximum at surface and decreases gradually inside the semiconductor.

(c) **Conduction of current in P-N Junction:**







(i) In P-N junction the majority cotters in P-region and majority electrons in N-region start diffusing due to concentration gradient and thermal disturbance towards N-region and P-region respectively and combine respectively with electrons and cotters and become neutral.

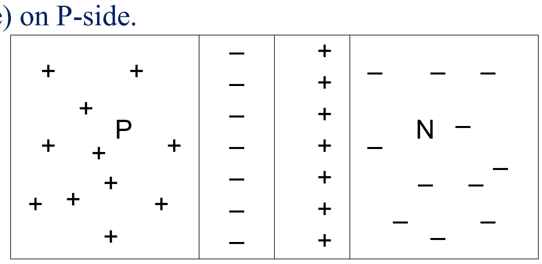
(ii) In this process of neutralization there occurs deficiency of free current carriers near the junction and layers of positive ions in N-region and negative ions in P-region are formed. These ions are immobile. Due to this an imaginary battery or internal electric field is formed at the junction which is directed from N to P.

(iii) **Depletion layer:**

(a) The region on both sides of P-N junction in which there is deficiency of free current carriers, is known as the depletion layer.

(b) Its thickness is of the order of 1 μm (= 10^{-6})

(c) On two sides of it, there are ions of opposite nature. i.e. donor ion (+ve) on N-side and acceptor ions (–ve) on P-side.



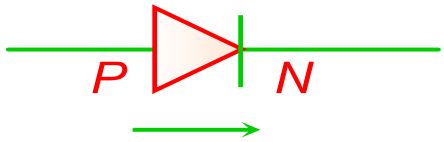
(d) This stops the free current carriers to crossover the junction and consequently a potential barrier is formed at the junction.

(e) The potential difference between the ends of this layer is defined as the contact potential or potential barrier (V_B).

(f) The value of V_B is from 0.1 to 0.7 volt which depends on the temperature of the junction. It also depends on the nature of semiconductor and the doping concentration. For germanium and silicon its values are 0.3 V and 0.7 V respectively.

(g) **P-N Junction diode or semiconductor diode:**

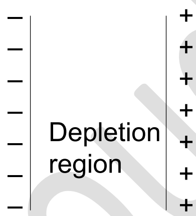
(i) **Symbolic representation of diode:**



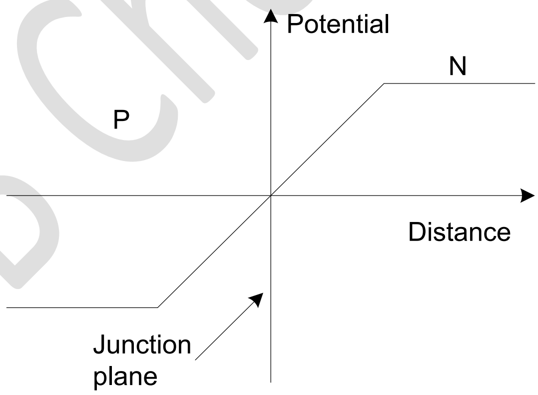
(ii) The direction of current flow is represented by the arrow head.

(iii) In equilibrium state current does not flow in the junction diode.

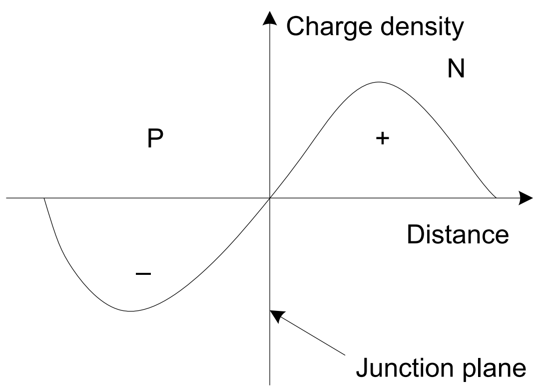
(iv) In can be presumed to be equivalent to a condenser in which the depletion layer acts as a dielectric.



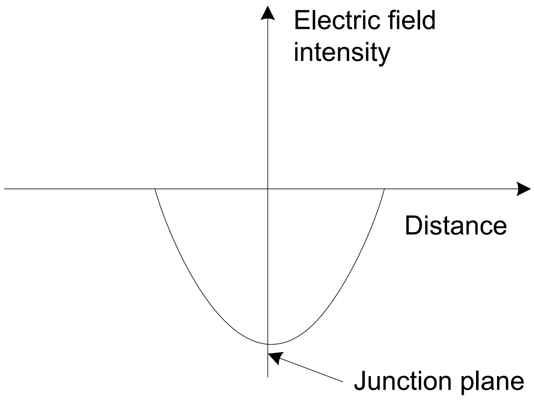
(v) **Potential distance curve at P-N Junction**

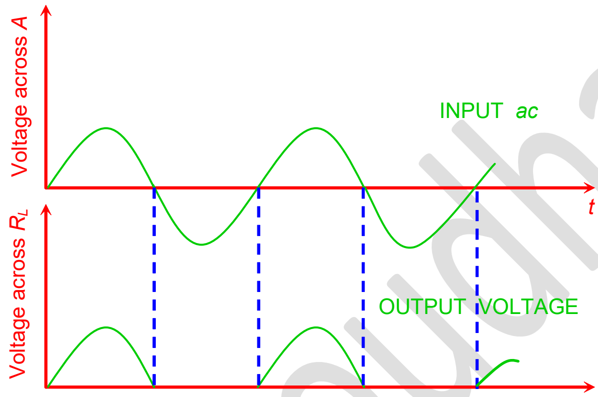


(vi) **Charge density curve at P-N Junction**



(vii) **Curve between electric field and distance near P-N junction**



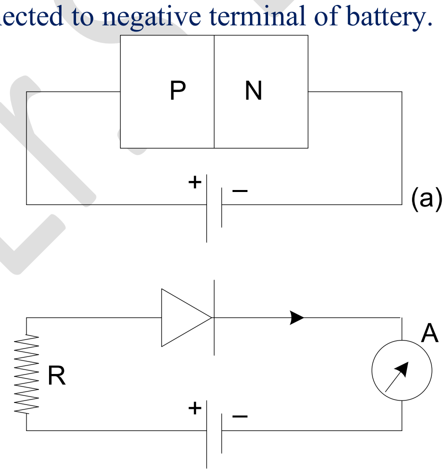
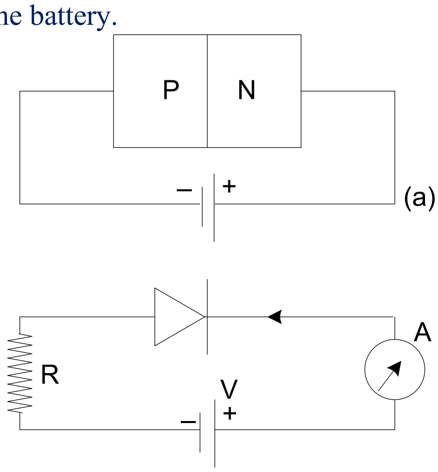


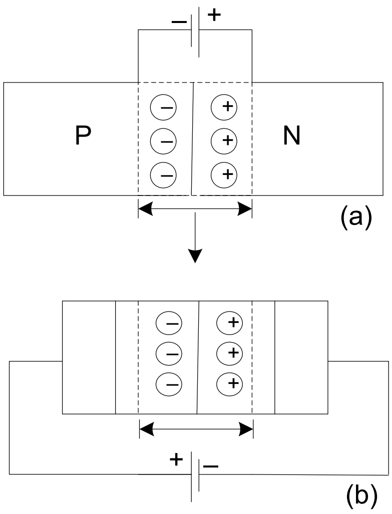
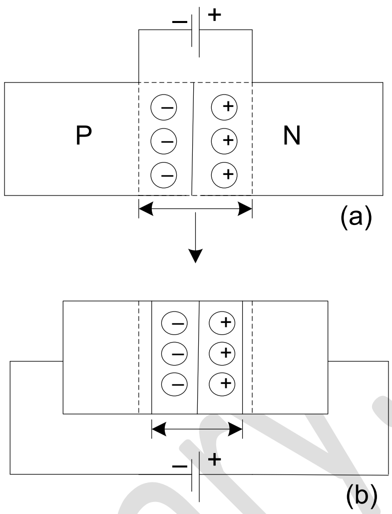
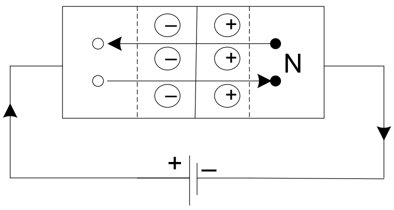
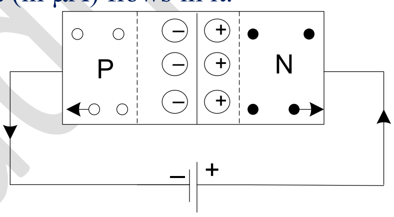
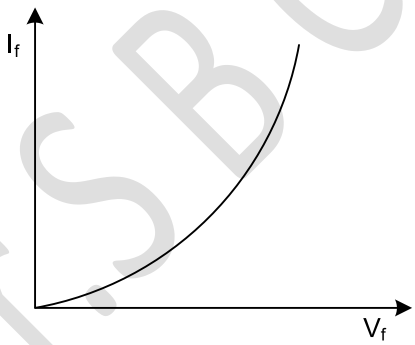
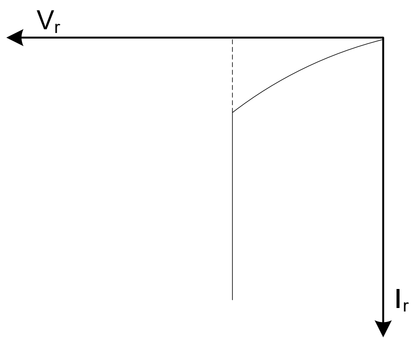
5 BIASING OF JUNCTION DIODE

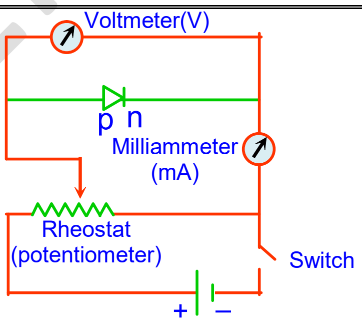
(i) No current flows in the junction diode without an external battery. It is connected to a battery in two different ways. Hence two different bias are possible in junction diode.

(a) Forward bias (b) Reverse bias

(ii) **Difference between forward bias and reverse bias:**

S.No.	Forward bias	Reverse bias
1.	The P-region of junction diode is connected to positive terminal of battery and N-region is connected to negative terminal of battery. 	The P-region is connected to negative terminal and N-region is connected to positive terminal of the battery. 

2.	In this the width of depletion layer decreases 	In this the width of depletion layer increases 
3.	Current flows in it due to majority electrons and majority holes and hence high current (mA) flows in it.  The direction of current in it is from P to N.	Current flows in it due to minority electrons and minority holes and hence negligible current (in μA) flows in it.  Direction of current is from N to P
4.	The junction resistance is low	The junction resistance is high
5.	Curve between forward voltage and forward current 	Curve between reverse voltage and reverse current 



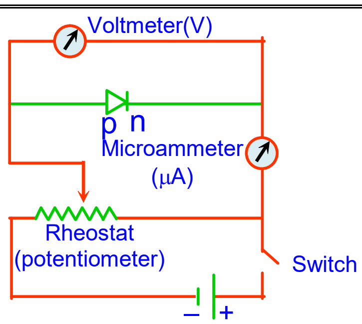


Illustration 1: When the reverse potential in a semiconductor diode are 10V and 20V, then the corresponding reverse currents are 25μ A and 50μA respectively. The reverse resistance of junction diode will be:

(A) 40 Ω (B) $4 \times 10^5\,\Omega$
(C) 40K Ω (D) $4 \times 10^{-5}\,\Omega$

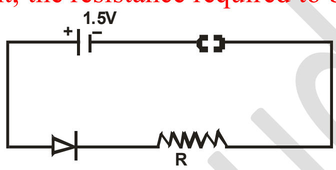
Sol. **(B)** $r_r = \dfrac{V_{r_2} - V_{r_1}}{I_{r_2} - I_{r_1}} = \dfrac{20-10}{(50-25)\times 10^{-6}} = 4 \times 10^5\ \Omega$

Illustration 2: The depletion layer in a silicon diode is 1μm wide and its knee potential is 0.6V, then the electric field in the depletion layer will be:

(A) 0.6 V/m (B) 6×10^4 V/m
(C) 6×10^5 V/m (D) Zero

Sol: **(C)** $E = -\dfrac{dV}{dr} = \dfrac{0.6}{10^{-6}} = 6\times 10^5\,V/m$

Illustration 3: A semiconductor P-N junction is to be forward biased with a battery of e.m.f. 1.5 Volt. If a potential difference of 0.5V appears on the junction which does not depend on current and on passing 10mA current through the junction there occurs huge Joule loss, then to use the junction at 5mA current, the resistance required to be connected in its series will be:



(A) 3 KΩ (B) 300 Ω
(C) 300 KΩ (D) 200 Ω

Sol: **(D)** $V_R = (1.5 - 0.5) = 1V = IR$

$\therefore R = \dfrac{1}{5\times 10^{-3}} = 200\Omega$

6 CHARACTERISTICS OF JUNCTION DIODE

(i) The characteristic curves of junction diode are of two types
 (a) Static characteristic curves
 (b) Dynamic characteristic curves

(ii) The static and the dynamic characteristics are also of two types

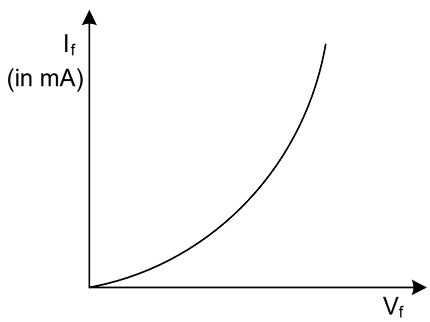
(A) (a) Static forward characteristics curves
 (b) Static reverse characteristic curves

(B) (a) Dynamic forward characteristic curves
 (b) Dynamic reverse characteristic curves

(iii) Static forward characteristics

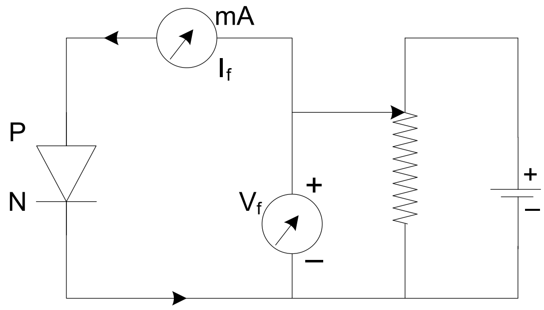
(a) In the absence of load resistance, the curves drawn between the forward voltage (V_f) and forward current (I_f) are known as the static forward characteristics of junction diode.

(b)



(c) On increasing the V_f the value of I_f increases exponentially

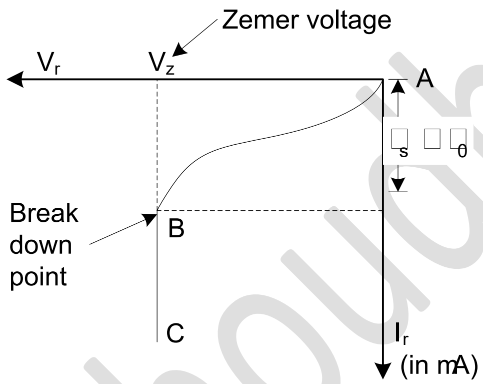
(d) **Circuit diagram:**



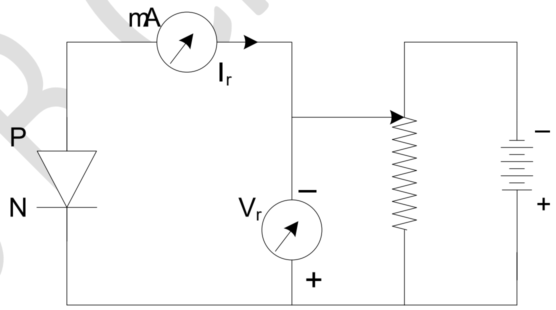
(iv) Static reverse characteristics:

(a) In the absence of load resistance, the curves drawn between the reverse voltage (V_r) and reverse current (I_r) are known as the static reverse characteristics of junctions diode.

(b)



(c)



(d) After the breakdown point at B, the reverse current (I_r) does not depend on the reverse voltage (V_r) in the BC portion of curve.

7 CONSTANTS OF JUNCTION DIODE

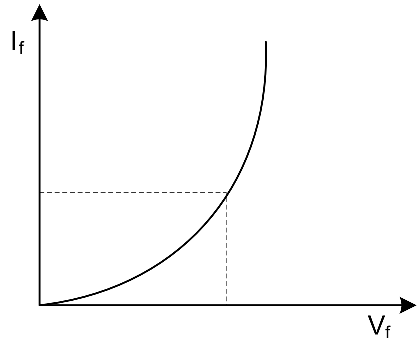
(A) (i) Static forward and reverse resistances

(ii) Dynamic forward and reverse resistances

(B) Static forward resistance (R_f):

(i) The ratio of the forward voltage (V_f) and forward current (I_f) at any point on the static forward characteristic is defined as static forward resistance of junction diode.

$$\text{i.e. } R_f = \frac{V_f}{I_f}$$



(ii) Its value is of the order of $10^2\ \Omega$.

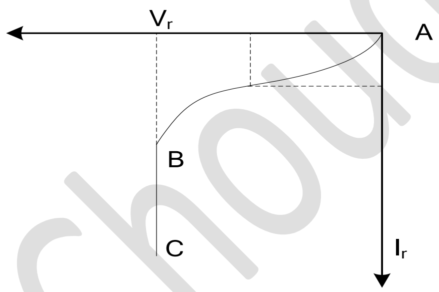
(C) Static reverse resistance (R_r):

(i) The ratio of reverse voltage (V_r) and reverse current (I_r) at any point on static reverse characteristic is defined as the static reverse resistance of junction diode.

$$\text{i.e. } R_r = \frac{V_r}{I_r}$$

(ii) Its value of is of the order of 10^6

(iii)



(D) Dynamic forward resistance (V_r):

(i) The ratio of small change in forward voltage to the corresponding small change in forwards current on static forward characteristic is defined as the dynamic forward resistance of junction diode (r_f)

(ii) $$r_f = \frac{\Delta V_f}{\Delta I_f} = \frac{V_{f_2} - V_{f_1}}{I_{f_2} - I_{f_1}}$$

(E) Dynamic reverse resistance (r_r):

(i) The ratio of the small change in reverse voltage to the corresponding small change in reverse current on the static reverse characteristics is defined as the dynamic reverse resistance of junction diode.

(ii) $$r_r = \frac{\Delta V_r}{\Delta I_r} = \frac{V_{r_2} - V_{r_1}}{I_{r_2} - I_{r_1}}$$

(iii)

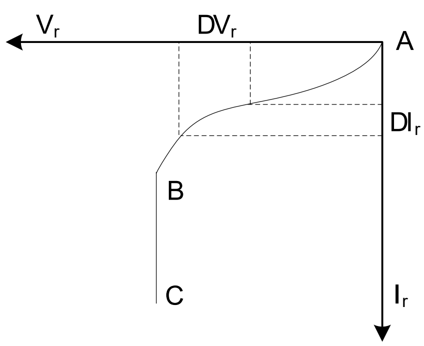
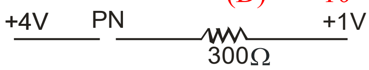


Illustration 4: The value of current in the adjoining diagram will be:

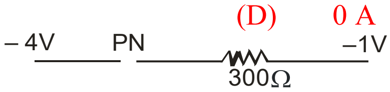
(A) 0 amp (B) 10^{-2} amp
(C) 10^{2} amp (D) 10^{-3} amp



Sol. **(B)** $I_f = \frac{4-1}{300} = 10^{-2}A$

Illustration 5: The value of current in the following diagram will be:

(A) 0.10A (B) 10^{-2} A
(C) 1 A (D) 0 A



Sol. **(D)** In reverse bies $I_r = 0$

Illustration 6: The saturation current of a P-N junction germanium at 27°C is 10^{-5} amp. The potential required to be applied in order to obtain a current of 250mA in forward bias will be:

(A) 0.57 V (B) 0.48 V
(C) 0.26 V (D) 0.63 V

Sol. **(C)** $I_f = I_S\left[e^{qV/KT} - 1\right]$

or $e^{\frac{qV}{kt}} = \frac{I_f}{I_s} + 1 = \frac{250\times10^{-3}}{10^{-5}} + 1 = 25001$

or $\frac{qV}{KT} = 10.126$

$\therefore V = \frac{10.126\times1.38\times10^{-23}\times300}{1.6\times10^{-19}} = 0.26$ V

Illustration 7:The junction diode in the following circuit requires a minimum current of 1mA to be above the knee point (0.7V) of its I-V characteristic curve. The voltage across the diode is independent of current above the knee point, If V_B = 5V, then the maximum value of R so that the voltage is above the knee point will be:

(A) 4.3kΩ (B) 860kΩ
(C) 4.3Ω (D) 860Ω

Sol% **(B)** $V_B = V_{knee} + I_R$

or $5 = 0.7 + 10^{-3}$ R or R = 4.3KΩ

8 ZENER BREAKDOWN, AVALANCHE BREAKDOWN AND ZENER DIODE

S.No.	Avalanche breakdown	Zener breakdown
1.	The doping in the formation of P-N Junction is low	The doping in the formation of P-N junction is high
2.	The covalent bonds break as a result of collision of electrons and holes with the valence electrons	In this the covalent bonds break spontaneously.
3.	Higher reverse potential is required for breakdown.	Low reverse potential is required for breakdown
4.	In this the thermally generated electrons due to electric field ionize other atoms and release electrons.	In this the covalent bonds near the junction break due to high reverse potential ~20 V and consequently electrons become free.

(ii) **Zener diode:**

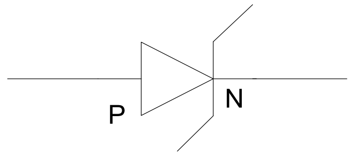
(a) The junction diode made of Si or Ge, whose reverse resistance is very high, is known as Zener diode.

(b) It works at Zener voltage (V_z) i.e. the voltage at which breakdown starts.

Zener voltage (V_z): The voltage at which breakdown starts in Zener diode and consequently the reverse current in the circuit abruptly increases, is defined as Zener voltage.

(c) It is used in power supplies as a voltage regulator.

(d) **Symbolic representation of Zener diode.**



9 SALIENT FEATURES RELATING TO JUNCTION DIODE

(i) In junction diode the current flow is unidirectional as in vacuum diode.

(ii) Current flows in the semiconductor diode when it is forward biased.

(iii) Its P-part behaves like a plate and N-apart behaves like a cathode.

(iv) **Relation between forward current and saturation current**

$$I_f = I_s(e^{\frac{IV}{kT}} - 1)$$

Where I_f and I_s are forward and saturation currents respectively, K = Boltzmann constant, T = absolute temperature V = potential difference

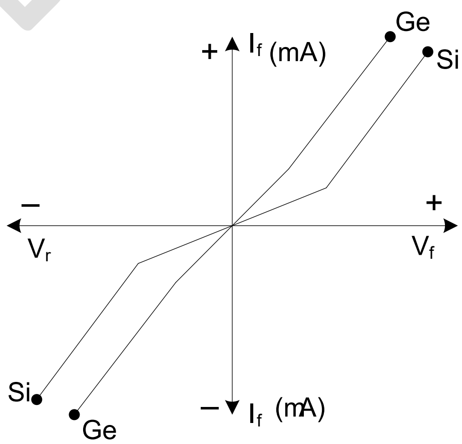
(a) In forward bias $e^{qV/kT} >> 1$ then $I_f = I_s qV/KT$

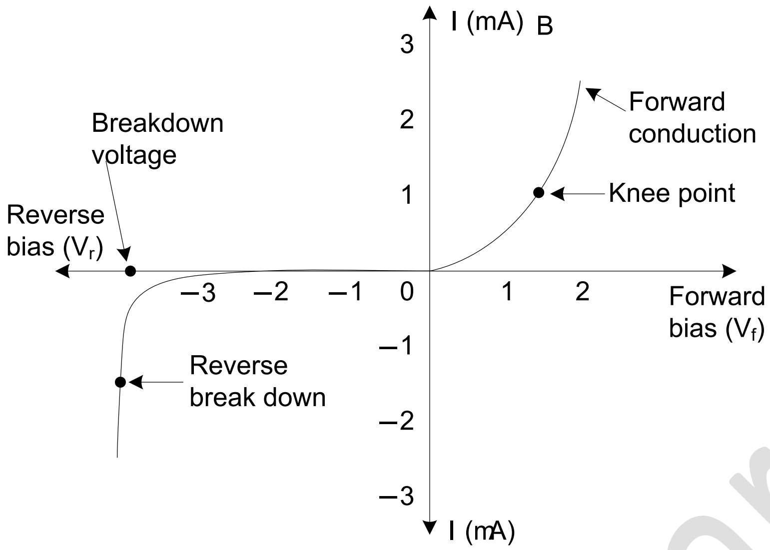
(b) In reverse bias $e^{qV/kT} << 1$ then $I_f = I_s$

(v) The velocity gained by the charge carriers in an electric field of unit intensity, is defined as their mobility

$$m = \frac{V_d}{E} = \frac{\text{Drift Velocity}}{\text{Intensity of electricity field}}$$

(vi) **Forward and reverse characteristic curves of Si and Ge diodes:**





Knee Point: That point on the forward characteristics of junction diode after which the curve becomes linear, is known as the knee point. In the diagram it is represented by the point A.

Knee voltage: The potential at knee point A is known as the knee potential or forward potential at which the forward current abruptly increases is known as the knee potential.

(a) This potential does not depend on the current.

(b) For Si its value is 0.7 V.

(vii) Greater the value of ΔE_g, stronger will be the binding of valence electrons to the nucleus.

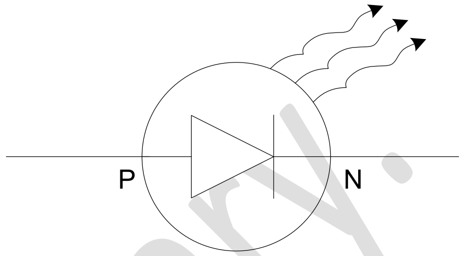
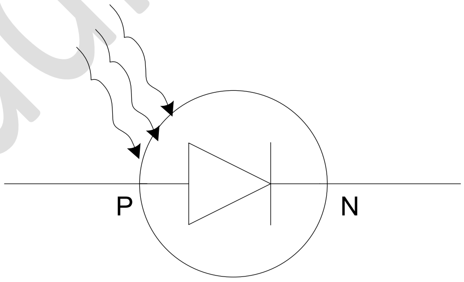
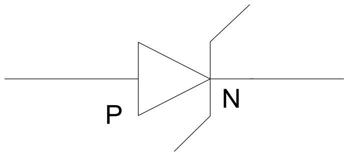
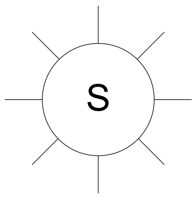
10 USES OF JUNCTION DIODE

(i) Rectifier
(ii) Off switch
(iii) Condenser

11 DIFFERENT BETWEEN VACUUM TUBE DEVICES AND SEMICONDUCTOR DEVICES

S.No.	Vacuum tube devices	semiconductor devices
1.	These are voltage controlled devices.	These are current driven devices
2.	These work at high voltage	These work at low voltage.
3.	For these a filament battery is required.	For these no filament batteries required
4.	These are not temperature sensitive devices	These are temperature sensitive devices
5.	Their life is less and are more expensive	Their life is longer and are cheap
6.	Their size is big	Their size is small.
7.	Their efficiency is more	Their efficiency is less
8.	Power consumption is maximum	Power consumption is minimum
9.	These can not be used integrated circuit (IC's)	These can be used as integrated circuits
10.	Electric conduction is only via electrons.	Electric conduction takes place both by electrons and cotters.

12 VARIOUS TYPE OF P-N JUNCTION

S.No.	P-N Device	Biasing	Principle	Uses	Explanation
1.	Light Emitting Diode (LED)	Forward	Production of light from electric current	Burglar alarms, calculators, pilot lamps, telephone, digital watch and in switch boards	In Ga, As, Electromagnetic radiations are emitted on account of transitions of electron from conduction band to valance band. 
2.	Photodiode	Reverse	Electric conduction from light	In sound films, computers, tape, in reading computer cards and in light driven switches.	The covalent bonds in semiconductors break due to electromagnetic radiations and more electrons become free and conductivity increases. 
3.	Zener diode	Reverse	Current is controlled	In voltage regulation	Voltage across it remains constant 
4.	Solar cell	No biasing	Production of potential difference by sun light	For generating electrical energy in cooking food etc.	Due to nuclear fusion process sun is constantly emitting light and heat energy. The upper surface of P-N junction is thin in this diode. 

Other salient features

(a) The value of electric field across the P-N junction is 10^5 V/m

(b) $E = \frac{V_B}{d} = \frac{0.5}{10^{-6}} = 5 \times 10^5$

(c) The values of contact potential for Si and Ge are 0.7 V and 0.3 V respectively.

13 SEMICONDUCTOR DIODE AS RECTIFIER

(i) **Rectification:** The process in which an alternating current is converted into direct current, is defined as rectification.

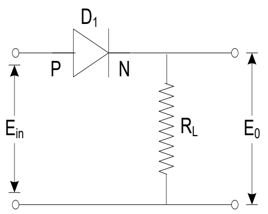
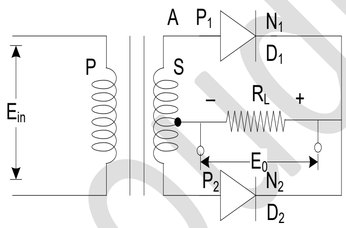
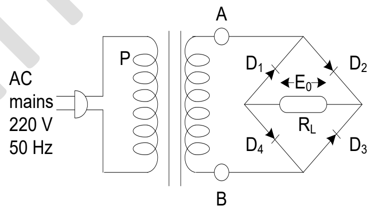
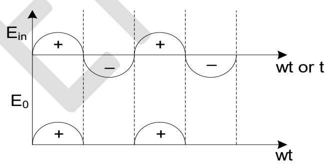
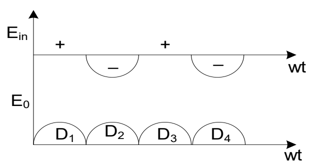
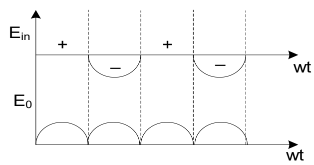
(ii) **Rectifier:** The device employing diode, used to convert an alternating current into direct current, is known as rectifier.

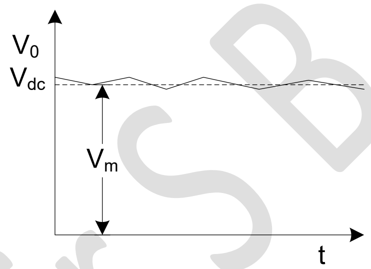
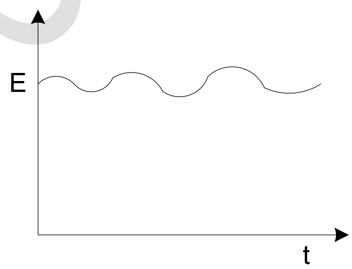
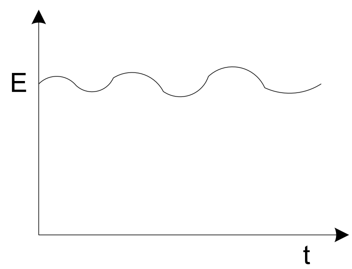
(iii) The rectifiers are of two types:
(a) Half wave rectifier (b) Full wave rectifier

Half wave rectifier: The rectifier, in which only alternate half cycles of applied alternating signal are converted into direct current, is known as half wave rectifier.

Full wave rectifier: The rectifier is which the whole cycle of applied alternating signal is converted into direct current, is known as full wave rectifier.

(iv) **Difference between half wave rectifier and full wave rectifier**

No.	Half-Wave Rectifier	Full Wave Rectifier centre taped	Full wave Bridge Rectifier
1.			
2.	In this, one diode or one semiconductor diode is used	In this, two diodes or one double diode or two junction diodes are used.	In this four junction diodes from the bridge circuit.
3.	Ordinary transformer is used	Centre tap transformer is used	Transformer is not required.
4.	It converts half cycle of applied A.C. signal into D.C. signal	It converts the whole cycle of applied A.C. signal into D.C. signal	It converts the whole cycle of applied A.C. signal into D.C. signal
5.	Input and output curves 	Input and output curves 	Input and output curves 
6.	The value of $I_{rms} = \frac{I_0}{2}$	$I_{rms} = \frac{I_0}{\sqrt{2}}$	$I_{rms} = \frac{I_0}{\sqrt{2}}$
7.	$I_{dc} = \frac{I_0}{p}$	$I_{dc} = \frac{2I_0}{p}$	$I_{dc} = \frac{2I_0}{p}$
8.	The value of ripple factor is	The value of r in it is 48.2%	The value of r in it is 48.2%

	$r = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1} = 121\%$		
9.	Efficiency (η) (a) $\eta = \frac{40.6}{\left(1 + \frac{r_p}{R_L}\right)}$ (b) When $r_p = R_L$ then η = 20.3% (c) When $r_p << R_L$ then η = 40.6%	(a) $\eta = \frac{81.2}{\left(1 + \frac{r_p}{R_L}\right)}$ (b) When $r_p = R_L$ then η = 40.6% (c) When $\frac{r_p}{R_L} << 1$ then η = 81.2%	Its efficiency is 81.2%
10.	Peak inverse voltage PIV = E_0	PIV = $2E_0$	PIV = $2E_0$
11.	Form factor $F = \frac{I_{rms}}{I_{dc}} = \frac{E_{rms}}{E_{dc}} = \frac{\pi}{2} = 1.57$	F = 1.11	F = 1.11
12.	The ripple frequency is equal to the frequency of applied e.m.f.	The ripple frequency is twice that of the applied e.m.f.	The ripple frequency is twice that of the applied e.m.f.
13.	Curve between the output voltage from filter circuit and time  	Curve  	Curve 
14.	The value of D.C. component in output voltage is less than the A.C.	The value of D.C. component in output voltage is more than that of A.C.	The value of D.,C. component in output voltage is more than that of A.C.
15.	The value of peak inverse voltage (PIV) is E_0	The value of PIV is E_0	The value of PIV is E_0
16.	The value of peak load current is $\frac{E_0}{r_p + R_L}$	The value of PLC is $\frac{E_0}{r_p + R_L}$	The value of PLC is $\frac{2E_0}{2r_p + 2R_L}$

(v) Similarities between half wave and full wave rectifiers

(a) The alternating input signal to be rectified is connected to the primary of transformer.
(b) The output voltage is obtained across the ends of load resistance.
(c) The output voltage is unidirectional but it is not constant rather pulsating.
(d) The output voltage is the mixture of alternating and direct voltages.
(e) In output, the direct components are more than the alternating components.
(f) Diode conducts only when the plate is positive with respect to the cathode. semiconductor diode conducts only when it is forward biased.
(g) When the plate of diode is negative with respect to the cathode than it does not conduct.

(vi) Definitions:

(a) Efficiency of rectifier

(i) $$\eta = \frac{\text{output D.C. power}}{\text{input A.C. power}}$$

(ii) $$\eta = \frac{P_{dc}}{P_{ac}} \times 100\%$$

(b) Ripple Factor (r):

(i) $$r = \frac{I_{ac}}{I_{dc}} = \frac{E_{ac}}{E_{dc}} = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$$

(ii) $$r = \frac{\text{r.m.s. of value of fluctuating voltage or current}}{\text{average D.C. value of voltage or current}}$$

(c) Form factor

(i) $$F = \frac{I_{rms}}{I_{dc}}$$

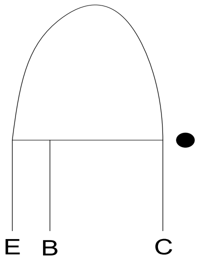
(ii) $$F = \frac{E_{rms}}{E_{dc}}$$

(iii) $$F = \frac{\pi}{2\sqrt{2}} = 1.11$$ For full wave rectifier

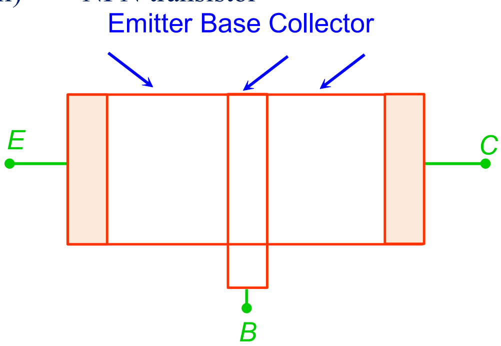
(iv) $$F = \frac{\pi}{2} = 1.57$$ For half wave rectifier

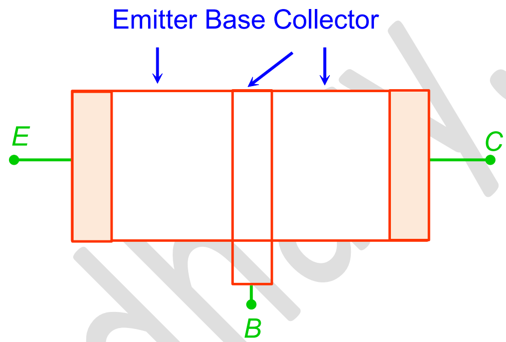
14 TRANSISTOR

(i) That current driven device, which is formed by three doped semiconductor regions, is known as transistor.
(ii) That current driven device, in which the emitter current controls the collector current, is known as transistor.
(iii) There are three semiconductor regions in a transistor viz Emitter (E), Base (B) and collector (C).
(iv) **Function of emitter:** To send electrons or cotters into the base
Function of base: To send electrons or cotters received from the emitter into the collector region.
Function of collector: To collect electrons or cotters from the base region.
(v) The distance between E and B in a transistor is less than that between B and C and the collector is marked with a dot (.)



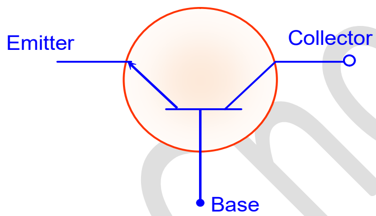
(vi) Transistors are of two types:
(i) PNP transistor
(ii) NPN transistor



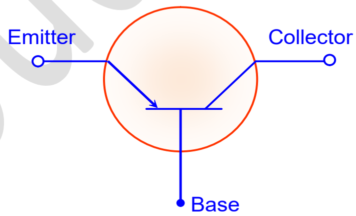


(i) n-p-n transistor

(ii) p-n-p transistor



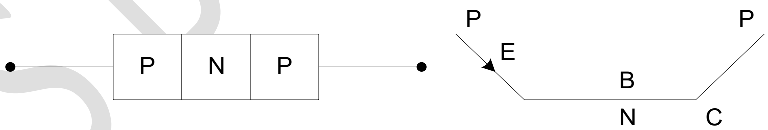
(i) n-p-n transistor



(ii) p-n-p transistor

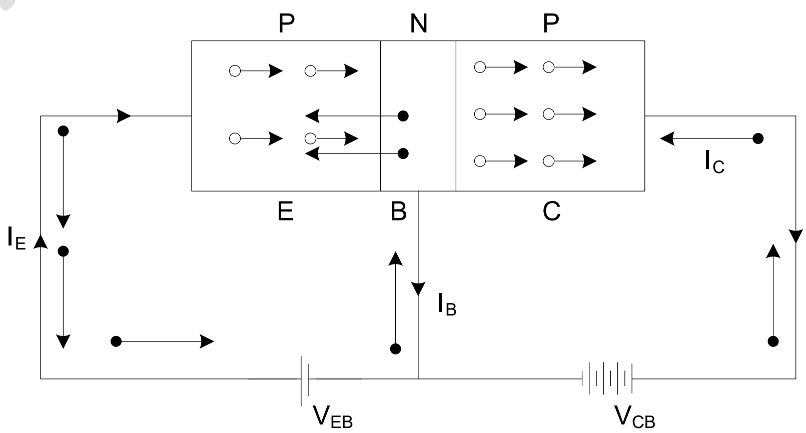
PNP-transistor:

(i) Symbolic representation:



(ii) In this conventional current flows from emitter (E) to base (B) hence the arrow head on emitter is from E to B.

(iii) Sketch diagram



(iv) Working of PNP transistor

(a) The emitter-base junction is forward biased while base-collector junction is reverse biased.

(b) A large number of holes enter from emitter to base and at the same time a very small number of electrons enter from the base to the emitter.

(c) The electrons in the emitter region recombine with an equal number holes and neutralise them.

(d) The loss of total number of holes in the emitter is compensated by the flow of an equal number of electrons from the emitter to the positive terminal of battery.

(e) These electrons are released by breaking of covalent bonds among the crystal atoms in the emitter and an equal number holes is again created.

(f) Thus in PNP transistor emitter current is mainly due to the flow of holes, but in eternal circuit it is due to flow of electron from emitter to the positive terminal of the battery.

(g) The base is very thin and is lightly doped. Therefore only a few holes (~ 1%) combine with electrons in base. Hence the base current I_B is very small.

(h) Nearly 99% of the holes coming from the emitter are collected by the collector.

(i) For each hole reaching the collector, an electron is released from the negative terminal of collector base battery to neutralise the hole.

(j) The relation between three currents is as under

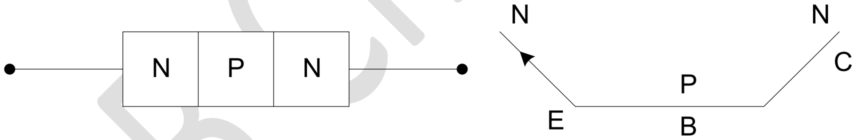
$I_E = I_B + I_C, I_E >> I_B, I_C < I_E$ and $I_B << I_C$

(k) The input impedance is low and output impedance is high. The output voltage required to be applied is more than the input voltage.

(l) The functions of E, B and C are to send cotters into base region, to send these cotters into collector region and to collect the cotters received from base region respectively.

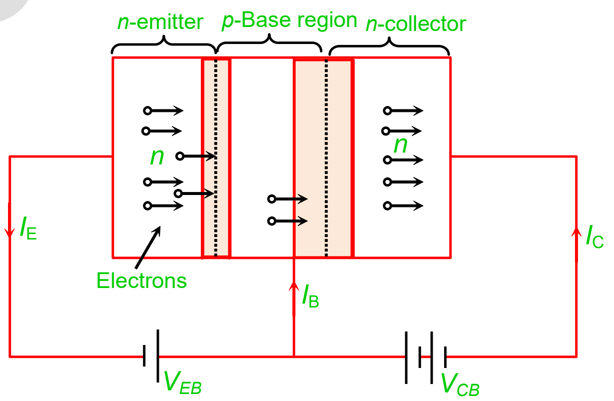
NPN-transistor:

(i) Symbolic representation



(ii) In this conventional current flows from base towards emitter, hence the arrow head on emitter is directed from B to E.

(iii) Sketch diagram



n-p-n transistor

(iv) Working of NPN transistor

(a) The emitter-base junction is forward biased whereas the collector-base junction is reverse biased.

(b) The majority electrons in the emitter are pushed into the base.

(c) The base is thin and is lightly doped. Therefore a very small fraction (say 1%) of incoming electrons combine with the holes. Hence base current is very small.

(d) The majority of electrons are rushing towards the collector under the electrostatic influence of C-B battery.

(e) The electrons collected by the collector move towards the positive terminal of C-B battery.

(f) The deficiency of these electron is compensated by the electrons released from the negative terminal of E-B battery.

(g) Thus in NPN transistors current is carried by electron both in the external circuit as well as inside the transistor.

(h) The relation between these current is given by

$$I_E = I_C + I_B$$

$$I_E >> I_B, I_C < I_E \text{ and } I_B << I_C$$

(i) The input impedance is low and output impedance is high. The output voltage required to be applied is more than the input voltage.

Illustration 8: For a common emitter connection the values of constant collector and base current are 5mA and 50 μA respectively. The current gain will be:

(A) 10 (B) 20 (C) 40 (D) 100

Sol. **(D)** $\beta = \left(\frac{\delta I_C}{\delta I_B}\right)_{V_e} = \frac{5\times10^{-3}}{50\times10^{-6}} = 100$

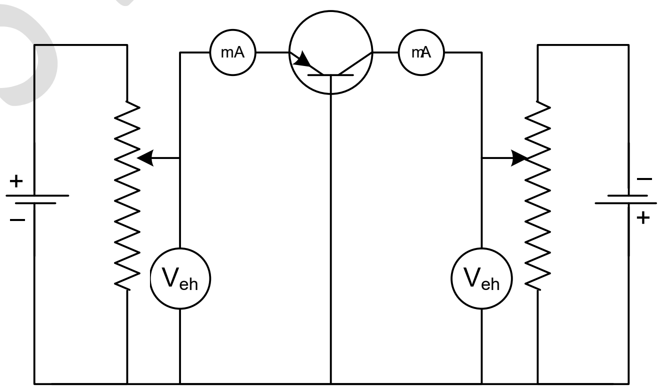
15 CHARACTERISTICS OF TRANSISTOR

The study of variation in current with respect to voltage in a transistor is called its characteristic. For each configuration of transistor, there are two types of characteristics:

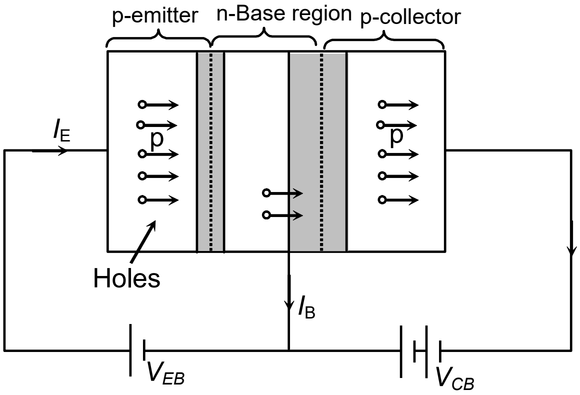
(i) Input characteristics (ii) Output characteristics

(A) Common base configuration

(i) Circuit diagram



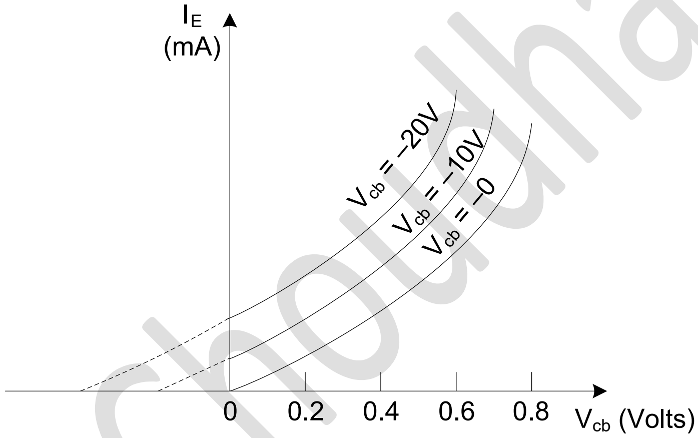
Common base PNP transistor



p-n-p transistor

(ii) Input characteristics

(a) Input characteristics are obtained by plotting the emitter current I_E versus emitter-base voltage V_{EB} at constant collector base potential V_{CB}.



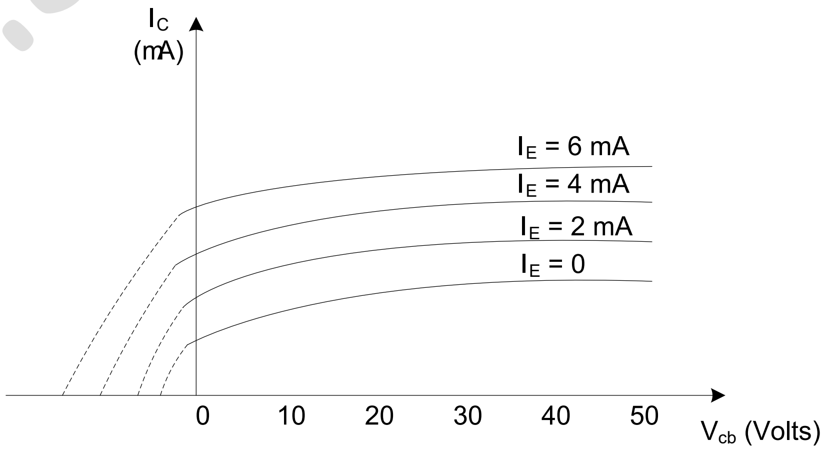
(b) I_E is almost independent of V_{CB}.

(c) Due to very low input impedance, I_E increases rapidly with small increase in V_{EB}.

(d) I_E is finite at finite value of V_{CB} even when V_{EB} is zero. To reduce I_E to zero, the emitter must be reverse biased.

(iii) Output characteristics:

(a) The output characteristics are obtained by plotting the collector current (I_C) versus collector-base voltage (V_{CB}) at constant emitter current (I_E).



(b) I_C varies with V_{CB} only at very low voltage (< 1 V). Transistor is not operated in this region.

(c) As V_{CB} increases beyond 1 volt, I_C becomes independent of V_{CB} but depends only upon the emitter current I_E.

(d) Due to high output impedance, a very large change in V_{CB} produces a very small change in I_C.

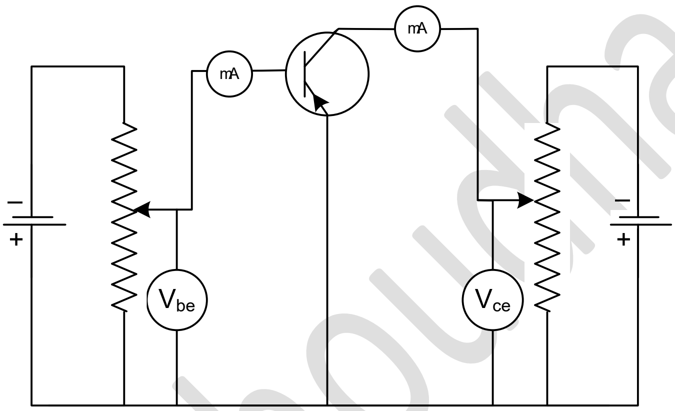
(e) For the region to the left of $V_{CB} = 0$ and for $I_E > 0$, both emitter and collector are forward biased and it is called saturation region.

(f) For $I_E < 0$, both emitter and collector are reverse biased and the region is called the cut-off region.

(g) For central region $V_{CB} > 0$, the curves are parallel and it is called active region. In this region emitter is forward biased and collector is reverse biased.

(B) **Common emitter configuration:** In this configuration emitter is common to input and output circuits.

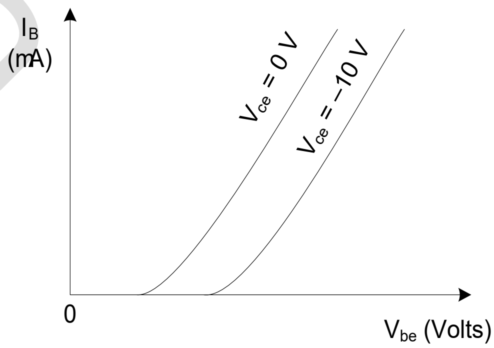
(i) **Circuit diagram**



Common base PNP transistor

(ii) **Input characteristics**

(a) Input characteristics are obtained by plotting the base current (I_B) versus base emitter voltage (V_{BE}) for constant collector-emitter voltage (V_{CE}).

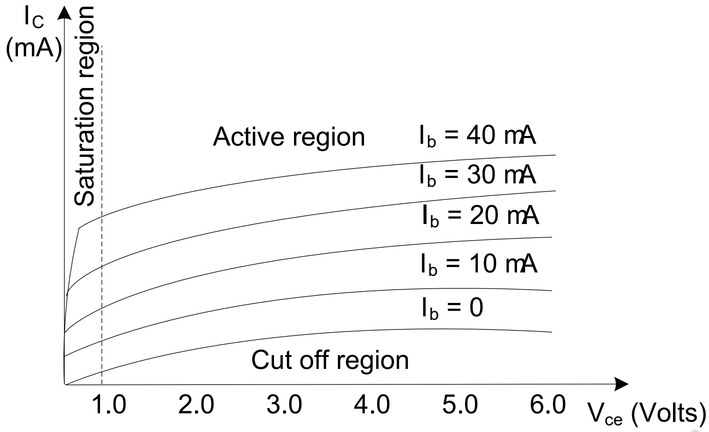


(b) I_B increases with increase in V_{BE}, but less rapidly as compared to common base configuration, indicating that input resistance of common emitter configuration is greater than that of common base configuration.

(c) These characteristics resemble with those of a forward biased junction diode indicating that the base-emitter section of a transistor is essentially a junction diode.

(iii) **Output characteristics:**

(a) The output characteristics are obtained by plotting collector current I_C versus collector-emitter voltage (V_{CE}) at constant value of base current (I_B).



(b) I_C increases with increase of V_{CE} upto 1 volt and beyond 1 volt it becomes almost constant.

(c) The value of V_{CE} upto which I_C increases is called the knee voltage. The transistor always operates above knee voltage.

(d) Above knee voltage, I_C is almost constant.

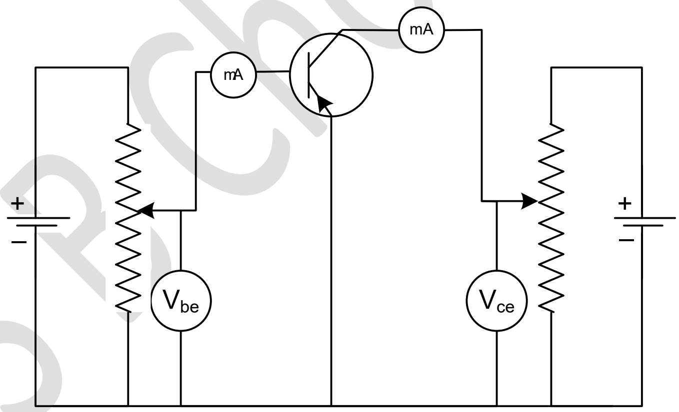
(e) The region for $V_{CE} < 1$ volt is called saturation region as both emitter and collector are forward biased.

(f) In the region $I_B \leq 0$, both emitter and collector are reverse biased and it is called the cut-ff region.

(g) The central region, where the curves are uniformly spaced and sloped, is called the active region. In this region the emitter is forward biased and the collector is reverse biased.

(C) **Common collector configuration:** In this configuration collector is common to input and output circuits.

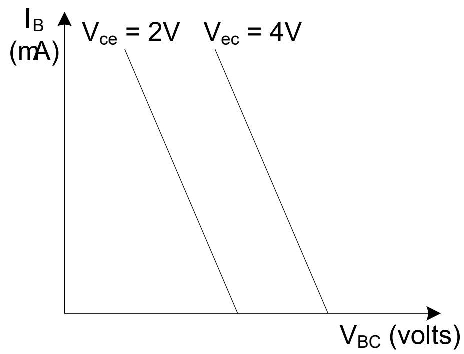
(i) **Circuit diagram**



Common base PNP transistor

(ii) **Input characteristics:**

(a) The input characteristics are obtained by plotting the base current I_B versus base-collector voltage (V_{BC}) for constant emitter-collector voltage (V_{BC}).



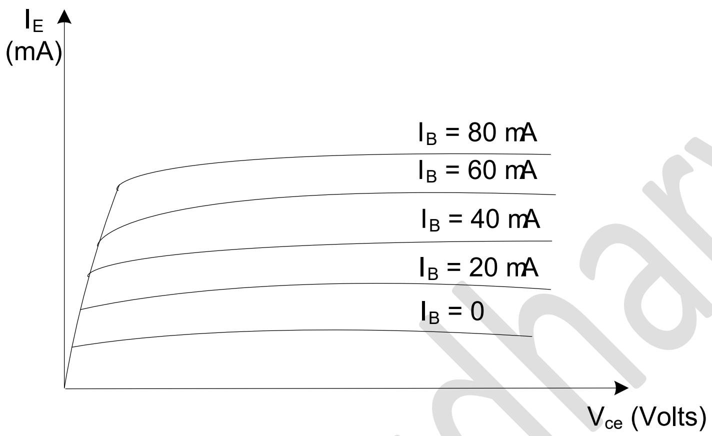
(b) I_B decreases with increase of V_{BC}. These characteristics are quite different from those of common base and common emitter configurations.

(c) $\because V_{BE} = V_{EC} - V_{BC}$

As V_{BC} increases, V_{BE} decreases for constant value of V_{EC}, thereby reducing I_B.

(iii) **Output characteristics:**

(a) Output characteristics are obtained by plotting emitter current I_E versus collector-emitter voltage (V_{CE}) for constant base current (I_B).



(b) The curves are similar to those obtained in output characteristics in common emitter configuration indicating that

$I_E \approx I_C$ ($\because$ I_B is very small)

(c) In this configuration the output can be obtained in either direction and hence it is used for matching the impedance for two way amplifier and switching circuits.

Illustration 9: In a transistor amplifier, $\beta = 62$, $R_L = 5000\ \Omega$ and internal resistance of the transistor is 500 Ω. The voltage amplification of the amplifier will be:

(A) 500 (B) 620
(C) 780 (D) 950

Sol. **(B)** Voltage amplification $= \frac{\beta R_L}{R_e} = \frac{62 \times 5000}{500}$

Illustration 10: In the above problem, the power amplification will be:

(A) 25580 (B) 33760
(C) 38440 (D) None of these

Sol. **(C)** Power amplification $= \frac{\beta^2 R_L}{R_e} = \frac{62^2 \times 5000}{500} = 38440$

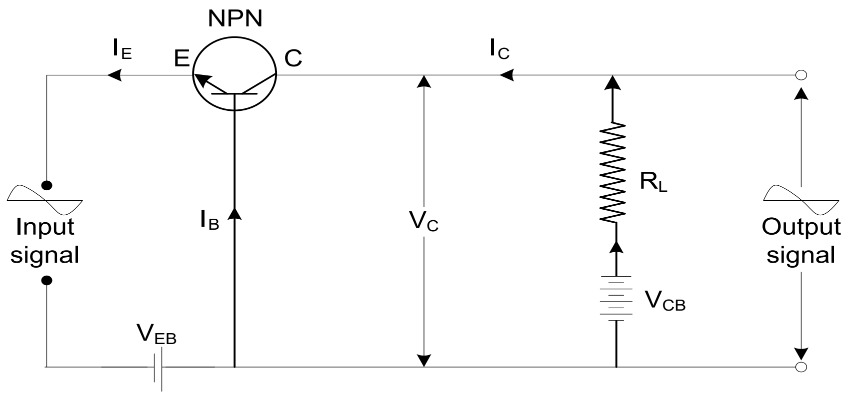
16 TRANSISTOR AS AN AMPLIFIER

(i) Amplification: The phenomenon, in which the amplitude of input signal (Voltage, current or power) is increased, is defined as amplification.

(ii) Amplifier: The device (electronic circuits), used to increase the amplitude of input signal is known as amplifier.

(A) **Common base amplifier:**

(i) **NPN Transistor:** (a) **Circuit diagram**



(b) When no A.C. signal is applied, then only collector current I_C flowing through the load resistance R_L will produce a voltage drop $I_C R_L$ across the load resistance.
$\therefore$ net collector voltage $V_C = V_{CB} - I_C R_L$ . . . (1)

(c) Now input A.C. signal, to be amplified, is applied to the input circuit. During positive half of the input signal, the forward bias is reduced. This reduced emitter current (I_E) and consequently I_C is also reduced. According to Eq. (1) V_C increases.

(d) During negative half cycle of the input signal, the forward bias is increased So, I_E and hence I_C increases. According to Eq. (1), V_C decreases.

(e) The input and the output signals are in same phase.

(f) **Current amplification factor (α):**

(i) DC current gain (α_{DC}): The ratio of the collector current to the emitter current at constant collector voltage is defined as D.C. current gain

$$\alpha_{DC} = \left(\frac{I_C}{I_E}\right)_{V_C}$$

α_{DC} is always less than one.

(ii) AC current gain (α_{AC}): The ratio of change in collector current to the change in emitter current at constant collector voltage is defined as AC current gain.

$$\alpha_{AC} = \left(\frac{\Delta I_C}{\Delta I_E}\right)_{V_C}$$

(g) **Voltage gain:** (i) The ratio of the output voltage across the load resistance to the input signal voltage is defined as voltage gain.

$$\text{Voltage gain} = \frac{V_0}{V_i} = \frac{I_C R_L}{I_E R_0} = \alpha \times \frac{R_L}{R_i}$$

(R_i is the resistance of the input circuit)

(ii) Since α is approximately equal to one and $R_L >> R_i$, hence very high voltage gain can be obtained.

(h) **Power gain:** (i) The ratio of the output power to the input power is defined as power gain.

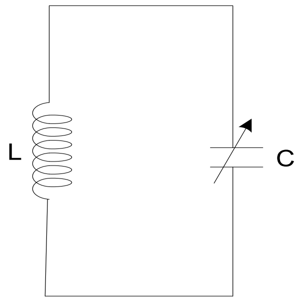
$$\text{Power gain} = \frac{\text{output power}}{\text{input power}} = \frac{\text{output current} \times \text{output voltage}}{\text{input current} \times \text{input voltage}}$$

$$= \text{Current gain} \times \text{voltage gain} = \alpha \times \alpha \times \frac{R_L}{R_i} = \alpha^2 \frac{R_L}{R_i}$$

(ii) Since $R_L >> R_i$, hence power gain is quite large.

17 TRANSISTOR AS AN OSCILLATOR

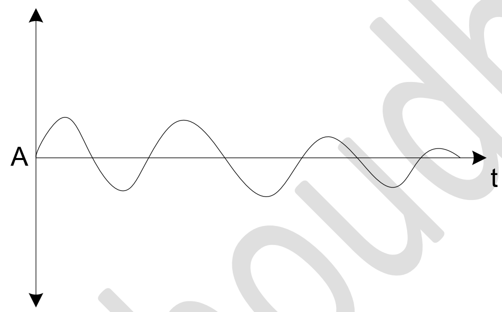
(i) The simplest electrical oscillating system consists of an inductance L and a capacitor C connected in parallel.



(ii) Once an electrical energy is given to the circuit, this energy oscillates between capacitance (in the form of electrical energy) and inductance (in the form of magnetic energy) with a frequency

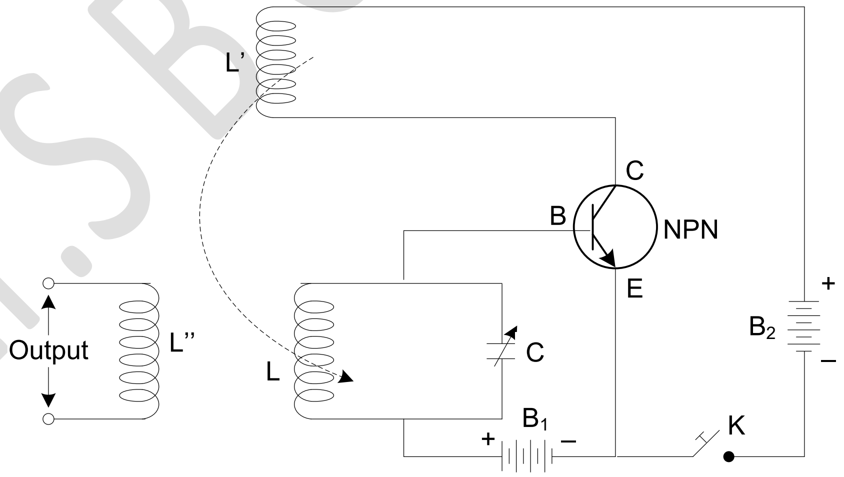
$$v = \frac{1}{2p/\sqrt{LC}}$$

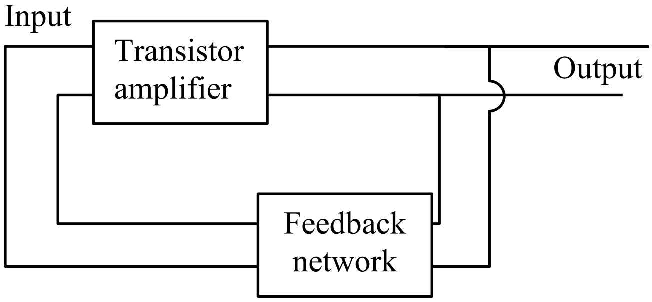
(iii) The amplitude of oscillations is damped due the presence of inherent resistance in the circuit



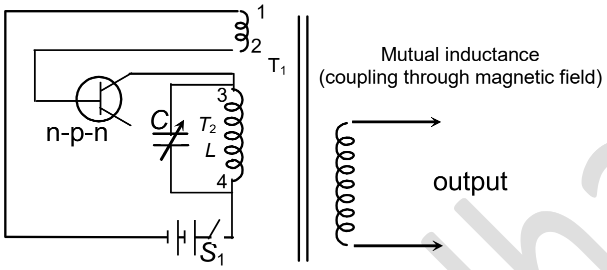
(iv) In order to obtain oscillations of constant amplitude, an arrangement of regenerative or positive feedback from an output circuit to the input circuit is made so that the circuit losses may be compensated.

(v) **Circuit diagram of NPN transistor in common emitter configuration as an oscillator.**





(a)



(vi) The tank circuit is used in emitter-base circuit of the transistor. The E-B circuit is forward biased whereas the C-B circuit is reverse biased.

(vii) The coil L' in the emitter-collector circuit is inductively coupled with coil L.

(viii) When the key K is closed, I_C begins to increase. The magnetic flux linked with coil L' and hence with L also begins to increase. This supports the forward bias of B-E circuit. As a result of this I_E increases. Consequently I_C also continues increase till saturation.

(ix) When I_C attains saturation value, mutual inductance has no role to play.

(x) When the capacitor begins to discharge through inductance L, the I_E and hence I_C begins to decrease. consequently, the magnetic flux linked with L' and hence with L decreases. The forward bias of E-B circuit is opposed thereby further reducing I_E and I_C. This process continues till I_C becomes zero.

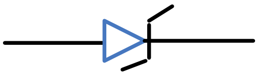
(xi) At this stage too, the mutual inductance has once again no role to play.

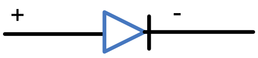
ASSIGNMENT-1

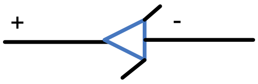
1. Zener breakdown will occur if :
(A) Impurity level is low (B) Impurity level is high
(C) Impurity is less in n-side (D) Impurity is less in p-side

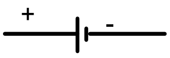
Solution : (D)

2. The correct symbol for zener diode is :

(A) 

(B) 

(C) 

(D) 

Solution : (A)

3. The reason of current flow in PN junction in forward bias is :
(A) Drifting of charge carriers (B) Minority charge carries
(C) Diffusion of charge carries (D) all of the above

Solution : (C)

4. In a half wave rectifier circuit, the input signal frequency is 50 Hz, the output frequency will be :
(A) 25 Hz (B) 50 Hz
(C) 200 Hz (D) 100 Hz

Solution : (D)

5. The reverse bias in a junction diode is changed from 5V to 15V then the value of current changes from 38μA to 88 μA. The resistance of junction diode will be:
(A) $4 \times 10^5\ \Omega$ (B) $3 \times 10^5\ \Omega$ (C) $2 \times 10^5\ \Omega$ (D) $10^6\ \Omega$

Sol.**(C)** $r_r = \dfrac{V_{r_2} - V_{r_1}}{I_{r_2} - I_{r_1}} = \dfrac{15-5}{(88-38)\times 10^{-6}} = 2 \times 10^5\,\Omega$

6. The inverse saturation current in a P-N junction diode at 27°C is 10^{-5} ampere. The value of forward current at 0.2 volt will be:
(A) 2037.6×10^{-3}A (B) 203.76×10^{-3}A
(C) 20.376×10^{-3}A (D) 2.0376×10^{-3}A

Sol.**(C)** $I_f = I_s\left[e^{\frac{qV}{kt}} - 1\right]$

$$= 10^{-5} \times \left[\exp.\left(\frac{1.6\times 10^{-19}\times 0.2}{1.4\times 10^{-23}\times 300}\right) - 1\right]$$

$= 10^{-5} \times [2038.6 - 1] = 20.376 \times 10^{-3}$A

7. The potential barrier in the depletion layer is due to
(A) Ions (B) Holes
(C) Electrons (D) Forbidden band

Solution : (A)
We konw that the recombination of free and mobile electrons and holes produces the narrow region at the junction called depletion layer. It is so named because this region is devoid of free and mobile charges carriers take electrons and holes and there being present only positive ions which are not free to move.

8. In a forward biased p-n junction, the potential barrier
(A) Decreases (B) Increases
(C) Remains constant (D) Becomes zero

Solution : (A)
We know that for a forward-biased p-n junction, the forward current rises exponentially with the applied forward voltage and get a certain potential, it is ready to break the potential barrier. Therefore in forward biased p-n junction, the potential barrier will decrease.

9. The logic behind 'NOR' gate is that it gives
(A) High output when both the inputs are low
(B) Low output when both the inputs are low
(C) High output when both the inputs are high
(D) None of these

Solution : (A)
We know that the 'NOR' gate is the opposite of 'OR' gate. Therefore its gives a high output only when both its inputs are low.

10. In n-type semi conductors, majority charge carriers are
(A) Holes (B) Protons
(C) Neutrons (D) Electrons

Solution : (D)

11. In the above problem, if $V_B = 5V$, what should be the value of R to establish a current of 5mA in the current of –5mA in the circuit?
(A) $4.3k\Omega$ (B) $860k\Omega$ (C) 4.3Ω (D) 860Ω

Sol. **(D)** $V_B = V_{knee} + I'R'$
or $5 = 0.7 + 5 \times 10^{-3}$ R' or R' = 860Ω
or $5 = 0.7 + 10^{-3}$ R or R = $4.3K\Omega$

12. In Q. 70, what is the power dissipated in the resistance R when a current of 5mA flows in the circuit at $V_B = 6V$-
(A) 3.5W (B) 3.5 mW (C) 26.5 W (D) 26.5mW

Sol. **(D)** $6 = 0.7 + 5 \times 10^{-3}$ R' or R' = 1060Ω
$P = I^2R'' = (5 \times 10^{-3})^2 \times 1060 = 26.5$ mW

13. In the above problem, the power dissipated in the diode will be:
(A) 3.5W (B) 3.5 mW (C) 26.5 W (D) 26.5mW

Sol. **(B)** Power dissipated in diode
$= VI = 0.74 \times 5 \times 10^{-3} = 3.5$ mW

14. In Q. 70, if R = 1 KΩ the minimum voltage V_B required to keep the diode above the knee point will be:
(A) 170 V (B) 17 V (C) 1.7 V (D) 0.17 V

Sol.% (C) $V_B = V_{knee} + IR = 0.7 + 10^3 \times 10^{-3}$
= 1.7V output resistance

15. In a common emitter circuit if V_{CC} is changed by 0.2 V, collector current changes by 4 x 10^{-3} mA. The output resistance will be:
(A) 10 kΩ (B) 30 kΩ (C) 50 kΩ (D) 70 kΩ

Sol.(C) $R = \frac{\Delta_{knee}}{\Delta I_{ce}} = \frac{0.2}{0.004 \times 10^{-3}} = 50K\Omega$

16. A transistor has a base current of 1 mA and emitter current 100 mA. The collector current will be:
(A) 100 mA (B) 1 mA (C) 99 mA (D) None of these

Sol. **(C)** $I_C = I_e - I_b = (100 - 1) = 99mA$

17. In the above problem, the current transfer ratio will be:
(A) 0.90 (B) 0.99 (C) 1.1 (D) None of these

Sol. **(B)** $\alpha = \frac{I_C}{I_e} = \frac{99}{100} = 0.99$

18. In Q.17 the current amplification factor (β) will be:
(A) 89 (B) 95 (C) 99 (D) 101

Sol. **(C)** $\beta = \frac{I_C}{I_b} = \frac{99}{1} = 99$

19. A transistor has α = 0.95. If the emitter current is 10 mA, then collector current will be:
(A) 9.5 mA (B) 10 mA (C) 0.95 mA (D) None of these

Sol. **(A)** Collector current
$I_c = \alpha I_e = 0.95 \times 10 = 9.5$ mA

20. In the above problem, the base current will be:
(A) 0.1 mA (B) 0.2 mA (C) 0.3 mA (D) 0.5 mA

Sol.(D) $I_b = I_e - I_c = (10 - 9.5) = 0.5mA$

21. In Q. 90 the current amplification factor will be:
(A) 11 (B) 19 (C) 35 (D) 79

Sol.(B) $\beta = \frac{\alpha}{1-\alpha} = \frac{0.95}{1-0.95} = 19$

22. Which one of the following gates can be served as a building block for any digital circuit?
(A) OR (B) AND
(C) NOT (D) NAND

Solution : (D)
We know that the basic gates (i.e. OR, AND and NOT) can be obtained by the repeated use of the NAND gates. Therefore in the digital circuits NAND gates can be served as a building block.

23. The cause of the potential barrier in a p-n junction diode is
(A) Depletion of positive charges near the junction
(B) Depletion of negative charges near the junction
(C) Concentration of positive charges near the junction
(D) Concentration of positive and negative charges near the junction

Solution : (D)
We know that the concentration of holes and electrons are greater in p and n regions respectively with some concentration difference. This concentration difference establishes density gradient and it results into diffusion. Therefore a potential barrier is produced due to the concentration of positive and negative charges near the junction.

24. A transistor having α = 0.99, is used in a common-base amplifier. If the load resistance is 4.5 KΩ and the dynamic resistance of the emitter junction is 50 KΩ, the voltage gain of the amplifier will be:
(A) 79.1 (B) 89.1 (C) 99.1 (D) None of these

Sol. **(B)** $\frac{\alpha R_L}{R_e} = \frac{0.99 \times 4500}{50} = 891$

25. In the above problem, the power gain will be:
(A) 88.2 (B) 98.2 (C) 78.2 (D) None of these

Sol. **(A)** A_p = Current gain × voltage gain
$0.99 \times 89.1 = 88.2$

26. The binary equivalent of 25 is:
(A) 111001 (B) 11001 (C) 10001 (D) 10011

Sol. **(B)** $25 = 16 + 8 + 1 = 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$
∴ Binary equivalent = 11001

27. The decimal equivalent of 1111:
(A) 25 (B) 35 (C) 15 (D) 5

Sol. **(C)** $1111 = 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$
$= 8 + 4 + 2 + 1 = 15$

28. In binary system, 11000101 represents the following number on decimal system:
(A) 4 (B) 401 (C) 197 (D) 204

Sol. **(C)** $11000101 = 1 \times 2^7 + 1 \times 2^6 + 0 \times 2^5$
$+ 0 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$
$= 128 + 64 + 0 + 0 + 0 + 4 + 1 = 197$

29. In a transistor circuit, when the base current is increased by 50 μA, keeping collector voltage fixed at 2 volt, the collector current increase by 1.0 mA. The current amplification factor of the transistor will be:
(A) 10 (B) 20 (C) 30 (D) 40

Sol. **(B)** $\beta = \frac{\Delta I_c}{\Delta I_b} = \frac{1 \times 10^{-3}}{50 \times 10^{-6}} = 20$

30. The value of α for a transistor is 0.9. What would be the change in the collector current corresponding to a change of 4 mA in the base current in a common emitter arrangement ?
(A) 36 mA (B) 72 mA (C) 18 mA (D) None of these

Sol. **(A)** $\Delta I_c = \beta\, \Delta I_b = \frac{\alpha \Delta I_b}{1-\alpha} = \frac{0.9 \times 4}{0.1} = 25$ mA

ASSIGNMENT-2

1. In a common base circuit at $V_C = 3V$, a change in emitter current from 12.0 mA to 18.5 mA produces a change in collector current from 11.8 to 17.4 mA. The current gain will be:
(A) 0.9521 (B) 0.8615 (C) 0.7351 (D) None of these

Sol. **(B)** $\alpha = \left(\frac{\Delta I_c}{\Delta I_e}\right)_{V_e} = \frac{17.4-11.8}{18.5-12.0} = \frac{5.6}{6.5} = 0.8615$

2. For a common base amplifier, the values of resistance gain and voltage gain are 3000 and 2800 respectively. The current gain will be:
(A) 0.93 (B) 0.83 (C) 0.73 (D) 0.63

Sol. **(A)** $A_I = \frac{A_V}{A_R} = \frac{2800}{3000} = 0.93$

3. In the above problem the power gain of the amplifier will be:
(A) 351.2 (B) 1575.30 (C) 2173.6 (D) 2613.3

Sol. **(D)** $A_P = \frac{A_V^2}{A_R} = \frac{(2800)^2}{3000} = 2613.3$

4. In the above problem, the collector current will be:
(A) 0.44 A (B) 1.44 A (C) 0.44 mA (D) 1.44 mA

Sol. **(D)** $I_c = I_e - I_b = 1.5 \times 10^{-3} - 60 \times 10^{-6} = 1.44$ mA

5. In the above problem, the collector current will be:
(A) 6.676 mA (B) 5.382 mA (C) 4.987 mA (D) None of these

Sol. **(A)** $I_c = I_e - I_b = 6.8 \times 10^{-3} - 0.124 \times 10^{-3} = 6.676$ mA

6. In a given transistor, the emitter current is changed by 2.1 mA. This results in a change of 2 mA in the collector current and a change of 1.05 V in the emitter-base voltage. The input resistance is:
(A) 5000 Ω (B) 3000 Ω (C) 1000 Ω (D) 500 Ω

Sol. **(D)** Input resistance $= \frac{\Delta V_{EB}}{\Delta I} = \frac{1.05}{2.1\times10^{-3}} = 500\Omega$

7. In the above problem, the A.C. gain of the transistor A.C. gain of the transistor (α_{AC}) will be:
(A) 0.90 (B) 0.95 (C) 0.99 (D) None of these

Sol. **(B)** $\alpha_{AC} = \frac{\Delta I_C}{\Delta I_B} = \frac{2\times10^{-3}}{2.1\times10^{-3}} \approx 0.95$

8. In Q. 132, if the transistor is used in common emitter configuration, then the value of β_{AC} will be:
(A) 9 (B) 19 (C) 29 (D) 39

Sol. **(B)** $\beta_{AC} = \frac{\alpha}{1-\alpha} = \frac{0.95}{1-0.95} = 19$

9. The DC current gain of a transistor in common base configuration is 0.98. Its current gain in common emitter configuration will be:
(A) 99 (B) 69 (C) 49 (D) 39

Sol. **(C)** $\beta = \dfrac{\alpha}{1-\alpha} = \dfrac{0.98}{1-0.98} = \dfrac{0.98}{0.02} = 49$

10. When the emitter current in a transistor is changed by 1 mA, then its collector current changes by 0.99 mA. The value of its common base current gain will be:
(A) 1.99 (B) 9.99 (C) 0.999 (D) 0.99

Sol. **(D)** $\alpha = \dfrac{\Delta I_C}{\Delta I_E} = \dfrac{0.99}{1} = 0.99$

11. In the above problem, the value of common emitter current gain will be:
(A) 0.99 (B) 9.9 (C) 99 (D) 999

Sol. **(C)** $\beta = \dfrac{\alpha}{1-\alpha} = \dfrac{0.99}{1-0.99} = \dfrac{0.99}{0.01} = 99$

12. In the above problem, the value of base current will be:
(A) 0.0132 mA (B) 0.132 mA (C) 0.00132 mA (D) 1.32 mA

Sol. **(A)** $I_B = I_E = 1.1 - 1.0868 = 0.0132$ mA

13. The current gain in a common base circuit is 0.98. When the emitter current is changed by 5 mA, then the change in collector current will be:
(A) 0.196 mA (B) 2.45 mA (C) 4.90 mA (D) 5.10 mA

Sol. **(C)** $\alpha = \dfrac{\Delta I_C}{\Delta I_E}$

or $\Delta I_C = \alpha\, \Delta I_E = 0.98 x 5 = 4.90\text{ mA}$

14. A doped semiconductor has impurity levels 32 meV below the conduction band. The semiconductor is:
(A) N-type (B) P-type
(C) N-P junction (D) None of the above

Sol. **(A)** The impurity level shifts towards conduction band in N-type semiconductor.

15. A potential barrier of 0.5 V exists across a p - n junction. If the width of depletion layer is 10^{-6} m, the intensity of electric field in this region will be:
(A) 1 x 10^6 V/m (B) 5 x 10^5 V/m (C) 4 x 10^4 V/m (D) None of these

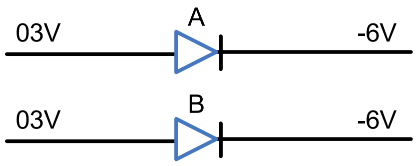
Sol. **(B)** $E = \dfrac{V}{d} = \dfrac{0.5}{10^{-6}} = 5\times10^5$ V/m

16. When a p-n junction in a diode is reverse biased, the thickness of the depletion layer
(A) increases (B) decreases
(C) become zero (D) remains constant

Solution : (A)

In reverse bias, as electrons and holes move away from the junction, the thickness of the depletion layer increases.

17. The two diodes A and B are biased as shown, then



(A) The diodes A and B are reverse biased
(B) The diodes A is forward biased and B is reverse biased
(C) The diodes B is forward biased and diode A is reverse biased
(D) The diodes A and B are forward biased.

Solution : (D)

18. The potential in the depletion layer is due to
(A) electrons (B) holes
(C) ions (D) forbidden band

Solution : (C)

19. The width of forbidden gap in silicon crystal is 1.1 eV. When the crystal is converted in to a n-type semiconductor the distance of Fermi level from conduction band is
(A) greater than 0.55 eV (B) equal to 0.55 eV
(C) lesser than 0.55 eV (D) equal to 1.1 eV

Solution : (C)

20. Consider the following statements A and B and identify the correct choice of the given answers.
(1) The width of the depletion layer in a p-n junction diode increases in forward bias.
(2) In an intrinsic semiconductor the Fermi energy level is exaclty in the middle of the forbidden gap.
(A) A is true and B is False (B) Both A and B are false
(C) A is false and B is true (D) Both A and B is true

Solution : (C)

When a p-n junction diode is forward biased the thickness of depletion layer decreases and thereby the current across the junction increases.
In an intrinsic semi-conductor, Fermi energy level will be in the middle of the forbidden gap.

21. In the study of transistor as amplifier, if $\alpha = \frac{I_C}{I_E}$ and $\beta = \frac{I_C}{I_B}$ where I_C, I_B, I_E are the collector, base and emitted currents, then

(A) $\beta = \frac{(1-\alpha)}{\alpha}$ (B) $\beta = \frac{\alpha}{(1+\alpha)}$

(C) $\beta = \frac{\alpha}{(1-\alpha)}$ (D) $\beta = \frac{(1+\alpha)}{\alpha}$

Solution : (C)

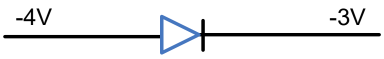
22. A gate has the following truth table

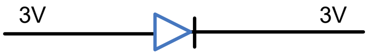
A	B	R
1	1	1
1	0	0
0	1	0
0	0	0

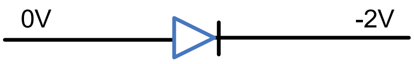
The gate is:
(A) AND (B) OR
(C) NOR (D) NAND

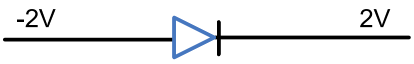
Solution : (A)

23. Out of following the forward based diode is

(A) 

(B) 

(C) 

(D) 

Solution : (C)

24. The approximate ratio of resistance in the forward and reverse bias of the PN junction diode is
(A) $10^2 : 1$ (B) $10^{-2} : 1$
(C) $1 : 10^{-4}$ (D) $1 : 10^4$

Solution : (D)

25. The resistance of a reverse biased pn junction diode is about :
(A) 1 ohm (B) 10^2 ohm
(C) 10^3 ohm (D) 10^6 ohm

Solution : (D)

26. On reducing forward voltage, the potential barrier
(A) increases (B) decreases
(C) unchanged (D) none of these

Solution : (A)

27. In the depletion layer, there are
(A) Only electrons (B) only holes
(C) electrons and holes (D) None of the above

Solution : (D)

28. Zener diode is used :
(A) As a amplifier (B) As a rectifier
(C) As a oscillator (D) As a voltage regulator

Solution : (D)

29. Which of the following is a correct relation for a transistor

(A) $\alpha = \frac{\beta}{1-\beta}$ (B) $\beta = \frac{\alpha}{1-\alpha}$

(C) $\beta = \frac{\alpha}{1+\alpha}$ (D) $\alpha = \frac{\beta}{1+\alpha}$

Solution : (B)

$I_E = I_B + I_C$

Differentiating, we get

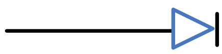
$$\Delta I_E = \Delta I_B + \Delta I_C$$

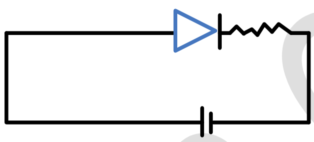
$$\Rightarrow \frac{\Delta I_E}{\Delta I_C} = \frac{\Delta I_B}{\Delta I_C} + 1$$

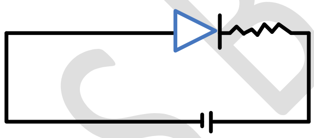
$$\Rightarrow \frac{1}{\alpha} = \frac{1}{\beta} + 1 = \frac{1+\beta}{\beta}$$

$$\Rightarrow \alpha = \frac{\beta}{1+\beta}$$

30. Which one is in forward bias :

(A) 

(B) 

(C) 

(D) None of these

Solution : (B)

CBSE-EXERCISE - I

1. What is a p-n junction diode? Explain with the help of a diagram, how is depletion region formed near the junction? Explain also what happens to this layer when the junction is (i) forward biased and (ii) reverse biased.

2. What is rectification? With the help of a labeled circuit diagram, explain full wave rectification using junction diodes.

3. With the help of a labeled circuit diagram, explain how n-p-n transistor can be used as an amplifier in common emitter configuration. Show the input and output wave forms.

4. Give the symbols of n-p-n and p-n-p transistors. Show the biasing of an n-p-n transistor and explain the transistor action.

5. Explain by drawing a circuit diagram, how an AND gate can be realised in practice using p-n junction diodes?

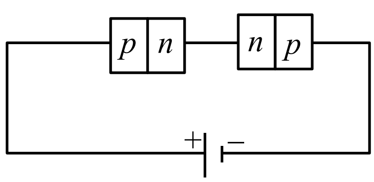
6. With the help of energy band diagram, distinguish between conductor, insulator and semiconductor.

7. Distinguish between an intrinsic and an extrinsic semiconductor.

8. What is a Zener diode? Give its symbol. Write its one specific use.

9. Why is the common emitter amplifier preferred over a common base amplifier?

10. Is the potential difference across the two *p*-*n*-junctions in the given circuit same or different?



EXERCISE - II

1. Choose the correct statement:
(a) When we heat a semiconductor its resistance increases.
(b) When we heat a semiconductor its resistance decreases.
(c) When we cool a semiconductor to 0^0C then it becomes super conductor.
(d) Resistance of a semiconductor is independent of temperature.

2. Germanium is doped with arsenic, what will be the result?
(a) *p*-type semi-conductor (b) *n*-type semi-conductor
(c) Intrinsic semi-conductor (d) none of these

3. In a transistor, current gain for common base and common emitter configurations are α and β respectively. The relation between α and β is

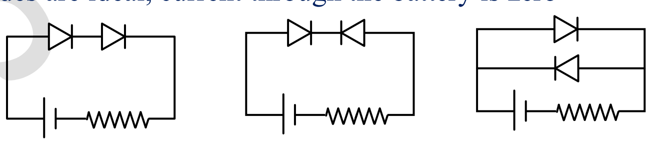
(a) $\beta = \alpha/(1-\alpha)$ (b) $\beta = 1/(1-\alpha)$ (c) $\beta = \alpha/(1+\alpha)$ (d) β = (1-α)

4. A transistor in common base configuration has current gain α = 0.95. It has a change in emitter current of 100 milliampere. Then the change in collector current is
(a) 95 mA (b) 100 mA (c) 99.05 mA (d) 100.95 mA

5. The value of current gain in common base amplifier is
(a) greater than one (b) less or greater than one
(c) less than one (d) none of these

6. The current gain for a transistor working as common-base amplifier is 0.96. If the emitter current is 7.2 mA, then the base current is
(a) 0.29 mA (b) 0.35 mA (c) 0.39 mA (d) 0.43 mA

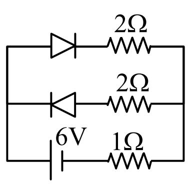
7. Assuming the diodes are ideal, current through the battery is zero



(i) (ii) (iii)

(a) in (i) and (iii) (b) in (ii) and (iii) (c) in only (ii) (d) in only (iii)

8. Assuming ideal diode the current through the 1Ω resistance in the circuit as shown in the figure is
(a) 2A (b) 1A
(c) 3A (d) none of the above



9. The majority of current carrier in an *n*-type semiconductor are
(a) holes (b) electrons (c) negative ions (d) positive ions

10. In a forward biased p-n junction, the potential barrier

(a) becomes zero (b) decreases (c) increases (d) remain constant

11. A transistor can be used as an amplifier when

(a) base-emitter is forward biased and base-collector is reverse biased

(b) both base-emitter and base-collector are reverse biased

(c) both base-emitter and base-collector are forward biased

(d) none of these

12. The current gain in the common emitter mode of a transistor is 10. The input impedance is 20 kΩ and load of resistance is 100 kΩ. The power gain is

(a) 300 (b) 500 (c) 200 (d) 100

13. A silicon diode has a threshold voltage of 0.7V. If an input voltage given by 2sin (πt) is supplied to a half-wave rectifier circuit using this diode, the rectifier output has a peak value of

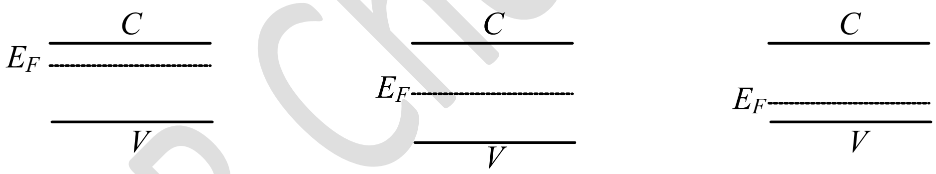
(a) 2V (b) 1.4V (c) 1.3V (d) 0.7V

14. For a heavily doped n-type semi-conductor Fermi-level lies

(a) a little below the conduction band (b) a little above the valence band

(c) a little inside the valence band (d) at the centre of the band gap

15. The band diagrams of the three semiconductors are given in the figure. From left to right, they are respectively



(a) n-intrinsic-p (b) p-intrinsic-n (c) intrinsic-p-n (d) p-n-intrinsic

16. A solid which is not transparent to visible light and whose conductivity increases with temperature is formed by

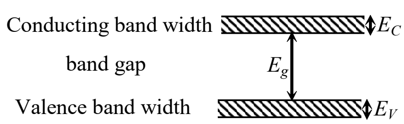
(a) Metallic binding (b) Ionic binding

(c) Covalent binding (d) Vander Waals binding

17. In a common base mode of a transistor, the collector current is 5.488 mA for an emitter current of 5.60 mA. The value of the base current amplification factor (β) will be

(a) 48 (b) 49 (c) 50 (d) 51

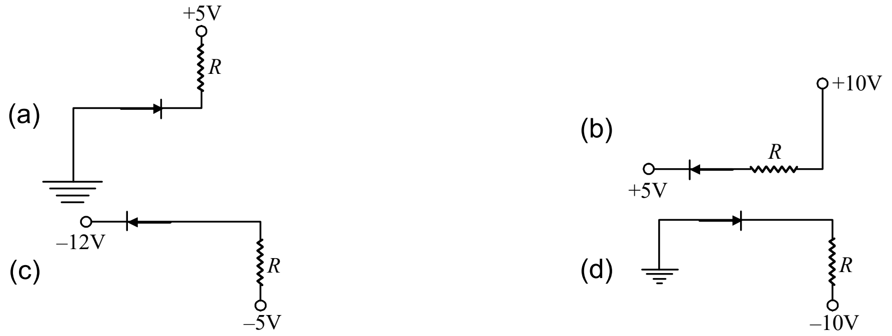
18. If the lattice constant of this semiconductor is decreased, then which of the following is correct?



(a) All E_C, E_g, E_v decrease (b) All E_C, E_g, E_v increase

(c) E_C, and E_v increase, but E_g decrease (d) E_C, and E_v decrease, but E_g increases

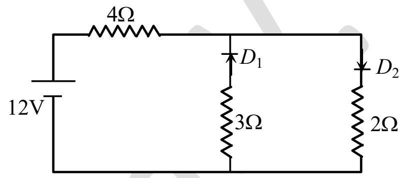
19. In the following, which one of the diodes is reverse biased?



20. The circuit has two oppositely connected ideal diodes in parallel. What is the current flowing in the circuit?

(a) 01.33 A (b) 1.71 A

(c) 2.00 A (d) 2.31 A



ANSWERS TO EXERCISE - II

1. (b)	2. (b)	3. (a)	4. (a)	5. (c)
6. (a)	7. (c)	8. (a)	9. (b)	10. (b)
11. (a)	12. (b)	13. (c)	14. (a)	15. (a)
16. (c)	17. (b)	18. (c)	19. (a)	20. (c)

IMPORTANT PRACTICE QUESTION SERIES FOR IIT-JEE EXAM – 1

Q.1 In conductors -
(1) conduction band is completely empty but forbidden energy gap is small
(2) conduction and valence bands are overlapped
(3) valence band is completely filled but the conduction band is completely empty
(4) no energy band is present

Q.2 The forbidden energy gap of a germanium semiconductor is 0.75 eV. The minimum thermal energy of electrons reaching the conduction band from the valence band should be -
(1) 0.5 eV (2) 0.75 eV
(3) 0.25 eV (4) 1.5eV

Q.3 The energy of a photon of sodium light (λ = 5890Å) equals the band gap of a semiconductor. The minimum energy required to create an electron-hole pair is -
(1) 0.026 eV (2) 0.31 eV
(3) 2.1eV (4) 6.4 eV

Q.4 The forbidden energy band gap in conductors, semiconductors and insulators are EG_1, EG_2 and EG_3 respectively. The relation among them is -
(1) $EG_1 = EG_2 = EG_3$
(2) $EG_1 < EG_2 < EG_3$
(3) $EG_1 > EG_2 > EG_3$
(4) $EG_1 < EG_2 > EG_3$

Q.5 On increasing temperature the specific resistance of a semiconductor -
(1) decreases
(2) increases
(3) remains constant
(4) becomes zero

Q.6 Which of the following statements is not correct ?
(1) Resistance of semiconductor decreases with increase in temperature
(2) In an electric field, displacement of holes is opposite to the displacement of electrons
(3) Resistance of a conductor decreases with the increase in temperature
(4) n-type semiconductors are neutral

Q.7 Wires P and Q have the same resistance at ordinary (room) temperature. When heated, resistance of P increases and that of Q decreases. We conclude that -
(1) P and Q are conductors of different materials
(2) P is N-type semiconductor and Q is P-type semiconductor
(3) P is semiconductor and Q is conductor
(4) P is conductor and Q is semiconductor

Q.8 In a good conductor the energy gap between the conduction band and the valence band is -
(1) Infinite (2) Wide
(3) Narrow (4) Zero

Q.9 In a semi conducting material the mobilities of electrons and holes are μ_e and μ_h respectively. Which of the following is true ?
(1) $\mu_e > \mu_h$ (2) $\mu_e < \mu_h$
(3) $\mu_e = \mu_h$ (4) $\mu_e < 0$; $\mu_h > 0$

Q.10 Those materials in which number of holes in valence band is equal to number of electrons in conduction band are called
(1) conductors
(2) Intrinsic semiconductors
(3) p-type semiconductors
(4) n-type semiconductors

Q.11 In p-type semiconductor holes move in
(1) forbidden region
(2) conduction band
(3) valence band
(4) all the above regions

Q.12 Which of the following statement is wrong ?
(1) Resistance of extrinsic semiconductors can be changed as required
(2) In n-type semiconductor the number of electrons increases in valence band
(3) In p-type semiconductors the number of holes increases in valence band
(4) In pure semiconductor fermi band is situated in between the valence band and conduction band

Q.13 P-type semiconductor is formed when -
A. As impurity is mixed in Si
B. Al impurity is mixed in Si
C. B impurity is mixed in Ge
D. P impurity is mixed in Ge
(1) A and C (2) A and D
(3) B and C (4) B and D

Q.14 In extrinsic semiconductors -
(1) The conduction band and valence band overlap
(2) The gap between conduction band and valence band is more than 16 eV
(3) The gap between conduction band and valence band is near about 1 eV
(4) The gap between conduction band and valence band will be 100 eV and more

Q.15 Fermi level of energy of an intrinsic semiconductor lies -
(1) In the middle of forbidden gap
(2) Below the middle of forbidden gap
(3) Above the middle of forbidden gap
(4) Outside the forbidden gap

Q.16 If n_e and v_d be the number of electrons and drift velocity in a semiconductor. When the temperature is increased -
(1) n_e increases and v_d decreases
(2) n_e decreases and v_d increases
(3) Both n_e and v_d increases
(4) Both n_e and v_d decreases

Q.17 The electron mobility in N-type germanium is 3900 $cm^2/v.s$ and its conductivity is 6.24 mho/cm, then impurity concentration will be if the effect of cotters is negligible -
(1) 10^{15} cm^3 (2) $10^{13}/cm^3$
(3) $10^{12}/cm^3$ (4) $10^{16}/cm^3$

Q.18 In semiconductor the concentrations of electrons and holes are $8 \times 10^{18}/m^3$ and $5 \times 10^{18}/m^3$ respectively. If the mobilities of electrons and hole are 2.3 m^2/volt-sec and 0.01 m^2/volt-sec respectively, then semiconductor is -
(1) N-type and its resistivity is 0.34 ohm-metre
(2) P-type and its resistivity is 0.034 ohm-metre
(3) N-type and its resistivity is 0.034 ohm-metre
(4) P-type and its resistivity is 3.40 ohm-metre

Q.19 A potential difference of 2V is applied between the opposite faces of a Ge crystal plate of area 1 cm^2 and thickness 0.5 mm. If the concentration of electrons in Ge is $2 \times 10^{19}/m^3$ and mobilities of electrons and holes are $0.36 \frac{m^2}{volt - sec}$ and $0.14 \frac{m^2}{volt - sec}$ respectively, then the current flowing through the plate will be -
(1) 0.25 A (2) 0.45 A
(3) 0.56 A (4) 0.64 A

Q.20 A potential barrier of 0.50 V exists across a P-N junction. If the depletion region is 5.0×10^{-7} m wide, the intensity of the electric field in this region is -
(1) 1.0×10^6 V/m (2) 1.0×10^5\ V/m
(3) 2.0×10^5 V/m (4) 2.0×10^6 V/m

Q.21 If no external voltage is applied across P-N junction, there would be -
(1) No electric field across the junction
(2) An electric field pointing from N-type to P-type side across the junction
(3) An electric field pointing from P-type to N-type side across the junction
(4) A temporary electric field during formation of P-N junction that would subsequently disappear

Q.22 No bias is applied to a P-N junction, then the current -
(1) Is zero because the number of charge carriers flowing on both sides is same
(2) Is zero because the charge carriers do not move
(3) Is non-zero
(4) None of these

Q.23 The main cause of avalanche breakdown is -
(1) collision ionisation
(2) high doping
(3) recombination of electron and holes
(4) none of these

Q.24 The main cause of Zener breakdown is -
(1) the base semiconductor being germanium
(2) production of electron-hole pairs due to thermal excitation
(3) low doping
(4) high doping

Q.25 Which of the following statements is correct ?
(1) The depletion region of P-N junction diode increases with forward biasing
(2) The depletion region of P-N junction diode decreases with reverse biasing
(3) The depletion region of P-N junction diode does not change with biasing
(4) The depletion region of P-N junction diode decreases with forward biasing

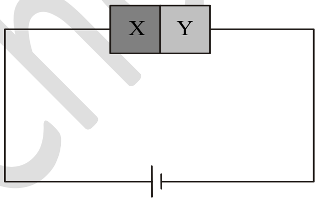
Q.26 When reverse bias in a junction diode is increased, the width of depletion layer -
(1) increase (2) decreases
(3) does not change (4) fluctuate

Q.27 A semiconductor device is connected in a series circuit with a battery and resistance. A current is found to pass through the circuit. If the polarity of the battery is reversed, the current drops almost to zero. The device may be -
(1) A P-type semiconductor
(2) An N-type semiconductor
(3) A PN-junction
(4) An intrinsic semiconductor

Q.28 The approximate ratio of resistances in the forward and reverse bias of the PN-junction diode is -
(1) $10^2 : 1$ (2) $10^{-2} : 1$
(3) $1 : 10^{-4}$ (4) $1 : 10^4$

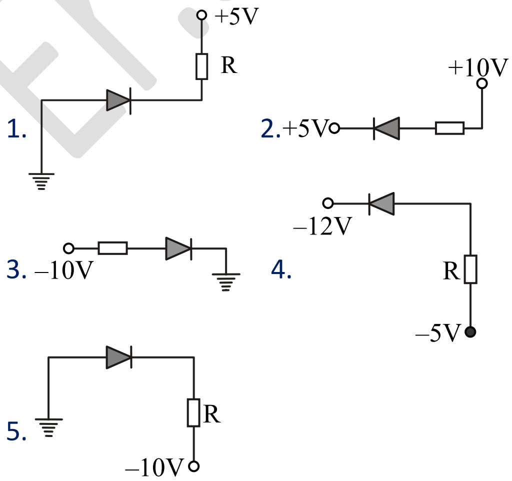
Q.29 The dominant mechanisms for motion of charge carriers in forward and reverse biased silicon P-N junctions are -
(1) Drift in forward bias, diffusion in reversebias
(2) Diffusion in forward bias, drift in reverse bias
(3) Diffusion in both forward and reverse bias
(4) Drift in both forward and reverse bias

Q.30 A semiconductor X is made by doping a germanium crystal with arsenic (Z = 33). A second semiconductor Y is made by doping germanium with indium (Z = 49). The two are joined end to end and connected to a battery as shown. Which of the following statements is correct ?



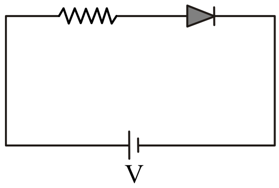
(1) X is P-type, Y is N-type and the junction is forward biased
(2) X is N-type, Y is P-type and the junction is forward biased
(3) X is P-type, Y is N-type and the junction is reverse biased
(4) X is N-type, Y is P-type and the junction is reverse biased

Q.31 In the given figure, which of the diodes are forward biased ?



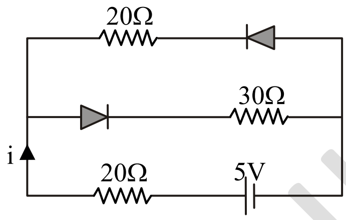
(1) 1, 2, 3 (2) 2, 4, 5
(3) 1, 3, 4 (4) 2, 3, 4

Q.32 For the given circuit of PN-junction diode, which of the following statements is correct -



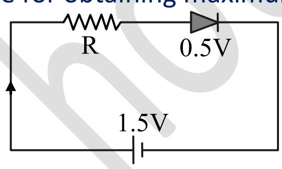
(1) In forward biasing the voltage across R is V
(2) In forward biasing the voltage across R is 2V
(3) In reverse biasing the voltage across R is V
(4) In reverse biasing the voltage across R is 2V

Q.33 Current in the circuit will be -



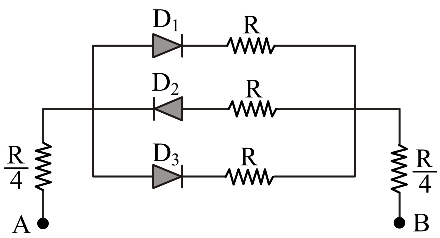
(1) $\frac{5}{40}$ A (2) $\frac{5}{50}$ A (3) $\frac{5}{10}$ A (4) $\frac{5}{20}$ A

Q.34 The diode used in the circuit shown in the figure has a constant voltage drop of 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 the diode for obtaining maximum current -



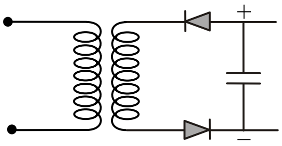
(1) 1.5 Ω (2) 5 Ω
(3) 6.67 Ω (4) 200 Ω

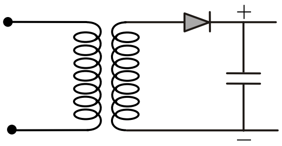
Q.35 In the following circuits PN-junction diodes D_1, D_2 and D_3 are ideal for the following potential of A and B, the correct increasing order of resistance between A and B will be -

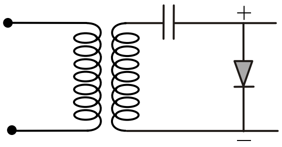


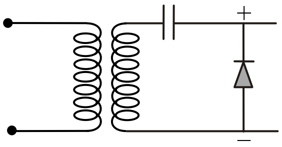
(i) – 10 V, – 5 V (ii) – 5V, – 10 V
(iii) – 4V, – 12 V
(1) (i) < (ii) < (iii) (2) (iii) < (ii) < (i)
(3) (ii) = (iii) < (i) (4) (i) = (iii) < (ii)

Q.36 Which is the correct diagram of a half-wave rectifier?

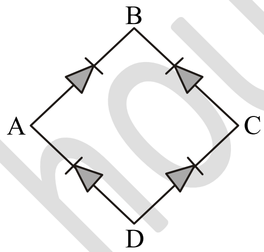
(1) 

(2) 

(3) 

(4) 

Q.37 In the diagram, the input is across the terminals A and C and the output is across the terminals B and D, then the output is -

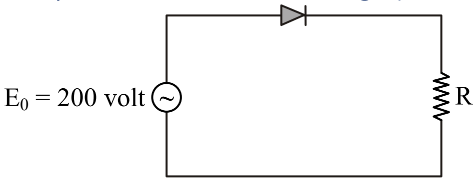


(1) zero (2) same as input
(3) full wave rectifier (4) half wave rectifier

Q.38 If a full wave rectifier circuit is operating from 50 Hz mains, the fundamental frequency in the ripple will be -
(1) 50 Hz (2) 70.7 Hz
(3) 100 Hz (4) 25 Hz

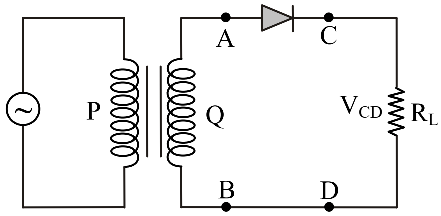
Q.39 In a full wave rectifiers input ac current has a frequency ν. The output frequency of current is -
(1) $\nu/2$ (2) ν
(3) 2ν (4) None of these

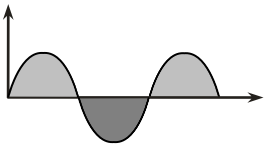
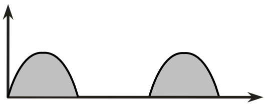
Q.40 A sinusoidal voltage of peak value 200 volt is connected to a diode and resistor R in the circuit shown so that half wave rectification occurs. If the forward resistance of the diode is negligible compared to R then rms voltage (in volt) across R is approximately -

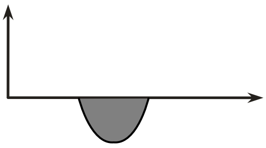
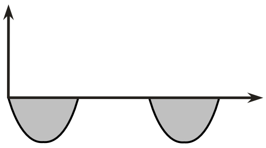


(1) 200 (2) 100 (3) $\frac{200}{\sqrt{2}}$ (4) 280

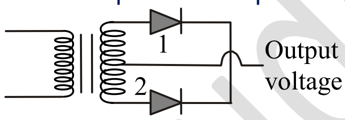
Q.41 In the half-wave rectifier circuit shown. Which one of the following wave forms is true for V_{CD}, the output across C and D?

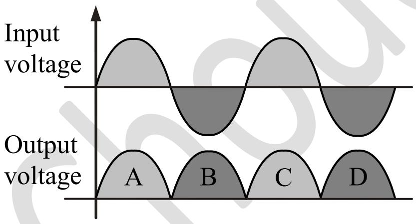


(1)  (2) 

(3)  (4) 

Q.42 A full wave rectifier circuit along with the input and output voltage is shown in the figure.

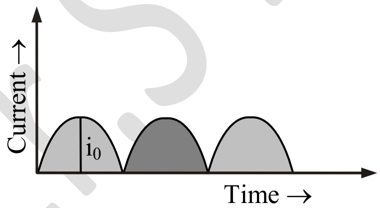




The contribution to output voltage from diode – 2 to -

(1) A, C (2) B, D
(3) B, C (4) A, D

Q.43 The output current versus time curve of a rectifier is shown in the figure. The average value of the input current in this case is -

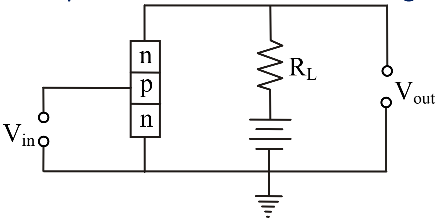


(1) 0 (2) i_0/π (3) $2i_0/\pi$ (4) i_0

Q.44 n-p-n transistors are preferred to p-n-p transistors because -

(1) they have low cost
(2) they have low dissipation energy
(3) they are capable of handling large power
(4) electrons have high mobility than holes and hence high mobility of energy

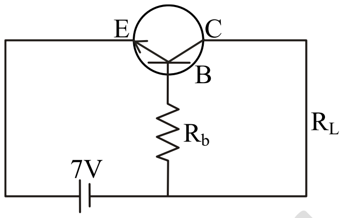
Q.45 An n-p-n transistor circuit is arranged as shown in fig. It is -



(1) a common-base amplifier circuit
(2) a common-emitter amplifier circuit
(3) a common-collector amplifier circuit
(4) none of the above

Q.46 Compared to CB amplifier, the CE amplifier has -
(1) lower input resistance
(2) higher output resistance
(3) lower current amplification
(4) higher output resistance

Q.47 In the given transistor circuit, the base current is 35 μA. The value of R_b is -



(1) 100 kΩ (2) 200 kΩ
(3) 300 kΩ (4) 400 kΩ

Q.48 I. In a P-N-P type common base amplifier the input and output are in same phase.
II. In a P-N-P common base amplifier input and output are out of phase.
III. In a N-P-N- common base amplifier the input and output are in same phase.
IV. In a N-P-N common base amplifier input and output are out of phase.
State if -
(1) I and III are correct
(2) II and III are correct
(3) I and IV are correct
(4) II and IV are correct

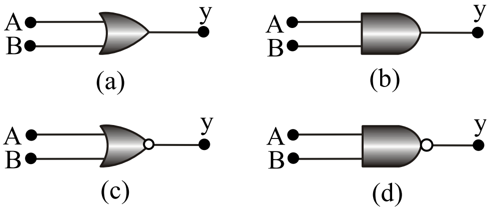
Q.49 In a transistor the base is made very thin and is lightly doped with an impurity because-
(1) to enable the collector to collect 95% of The holes or electrons coming from the emitter side
(2) to enable the emitter to emit small number of holes or electrons
(3) to save the transistor from higher current effects
(4) none of the above

Q.50 In an NPN transistor 10^{10} electrons enter the emitter in 10^{-6}s. 2% of the electrons are lost in the base. The current transfer ratio will be-
(1) 0.95 (2) 0.96 (3) 0.97 (4) 0.98

Q.51 In an NPN transistor the values of base current and collector current are 100μA and 9 mA respectively, the emitter current will be-
(1) 9.1 mA (2) 18.2 mA
(3) 9.1μ A (4) 18.2 μA

Q.52 For a common base amplifier, the values of resistance gain and voltage gain are 3000 and 2800 respectively. The current gain will be -
(1) 0.93 (2) 0.83 (3) 0.73 (4) 0.63

Q.53 Given below are four logic gate symbol (figure). Those for OR, NOR and NAND are respectively -



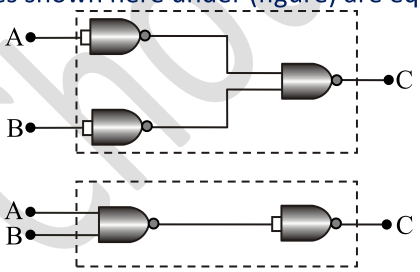
(1) a, d, c (2) d, a, b
(3) a, c, d (4) d, b, a

Q.54 The following truth table corresponds to the logic gate -

A	0	0	1	1
B	0	1	0	1
X	0	1	1	1

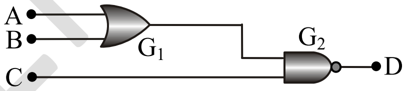
(1) NAND
(2) OR
(3) AND
(4) XOR

Q.55 The combination of 'NAND' gates shown here under (figure) are equivalent to –



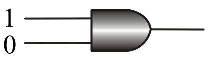
(1) An OR gate and an AND gate respectively
(2) An AND gate and a NOT gate respectively
(3) An AND gate and an OR gate respectively
(4) An OR gate and a NOT gate respectively

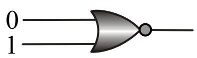
Q.56 For the given combination of gates, if the logic states of inputs A, B, C are as follows A = B = C = 0 and A = B = 1, C = 0 then the logic states of output D are -

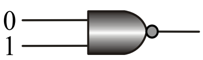


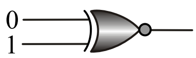
(1) 0, 0 (2) 0, 1
(3) 1, 0 (4) 1, 1

Q.57 Which of the following gates will have an output of 1 ?

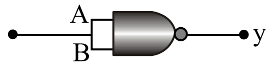
(1) 

(2) 

(3) 

(4) 

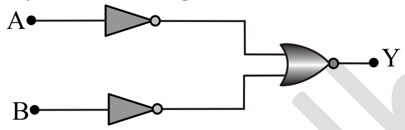
Q.58 This symbol represents -



(1) NOT gate
(2) OR gate
(3) AND gate
(4) NOR gate

Q.59 The output of a NAND gate is 0 -
(1) If both inputs are 0
(2) If one input is 0 and the other input is 1
(3) If both inputs are 1
(4) Either if both inputs are 1 or if one of the inputs is 1 and the other 0

Q.60 Which logic gate is represented by the following combination of logic gates -



(1) OR (2) NAND
(3) AND (4) NOR

Q.61 The output of OR gate is 1 -
(1) If both inputs are zero
(2) If either or both inputs are 1
(3) Only if both input are 1
(4) If either input is zero

IMPORTANT PRACTICE QUESTION SERIES FOR IIT-JEE EXAM – 2

Q.1 Which of the following statement is true ?
(1) In insulators the conduction band is completely empty
(2) In conductor the conduction band is completely empty
(3) In semiconductor the conduction band is partially empty at low temperature
(4) In insulators the conduction band is completely filled with electrons

Q.2 The materials resistance of which decreases with increases in temperature (i.e. the temperature coefficient of resistance is negative) are called -
(1) conductors
(2) insulators
(3) semiconductors
(4) all of the above

Q.3 The diffusion current in a p-n junction is from -
(1) p-side to n-side
(2) n-side to p-side
(3) p-side to n-side if the junction is forward biased and in the opposite direction if it is reverse biased
(4) n-side to p-side if the junction is forward biased and in the opposite direction if it is reverse based

Q.4 In n-type semiconductors the Fermi energy level is displaced -
(1) towards the valence band
(2) towards the conduction band
(3) not displaced
(4) and it does not depend on quantity of impurity

Q.5 If n-type semiconductor is heated then -
(1) the number of electrons increases and the number of holes decreases
(2) the number of holes increases and the number of electrons decreases
(3) at the number of electrons and holes both remains equal
(4) the number of both electrons and holes increases

Q.6 Forbidden energy gap of a silicon semiconductor is 1.12 eV. In order to generate electron-hole pairs in it, the maximum wavelength of the incident photons will be -
(1) 11080Å (2) 11250Å
(3) 12370Å (4) 14400Å

Q.7 If the two ends of a p-n junction are joined by a conducting wire, then -
(1) there will be no current in the circuit
(2) there will be steady current from n-side to p-side
(3) there will be steady current from p-side to n-side
(4) there will be a steady current in the circuit

Q.8 A doped semiconductor has impurity levels 32 meV below the conduction band. The semiconductor is -
(1) N-type (2) P-type
(3) N-P junction (4) none of the above

Q.9 The mean free path of a conduction electron in a metal is 5×10^{-8} m. The electric field, required to be applied across the conductor so as to impart 1eV energy to the conduction electron, will be -
(1) 1×10^{-7} V/m (2) 2×10^{7} V/m
(3) 3×10^{7} V/m (4) 4×10^{7} V/m

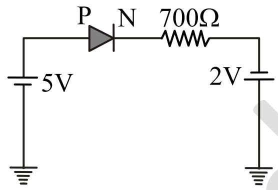
Q.10 Which of the following statements is correct ?

(1) when forward bias is applied on a p-n junction then current does not flow in the circuit
(2) rectification of alternating current can not be achieved by p-n junction
(3) when reverse bias is applied on a p-n junction then it acts as a conductor
(4) some potential gap developed across the p-n junction when it is formed

Q.11 In semiconductor the concentrations of electrons and holes are $8 \times 10^{18}/m^3$ and $5 \times 10^{18}/m^3$ respectively. If the mobilities of electrons and holes are 2.3 m^2/V-s and 0.01 m^2/V-s respectively, then semiconductor is -

(1) N-type and its resistivity is 0.34 ohm-metre
(2) P-type and its resistivity is 0.034 ohm-metre
(3) N-type and its resistivity is 0.034 ohm-metre
(4) P-type and its resistivity is 3.40 ohm-metre

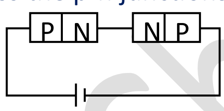
Q.12 The current through an ideal PN junction shown in the following circuit diagram will be -



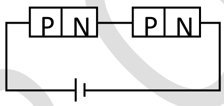
(1) 5 mA (2) 10 mA
(3) 70 mA (4) 100 mA

Q.13 Two identical p-n junction may be connected in series with a battery in three ways (fig). The potential drops across the p-n junctions are equal in -

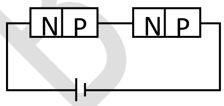
(1) circuit 1 and 2



(2) circuit 2 and 3

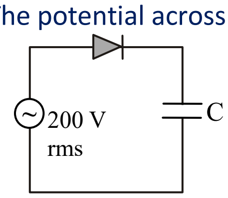


(3) circuit 3 and 1



(4) circuit 1 only

Q.14 In the figure , an A.C. of 200 rms voltage is applied to the circuit containing diode and the capacitor and it is being rectified. The potential across the capacitor C will be -



(1) 500V
(2) 200V
(3) 283V
(4) 141V

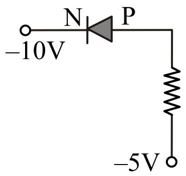
Q.15 Which of the following statements is wrong ?

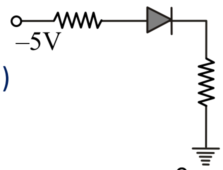
(1) The resistance of a semiconductor decreases with the increases of temperature
(2) In electric field the displacement of holes is opposite in direction to that of electrons
(3) The resistance of conductor decreases with the increase of temperature
(4) N-type semiconductors are neutral

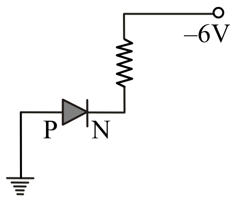
Q.16 The value of current in the following diagram will be –

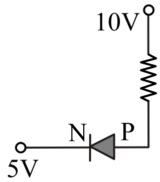
(1) 0.10 Ac (2) 10^{-2} A
(3) 1 A (4) 0 A

Q.17 In which of the following figures the junction diode is in reverse bias

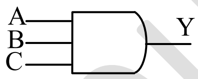
(1)


(2)


(3)


(4)


Q.18 The output of the given logic gate is 1 when inputs A, B and C are such that-



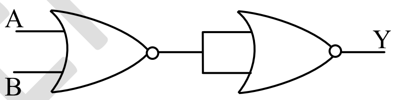
(1) A = 1, B = 0, C = 1
(2) A = 1, B = 1, C = 0
(3) A = B = C = 0
(4) A = B = C = 1

Q.19 The truth table given below is for-

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

(1) OR gate (2) AND gate
(3) XNOR gate (4) XOR gate

Q.20 The arrangement shown in figure performs the logic function of a/an .... gate –

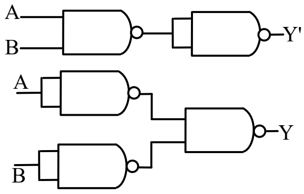


(1) OR (2) XOR
(3) NAND (4) AND

Q.21 The output of gate is low when at least one of its two input is high. This is true for -
(1) NOR (2) OR
(3) AND (4) NAND

Q.22 An XOR gate produces an output only when its two inputs are -
(1) same (2) different(3) low (4) high

Q.23 You are given two circuits as shown in following figure. The logic operation carried out by the two circuit are respectively-



(1) AND, OR (2) OR, AND
(3) NAND, OR (4) NOR, AND

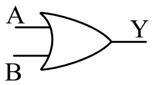
Q.24 Which of the following Boolean expression is not correct -
(1) $\overline{\overline{A}.\overline{B}} = A + B$ (2) $\overline{\overline{A}+\overline{B}} = A.B$
(3) $\overline{(\overline{A.B})(\overline{A.B})} = AB$ (4) $\overline{1}+\overline{1} = 1$

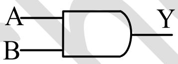
Q.25 In Boolean algebra, which of the following is not equal to zero-
(1) $A.\overline{A}$ (2) A.0 (3) $\overline{A+\overline{A}}$ (4) $\overline{\overline{A}.0}$

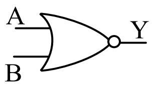
Q.26 Digital circuits can be made by repetitive use of-
(1) OR gate (2) AND gate
(3) NOT gate (4) NAND gate

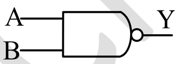
Q.27 Which of the following relation is valid in Boolean algebra -
(1) $A+\overline{A}=0$ (2) A + A = 2A
(3) $A+\overline{A}=1$ (4) $A+\overline{A}=A$

Q.28 Given below are four logic symbols. Those for OR, NOR and NAND gates are respectively-

(a) 

(b) 

(c) 

(d) 

(1) a, d, c (2) d, a, b
(3) a, c, d (4) d, b, a

Q.29 When all the inputs of a NAND gate are connected together, the resulting circuit is-
(1) a NOT gate (2) an AND gate
(3) an OR gate (4) a NOR gate

Q.30 Which of the following pairs are universal gates-
(1) NAND, NOT (2) NAND, AND
(3) NOR, OR (4) NAND, NOR

Q.31 A NAND gate followed by a NOT gate is-
(1) an OR gate (2) an AND gate
(3) a NOR gate (4) a XOR gate

Q.32 The NOR gate is logically equivalent to an OR gate followed by -
(1) an inverter (2) a NOR gate
(3) a NAND gate (4) an OR gate

Q.33 The output of a two input NOR gate is in state 1 when-
(1) either input terminals is at 0 state
(2) either input terminals is at 1 state
(3) both input terminals are at 0 state
(4) both input terminals are at 1 state

Q.34 'Output is LOW if and only if all the inputs are HIGH' indicate the logic gate for which the above statement is true-

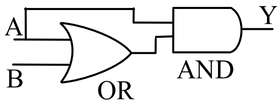
(1) AND (2) OR
(3) NOR (4) NAND

Q.35 The truth table shown is of-

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

(1) NAND gate (2) NOR gate
(3) XOR gate (4) XNOR gate

Q.36 The output Y of the combination of gates shown is equal to-



(1) A (2) $\overline{A}$
(3) A + B (4) AB

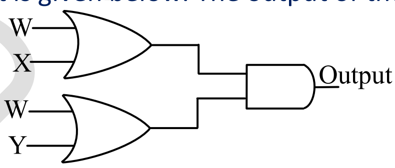
Q.37 Which of the following relations is valid for Boolean algebra -

(1) A + A = A (2) A.A = A
(3) A. $\overline{A}$ = 0 (4) all

Q.38 What would be the output of the circuit whose Boolean expression Y = $A\overline{B}$ + AB when A = 1, B = 0 -

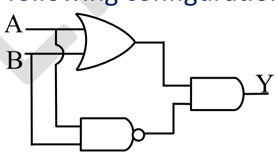
(1) 1 (2) 0
(3) both (1) & (2) (4) none of these

Q.39 The diagram of a logic circuit is given below. The output of the circuit is represented by-



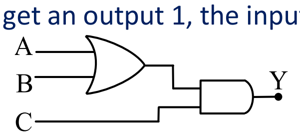
(1) W.(X + Y) (2) X.(X.Y)
(3) W + (X + Y) (4) W + (X.Y)

Q.40 The following configuration of gates is equivalent to –



(1) NAND (2) OR
(3) XOR (4) NOR

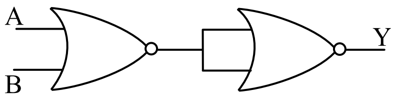
Q.41 To get an output 1, the input ABC should be-



(1) 101 (2) 100
(3) 110 (4) 010

Q.42 The output of 2 input gate is 1 only if its inputs are equal. It is true for-
(1) NAND (2) AND
(3) EX-NOR (4) EX-OR

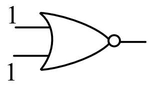
Q.43 The circuit-shown here is logically equivalent to-

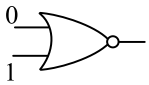


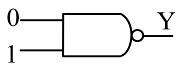
(1) OR gate (2) AND gate
(3) NOT gate (4) NAND gate

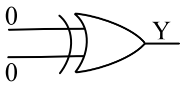
Q.44 A two-input NAND gate is followed by a single input NOR gate. This logic circuit will function as-
(1) an AND gate (2) an OR gate
(3) a NOT gate (4) a NOR gate

Q.45 Which of the following will have an output of 1 –

(a) 

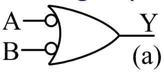
(b) 

(c) 

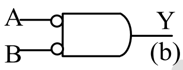
(d) 

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

Q.46 The logic symbols shown here are logically equivalent to –



(a)



(b)

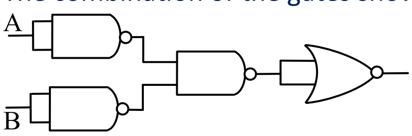
(1) 'a' AND and 'b' OR gate
(2) 'a' NOR and 'b' NAND gate
(3) 'a' OR and 'b' AND gate
(4) 'a' NAND and 'b' NOR gate

Q.47 Output of the four entries is given in the truth table, the correct ones for a two-input AND gate are-

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

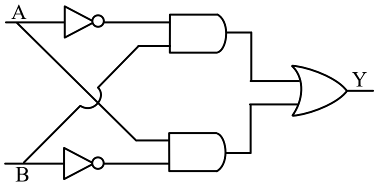
(1) 1 and 2 only
(2) 2, 3 and 4 only
(3) 1, 3 and 4 only
(4) 2 and 4 only

Q.48 The combination of the gates shown will produce



(1) OR gate
(2) AND gate
(3) NOR gate
(4) NAND gate

Q.49 Which of the following represents correctly the truth table of configuration of gates shown here



(1)

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

(2)

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

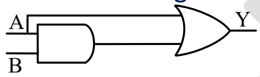
(3)

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

(4)

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

Q.50 The truth table for the following combination of gates is-



(a)

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

(b)

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

(c)

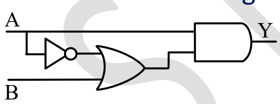
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

(d)

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

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

Q.51 The combination of the gates shown represents-



(1) AND gate (2) OR gate
(3) NAND gate (4) NOR gate

Q.52 Which of the following relations is valid for Boolean algebra-

(1) $A(B+\overline{B}) = A$
(2) A + AB = A
(3) A + 0 = A
(4) all

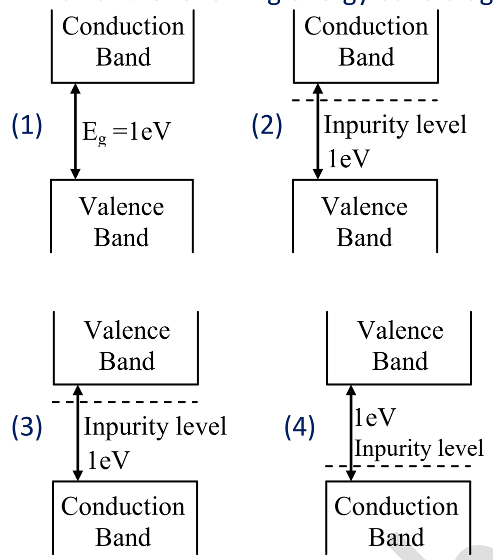
Q.53 On increasing the temperature the specific resistance of a semiconductor -

(1) increases
(2) decreases
(3) does not change
(4) first decreases and then increases

Q.54 Platinum and silicon are cooled after heating up to 250ºC -
(1) resistance of platinum will increase and that of silicon decreases
(2) resistance of silicon will increase and that of platinum decreases
(3) resistance of both will decrease
(4) resistance of both increases

Q.55 The atomic bonding is same for which of the following pairs -
(1) Ag and Si (2) Ge and Si
(3) Ne and Ge (4) NaCl and Ge

Q.56 Which of the following energy band diagram shows the N-type semiconductor -



Q.57 Which value of potential barrier is in the range, for given PN junction -
(1) 0.2 (2) 25
(3) 2.5 (4) 35

Q.58 In a P-N junction diode not connected to any circuit-
(1) potential is the same every where
(2) the P-type side is at a higher potential than the N-type side
(3) there is an electric field at the junction directed from the N-type side to the P-type side
(4) there is an electric field at the junction directed from the P-type side to the N-type side

Q.59 A transistor is used in the common emitter mode as an amplifier then-
(A) the base emitter junction is forward biased
(B) the base emitter junction is reverse biased
(C) the input signal is connected in series with the voltage applied to bias the base emitter junction
(D) the input signal is connected in series with the voltage applied to bias the base collector junction
(1) A, B (2) A, D (3) A, C (4) only C

Q.60 When a potential difference is applied across, the current passing through-
(1) a semiconductor at 0 K is zero
(2) a metal at 0 K is finite
(3) a P-N diode at 300 K is finite if it is reverse biased
(4) all

Q.61 Electric conduction in a semiconductor takes place due to-
(1) electrons only (2) holes only
(3) both electrons and holes (4) neither electrons nor holes

Q.62 Let n_p and n_e be the numbers of holes and conduction electrons in an extrinsic semiconductor.
(1) $n_p > n_e$
(2) $n_p = n_e$
(3) $n_p < n_e$
(4) $n_p \neq n_e$

Q.63 A p-type semiconductor is-
(1) positively charged
(2) negatively charged
(3) uncharged
(4) uncharged at 0 K but charged at higher temperatures

Q.64 When an impurity is doped into an intrinsic semiconductor, the conductivity of the semiconductor -
(1) increases
(2) decreases
(3) remains the same
(4) become zero

Q.65 The minority current in a p-n junction is-
(1) from the n-side to the p-side
(2) from the p-side to the n-side
(3) from the n-side to the p-side if the junction is forward-biased and in the opposite direction if it is reverse biased
(4) from the p-side to the n-side if the junction is forward-biased and in the opposite direction if it is reverse biased

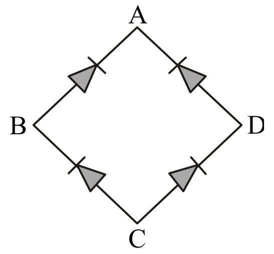
Q.66 The diffusion current in a p-n junction is-
(1) from the n-side to the p-side
(2) from the p-side to the n-side
(3) from the n-side to the p-side if the junction is forward-biased and in the opposite direction if it is reverse biased
(4) from the p-side to the n-side if the junction is forward-biased and in the opposite direction if it is reverse biased

Q.67 Diffusion current in a p-n junction is greater than the drift current in magnitude-
(1) if the junction is forward-biased
(2) if the junction is reverse-biased
(3) if the junction is unbiased
(4) in no case

Q.68 A hole diffuses from the p-side to the n-side in a p-n junction. This means that-
(1) a bond is broken on the n-side and the electron freed from the bond jumps to the conduction band
(2) a conduction electron on the p-side jumps to a broken bond to complete it
(3) a bond is broken on the n-side and the electron free from the bond jumps to a broken bond on the p-side to complete it
(4) a bond is broken on the p-side and the electron free from the bond jumps to a broken bond on the n-side to complete it

Q.69 In a transistor-
(1) the emitter has the least concentration of impurity
(2) the collector has the least concentration of impurity
(3) the base has the least concentration of impurity
(4) all the three regions have equal concentration of impurity

Q.70 For the given circuit shown in figure to act as full wave rectifier, a.c. input should be connected across .... and .... the d.c. output would appear across .... and ....



(1) A, C, B, D (2) B, D, A, C
(3) A, B, C, D (4) C, A, D, B

Q.71 In a .... biased P-N junction, the net flow holes is from N-region to the P-region -
(1) F.B. (2) R.B.
(3) NO (4) both 1 & 2

Q.72 The intrinsic semiconductor becomes an insulator at -
(1) 0ºC (2) 0 K
(3) 300 K (4) –100 ºC

Q.73 Region which have no free electrons and holes in a p-n junction is-
(1) p-region
(2) n-region
(3) junction
(4) depletion region

Q.74 In an n-p-n transistor circuit, the collector current is 20mA. If 90% of electron emitted reach the collector -
(1) the emitter current will be 18 mA
(2) emitter current will be 22 mA
(3) base current will be 2 mA
(4) base current will be 1 mA

Q.75 What will be conductance of pure silicon crystal at 300 K temperature. If electron hole pairs per cm^3 is 1.072×10^{10} at this temperature, $\mu_n = 1350\ cm^2$/volt-s and $\mu_p = 480\ cm^2$/volt-s
(1) 3.14×10^{-6} mho/cm
(2) 3×10^{6} mho/cm
(3) 10^{-6} mho/cm
(4) 10 mho/cm

Q.76 In sample of pure silicon 10^{13} atom/cm^3 is mixed of phosphorus. If all donor atoms are active then what will be resistivity at 20ºC if mobility of electron is 1200 cm^2/volt-s -
(1) 0.5209 ohm cm (2) 5.209 ohm cm
(3) 52.09 ohm cm (4) 520.9 ohm cm

Q.77 Mobility of electrons in N-type Ge is 5000 cm^2/volt sec and conductivity 5 mho/cm. If effect of holes is negligible then impurity concentration will be-
(1) $6.25 \times 10^{15}\ cm^3$ (2) $9.25 \times 10^{14}\ cm^3$
(3) $6 \times 10^{13}\ cm^3$ (4) $9 \times 10^{13}\ cm^3$

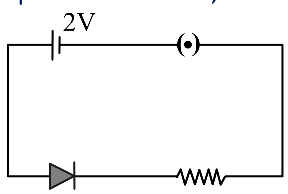
Q.78 Out of the following, which substance is not a semiconductor-
(1) ZnS (2) Cds (3) SiC (4) LiS

Q.79 Out of the following, which substance is not a semiconductor-

(1) Se (2) Te

(3) CuCl (4) CuO

Q.80 A two volts battery forward biases a diode however there is a drop of 0.5 V across the diode which is independent of current. Also a current greater than 10 mA produce large joule loss and damages diode. If diode is to be operated at 5 mA, the series resistance to be put is-



(1) 3 kΩ (2) 300 kΩ

(3) 300 Ω (4) 200 kΩ

IMPORTANT PRACTICE QUESTION SERIES FOR IIT-JEE EXAM – 1 (ANSWERS)

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ans.	2	2	3	2	1	3	4	4	1	2	3	2	3	3	1	1	4	1	4	1	2	2	1	2	4
Q.No.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Ans.	1	3	4	2	4	2	4	2	2	3	2	3	3	3	2	2	2	1	4	2	4	2	1	1	4
Q.No.	51	52	53	54	55	56	57	58	59	60	61														
Ans.	1	1	3	2	1	4	3	1	3	3	2														

IMPORTANT PRACTICE QUESTION SERIES FOR IIT-JEE EXAM – 2 (ANSWERS)

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	2,3	1	2	4	1	1	1	2	4	1	2	2	3	3	4	2	4	3	1
Q.No.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	2	1	4	4	4	3	3	1	4	2	1	3	4	3	1	4	1	4	3
Q.No.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	3	1	2	2	4	2	3	3	1	1	4	2	2	2	2	1	3	3	4
Q.No.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	4	3	1	1	2	1	3	3	2	2	2	4	2,3	1	4	1	4	4	3