Important 2 and 3 mark Questions and Answers

Sub : Physics Class : II PUC

1. Write any three properties of electric charge.
Ans: (i) Additivity of charges: The total charge of a system is the algebraic sum of all individual charges in the system.
(ii) Conservation of charge: The total charge of an isolated system remains unchanged with time.
(iii) Quantisation of charge: The total charge of a body is always integral multiple of a basic quantum of charge 'e' i.e. $q = \pm ne$
(iv) Like charges repel and unlike charges attract each other.

2. State and explain Coulomb's law in electrostatics.
Ans: "The **electrostatic force** between two point charges is directly **proportional to the product of magnitude of the charges** and **inversely proportional to the square of the distance between them** and acts along the line joining the two charges".
Consider two point charges q_1 and q_2 separated by distance 'r' in vacuum. According to the law the magnitude of force F between them is given by, $\frac{1}{4\pi\varepsilon_0}$

$$F \propto \frac{|q_1 q_2|}{r^2} \qquad \Rightarrow \qquad F = k\frac{|q_1 q_2|}{r^2}$$

Where, k is proportionality constant. In SI system, for free space $k = \frac{1}{4\pi\varepsilon_0}$

$$\therefore \quad \boxed{F = \frac{1}{4\pi\varepsilon_0}\frac{|q_1 q_2|}{r^2}}$$

3. Write Coulomb's law in vector form and explain the terms.
Ans: The of force on charge q_1 due to q_2 is given by,

$$\boxed{\vec{F}_{12} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}}$$

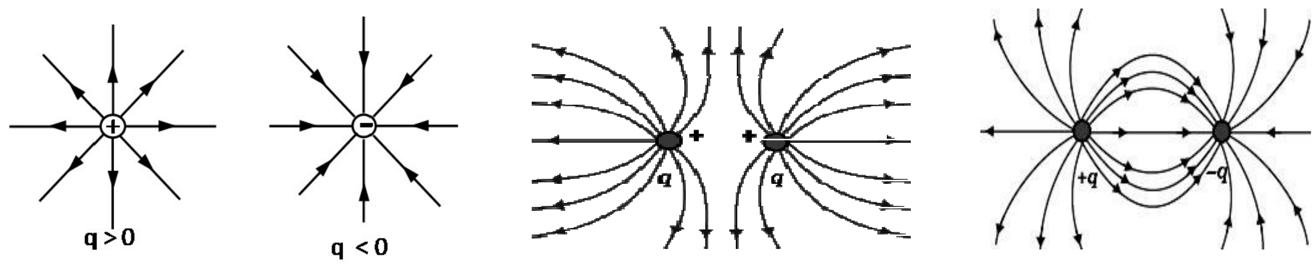
Where, r_{12} – distance between q_1 & q_2
$\hat{r}_{12}$ – un vector along $\vec{F}_{12}$ and
ε_0– permittivity of free space.

4. Mention the expression for electric field at a point due to a point charge in free space.
Ans: Electric field due to a point charge 'Q' at a distance 'r' from charge is

$$\boxed{E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}}$$ where, ε_0 – permittivity of free space

5. Write the properties of electric field lines.
- Electric field lines **start at positive** charge and **terminate at negative** charge. For an isolated charge they may start or end at infinity.
- Electric field lines **never intersect** each other.
- Electric field lines **do not form closed loops**.
- Tangent drawn to the field lines represents direction of electric field at that point.

6. Draw the electric field lines for
(i) q > 0 (ii) q < 0 (iii) system two positive charges and (iv) dipole.



7. Define electric dipole moment? And mention the expression for the dipole moment.

Ans: The product of the magnitude of either of charge of the dipole and separation between the two charges is called electric dipole moment.

Magnitude of electric dipole moment, ***p = q⃞2a*** ,

Where, q –magnitude of either charge and 2a –separation between charges.

8. State and explain Gauss theorem in electrostatics.

Ans: "The total electric flux through any closed surface is equal to $(^1/_{s_0})$ times the total charge enclosed by the surface".

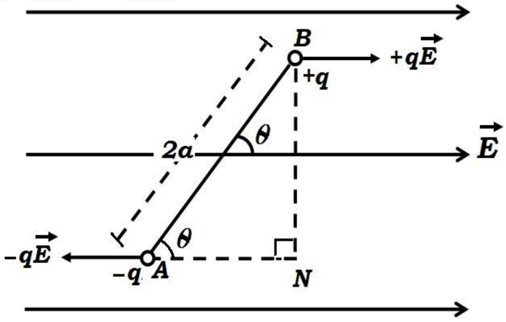
If q is the total charge enclosed by the Gaussian surface, then total electric flux ($) through the surface is, $\$ = \frac{1}{\varsigma_0}(q)$

9. Obtain the expression for torque on a dipole placed in uniform external electric field. (3M)

Ans: Consider an electric dipole consisting of charges −q and +q and of length 2a placed in a uniform electric field $\vec{E}$ making an angle θ with electric field.

Force on charge −*q* at A, $\dot{F} = -q\vec{E}$ (opposite to $\vec{E}$)

Force on charge +*q* at B, $\dot{F} = +q\vec{E}$ (along $\vec{E}$)



Electric dipole is under the action of two equal and unlike parallel forces, which give rise to a torque on the dipole and is given by,

τ = Force × Perpendicular distance between two forces

τ = *qE* (BN) = *qE* (2*a* sin θ)

τ = *q* (2*a*) *E* sin θ

τ = *pE* sin θ

$$\vec{v} = \vec{p} \times \vec{E}$$

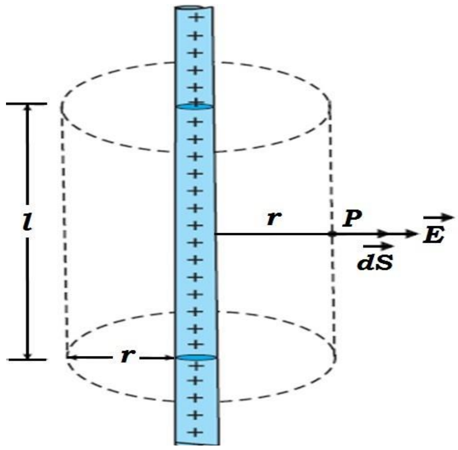
10. When does the torque on an electric dipole kept in uniform electric field is maximum & minimum?

Ans: (a) The torque on dipole in external field is maximum, when dipole moment & electric field are perpendicular to each other (axis of dipole is normal to electric field direction i.e. $8 = 90^0$)

(b) The torque on the dipole is minimum & equal to zero, when the dipole is parallel or anti-parallel to the electric field direction (i.e. $8 = 0^0$).

11. Obtain the expression for electric field at a point due to an infinitely long straight uniformly charged wire. (3 M)

Ans: Consider an infinitely long thin straight wire as shown in figure.



Let h – linear charge density

r – distance of point P from the wire/ radius of Gaussian cylinder.

l – length of Gaussian cylinder.

A – Area of cross section of Gaussian surface

By symmetry, the magnitude of the electric field $\vec{E}$ will be the same at all points on the curved surface of the cylinder and directed radially outward.

(i) Electric flux through the curved surface of the cylinder is, $\phi_1 = EA = E \times 2nrl$

(ii) Electric flux through the circular ends of the cylinder is, $\phi_2 = 0$

(Because no field lines cross this region)

∴ Total flux through the Gaussian surface is

$$\phi = \phi_1 + \phi_2 = E \times 2nrl \quad \ldots \ldots \ldots (1)$$

Total charge enclosed by the Gaussian surface, $Q = hl$

According to Gauss theorem, we have

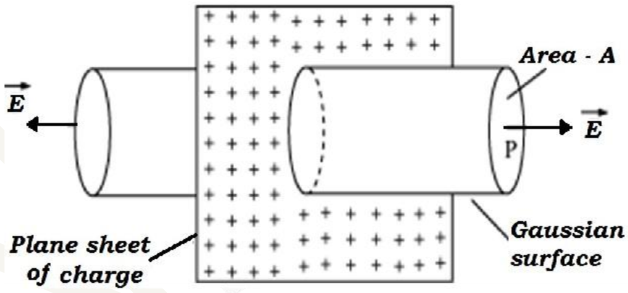
$$\phi = \frac{q}{\varepsilon_0} = \frac{hl}{s_0} \quad \ldots \ldots \ldots (2)$$

From equation (1) and (2),

$$E \times 2nrl = \frac{hl}{s_0} \quad \Rightarrow \quad \boxed{E = \frac{fi}{2Gç_0 r}}$$

12. Derive an expression for electric field at any point near the surface of a uniformly charged infinite plane sheet using Gauss' law. (3M)

Ans: Consider a uniformly charged thin infinite plane sheet as shown in figure.



Let σ – surface charge density

r –perpendicular distance of point P from the sheet.

A – area of cross section Gaussian cylinder

Due to symmetrical charge distribution, electric field at any point near the sheet in normal to the plane of the sheet.

(i) Electric flux through curved surface of the cylinder is, $\phi_1 = 0$
(Because no field lines cross this region)

(ii) The circular regions of the cylinder are at equidistance from the sheet, hence electric field is same at both surfaces & normal to the surface. Electric flux through the circular parts of the cylinder are, $\phi_2 = EA$ and $\phi_3 = EA$

∴ Total flux through the Gaussian surface is

$$\phi = \phi_1 + \phi_2 + \phi_3 = 0 + EA + EA = 2EA$$

Total charge enclosed by the Gaussian surface is, $q = oA$,

From Gauss' law, $\phi = \frac{1}{s_0}(q)$

$$2EA = \frac{1}{s_0}(oA)$$

$$\boxed{E = \frac{o}{2s_0}}$$

13. What are equipotential surfaces? Write the properties of equipotential surfaces.

Ans: An equipotential surface is that surface at every point of which, the electric potential is the same or constant.

The properties of equipotential surfaces are

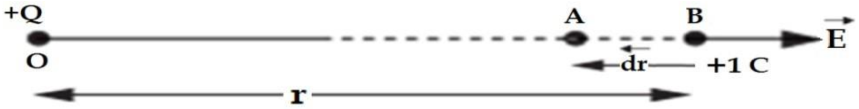
- The work is done in moving a test charge from one point to another on an equipotential surface is zero.
- For any charge configuration, equipotential surface through a point is normal to the electric field at that point.
- Two equipotential surfaces will never intersect.

14. Derive the relation between the electric field and potential for a point charge. (3 M) Ans: Consider a point charge Q situated at origin O.

Let A and B - two closely spaced points with potential values V and $V - dV$ respectively,

dV - is the change in potential in the direction of the electric field $\vec{E}$.

dr - distance of the point A from B.



Let a unit positive charge (+1C) is moved from B to A against the electric field $\vec{E}$. The work done in this process is, $dW = \vec{E} \cdot \vec{dr} = Edr\cos 180^0 = -E\,dr$ ----------------(1)
This work is equal to the potential difference, $dW = V_A - V_B$ --------------------- (2)

$\therefore -E\,dr = V_A - V_B$

$-E\,dr = V - (V - dV) = dV$

$$E = -\frac{dV}{dr}$$

Hence electric field at a point is the negative gradient of potential at that point.

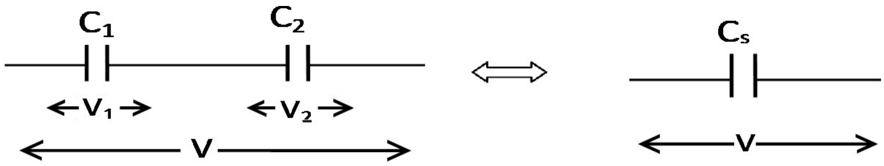
15. Obtain the expression for Potential Energy of a system of two charges in the absence of external field. (3 M)
Ans: Consider two point charges q_1 and q_2 with position vectors $\vec{r}_1$ and $\vec{r}_2$.
Work done in bringing a charge q_1 from infinity to a point $\vec{r}_1$ is,
$W_1 = 0$ ------ (1)
This charge q_1 produces a potential in the space given by
$$V = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{r} \quad -------- (2)$$
Work done in bringing a charge q_2 from infinity to a point $\vec{r}_2$ is
$W_2 = Vq_2$
$$W_2 = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r_{12}} \quad --- (3)$$ where, r_{12} is the distance between q_1 and q_2
$\therefore$ Total work done in assembling the charges at their locations is
$$W = W_1 + W_2 = 0 + \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r_{12}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r_{12}}$$
The electric potential energy of two point charges is the total work done in bringing each charge from infinite distance to their locations i.e. U = W
$$\therefore \quad U = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r_{12}}$$

16. Write the electrostatic properties of a conductor.
Ans: The electrostatic properties of a conductor are
- In static state, inside a conductor electric field is zero.
- At the surface of a charged conductor, electrostatic field must be normal to the surface at every point.
- The interior of a conductor can have no excess charge in the static situation.
- Electrostatic potential is constant throughout the volume of the conductor and is equal to the potential as on its surface.
- Electric field at the surface of a charged conductor is given by, $\vec{E} = \frac{\sigma}{\varepsilon_0}\hat{n}$
- Electrostatic shielding – The cavity inside a conductor is shielded from outside electrical influence, so that electric field inside the cavity is always zero. This is known as electrostatic shielding.

17. Mention the factors on which capacitance of a parallel plate capacitor depends. Ans: The capacitance of a parallel plate capacitor depends on
- area of plates of the capacitor (A).
- the dielectric constant (K or ε_r) of the medium between plates.
- the separation between the plates (d).

18. Derive the expression for equivalent capacitance of two capacitors connected in series.

Ans:



Consider two capacitors C_1 and C_2 are connected in series across a potential difference V, as shown in fig. In series combination of capacitors, the charge on each capacitor is same. Let Q be the charge on each capacitor.

The potential difference applied across their combination is the sum of the potential differences across each capacitor.

$\therefore V = V_1 + V_2$

but $V_1 = \frac{Q}{C_1}$ and $V_2 = \frac{Q}{C_2}$

$\therefore \quad V = \frac{Q}{C_1} + \frac{Q}{C_2} = Q\left(\frac{1}{C_1} + \frac{1}{C_2}\right) \quad ------ (1)$

For equivalent capacitor of capacitance C_S, under same applied potential difference V volts,

$$V = \frac{Q}{C_S} \quad --------- (2)$$

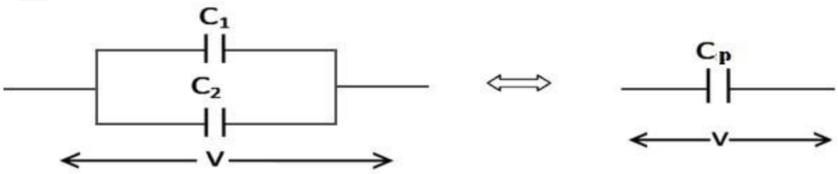
Combining (1) and (2), we obtain

$$\frac{Q}{C_S} = Q\left(\frac{1}{C_1} + \frac{1}{C_2}\right)$$

$$\boxed{\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2}}$$

19. Derive the expression for equivalent capacitance of two capacitors connected in parallel.

Ans:



Consider two capacitors C_1 and C_2 are connected in parallel across a potential difference V, as shown in fig.

In parallel combination of capacitors, the potential difference across each capacitor is same and is same as that of applied potential V.

The total charge stored in the combination is the sum of the charges on each capacitor.

$\therefore \quad Q = Q_1 + Q_2$

but $Q_1 = C_1V$ and $Q_2 = C_2V$

$\therefore \quad Q = C_1V + C_2V = (C_1 + C_2)V \quad ----- (1)$

For equivalent capacitor of capacitance C_p, under same applied potential difference V volts,

$Q = C_pV \quad ------(2)$

From equation (1) and (2), we have

$C_pV = (C_1 + C_2)V$

$$\boxed{C_p = C_1 + C_2}$$

20. Define drift velocity of conduction electrons? Mention the expression for drift velocity.

Ans: The average velocity with which conduction electrons in a conductor gets drifted against applied electric field is called drift velocity.

The expression for drift velocity is, $v_d = -\frac{eE}{m}v$

Where, E — uniform electric field in the conductor, e — charge of electron,
m — mass of electron and v — relaxation time

21. Deduce the expression for drift velocity of conduction electrons. (3 M)

Ans: In conductor the free electrons are in random thermal motion. The average thermal velocity of all such electrons in a conductor is zero. ∴ $(u_i)_{av} = 0$-------------- (1)

In presence of external field E, acceleration of free electrons is given by

$$a = \frac{F}{N} = \frac{-eE}{N} \quad --- (2)$$

Where, −e is charge of electron & m is mass of electron.

Let u_i - velocity of i^{th} electron immediately after the previous collision

t_i - time lapsed after the previous collision

Then the velocty v_i of i^{th} electron at time t_i is,

$$v_i = u_i + at_i = u_i - \frac{eE}{N} t_i$$

Average velocity of all N free electrons in time interval '*t*' is

$$(v_i)_{av} = (u_i)_{av} - \frac{eE}{N} (t_i)_{av}$$

By the definition, $(v_i)_{av} = v_d$ drift velocity and $(t_i)_{av} = v$ relaxation time, we get

$$v_d = 0 - \frac{eE}{N} v \quad \Rightarrow \quad \boxed{v_d = -\frac{eE}{m} v}$$

22. State and explain Ohm's law.

Ans: The current through a conductor is directly proportional to the potential difference across the ends of the conductor, provided the temperature and other physical conditions remain same.

current ∝ potential difference ⇒ $I \propto V$ or $V \propto I$

$\boxed{V = RI}$ where, R − resistance of conductor.

23. Mention limitations of Ohm's law.

Ans: (i) Ohm's law is not applicable at very low and very high temperature.

(ii) Ohm's law is not applicable for non-ohmic devices such as semiconductors, transistors, discharge tubes, superconductors.

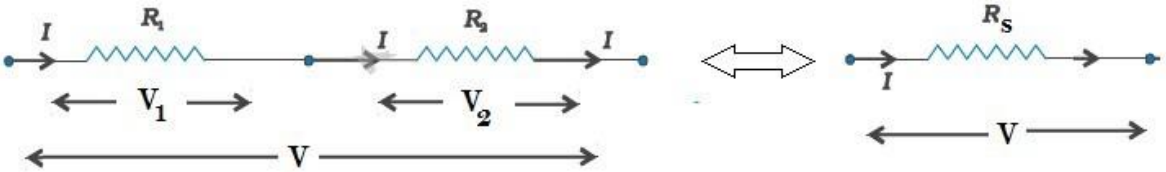
24. Explain the dependence of resistance on the dimensions of a conductor.

Ans: Resistance of a conductor is **directly proportional to the length** of the conductor ($R \propto l$) and **inversely proportional to the area of cross section** ($R \propto 1/A$) of the conductor.

$$R \propto \frac{l}{A} \quad \Rightarrow \quad R = q\frac{l}{A}$$ where, q − resistivity of the material of conductor.

25. Deduce an expression for effective resistance of two resistors in series combination. (3 M)

Ans: Consider two resistors of resistance R_1 and R_2 connected in series across a battery of potential V as shown in figure.



Let I be the steady current in the circuit, V_1 and V_2 be the potential drops across resistors R_1 and R_2 respectively. Then $V = V_1 + V_2$.

From Ohm's law: $V_1 = I R_1$ and $V_2 = I R_2$.

∴ $V = I R_1 + I R_2$

$V = I (R_1 + R_2)$--------------- (1)

For equivalent circuit,

$V = I R_S$------------------- (2)

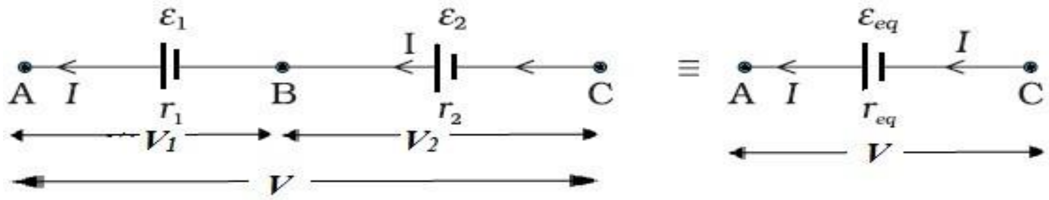
From Equation (1) and (2)

$I R_S = I (R_1 + R_2)$

$\boxed{R_S = R_1 + R_2}$

26. Derive the expressions for equivalent emf and equivalent internal resistance of series combination of two cells. (3M)

Ans: Consider two cells connected in series as shown in figure.



Let, ε_1 and ε_2 – emf of two cells

r_1, r_2 – Internal resistance of two cells

I – Current in the circuit

Terminal potential difference across the first cell, $V_1 = \varepsilon_1 - Ir_1$

Terminal potential difference across the second cell, $V_2 = \varepsilon_2 - Ir_2$

Potential difference across the combination (between the points A and C),

$V = V_1 + V_2 = (\varepsilon_1 - Ir_1) + (\varepsilon_2 - Ir_2)$

$V = (\varepsilon_1 + \varepsilon_2) - I(r_1 + r_2)$ ---------------- (1)

If the combination of cells is replaced by an equivalent cell of emf ε_{eq} and internal resistance r_{eq}, then terminal potential difference of that cell is

$V = \varepsilon_{eq} - I\, r_{eq}$------------------------(2)

From(1) and (2)

$\varsigma_{eq} = \varsigma_1 + \varsigma_2$ and $r_{eq} = r_1 + r_2$

27. State Kirchhoff's laws of an electrical network?

Ans: (i) Kirchhoff's First law: The sum of currents entering the junction is equal to the sum of currents leaving the junction of an electrical network.

(ii) Kirchhoff's Second law: In a closed loop the algebraic sum of the changes in potential consisting cells and resistances is zero.

28. Write the applications of potentiometer.

Ans: (i) Potentiometer is used to **compare emf** of two cells

(ii) Potentiometer is used to **determine the internal resistance** of a cell.

29. Write the expression for magnitude of force on a charge moving in a uniform magnetic field. Explain the terms.

Ans: Magnetic force, **F = qvB sin θ**

Where, B – magnetic field, q – magnitude of charge

v – velocity of charge, θ – angle between $\vec{v}$ and $\vec{B}$.

30. When does the force experienced by a charged particle moving in a magnetic field is (i) minimum (ii) maximum?

Ans: Force is **maximum**, when the charge is **moving perpendicular to the magnetic field** $(8 = 90^0)$

Force is **minimum**, when the charge **is moving parallel to the magnetic field** $(8 = 0^0)$.

31. What is cyclotron? Mention the application of cyclotron.

Ans: Cyclotron is a device used to **accelerate the charged particles** to very high energies.

Cyclotron is used to **accelerate the charged particles** to very high energies.

Further these high energy particles are used to induce nuclear reactions, induce artificial radioactivity, to synthesize new elements.

32. Write the Biot-savart's law and explain the symbols.

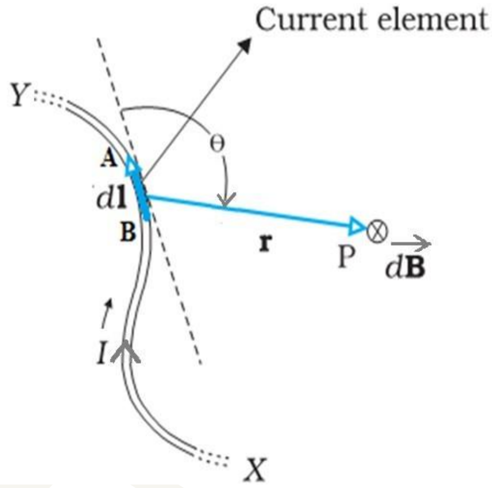
Ans: "The magnitude of the magnetic field at a point due to a current element is

(i) directly proportional to the strength of the current $(dB \propto I)$,

(ii) directly proportional to length of the current element $(dB \propto dl)$,

(iii) directly proportional to the Sine of the angle between the current element and the line joining the point from the current element ($dB \propto \sin 8$) and
(iv) inversely proportional to square of the distance between the point and the current element ($dB \propto 1/r^2$).

XY→ Current carrying conductor
AB→ Infinitesimal element of the conductor of length 'dl'
dB → Magnetic field at point P due to current element 'Idl'
r → Distance of point P from the current element



According to Biot-Savart law,

$$dB \propto \frac{I\,dl \sin 8}{r^2}$$

$$\boxed{dB = \frac{\mu_0}{4G}\frac{I\,dl \sin 8}{r^2}}$$

Where, $\frac{\mu_0}{4n}$ - proportionality constant in SI system and
μ_0 - permeability of free space.

33. State and explain Ampere's circuital law.
Ans: 'The line integral of magnetic field around a closed path/boundary ($\oint \vec{B} \cdot \vec{dl}$) is equal to the μ_0 times the total current (I) through the surface that enclosed by the path/boundary'.

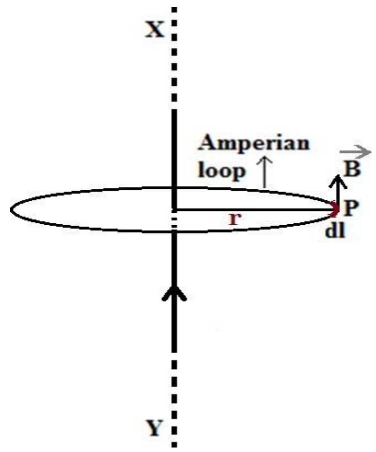
$$\boxed{Ø\,\vec{B} \cdot \vec{dl} = \mu_0 I}$$

34. What is solenoid? Write the expression for magnetic field inside the current carrying solenoid.
Ans: Solenoid is a long insulated copper wire wound closely in the form of helix.
Magnetic field inside the solenoid is, $B = \mu_0 nI$
Where, n - number of turns per unit length of solenoid
I - current through the solenoid
μ_0 - permeability of free space.
(Toroid is a ring shaped closed solenoid and the magnetic field inside toroid is $B = \mu_0 nI$)

35. Derive an expression for magnetic field due to a straight conductor of infinite length carrying current using Ampere's circuital law.
Ans:

Consider an infinite long straight wire XY, carrying steady current 'I' as shown in figure. Let P be a point at a perpendicular distance 'r' from the wire. Consider a circle of radius 'r' around the wire passing through the point P as amperian loop.

Since every point on the loop is at same distance from the wire, the magnetic field B is same at all points and parallel to the line element.



Apply Ampere's circuital law to the amperian loop.

$$Ø\,\vec{B} \cdot \vec{dl} = \mu_0 I$$

$$Ø\,B\,dl = \mu_0 I \qquad \text{Because } 8 = 0$$

$$B\,Ø\,dl = \mu_0 I$$

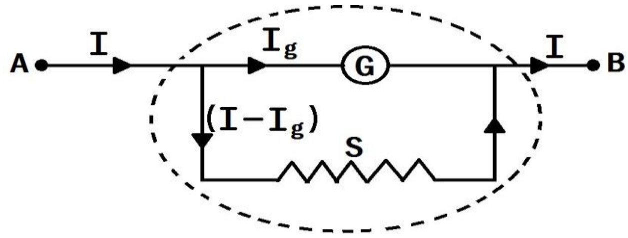
$$B\,2nr = \mu_0 I \qquad \because \text{for circle } Ø\,dl = 2nr$$

$$\boxed{B = \frac{\mu_0}{2G}\frac{I}{r}}$$

36. With circuit diagram explain how can a galvanometer be converted into an ammeter? (3 M)

Ans: 'Galvanometer is converted in to Ammeter by connecting suitable low resistance (shunt resistance) parallel to the galvanometer'.

Consider galvanometer of resistance G is connected with shunt resistance S as shown in fig.



Let, (0 – I) – the range of converted Ammeter

I_g – Current required for full scale deflection of galvanometer

G – resistance of Galvanometer

S – shunt resistance

Here, P.d. across S = P.d. across G

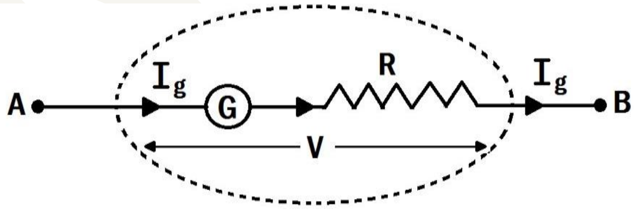
$$S(I - I_g) = I_g G$$

$$\boxed{S = \frac{I_g}{I - I_g} G}$$

37. With circuit diagram explain how can a galvanometer be converted into a voltmeter? (3 M)

Ans: *'A galvanometer can be converted into a voltmeter by connecting a suitable high resistance in series with the galvanometer'.*

To convert galvanometer into a voltmeter of range 0 - V volt the circuit diagram is as shown the figure.



Let, R - Series resistance,

G - Resistance of galvanometer,

I_g - Current for full scale deflection of galvanometer.

The potential difference across the combination is,

$$V = I_g(G + R)$$

$$G + R = \frac{V}{I_g}$$

$$\boxed{R = \frac{V}{I_g} - G}$$

38. Write the properties of magnetic field lines.

Ans: The properties of magnetic field lines are

(i) The magnetic field lines of a magnet (or a solenoid) **form continuous closed loops**.

(ii) The magnetic field lines do not intersect.

(iii) The tangent to the field line at a given point represents the direction of the net magnetic field $\vec{B}$ at that point.

(iv) The larger the number of field lines crossing per unit area, the stronger is the magnitude of the magnetic field $\vec{B}$.

39. State and explain Gauss's law in magnetism. Mention its significance.

Ans: The total **magnetic flux** through any closed surface is zero.

Magnetic flux, $\$_B = \sum_{aSS} \vec{B} \cdot \vec{ds} = 0$

The significance of Gauss's law is that, 'magnetic monopoles do not appear to exist in nature' OR 'isolated magnetic monopoles do not exist in nature'.

40. What do you mean by magnetic elements of earth? Name the magnetic elements of earth.

Ans: Magnetic elements of earth at a place are the physical quantities that determine the magnitude and direction of earth's magnetic field at that place.

Magnetic elements of earth are 1) Declination, 2) Inclination or Dip and 3) Horizontal component of Earth's magnetic field (B_H).

41. Define the terms ' Declination', ' Inclination' and ' horizontal component of earth's magnetic field' at a place.

Ans: Declination: The angle between geographic meridian and magnetic meridian of the earth at that place.

Inclination (magnetic dip): The angle between the earth’s total magnetic field and the horizontal in the magnetic meridian at that place.

Horizontal component of earth's magnetic field (B_H): The component of earth's total magnetic field along the horizontal in the magnetic meridian at that place.

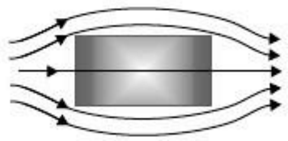
42. State and explain Curie’s law of paramagnetism.

Ans: The susceptibility of paramagnetic sample is inversely proportional to the absolute temperature.

$3 \propto \frac{1}{T}$ OR $3 = C\frac{\mu_0}{T}$ where, C - Curie’s constant.

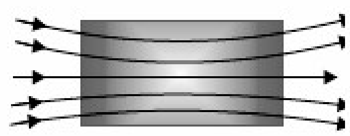
43. Write any three magnetic properties of diamagnetic materials. (3 M) Ans: The properties of diamagnetic are

- These substances which have tendency to move from stronger to the weaker part of the external magnetic field. Or these substances which are weakly repelled by the magnetic field.
- Their magnetic susceptibility (3) is small and negative value ($-1 \leq 3$ € 0).
- Their relative permeability is less than one ($0 \leq \mu_r$ € 1).
- Their permeability is less than absolute permeability (μ € μ_0).
- Their susceptibility (3) is independent of temperature.
- Behaviour of magnetic field lines near a diamagnetic material in the magnetic field is as shown in the figure (expelled out of material).



44. Write the magnetic properties of paramagnetic materials. (3 M) Ans: The properties of paramagnetic are

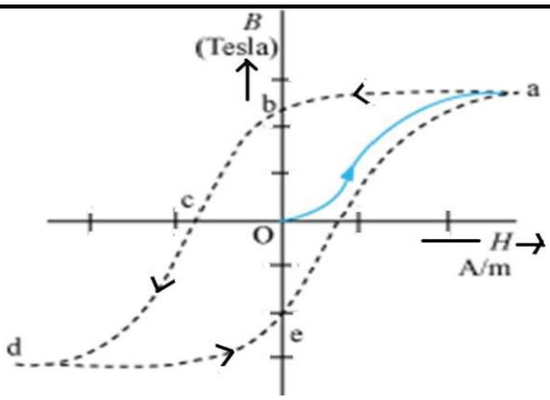
- The substances are weakly magnetised in an external magnetic field i.e they are weakly attracted by the magnetic field.
- Their magnetic susceptibility (3) is small and positive (0 € 3 € s).
- Their relative permeability is slightly more than one (1 € μ_r € 1 + s).
- Their permeability is more than absolute permeability ($\mu > \mu_0$).
- Their susceptibility (3) varies inversely with temperature ($3 \propto \frac{1}{T}$ Curie law).
- Behaviour of magnetic field lines near a diamagnetic material in the magnetic field is as shown in the figure (concentrated in the material).



45. Write the magnetic properties of ferromagnetic materials. (3 M) Ans: The properties of ferromagnetic are

- The substances are strongly magnetised in an external magnetic field i.e they are strongly attracted by the magnetic field.
- Their magnetic susceptibility (3) is large and positive ($3 \gg 1$).
- Their relative permeability is much greater than one ($\mu_r \gg 1$).
- Their permeability is many times more than absolute permeability ($\mu \gg \mu_0$).
- Their susceptibility (3) decreases with increase in temperature. At higher temperature they become paramagnetic. The temperature of transition from ferromagnetic to paramagnetic is called Curie temperature.
- Magnetic field lines are highly concentrated inside the material.
- They exhibit hysteresis.

46. Draw the hysteresis curve for a cycle of magnetization of ferromagnetic material.
Ans:



H – magnetic intensity

B – magnetic field inside the sample

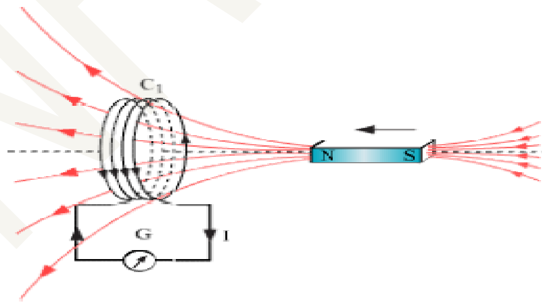
Oc – coercive field

Ob – retentive field

47. Write the properties of magnetic materials required to prepare electromagnets.
Ans: Low retentivity, low coercivity and high permeability.

48. Write the properties of magnetic materials required to prepare permanent magnets.
Ans: High retentivity, high coercivity and high permeability.

49. Explain briefly the coil-magnet experiment to demonstrate the phenomenon of electromagnetic induction. (3 M)
Ans: Consider a coil C_1 connected to a galvanometer G as shown in fig.



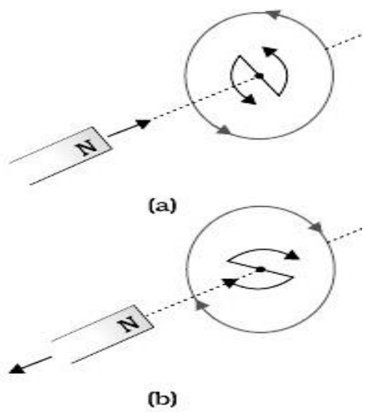
- When the North-pole of a bar magnet is pushed towards the coil, the pointer of the galvanometer deflects, indicating the presence of electric current in the coil.
- The deflection lasts as long as the bar magnet is in motion. The galvanometer does not show any deflection when the magnet is held stationary.
- When the magnet is pulled away from the coil, the galvanometer again shows deflection but in the opposite direction, which indicates reversal of the current's direction.
- The deflection (and hence current) is found to be larger when the magnet is pushed towards or pulled away from the coil faster.
- When the bar magnet is held fixed and the coil C_1 is moved towards or away from the magnet, the same effects are observed.

Conclusion: 'The relative motion between the magnet and the coil that is responsible for generation (induction) of electric current in the coil'.

50. State and explain Faraday's law of electromagnetic induction.
Ans: 'The magnitude of induced emf is proportional to time rate of change of magnetic flux linked with the circuit'.

Induced emf ∝ Rate of change of magnetic flux $\Rightarrow$ $\boxed{\varepsilon \propto \frac{d\phi_B}{dt}}$

51. State and explain Lenz's law of electromagnetic induction. (3 M)
Ans: **Lenz's law:** "The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it."
Lenz's law is in accordance with conservation of energy.

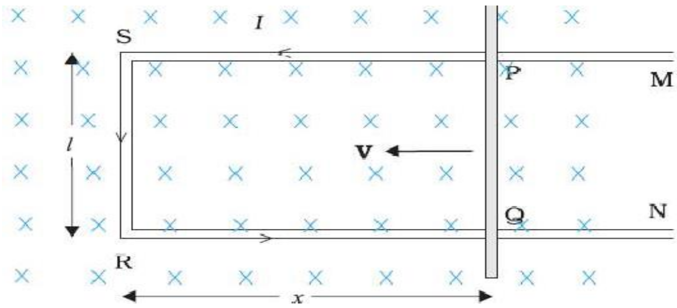


- When the North-pole of a bar magnet is pushed towards the closed coil, current is induced in the coil in such a direction that it opposes the increase in flux. This is possible only if the current in the coil is in a counter-clockwise direction (fig.a).
- Similarly, if the North pole of the magnet is being withdrawn from the coil, the magnetic flux through the coil will decrease, the induced current in the coil flows in clockwise direction (fig.b) so that it opposes the decrease in flux.

52. Derive the expression for motional emf induced in a conductor moving in a uniform magnetic field. (3 M)

Ans: The emf induced in a conductor moving in the magnetic field is called motional emf.

Let, B – magnetic field perpendicular and into the plane of paper.
PQRS – closed circuit
$\vec{v}$ – velocity of conductor PQ
RQ = x
RS = l



Consider a straight conductor PQ is moved towards the left with a constant velocity **v**.
The magnetic flux Φ_B enclosed by the loop PQRS at any instant will be

$$0_B = BA\cos\theta = B(lx)\cos 0^0$$

$$0_B = Blx$$

The moving rod PQ changes the magnetic flux Φ_B linked with circuit. This induces the emf given by,

$$s = -\frac{d0_B}{dt} = -\frac{d}{dt}(Blx) = -Bl\frac{dx}{dt}$$

$$\boxed{ç = Blv} \qquad \left(\because v = -\frac{dx}{dt}\right)$$

This induced emf *Blv* is called *motional emf*.

53. Derive the expression for energy (or magnetic potential energy) stored in the coil (or solenoid) carrying current. (3 M)

Ans: To establish a current in a coil (solenoid) work has to be done against back emf. This work done is stored as magnetic potential energy in the coil.

While establishing the current in a coil the induced back emf is given by,

$$s = -L\frac{dI}{dt} \quad ---(1)$$

Where, L – self inductance of the coil

For the current *I* at an instant in a circuit, the rate of work done is

$$\frac{dW}{dt} = |s|I = LI\frac{dI}{dt}$$

$$dW = LI\,dI$$

Total amount of work done in establishing the current from **0** to **I** is

$$W = \int_0^I LI\,dI = \frac{1}{2}LI^2$$

This work done is stored as magnetic potential energy in the coil. Therefore the magnetic energy stored in the coil is

$$\boxed{\therefore U = \frac{1}{2}LI^2}$$

54. What are eddy currents? How to minimize the eddy current. Mention the uses of it.

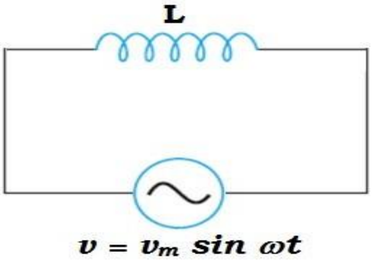
Ans: The **circulating currents** induced in a thick conductor due to changing magnetic flux linked with it are called eddy currents.

Eddy currents can be minimized by using laminated metal core. The laminations of metal are separated by an insulating material.

Eddy currents are used in **induction furnace, magnetic braking of trains, speedometers and electric power meters**.

55. Show that the voltage leads current by $\pi/2$, when A.C. voltage applied to pure inductance.

Ans: Consider an ac source connected to an inductor. Assume that the inductor has negligible resistance. Thus, the circuit is a purely inductive ac circuit.



Let the voltage across the source be $v = v_m \sin \omega t$ -----------(1).

Using the Kirchhoff's loop rule, $\Sigma\, \varepsilon(t) = 0$, we have,

$$v - L\frac{di}{dt} = 0$$

Where, $L\frac{di}{dt}$ is the self-induced emf in the inductor; and L is the self-inductance of the inductor.

From eqn. (2) we have, $v = L\frac{di}{dt}$

$$\Rightarrow \quad \frac{di}{dt} = \frac{v}{L} = \frac{v_m}{L}\sin \omega t$$

Integrating the above equation with respect to time:

$$\int \frac{di}{dt}\,dt = \frac{v_m}{L}\int \sin \omega t\ dt$$

$$\Rightarrow \quad i = -\frac{v_m}{\omega L}\cos \omega t + \text{constant}$$

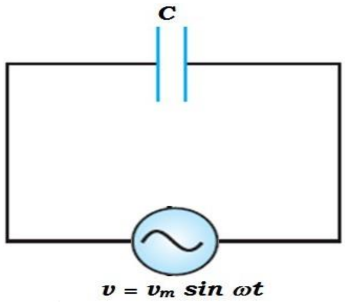
Here, the integration constant is zero and $-\cos \omega t = \sin(\omega t - \frac{\pi}{2})$, hence,

$$i = i_m \sin(\omega t - \tfrac{\pi}{2}) \text{ --------------(2)}$$

Where, $i_m = \frac{v_m}{\omega L}$ is the amplitude of the current.

Comparing of Eqs. (1) and (2) for the source voltage and the current in an inductor shows that **the current lags the voltage by π/2.**

56. Show that the current leads voltage by $\pi/2$, when A.C. voltage applied to pure capacitor. Ans: Consider an ac source connected to a capacitor of capacitance C.



Let ac voltage $v = v_m \sin \omega t$ ----------- (1)

Let q be the charge on the capacitor at any time t. The instantaneous voltage v across the capacitor is given by,

$$v = \frac{q}{C}$$

From the Kirchhoff's loop rule, the voltage across the source and the capacitor are equal,

$$v_m \sin \omega t = \frac{q}{C}$$

We have, $i = \frac{dq}{dt} = \frac{d}{dt}(Cv_m \sin \omega t) = \omega C v_m \cos \omega t$

Using the relation, $\cos \omega t = \sin(\omega t + \frac{\pi}{2})$, we get

$$i = i_m \sin(\omega t + \tfrac{\pi}{2}) \text{ ----------------- (2)}$$

Where, the amplitude of the oscillating current is $i_m = \omega C v_m$.

Comparing of Eq. (1) and (2) for the source voltage and the current in a capacitor shows that **the current leads the voltage by π/2.**

57. Derive the expression for resonant frequency of series LCR circuit.

Ans: Series LCR circuit is said to be in resonance when current through the circuit is maximum.

In an series LCR circuit current is given by

$$I = \frac{V}{Z} = \frac{V}{\sqrt{R^2 + (X_L - X_C)^2}}$$

Series LCR circuit is said to be in resonance when **current I is maximum,** hence impedance Z must be minimum. This implies that **condition for resonance** is, $\mathbf{X_L = X_C}$

∴ $\omega_0 L = \dfrac{1}{\omega_0 C}$

⇒ resonant frequency, $\boxed{m_0 = \dfrac{1}{\sqrt{LC}}}$

OR $2\pi\nu_0 = \dfrac{1}{\sqrt{LC}}$

⇒ resonant frequency, $\boxed{v_0 = \dfrac{1}{2G\sqrt{LC}}}$

where, L − inductance, C − capacitance

58. Write the expression for power consumed in an AC circuit.
Ans: Average power consumed in an AC circuit is

$$\mathbf{P_{av} = V_{rms} I_{rms} \cos \varphi}$$

Where, V_{rms} and I_{rms} - rms values of voltage and current respectively
φ - phase difference between voltage and current

59. What is a transformer? Give the working principle of transformer.
Ans: Transformer is a device used to step up or step down **ac voltages.**
The working principle of transformer is 'Mutual induction'.

60. Mention any two causes of power loss in transformer.
- Loss due to magnetic flux leakage.
- Loss due to eddy currents.
- Loss due to heating because of resistance of winding wires.
- Loss due to magnetic hysteresis.

61. What is displacement current? Mention the expression for displacement current.
Ans: The electric current due to **changing electric field/flux** is called displacement current.

$\boxed{i_d = ç_0 \dfrac{d\$_E}{dt}}$ where, s_0 − permittivity of free space and $\$_E$ − electric flux.

62. Write the expression for speed of electromagnetic wave in vacuum in terms of permeability of free space and permittivity of free space.
Ans: Speed of electromagnetic wave, $\boxed{c = \dfrac{1}{ƒ\mu_0 s_0}}$

Where, s_0 − permittivity of free space and μ_0 − permittivity of free space

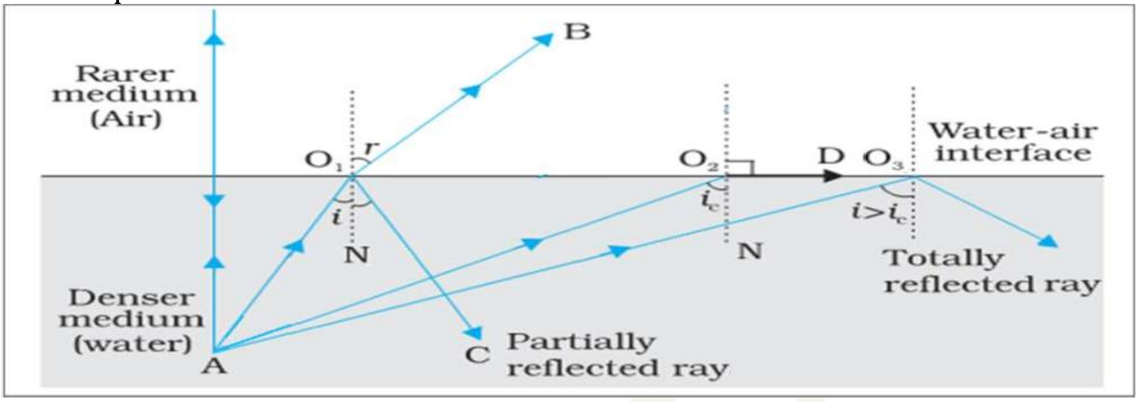
63. State laws of refraction.
Ans: *I law of Refraction* : The incident ray, the refracted ray and the normal at point of incidence all lie in the same plane.
II law of Refraction : The ratio of sine of the angle of incidence to the sine of the angle of refraction is a constant for a given pair of media and for given wavelength of light.
i. e. $\dfrac{\sin i}{\sin r}$ = constant.

64. State and explain Snell's law of refraction.
Ans: "The ratio of sine of the angle of incidence to the sine of the angle of refraction is a constant and is equal to the refractive index of the second medium with respect to first medium".
Refractive index of second medium relative to first medium is, $n_{21} = \dfrac{\sin i}{\sin r}$

65. What are the conditions for Total Internal Reflection?
- Light ray must travel form denser medium to Rarer medium
- The angle of incidence in denser medium must be greater than the critical angle for the pair of media.

66. What is total internal reflection of light? Explain. (3 M)

Ans: When a ray of light travels from a denser medium to a rarer medium such that the angle of incidence is greater than the critical angle, the ray is totally reflected back into the denser medium. This phenomenon is called total internal reflection.



Explanation: Let A is the object in the denser medium (water).The light from the object incident on the interface separating two media, it is partly reflected back into the same medium and partly refracted to the second medium. The refracted ray bends away from the normal. For the certain angle of incidence called critical angle (i_C), the angle of refraction is 90°. For the angle of incidence greater than the critical angle ($i > i_C$), incident ray gets completely reflected back to the denser medium. This is called total internal reflection.

Conditions for Total Internal Reflection:

- The ray must travel from a denser medium to a rarer medium.
- Angle of incidence in the denser medium must be greater than the critical angle, for the pair of media and for the given colour (wavelength) of light.

67. Mention the applications of total internal reflection of light.

Ans: The applications of total internal reflection are

- In the brilliance of diamond
- In optical fibres (for sending light signals)
- In prisms to bend a light ray by 90^0 or 180^0 or to invert the images.

68. Give the applications of optical fibres.

Ans: The applications of optical fibres are

- used in communication system for transmitting and receiving optical signals.
- used as a 'light pipe' to facilitate visual examination of internal organs like oesophagus, stomach and intestines.

69. What is myopia? How to correct it?

Ans: Myopia (short/near sightedness) is an eye defect due to which the **image of the object is formed in front of the retina.**

It can be corrected using a ***concave lens***.

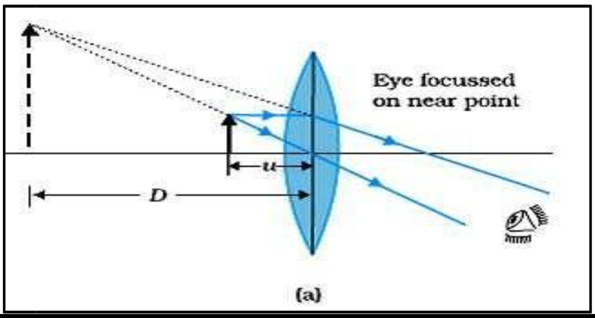
70. What is hypermetropia? How to correct it?

Ans: Hypermetropia (long/far sightedness) is an eye defect due to which the **image of the object is formed behind the retina.**

It can be corrected using a ***convex lens***.

71. Draw the ray diagram of a Compound Microscope when the image is formed at near point or least distance of distinct vision.

Ans:



72. State and explain Huygens principle. (3 M)

Ans : Huygens principle is stated as follows:

- Each point on a wave front is a source of secondary disturbance and the secondary wavelets originating from these points spread out in all direction with the speed of the wave.
- The new wave front at any later time is obtained by taking the tangential surface in the forward direction to all the spheres of secondary wavelets.

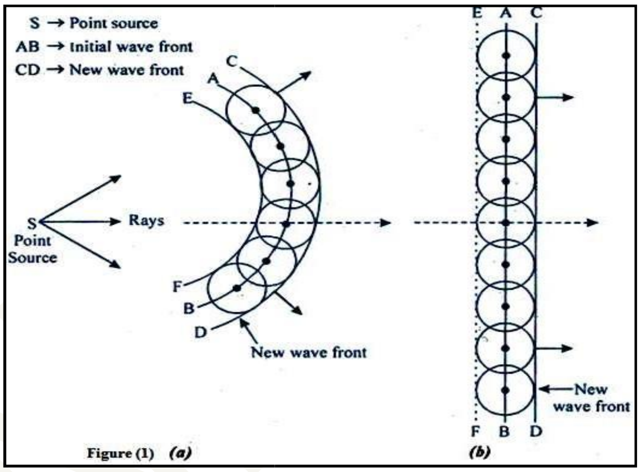


Figure (1) (a) (b)

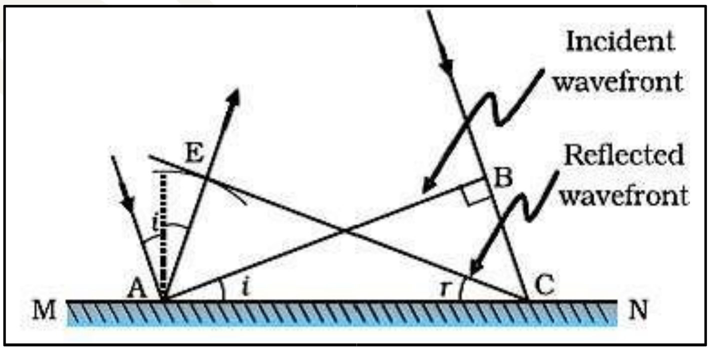
Explanation:

In **Fig [1(a)],** AB is the initial spherical wave front. Secondary wavelets originating from every point on this wave front travel in all direction with the same speed v and in a time t, they develop into a sphere of radius = vt.

The tangential surface CD drawn to all these spheres in the forward direction gives the shape and position of the **new wave front** after a time t.

Fig [1 (b)] represents the same process in the case of a plane wave front.

73. Using Huygens principle show that angle of incidence is equal to the angle of reflection for a reflection of plane wave front at a plane surface.



Ans:

MN – reflecting surface

AB – Incident plane wave front

i – angle of incidence

r – angle of reflection

v – speed of light in the medium

If v represents the speed of the wave in the medium and if τ represents the time taken by the wave front to advance from the point B to C then the distance BC is, BC= vτ----------------(1)

In order the construct the reflected wave front, a sphere of radius = vτ, is drawn from the point A as shown in the adjacent figure. The tangent plane CE drawn from the point C to this sphere represents reflected wave front.

∴ AE = BC = vτ , ∠ABC= ∠CEA = 90°, AC is common.

Triangles EAC and BAC are congruent.

∴ ***i = r*** **---------------**(2)

This is the *law of reflection*.

74. Write the condition for **constructive interference** in terms of phase difference and path difference.

Ans: Phase difference, $ **= 2nπ**

Path difference, **δ = nλ**

75. Give the condition for **destructive interference** in terms of phase difference and path difference.

Ans: Phase difference $ **= (2n+1)π**

Path difference $ð = (2n + 1)\frac{h}{2}$

76. Write the differences between diffraction and interference of light.

Interference	Diffraction
Interference is the phenomenon of modification in the distribution of light energy due to superposition of two or more waves.	Diffraction is phenomenon of bending of light wave around an obstacle and entering into its geometrical shadow.
Interference fringes are due to superposition of waves emerging from different coherent sources.	Diffraction fringes are due to super position of secondary waves emerging from single wave front.
Interference fringes are of equal width.	Diffraction bands are of unequal width.
Intensity of all bright fringes is same.	Intensity of bright bands decreases on either side of central fringe.
Good contrast between the maxima and minima	Comparatively poor contrast between the maxima and minima

77. Mention the expression for resolving power of microscope.
Ans: RP of microscope is,

$$RP = \frac{2n \sin}{1.22\ \text{fi}}$$

where, n − R. I of medium between object and microscope, λ − wavelength of light
θ − semiverticle θ subtented by object to the objective of microscope.

78. Mention the methods of increasing resolving power of microscope.
Ans: RP of microscope can be increased by

- By using light of **short wavelength.**
- By using **medium of higher refractive index** between the object and microscope.

79. Mention the expression for resolving power of telescope.
Ans: RP of telescope is,

$$RP = \frac{2a}{1.22\ \text{fi}}$$

where, 2a − Diameter of objective of telescope, λ − wavelength of light
[RP of telescope can be increased by 'using objective of larger diameter']

80. Mention any two uses of polaroids.
Ans: Polaroids are used to produce plane polarised light and to analyse the polarised light.
They are used in sun glasses.
They are used to see three dimensional (3D) pictures.
They are used in window panes of trains and aeroplanes.
They are used in photographic cameras as filters.

81. State and explain Malus' law.
Ans: 'The intensity of polarised light passing through the analyser is proportional to the square of the cosine of angle between pass axes of polariser and the analyser'.
The intensity of light through analyser is, $I = I_0 \cos^2 8$
Where, I_0 is the intensity of the polarized light after passing through *polariser*.

82. Write the expression of Malus' law.
Ans: The intensity of light through analyser is, $I = I_0 \cos^2 8$
Where, I_0 - the intensity of the incident polarised light (light passing through *polarizer)*.
8 **-** angle between the pass axes of polariser and analyser.

83. Name any two types of electron emission.
Ans: The types of electron emission are

- Thermionic emission
- Photoelectric emission
- Field emission

84. Write the experimental observations (or laws) of photoelectric effect.
Ans: The experimental observations of photoelectric effect are

- The photoelectric emission is an **instantaneous process**.
  (Time lag between incidence of photon & electron emission is nearly 10^{-9} s)
- For a given photosensitive material and frequency of incident radiation (and $\upsilon > \upsilon_0$), the **photoelectric current is directly proportional to the intensity of incident light.**
- For a given photosensitive material and frequency of incident radiation, **saturation current is proportional to the intensity of incident radiation**
- For a given photosensitive material, there exists a certain minimum cut-off frequency of the incident radiation, called the threshold frequency, p below which no emission of hotoelectrons takes place.
- Above the threshold frequency, the stopping potential or **the maximum kinetic energy of the emitted photoelectrons increases linearly with the frequency** of the incident radiation.

85. Write Einstein's photo electric equation. Explain symbols.
Ans: $\mathbf{K_{max} = h\upsilon - \phi_o}$
Where, h – Planks constant,
$\phi_o = h\,\upsilon_0$ work function and υ_0 – threshold frequency,
$K_{max} = \frac{1}{2} m v^2_{max}$ maximum kinetic energy of electron,
v_{max} – velocity of electron

86. Mention the properties of photons.
Ans: The properties of photons are

- In interaction of radiation with matter, radiation behaves as particles called photons.
- Energy of each photon is $E = h\upsilon$
- Momentum of each photon is $p = h\upsilon/c$.
- Photons travel with a speed c in vacuum.
- Photons are electrically neutral and are not deflected by electric and magnetic fields.
- In a photon-particle collision, the total energy and total momentum are conserved.

87. What are matter waves (de Broglie waves)? Write the expression for 'de Broglie' wavelength.
Ans: The waves associated with a **material particle in motion** are called matter waves or de-Broglie waves.

The wavelength of de Broglie waves/ matter waves is given by, $\lambda = \frac{h}{p} = \frac{h}{mv}$

Where, h – Plank's constant,
p = mv - momentum of moving particle.

88. State Bohr's postulates of a hydrogen atom. (3 M)
Ans: Bohr's postulates of a hydrogen atom are

(1) An electron in an atom could revolve in certain stable orbits **without the emission** of radiant energy, these are called the **stationary states** (non-radiating orbits) of the atom.
(2) Stationary orbits are those orbits for which the angular momentum is some integral multiple of $h/2\pi$, where h is the Planck's constant (i.e. $L=nh/2\pi$).
(3) An electron might make a transition from one of its specified non-radiating orbits to another of lower energy. When it does so, a photon is emitted having energy equal to the energy difference between the initial and final states.
The frequency of the emitted photon is then given by, $\mathbf{h\nu = E_i - E_f}$
where E_i and E_f are the energies of the initial and final states and $E_i > E_f$.

89. Mention limitations of Bohr's atom model.
Ans: The limitations of Bohr's atom model are

- This theory is only applicable to hydrogen and hydrogen like atoms. It fails account for spectra of other atoms.
- This theory fails to explain hyperfine structure of hydrogen spectra.

- The theory fails to account for relative intensities of spectral lines.
- It fails to explain wave nature of electrons.

90. Give the de Broglie explanation of Bohr quantization of angular momentum of an electron in the atom.

Ans: According to Broglie electron in its circular orbit must be seen as a particle wave.
The **stationary orbits** are those in which **circular standing waves of electron exist**. For this the circumference of orbits are equal to the whole number of wavelength of electron in the orbit, ∴ $2nr_n = nh$

From de Broglie dual nature of matter, wavelength of matter waves is, $h = \frac{h}{Nv_n}$

$$\therefore \quad 2nr_n = n\left(\frac{h}{Nv_n}\right) \quad \Rightarrow \quad Nv_n r_n = \frac{nh}{2n}$$

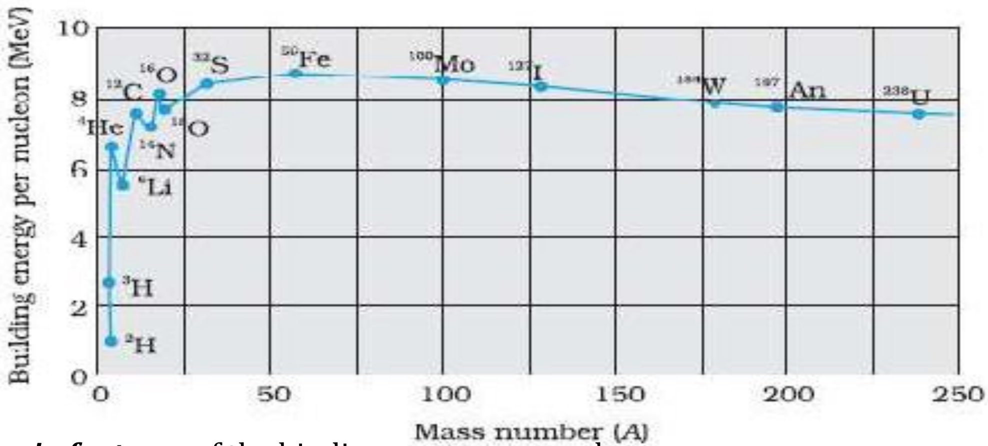
Angular momentum, $L = Nv_n r_n = \frac{nh}{2n}$

91. What is 'mass defect'? Write the expression for it.

Ans: The difference between the sum of the masses of the nucleons forming the nucleus with the rest mass of nucleus is called mass defect.
Mass defect $\mathbf{\Delta M = [\, Z\, m_p + (A\text{-}Z)\, m_n\,] - M}$
Where, Z - atomic number
A - mass number and (A–Z) - number of neutrons
m_p -mass of proton, m_n -mass of neutron
M – rest mass of nucleus.

92. Draw binding energy curve and write main features of binding energy curve.

Ans: The variation of Binding energy per nucleon (E_{bn}) with mass number (A) is as follows.



The ***main features*** of the binding energy per nucleon curve are

- The binding energy per nucleon, E_{bn} is *lower* for both light nuclei (A<30) and heavy nuclei (A>170).
- The binding energy per nucleon, E_{bn}, is practically constant, i.e. practically independent of the atomic number for nuclei of middle mass number (30< A < 170).
- The curve has a maximum of about 8.75 MeV for A = 56.
- The binding energy per nucleon E_{bn} for A = 238 is 7.6 MeV.

93. Write the properties of nuclear forces?

Ans: The properties of nuclear forces are

- Nuclear forces are strongest forces in nature.
- They are short range forces.
- They are saturated forces.
- They are spin dependent forces.
- They are charge independent forces.

94. State and explain radioactive decay law.

Ans: "The time rate of disintegration of radioactive sample is directly proportional to the number of radioactive nuclei present in the sample at that instant".

Rate of disintegration ∝ number of atoms present

$$\frac{dN}{dt} \propto N \quad \Rightarrow \quad \frac{dN}{dt} = -\lambda N$$

Where, λ −decay constant. [–ve sign shows that number of radioactive nuclei in the radioactive sample decrease with time]

95. Distinguish between nuclear fission and nuclear fusion.

Nuclear Fission	**Nuclear Fusion**
• It is the process of splitting of heavy nucleus into two lighter nuclei of comparable masses with release of energy.	• It is the process of combining of two lighter nuclei to form a heavy nucleus with release of energy.
• Energy released **per reaction** is more (about 200 MeV).	• Energy released **per reaction** is less (about 25 Mev)
• Energy released **per nucleon** is less.	• Energy released **per nucleon** is more.
• It takes place at low temperature. (about room temperature)	• It takes place at very high temperature (10^8 K)
• Nuclear wastages are harmful and their disposal is much difficult.	• No nuclear wastages left and products are non-radioactive.
• It forms the principle of atomic bomb, nuclear reactor.	• It forms the principle of Hydrogen bomb.
• Controlled fission is possible.	• Controlled fusion is still not possible.

96. Give any two differences between intrinsic and extrinsic semiconductors.

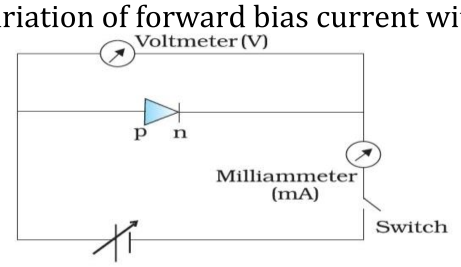
Intrinsic semiconductor	Extrinsic semiconductor
• It is the purest form of semiconductor.	• It is doped (impurity added) semiconductor.
• Number of free electrons and holes are equal.	• Number of free electrons and holes are unequal.
• Electrical conductivity depends on temperature.	• Electrical conductivity depends on both temperature and doping concentration.
• Electrical conductivity is relatively less.	• Electrical conductivity is relatively more.

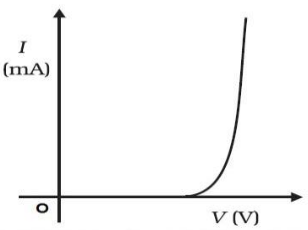
97. Give any two differences between P-type and N-type semiconductors.

P-type semiconductor	N-type semiconductor
• The semiconductor is doped with trivalent impurities.	• The semiconductor is doped with pentavalent impurities.
• Holes are majority charge carriers.	• Electrons are majority charge carriers.
• Electrons are minority charge carriers.	• Holes are minority charge carriers.
• The impurity atom is called acceptor impurity. Ex. Indium, Aluminum, Boron, Gallium.	• The impurity atom is called donor impurity. Ex. Phosphorus, Bismuth, Antimony, Arsenic.
• Electrical conductivity is relatively less.	• Electrical conductivity is relatively more.

98. What is forward biasing of pn junction diode. Explain.

Ans: When p-region of a p-n junction is connected to the positive terminal and n-region is connected to the negative terminal of the battery, then the p-n junction is said to be forward biased. Variation of forward bias current with potential difference is as shown in fig.

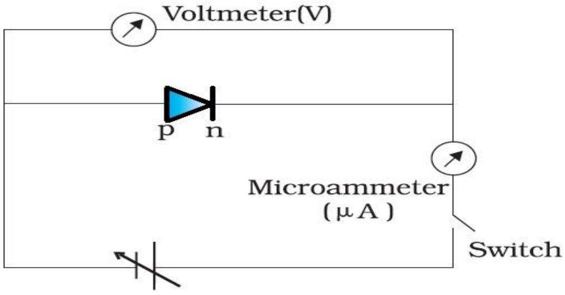


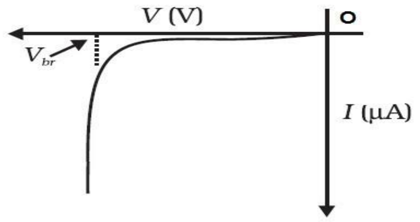


Forward Bias Characteristics of pn juntion diode

99. When p-n junction is said to be reverse biased? Explain.

Ans: When p-region of a p-n junction is connected to the negative terminal and n-region is connected to the positive terminal of the battery, then the p-n junction is said to be reverse biased. The variation of reverse bias current with potential difference is as shown in fig.



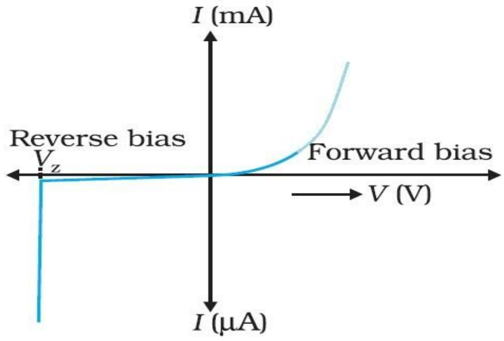


Reverse Bias Characteristics of pn junction diode

100. Draw the I – V characteristics of Zener diode.

Ans:

V_Z – Reverse break down voltage of Zener diode



I-V Characteristics of Zener diode

101. Explain the working of Zener diode as a voltage regulator.

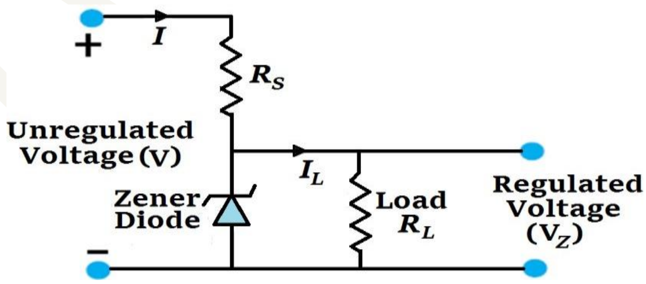
Ans:

R_S – series resistance

V – unregulated voltage

I_L – load current

V_Z – Break down Voltage of Zener/Regulated voltage



The circuit diagram of voltage regulator is as shown in figure.

Zener diode as a voltage regulator operates in **reverse bias breakdown region**. This is because in the breakdown region, the zener voltage V_Z remains constant even though the zener current varies (between I_Z min to I_Z max).

- When the input voltage increases, the current through R_S and that through the zener diode will increase. This increases the voltage drop across R_S but the voltage V_Z across the zener diode (thus across load resistance) remains same.
- If the input voltage decreases, the currents through R_S and zener diode will decrease, but zener voltage V_Z will remain constant.

Thus the zener diode acts as a voltage regulator.

102. Describe the various regions of a transistor.

Ans: A transistor has three doped regions namely emitter, base and collector.

Emitter: It is moderate in size and heavily doped. It supplies large number of majority charge carriers.

Collector: It is larger in size compared to emitter and is moderately doped.

Base: It is the Central region which is very thin and lightly doped.

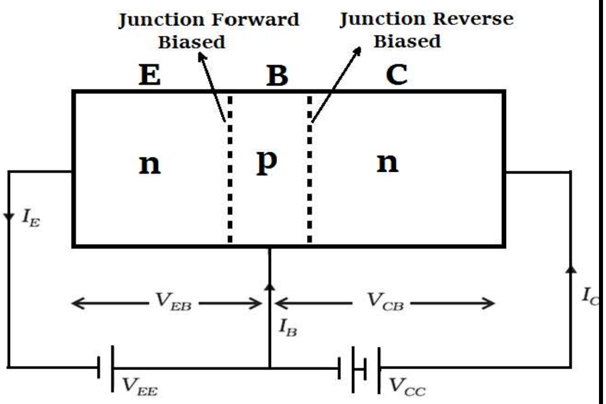
103. Explain the basic action of npn transistor.

Ans: Consider an npn transistor with its emitter- base junction forward biased and collector-base junction reverse biased as shown in figure.

- The heavily doped n-type emitter has a high concentration of electrons (majority carriers). The electrons cross the emitter base junction and enter the base region in large number as it offers least resistance due to its forward biased condition. This gives rise to emitter current I_E.

- As the p-type base is very thin and lightly doped only few holes are present in base. As such very few electrons from the emitter combine with the holes of base, giving rise to base current I_B.
- The remaining large number of electrons in the base region are minority carriers there and hence can easily cross the reverse-biased collector- base junction to enter the collector. This gives rise to collector current I_C.

  The base current is only a small fraction of the emitter current. It is seen that the emitter current is the sum of base current and collector current.



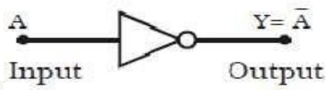
$$I_E = I_B + I_C$$

I_E and I_C are of the order of mA such that $I_E > I_C$. I_B is of the order of μA.

104. Write the truth table and logic symbol of NOT gate.

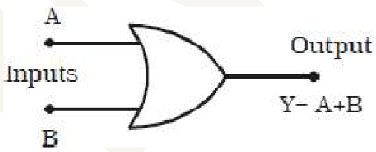
Ans:

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



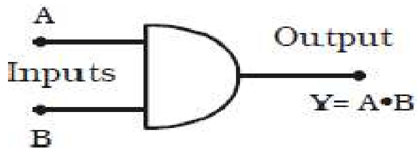
105. Write the truth table and circuit/logic symbol of OR gate.

A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1



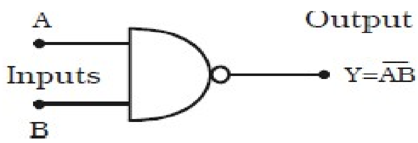
106. Give the truth table and circuit symbol of AND gate.

A	B	Y=AB
0	0	0
0	1	0
1	0	0
1	1	1



107. Write the truth table and circuit symbol NAND gate.

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

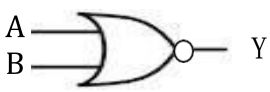


108. What is NAND gate? Write the circuit symbol of NAND gate.

Ans: NAND gate is logic circuit in which AND gate followed by NOT gate.

109. What is NOR gate? Write the circuit symbol of NOR gate.

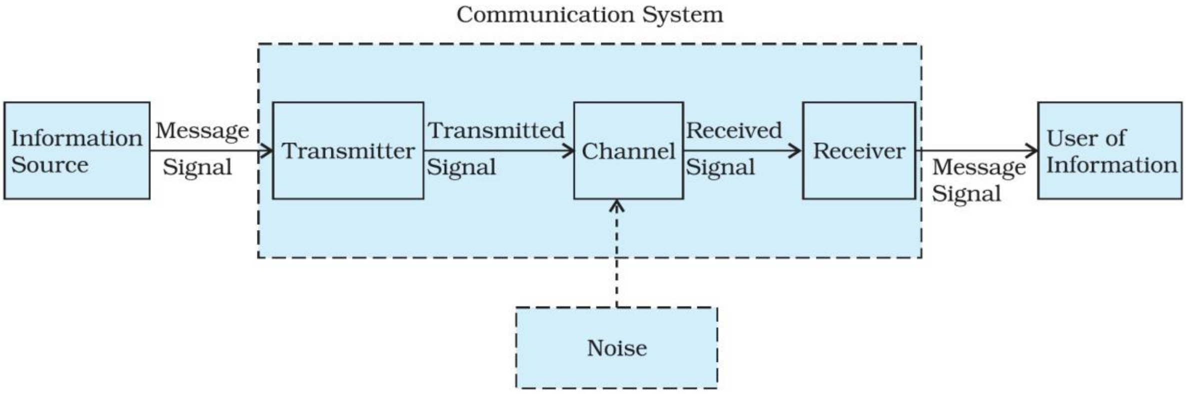
Ans: NOR gate is a logic circuit in which OR gate followed by NOT gate.



110. Why NAND and NOR gates are called universal gates?

Ans: NAND gate and NOR gate are called Universal gates because any logic gates can be prepared by suitable combination of these logic gates.

111. Draw the block diagram of a generalised communication system.
Ans:



112. What is the necessity of modulation of transmitting signals in communication process?
Ans: For transmission of information or message signals ***modulation is essential*** because of following reasons.

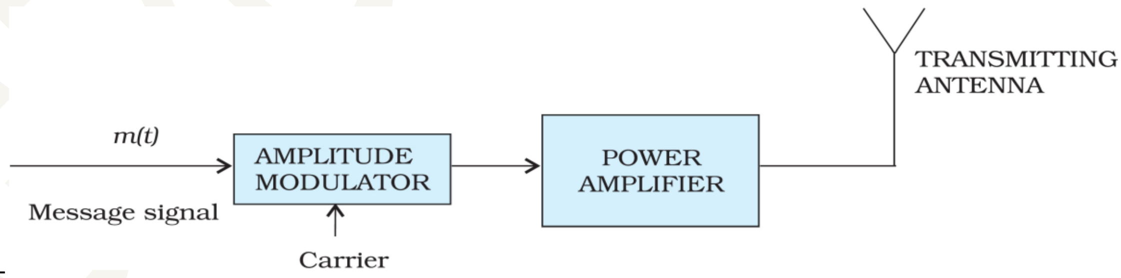
- To reduce the size of the antenna to propagate low frequency signals.
- To avoid mixing up signals from different transmitters.
- To increase effective power radiated by antenna.

113. Name the different modes/ways of transmission of electromagnetic waves (radio waves) in communication.
Ans: Radio wave is propagated from the transmitting to the receiving antenna mainly in three different ways depending on the frequency of the wave. They are

1. Ground (surface) wave propagation
2. Space wave propagation
3. Sky wave propagation

114. Why does the radio wave frequencies greater than 30 MHz are not used in sky wave propagation? How does the waves above 30 MHz are transmitted?
Ans: The radio wave frequencies greater than 30 MHz penetrate through the atmosphere and escape.
The frequencies above 30 MHz are transmitted by space wave propagation (LOS and satellite communication).

115. Draw the block diagram of AM transmitter.
Ans:



116. Draw the block diagram of AM receiver.
Ans: