12 TH STD PHYSICS

(Minimum study material for very slow learners)

LAWS

1. State law of conservation of electric charge.
   * The total electric charge in the universe is constant and charge can neither be created nor be destroyed.
   * In any physical process, the net change in charge will always be zero.

2. State Coulomb's law.

   Coulomb's law states that the electrostatic force is directly proportional to the product of the magnitude of the two point charges and inversely proportional to the square of the distance between the two point charges.

3. State Gauss's law

   Gauss's law states that if a charge Q is enclosed by an arbitrary closed surface, then the total electric flux ϕ_E through the closed surface is $\phi_E = \frac{Q_{encl}}{\varepsilon_0}$

4. State microscopic form of Ohm's law.
   - $\vec{J} = \sigma\vec{E}$
   - $\vec{J}$ is the current density
   - σ conductivity of the conductor
   - $\vec{E}$ is the electric field in the conductor

5. State macroscopic form of Ohm's law.
   - $V = IR$
   - V is the potential difference across the ends of the conductor
   - I is the current passing through the conductor.
   - R is the resistance of the conductor

6. State Kirchoff's first rule or current rule or junction rule.

   It states that the algebraic sum of the currents at any junction of a circuit is zero.

7. Kirchoff's second rule or voltage rule or loop rule:

   The algebraic sum of the products of resistance and current in each part of any closed circuit is equal to the algebraic sum of the emf's in that closed circuit.

8. State the principle of potentiometer.
   - The emf of the cell is directly proportional to the balancing length.
   - $\xi \propto l$

9. State Joule's law of heating.

   Joule's law heating states that the heat developed in an electrical circuit due to the flow of electric current varies directly as
   - the square of the current
   - the resistance of the circuit
   - the time of flow

10. State Coulomb's inverse square law in magnetism.
    - The force of attraction or repulsion between two magnetic poles is
    - directly proportional to the product of their pole strengths and
    - inversely proportional to the square of the distance between them.
    - $\vec{F} \propto \frac{q_{m_A} q_{m_B}}{r^2}\hat{r}$

11. State Biot – Savart law
    - $dB \propto \frac{Idl \sin\theta}{r^2}$

12. Statge Ampere's circuital law.
    - The line integral of magnetic field over a closed loop is μ_0 times net current enclosed by the loop.
    - $\oint_C \vec{B}.\vec{dl} = \mu_o I_{enclosed}$

13. State Maxwell's right hand cork screw rule.

    The law states that if we rotate a right – handed screw using a screw driver, then the direction of current is same as the direction in which screw advances and the direction of rotation of the screw gives the direction of the magnetic field.

14. State right hand thumb rule.

    If we hold the current carrying conductor in our right hand such that the thumb points in the direction of current flow, then the fingers encircling the wire points in the direction of the magnetic field lines produced.

15. State Fleming's left hand rule.

    Stretch forefinger, the middle finger and the thumb of the left hand such that they are in mutually perpendicular directions, If
    - index finger points the direction of magnetic field,
    - the middle finger points in the direction of the electric current, then
    - thumb will point in the direction of the force experienced by the conductor.

16. State tangent's law

    When a magnetic needle or magnet is freely suspended in two mutually perpendicular uniform magnetic fields, it will come to rest in the direction of the resultant of the two fields.

17. State Faraday's first law of electromagnetic inductioin.

    Whenever magnetic flux linked with a closed circuit changes, an emf is induced in the circuit.

18. State Faraday's second law of electromagnetic induction.

The magnitude of induced emf in a closed circuit is equal to the time rate of change of magnetic flux linked with the circuit.

19. State Lenz's law.

The law states that the ddcirection of the induced current is such that it always opposes the cause responsible for its production.

20. State Flemming's right hand rule.

The thumb, index finger and middle finger of right hand are stretched out in mutually perpendicular directions. If the index finger points the direction of the magnetic field and the thumb indicates the direction of the motion of the conductor, then the middle finger will indicate the direction of the induced current.

DEFINE

1. Define relative permittivity.

Relative permittivity is defined as the ratio of permittivity of the medium to the permittivity of free space.

2. Define Electric field.

- Electric field at a point P at a distance r from the point charge q is the force experienced by a unit charge.
- $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}$
- Its unit is $N\ C^{-1}$

3. Define Electric dipole.

- Two equal and opposite charges separated by a small distance constitute an electric dipole.
- Examples: CO, H_2O, NH_3, HCl

4. Define electric dipole moment

- For a collection of n point charges, the electric dipole moment is defined as

$$\vec{p} = \sum_{i=1}^{n} q_i \vec{r}_i$$

- Its unit is C m

5. Define electric potential difference.

The electric potential difference is defined as the work done by an external force to bring unit positive charge form one point to another point.

6. Define electrostatic potential.

The electric potential at a point P is equal to the work done by an external force to bring a unit positive charge with constant velocity from infinity to the point P in the region of the external electric field $\vec{E}$.

7. Define electrostatic potential energy.

The electrostatic potential energy is defined as the work done to bring a test charge from one point to another point in an electrostatic field.

8. Define electric flux.

- The number of electric field lines crossing a given area kept normal to the electric field lines is called electric flux.
- It is a scalar quantity.
- Its unit is $N\ m^2\ C^{-1}$

9. Define electrostatic energy density.

The energy stored per unit volume of space is defined as energy density.

10. Define capacitance. Give its unit.

- The capacitance C of a capacitor is defined as the ratio of the magnitude of charge on either of the conductor plates to the potential difference existing between the conductors.
- $C = \frac{Q}{V}$
- Its SI unit is coulomb per volt or *farad* (F)

11. Define drift velocity.

Drift velocity is defined as the velocity with which free electrons get drifted towards the positive terminal, when an electric field is applied. Its unit is $m\ s^{-1}$

12. Define mobility.

Mobility is defined as the drift velocity acquired per unit electric field. Its unit is $m^2\ V^{-1}\ s^{-1}$

13. Define current density.

- The current density is defined as the current per unit area of cross section of the conductor.
- It is a vector quantity.
- Its unit is $A\ m^{-2}$

14. Define resistance of a conductor.

Resistance of a conductor is defined as the ratio of potential difference across the conductor to the current flowing through it. Its unit is ohm.

15. Define electrical resistivity.

The electrical resistivity of a material is defined as the resistance offered to current flow by a conductor of unit length having unit area of cross section. Its unit is $\Omega\ m$.

16. Define temperature coefficient of resistance.

The temperature coefficient of resistance is defined as the ratio of increase in resistivity per degree rise in temperature to its resistivity at T_0. Its unit is per $°C$.

17. Define magnetic flux.
- The number of magnetic field lines crossing a given area is defined as magnetic flux Φ_B
- It is a scalar quantity.
- Its SI unit is Wb.

18. Define magnetic dipole moment.
- The magnetic dipole moment is defined as the product of its pole strength and magnetic length.
- It is a vector quantity.
- $p_m = q_m\ 2l$
- Its unit is A m^2

19. Define magnetic flux density.
- The magnetic flux density is defined as the number of magnetic field lines crossing unit area kept normal to the direction of line of force.
- Its unit is Wb m^{-2} or tesla.

20. Define magnetic field.
- The magnetic field $\vec{B}$ at appoint is defined as a force experienced by the bar magnet of unit pole strength.
- $\vec{B} = \frac{\vec{F}}{q_m}$
- Its unit is N A^{-1} m^{-1}

21. Define magnetizing field.
- The magnetic field which is used to magnetize a material is called as magnetizing field.
- Its unit is A m^{-1}

22. Define relative permeability.

The relative permeability is defined as the ratio between absolute permeability of the medium to the permeability of free space.

23. Define intensity of magnetization.
- The net magnetic moment per unit volume of the material is known as intensity of magnetization.
- It is a vector quantity.
- Its unit is A m^{-1}

24. Define magnetic susceptibility.
- It is defined as the ratio of the intensity of magnetization $\vec{M}$ induced in the material due to the magnetizing field $\vec{H}$.
- $\chi_m = \frac{M}{H}$

25. Define Curie temperature or State Curie - Weiss law
- The temperatue at which the ferromagnetic material becomes paramagnetic material is known as Curie temperature.
- $\chi_m = \frac{C}{T - T_C}$ ---- This Curie – Weiss law.

26. Define one tesla
- The strength of the magnetic field is one tesla if unit charge moving in it with unit velocity experiences unit force.
- 1 T = 1 N A^{-1} m^{-1}

27. Define remanence or retentivity.

It is defined as the ability of the materials to retain the magnetism in them even magnetizing field vanishes.

28. Define one ampere.

One ampere is defined as that current when it is passed through each of the two infinitely long parallel straight conductors kept at a distance of one meter apart in vacuum causes each conductor to experience a force of 2 x 10^{-7} N m^{-1} of the conductor.

29. Define figure of merit of a galvanometer.

It is defined as the current which produces a deflection of one scale division in the galvanometer.

30. Define current sensitivity of galvanometer.

It is defined as the deflection produced per unit current flowing through it.

31. Define voltage sensitivity of a galvanometer.

It is defined as the deflection produced per unti voltage applied across it.

32. Define inductance of a coil.

Inductance of a coil is defined as the opposing emf induced in the coil when the rate of chage of current through the coil is 1 A s^{-1}

33. Define one henry based on self induction.

The inductance of the coil is one henry if a current changing at the rate of 1 A s^{-1} induces an opposing emf of 1 V in it.

34. Define efficiency of a transformer.

The efficiency of a transformer is defined as the ratio of the useful output power to the input power.

35. Define average value of alternating current.

The average value o f alternating current is defined as the average of all values of current over a positive half – cycle or negative half cycle.

36. Define RMS value of alternating current.

The RMS value of an alternating current is defined as the square root of the mean of the squares of all currents over one cycle.

37. Define electrical resonance.

When the frequency of the applied alternating source is equal to the natural frequency of the RLC circuit, the current in the circuit reaches its maximum value. Then the circuit is said to be in electrical resonance.

38. Define resonant frequency.

The frequency at which resonance takes place is called resonant frequency.

39. Define quality factor or Q – factor.

It is defined as the ratio of voltage across L or C to the applied voltage.

40. Define power in AC circuit.

Power of a circuit is defined as the rate of consumption of electric energy in that circuit.

41. Give any one definition of power factor.

Power factor = cosine of the anlge of lead or lag.

42. Define intensity of electromagnetic waves.

The energy crossing per unit area per unit time and perpendicular to the direction of propagation of electromagnetic wave is called the intensity of electromagnetic waves.

What is and What are?

1. What is equipotential surface?

An equipotential surface is a surface on which all the points are at the same potential.

2. What is dielectric or an insulator?
   - A dielectric is a non-conducting material has no free electrons.
   - The electrons in a dielectric are bound within the atoms.
   - Examples: Ebonite, Glass, and Mica

3. What is Polarisation?
   - Polarisation $\vec{P}$ is defined as the total dipole moment per unit volume of the dielectric.
   - $\vec{P} = \chi_e \vec{E}_{ext}$

4. What is electrostatic induction?

Charging a material without actual contact is called electrostatic induction.

5. What are non-polar molecules?
   - In polar molecules, the centers of positive and negative charges coincide.
   - Ex: H_2, O_2, CO_2

6. What are polar molecules?
   - In polar molecules, the centers of the positive and negative charges are separated even in the absence of external electric field.
   - Ex: H_2O, N_2O, HCl

7. What is dielectric breakdown?
   - When the external electric field applied to a dielectric is very large, it tears the atoms apart so that the bound charges become free charges.
   - Then the dielectric starts to conduct electricity.
   - This is called dielectric breakdown.

8. What is dielectric strength?

The maximum electric field the dielectric can withstand before it breakdowns is called dielectric strength.

9. What is action at points or corona discharge?

The leakage of electric charges from the sharp points of the charged conductor is called as action at points or corona discharge.

10. What is superconductivity?

The ability of certain metals, their compounds and alloys to **conduct electricity with zero resistance at very low temperature** is called superconductivity.

11. What is internal resistance of a cell?

During the process of flow current inside the cell, a resistance offered to current flow by the electrolyte of the cell is known as the internal resistance of the cell.

12. Why current is a scalar?
   - The electric current does not obey the laws of vector addition.
   - Also, $I = \vec{J}.\vec{A} = JA\cos\theta$
   - Hence, current is a scalar.

13. What are ohmic and non ohmic conductors?
   - The devices which obey the Ohm's law are called ohmic conductors.
   - Example: Copper wire, Metals
   - The devices which do not obey the Ohm's law are called non – ohmic conductors.
   - Example: Diodes, Filament lamp, Semiconductor.

14. Derive expression for power P = VI in electrical circuit.
   - $P = \frac{dU}{dt} = \frac{d}{dt}(V.dQ)$
   - $P = V\frac{dQ}{dt}$
   - $P = VI \qquad (\because I = \frac{dQ}{dt})$

15. Write down the various forms of expression for power in electrical circuit.
    - P = VI
    - $P = I^2 R$
    - $P = V^2/R$

16. What is thermoelectric effect?
    Conversion of temperature differences into electrical voltage and vice versa is known as thermoelectric effect.

17. What is Seebeck effect?
    Seebeck discovered that in a closed circuit consisting of two dissimilar metals, when the junctions are maintained at different temperatures an emf is developed.

18. What is Peltier effect?
    When an electric current is passed through a circuit of a thermocouple, heat is evolved at one junction and absorbed at other junction. This is Peltier effect.

19. What is Thomson effect?
    If two points in a conductor are at different temperatures, the density of electrons at these points will differ and as result the potential difference is created between these points. Thomson effect is also reversible.

20. What is magnetic declination?
    The angle between magnetic meridian at a point and geographical meridian is called the magnetic declination (D).

21. What is dip or magnetic inclination?
    The angle subtended by the Earth's total magnetic field with the horizontal direction in the magnetic meridian is called dip or magnetic inclination (I).

22. What is magnetic permeability?
    The magnetic permeability is the measure of ability of the material to allow the passage of magnetic field lines through it.

23. What is coercivity?
    The magnitude of the reverse magnetizing field for which the residual magnetism of the material vanishes is called its coercivity.

24. What is hysteresis?
    The phenomenon of lagging of magnetic induction behind the magnetizing field is called hysteresis.

25. What are the limitations of cyclotron?
    - The speed of the ion is limited.
    - Electron cannot be accelerated
    - Uncharged particles cannot be accelerated.

26. What is electromagnetic induction?
    - Wheneve the magnetic flux linked with a closed coil changes, an emf is induced and hence an electric current flows in the circuit.
    - This current is called an induced current and the emf giving rise to such current is called and induced emf.
    - This phenomenon is known as electromagnetic induction.

27. What are eddy currents or Focault currents?
    The induced currents flow in concentric circular paths are called as eddy currents or Focault currents.

28. What for an inductor used?
    Inductor is a device used to store energy in a magnetic field when an electric current flows through it.

29. What is mutual induction?
    The phenomenon that when an electric current passing through a coil changes with time, an emf is induced in the neighbouring coil is called a mutual induction.

30. What are the methods of producing induced emf?
    The induced emf can be produced by
    - Changing the magnetic field
    - Changing the area A of the coil
    - Changing the relative orientation of the coil with magnetic field.

31. What are step up and step down transformers?

STEP UP TRANSFORMER	STEP DOWN TRANSFORMER
If the transformer converts an alternating current with low voltage into an alternating current with high voltage, it is called step-up transformer.	If the transformer converts an alternating current with high voltage into an alternating current with low voltage, it is called step-up transformer.

32. What is phasor?
    A sinusoidal alternating voltage can be represented by a vector which rotates about the origin in anti-clockwise direction at a constant angular velocity. Such a rotating vector is called a phasor.

33. What is meant by wattles current?
    The current in an AC circuits is said to be wattles current if the power consumed by it is zero.

34. What are LC oscillations?

Whenever energy is given to a LC circuit, the electrical oscillations of definite frequency are generated. These oscillations are called LC oscillations.

35. What is displacement current?

Displacement current can be defined as the current which comes into play in the region in which the electric field and the electric flux are changing with time.

36. What are electromagnetic waves?

An electromagnetic wave is radiated by an accelerated charge which propagates through space as coupled electric and magnetic fields, oscillating perpendicular to each other and to the direction of propagation of the wave

37. What is radiation pressure?

The force exerted by an electromagnetic wave on unit area of a surface is called radiation pressure.

38. What is poiting vector?

The rate of flow of energy crossing a unit area is known as pointing vector for electromagnetic waves.

39. What are Fruanhofer lines?

The spectrum obtained from the Sun is examined, it consists of large number of dark lines. These dark lines in the solar spectrum are known as Fraunhofer lines.

THREE MARKS

1. Differentiate uniform and non-uniform electric fields.

Uniform electric field	Non-uniform electric field
Uniform electric field will have the same direction and constant magnitude at all points in space.	Non-uniform electric field will have different directions or different magnitudes or both at different points in space.

2. Compare gravitational force and Coloumb force.

Gravitational force	Coulomb force
It is always attractive between two masses.	It can be attractive or repulsive, depending upon the nature of charges
$G = 6.626 \times 10^{-11}\ N\,m^2kg^{-2}$	$k = 9 \times 10^9\ N\,m^2C^{-2}$
It is independent of the medium	It depends on nature of the medium in which the two charges are kept at rest.
It is same whether two point masses are at rest or in motion	If the charges are in motion, yet another force (Lorentz force) comes into play in addition to coulomb force.

3. What are the properties of electric field lines?

- They start form a positive charge and end at negative charge or at infinity.
- For a positive point charge, the electric field lines pint radially outward
- For a negative point charge, the electric field lines point radially inward.
- The electric field vector at a point in space is tangential to the electric field line at that point.
- The electric field lines are denser in a region where the electric field has large magnitude and less dense in a region where the electric field is of smaller magnitude.
- No twos electric field lines intersect each other.
- The number of electric field lines that emanate from the positive charge or end at a negative charge is directly proportional to the magnitude of the charges.

4. Derive an expression for the torque experienced by a dipole due to a uniform electric field.

- * $\vec{\tau} = [\overrightarrow{OA} \text{ x } (-q\vec{E})] + [\overrightarrow{OB} \text{ x } (q\vec{E})]$
- * $\tau = 2qaE\sin\theta$
- * $\tau = pE\sin\theta$
- * $\vec{\tau} = \vec{p} \text{ x } \vec{E}$
- * If $\theta = 90°$ then torque is maximum.
- * If $\theta = 0°$ then torque is minimum.

5. What are the properties of equipotential surface?

- The work done to move a charge q between any two points A and B, $W = q(V_B - V_A)$
- If the points A and B lie on the same equipotential surface, work done is zero because $V_A = V_B$
- The electric field is normal to an equipotential surface.

6. Discuss the various properties of conductors in electrostatic equilibrium.

- The electric field is zero everywhere inside the conductor. This is true regardless of whether the conductor is solid or hollow.
- There is no net charge inside the conductors. The charges must reside only on the surface of the conductors.
- The electric field outside the conductor is perpendicular to the surface of the conductor and has a magnitude of $\frac{\sigma}{\varepsilon_0}$
- The electrostatic potential has the same value on the surface and inside of the conductor.

7. What are the applications of capacitor?
- Capacitors are used as flash capacitors in digital camera to release the energy as flash.
- Capacitors are used in heart defibrillator device to give a sudden surge of a large amount electrical energy to the patient's chest to retrieve the normal heart function.
- Capacitors are used in the ignition system of automobile engines to eliminate sparking.
- Capacitors are used to reduce power fluctuations in power supplies and to increase the efficiency of power transmission.

8. What are the applications of Seebeck effect?
- Seebeck effect is used in thermoelectric generators.
- Thers thermoelectric generators are used in power plants to convert waste heat into electricity.
- This effect is utilized in automobiles as automotive thermoelectric generators.
- Seebeck effect is used in thermocouples and thermopiles to measure the temperature difference between the two objects.

9. What are the properties of magnet?
- A freely suspended bar magnet will always point along the north – south direction.
- A magnet attracts another magnet or magnetic substances towards itself.
- The attractive force is maximum near the end of the bar magnet.
- When a bar magnet is dipped into iron filling, they cling to the ends of the magnet.
- When a magnet is broken into pieces, each piece behaves like a magnet with poles at its ends.
- Two poles of a magnet have pole strength equal to one another.
- The length of the bar magnet is called geometrical length
- The length between two poles in a bar magnet is called magnetic length.
- Magnetic length is always slightly smaller than geometrical length.
- The ratio of magnetic length and geometrical length is 5/6.

10. What are the properties of magnetic field lines?
1. Magnetic field lines are continuous closed curves.
2. The direction of magnetic field lines is from North pole to South pole outside the magnet and South pole to North pole inside the magnet.
3. The direction of magnetic field at any point on the curve is known by drawing tangent to the magnetic line of force at the point.
4. Magnetic field lines never intersect each other.
5. The magnetic field is strong where magnetic field lines crowd and weak where magnetic field lines thin out.

11. Differentiate Uniform and Non-uniform magnetic fields.

Uniform Magnetic field	Non – Uniform magnetic field
Magnetic field is said to be uniform if it has same magnitude and direction at all the points in a given region.	Magnetic field is said to be non – uniform if the magnitude or direction or both varies at all points

12. Obtain an expression for torque acting on a bar magnet when it is placed in a uniform magnetic field.
- $\vec{\tau} = [\overrightarrow{ON} \text{ x } \vec{F}_N] + [\overrightarrow{OS} \text{ x } \vec{F}_S]$
- $\vec{\tau} = [\overrightarrow{ON} \text{ x } (q_m\vec{B})] + [\overrightarrow{OS} \text{ x } (-q_m\vec{B})]$
- $\tau = 2l\, q_m B \sin\theta$
- $\tau = p_m B \sin\theta \quad (\because p_m = 2l \text{ x } q_m)$
- $\vec{\tau} = \vec{p} \text{ x } \vec{B}$

13. What are the special features of magnetic Lorentz force?
- $\vec{F}_m = q(\vec{v}\, X\, \vec{B})$
- $\vec{F}_m$ is directly proportional to the magnetic field $\vec{B}$
- $\vec{F}_m$ is directly proportional to the velocity $\vec{v}$
- $\vec{F}_m$ is directly proportional to sine of the angle between the velocity and magnetic field
- $\vec{F}_m$ is directly proportional to the magnitude of the charge q
- The direction of $\vec{F}_m$ is always perpendicular to $\vec{v}$ and $\vec{B}$
- The direction of force on negative charge is opposite to the direction of force on positive charge.
- If velocity $\vec{v}$ of the charge q is along $\vec{B}$, then $\vec{F}_m$ is zero.

14. Compare the properties of Dia, Para and Ferro magntic materials.

Magnetic properties	Dia magnetic materials	Para magnetic materials	Ferro magnetic materials
Magnetic susceptibility	negative	positive and small	positive and large
Relative permeability	slightly less than unity	greater than unity	large
When placed in a magnetic field	magnetic field lines are repelled by these materials	magnetic field lines are attracted into these materials	magnetic field lines are strongly attracted into these materials
Temperature	susceptibility is independent of temperature	susceptibility is inversely proportional to temperature.	susceptibility is inversely proportional to temperature.

15. Differentiate between soft and hard ferro magnetic materials

Properties	Soft ferromagnetic materials	Hard ferromagnetic materials
When external field is removed	Magnetisation disappears	Magnetisation persists
Area of the loop	Small	Large
Retentivity	Low	High
Coercivity	Low	High
Susceptibility	High	Low
Permeability	High	Low
Hysteresis loss	Less	More
Uses	Solenoid core, transformer core, electromagnets	Permanent magnets
Examples	Soft iron, Mumetal, Stalloy	Steel, Alnico, Lodestone

16. What are the applications of hysteresis loop?

Permanent magnets:

- The materials with high retentivity, high coercivity and high permeability are suitable for making permanent magnets.
- Example: Steel and Alnico

Electromagnets:

- The materials with high initial permeability, low retentivity, low coercivity and thin hysteresis loop with smaller area are preferred to make electromagnets.
- Examples: Soft iron and Mumetal (Nickel Iron alloy)

Core of the transformer:

- The materials with high initial permeability, large magnetic induction and thin hysteresis loop with smaller area are needed to design transformer cores.
- Examples: soft iron

17. Differentiate between Coulomb's law and Biot – Savart law.

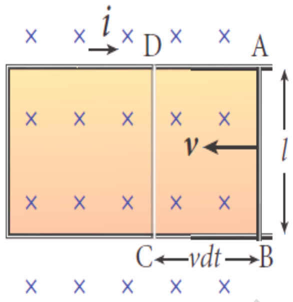
Coulomb's law	**Biot – Savart law**
Produced by a scalar source	Produced by a vectos source
Produced by an electric charge q	Produced by a current element $Id\vec{l}$
It is directed along the position vector joining the source and the point at which the field is calculated	It is directed perpendicular to the position vector $\vec{r}$ and the current element $Id\vec{l}$
Does not depend on angle	Depends on the angle between the position vector $\vec{r}$ and the current element $Id\vec{l}$

18. Obtain an expression for motional emf from Lorentz force.
- $\vec{F}_B = -e(\vec{v} \times \vec{B})$
- $\vec{F}_E = -e\,\vec{E}$
- $F_B = F_E$
- $ev\,B = eE$
- $E = vB$
- $V = El$
- $V = Blv$
- $\varepsilon = Blv$

19. What are the advantages of stationary armature-rotating field alternator?
- ➢ The cuurent is drawn directly from fixed terminals on the stator without the use of brush contacts.
- ➢ The insulation of stationary armature winding is easier.
- ➢ The number of sliding contacts is reduced.
- ➢ Armature windings can be constructed more rigidly to prevent deformation due to any mechanical stress.

20. What are the advantages of three phase alternator?
- For a given dimension of the generator, three-phase machine produces higher power output than a single-phase machine.
- For the same capacity, three-phase alternator is smaller in size when compared to single phase alternator.
- Three phase transmission system is cheaper.
- A relatively thinner wire is sufficient for transmission of three phase power.

21. How will you induce an emf by changing the area enclosed by the coil?
- ➢ $d\Phi_B = B\,dA$
- ➢ $d\Phi_B = B\,lvdt$
- ➢ $\frac{d\Phi_B}{dt} = B\,lv$
- ➢ $\varepsilon = \frac{d\Phi_B}{dt}$
- ➢ $\varepsilon = B\,lv$



22. What are the advantages and disadvantages of AC over DC?

Advantages:
- ∗ The generation of AC is cheaper than that of DC.
- ∗ When AC is supplied at higher voltages, the transmission losses are small compared to DC transmission.
- ∗ AC can easily be converted into DC with the help of rectifiers.

Disadvantages:
- ➢ Alternating voltages cannot be used for certain applications e.g. charging of batteries, electroplating, and electric traction.
- ➢ At higher voltages, it is more dangerous to work with AC than DC.

23. Write down Maxwell equations in integral form.
1. $\oint \vec{E}.d\vec{A} = \frac{Q_{enclosed}}{\varepsilon_0}$
2. $\oint_S \vec{B}.d\vec{A} = 0$
3. $\oint_l \vec{E}.d\vec{l} = -\frac{d\Phi_B}{dt}$
4. $\oint \vec{B}.d\vec{l} = \mu_0\,(I_c + I_d)$

24. Write a short note on radio waves.
- ➢ It is produced by oscillators in electric circuits.
- ➢ Wavelength range: 1 x 10^{-4} m – 1 x 10^{4} m
- ➢ Frequency range: 3 x 10^{9} Hz – 3 x 10^{4} Hz
- ➢ It obeys relection and diffraction..
- ➢ It is used in radio and television communication systems.
- ➢ It is also used in cellular phones to transmit voice communication in the ultra high frequency band.

25. Write a short note on microwaves.
- ∗ IT is produced by electromagnetic oscillators in electric circuits.
- ∗ Wavelength range: 1 x 10^{-3} m – 3 x 10^{-1} m
- ∗ Frequency range: 3 x 10^{11} Hz – 1 x 10^{9} Hz
- ∗ It obeys reglection and polarization.
- ∗ It is used in radar system for aircraft navigation.
- ∗ It is also used in microwave oven for cooking and very long distance wireless communications through satellites

26. Write a short note on infrared radiations (IR)..

* It is produced from hot bodies and also
* It is also known as heat waves.
* It is also produced when the molecules undergo rotational and vibrational transitions.
* Wavelength range: 8×10^{-7} m – 5×10^{-3} m
* Frequency range: 4×10^{14} Hz – 6×10^{10} Hz
* It provides electrical energy to satellites by means of solar cells.
* It is used to produce dehydrated fruits, in green houses to keep the plants warm.
* It is used in heat therapy for muscular pain or spain.
* It is used in TV remote as a signal carrier.
* It is used to look through haze fog or mist.
* It is used in night vision or infrared photography.

27. Write a short note on visible light.

* It is produced by incandescent bodies.
* It is radiated by excited atoms in gases.
* Wavelenght range: 4×10^{-7} m – 7×10^{-7} m
* Freqeuncy range: 7×10^{14} Hz – 4×10^{14} Hz
* It obeys laws of reflection, refraction, interference, diffraction, polarization, photo-electric effect and
* It is used in photographic action.
* It can be used to study the structure of molecules, arrangement of electrons in external shells of atoms and sensation of our eyes.

28. Write a short note on ultraviolet radiation.

* It is produced by Sun, arc and ionized gases.
* Wavelength range: 6×10^{-10} m – 4×10^{-7} m
* Frequency range: 5×10^{17} Hz – 7×10^{14} Hz
* It has less penetrating power.
* It can be absorbed by atmospheric ozone.
* It is harmful to human body.
* It is used to destroy bacteria.
* It is used in sterilizing the surgical instruments.
* It is used in burglar alarm.
* It is used to detect the invisible writing, finger prints.
* It is used in the study of molecular structure.

29. Write a short note on X - rays.

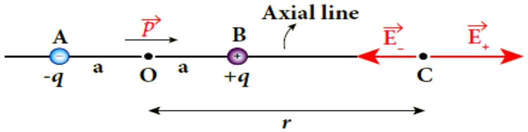
* It is produced when there is a sudden deceleration of high speed electrons at high atomic number target.
* It also produced by electronic transitions among the innermost orbits of atoms.
* Wavelength range: 1×10^{-13} m – 1×10^{-8} m
* Frequency range: 3×10^{21} Hz – 1×10^{16} Hz
* They have more penetrating power than ultraviolet radiation.
* They are used in studying structures of inner atomic electron shells and crystal structures.
* They are used in detecting fractures, diseased organs, formation of bones and stones, observing the progeress of healing bones.
* In a finished metal product, they are used to detect faults, cracks, flaws and holes.

30. Write a short note on gamma rays.

* It is produced by transitions of atomic nuclei and decay oif certain elementary particles.
* Wavelength range: 1×10^{-14} m – 1×10^{-10} m
* Frequency range: 3×10^{22} Hz – 1×10^{18} Hz
* They have high penetrating power than X-rays and ultraviolet radiations.
* It has no charge, but harmful to human body.
* They provide information about the structure of atomic nuclei.
* It is used in radio therapy for the treatment of cancer and tumour.
* It is used in food industry to kill pathogenic microorganism.

5 mark questions:

1. Obtain an expression for electric field due to an electric dipole on its axial line.



- $\vec{E}_+ = k\frac{q}{(r-a)^2}\hat{p}$
- $\vec{E}_- = -k\frac{q}{(r+a)^2}\hat{p}$
- $\vec{E}_{tot} = \vec{E}_+ + \vec{E}_-$
- $\vec{E}_{tot} = kq\left[\frac{4ra}{(r^2-a^2)^2}\right]\hat{p}$
- $2aq\,\hat{p} = \vec{p}$ and $k = \frac{1}{4\pi\varepsilon_0}$
- $\vec{E}_{tot} = \frac{1}{4\pi\varepsilon_0}\frac{2\vec{p}}{r^3} \qquad (r \gg a)$

2. Obtain and expression for electric field due to an electric dipole along its equatorial plane.

- $\vec{E}_+ = k\frac{q}{(r^2+a^2)}$ (along BC)
- $\vec{E}_- = k\frac{q}{(r^2+a^2)}$ (along CA)
- $\vec{E}_{tot} = -2|\vec{E}_+|\cos\theta\,\hat{p} \quad (\because |\vec{E}_+| = |\vec{E}_-|)$
- $\vec{E}_{tot} = -\frac{1}{4\pi\varepsilon_0}\frac{\vec{p}}{r^3} \quad (r \gg a)(k = \frac{1}{4\pi\varepsilon_0})$

3. Obtain an expression for electric potential at a point due to an electri dipole.

- $V_1 = k\frac{q}{r_1}$
- $V_2 = -k\frac{q}{r_2}$
- $V = kq\left[\frac{1}{r_1} - \frac{1}{r_2}\right]$
- $\frac{1}{r_1} = \frac{1}{r}\left(1 + \frac{a}{r}\cos\theta\right)$
- $\frac{1}{r_2} = \frac{1}{r}\left(1 - \frac{a}{r}\cos\theta\right)$
- $(\because p = q2a)$
- $V = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{r^2} \quad \left(\because k = \frac{1}{4\pi\varepsilon_0}\right)$
- $V = \frac{1}{4\pi\varepsilon_0}\frac{\vec{p}\cdot\hat{r}}{r^2} \quad (r >> a) \quad (\because p\cos\theta = \vec{p}\cdot\hat{r})$

Special cases:

- If $\theta = 0°, V = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^2}$
- If $\theta = 180°, V = -\frac{1}{4\pi\varepsilon_0}\frac{p}{r^2}$
- If $\theta = 90°, V = 0$

4. Obtain the expression for electric field due to an infinitely long charged wire.

* $\phi_E = \oint \vec{E}\cdot d\vec{A}$
* $\phi_E = \int_{CS}\vec{E}\cdot d\vec{A} + \int_{TS}\vec{E}\cdot d\vec{A} + \int_{BS}\vec{E}\cdot d\vec{A}$
* For the curved surface, $\vec{E}\cdot d\vec{A} = E.dA$
* For the top and bottom surfaces, $\vec{E}\cdot d\vec{A} = 0$
* $\phi_E = \int_{CS}\vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\varepsilon_0}$
* $Q_{encl} = \lambda L$
* $E\int_{CS} dA = \frac{\lambda L}{\varepsilon_0}$
* $\int_{CS} dA = 2\pi rL$
* $\vec{E} = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}\hat{r}$

5. Obtain the expression for electric field due to a charged infinite plane sheet.

- $\phi_E = \oint \vec{E}\cdot d\vec{A}$
- $\int_{CS}\vec{E}\cdot d\vec{A} + \int_{P}\vec{E}\cdot d\vec{A} + \int_{P'}\vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\varepsilon_0}$
- At curved surfaces, $\vec{E}\cdot d\vec{A} = 0$
- At P and P’, $\vec{E}\cdot d\vec{A} = E.dA$
- $\int_{P} E.dA + \int_{P'} E.dA = \frac{Q_{encl}}{\varepsilon_0}$
- $Q_{encl} = \sigma A$
- $2E\int_{P} dA = \frac{\sigma A}{\varepsilon_0}$

- $\int_P dA = A$
- $\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$

6. Obtain the expression for electric field due to a uniformly charged spherical shell.

At a point outside the spherical shell (r >R):

* $\oint_{\text{Gaussian surface}} \vec{E}.d\vec{A} = \frac{Q}{\varepsilon_0}$
* $E \oint_{\text{Gaussian surface}} d\vec{A} = \frac{Q}{\varepsilon_0}$
* $\oint_{\text{Gaussian surface}} d\vec{A} = 4\pi r^2$
* $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}\hat{r}$

At a point on the surface of the spherical shell (r = R):

$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}\hat{r}$ (r = R)

At a point outside the spherical shell (r <R):

* $\oint_{\text{காஸியன் பரப்பு}} \vec{E}.d\vec{A} = \frac{Q}{\varepsilon_0}$
* For Gaussian surface, Q = 0.
* E = 0.

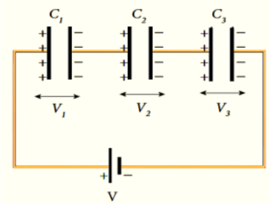
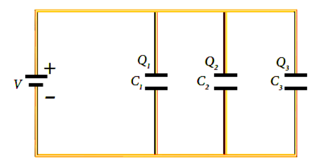
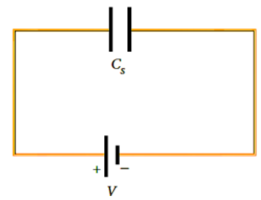
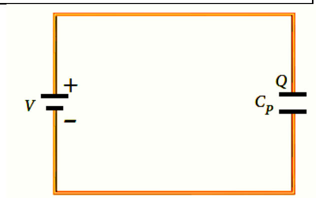
7. Explain in detail the effect of a dielectric placed in a parallel plate capacitor When the capacitor is disconnected from the battery.

* $C_o = V_o / Q_o$
* $E = \frac{E_0}{\varepsilon_r}$
* $\varepsilon_r > 1, \quad E < E_0$
* $V = \frac{V_0}{\varepsilon_r}$
* $C = \varepsilon_r C_0$
* $\varepsilon_r > 1, \quad C > C_0$
* $C = \frac{\varepsilon A}{d}$
* Energy of the capacitor without dielectric
  $U_0 = \frac{1}{2}\frac{Q_0^2}{C_0}$
* Energy of the capacitor with dielectric
  $U = \frac{U_o}{\varepsilon_r}$
* $\varepsilon_r > 1, \quad U < U_0$

8. Explain in detail the effect of a dielectric placed in a parallel plate capacitor when the battery remains connected to the capacitor.

* $Q = \varepsilon_r Q_0$
* $C = \varepsilon_r C_0$
* $C_0 = \frac{\varepsilon_0 A}{d}$
* $C = \frac{\varepsilon A}{d}$
* Energy of the capacitor without dielectric
  $U_0 = \frac{1}{2} C_0 V_0^2$
* Energy of the capacitor with dielectric
  $U = \varepsilon_r U_o \quad \varepsilon_r > 1, \quad U > U_0$
* Energy density $u = \frac{1}{2}\varepsilon E_0^2$

9. Explain the series and parallel combinations of capacitors.

Capacitors in series	Capacitors in parallel
Three capacitors of capacitance C_1, C_2 and C_3 are connected in series.	Three capacitors of capacitance C_1, C_2 and C_3 are connected in parallel.
Charge Q across each capacitor is same	Potential difference across each capacitor is same.
$V = V_1 + V_2 + V_3$	$Q = Q_1 + Q_2 + Q_3$
$Q = CV$	$Q = CV$
$V = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$	$Q = C_1V + C_2V + C_3V$
$V = \frac{Q}{C_S}$	$Q = C_PV$
$\frac{Q}{C_S} = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$	$C_PV = C_1V + C_2V + C_3V$
$\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$	$C_P = C_1 + C_2 + C_3$
	
	

10. Explain in detail the construction and working of a Van de Graff generator.

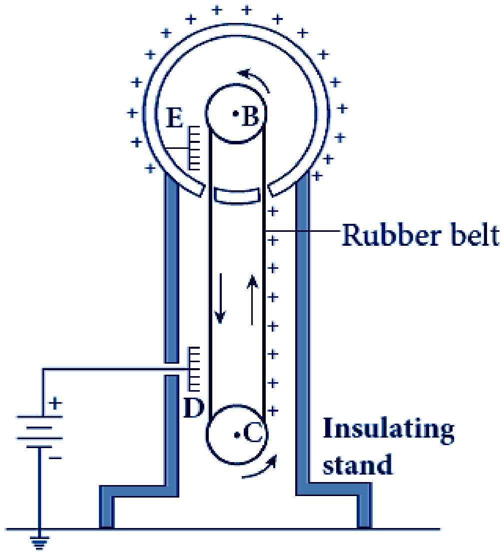
Principle: Action of points and Electrostatic induction.

Prevention of leaking electric charge:

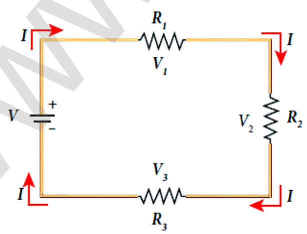
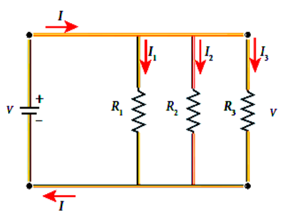
- **The leakage of charge** from the sphere can be **reduced by enclosing it in a gas filled steel chamber** at a very high temperature.

Uses:

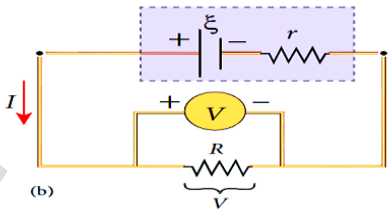
- It is used to produce large electrostatic potential difference of the order of 10^7 **V.**
- This high voltage is used to **accelerate positive ions (protons, deuterons) for the purpose of nuclear disintegration.**



11. Explain the effective resistance of a series network and parallel network.

RESISTORS IN SERIES	RESISTORS IN PARALLEL
Three resistors of resistances R_1, R_2 and R_3 are connected in series connection.	Three resistors of resistances R_1, R_2 and R_3 are connected in parallel connection.
The current I through each resistor is same	The potential difference V across each resistor is same.
$V = V_1 + V_2 + V_3$	$I = I_1 + I_2 + I_3$
$V_1 = IR_1$ $V_2 = IR_2$ $V_3 = IR_3$,	$I_1 = \frac{V}{R_1}$ $I_2 = \frac{V}{R_2}$ $I_3 = \frac{V}{R_3}$,
$V = IR_S$	$I = \frac{V}{R_P}$
$IR_S = I(R_1 + R_2 + R_3)$	$\frac{V}{R_P} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$
$R_S = R_1 + R_2 + R_3$	$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
	

12. Explain the determination of internal resistance of a cell using voltmeter.



- $V = IR$
- $V = \xi - Ir$
- $Ir = \xi - V$
- $r = \left(\frac{\xi - V}{V}\right)R$

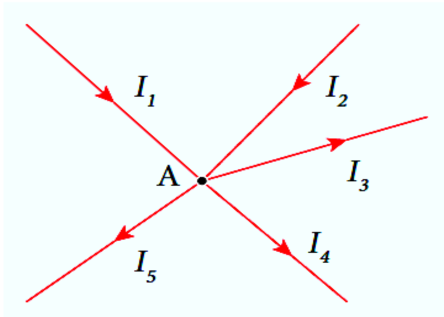
13. State and explain Kirchoff's first law.

Kirchoff's first law:

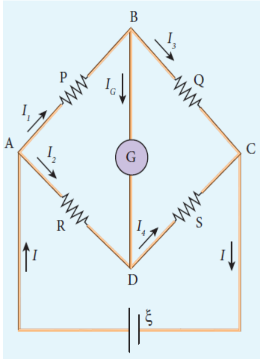
The law states that the algebraic sum of the currents meeting at any junction of a circuit is zero.

Explanation:

- It is a statement of conservation of electric charge.
- All charges that enter a given junction in a circuit must leave that junction.
- Current entering the junction is taken as positive.
- Current leaving the junction is taken as negative.
- $I_1 + I_2 = I_3 + I_4 + I_5$



14. Obtain the codition for balancing in Wheatstone's bridge.

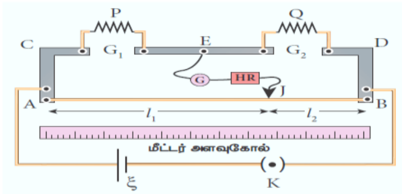


* $I_1 - I_G - I_3 = 0$
* $I_2 + I_G - I_4 = 0$
* $I_1 P + I_G G - I_2 R = 0$
* $I_1 P + I_3 Q - I_4 S - I_2 R = 0$
* $I_G = 0$
* $I_1 = I_3$
* $I_2 = I_4$
* $I_1 P = I_2 R$
* $I_1(P+Q) = I_2(R+S)$
* $\frac{I_1(P+Q)}{I_1 P} = \frac{I_2(R+S)}{I_2 R}$
* $\frac{P}{Q} = \frac{R}{S}$

13. Describe an experiment to find unknown resistance and temperature coefficient of resistance using Metre Bridge.

Principle:

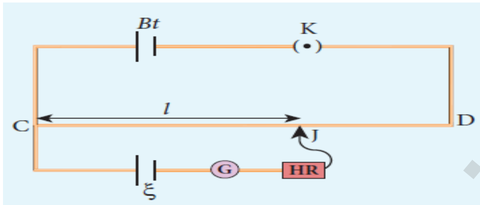
Metre bridge is one form of Wheatstone's bridge.



* $\frac{P}{Q} = \frac{R}{S} = \frac{R' AJ}{R' JB}$
* $\frac{P}{Q} = \frac{AJ}{JB} = \frac{l_1}{l_2}$
* $P = Q\frac{l_1}{l_2}$
* $\mathbf{R = \rho \frac{l}{A}}$
* **Resistivity:** $\rho = \frac{P\pi r^2}{l}$

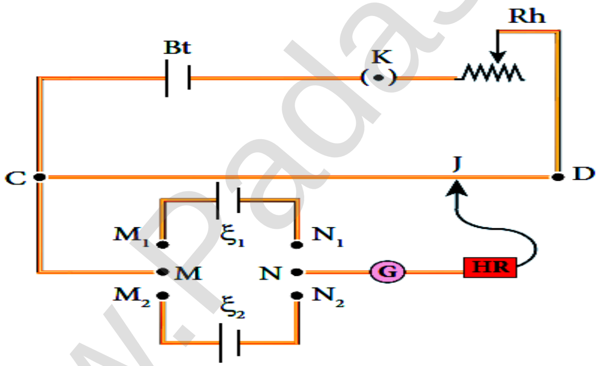
14. Explain the principle of potentiometer.

* CJ = Irl
* $\xi = Irl$
* $\xi \propto l$
* ***Emf of the cell is directly proportional to the balancing length***



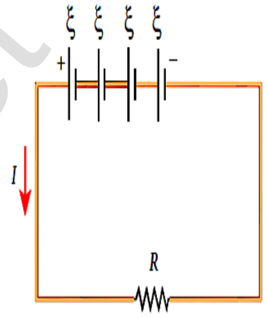
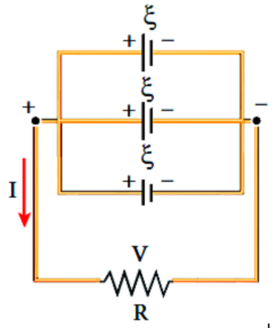
15. Explain the comparison of emfs of two given cells using potentiometer?

* **Principle:** ***Emf of the cell is directly proportional to the balancing length***



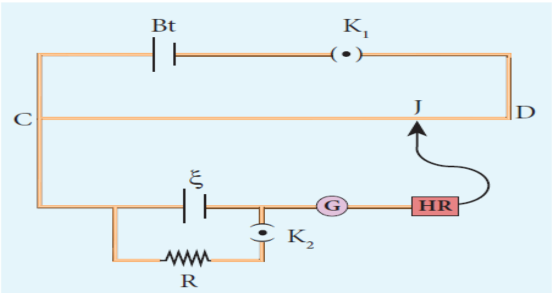
- $\xi_1 = Irl_1$
- $\xi_2 = Irl_2$
- $\frac{\xi_1}{\xi_2} = \frac{l_1}{l_2}$

16. Explain the series and parallel combination of electric cells.

Cells in series connection	Cells in parallel connection
	
Total emf $= n\xi$	Total emf $= \xi$
Total resistance $= nr + R$	Total resistance $= R + \frac{r}{n}$
$I = \frac{n\xi}{nr+R}$	$I = \frac{n\xi}{r+nR}$
$If\ r \ll R,$	$If\ r \gg R,$
$I = \frac{n\xi}{R} \approx nI_1$	$I = \frac{n\xi}{r} = nI_1$
$If\ r \gg R\ ,$	$If\ r \ll R\ ,$
$I = \frac{\xi}{r}$	$I = \frac{\xi}{R}$

17. How will you determine the internal resistance of a cell using potentiometer?

- $\xi \propto l_1$ -------------- (1)
- $I = \frac{\xi}{R+r}$
- $V = IR = \frac{\xi R}{R+r}$
- $V \propto l_2$ ---------------(2)
- $\frac{\xi R}{R+r} \propto l_2$
- $\frac{(1)}{(2)} \Longrightarrow \frac{\xi}{V} \propto \frac{l_1}{l_2}$
- $r = R\left(\frac{l_1 - l_2}{l_2}\right)$



18. Obtain the magnetic induction at a point on the axial line of a bar magnet.

➢ $\vec{F}_N = k\,\frac{q_m}{(r-l)^2}\,\hat{\imath}$

➢ $\vec{F}_S = -k\,\frac{q_m}{(r+l)^2}\,\hat{\imath}$

➢ $\vec{F}_{tot} = \vec{F}_N + \vec{F}_S$

➢ $\vec{F}_{tot} = kq_m\left[\frac{4rl}{(r^2-l^2)^2}\right]\hat{\imath}$

➢ $\vec{F}_{tot} = k\left(\frac{4lq_m}{r^3}\right)\hat{\imath} \qquad (r \gg a)$

➢ $k = \frac{\mu_0}{4\pi}$

➢ At point C , $\vec{F}_{tot} = \vec{B}_{tot}$

➢ $\vec{B}_{tot} = \frac{\mu_0}{4\pi}\,\frac{2\vec{p}_m}{r^3} \qquad (\vec{p}_m = p_m\hat{\imath})$

19. Obtain the magnetic induction at a point on the equatorial line of a bar magnet.

➢ $\vec{F}_N = k\,\frac{q_m}{(r^2+l^2)}$ (Along NC)

➢ $\vec{F}_S = -k\,\frac{q_m}{(r^2+l^2)}$ (Along CS)

➢ $\vec{F}_{tot} = -2\vec{F}_N\cos\theta\ \hat{p} \quad (\because F_N = F_S)$

➢ $\vec{F}_{tot} = -k\,\frac{\vec{p}_m}{(r^2+l^2)^{\frac{3}{2}}} \quad (\because \vec{p}_m = 2q_m l\hat{\imath})$

➢ $\vec{F}_{tot} = -k\,\frac{\vec{p}_m}{r^3}$

➢ At point C $\vec{F}_{tot} = \vec{B}_{tot}$

➢ $\vec{B}_{tot} = -\frac{\mu_0}{4\pi}\,\frac{\vec{p}_m}{r^3} \qquad (\because k = \frac{\mu_0}{4\pi})$

20. Deduce the relation for the magnetic induction at a point due to an infinitely long straight conductor carrying current..

➢ $dB = k\frac{Id\vec{l}}{r^2}\sin\theta$

➢ $\tan(\pi - \theta) = \frac{a}{l}$

➢ $l = -a\cot\theta$

➢ $r = a\ cosec\ \theta$

➢ $dl = a\ cosec^2\ \theta\ \ d\theta$

➢ $\frac{dl}{r^2} = \frac{d\theta}{a}$

➢ $dB = \frac{\mu_0 I}{4\pi a}\sin\theta\, d\theta \qquad \left(\because k = \frac{\mu_0}{4\pi}\right)$

➢ $d\vec{B} = \frac{\mu_0 I}{4\pi a}\sin\theta\, d\theta\ \hat{n}$

➢ $\vec{B} = \frac{\mu_0 I}{4\pi a}\int_{\varphi_1}^{\varphi_2}\sin\theta\, d\theta\ \hat{n}$

➢ $\vec{B} = \frac{\mu_0 I}{4\pi a}(\cos\varphi_1 - \cos\varphi_2)\hat{n}$

➢ $\varphi_1 = 0,\ \ \varphi_2 = \pi$

➢ $\vec{B} = \frac{\mu_0 I}{2\pi a}\hat{n}$

21. Deduce the relation for the magnetic induction at a point along the axis of a circular coil carrying current.

➢ $dB = \frac{\mu_0}{4\pi a}\,\frac{Idl}{r^2}$

➢ $\vec{B} = \frac{\mu_0 I}{4\pi a}\int dB\cos\theta\ \hat{k}$

➢ $\vec{B} = \frac{\mu_0 I}{4\pi a}\int\frac{dl}{r^2}\cos\theta\ \hat{k}$

➢ $\cos\theta = \frac{R}{(\sqrt{R^2+z^2})}$

➢ $r^2 = R^2 + z^2$

➢ $\vec{B} = \frac{\mu_0 I}{2a}\,\frac{R^2}{(R^2+z^2)^{\frac{3}{2}}}\hat{k}$

22. Find the magnetic induction due to a long straight conductor using Ampere's circuital law.

➢ $\oint_C \vec{B}\,.d\vec{l} = \mu_0 I$

➢ $\oint_C B\,dl = \mu_0 I$

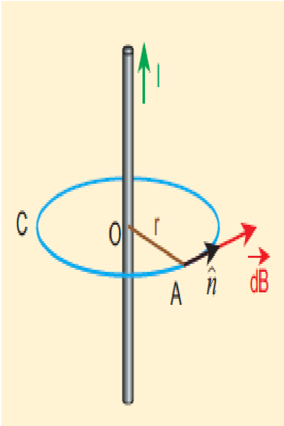
➢ $B \oint_C dl = \mu_0 I$

➢ $\oint_C dl = 2\pi r$

➢ $B.2\pi r = \mu_0 I$

➢ $B = \frac{\mu_0 I}{2\pi r}$

➢ $\vec{B} = \frac{\mu_0 I}{2\pi r}\hat{n}$



23. Find the magnetic induction due to a long current carrying solenoid using Ampere's circuital law.

➢ $\oint_C \vec{B}\,.d\vec{l} = \mu_0 I$

➢ $\oint_C \vec{B}.d\vec{l} = \int_a^b \vec{B}.d\vec{l} + \int_b^c \vec{B}.d\vec{l} + \int_c^d \vec{B}.d\vec{l} + \int_d^a \vec{B}.d\vec{l}$

➢ $\int_b^c \vec{B}.d\vec{l} = \int_d^a \vec{B}.d\vec{l} = 0$

➢ Outside the solenoid, $\int_c^d \vec{B}.d\vec{l} = 0$

➢ $\int_a^b \vec{B}.d\vec{l} = B\int_a^b \,dl$

➢ $\int_a^b \,dl = L$

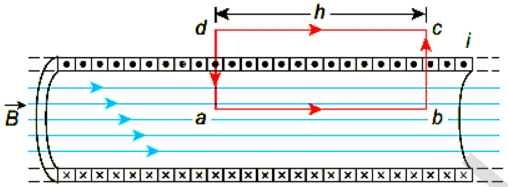
➢ $\int_a^b \vec{B}.d\vec{l} = BL$

➢ $\int_a^b \vec{B}.d\vec{l} = \mu_0 NI$

➢ $B = \frac{\mu_0 NI}{L}$

➢ $\frac{N}{L} = n$

➢ $B = \mu_0 nI$



24. Obtain an expression for the force on a current carrying conductor placed in a magnetic field.

∗ $I = neAv_d$
∗ $\vec{F} = -e(\vec{v}_d \; X\; \vec{B})$
∗ $n = \frac{N}{V}$
∗ $N = nV = nAdl$
∗ $d\vec{F} = -enAdl(\vec{v}_d \; X\; \vec{B})$
∗ $I\vec{dl} = -enA\vec{v}_d dl$
∗ $d\vec{F} = (I\vec{dl} \; X\; \vec{B})$
∗ $\vec{F} = (I\vec{l} \; X\; \vec{B})$
∗ $F = BIl\sin\theta$

Special cases:

∗ $If\ \theta = 0°, \quad F = 0$
∗ $If\ \theta = 90°, \quad F = BIl$

Fleming's left hand rule:

Stretch forefinger, the middle finger and the thumb of the left hand such that they are in mutually perpendicular directions, If

- forefinger points the direction of magnetic field,
- the middle finger points in the direction of the electric current, then
- thumb will point in the direction of the force experienced by the conductor.

25. Explain the construction and working of a cyclotron

- Cyclotron is used to accelerate the charged particles to gain large kinetic energy.
- It is also called as high energy accelerator.

Principle:

When a charged particle moves normal to the magnetic field, it experiences magnetic Lorentz force.

➢ $\frac{mv^2}{r} = qvB$

➢ $r = \frac{mv}{qB}$

➢ $r \propto v$

➢ $\int_{Oscillator} = \frac{Bq}{2\pi m}$

➢ $T = \frac{2\pi m}{Bq}$

Limitations of Cyclotron:

∗ the speed of the ion is limited
∗ electron cannot be accelerated
∗ uncharged particles cannot be accelerated

26. Find the magnetic induction at a point inside and outside of a current carrying **toroid** using Ampere's circuital law.

Open space interior to the toroid	**Open space exterior to the toroid:**	**Inside the toroid:**
$L_1 = 2\pi r_1$	$L_3 = 2\pi r_3$	$L_2 = 2\pi r_2$
$\oint_{loop1} \vec{B}_P . \vec{dl} = \mu_0 I_{enclosed}$	$\oint_{loop3} \vec{B}_Q . \vec{dl} = \mu_0 I_{enclosed}$	$\oint_{loop2} \vec{B}_S . \vec{dl} = \mu_0 I_{enclosed}$
$I_{enclosed} = 0$	$I_{enclosed} = 0$	$I_{enclosed} = NI$
$\oint_{loop1} \vec{B}_P . \vec{dl} = 0$	$\oint_{loop3} \vec{B}_Q . \vec{dl} = 0$	$\oint_{loop2} \vec{B}_S . \vec{dl} = \mu_0 NI$
$\vec{B}_P = 0$	$\vec{B}_Q = 0$	$B_S = \mu_0 nI$

27. Obtain expression for the torque produced on a current carrying rectangular coil when its unit vector $\hat{n}$ is perpendicular to the magnetic field.

Parts	$\vec{l}$	$\vec{B}$	$\vec{F} = I\vec{l} \text{ x } \vec{B}$	$\vec{\tau} = \vec{r} \text{ x } \vec{F}$	
PQ	$-a\hat{j}$	$B\hat{i}$	$IaB\hat{k}$	$\frac{1}{2}abIB\hat{j}$	
QR	$b\hat{i}$	$B\hat{i}$	$\vec{0}$	$0\hat{j}$	
RS	$a\hat{j}$	$B\hat{i}$	$-IaB\hat{k}$	$\frac{1}{2}abIB\hat{j}$	
SP	$-b\hat{i}$	$B\hat{i}$	$\vec{0}$	$0\hat{j}$	
		Net force	$\vec{F} = \vec{0}$	Net torque	$\vec{\tau} = abIB\hat{j} = A\ BI\hat{j}$

28. Explain the principle, construction and working of a moving coil galvanometer.

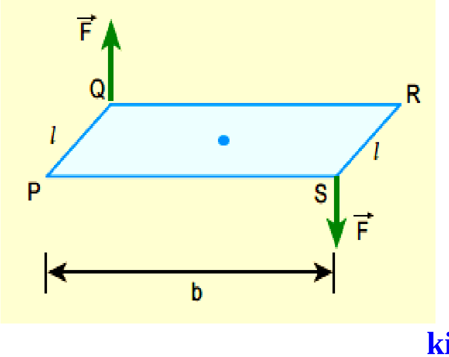
* Moving coil galvanometer is a device which is used to indicate the flow of current in an electrical circuit.

Principle:

When a current carrying loop is placed in a uniform magnetic field it experiences a torque.

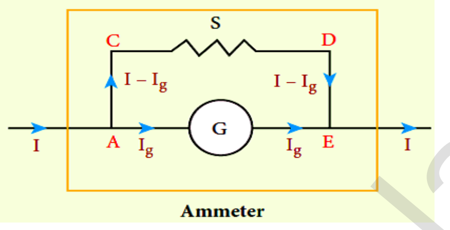
Working:

* PQ = RS = l
* QR = SP = b
* $\tau = bF = bBIl = (lb)BI = ABI$
* $A = lb$
* For N turns, $\tau = NABI$
* $\tau = K\theta$
* $NABI = K\theta$
* $I = \frac{K}{NAB}\theta$
* $I = G\theta$
* $G = \frac{K}{NAB}$ is the figure of merit of the galvanometer.
* Current sensitivity: $I_S = \frac{\theta}{I} = \frac{1}{G}$
* Voltage sensitivity: $V_S = \frac{\theta}{V} = \frac{I_S}{R_g}$



29. How will you convert a galvanometer into an ammeter?

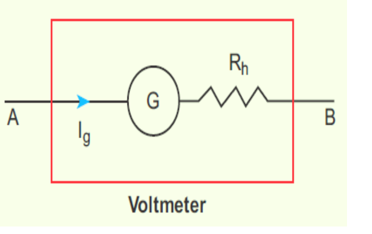
* Ammeter is an instrument used to measure current flowing in the electrical circuit.
* A galvanometer is converted into an ammeter by connecting a low resistance in parallel with the galvanometer.
* This low resistance is called shunt resistance S.



* $V_g = V_S$
* $I_g R_g = (I - I_g) S$
* $S = \frac{I_g}{(I-I_g)} R_g$
* $I_g = \left(\frac{S}{S+R_g}\right) I$
* $I_g \propto I$
* $\theta = \frac{I_g}{G}$
* $\theta \propto I_g$
* $\theta \propto I$
* $R_{eff} = \frac{R_g S}{R_g + S} = R_a$
* For an ideal ammeter, the resistance must be equal to zero.

30. How will you convert a galvanometer into a voltmeter?

* A voltmeter is an instrument used to measure potential difference across any two points in the electrical circuits.
* A galvanometer is converted into a voltmeter by connecting high resistance R_h in series with galvanometer.
* $I = I_g$
* $R_V = R_g + R_h$
* $I_g = \frac{V}{R_g + R_h}$
* $R_h = \frac{V}{I_g} - R_g$
* $I_g \propto V$
* An ideal voltmeter is one in which has infinite resistance.

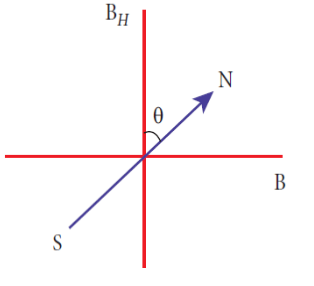


31. State Tangent's law and explain it in detail.

Tangent's law:

When a magnetic needle or magnet is freely suspended in two mutually perpendicular uniform magnetic fields, it will come to rest in the direction of the resultant of the two fields.

* $B = B_H \tan\theta$
* $B = \mu_0 \frac{NI}{2R}$
* $B_H = \frac{\mu_0 N}{2R} \frac{I}{\tan\theta}$



32. Write the properties of electromagnetic waves.

- They are produced by any accelerated charge.
- They do not require any medium for propagation.
- Electromagnetic wave is a non-mechanical wave.
- They are transverse in nature.
- They travel with speed which is equal to the speed of light in vacuum or free space.
- The speed of electromagnetic wave is less than speed in free space or vacuum.
- They are not deflected by electric and magnetic fields.
- They can show interference, diffraction and also can be polarized.
- The energy density is $u = \varepsilon_0 E^2 = \frac{1}{\mu_0} B^2$
- Average energy density is $\langle u \rangle = \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2\mu_0} B^2$
- Intensity, $I = \langle u \rangle c$
- They carry energy and mometum.
- The force exerted by an electromagnetic wave on unit area of a surface is called radiation pressure.
- If the electromagnetic wave incident on a material surface is completely absorbed, then the energy delivered is U and momentum imparted on the surface is $p = \frac{U}{c}$
- If the incident electromagnetic wave of energy U is totally reflected from the surface, then the momentum delivered to the surface is $\Delta p = \frac{2U}{c}$
- The rate of flow of energy crossing a unit area is known as pointing vector for electromagnetic wave.
- $\vec{S} = \frac{1}{\mu_0}(\vec{E} \times \vec{B})$
- They also carries angular momentum

33. What are emission spectra? Explain its types.

- When the spectrum of self luminous source is taken, we get emission spectrum.
- Each source has its own characteristic emission spectrum.

Continuous emission spectra:

- If the light from incandescent lamp is allowed to pass through prism, it splits into seven colours.
- Thus, it consists of wavelengths containing all the visible colours ranging from violet to red.
- Examples: Carbon arc, incandescent solids, liquids.

Line emission spectra:

- Suppose light from hot gas is allowed to pass through prism, line spectrum is observed.
- Line spectra are also known as discontinuous spectra.
- The line spectra are sharp lines of definite wavelengths or frequencies.
- Such spectra arise due to excited atoms of elements.
- These lines are the characteristics of the element which means it is different for different elements.
- Examples: spectra of hydrogen, helium.

Band emission spectra:

- Band spectrum consists of severa number of very closely spaced spectral lines which overlapped together forming specific bands which are separated by dark spaces, known as band spectra.
- Band spectrum is the characteristic of the molecule can be studied using their band spectra.
- Examples: spectra of hydrogen gas in the discharge tube.

34. What are absorption spectra? Explain its types.

* When light is allowed to pass through a medium or an absorbing substance then the spectrum obtained is known as absorption spectrum.
* It is the characteristic of absorbing substance.

Continuous absorption spectrum:

* When the light is passed through a medium, it is dispersed by the prism,we get continuous absorption spectrum.
* For instance, when we pass white light through a blue glass plate, it absorbs everything except blue.
* This is an example of continuous absorption spectrum.

Line absorption spectrum:

* When light from the incandescent lamp is passed through cold gas, the spectrum obtained through the diepersion due to prism is line absorption spectrum.
* Similarly, if the light from the carbon arc is made to pass through sodium vapour, a continuous spectrum of carbon arc with two dark lines in the yellow region of sodium vapour is obtained.

Band absorption spectrum:

* When the white light is passed through the iodine vapour, dark bands on continuous bright background is obtained.
* This type of band is also obtained when white light is passed through diluted solution of blood or chlorophyll or through certain solutions of organic and inorganic compounds.