# Physics

## UNIT - I ELECTRO STATISTICS

## ONE MARK QUESTIONS:

1. A glass rod rubbed with silk acquires a charge of $+8\times10^{-12}$C The number of electrons it has gained or lost ___________ **($5 \times 10^7$ lost)**
2. The electro static force between two point charges kept at a distance d apart in a medium $\varepsilon_r = 6$ is 0.3 N. The force between them at the same separation in vacuum is ____**(1.8N).**
3. Electric field intensity is 400 $Vm^{-1}$ at a distance of 2m from a point charge. It will be 100 $Vm^{-1}$ at a distance __________ **(4m)**
4. Two point charges +4q and +q are placed 30cm apart. At what point on the line joining them the electric field is zero. **(20cm from the charge +4q)**
5. A dipole is placed in a uniform electric field with its axis parallel to the field. It experiences. **(neither a net force nor a torque)**
6. If a point lies at distance x from the midpoint of the dipole, the electric potential at this point is proportional to **($1/x^2$)**
7. Four charges +q, +q, -q and -q respectively are placed at the corners. A,B,C and D of a square of side a. The electric potential at the centre of the square is ______**(zero)**
8. The work done in moving 500 μc charge between two points on equipotential surface is __________ **(zero)**
9. Which of the following quantities is scalar?

   a. dipole moment b. electric force

   c. electric field d. electric potential **(Electric potential)**
10. The unit of permittivity is **($C^2N^{-1}m^{-2}$)**
11. The number of electric lines of force originating from a charge of 1c is **($1.129 \times 10^{11}$)**
12. The electric field outside the plates of two oppositely charged plane sheets of charge density is **(zero)**
13. The capacitance of a parallel plate capacitor increases from 5μF to 60μF when a dielectric is filled between the plates. The dielectric constant of the dielectric is **(12)**
14. A hollow metal ball carrying an electric charge produces no electric field at points. **(inside the sphere)**
15. A relative permittivity of air or vacuum is **(1)**

16. The unit of electric field intensity is **($NC^{-1}$) or $Vm^{-1}$**
17. Number of electric lines of force originating from a unit positive charge is **($1/\varepsilon_o$)**
18. Electric potential at a point on the equatorial line of the dipole is **(zero)**
19. Electric field at a point inside the uniformly charged spherical shell is **(zero)**
20. Relation between electric field and potential is **(E = -dV/dx)**
21. The unit of capacitance is ________ **(farad)**
22. The magnitude of the induced dipole moment is **(directly proportional to the external electric field)**
23. Usage of capacitor in power supplier is **(to increase the efficiency of power transmission)**
24. Two capacitor of 2μF capacitance are connected in series. The effective capacitance is **(1μF)**
25. Electrostatic potential energy of the capacitor is **($U = 1/2\ CV^2$)**
26. Values of three electric fields are $8NC^{-1}$, $-10NC^{-1}$ $2Nc^{-1}$. Resultant electric field is **(zero)**
27. In a electric field, two point charges, separated at a distance of 4cm, gives a potential 20V. Electric field between the point is **(5 V/cm)**
28. The effect of capacitance of capacitor when the region between the two plates is filled with dielectric **(increases)**
29. The unit of electric flux is **($Nm^2C^{-1}$)**
30. The Value of permittivity of free space is

**Ans** : $$\frac{1}{4\pi\times 9\times 10^9}C^2N^{-1}m^{-2}\ (or)\ 8.854\times 10^{-12}C^2N^{-1}m^{-2}$$

31. Electric potential energy of two point charges is **Ans** : $U = \frac{q_1q_2}{4\pi Cor}$
32. The negative gradient of potential is

**Ans :** Electric field intensity $E = \frac{-dv}{dx}$

33. The work done is moving 500 μc charge between two points on equipotential surface is **Ans** : Zero
34. n Capacitors each of capacitance C are connected in series. The effective capacitance is

**Ans :** $\frac{C}{n}$

35. n Capacitors each of capacitance C are connected in parallel. The effective capacitance is

**Ans : (nC)**

36. When the charge given to a capacitor is doubled, its capacitance

**Ans :** dose not change

## THREE MARK QUESTIONS

**1. Distinguish between the conductor and insulator. Give examples.**

i. Bodies which allow the charges to pass through itself are called conductor. eg. metals, human body, earth etc.,

ii. Bodies which do not allow the charges to pass through are called insulator eg., glass, mica, ebonite, plastic etc.,

**2. Write notes on Quantisation of Electric Charge.**

In nature the electric charge of any system is always an integral multiple of the least amount of charge. (q=ne)

**3. Write notes on Conservation of Electric Charge.**

According to the law of conservation of electric charge, the total charge in an isolated system remains constant.

Eg. $_{92}U^{238}$ -------> $_{90}Th^{234}$ + $_{2}He^{4}$

Total charge before decay = +92e

Total charge after decay = 90e + 2e

**4. Write notes on Additive Nature of Charge**

The total electric charge of a system is equal to their algebric sum of electric charges located in the system.

eg. (+2q) + (-5q) = -3q

**5. State Coulomb's law in electrostatics.**

The force of attraction or repulsion between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them

**6. Define Coulomb:**

One coulomb is defined as the quantity of charge, which when placed at a distance of 1 metre in air or vacuum from an equal and similar charge experiences a repulsive force of 9 x $10^9$ N.

**7. What is Relative Permittivity?**

The ratio between the permittivity of medium and permittivity of free space is called as relative permittivity (or) dielectric constant of the medium.

$$\varepsilon_r = \frac{\varepsilon}{\varepsilon_o}$$

**8. Explain the principle of Superposition.**

The total force on a given charge is the vector sum of the forces exerted on it due to all other charges.

**9. Define: Electric Field Intensity.**

Electric field intensity at a point, in an electric field is defined as the force experienced by a unit positive charge kept at that point.

$E = F/q$, unit : $NC^{-1}$

**10. What is Electric Dipole? Give Examples.**

Two equal and opposite charges separated by a very small distance constitute an electric dipole.

Eg. Water, Ammonia

**11. What is Electric Dipole Moment? Give its unit.**

The magnitude of the dipole moment is given by the product of the magnitude of the one of the charges and the distance between them. $P = q.2d$ unit = Cm

**12. Write short notes on Microwave oven?**

It is used to cook the food in a short time. When the oven is operated, the microwaves are generated, which in turn produce a non-uniform oscillating electric field. The water molecules in the food which are the electric dipoles are excited by an oscillating torque, Hence few bonds in the water molecules are broken, and heat energy is produced. This is used to cook food.

**13. Distinguish between Electric Potential and Potential Difference.**

| Electric Potential | Potential Difference |
|---|---|
| The electric potential in an electric field at a point is defined as the amount of work done in moving a unit positive charge from infinity to that point against the electric forces | The potential difference between two point in an electric field is defined as the amount of work done in moving a unit positive charge from one point to the other against the electric forces |
| This is a scalar quantity | This may be changed to being either scalar or vector quantity |

**14. What is Equipotential Surface?**

If all the points of a surface are at the same electric potential, then the surface is called an equipotential surface.

**15. Define Gauss law:**

The total flux of the electric field E over any closed surface is equal to $\frac{1}{\varepsilon_0}$ times the net charge enclosed by the surface

**16. Why is it safer to be inside a car than standing under a tree during lightning?**

The metal body of the car provides electro static shielding, where the electric field is zero. During lightning the electric discharge passes through the body of the car.

**17. What is Electro Static Induction?**

It is possible to obtain charges without any contact with another charge. They are known as induced charges and the phenomenon of producing induced charges is known as electrostatic induction.

It is used in electro static machines like Vande Graff generator and capacitors.

**18. What is a Capacitor? Define its capacitances and give its unit?**

A capacitor is a device for storing electric charges.

The capacitance of a conductor is defined as the ratio of the charge given to the conductor to the potential developed in the conductor.

The unit of capacitance is farad.

**19. Define farad**

The unit of capacitance is farad

The conductor has a capacitance of one farad, if a charge of 1 coulomb given to it rises its potential by 1 volt.

**20. What are Non Polar Molecules? Give examples.**

A non polar molecules is one in which the centre of gravity of the positive charges coincide with the centre of gravity of the negative charges. Eg : $O_2$, $N_2$, $H_2$

**21. What are Polar Molecules? Give its examples.**

A polar molecule is one in which the centre of gravity of the positive charges is separated from the centre of gravity of the negative charges by the finite distance.

Eg : $N_2O$, $H_2O$

**22. What is Polarisation?**

The alignment of the dipole moments of the permanent or induced dipoles in the direction of applied electric field is called polarisation or electric polarisation.

**23. What is Dielectrics?**

A dielectric is an insulating material in which all the electrons are tightly bound to the nucleus of the atom. There are no free electrons to carry current. Eg:Ebonite,Mica

**24. Explain the effect of introducing a dielectric slab between the plates of the parallel plate capacitor.**

The capacitance of a capacitor $C^1 = \varepsilon_0 \varepsilon_\gamma A/d$

for any dielectric $\varepsilon_\gamma > 1$, so the capacitance increases when dielectric is placed.

**25. What are uses of Capacitors?**

They are used in the ignition system of automobile engines to eliminate sparking.

They are used to reduce voltage fluctuations in power supplies and to increase the efficiency of power transmission.

Capacitors are used to generate electro magnetic oscillations and in tuning the radio circuits.

**26. What is meant by Action of Point?**

The leakage of electric charges from the sharp point on the charged conductor is known as action of point or corona discharge.

This principle is made use of in the electro static machines for collecting charges and in lightning arrestors.

**27. Three capacitors each of capacitance 9μF are connected in series. Find the resultant capacitance of the combination.**

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$\frac{1}{C_s} = \frac{1}{9} + \frac{1}{9} + \frac{1}{9}$$

$$\frac{1}{C_s} = \frac{1+1+1}{9}$$

$$\frac{1}{C_s} = \frac{3}{9}$$

$$\frac{1}{C_s} = \frac{1}{3}$$

$$C_s = 3\mu F$$

**28. What is electrostatic shielding?**

It is a process of isolating a certain region of space from an external field. It is based on the fact that the electric field inside the conductor is zero.

**29. Define electric flux. Give its unit.**

The total number of electric lines of force crossing through the given area. It's unit is $Nm^2C^{-1}$.

## <u>Five Mark Questions:</u>

1. Write the properties of electric lines of forces.
2. Derive an expression for the torque acting on the electric dipole when placed in a uniform field.

3. Obtain an expression for electric potential due to a point charge.
4. Explain the principle of capacitor
5. Prove that energy stored in a parallel plate capacitor is $\frac{q^2}{2c}$ (or) $\frac{1}{2}CV^2$
6. What is electrostatic potential energy of a system of two point charges? Deduce an expression for it.
7. Using Gauss law: derive an expression for electric field due to two parallel charged sheets.
8. Derive an expression for electric potential energy of an electric dipole in an electric field.

**Ten Mark Questions:**

1. Derive an expression for electric field due to electric dipole at a point on its axial line
2. Derive an expression for electric field due to electric dipole at a point on its equatorial line.
3. Derive an expression for electric potential due to an electric dipole, discuss the special cases.
4. State Gauss law. Applying this, calculate electric field due to i) an infinitely long straight conductor with uniform charge density ii) an infinite plane sheet of charge of q.
5. Explain the principle of capacitor. Deduce an expression for the capacitance of the parallel plate capacitor.
6. What is dielectric? Derive an expression for capacitance of parallel plate capacitor with a dielectric medium.
7. Deduce an expression for the equivalent capacitance of capacitors connected in series and parallel.
8. State the principle and explain the construction and working of Van de Graff generator.

## UNIT -2 CURRENT ELECTRICITY

**One Mark Questions.**

1. A charge of 60 C passes through an electric lamp in 2 minutes. Then the current in the lamp is ____ **(0.5A)**
2. The material through which electric charge can flow easily is ______________
   a). quartz b) mica c) germanium d) copper. **[copper]**
3. The current flowing in a conductor is proportional to ________________
   a) drift velocity b) 1/ area of cross section
   c) 1/ no. of electrons d).square of area of cross section. **[drift velocity]**
4. A toaster operating at 240v has a resistance of 120 Ohm. The power is ______ **[480 W]**
5. If the length of a copper wire has a certain resistance R, then on doubling the length its specific resistance ___________ **[will remain the same]**
6. When two 2 Ohm resistances are in parallel, the effective resistance is _____**[$1\Omega$]**
7. In the case of insulator, as the temperature decreases, resistivity __________ **[increases]**

8. If the resistance of coil is 2 Ohm at 0°C and $\alpha$ = 0.004/°C then its resistance at 100°C is __________ **[2.8 Ohm]**
9. According to Faraday's law of electrolysis, when a current is passed, the mass of ions deposited at the cathode is independent of __________ **[ resistance]**
10. Expression for current density is __________ **[J = I/A]**
11. The unit of conductance is __________ **[mho]**
12. If the sum of the currents entering the junction is equal to 12 A, then the sum of the currents leaving the junction is __________ **[12 A]**
13. Which of the following is conducting current?
    a) Wood b) Micac) Glass d) Tungsten **[Tungsten]**
14. The example for the material whose resistivity is $10^{-2}$ to $10^{4}$ Ohm meter ____ **[ germanium or silicon]**
15. Transition temperature of mercury is __________ **[4.2 K]**
16. ________________ can be used as memory or storage element in computer **[super conductors]**
17. In carbon resistors, silver rings indicates __________ **[10% variation of Resistance]**
18. When two 6 Ohm resistances are in parallel the effective resistance is **[ 3 Ohm]**
19. Example for secondary cell is __________ **[Lead - Acid accumulator]**
20. 5 A Current, 200 V voltage being a Electric heater. Power of Electric heater is __ **[1 KW]**
21. A material with a negative temperature coefficient is called as a____ **[ Thermistor]**
22. When n resistors of equal resistances (R) are connected in series the effective resistance is **Ans: nR.**
23. The unit of electro cheimal equivalent **Ans: Kg C-1**
24. The energy equivalent to $1Kwh = 36 \times 10^5 J$

## THREE MARKS - QUESTIONS

**1. Define Drift Velocity. Give its unit.**

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 ms -1.

**2. Define Mobility. Give its unit.**

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

**3. State Ohm's law.**

At a constant temperature, the steady current flowing through a conductor is directly proportional to the potential difference between the two ends of the conductor.

$I \alpha V$, $V = IR$

**4. Define Conductance. Write its unit.**

The reciprocal of resistance is conductance. G=1/R Its unit is mho.

**5. What is Electrical Conductivity. Give its unit.**

The reciprocal of electrical resistivity, is called electrical conductivity. Unit is mho $m^{-1}$

**6. What is called specific resistance [or] electrical resistivity? Give its unit.**

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 ohm –m.

**7. What are called Superconductors?**

The ability of certain metals, their compounds and alloys to conduct electricity with zero resistance at very low temperatures is called superconductivity. The materials which exhibit this property are called superconductors.

**8. What is called the Transition or Critical Temperature?**

The temperature at which electrical resistivity of the material suddenly drops to zero and the material changes from normal conductor to superconductor is called the transition [or] critical temperature.

**9. List some applications of Superconductors.**

(i) Superconductors can be used as memory or storage elements in computers.

(ii) Since the current in a superconducting wire can flow without any change in magnitude, it can be used for transmission lines.

(iii) It is used to produce powerful electromagnets.

(iv) Superconducting magnetic propulsion systems may be used to launch satellites into orbits directly from the earth without the use of rockets.

**10. The colours of a carbon resistor is orange, orange, orange. What is the value of Resistance?**

The first orange ring corresponds to 3

The second orange ring corresponds to 3

The third orange ring corresponds to $10^3$

The total resistance is $33 X 10^3 = 33000\ \Omega = 33k\ \Omega \pm 20\%$

**11. Define the temperature co-efficient of resistance.**

The temperature coefficient of resistance is defined as the ratio of increase in resistance per degree rise in temperature to its resistance at 0°C.

**12. State Kirchoffs Laws.**

(i) Kirchoffs current law states that the algebraic sum of the currents meeting at any junction in a circuit is zero.

(ii) Kirchoffs voltage law states that the algebraic sum of the products of resistance and current in each path of any closed circuit is equal to the algebraic sum of the emf 's in that closed circuit.

**13. State the principle of Potentiometer.**

The emf of the cell is directly proportional to its balancing length. $E \alpha l$.

**14. Why is copper wire not suitable for a Potentiometer?**

Because (i) Its temperature co - efficient is high and

(ii) Specific resistance is low.

**15. State Faraday's laws of Electrolysis.**

(i) The mass of a substance liberated at an electrode is directly proportional to the charge passing through the electrolyte.

(ii) The mass of a substance liberated at an electrode by a given amount of charge is proportional to the chemical equivalent of the substance.

**16. What are called Primary Cell?**

The cells from which the electric energy is derived by irreversible chemical reaction are called primary cells. They cannot rechargeable

**17. What are called Secondary Cell?**

The cells from which the electric energy is derived by reversible chemical reaction are called secondary cell. They can rechargeable

**18. A manganin wire of length 2m has a diameter of 0.4mm with a resister of 70Ω. Find the resistivity of the material.**

L = 2m, r = 0.2 x 10-3m, R = 70Ω.

*resistivity*

$$\rho = \frac{\pi r^2 R}{l}$$

$$= \frac{3.14 \times (0.2 \times 10^{-3})^2 \times 70}{2m}$$

$$\rho = 4.4 \times 10^{-6}\,\Omega m$$

**19. Distinguish between EMF and potential difference.**

| EMF | Potential difference |
|---|---|
| 1. The difference of potential between the two terminals of a cell in an open circuit is called EMF.<br>2. The EMF is independent of external resistance of the circuit. | 1. The difference in potential between any two points in a closed circuit is called potential difference.<br>2. Potential difference is proportional to the resistance between any two points. |

**20. The resistance of a nichrome wire at 00 C is 10Ω. If its temperature co efficient of resistance is 0.004/0C. Find its resistance at boiling point of water. Comment on the result.**

$$R_t = R_0(1 + \alpha t)$$

$$= 10[1 + (0.004 \times 100)]$$

$$= 10[1.4]$$

$$Rt = 14\Omega$$

As the temperature increase the resistance of wire also increases.

**21. Distinguish between electric power and electric energy.**

| Electric Power | Electric Energy |
|---|---|
| 1. It is defined as the rate of doing electric work. | It is the capacity to do work. |
| 2. Its unit is watt. | Its unit is joul or Kilowatthour. |

**22. What are the applications of Secondary cells?**

1. The secondary cells are rechargeable.
2. They have low internal resistance. Hence they deliver a high current of required.
3. These cells are huge in size. Hence they are used in automobiles like car, two wheelers etc.

**23. What are the changes observed at transistor temperature, when the conductor becomes a super conductor?**

1. The electrical resistivity drops to zero.
2. The conductivity becomes infinity.
3. The magnetic flux lines are excluded from the material.

## <u>Part C: FIVE MARK QUESTIONS</u>

1. Derive the relationship between current and drift velocity.
2. Explain the determination of the internal resistance of a cell using volt meter.
3. State and explain Kirchoff's laws for electrical networks.
4. State and explain Faraday's laws of electrolysis. How are the laws verified experimentally?
5. Describe an experiment to find unknown resistance, specific resistance and temperature co-efficient of resistance using meter bridge?
6. How can emf of two given cells be compared using potentiometer?
7. Derive an expression for bridge balance condition for wheatstone's bridge.
8. If two more resistors are connected in parallel, derive an expression for the effective capacitance.
9. Explain the working of Lechlache's cell with a diagram.
10. Explain the action of leed-oxid accumulator.
11. Explain the construction and working of Daniell cell.
12. Write any five applications of superconductors.

# UNIT 3 - EFFECTS OF ELECTRIC CURRENT

## One Mark Questions:

1. Joule's law of heating is **( H = VIt)** (or) **$H = I^2RT$** (or) $\frac{v^2t}{R}$
2. Nicrome wire is used as the heating element because it has **high specific resistance**
3. Petlier coefficient at a junction of thermocouple depends on the **(temperature of the junction)**
4. In a thermo couple, the temperature of the cold junction is 20°C, the neutral temperature is 270°C. The temperature of inversion is **(520°C)**
5. Which of the following equations represents Biot - Savart law? $dB = \frac{\mu_0}{4\pi} \frac{(\overrightarrow{Idl} \times \vec{r})}{r^3}$
6. Magnetic field at a point along the axis of the circular coil carrying current at a distance x from the centre of the coil is directly proportional to **($x^{-3}$)**
7. In a tangent galvanometer, for a constant current the deflection is 30°C. The plane of the coil is rotated through 90°C Now, for the same constant current, the deflection will be **( 0°)**
8. The period of revolution of a charged particle inside a cyclotron does not depend on **[ the velocity of the particle]**
9. The torque on a rectangular coil placed on a uniform magnetic field is large when **[the number of turns is large]**
10. Phosphor - bronze wire is used for suspension in a moving coil galvanometer because it has **[Small couple per unit twist]**
11. Of the following devices, which has small resistance?**[ammeter of range 0 - 10A]**
12. A galvanometer of resistance G Ohm - is shunted with S Ohm. The effective resistance of the combination is Ra then which of the following statements is true? (**Ra is less than both G and S)**
13. An ideal voltmeter has **[infinite resistance.]**
14. Which of the following principle is used in a Thermopile? **[Seebeck Effect]**
15. The positive Thomson effect present in **[Ag]**
16. The unit of Thomson coefficient is **[ Volt/°C]**
17. The permeability of vacuum is [**$4\pi \times 10^{-7}$ H/m]**
18. According to Tangent law is **$B = B_h \tan\theta$**
19. The radius of circular path of a charged particle in a uniform magnetic field is (**r = mv / Bq)**
20. Current sensitivity of a galvanometer is **[ nBA / C]**
21. For a given thermocouple the neutral temperature **[is a constant]**
22. An electron is moving with a velocity of $3\times10^6 ms^{-1}$ perpendicular to a uniform magnetic field of induction 0.5 T. The force experienced by the electron is **[2.4 x 10-13N]**
23. The period of revolution of a charged particle inside a cyclotron does not depend on **[the velocity of the particle]**
24. Fuse wire **[has high resistance]**
25. Voltage sensitivity of a galvanometer **[nBA / CG]**

## 3 MARK QUESTIONS :

**1. State Joule's Law?**

The current carrying conductor produces the heat.

Joules law states that the heat produced is

i) directly proportional to the square of the current $I^2$ for a given R.

ii) directly proportional to Resistance R for a given I

iii) directly proportional to the time of passage of current. **$H = I^2 Rt$.**

**2. Define Peltier coefficient ($\pi$)**

The amount of heat energy absorbed or evolved at one of the junctions of a thermo couple when one ampere current flows for one second is called Peltier coefficient. It is denoted by $H = \pi It$ (Unit : Volt).

**3. Define Thomson coefficient.**

The amount of heat energy absorbed or evolved when one ampere current flows for one second (One coulomb) in a metal between two points which differ in temperature by 1°C is called Thomson coefficient. (Unit : Volt/°C).

**4. State Biot's Savart law?**

The Magnetic induction of a current carrying conductor is

(i) directly. proportional to the current.(I)

(ii) directly proportional to the length. of the current element dl)

(iii) directly proportional to the sine of the angle between the line joining element dl and the point ($\sin\theta$)

(iv) inversely proportional to the square of the distance of the point from the element. ($\frac{1}{\gamma^2}$)

**5. State the End rule.**

When looked from one end if the current through the solenoid is along clockwise direction the nearer end corresponds to south pole and the other end is north pole.

When looked from one end is the current through the solenoid is along anticlockwise direction, the nearer end corresponds to North pole and the other end is south pole.

**6. Define Ampere.**

Ampere is defined as that constant current which when flowing through two parallel infinitely long straight conductors of negligible cross section and place in air (or) vacuum at a distance of one meter apart, experience a force of $2 \times 10^{-7}$ newton per unit length of the conductor.

**7. What is Seebeck effect?**

Two dissimilar metals connected to form two junctions is called thermo couple. The emf developed in the circuit is thermo electric emf. the current through the circuit is called thermo electric current. This effect is called Thermo Electric Effect (or) Seebeck Effect.

**8. What is Neutral and Inversion temperature?**

The thermo emf rises to a maximum at a temperature (Tn) is called neutral temperature.

Above neutral temperature, the thermo emf decreases and eventually becomes zero at a particular temperature called temperature of inversion.

**9. What is Peltier effect?**

When electric current is passed through a circuit consists of two dissimilar metals, heat is evolved at one junction and absorbed at the other junction. This is called peltier effect.

**10. What is Thomson effect?**

When current flows through an unequally heated conductor heat is evolved or absorbed through the body of the conductor this effect is called Thomson effect.

**11. State the Right Hand Palm Rule**

The coil is held in the right hand so that the fingers point in the direction of the current in the windings. The extended thumb points in the direction of the magnetic field.

**12. State Flemming's Left Hand Rule**

The forefinger the middle finger and the thumb of the left hand are stretched in mutually perpendicular directions. If the forefinger points in the direction of the magnetic field, the middle finger point in the direction of the current then the thumb points in the direction of the force on the conductor.

**13. What is current sensitivity of a Galvanometer?**

The current sensitivity of the galvanometer is defined as the deflection produced when unit current passes through the galvanometer.

Current sensitivity $\frac{\theta}{I} = \frac{nBA}{C}$

**14. What are the limitations of Cyclotron?**

i) Maintaining a uniform magnetic field over a large area of the Dees is difficult.

ii) At high velocities, relativistic variation of mass of the particle upsets the resonance condition.

iii) At high frequencies, relativistic variation of mass of the electron is appreciable and hence electrons cannot be accelerated by cyclotron.

**15. How will you convert a Galvanometer into an Ammeter and a Volt Meter?**

1. A galvanometer is converted into an ammeter by connecting. A low resistance in parallel with it.
2. A galvanometer is converted into a voltmeter by connecting a high resistance in series with it.

**16. Calculate the resistance of the filament of a 100W, 220V electric bulb.**

$$P = \frac{V^2}{R} ; R = \frac{V^2}{P}$$

V = 220V ; P = 100W

$$R = \frac{220 \times 220}{100}$$

$$R = 484\Omega.$$

**17. Mention any two differences between peltier effect and Jowle's heating.**

| Peltler Effect | Joule's Effect |
|---|---|
| 1. Heat is absorbed or evolved at the junction. | Heat is always evolved throughout the conductor. |
| 2. Heat is directly at proportional to current (I) | Heat is directly proportional to square of the current (I2). |
| 3. Reversible process. | Irreversible process. |
| 4. It depends on the direction of current. | It does not depend on direction of current |

**18. Why is nichrome used as a heating element? (or) what are the characteristics of heating element used in electric heating device?**

(i) It has high specific resistance.
(ii) It has high melting point.
(iii) It is not easily oxidized.

**19. How can we increase the current sensitivity of a galvanometer?**

Current sensitivity $\frac{\theta}{I} = \frac{nBA}{C}$

The current sensitivity of a galvanometer can be increased by

(i) Increasing the number of tums (n)
(ii) Increasing the magnetic induction (B)
(iii) Increasing the area of the coil (A)
(iv) Decreasing the couple per unit twist of the suspension wire (c)

**20. State Tangent law.**

A magnetic needle suspended at a point where there are two crossed magnetic fields at rightangle to each other will come to rest in the direction of resultant of these two fields. $B = B_h \tan \theta$

**21. In galvanometer, increasing the current sensitivity does not necessarily increase the voltage sensitivity explain.**

(i) Current sensitivity $\frac{\theta}{I} = \frac{nBA}{C}$

(ii) Voltage sensitivity $\frac{\theta}{V} = \frac{nBA}{CG}$

When the number of turns is doubled , current sensitivity is also doubled, but increasing the number of turns, correspondingly increase the resistance. Hence voltage sensitivity remains unchanged.

**22. What is Ampere's circutal law?**

The line integral $\oint \vec{B}.\vec{dl}$ for a closed curve is equal to μo times the not current Iothrough the area bounded by the curve.

$$\oint \vec{B}.\vec{dl} = \mu_o I_o$$

## 5 MARK QUESTIONS:

1. State and Explain the Biot - Savart law?
2. Explain the Thomson effect?
3. Derive the Ampere's circuital law?
4. How can we convert the galvanometer into an ammeter and a Volt meter. Explain with circuits.
5. What are the special features of magnetic Lorenlz force.

## 10 MARK QUESTIONS:

1. Explain the construction and principle of a Tangent Galvanometer.
2. Explain the Joule's law and its verifications.
3. Obtain an expression for the magnetic induction at a point due to an infinitely long straight conductor carrying current.
4. State Ampere's circuital law. And find the magnetic induction due to a straight solenoid.
5. Explain in details the principle. Construction and worming of cyclotron with neat diagram.
6. Deduce the relation for the magnetic induction at a point along the axis of a circular will carrying current.
7. Deduce the expression for the force in a current carrying conductor placed in a magnetic field.
8. Deduce an expression for the period of rotation of the charged practical in a uniform magnetic field.

# UNIT – 4
# ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENT.

## One mark Questions :

1. Electromagnetic induction is not used in **room heater**
2. A. coil of area of cross section 0.5 $m^2$ with 10 turns is in a plane which is perpendicular to as uniform Magnetic field of 0.2 Wb/ $m^2$ The flux through the coil is **1 Wb.**
3. Lenz's law is in accordance with the law of **conservation of energy**
4. The self inductance of a straight conductor is **Zero**
5. The unit Henry can also be written as a) $VsA^{-1}$ b) $Wb\ A^{-1}$ c) Ohm s **d) all**
6. An emf of 12V is induced when the current in the coil changes at the rate of $40As^{-1}$ the coefficient of self induction of the coil is **0.3 H**
7. DC of 5A produces the same heating effect as an AC of **5A rms current**
8. Transformer works on **Ac only**
9. The part of the AC generator that passes the current from the coil to the external circuit is **Brushes**
10. In an Ac circuit the applied emf $e=E_0 \sin(\omega t+\pi/2)$ leads the current. $I = I_0 \sin(\omega t-\pi/2)$ by $\pi$
11. Which of the following cannot be stepped up in a transformer? **input power**
12. The power loss is less in transmission lines when **voltage is more but current are less.**
13. Which of the following devices does not allow dc. to pass through **capacitor**
14. In an AC circuit **the average value of current is zero**
15. In mutual Induction, magnetic flux is **directly proportional to current.**
16. The impedance of a capacitor is **inversely proportional to the capacitance.**
17. The emf in a circuit with an inductor only **$\pi$/2 ahead over current.**
18. The potential difference of primary coil of an ideal transformer, having input power is 10 KW, Secondary coil current 25 A ratio of primary and secondary coil 5 : 1 is **2000V**
19. In a LCR circuit if $X_L=X_c$ Then **maximum current, minimum resistance**
20. The power of complete capacitor circuit is **Zero**
21. Which is used to transmit high power with low cost? Three phase generator
22. The flux passing normally through unit area is **Magnetic Induction**
23. The principle of transformer is **mutual Induction**
24. **Resonance** is used in radio receiver circuit.
25. The frequency of electric power used at home is **50 Hz**
26. Transformer works on **[Ac only]**
27. The reactance offered by 3 mH inductor to an Ac supply of frequency 50 Hz is **[94.2 Ohm]**
28. The r.m.s of an ac voltage with a peak value of 310 V is (**220 V)**

29. The part of the AC generator that passes the current from the coil to the external circuit is **brushes.**
30. The r.m.s. value of the AC current flowing through a resistor is 5A. Its peak value is **7.07A.**
31. In an AC circuit, the voltage leads the current by a phase of $\frac{\pi}{2}$ then the circuit has **Only an Inductor (L)**
32. An e.m.f. of 12V is induced when the current in the coil changes at the rate of 40 $As^{-1}$. The co efficient of self-induction of the coil is **0.3H**
33. Which of the following devices does not allow DC to fan through? **Capacitor**
34. The unit henry can also be written as **All the above.**

## 3 MARKS QUESTIONS:

**1. What is electromagnetic induction?**

The phenomenon of producing an induced emf due to the changes in the magnetic flux associated with a closed circuit is known as electromagnetic induction.

**2. State Faraday's laws of electromagnetic induction?**

First law:

Whenever the amount of magnetic flux linked with a closed circuit changes, an emf is induced in the circuit. The induced emf lasts so long as the change in magnetic flux continues.

Second law:

The magnitude of emf induced in a closed circuit is directly proportional to the rate of change of magnetic flux linked with the circuit

$$e \propto \frac{d\phi}{dt}$$

**3. State the Lenz's law?**

Lenz's law states that the induced current produced in a circuit always flows in such a direction that it opposes the change or cause that produces it.

$$e = \frac{-d(N\phi)}{dt}$$

**4. Define Coefficient of Self Induction?**

Coefficient of self induction of a coil is numerically equal to the magnetic flux linked with a coil when unit current flows through it.

$$L = -e \Big/ \frac{di}{dt}$$

**5. Define 1 Henry**

One henry is defined as the self inductance of a coil in which a change in current of one ampere per second produces an opposing emf of one volt.

**6. Define Coefficient of Mutual Induction**

Coefficient of mutual induction of two coils is numerically equal to the magnetic flux linked with one coil when unit current flows through the neighbouring coil.

**7. State Flemming's right hand rule. (or) generator Rule**

The forefinger, the middle finger and the thumb of the right hand are held in the three inutually perpendicular directions. If the forefinger points along the direction of the magnetic field and the thumb is along the direction of motion of the conductor, then the middle finger points in the direction of the induced current. This rule is also called generator rule.

**8. Define the RMS value of a.c.**

The rms value of alternating current is defined as that value of the steady current, which when passed through a resistor for a given time will generate the same amount of heat as generated by an alternating current when passed through the same resistor for the same time.

**9. What is Q - factor?**

The Q factor of a series resonance circuit is defined as the ratio of the voltage across a coil or capacitor to the applied voltage.

$$Q = \frac{\text{Voltage across L or C}}{\text{applied voltage}}$$

**10. What is Eddy current? (or) Foucault Current?**

When a mass of metal moves in a magnetic field or when the magnetic field through a stationary mass of metal is altered, induced current is produced in the metal. This induced current flows in the metal in the form of closed loops resembling "eddies" or whirl pool. Hence this current is called eddy current.

**11. Define Magnetic flux?**

The magnetic flux ($\phi$) linked with a surface held in a magnetic field (B) is defined as the number of magnetic lines of force crossing a closed area$\phi$ = BA cos $\theta$

**12. Define efficiency of a Transformer?**

Efficiency of a transformer is defined as the ratio of percentage of output power to the input power.

$$\eta = \frac{\text{output power}}{\text{input power}} \quad \frac{E_s I_s}{E_p I_P} \times 100\%$$

**13. What are the uses of a Transformer?**

It is used in voltage rectifiers

It is used in induced reactors

It is used in welding process.

It is used in power transmissions

**14. An aircraft having a wingspan of 20.48 m flies due north at a speed of 40 ms $^{-1}$ If the vertical component of earths magnetic field at that place is 2 x $10^{-5}$ T, Calculate the emf induced between the ends of the wings.**

Data: l = 20. 48 m

v = 40 $ms^{-1}$

B = $2 \times 10^{-5}$

e = ?

e = - Blv

= $- 2 \times 10^{-5} \times 20.48 \times 40$

e = - 0.0164 Volt

**15. Calculate the mutual inductance between two coils when a current of 4 A changing to 8 A in 0.5s in one coil induces an emf of 50 mV in the other coil.**

Data:

$I_1 = 4A$; $I_2 = 8\ A$ t : 0.5s

$e = 50\ mV = 50 \times 10^{-3}\ V$

M = ?

Solution:

$$e = -M \cdot \frac{dl}{dt}$$

$$M = {-e}\Big/\left(\frac{dl}{dt}\right) = {e}\Big/\left(\frac{l_2 - l_1}{dt}\right) = {50 \times 10^{-3}}\Big/{\frac{8-4}{0.5}}$$

$$M = 6.25 \times 10^{-3} \text{ henry}$$

**16. A coil of area of cross-section 0.5m² with 10 turns is in a plane perpendicular to a uniform magnetic field of 0.2 wb/m². Calculate the flues through the coil .**

$$\phi = NBA (or) f = NBA$$

$$\phi = 0.5 \times 10 \times 0.2$$

$$\phi = 1 Wb$$

**17. An e.m.f. of 5V is induced when the current in the coil changes at the rate of 100 $As^{-1}$ Find the co efficient if self-induction of the coil.**

$$e = -L.\frac{dI}{dt}$$

$$L = \frac{-e}{dI/dt} = \frac{-5}{100} = -0.05H$$

$$L = 50mH.$$

**18. Write the equation of a 25 cycle current size wave having rms value of 30A.**

**Solution:**

$$i = I_{\circ} \sin wt$$

$$i = I_{rms}\sqrt{2}\sin 2\pi\gamma t$$

$$i = 30\sqrt{2}\sin 2\pi \times 25t$$

$$i = 42.42\sin 157t$$

**19. Define unit of self inductance (or) Define henry (H)**

**One henry is defined as the self inductance of a coil in which a change in current of one ampere per second produces an opposing emf of one volt.**

**20. Mention the methods of producing induced e.m.f.**

Ans: The induced emf can be produced by changing.

a) The magnetic induction (B)

b) Area enclosed by the coil (A) and

c) The orientation of the coil ($\theta$) with respect to the magnetic field.

$$e = \frac{-d}{dt}(NBA\cos\theta)$$

**21. Define quality factor (or) Q factor.**

Q factor of a series resonant circuit is defined as the ratio of the voltage across a coil or capacitor to the applied voltage.

$$Q = \frac{Voltage across L or C}{applied voltage} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

**22. Give the difference between AF choke and RF choke.**

| AF choke | RF Choke |
|---|---|
| 1. It is used in low frequency a.c. circuit. | 1. it is used in high frequency wireless receiver circuit. |
| 2. AF chokes have iron wire. | 2. RF chokes have air core. |
| 3. It has high inductance. | 3. It has low inductance. |

**5 Marks Questions**

1. Explain how an emf can be induced by changing the area enclosed by the coil.
2. What are the power losses in transformer. How can be reduced it.
3. Obtain an expression for the self-inductance of a long solenoid.
4. Describe the principle, construction and working of a choke coil.
5. Explain the mutual induction between two long solenoids. Obtain the expression for the mutual inductance of two long solenoids.

6. State Faraday's laws and Lenz's law of electromagnetic induction.
7. Obtain an expression for the current flowing in a circuit containing resistance only to which alternating emf is applied. Find the phase relationship between voltage and current.
8. Explain the application of Eddy current.
9. Obtain the phase relation between current and voltage in an a.c. circuit with inductor only.

**10 Marks Questions**

1. Discuss with theory the method of inducing emf in a coil by changing its orientation with respect to the direction of the magnetic field.
2. Describe the principle, construction and working of a single phase AC generator.
3. Explain the principle of transformer and discuss its construction and working
4. A source of alternating emf is connected to a series combination of a resistor R an inductor L and a capacitor C. Obtain with the help of a vector diagram of emf and impedance, an expression for (i) the effective voltage (ii). the impedance (iii) the phase relationship between the current and the voltage.
5. Obtain the phase relation between current and voltage in an a.c. circuit with Capacitor only.

## UNIT - 5
## ELECTROMAGNETIC WAVES & WAVE OPTICS

**One mark Questions**

1. In an electromagnetic wave **power is transmitted in a direction perpendicular to both fields**.
2. Electromagnetic waves are **transverse waves**.
3. In an electromagnetic wave the phase difference between electric field E and magnetic field B is **zero**.
4. Atomic spectrum should be **pure line spectrum**
5. When a drop of water is introduced between the glass plate and plano convex lens in Newton's ring system, the ring system **contracts**.
6. A beam of mono chromatic light enters from vacuum into a medium of refractive index $\mu$. The ratio of the wavelengths of the incident and refracted waves is **$\mu$:1**
7. It the wavelength of the light is reduced to one forth, then the amount of scattering is **increases by 256 times.**
8. In Newton's ring experiment the radii of $m^{th}$ and $(m+4)^{th}$ dark rings are respectively $\sqrt{5}$mm and $\sqrt{7}$mm. What is the value of m? **10**
9. The path difference between two monochromatic light waves of wavelength 4000 $A^0$ is $2\times10^{-7}$m. The phase difference between them is $\pi$

10. In young's double slit experiment the third bright band for wave length of light 6000 $A^0$ coincides with the fourth bright band for another source in the same arrangement. The wave length of the another source is **4500 $A^0$**
11. A light of wave length 6000 $A^0$ is incident normally on a grating 0.005m wide with 2500 lines. Then the maximum order is **3**
12. A diffraction pattern is obtained using a beam of red light. What happens if the red light is replaced by blue light? **diffraction pattern becomes narrower and crowded together**.
13. The refractive index of the medium for the polarising angle $60^0$ is **1.732 or $\sqrt{3}$**
14. Accelerated charges generate **Electromagnetic waves**
15. The velocity of electromagnetic waves in vacuum or free space is **$1/\sqrt{\mu_0\varepsilon_0}$**
16. In Hertz experiment the two metal plates A and B are placed with a separation of **60cm**
17. Frequency of electromagnetic waves produced by hertz arrangement was about **$5x10^7$Hz**
18. Frequency range of AM band of radio waves is from **530 KHz to 1710 KHz**
19. Infrared lamps are used in **Physiotherapy**
20. Radiation used in the detection of forged documents and finger prints in forensic laboratory is **Ultraviolet rays**
21. Wavelength of two sodium lines (D1 & D2) **5896$A^0$ and 5890$A^0$**
22. ____ Spectrum is characteristic of the emitting substance and is used to identify the gas. **Line emission**
23. The Spectrum used for making dye is **band absorption**
24. Dark lines appearing in the solar spectrum are called **Fraunhofer lines**
25. Temperature of sun's outer layer is about **6000K**
26. Delayed fluorescence is known as **Phosphorescence**
27. According to Rayleigh scattering law, the amount of scattering is **inversely proportional to** $\lambda^4$
28. In Raman effect, lines of shorter wave lengths are called **anti - Stokes lines**
29. Raman shift or Raman frequency is positive for **stokes lines**
30. Corpuscular theory was put forward by **Newton**
31. A point source at a finite distance in an isotropic medium emits **spherical wavefront**
32. A point source of light at infinite distance emits **plane wavefront**
33. When the distance between the source and the screen is increased in young's double slit expt the fringe **width increases**.
34. The phenomenon which confirms that light waves are transverse in nature is **polarisation**
35. According to Brewster's law **$\mu = \tan i_p$**
36. The ratio of the radi of Newton's rings **$\sqrt{1} : \sqrt{2} : \sqrt{3}$**

37. The face angles of Nicol prism is **72° and 108°**
38. Double refraction was discovered by **Bartholinus**.
39. The polarizing angle for glass is **57.5°**
40. Of the following, which one is a biaxial crystal. **Mica, topaz, selenite and Aragonite**.
41. An example for uni - axial crystal **Calcite, Quartz, ice and tourmaline**.
42. A Nicol prism is based on the principle of **Double refraction**.
43. Polarization by reflection was discovered by **Malus**.
44. The unit of grating element in a grating is **Metre**
45. When a beam of light incident on the glass plate at its polarising angle, the angle between the incident ray and reflecting surface **32.5°**
46. In case of partially polarized light, when the analyzer is rotated through $90^0$ the intensity of light beam varies from. **Maximum to Minimum**
47. Instrument used to determine the optical rotation produced by the substance is **Polarimeter**
48. The ratio of scattering powers of two wavelengths 4000 nm and 6000 nm is **81:16**
49. In young's double slit experiment, sodium light is employed and interference fringes are obtained in which the band width of 3rd bright fringe is 2.2mm. what will be the band width of 2nd dark fringe? **2.2 mm**
50. In Newton's ring experiment, the ratio of the radii of 4th ring and 9th ring is **2:3**

## 3 MARK QUESTIONS:

### 1. What are Electromagnetic Waves?

Accelerated charges generate linked electric and magnetic disturbances. If the charges oscillate periodically, the electric and magnetic disturbances are perpendicular to each other and perpendicular to the direction of motion. These disturbances have the properties of a wave and propagate through space without any material medium. These waves are called electromagnetic waves.

### 2. What are Fraunhofer lines?

The dark lines in the solar spectrum are called fraunhofer lines.
It is example of line absorption spectra.

### 3. Why the centre of newton's ring is dark?

The reflected ray suffered a phase change $\pi$ at denser medium itself. So the centre of newton's ring is dark.

### 4. What are the uses of uv rays?

i) They are used for sterlizing surgical instruments.
ii) They are used for detection of forged documents, finger prints.
iii) They are used for find atomic structure.

### 5. What are the two modes of propagation of Light Energy?

There are two modes of propagation of energy from one place to another place.
1. By a stream of particles moving with a finite velocity.

2. By wave motion

**6. Difference between ordinaray ray and extra ordinaray ray.**

| Ordinaray ray | Extra Ordinaray ray |
|---|---|
| 1.It obeys laws of refraction<br>2.It travel the velocity of light.<br>3.It forms spherical wave front. | 1.It doesn't obeys laws of refraction<br>2.It doesn't travel the velocity of light.<br>3.It forms elliptical wave front. |

**7. State Rayleigh's Scattering law?**

The amount of scattering of light is inversely proportional to fourth power of the wavelength.

**8. Why the sky appears bluish in colour?**

The blue appearance of sky is due to scattering of light by the atmosphere. according to Rayleigh's scattering law shorter wavelength (blue colour) scattered much more than the longer wave length (Red light). This scattered radiation cause the sky to appear blue.

**9. At sunset and sunrise, the sun appears reddish. Why?**

At sunrise and sunset, the light from the sun have to travel a larger part of atmosphere than at noon. Therefore most of the shorter wavelength (blue light) is scattered and only the red light having longer wavelength reaches the observer. Hence, sun appears reddish at sunrise and sunset.

**10. Define Wave front.**

The locus of all points having the same state of vibration is called wavefront.

**11. State Huygen's principle**

Huygen's principle states that.

1. Every point on a given wave front may be considered as a source of secondary wavelets which spread out with the speed of light in that medium

2. The new wavefront is the forward envelope of the secondary wavelets at that instant.

**12. What is Tyndal Scattering?**

The scattering of light by colloidal particles is called Tyndal scattering.

**13. State Superposition Principle.**

When two or more waves passes simultaneously through the same medium, each wave proceeds as if the other waves are absent. the resultant displacement at any point is the vector addition of the displacements due to the individual waves. This is known as principle of superposition. If $Y_1$ and $Y_2$ represent the individual displacements, then the resultant displacement is given by $Y = Y_1 + Y_2$

**14. What are Coherent Sources?**

Two sources are said to be coherent if they emit light waves of same wave length, same amplitude and start with same phase

**15. What is Interference?**

The redistribution of intensity of light on account of the superposition of two waves is called interference.

**16. What are the conditions for the formation of sustained interference?**

The conditions for the formation of sustained interference are

1. The sources should be coherent.
2. The two sources should be very narrow.
3. The sources should lie close to each other to form distinct and broad fringes.

**17. State the conditions for obtaining clear and broad interference bands.**

1. The wavelength of light used must be larger.
2. The source and screen must be separated as far as possible
3. The sources should lie close to each other to form distinct and broad fringes.

**18. Difference between fluorescence and phosphorescence.**

| Fluorescence | Phosphorescence |
|---|---|
| The excited atoms return to their lower energy sate immediately with in $10^{-5}$ second. Since high wavelength is emitted. | The excited atoms does not return to their lower energy sate immediately. |
| | The delayed fluorescence is called phosphorescence. |

**19. Distinguish between Freshnel and Fraunhofer diffraction.**

| | Fresnel Diffraction | Fraunhofer Diffraction |
|---|---|---|
| 1. | The source and screen are at infinite distance from the obstacle producing diffraction. | The source and screen are at infinite distance from the obstacle producing diffraction. |
| 2. | The wave front undergoing diffraction is either spherical or cylindrical. | The wave front undergoing diffraction is plane wave front. |
| 3. | No lens is used to focus the rays. | The converging lens is used to focus the rays. |

**20. What is a Plane Transmission grating?**

The plane transmission grating is plane sheet of transparent material on which opaque rulings are made with a diamond point.

**21. Define Grating element and corresponding points.**

The combined width of slit and a ruling is called grating element.

Points on successive slite separated by a distance equal to the grating element are called corresponding points.

**22. Differentiate Interference and Diffraction.**

| | Interference | Diffraction |
|---|---|---|
| 1. | It is due to the superposition of secondary wavelets from two different wave fronts produced by two coherent sources. | It is due to superposition of secondary wavelets emitted from various points of the same wave front. |
| 2. | Fringes are equally spaced | Fringes are unequally spaced. |
| 3. | Bright fringes are of same intensity | Intensity falls rapidly |
| 4. | It has large no of frings | It has less no. of fringes. |

**23. What is meant by Polarisation?**

The phenomenon of restricting the vibrations into a particular plane is known as polarisation.

**24. Define plane of Polarisation and plane of vibration.**

The plane in which no vibrations occur and which contains the direction of propagation of polarised light is known as plane of polarisation.

The plane in which vibrations occur is known as plane of vibration. The plane of vibration contains optic axis.

The plane of polarisation and plane of vibration are at right angles to each other.

**25. Define Polarising Angle.**

The angle of incidence at which the reflected beam is completely plane polarised is called the polarising angle.

**26. What is a Polariser and Analyser?**

Polariser is a device which produces plane polarised light.

Analyser is a device which examines whether the light is polarised or not.

**27. State Brewster's law**

According to Brewster's law, the tangent of the polarising angle is numerically equal to the refractive index of the medium.

$$\tan i_p = \mu.$$

**28. What is Double Refraction?**

Bartholinus absorbs when a ray of light incident on a calcite crystal, two refracted rays are produced. This phenomenon is known as double refraction.

**29. Define Optic axis.**

Inside the crystal there is a particular direction in which both ordinary and extraordinary rays travel with same velocity. This direction is called optic axis.

**30. Define Optical activity.**

When a plane polarised light is made to pass through certain substances, the plane of polarisation of emergent light is not the same as that of incident light, but it has been rotated through some angle. This phenomenon is known as optical activity.

**31. Mention the factors on which the optical activity depends.**

The amount of optical rotation depends on

a. thickness of crystal
b. density of the crystal (or) concentration in the case of solution.
c. wavelength of light used.
d. the temperature of the solutions.

**32. Define Specific Rotation.**

Specific rotation for a given wavelength of light at a given temperature is defined as the rotation produced by one decimeter length of the liquid column containing I gram of the active material in 1cc of the solution.

**33. In young's double slit experiment, the intensity ratio of two coherent sources are 81:1. Calculate the ratio between maximum and minimum intensities.**

$I_1 ; I_2 = 81 : 1$

$$\frac{I_1}{I_2} = \frac{a_1^2}{a_2^2} = \frac{81}{1}$$

$$\frac{a_1}{a_2} = \frac{9}{1}$$

$$\therefore a_1 = 9$$

$$a_2 = 1$$

$$\frac{I_{max}}{I_{min}} = \frac{(a_1 + a_1)^2}{(a_1 - a_2)^2} = \frac{(10)^2}{(8)^2} = \frac{100}{64} = \frac{25 \text{ x } 4}{4 \text{ x } 16}$$

$$I_{max} : I_{min} = 25 : 16$$

**34. In young's experiment, the width of the fringes obtained with light of wavelength 6000 A° is 2mm. calculate the fringe width if the entire apparatus is immersed in a liquid of refractive index 1.33**

$\lambda = 6000A^\circ = 6 \times 10^{-7}m : \beta = 2mm = 2\times10^{-3}m$

$\mu = 1.33 \; \beta^1 = ?$

$\beta^1 = \frac{D\lambda^1}{d} = \frac{\lambda D}{\mu d} = \frac{B}{\mu}$ $\quad \mu = \frac{\lambda}{\lambda_1}$

$\therefore \beta^1 = \frac{2\times10^{-3}}{1.33}$ $\quad \beta = \frac{\lambda D}{d}$

$= 1.4 \times 10^{-3}m$ (or) 1.4 mm

**35. A plano - convex lens of radius 3m is placed on optically flat glass plate and is illuminated by monochromatic light. The radius of the 8th dark ring is 3.6mm. calculate the wavelength of light used.**

$R = 3m : n = 8, r_8 = 3.6mm = 3.6 \times 10^{-3}m \quad \lambda = ?$

$r_n = \sqrt{nR\lambda}$

$r_n^2 = nR\lambda$

$\lambda = \frac{r_n^2}{nR} = \frac{(3.6 \times 10^{-3})^2}{8x3} = 5400 \times 10^{-10}m$

$= 5400 \; A^0$

**36. The refractive index of the medium is √3. calculate the angle of refraction if the unpolarised light is incident on at polarising angle.**

$\mu = \tan i_p, \sqrt{3} = \tan i$

$i_p = \tan^{-1}\sqrt{3} = 30^\circ$

Angle of refraction $r = 90^0 - ip$

$r = 90^0 - 60^0$

$= 30^0$

**37. In Newton's ring experiment the diameter of certain order of dark ring is measured to be double that of second ring. What is the order of the ring?**

Given $d_n = 2d_2 : n =?$

$rn^2 = nR\lambda$

$\left(\frac{dn}{2}\right)^2 = nR\lambda$

$dn^2 = 4nR\lambda$

$d_2^2 = 4\,(2)\,R\lambda$

$d_2^2 = 8R\lambda$

$\frac{d_2^2}{dn^2} = \frac{8R\lambda}{4nR\lambda}$

$= \frac{2}{n}$

$\frac{d_2^2}{(2d_2)^2} = \frac{d_2^2}{2^2 d_2^2} = \frac{2}{n}$

$\frac{1}{4} = \frac{2}{n}$

$n = 8$

**38. What are the uses of Infrared rays?**

1. Infrared lamps are used in physiotherapy.
2. Infrared photographs are used in weather forecasting.
3. Infrared absorption spectrum is used to study the molecular structure.

**39. What are conditions for total internal reflection?**

1. Light must travel foom a denser medicine to a rarer medium.
2. The angle of incidence inside the denser medium must be greater than the critical angle.(i.e.) i > c.

**40. A bright wavelength 6000A falls normally on a thin air film, 6 dark fringes are seen between two points calculate the thickness of the film.**

$$l = 6\times10^{-7} m, n = 6, t = ?$$

$$t = \frac{nl}{2} = \frac{6\times6\times10^{-7}}{2}$$

$$t = 18\times10^{-7} m.$$

**41. A 300mm long tube containing 60 cc of sugar solution produces a rotation of 9° when placed in a polar meter. If the specific rotation is 60°. Calculate the quality of sugar in the solution.**

$$S = \frac{\theta}{lc}$$

$$S = \frac{\theta}{l\frac{m}{v}}$$

$$S = \frac{\theta v}{lm}$$

$$m = \frac{\theta v}{lS}$$

$$m = \frac{9^\circ \, x \, 60}{3 \, x \, 60^\circ}$$

$$m = 3g$$

**[300mm = 3 deci]**

**42. Two slits 0.3mm a part are illuminated by light of wavelength 4500A. The screen is placed at 1m distance from the slits. Find the separation between the second the bright fringe on both sides of the central maxium.**

**Data:** $d = 0.3mm = 0.3\times10^{-3} m$

$$l = 4500A = 4.5\times10^{-7} m$$

$$D = 1m$$

$$n = 2$$

$$2x = ?$$

**Sol :** $$2x = 2\frac{D}{d}nl$$

$$= \frac{2\times1\times2\times4.5\times10^{-7}}{0.3\times10^{-3}}$$

$$2x = 6\times10^{-3}m$$

$$2x = 6mm$$

**43. Distinguish between Corpuscles and photons.**

| Corpuscles | Photons |
|---|---|
| 1. They posses no energy.<br>2. These are introduced by newton.<br>3. They are Mass less, tiny and drastic particles. | 1. They posses energy.<br>2. These are introduced by Planck.<br>3. They are particle as well as waves. |

**44. What is Rayleigh Scattering?**

The Scattering sun light by the molecules of the gases in the earth's atmosphere is called Rayleigh Scattering.

**45. What are Polaroid. Mention its types.**

Polaroid is a material. Which polarizes light.

1. K Polaroid
2. H Polaroid.

**46. What are the uses of Polaroid?**

1. Polaroids are widely used as polarizing sun glasses.
2. They are used to elimate the head light glane in motor cars.
3. Polaroid films are used to produce three dimensional moving pictures.

**47. Mention any three applications of Raman spectrum.**

1. It is widely used in almost all branches of science.
2. It is used to study the peoperties of materials.
3. It is used to analyze the chemical constitution.

**48. What are the uses of Neuton's ring?**

1. To find the wavelength of light source.
2. To find the refractive index of medium.
3. To find the radials of plane corner them.

**49. What is Polarisation?**

The Pnenomenon of restricting the vibration into a particular plane is known as Polarisation.

**50. Define Emission spectra and Absorption spectra.**

**Emission Spectra:**

When the light emitted directly from a source is examined with a spectrometer, the emission spectrum is obtained.

**Absorption Spectra:**

When the light emitted from a source is made to pass through an absorbing material and then examined with a spectrometer, the obtained spectrum is called absorption spectra.

## 5 Mark Questions

1. What are the characteristics of electromagnetic waves?
2. Write notes on corpuscular theory of light.
3. Derive an expression for the radius of the n th dark ring in Newton's ring Experiment.
4. Describe and experiment to demonstrate transverse nature of light.
5. State and Explain Brewster's law.
6. Write a note on Double refraction.
7. Write a note on Nicol prism.
8. Mention the uses of polaroids.

## 10 Mark Questions

1. Explain emission spectra and absorption spectra.
2. Explain the Raman scattering of light
3. On the basis of wave theory of light, explain total internal reflection.
4. Explain Young's double slit experiment. derive an expression for band width of interference fringes in Young's slit experiment.
5. Discuss the theory of plane transmission grating (or) Derive Sin $\theta$ = Nm$\lambda$

# UNIT 6
# ATOMIC PHYSICS

1. The cathode rays are **a stream of electrons**.
2. A narrow electron beam passes undeviated through an electric field E= $3 \times 10^4$ v/m and an overlapping magnetic field B= $2 \times 10^{-3}$ wb/m$^2$ The electron motion, electric field and magnetic field are mutually perpendicular. The speed of the electron is **$1 \cdot 5 \times 10^7$ ms$^{-1}$.**

3. According to Bohr's postulates, which of the following quantities take discrete values? **<u>Angular momentum</u>**

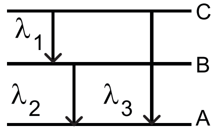
4. The ratio of the radii of the first three Bohr orbit is **<u>1:4:9</u>**

5. The first excitation potential energy or the minimum energy required to excite the atom from ground state of hydrogen atom is **<u>10.2 eV.</u>**

6. According to Rutherford atom model, the spectral lines emitted by an atom is **<u>Continuous spectrum</u>**

7. Energy levels A,B,C, of a certain atom correspond to increasing values of energy (ie) $E_A < E_B < E_C$. If $\lambda 1$, $\lambda 2$, $\lambda 3$ are the wavelengths of radiations corresponding to the transitions C to B, Bto A and C to A respectively, which of the following statement is correct.

$$\lambda 3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$




8. The elliptical orbits of electron in the atom were proposed by **<u>Sommerfeld</u>**.

9. X-ray is **<u>phenomenon of conversion of kinetic energy into radiation</u>**.

10. In an X - ray tube, the intensity of the emitted X-ray beam is increased by **<u>Increasing the filament current</u>**.

11. The energy of photon of characteristic X- ray from a Coolidge tube comes from **<u>An atomic transition in the target</u>**.

12. A Coolidge tube operates at 24800 V. The maximum frequency radiation emitted from Coolidge tube is **<u>$6 \times 10^{18}$ Hz</u>**

13. In hydrogen atom, which of the following transitions produces spectral line of maximum wavelength **<u>6—>5</u>**

14. In hydrogen atom, which of the following transitions produces a spectral line of maximum frequency. **<u>2—>1</u>**

15. After pumping process in laser **<u>the number of atoms in the excited state is greater than the no of atoms in the ground state.</u>**

16. The chromium ions doped in the ruby rod **<u>absorbs green light</u>**.

17. The life times of atoms in excited state. **<u>$10^{-8}$s</u>**.

18. When an electron jumps from M shell to the vacant K shell, it contributes **<u>$K\beta$ line</u>**.

19. Sommerfeld model explains the **<u>background of fine structure of spectral lines</u>**.

20. For a given operating voltage the minimum wavelength X - ray is **<u>the same for all metals</u>**.

21. Laue used ________________ crystals to demonstrate the diffraction of x-rays. **<u>Zinc Sulphide (Zns)</u>**

22. Mosley's law led to the discovery of new element ______ **Hafnium and Rhenium**
23. The life time of metastable state is **$10^{-3}$s**.
24. In He-Ne Laser, the ratio of helium and neon is **1:4**
25. If the potential difference between the cathode and the target of coolidge tube is 1.24 x $10^5$v, then the minimum wavelength of continuous x - rays is **o.1A°**
26. For hydrogen the energy of the electron in first orbit is - 13.6eV. The ionisation potential of hydrogen atom is **13.6 eV**
27. The spectral lines of hydrogen in UV region are called _______ **Lyman Series**.
28. For the principal quantum numbers 3, the possible l values are **0, 1, 2**
29. Radius of first orbit of hydrogen atom is 0.53A° then the radius of third orbit is **4.77 A°**
30. The charge on an oil drop is $12.82 \times 10^{-19}$c, then the no of elementary charges are **8**

## 3 Mark Questions

**1. State the principle of Millikan's Oil Drop experiment.**

Millikan's oil drop experiment is based on the study of the motion of uncharged oil drop under free fall due to gravity and charged oil drop in a uniform electric field. By adjusting uniform electric field suitably, a charged oil drop can be made to move up or down or even kept balanced in the field of view for sufficiently long time and a series of observation can be made.

**2. State Bohr's Postulates.**

1. An electron cannot revolve around the nucleus in all possible orbits. The electrons revolve around the nucleus only in those allowed or permissible orbits for which the angular momentum of the electron is an integral multiple of $h/2\pi$.

2. An atom radiates energy of $h\gamma = E_2 - E_1$ only when an electron jumps from a stationary orbit of higher energy $E_2$ to an orbit of lower energy $E_1$.

**3. What is excitation potential energy of an atom?**

The energy required to raise an atom from its normal state into an excited state is called excitation potential energy of an atom.

**4. Define Critical Potential of an atom.**

The critical potential of an atom, is defined as the minimum potential required to excite free neutral atom from its ground state to higher state.

**5. What are soft and hard X-rays?**

Soft X-Rays

X - rays having wavelength of 4 A° or above, have lesser frequency and hence lesser energy. They are called soft X-ray due to their low penetrating power.

Hard X-Rays

X-rays having low wavelength of the order of 1A° have higher frequency and higher energy. Their penetrating power is high, therefore they are called Hard X -ray.

**6. State Bragg's law**

If the path difference 2d sin $\theta$ is equal to integral multiples of wavelength of X - rays i.e., n. then constructive interference will occur between the reflected beams and they will reinforce with each other. Therefore the intensity of the reflected beam is maximum 2d sin $\theta = n\lambda$

**7. State Moseley's law**

Moseley's law:

The frequency of the spectral line in the characteristic X-ray spectrum is directly proportional to the square of the atomic number (Z) of the element.

$\nu \; \alpha \; z^2$

**8. What is laser?**

The word 'Laser' is an acronym for Light Amplification by stimulated Emission of Radiation.

**9. What are the characteristics of the LASER?**

Characteristics of a LASER

1. Monochromatic 2. Coherent 3. Does not diverge at all. 4. Extremely intense.

**10. What are the conditions to achieve Laser action?**

Conditions to achieve Laser Action

1. There must be population inversion (ie) more atoms in the excited state than in ground state.
2. The excited state must be meta-stable state.
3. The emitted photons must stimulate further emission.

**11. What is a MASER?**

MASER Stands for Microwave Amplification by stimulated emission of Radiation.

**12. Calculate the mass of an electron from the known value of specific charge and charge of an electron**

$m = e \;/\; e/m = 1.602 \times 10^{-19} / 1.752 \times 10^{11} = 9.11 \times 10^{-31}$ kg

**13. Calculate the longest wavelength that can be analysed by a rock salt crystal of spacing d = 2.82 $A^0$ in the first order.**

Bragg's law 2d sin$\theta$ = n$\lambda$

$d = 2.82\ A^0 = 2.82 \times 10^{-10}$ m

n = 1

for longest wavelength sin$\theta$ = maximum =1

$\lambda = 2d$

$= 2 \times 2.82 \times 10^{-10}$

$= 5.64 \times 10^{-10}$m

**14. Find the minimum wavelength of x - rays produced by an x- ray tube at 1000 kv.**

$$\lambda = 12400A^0 / V$$

$$= \frac{12400A^0}{1000 \times 10^3}$$

$$\lambda = 0.0124A^0$$

**15. Write short note on hologram?**

In holography, both the phase and amplitude of the light waves are recorded on the film. The resulting photograph is called hologram.

**16. Write down the two important facts of Laue experiments.**

1. X-rays are electromagnetic waves of extremely short wave length.
2. The atoms in a crystal are arranged in a regular three dimensional lattice.

**17. What are the draw backs of Rutherford atom model?**

1. The electron in the circular orbit experiences a centripetal acceleration. According to electromagnetic theory an accelerated electric charge must radiate energy in the form of electromagnetic waves. Therefore if the accelerated electron lose energy by radiation, the energy of the electron continuously decreases and it must spiral down into the nucleus. Thus the atom cannot be stable. But it is well known that most of the atoms are stable.
2. According to this model, the atom must emit continuous spectrum with all possible wavelengths. But experiments result shows that only line spectra of fixed wavelength is obtained from atoms.

**18. What is excitation potential energy of the atom?**

The energy required to raise an atom from its normal state in to excited state is called excitation potential energy of the atom.

**19. What is ionization potential?**

The ionization potential is that accelerating potential which makes the impinging electron acquire sufficient energy to knock out an electron from the atom and there by ionize the atom.

**20. Mention the uses of laser in medical field?**

1. In medicine, microsurgery has become possible due to the narrow angular spread of laser.
2. Laser beam are used in endoscopy.
3. If can also used for the treatment of human and animal cancer.

**21. Write the uses of laser in industrial field?**

1. The laser beam is used to drill extremely fine holes in diamonds, hard sheets etc.
2. They are also used for cutting thick sheets of hard metals and welding.
3. They can be used to test the quality of the materials.

**22. What are drawbacks in J.J.Thomson atom model?**

1. J.J.Thomson atom model could not explain fine structure of hydrogen spectrum.
2. It could not account for the scattering of $\alpha$ in large angle.

**23. Write the uses of Moseley Law?**

1. Any discrepancy in the order of the elements in the periodic table can be removed by Moseley law.
2. Mosely law has led to the discovery of new elements like hafnium(72), technetium(43), rhenium(75) etc.
3. This law has been helpful in determining the atomic number of rare earths, there by fixing their position in the periodic table.

**24. What is optical pumping?**

If the atoms are taken to the higher energy levels with the help of light, it is called optical pumping.

**25. What is the normal population?**

In a system of thermal equilibrium, the number of atoms in the ground state is greater than the number of atoms in the excited state. This is called normal population.

**26. What is population inversion?**

If the atoms in the ground state are pumped to the excited state by means of external agency, the number of atoms in the excited state becomes greater than the number of atoms in the ground state. This is called population inversion.

## 5 Mark Questions

1. Write any five properties of cathode rays.
2. Write the properties of canal rays.
3. Explain the spectral series of hydrogen atom.
4. Write any five properties of x- rays.
5. State and derive Bragg' s law.
6. Explain the origin of continuous x- rays
7. Explain the origin of characteristic x - rays.

8. Describe Laue experiment. What are the facts established by this experiment.
9. Write the uses of X-rays?

**10 Mark Questions**

1. Describe the J.J. Thomson method of determine the specific charge of electron.
2. Describe Millikan's oil drop experiment to determine the charge of an electron.
3. State Bohr's postulates. obtain the expression for the radius of the $n^{th}$ orbit of an electron based on Bohr's theory.
4. Prove that the energy of an electron for hydrogen atom in $n^{th}$ orbit is $En = -me^4 / 8\varepsilon^2 n^2 h^2$
5. Explain how a Bragg spectrometer can be used to determine the wavelength of x-rays.
6. Explain the working of Ruby Laser with neat sketch.
7. With the help of energy level diagram, explain the working of He - Ne laser.

# UNIT - 7

## DUAL NATURE OF RADIATION AND MATTER AND RELATIVITY

**1 Mark Questions**

1. The value of stopping potential when the frequency of light is equal to the threshold frequency is **Zero**
2. According to special theory of relativity the only constant in all frames is **velocity of light**
3. In photo electric effect the threshold frequency depends on **nature of the metal surface**
4. The resolving power of an electron microscope is ______ times greater than the resolving power of optical microscope. **1,00,000**
5. In electron microscope, the potential difference required is **60,000V**
6. The work function of a metal is 6.626 x $10^{-19}$ J. Threshold frequency is **$1 \times 10^{15}$ Hz**
7. A photon of frequency of $\gamma$ is incident on a metal surface of threshold frequency of $\gamma_0$. The kinetic energy of the emitted photoelectron is **h ($\gamma$ - $\gamma$o)**
8. At the threshold frequency, the velocity of the electron is **Zero**
9. The photoelectric effect can be explained on the basis of **Quantum theory of light**
10. The wavelength of the matter wave is independent of **Charge**
11. The momentum of the electron having wavelength 2A° is **3.3 x $10^{-24}$ kgms$^{-1}$**
12. According to relativity, the length of a rod in motion **is less then its rest length**
13. The work function of a photoelectric material is 3.3 ev. The threshold frequency will be equal to **$8 \times 10^{14}$ Hz**
14. The stopping potential of a metal surface is independent of **intensity of incident**

**radiation**

15. If the kinetic energy of the moving particle is E, then the de - Broglie wavelength is **$\lambda = h/\sqrt{2mE}$**
16. If 1 kg of a substance is fully converted into energy, then the energy produced is **$9 \times 10^{16}$ J**
17. Electron microscope is operated in **high vacuum**
18. In photo cell the light energy is converted into **electric energy**
19. The mathematical form of Einstein's photo electric equation is $h\nu - h\nu_o = \frac{1}{2} mv^2_{max}$
20. If the electron is moving with a velocity of 500 km/s then the deBroglie wavelength is **14.5 A°**

## 3 Mark Questions

### 1. What is Photo Electric Effect?

Photoelectric emission is the phenomenon by which a good number of substances, chiefly metals, emit electrons under the influence of radiation such as r -rays, x - rays, ultraviolet and even visible light.

### 2. Define Stopping Potential.

The minimum negative (retarding) potential given to the anode for which the photoelectric current becomes zero is called the cut - off or stopping potential.

### 3. Define Threshold Frequency.

Threshold frequency is defined as the minimum frequency of incident radiation below which the photoelectric emission is not possible completely however high the intensity of incident radiation may be. The threshold frequency is different for different metals.

### 4. Define Work Function.

The work function of a photo metal is defined as the minimum amount of energy required to liberate an election from the metal surface.

### 5. What are Photocells?

The photoelectric cell is a device which converts light energy into electrical energy. The photo electric cells are three types: 1. photo emissive cell 2. photo voltaic cell and 3. photo conductive cell.

### 6. What are matter waves?

de-Broglie suggested that moving particles should possess wave like properties under suitable conditions. The wave associated with the matter in motion is called matter wave.

### 7. Mention the uses of Electron Microscope.

1. Electron microscope is used in the industry, to study the structure of textile fibres, surface of metals, composition of paints etc.

2. In medicine and biology, it is used to study virus and bacteria.
3. In physics, it has been used in the investigation of atomic structure and structure of crystals in detail.

**8. Mention the limitations of Electron Microscope.**

An electron microscope is operated only in high vacuum. This prohibits the use of the electron microscope to study living organism which would evaporate and disintegrate under such conditions.

**9. Define Frame of Reference.**

A system of co-ordinate axes which defines the position of a particle in two or three dimensional space is called a frame of reference. There are two types of frame of reference 1. inertial and 2. non - inertial frames.

**10. State the postulates of special theory of relativity.**

The two fundamental postulates of the special theory of relativity are

1. The laws of physics are the same in all inertial frames of reference.
2. The velocity of light in free space is a constant in all the frames of reference.

**11. Distinguish between inertial and non-inertial frame of reference.**

| | Inertial frame | Non-Inertial frame |
|---|---|---|
| 1. | In the inertial frame the body obeys Newton's laws. | In the non - inertial frame the body does not obey Newton's laws. |
| 2. | In this frame, a body remains at rest or is continuous motion unless acted upon by an external force. | In this frame, a body is not acted upon by an external force. |

**12. How can you confirm that light exhibits a wave particle duality?**

Experiments showed that light exhibited wave like properties of diffraction and interference. Photo electric effect indicates that light has the aspects of a particle photon with both energy and momentum. Thus light exhibits a wave particle duality.

## 3 Mark Questions

**1. The work function of Zinc in $6.8 \times 10^{-19}$J. What is the threshold frequency for emission of photo electrons from Zinc?**

Data : $W = 6.8 \times 10^{-19}$J $\quad \nu_0 = ?$

Solution : Work function $W = h\nu_0 = 6.8 \times 10^{-19}$J

$\nu_0 = 6.8 \times 10^{-19} / 6.626 \times 10^{-34}$

$= 1.026 \times 10^{15}$ Hz

**2. Calculate the de-Broglie wavelength of an electron, if the speed is $10^5$ $ms^{-1}$ ($m = 9.1 \times 10^{-31}$ kg, $h = 6.626 \times 10^{-34}$ Js)**

Data: $m = 9.1 \times 10^{-31}$ Kg; $V = 10^5$ $ms^{-1}$ ; $h = 6.626 \times 10^{-34}$ Js

Solution : Wavelength $\lambda = h / mv$

$= 6.626 \times 10^{-34} / 9.1 \times 10^{-31} \times 10^5$

$= 72.81$ A°

**3. What is the de-Broglie wavelength of an electron of kinetic energy 120 ev?**

Data : KE = 120 ev = $120 \times 1.6 \times 10^{-19}$ J

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{6.626\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times120\times1.6\times10^{-19}}}$$

$= 1.121 \times 10^{-10}$m

**4. At what speed is a particle moving if the mass is equal to three times its rest mass.**

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$3m_0 = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$9 = \frac{1}{\left(1-\frac{V^2}{C^2}\right)}$$

$$1-\frac{V^2}{C^2} = \frac{1}{9}$$

$$1-\frac{1}{9} = \frac{V^2}{C^2}$$

$$\frac{8}{9} = \frac{V^2}{C^2}$$

$$V^2 = \frac{8}{9}C^2$$

$$V = \sqrt{\frac{8}{9}C^2}$$

$$= 0.9C$$

$$= 0.9x3x10^8$$

$$= 2.7x10^8 ms^{-1}$$

**5. The rest mass of an electron is $9.1 \times 10^{-31}$ kg. What will be its mass it is moves with 4/5th of the speed of light?**

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{9.1x10^{-31}}{\sqrt{1-\frac{(4/5c)^2}{c^2}}} = \frac{9.1x10^{-31}}{\sqrt{1-\frac{16}{25}}}$$

$$= \frac{9.1x10^{-31}}{\sqrt{9/25}} = \frac{9.1x10^{-31}}{3/5} = \frac{9.1x5x10^{-31}}{3} = \frac{45.5x10^{-31}}{3}$$

$$= 15.16x10^{-31} Kg.$$

6. **Calculate the threshold frequency of photons which can remove photo electrons from 1 caesium and 2 nickel (Work function of cesium is 1.8 ev and work function of nickel is 5.9 ev.**

$$w = h\nu_o$$

Threshold frequency for caesium $\nu_o = \frac{w}{h} = \frac{1.8 \text{ x } 1.6 \text{ x } 10^{-19}}{6.626 \text{ x } 10^{-34}} = 4.34 \text{ x } 10^{14} \text{ Hz}$

Threshold frequency for nickel $\nu_o = \frac{w}{h} = \frac{5.9 \text{ x } 1.6 \text{ x } 10^{-19}}{6.626 \text{ x } 10^{-34}} = 1.42 \text{ x } 10^{15} \text{ Hz}$

7. **The time interval measured by an observer at rest is 2.5 x $10^{-8}$ s. What is the time interval as measured by an observer moving with a velocity V = 0.73C.**

$$t = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{2.5 \text{ x } 10^{-8}}{\sqrt{1-\frac{(0.73c)^2}{c^2}}}$$

$$= \frac{2.5 \text{ x } 10^{-8}}{\sqrt{1-0.5329}} = \frac{2.5 \text{ x } 10^{-8}}{\sqrt{0.4671}} = \frac{2.5 \text{ x } 10^{-8}}{\sqrt{0.68}} = 3.658 \text{ x } 10^{-8}\text{s}$$

8. **Calculate the rest energy of an electron in MeV (mass of an electron 9.11x$10^{-31}$kg).**

$$E = m_0c^2 = 9.11 \text{ x } 10^{-31} \text{ x } (3x10^8)^2$$

$$= 81.99 \text{ x } 10^{-15}\text{J} = \frac{81.99 \text{ x } 10^{-15}}{1.6 \text{ x } 10^{-19}}$$

$$E = 51.2 \text{ x } 10^4\text{eV} = 0.512 \text{ MeV}$$

## 5 Mark Questions

1. State the laws of photo electric emission.
2. What are the applications of photoelectric cells?
3. Derive an expression for de - Broglie wavelengths of matter waves.
4. Explain the working of an electron microscope with a neat sketch.
5. Explain length contraction with an example.
6. Explain time dilation with an example
7. Explain the variation of photo electric current with applied voltage.
8. Derive Einstein's photo electric equation.
9. Derive the equation $E = mc^2$
10. Explain the wave mechanical concept of atom.

## Problems:

1. If the speed of photo electrons is $10^4 ms^1$, calculate the frequency of the radiation incident on a potassium metal? Workfunction of potassium is 2.3 ev.
2. For an observer imagined to be moving at a speed of $36 \times 10^6$ Km / hr, length of rod measures 1 m. Find the length of the rod as measured by a stationary observer.

## UNIT 8 NUCLEAR PHYSICS

## 1 Mark Questions

1. The value of 1 amu is **mass of one proton**
2. When $_5B^{10}$ is bombarded with neutron and x - particle is emitted, the residual nucleus is $_3Li^7$
3. In a nuclear reactor cadmium rods are used to **absorb neutrons**
4. The principle involved is atom bomb is **Uncontrolled nuclear fission**
5. The number of neutrons in the nucleus of $_{15}p^{31}$ is **16**
6. If the nuclear radius is $2.6 \times 10^{-15}$m, the mass number will be **8**
7. $_{92}U^{235} + x \longrightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\,{}_0n^1 + Q$ nuclear reaction x refers $_0n^1$
8. The moderator use in nuclear reactor is **Heavy water, Graphite, Sea Water**
9. The number of $\alpha$ and $\beta$ particles emitted when an isotope $_{92}U^{238}$ undergoes $\alpha$ and $\beta$ decays to form $_{82}Pb^{206}$ are respectively **8,6**
10. The radio isotope used in agriculture is $_{15}p^{32}$
11. The particles which exchange between the nucleons and responsible for the origin of the nuclear force are **mesons**
12. Which of the following is not a moderator? **liquid sodium**
13. An element $_zX^A$ successively undergoes three $\alpha$ decays and four $\beta$ decays and gets converted to an element Y. The mass number and atomic number and atomic number of the element Y are respectively. **A–12, z–2**

14. The nuclear radius of $_4Be^8$ nucleus is **$2.6 \times 10^{-15}$m**
15. The nuclei $_{13}Al^{27}$ and $_{14}si^{28}$ are example of **isotones**
16. The mass defect of a certain nucleus is found to be 0.03 amu. Its binding energy is **27.93MeV**
17. Nuclear fission can be explained by **liquid dropmodel**
18. The nucleons in a nucleus are attracted by **nuclear force**
19. The ionisation power is maximum for **$\alpha$ - particles**
20. The half life period of a certain radio active element with disintegration constant 0.0693 per day is **10 days**
21. The average energy released per fission is **200MeV**
22. Anaemia can be diagnosed by **$_{26}Fe^{59}$**
23. In the nuclear reaction $_{80}Hg^{198} + x \longrightarrow {}_{79}AU^{198} + {}_1H^1$ x - stands for **neutron**
24. In $\beta$ - decay **neutron number decreases by one**
25. Isotopes have **same proton number but different neutron number**
26. The time taken by the radio active element to reduce to 1/e times is **mean life**
27. The half life period of $N^{13}$ is 10.1 minute. Its life time is **infinity**
28. Positive rays of the same element produce two different traces in a Bainbridge mass spectrometer. The positive ions have **different mass with same velocity**
29. The binding energy of $_{26}Fe^{56}$ nucleus is **493 MeV**
30. The ratio of nuclear density to the density of mercury is about **$1.3 \times 10^{13}$ Kgm$^{-3}$**

## 3 Mark Questions

**1. What is meant by Isotopes and Isobars? Give examples.**

Isotopes are atoms of the same element having the same atomic number z but different mass number A. eg: $_1H^1$, $_1H^2$, $_1H^3$ are the isotopes of hydrogen.

Isobars are atoms of different elements having the same mass number A, but different atomic number z, eg. $_8O^{16}$ and $_7N^{16}$ are isobars.

**2. Define Mass Defect.**

The difference in the total mass of the nucleons and the actual mass of the nucleus is known as mass defect. $\Delta_m = (Z_{mp} + N_{mn})$-m

**3. Define Binding Energy.**

When the protons and neutrons combine to form a nucleus, the mass that disappears (mass defect) is converted into an equivalent amount of energy which is called the binding energy of the nucleus. $BE = (\Delta m)C^2$

**4. What is $\alpha$ - decay? Give example.**

When a radioactive nucleus disintegrates by emitting an $\alpha$ - particle, the atomic number decreases by two and mass number decreases by four.

$$_ZX^A \xrightarrow{\alpha\ decay} {}_{Z-2}Y^{A-4} + {}_2He^4$$

**5. What is β- decay? Give example.**

When a radioactive nucleus disintegrates by entitting a β - Particle, the atomic number increases by one and the mass number remains the same.

$$_{Z}X^{A} \xrightarrow{\beta\ decay} {}_{Z+1}Y^{A} + {}_{-1}e^{0}$$

**6. Define Radioactivity.**

The phenomenon of spontaneous emission of highly penetrating radiations such as α, β and γ rays by heavy elements having atomic number greater than 82 is called radioactivity and the substances which emits these radiations are called radioactive elements.

**7. State the radio active law of Disintegration.**

(i) The rate of disintegration does not depend the physical and chemical properties of the element.

(ii) The rate of disintegration at any instant, is directly proportional to the number of atoms of the element present at that instant. This is known as radioactive law of disintegration.

**8. Define Half - life period and mean life period.**

The Half life period of a radioactive element is defined as the time taken for one half of the radioactive element to undergo disintegration. $T = \frac{0.6931}{\lambda}$

The mean life of a radio active sustance is defined as the ratio of total life time of all the radio active atoms to the total number of atoms in it.

**9. Define Curie**

Curie is defined as the quantity of a radioactive substance which gives $3.7 \times 10^{10}$ disintegrations per second or $3.7 \times 10^{10}$ becquerrel. This is equal to the activity of one gram of radium.

**10. Define artificial Radio Activity.**

The phenomenon by which even lighter elements are made radioactive by artificial or induced methods is called artificial radio activity.

**11. What are the methods to produce the Radio Isotopes?**

1. Artificial radio - isotopes are produced by placing the target element in the nuclear reactor, where plenty of neutrons are available.

2. By bombarding the target element with particles from particle accelerators like cyclotron

**12. What is meant by Radio - Carbon dating.**

The process of estimating the amount of $C^{14}$ in the sample which will enable the calculation of time of death i.e, the age of the specimen could be estimated. This is called radio carbon dating.

**13. What are the precautions to be taken for those who are working in Radiation Laboratories?**

1. Radioactive materials are kept in thick walled lead containers
2. Lead aprons and lead gloves are used while working in hazardous area.
3. All radioactive samples are handled by a remote control process.
4. A small micro film badge is always worn by the person and it is checked periodically for the safety limit of radiation

**14. What is Artificial Transmutation?**

Artificial transmutation is the conversion of one element into another by artificial methods. (eq) ${}_{11}Na^{23} + {}_{0}n^{1} \rightarrow {}_{11}Na^{24}$

**15. Define Nuclear Fission.**

The process of breaking up of the nucleus of a heavier atom into two fragments with the release of large amount of energy is called nuclear fission

Example : ${}_{92}U^{235} + {}_{0}n^{1} \longrightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3{}_{0}n^{1} + Q$.

**16. Define Nuclear Fusion and What are Thermonuclear Reactions?**

Nuclear fusion is a process in which two or more lighter nuclei combine to form a heavier nucleus. The nuclear fusion reactions are known as thermonuclear reactions.

Example : Fusion reaction in hydrogen bomb: ${}_{1}H^{3} + {}_{1}H^{2} \longrightarrow {}_{2}He^{4} + {}_{0}n^{1}$ + energy.

**17. Define Chain Reaction.**

A chain reaction is a self propagating process in which the number of neutrons goes on multiplying rapidly almost in a geometrical progression.

**18. Define Critical Size and Critical Mass.**

Critical size of a fissile material is defined as the minimum size in which at-least on neutron is available for further fission reaction. The mass of the fissile material at the critical size is called critical mass.

**19. What is a Breeder Reactor?**

Such a reactor is used to convert non fissile material into fissile material is called breeder reactor.

**20. What are the uses of Nuclear Reactors?**

1. Nuclear reactors are mostly aimed at power production due to the large amount of energy evolved with fission.
2. Nuclear reactors are useful to produce radio isotopes.
3. Nuclear reactors acts as a source of neutrons, hence it used in the scientific research.

**21. What are Cosmic Rays?**

The ionising radiation many times stronger than $\gamma$ - rays entering the earth's atmosphere from all the directions from cosmic or interstellar space is known as cosmic rays.

**22. What are the Primary Cosmic Rays?**

The primary cosmic rays are those coming from outer space and enter the outer boundary of the earth's atmosphere. The primary cosmic rays consist of 90% protons, 9% helium,nuclei and remaining heavy nuclei. The energy of the primary cosmic rays is of the order $10^8$ MeV.

**23. What are the Secondary Cosmic Rays?**

The secondary cosmic rays are produced when primary cosmic rays interact with gases in the upper layers of the atmosphere. They are made up of particles like $\alpha$ particles protons, electrons, positrons, mesons, photons etc. In different proportions.

**24. Define Pair Production and Annihilation of Matter.**

The conversion of a photon into an electron-positron pair on its interaction with the strong electricfield surrounding a nucleus is called pair production

The converse of pair production in which an electron and positron combine to produce a photon is known as annihilation of matter.

**25. Write short note on Leptons.**

Leptons are lighter particles having mass equal to or less than about 207 times the mass of an electron except neutrino and autineutrino. Leptons contains particles such as electron. Positron, positive and negative muons.

**PROBLEMS:**

**1. The half - life of radon is 3.8 days. Calculate its mean life.**

**Data:** $T_{1/2}$ = 3. 8 days.

**Solution:** $\lambda = \frac{0.6931}{T_{1/2}}$

**mean life** $\tau = \frac{1}{\lambda} = \frac{T_{1/2}}{0.6931}$

$= \frac{3.8}{0.6931}$

$=$ **5.482 days**

**2. The binding energy per nucleon for $_6C^{12}$ nucleus is 7.68 MeV and that for $_6C^{13}$ is 7.47 MeV. Calculate the energy required to remove a neutron from $_6C^{13}$ nucleus.**

**Data:** Binding energy per nucleon of $_6C^{13}$ = 7.47 MeV.

Binding energy per nucleon of $_6C^{12}$ = 7.68 MeV.

**Solution:** $_6C^{13} \longrightarrow {}_6C^{12} + {}_0n^1$

Total binding energy of $_6C^{13}$ = 7.47 x 13 = 97.11 MeV

Total binding energy of the reactant = Total binding energy of the product.

Binding energy of a neutron = 97.11 - 92.16 = 4.95 MeV.

3. **The half - life of $_{84}Po^{28}$ is 3 minute. What percentage of the sample has decayed is 15 minutes?**

**Data:** half life of $_{84}Po^{218}$ = 3 minute. time = 15 minutes

**Solution:** sample decayed
in 3 minutes = 50 %
in 6 minutes = 25%
in 9 minutes = 12.5%
in 12 minutes = 6.25%
in 15 minutes = 3.125%

percentage of sample decayed in 15 minutes = 96.875%

4. **Calculate the radius of $_{13}Al^{27}$ nucleus.**

$R = r_o A^{1/3} = 1.3 x (27)^{1/3} x 10^{-15} m = 1.3 x 3 x 10^{-15} m = 3.9 x 10^{-15} m = 3.9 F$

5. **Tritium has a half life of 12.5 years. What fraction of the sample will be left over after 25 years?**

**Data:** $T_{1/2}$ = 12.5 years time = 25 years.

Fraction decayed in 25 years = 50% + 25% = 75% = 3/4

**Solution:** Sample left = Initial sample - fraction decayed. => 1 - 3/4 = **1/4**

6. **The disintegration constant of a radioactive element is 0.00231 per day.**

half life $T_{1/2} = \frac{0.6931}{\lambda} = \frac{0.6931}{0.00231} = 300$ days

mean life $\tau = \frac{1}{\lambda} = \frac{1}{0.00231} = 432.9$ days

## 5 Mark Questions

1. Calculate the energy equivalence of 1 amu.
2. Explain $\frac{B.E}{A}$ curve.
3. Explain the different characteristics of nuclear forces.
4. Derive the equation $N = N_o e^{-\lambda t}$
5. What are the uses of radio - isotopes?
6. Write the properties of neutrons
7. Write short note on the elementary particles.
8. Describe the principle and action of an atom bomb.
9. Explain how Carbon - Nitrogen cycle can account for the production of stellar energy.

10. Explain how a cosmic ray shower is formed.

**PROBLEMS:**

1. If the mass defect of the nucleus $_6C^{12}$ is 0.098 amu. Calculate the binding energy per nucleon.
2. Calculate the energy released when 1 kg of $_{92}U^{235}$. undergoes nuclear fission. Assume, energy per fission is 200 MeV. Avogadro number = $6.023 \times 10^{23}$. Express your answer is kilowatt hour also.
3. Calculate the mass of coal required to produce the same energy as that produced by the fission of 1 kg of $U^{235}$

   Given; heat of combustion of coal = $33.6 \times 10^6$ J/kg.
   1ton = 1000 kg energy perfission of $U^{235}$ = 200 MeV.
   1ev = $1.6 \times 10^{-19}$J. Avagadro number N = $6.023 \times 10^{23}$
4. A piece of bone from an archaeological site is found to give a count rat of 15 counts per minute. A similar sample of fresh bone gives a count rate of 19 counts per minute. Calculate the age of the specimen. Given $T_{1/2}$= 5570 year
5. Find the energy released when two $_1H^2$ nuclei fuse together to form a single $_2He^4$ nucleus. Given, the binding energy per nucleon of $_1H^2$ and $_2He^4$ are 1.1 MeV and 7.0 MeV respectively.
6. Calculate the binding energy and binding energy per nucleon of $_{20}Ca^{40}$ nucleus. Given, mass of 1 proton = 1.00785amu, Mass of 1 neutron = 1.008665 amu; mass of $_{20}Ca^{40}$ nucleus is 39.96259 amu.
7. Show that the mass of radium ($_8Ra^{226}$) with an activity of 1 curie is almost a gram. Given $T_{1/2}$ = 1600 years 1 curie = $3.7 \times 10^{10}$ disintegrations per second.
8. A reactor is developing energy at the rate of 32 MW. Calculate the required number of fissions per second of $_{92}U^{235}$ Assume that energy per fission is 200 MeV.
9. A crabonspecimen found in a cave contained a fraction of 1/8 of $_6C^{14}$ to that present in a living system. Calculate the approximate age of the specimen. Given $T_{1/2}$ for $_6C^{14}$ = 5560 years.
10. The isotope $U^{238}$ successively undergoes three $\alpha$ - decays and two $\beta$ - decays, what is the resulting isotope?
11. Determine the amount of $P0^{210}$ required to provide a source of $\alpha$ - particles of activity 5 milli curie. Given $T_{1/2}$ of polonium is 138 days.
12. Calculate the time required for 60% of a sample of radon to undergo decay. Given $T_{1/2}$ of radon = 3.8 days.

**10 Mark Questions**

1. Describe the principle, construction and working of a Bain - bridge mass spectrometer.
2. Explain the principle, construction and working of a Geiger - Muller counter.
3. What are cosmic rays? Explain its latitude and altitude effects
4. What is a nuclear reactor? Explain the parts (i) moderators (ii) control rods and (iii) cooling system.

5. **Write the radioactive law of disintegration. Obtain $N = N_0 e^{-\lambda t}$.**

6. **Explain the discovery of neutron. Write the properties of neutron.**

## UNIT - 9

## SEMICONDUCTOR DEVICES AND THEIR APPLICATIONS

1. **What is forbidden energy gap?**

   The energy gap between valence band and conductor band is known as forbidden energy gap.

2. **What is Doping?**

   The process of addition of very small amount of impurity into an Intrinsic semiconductor is called doping.

3. **What are the methods of doping a semiconductor.**

   i) The impurity atoms are added to the semiconductor in its molten state.
   ii) The pure semiconductor is bombarded by irons of impurity atoms.
   iii) By heating the impurity atoms diffuse into the hot crystal.

4. **Differentiate intrinsic and Extrinsic semiconductor.**

| Intrinsic | Extrinsic |
|---|---|
| 1. Pure semiconductor. | Impure semiconductor. |
| 2. Electrical conductivity is low. | Electrical conductivity is high. |
| 3. Silicon and Germanium are common examples. | There are i) N-type ii) P-type |

**5. What is rectification?**

The process in which alternating voltage or alternating current is converted into direct voltage or direct current is known as rectification.

**6. What is called rectifier?**

The device used to convert ac voltage (or) current into dc voltage or current is called rectifier.

**7. What is Avalanche break down.**

When both sides if the PN junction are lightly doped and the depletion layer becomes large and the electric field across the depletion layer is weak.

**8. What is zenes breakdown?**

When both side of the PN junction is heavy doped, and the deplection layer is narrow, when a small reverse bias and the electric field across the depletion layer is strong.

**9. Why is transistors called as current amplification device?**

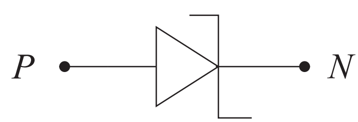
A variation in the base current in micro amperes produces a corresponding variation in the collector current in milli amperes.

**10. What is LED?**

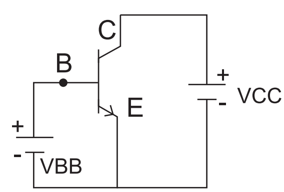
A LED (Light Emitting Diode) is a forward biased PN junction diode. Which emits visible light when energized. eg. gallium arsenide, gallium phosphide.

**11. What is Zener Diode. Draw its symbol.**

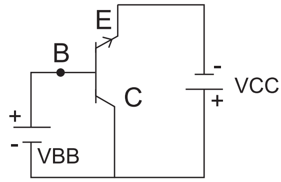
Zener diode is a reverse biased heavily doped semiconductor (Silicon or Germanium) PN junction diode. Which is operated exclusively in the breakdown region.




**12. Draw the circuit diagram for NPN transistor in common emitter (CE) mode.**



**13. Draw the circuit diagram for NPN transistor in common collector (CC) mode.**




**14. Define band width of an Amflifier?**

Band width is defined as the frequency internal between lower cut off and upper cut-off frequencies.

$$B_w = f_u - f_L$$

**15. What are the couplings of transistors coupifier?**

i) Resistance – capacitance (RC) coupling.

ii) Transformer – coupling

iii) Direct – coupling.

**16. What is feed back? What are the type of feed back?**

The process of adding a fraction of the out put signal with the input signal is called feed back.

Types : 1) Positive feed back 2) Negative feed back.

**17. What are the advantage of negative feed back?**

i) Highly stabilized gain

ii) Reduction in the noise level

iii) Increased band width

iv) less distortion

v) High input impedance, Low output impedance.

**18. Give the Barkhousen conditions for oscillation?**

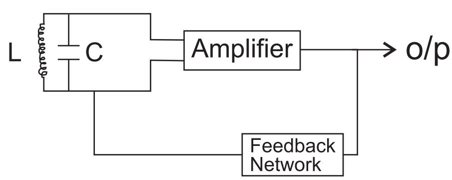
i) The loop gain $A\beta = 1$

ii) The net phase shift round the loop is $0^0$ or integral multiples of $2\pi$.

**19. What are universal gates? Why they are called so?**

NAND and NOR gates are called Universal gates. Because they can perform all the three basic logic gates functions (NOT, OR and AND)

**20. Draw the Block diagram of LC oscillator.**



**21. What are the uses of ICs?**

i) Extremely small in size.
ii) Low power consumption.
iii) Reliability
iv) Reduced cost
v) Very small weight
vi) Easy unpleasant

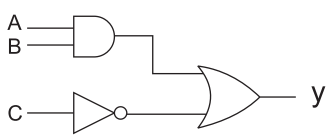
**22. What is Integrated circuit (IC)?**

The circuit containing both active (diodes and transistor) and passive (resistors and capacitors) elements and their inter connections is called IC.

**23. What is PN Junction diode?**

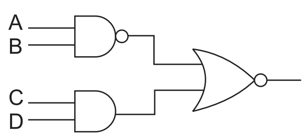
If one side of single pure semiconductor doped with acceptor impurity atoms and other one side of single pure semiconductor doped with donor impurity atoms, PN Junction diode is formed.

**24. What is the Boolean expression for the logic diagram shown in figure. Evaluate its output if A=1 B=1 and C=1**




$$y = (A.B) + \overline{c}$$
$$= (1.1) + \overline{1}$$
$$= 1 + 0$$
$$y = 1$$

**25. Give the Boolean equation for given logic diagram.**




$$y = \overline{(\overline{A.B}) + (C.D)}$$
$$= (\overline{\overline{A.B}}) . (\overline{C.D})$$
$$= (A.B) . (\overline{C}+\overline{D})$$
$$y = AB\overline{C} + AB\overline{D}$$

**26. What are the important characteristic of OP.AMP.**

i) Very high input impedance.
ii) Very low output impedance.
iii) Very high gain.

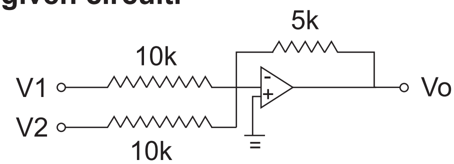
**27. What are the uses of CRO**

i) It is used to measure ac and dc voltage.
ii) It is used to study the waveforms of ac voltage.
iii) It is used to find the frequency of ac voltage.
iv) It is used to study the beating of least in cardiology.

**28. What is Multimeter?**

Multimeter is an electronic instrument, which is used to measure voltage, current and resistance. This is called as AVO meter (Ampere, Voltage, Ohm.)

**29. Find the output of the given circuit.**



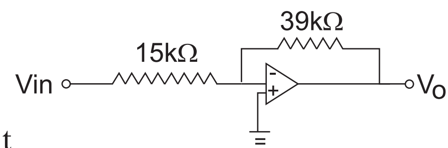

$$V_o = -\frac{(V_1+V_2)}{2}$$

**30. Find the output of the ideal OP-AMP shown in figure if input is**

$$Av = \frac{-Rf}{Rs}$$

$$Av = \frac{-39k\Omega}{15k\Omega}$$

Av = -2.6 no unit




$$Vin = 4 - \sin wt.V$$

$$A_V = \frac{-V_0}{Vin} = V_0 = -A_V \times Vin$$

$$V_0 = -2.6(4 - \sin wt\ V$$

$$V_0 = -10.4 + 2.6 \sin wtV$$

**31. When the negative feedback is applied to a amplifier of gain 50, the gain after feedback falls to 25, calculate feedback**

A = 50
Af = 25

After feed back $A_f = \frac{A}{1+A\beta}$

$$25 = \frac{50}{1+50\beta}$$

$$1+50\beta = \frac{50}{25} = 2$$

$$50\beta = 2-1 = 1$$

$$\beta = \frac{1}{50} = 0.02 \ \textit{no unit}$$

**32. When the positive feedback is applied to a amplifier of gain 100, After feedback the gain is 200. Find feedback.**

A = 100

Af = 200

$$A_f = \frac{A}{1 - A\beta}$$

$$200 = \frac{100}{1 - 100\beta}$$

$$1 - 100\beta = \frac{100}{200} = \frac{1}{2}$$

$$100\beta = 1 - \frac{1}{2} = \frac{1}{2}$$

$$\beta = \frac{1}{2 \times 100} = 0.005 \textit{ no unit}$$

**33. When the negative feedback is applied to a amplifier of gain 100, the feedback ratio is β = 0.01. Calculate the gain after feedback.**

A = 100

β = 0.01

$$A_f = \frac{A}{1 + A\beta}$$

$$A_f = \frac{100}{1 + (100 \times 0.01)}$$

$$A_f = \frac{100}{1 + 10} = \frac{100}{11} = 9.09 \textit{ no unit}$$

**<u>5 Mark Questions :</u>**

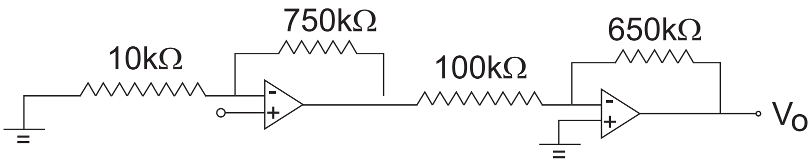
1. Describe the energy band structure of insulator, semiconductor and conductor on the basis of energy band theory.
2. Explain N-Type semiconductor.
3. Explain forward bias characteristics of PN junction diode.
4. Explain the working of a half wave diode rectifier.
5. Explain with necessary circuit low Zener diode can be used a voltage regulator.
6. Deduce the relation between α and β of a transistor.
7. Explain how transistor working as a switch.
8. Explain transistor voltage divider bias with circuit.
9. Explain frequency response curve of transistor amplifier and bond width.
10. Explain the function of OR gats using diodes.
11. State and prove De Morgan's theorems.

12 Explain working of cathode ray Oscrilloscope (CRO)

13. Explain how multimeter is used as ohm meter
14. Explain how OP-AMP is working as difference amplifier.
15. Explain how OP-AMP is used as summer.
16. How NAND gate converts into OR gate, AND gate.
17. How NOR gate converts into OR gate, AND gate.
18. Draw the AND gate, OR gate using diodes.

**Problem Questions : 5 Marks**

1. **A Transistor is connected in CE configuration. The voltage drop across the load resistance (RC) 3kΩ is 6V. Find the base current. The current gain α of the transistor is 0.97.**
2. **Find the output of the circuit given below.**




**10 Mark Questions**

1. **Describe the working of single stage transistor CE amplifier.**
2. **Describe an expression for voltage gain of an amplifier with negative feedback.**
3. **Describe an operational amplifier. Explain its action as**
   **(i) Investing amplifier and (ii) Non-investing amplifier**
4. **Explain the working of a bridge rectifier.**
5. **Sketch the circuit of colpitt's Osuillator. Explain its working.**

**UNIT - 10 COMMUNICATION SYSTEMS.**

**1 Mark Questions**

1. High frequency waves follows ____________ propagation. **ionospheric**
2. The main purpose of modulation is to transmit _________ **Low frequency information over long distances efficiently**
3. In amplitude modulation,the band width is ____ the signal frequency **twice**
4. In phase modulation, both the______ and ______ of the carrier wave varies **phase**, **frequency**
5. The RF Channel in a radio transmitter produces. ____________ **high frequency carrier waves.**
6. The purpose of dividing each frame into two fields so as to transmit 50 views of the picture per second is ______ **to avoid flicker in the picture**
7. Primary colours are _______ **red, green and blue**
8. Printed documents to be trasmitted by fax are converted into electrical signals by the process of ____________ **scanning**
9. Digital signals are converted into analog signals using ______ **Modem**

10. In 'RADAR' if the given range is doubled, then the peak power must be increased times. **16**
11. The medium wave signals received during the day time use _________ wave propagation **surface**.
12. _________ antennas are used in receiver for televison systems. **folded dipole**.
13. Usually, sound signals are_________ modulated and picture signals are ___________ modulated. **frequency, amplitude**.
14. The first man made satellite is **Sputnik.**
15. The principle used for transistor of light signals through optical fiber is **total internal reflection.**
16. In television blanking pulse is applied to **control grid**.
17. In interlaced scanning time taken to scan, one line is **64μs**.
18. Frequency of scanning **25 frames for second**.
19. The audio frequency range is **20 Hz to 20,000Hz**.
20. For FM receivers, the intermediate frequency is **10.7MHz**.

## 3 Mark Questions

**1. What are the different types of radio wave propagation?**

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

**2. What is meant by 'Skip Distance'?**

In the sky wave propagation for a fixed frequency, the shortest distance between the point of transmission and the point of reception along the surface is known as the 'skip distance'.

**3. Define Modulation Factor.**

It is defined as the ratio of the change of amplitude in carrierwave after modulation to the amplitude of the unmodulated carrierwave.

(or) $$\text{Modulation factor (m)} = \frac{\text{Signal amplitude}}{\text{Carrier amplitude}}$$

**4. Define: Band Width.**

Band width (channel width) is the two times of maximum frequency of modulating signal. Bandwidth = $2x(f_s)_{maximum}$

**5. What are te limitations of Amplitude Modulation?**

1. Noisy reception. 2. Low efficiency 3. Small operating range.

**6. What are the advantages of Digital Communication?**

1. The transmission quality is high.
2. The capacity of the trasmission system can be increased.
3. They are used in light beams in optical fibres and wave guides operating in the microwave frequency.

**7. Write any three applications of RADAR.**

1. RADAR systems are used for the safe landing of air craft.
2. Air and sea navigator is made starchy safe with radar installations.
3. Radar systems are used in weather forecasting.

**8. Mention any three advantages of fiber optic communication system.**

1. Transmission loss is low.
2. Fiber is lighter and less bulty than equivalent copper cable.
3. More information can be carried by each fiber than by equivalent copper cables.

**9. What is amplitude modulation?**

When the amplitude of high frequency carrier wave is changed in accordance with the intensity of the signal. The process is called amplitude modulation.

**10. Mention the advantages of frequency modulation.**

1. It gives noiseless reception.
2. The operating range is quite large.
3. The efficiency of transmission is very high.

**Additional Questions**

1. Write any three applications of RADAR.
2. What is fax? Mention it uses.
3. What is the necessity of modulation?
4. Mention the types of Wire and cables?
5. Mention any three advantages of sattilite communication?

**5 Mark Questions**

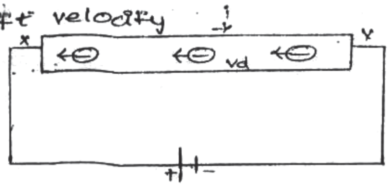
1. Mention the principle of RADAR and write its applications.
2. Explain the wave propagation in ionosphere.
3. Explain the function of FM trasmitter with neat block diagram.
4. What are the advantages and disadvantages of digital communication?
5. Write short note on fibre optical communication and mention its advantages.
6. Explain with the help of block diagram, the function of FM radio transmitter.
7. With the help of block diagram. Explain the operation of an FM superheteradyne receiver.

**10 Mark Questions**

1. With the help of a block diagram, explain the functions of various units in the monochrome television receiver.
2. Descripe the construction of Vidicon tube?
3. With the help of a functional block diagram, explain the operation of a superheterodyne AM receiver.
4. With the help of a block diagram, explain the function of a RADAR system.

## 5 Mark

1. Relation between current and drift velocity




consider a conductor xy of length L and area of cross section A.

Let N be the number of free electrons per unit volume.

The total charge passing through the conductor $q = nALe$ → (1)

The time in which the charge passes to the conductor $t = \frac{L}{v_d}$ → (2)

∴ The current flowing through the conductor $I = \frac{q}{t}$

$= n\frac{ALe}{L/v_d}$

$\boxed{I = nAev_d}$ → (3)

2. Application of super conductors

1. Super conductors forms the basis of energy power saving systems.

2. super conducting magnets have been used to levitate train above its rails.

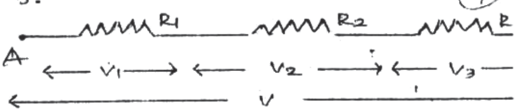
3. super conducting magnetic propulsion systems are used in launch of satellites.

4. High efficiency ore-seprating machines may be build using super-conducting magnets

5. super conducting wires can be used for transmission lines.

6. super conductors can be used as storage elements in computers

3. Resistors in series (7)




The net potential difference

$\boxed{V = V_1 + V_2 + V_3}$ → (1)

By ohm's law

$V_1 = IR_1$, $V_2 = IR_2$ $V_3 = IR_3$

and $V = IR_s$

sub the values in equ (1), we get

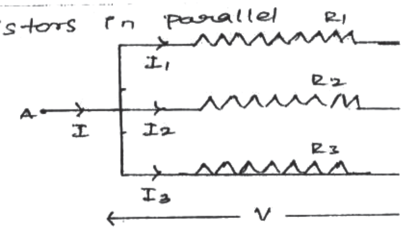
$IR_s = IR_1 + IR_2 + IR_3$

$\cancel{I}R_s = \cancel{I}(R_1 + R_2 + R_3)$

$\boxed{R_s = R_1 + R_2 + R_3}$ → (2)

The equivalent resistance of resistors in series connection is equal to the sum of resistance of individual resistors.

4. Resistors in parallel




current in the circuit

$I = I_1 + I_2 + I_3$ → (1)

By ohm's law

$I_1 = \frac{V}{R_1}$, $I_2 = \frac{V}{R_2}$ $I_3 = \frac{V}{R_3}$ and $I = \frac{V}{R_p}$

Sub values in equ (1)

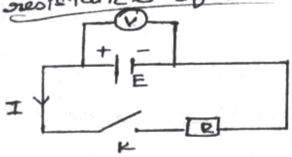
$\frac{V}{R_p} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$

$\frac{\cancel{V}}{R_p} = \cancel{V}\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$ → (2)

$\boxed{\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

The reciprocal of the effective resistance of the resistors connected in the parallel is equal to the sum of reciprocal of the resistance of the individual resistors

5. Internal resistance of a cell using voltmeter




The potential drop across R, when the key is closed

$$V = IR \rightarrow (1)$$

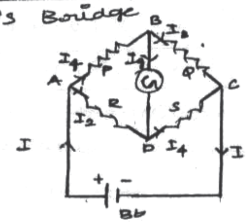
The emf of the cell when the key is opened

$$E - V = Ir \rightarrow (2)$$

$\frac{(2)}{(1)} \Rightarrow \frac{E-V}{V} = \frac{Ir}{IR}$

$$r = \frac{E-V}{V} R \rightarrow (3)$$

6. Wheatstone's Bridge




Applying Kirchoff's current law to Junction B

$I_1 - I_g - I_3 = 0 \rightarrow (1)$

Applying Kirchoff's current law to Junction D.

$I_2 + I_g - I_4 = 0 \rightarrow (2)$

Applying Kirchoff's voltage law to closed Path ABDA

$I_1 P + I_g G - I_2 R = 0 \rightarrow (3)$

Applying Kirchoff's voltage law to closed Path BCDB

$I_3 Q - I_4 S - I_g G = 0 \rightarrow (4)$

When the galvometer shows null deflection ($I_g = 0$)

$(1) \Rightarrow I_1 = I_3$

$(2) \Rightarrow I_2 = I_4$

$(3) \Rightarrow I_1 P = I_2 R \rightarrow (5)$

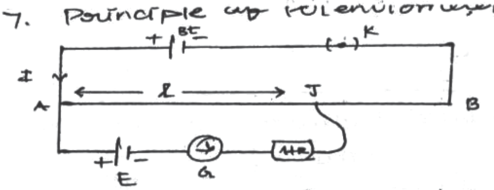
$(4) \Rightarrow I_3 Q = I_4 S \rightarrow (6)$

$\frac{(5)}{(6)} \Rightarrow \frac{I_1 P}{I_3 Q} = \frac{I_2 R}{I_4 S}$

$$\frac{P}{Q} = \frac{R}{S} \rightarrow (7)$$

This is the condition for Bridge Balance.

7. Principle of potentiometer




If the potential difference between A and J is equal to the emf of the cell, no current flow through the galvometer. It shows null deflection.

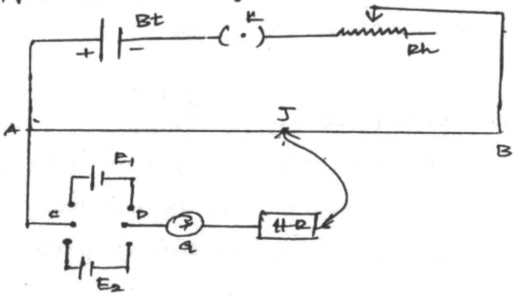
$$\therefore E = Irl$$

Since I and r are constants

$$E \propto l$$

Hence emf of the cell is directly proportional to its balancing length.

8. comparision of emf's of two given cells using potentiometer.




Emf of Lechlanche cell

$$E_1 = Irl_1 \rightarrow (1)$$

Emf of Daniel cell

$$E_2 = Irl_2 \rightarrow (2)$$

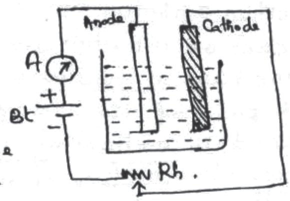
$$\frac{E_1}{E_2} = \frac{Irl_1}{Irl_2}$$

$$\frac{E_1}{E_2} = \frac{l_1}{l_2} \rightarrow (3)$$

## 9. Faraday's first law of electrolysis:

The mass of a substance liberated at an electrode is directly proportional to the charge passing through the electrolyte. $m \propto q$ $m = zIt$

If the masses deposited in the Cathode are $m_1$ and $m_2$ when $I_1$ and $I_2$ Currents passed for the same time,




$$\frac{m_1}{m_2} = \frac{I_1}{I_2}$$

$\therefore$ $m \propto I$ ——— (1).

If the masses deposited in the Cathode are $m_3$ and $m_4$ when same Current passed for different times $t_1$ and $t_2$.

$$\frac{m_3}{m_4} = \frac{t_1}{t_2}$$

$\therefore$ $m \propto t$ ——— (2)

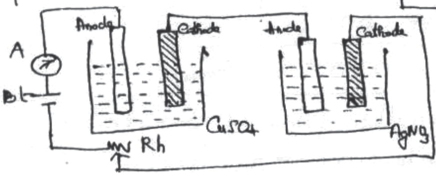
From relations (1) and (2).

$m \propto It$ or $m \propto q$

Thus, the first law is verified.

## 10. Faraday's Second law of electrolysis

The mass of a substance liberated at an electrode by a given amount of charge is proportional to the chemical equivalent of the Substance. $m \propto E$




If the masses deposites in the Cathode are $m_1$ and $m_2$ when same Current passed for same time through the Solutions, it is found that,

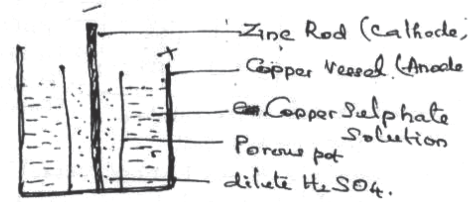
$$\frac{m_1}{m_2} = \frac{E_1}{E_2}$$

or $m \propto E$

Thus, the Second law is verified.

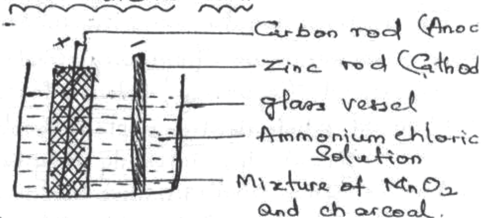
## 11. Daniel Cell:

(8)




1. Daniel cell is a primary cell
2. It Consists of a Copper vessel Containing a strong solution of Copper sulphate.
3. A zinc rod is dipped in dilute $H_2SO_4$ Contained in a porous pot.
4. The porous pot is placed inside the Copper sulphate solution.
5. The Zinc rod is reacting with dil $H_2SO_4$ and produces $Zn^{++}$ ions and 2 electrons.
6. $Zn^{++}$ ions pass through the pores of the porous pot and reacts with Copper sulphate Solution, producing $Cu^{++}$ ions.
7. The $Cu^{++}$ ions deposit on the Copper vessel.
8. Daniel cell produces an emf of 1.08 V

## 12. Lechlanche Cell



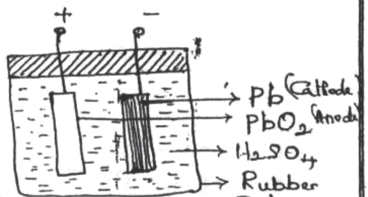

1. Lechlanche cell is a primary cell.
2. It Consists of a Carbon electrode packed in a porous pot Containing a mixture of $MnO_2$ and charcoal.
3. The porous pot is immersed in a saturated solution of ammonium chloride contain in a glass vessel.
4. A Zinc rod is immersed in ammonium chloride Solution.
5. When Zinc rod and Carbon rod are Connected externally the two electrons from the Zinc rod move towards Carbon and neutralizes the positive charge.
6. Thus current flows from Carbon to Zinc

$$Zn^{++} + 2NH_4Cl \rightarrow 2NH_3 + ZnCl_2 + 2H^+ + 2e$$

The ammonia gas escapes

7. Lechlanche Cell produces an emf of 1.5 Volt

## (15). Lead-Acid accumulator




(1). Lead-acid accumulator is a secondary cell.

(2). It consists of a Rubber vessel containing diluted sulphuric acid.

(3). Spongy lead acts as the negative electrode and lead oxide acts as the positive electrode.

(4). When the cell is connected in a circuit spongy lead reacting with dilute sulphuric acid produces lead sulphate and two electrons.

(5). The emf of a freshly charged cell is 2.2 volt and the specific gravity of the electrolyte is 1.28.

(6). In the process of charging, the chemical reactions are reversed

## (1). Laws of photo electric emission

(1) For a given photo sensitive material, there is a minimum frequency called the threshold frequency, below which emission of photoelectrons stops completely however great the intensity may be.

(2). For a given photosensitive material the photo electric current is directly proportional to the intensity of the incident radiation, provided the frequency is greater than the threshold frequency.

(3). The photo electric emission is an instantaneous process.

(4). The maximum kinetic energy of the photoelectrons is directly proportional to the frequency of incident radiation, but is independent of its intensity

#

## (2). Einstein's photoelectric equation:

(1). Einstein, successfully applied quantum theory of radiation to photoelectric effect.

(2). According to Einstein, the emission of photo electron is the result of the interaction between a single photon of the incident radiation and an electron in the metal.

(3). When a photon of energy $h\nu$, is incident on a metal surface, its energy is used up in two ways.

(i). A part of the energy of the photon is used in extracting the electron from the surface of metal.

[The work function W of a photo metal is defined as the minimum amount of energy required to liberate an electron from the metal surface.]

(ii). The remaining energy of the photon is used to impart kinetic energy of the liberated electron.

Energy of the incident photon = Work function + Kinetic energy of the electron.

$$h\nu = W + \frac{1}{2}mv^2$$

If the electron does not lose energy by internal collisions,

$$h\nu = W + \frac{1}{2}mv_{max}^2$$

This equation is known as Einstein's photo electric equation.

When, $W = h\nu_0$

$$h\nu = h\nu_0 + \frac{1}{2}mv_{max}^2$$

This is another form of Einstein's photo electric equation.

#

## 3. Photo electric cells

1. The photo electric cell is a device which converts light energy into electrical energy.

Types: 1. photo emissive cell 2. photo voltaic cell 3. photo conductive cell.

2. A simple photo emissive cell consists of a highly evacuated bulb made of glass or quartz.


3. A semi cylindrical metal plate C coated with caesium oxide acts as cathode.
4. A thin platinum wire connected to the positive terminal of the battery acts as anode.
5. When a light of suitable wavelength falls on the cathode, photo electrons are emitted, which are attracted by the anode.
6. The resulting current is measured by a microammeter.
7. The current produced is proportional to the intensity of incident light for a given frequency.

## 4. Applications of photo electric cells.

1. Photo electric cells are used for reproducing sound in cinematography.
2. They are used for controlling the temperature of furnaces.
3. Photo electric cells are used for automatic switching on and off the street lights.
4. Photoelectric cells are used in the study of temperature and spectra of stars.
5. These cells are used in opening and closing of door automatically.
6. Photo electric cells are used in burglar alarm and fire alarm.
7. These cells are used in instruments measuring light illumination.
8. They are used in obtaining electrical energy from sunlight during space travel.

## 5. de Broglie's wavelength of matter waves:

For a wave of frequency $\nu$ the energy associated with each photon is given by Plank's relation

$$E = h\nu \quad \text{--- (1)}$$ where $h$ is Plank's Const

According to Einstein's mass energy relation a mass $m$ equivalent to energy

$$E = mc^2 \quad \text{--- (2)}$$ where $c$ is velocity of light

On comparing (1) and (2).

$$h\nu = mc^2$$

$$\frac{hc}{\lambda} = mc^2$$

$$\lambda = \frac{h}{mc} \quad \text{--- (3)}$$

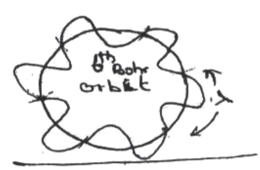
For a particle moving with a velocity $v$,

$$\lambda = \frac{h}{mv} \quad \text{--- (4)}$$

when, $p = mv$, the momentum of the particle,

$$\lambda = \frac{h}{p} \quad \text{--- (5).}$$

## 6. Wave mechanical concept of atom




Straightned orbit.

According to de Broglie's hypothesis an electron of mass $m$, in motion with a velocity $v$ is associated with a wave whose wavelength is given by.

$$\lambda = \frac{h}{mv} \quad \text{--- (1).}$$

It was suggested that stationary orbits are those in which orbital circumferences is an integral multiple of de Broglie wavelength. & That is,

$$2\pi r = n\lambda \quad \text{--- (2).}$$ where $n = 1, 2, \ldots$

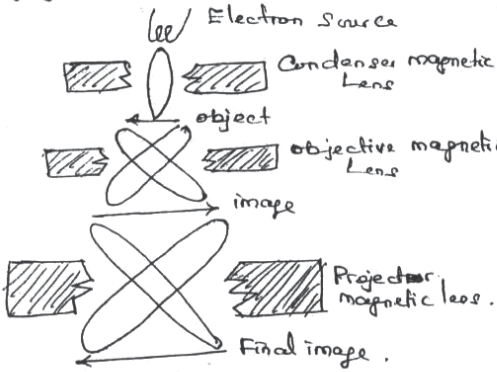
Sub. (1) in (2) we get

$$2\pi r = n\left(\frac{h}{mv}\right)$$

$$mvr = \frac{nh}{2\pi} \quad \text{--- (3)}$$

From eqn. (5). it is seen that the total angular momentum of the moving electron is an integral multiple of $\frac{h}{2\pi}$. Thus, de Broglie's Concept Confirms Bohr's postulate

## (7). Electron microscope




(1). The modern electron microscope is usually of transmission type in which magnetic lenses of short focal length are used to obtain large magnification.

(2) An electron beam emitted by a filament is accelerated through a device called electron gun.

(3). The fine beam of electrons get deflected to form a parallel beam when they passed through condenser magnetic lens which strikes the object to be magnified.

(4). The objective magnetic lens causes the electron beam to diverge to produce enlarged image of the object.

(5). The projector magnetic lens focusses the electron beam from the part of the enlarged image on the fluorescent screen.

(6). An electron microscope is operated only in high vacuum

## (8) Concept of Space, time and mass

**Concept of Space**

In classical mechanics

(1). Fixed frame of reference by which the position or motion of any object in the universe could be measured

(2). The geometrical form of an object remains same irrespective of changes in position or state of motion of the object or observer.

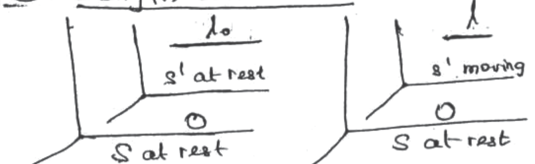
**Concept of time**: In classical mechanics.

(1). The time interval between two events has the same value for all observers irrespective of their motion.

(2). If two events are simultaneous for an observer, they are simultaneous for all observers, irrespective of their position or motion.

**Concept of mass**: In classical mechanics, the mass of the body is absolute and constant and independent of the motion of the body.

## (9). Length Contraction




(1). Consider two frames of references S and S' to be initially at rest.

(2). A rod is placed in the frame S' and an observer O is in S.

(3). The length of the rod in S' is measured by the observer in S is $l_0$.

(4). Now the frame of reference S' moves with a velocity v along the positive X axis.

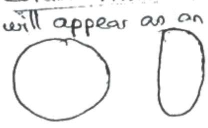
(5). Now, the length of the rod is measured as $l$ by the observers in S. Then.

$$l = l_0\sqrt{1-\frac{v^2}{c^2}}$$ ie $l < l_0$

(6) Thus the length of the rod moving with a velocity v relative to the observer at rest is contracted by a factor $\sqrt{1-\frac{v^2}{c^2}}$.

(7). This is known as Lorentz-Fitzerald Contraction.

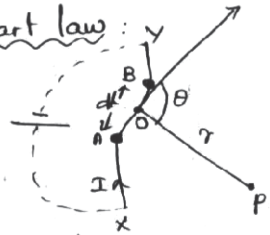
(8) A circular object will appear as an ellipse for a fast moving observer.



## III. Effects of electric Current

### (5) mark

**(1). Biot - Savart law:**




According to Biot - Savart law, the magnetic induction dB at P due to the current element AB is

(i). directly proportional to the current (I)

(ii). directly proportional to the element (dl)

(iii). directly proportional to the sine of the angle ($\sin\theta$) and

(iv). inversely proportional to the distance $\left(\frac{1}{r^2}\right)$

$$\therefore \quad dB \propto \frac{I\,dl\,\sin\theta}{r^2}$$

$$dB = \frac{\mu}{4\pi}\,\frac{I\,dl\,\sin\theta}{r^2}$$

where $\mu$ is the permeability of the medium. In air medium

$$dB = \frac{\mu_0\, I\,dl\,\sin\theta}{4\pi\, r^2}$$

In vector form

$$\vec{dB} = \frac{\mu_0}{4\pi}\,\frac{I\vec{dl}\times\vec{r}}{r^3}$$

**(2) Magnetic induction due to a long solenoid carrying current**


To find the magnetic induction at a point inside, let us consider a rectangular Amperean loop abcd. The line integral $\oint\vec{B}\cdot\vec{dl}$ for the loop abcd is the sum of four integrals.

$$\oint\vec{B}\cdot\vec{dl} = \int_a^b \vec{B}\cdot\vec{dl} + \int_b^c \vec{B}\cdot\vec{dl} + \int_c^d \vec{B}\cdot\vec{dl} + \int_d^a \vec{B}\cdot\vec{dl} \quad \text{—— (1)}$$

If $l$ is the length of the loop, the first integral on the right side is $Bl$. The second and fourth integrals are equal to zero because $\vec{B}$ is at right angles for every element $\vec{dl}$ along the path. The third integral is zero since the magnetic field at points outside the solenoid is zero.

$$\therefore \quad \oint\vec{B}\cdot\vec{dl} = B\,l \quad \text{—— (2)}$$

The net current enclosed by the closed loop is

$$I_0 = I\,n\,l \quad \text{—— (3)}$$

Ampere's Circuital law for a closed loop is,

$$\oint\vec{B}\cdot\vec{dl} = \mu_0 I_0 \quad \text{—— (4)}$$

Substituting eqn. (2) and (3) in eqn. (4).

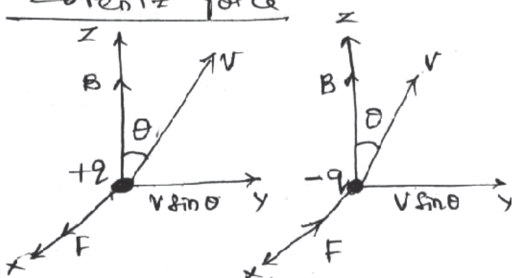
$$B\,l = \mu_0\, I\,n\,l$$

$$B = \mu_0\, n\, I \quad \text{—— (5)}$$

If a soft iron core is inserted inside the solenoid, then

$$B = \mu\, n\, I \quad \text{—— (6)}$$

**(3). Properties of magnetic Lorentz force**




The special features of the magnetic Lorentz force are, (1). The force on the charge is zero, if the charge is at rest.

(2). The force is zero, if the direction of motion of the charge is either parallel or antiparallel to the field and the force is maximum when the charge moves perpendicular to the field.

(3). The force is proportional to the magnitude of the charge ($q$)

(4) The force is proportional to the magnetic induction ($B$)

(5). The force is proportional to the speed of the charge ($v$)

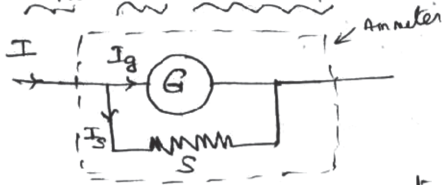
(6) The direction of the force is oppositely directed for opposite charges

$$\vec{F} = q(\vec{v} \times \vec{B})$$

The magnitude of the force is

$$F = Bqv\sin\theta$$

(4). Conversion of galvanometer into an ammeter:




A galvanometer is converted into an ammeter by connecting a low resistance in parallel with it.

Current through the low resistance (shunt)

$$I_s = I - I_g \quad \text{—— (1)}$$

Since, the galvanometer and shunt are in parallel then,

$$I_g G = I_s S \quad (2)$$

$$S = \frac{I_g}{I_s} G$$

$$S = \frac{I_g}{(I - I_g)} G \quad \text{—— (5)}$$

The effective resistance of the ammeter is,

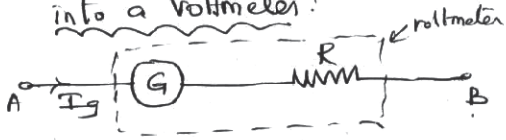
$$\frac{1}{R_a} = \frac{1}{G} + \frac{1}{S} \quad \text{—— (3)}$$

$R_a < G$ and $R_a < S$.

An ideal ammeter has zero resistance.

Always an ammeter is connected in series in a circuit.

(5). Conversion of galvanometer into a voltmeter:




A galvanometer is converted into a voltmeter by connecting a high resistance in series with it.

Potential difference between AB

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

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

$$R = \frac{V}{I_g} - G \quad \text{—— (1).}$$

The effective resistance of the voltmeter is

$$R_v = R + G \quad \text{—— (2)}$$

$R_v > G$ and $R_v > R$.

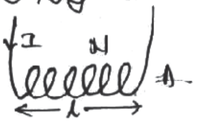
An ideal voltmeter is one which has infinite resistance.

Always a voltmeter is connected in parallel in a circuit

# IV. Electromagnetic induction and alternating Current

## 5 mark

### 1. Self inductance of a long solenoid




Let us Consider a solenoid of N turns with length $l$ and area of cross section A carries a Current I. If B is the magnetic field at any point inside the solenoid then, $B = \frac{\mu_0 N I}{l}$

Magnetic flux per turn $\phi_1 = B.A$

$$\phi_1 = \frac{\mu_0 N I A}{l} \quad \text{--- (1)}$$

Hence, the total magnetic flux linked with the solenoid.

$$\phi = \phi_1 . N$$

$$\phi = \frac{\mu_0 N^2 I A}{l} \quad \text{--- (2)}$$

If L is the coefficient of self induction then;

$$\phi = L I \quad \text{--- (3)}$$

On Comparing (2) and (3) we get,

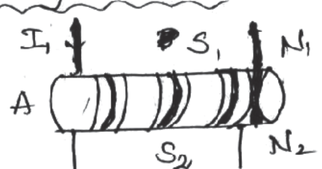
$$L I = \frac{\mu_0 N^2 I A}{l}$$

$$\therefore L = \frac{\mu_0 N^2 A}{l} \quad \text{--- (4)}$$

If the Core is filled with a magnetic material a permeability $\mu$ then

$$L = \frac{\mu N^2 A}{l} \quad \text{--- (5)}$$

### 2. ~~Energy~~ Mutual induction of two long solenoids




The magnetic field $B_1$ produced at any point inside the solenoid $S_1$ due the Current $I_1$ is

$$B_1 = \frac{\mu_0 N_1 I_1}{l}$$

The magnetic flux linked with each turn of $S_2$ is

$$\phi_1 = B_1 A$$

$$\phi_1 = \frac{\mu_0 N_1 I_1 A}{l} \quad \text{--- (1)}$$

Hence, the total magnetic flux linked with solenoid $S_2$ having $N_2$ turns is,

$$\phi_2 = \phi_1 . N_2$$

$$\phi_2 = \frac{\mu_0 N_1 N_2 I_1 A}{l} \quad \text{--- (2)}$$

If M is the Coefficient of Mutual induction between $S_1$ and $S_2$ then,

$$\phi_2 = M I_1 \quad \text{--- (3)}$$

On Comparing (2) and (3) we get

$$M I_1 = \frac{\mu_0 N_1 N_2 I_1 A}{l}$$

$$M = \frac{\mu_0 N_1 N_2 A}{l} \quad \text{--- (4)}$$

If the Core is filled with a magnetic material of permeability $\mu$, then,

$$M = \frac{\mu N_1 N_2 A}{l} \quad \text{--- (5)}$$

### 3. Energy associated with an induct

If e is the induced emf, then

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

The small amount of workdone dw in a time interval dt is,

$$dw = e I dt$$

$$= -L \frac{dI}{dt} . I dt$$

$$dw = -L I dI \quad \text{--- (2)}$$

$\therefore$ The total workdone when the Current increases from 0 to maximum value $I_0$ is

$$w = \int dw$$

$$= -\int_0^{I_0} L I dI$$

$$w = -\frac{1}{2} L I_0^2 \quad \text{--- (3)}$$

9

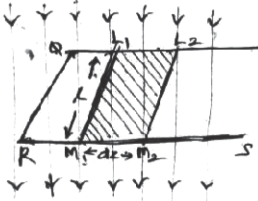
This workdone is stored as magnetic potential energy in the coil.

∴ The energy stored in the coil

$$U = -\frac{1}{2} L I_0^2 \quad \text{—— (4)}.$$

where the negative sign is consequence of Lenz's law.

④. Emf induced by changing the area enclosed by the coil.




PQRS is a conductor bent in the shape as shown in figure. A uniform magnetic field B acts perpendicular to the plane of the conductor. when a sliding conductor $L_1M_1$ is moved through a distance dx in time dt. Therefore an induced emf is produced.

$$e = -\frac{d\phi}{dt} \qquad d\phi = B\,l\,dx.$$

$$= -Bl\left(\frac{dx}{dt}\right)$$

$$e = -Blv$$

where $v = \frac{dx}{dt}$ is the velocity of the sliding conductor.

⑤. Energy losses in a transformer

①. Hysteresis loss:

The repeated magnetisation and demagnetisation of the iron core caused by the alternating input current, produces loss in energy called hysteresis loss.

Alloys like mumetal and silicon steel are used to reduce hysteresis loss.

② Copper loss: The current flowing through primary and secondary windings lead to Joule heating effect. Hence some energy is lost in the form of heat.

Thick wires with considerably low resistance are used to minimise this loss.

③. Eddy current loss (Iron loss).

The varying magnetic flux produces eddy current in the core. This leads to the wastage of energy in the form of heat. This loss is minimised by using a laminated core made of stelloy, an alloy of steel.

④. Flux loss: The flux produced in the primary coil is not completely linked with the secondary coil due to leakage. This results in the loss of energy. This loss can be minimised by using a shell type core.

⑥. A C Circuit with resistor


Let an alternating source of emf be connected across a resistor of resistance R.

The instantaneous value of the applied emf is

$$e = E_0 \sin\omega t \quad \text{—— (1)}.$$

The potential drop across R is

$$e = iR \quad \text{—— (2)}.$$

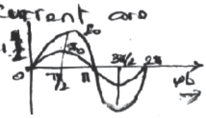
Hence, $iR = E_0 \sin\omega t$

$$i = \left(\frac{E_0}{R}\right)\sin\omega t$$

$$i = I_0 \sin\omega t \quad \text{—— (3)}.$$

where $I_0 = \frac{E_0}{R}$ is the peak value of current in the circuit.

From ① and ③ it is concluded that in a resistive circuit, the applied voltage and current are in phase with each other.



## 7. RMS Value of AC

When an ac $i = I_0 \sin\omega t$ flows through a resistor of resistance R, the amount of heat produced in the resistor in a small time dt is,

$$dH = i^2 R\, dt$$

The total amount of heat produced in the resistance in one complete cycle is,

$$H = \int_0^T dH = \int_0^T i^2 R\, dt$$

$$= \int_0^T I_0^2 \sin^2\omega t\, R\, dt$$

$$= I_0^2 R \int_0^T \sin^2\omega t\, dt$$

$$= I_0^2 R \int_0^T \left(\frac{1-\cos 2\omega t}{2}\right) dt$$

$$H = \frac{I_0^2 R}{2}\left[\int_0^T dt - \int_0^T \cos 2\omega t\, dt\right]$$

But for one complete cycle

$$\int_0^T \cos 2\omega t\, dt = 0.$$

Hence, $H = \dfrac{I_0^2 RT}{2}$ —— (1).

But this heat is also equal to the heat produced by rms value of AC in the same resistor R and in the same time T.

That is, $H = I_{rms}^2 RT$ —— (2).

On comparing (1) and (2).

$$I_{rms}^2 RT = \frac{I_0^2 RT}{2}$$

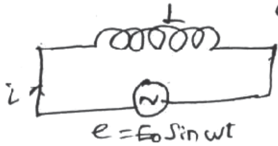
$$I_{rms}^2 = \frac{I_0^2}{2}$$

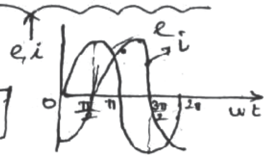
$$I_{rms} = \frac{I_0}{\sqrt{2}} = 0.707\, I_0 \quad \text{—— (3)}$$

Similarly it can be calculated that

$$E_{rms} = \frac{E_0}{\sqrt{2}} = 0.707 E_0 \quad \text{—— (4)}.$$

## 8. AC Circuit with an inductor




Let an alternating source of emf be connected to a pure inductor of self inductance L. The instantaneous value of applied emf is given by.

$$e = E_0 \sin\omega t \quad \text{—— (1)}.$$

Induced emf $e' = -L\dfrac{di}{dt}$

Since $e = -e'$

Then $E_0 \sin\omega t = L\dfrac{di}{dt}$

$$di = \frac{E_0}{L} \sin\omega t\, dt$$

Integrating on both sides.

$$i = \frac{E_0}{L}\int \sin\omega t\, dt.$$

$$= \frac{E_0}{L}\left(-\frac{\cos\omega t}{\omega}\right)$$

$$= \frac{E_0}{L\omega} \sin\left(\omega t - \frac{\pi}{2}\right)$$

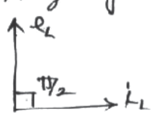
$$i = \frac{E_0}{X_L} \sin\left(\omega t - \frac{\pi}{2}\right)$$

where, $X_L = L\omega$ is the resistance offered by the coil. It is called inductive reactance. Its unit is ohm.

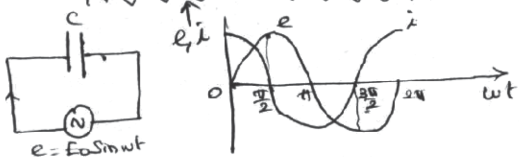
$$i = I_0 \sin\left(\omega t - \frac{\pi}{2}\right) \quad \text{—— (2)}.$$

where $I_0 = \dfrac{E_0}{X_L}$ is the peak value of ac in the circuit.

From equations (1) and (2) it is clear that in an ac circuit with a pure inductor the current i lags behind the voltage by the phase angle of $\frac{\pi}{2}$.



9. AC Circuit with a Capacitor (10 mark)




An alternating source of emf connected across a capacitor of capacitance C.

The instantaneous value of the applied emf is given by,

$$e = E_0 \sin\omega t \quad \text{——} (1)$$

The instantaneous current flowing through the circuit,

$$i = \frac{dq}{dt} = \frac{d}{dt}(Ce)$$

$$= \frac{d}{dt}(CE_0 \sin\omega t)$$

$$= CE_0 . \omega \cos\omega t$$

$$= \frac{E_0}{1/C\omega} \sin\left(\omega t + \frac{\pi}{2}\right)$$

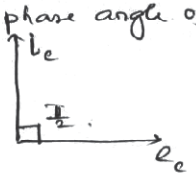
$$i = \frac{E_0}{X_C} \sin\left(\omega t + \frac{\pi}{2}\right)$$

where, $X_C = \frac{1}{C\omega}$ is the resistance offered by the capacitor. It is called capacitive reactance. Its unit is ohm.

$$i = I_0 \sin\left(\omega t + \frac{\pi}{2}\right) \quad \text{——} (2)$$

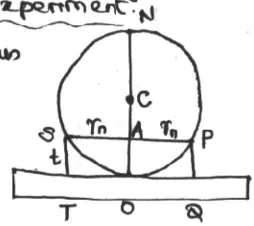
where, $I_0 = \frac{E_0}{X_C}$ is peak value of ac in the circuit.

From eqns. (1) and (2) it is clear that in an ac circuit with a capacitor, the current leads the voltage by a phase angle of $\frac{\pi}{2}$.



# V. Electromagnetic waves and wave optics - Five mark

## 1. Obtain the expressions for the radius of the $n^{th}$ dark ring in Newton's rings experiment.




Let $r_n$ be the radius of the $n^{th}$ dark ring which passes through the point S and P.

Then $SA = AP = r_n$.

If ON is the vertical diameter of the circle, then by the law of segment,

$SA \cdot AP = OA \cdot AN$.

$r_n \cdot r_n = t(2R - t)$

$r_n^2 = 2Rt - t^2$.

neglecting $t^2$ comparing with $2R$,

$r_n^2 = 2Rt$ or $\boxed{2t = \frac{r_n^2}{R}}$ — (1)

According to the condition for darkness $\boxed{2t = n\lambda}$ — (2).

On comparing (1) and (2), we get,

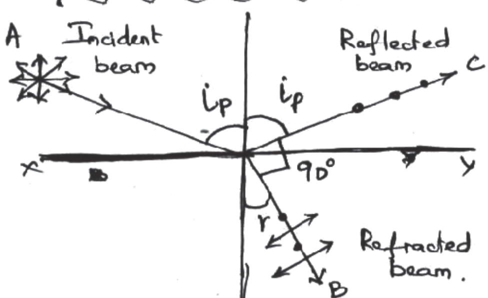
$\frac{r_n^2}{R} = n\lambda$

$r_n^2 = nR\lambda$ or $\boxed{r_n = \sqrt{nR\lambda}}$ (3)

Since R and $\lambda$ are constants.

$\boxed{r_n \propto \sqrt{n}}$ $r_n \propto \sqrt{1} : \sqrt{2} : \sqrt{3} : \ldots$

## 2. State and Proove Brewster's law.




Consider a beam of unpolarised light AB, incident at an angle $i_p$ on the reflecting glass surface. A part of the light is reflected along BC, and the rest is refracted along BD.

From Figure. $i_p + 90^\circ + r = 180^\circ$.

$\boxed{r = 90^\circ - i_p}$

From Snell's law, $\frac{\sin i_p}{\sin r} = \mu$.

where $\mu$ is the refractive index of the medium.

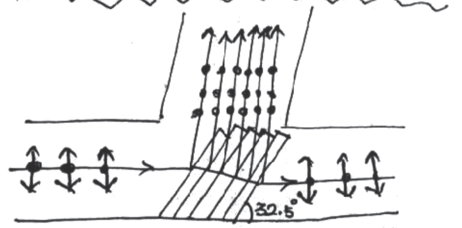
$\frac{\sin i_p}{\sin(90^\circ - i_p)} = \mu$

$\frac{\sin i_p}{\cos i_p} = \mu$

$\boxed{\tan i_p = \mu}$

The tangent of the polarising angle is numerically equal to the refractive index of the medium.

## 3. Write a note on pile of plates.

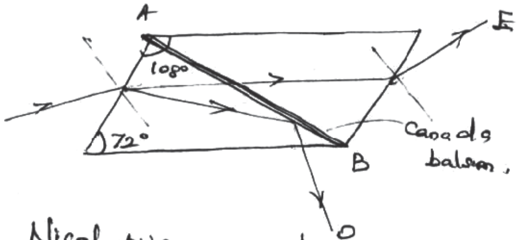



The phenomenon of polarisation by reflection is used in the construction of pile of plates.

It consists of a number of glass plates placed one over the other as shown in figure in a tube of suitable size. The plates are inclined at an angle of $32.5^\circ$ to the axis of the tube. A beam of monochromatic light is allowed to fall on the pile of plates along the axis of the tube, so, the angle of incidence will be $57.5^\circ$ which is the polarising angle for glass. Hence, the reflected light is plane polarised. The pile of plates is used as a polariser and an analyser.

#

4. write a note on Nicol prism.




Nicol prism was designed by William Nicol.

A Calcite crystal whose length is three time its breath is cut into two halves along the diagonal so that their face angles are 72° and 108°

And the two halves are joined together by a layer of Canada balsm, a transparent cement as shown in figure.

A monochromatic beam of unpolarised light is incident on the face of the nicol prism.

It splits up into two rays as ordinary ray and extra ordinary ray inside the nicol prism. The ordinary ray is totally internally reflected at the layer of Canada balsm.

The extra ordinary ray alone is transmitted through the crystal which is plane polarised.

The nicol prism serves as a polariser and also as analyser.

5. In Newton's rings expt. the diameter of the $20^{th}$ dark ring was found to be 5.82 mm and that of the $10^{th}$ ring 3.36 mm. If the radius of the plano-convex lens is 1 m, Calculate the wavelength of light used.

Data: $D_{20} = 5.82 \times 10^{-3} m$ $D_{10} = 3.36 \times 10^{-3} m$

$R = 1 m$, $m = 10$

$$\lambda = \frac{r_{n+m}^2 - r_n^2}{mR}$$

$$\lambda = \frac{D_{n+m}^2 - D_n^2}{4mR} = \frac{(5.82\times10^{-3})^2 - (3.36\times10^{-3})^2}{4\times10\times1}$$

$$\lambda = \frac{(5.82+3.36)(5.82-3.36)\times10^{-6}}{40}$$

(14)

$$\lambda = 5645.7\times10^{-10} m$$

6. A parallel beam of monochromatic light is allowed to incident normally on a plane transmission grating having 5000 lines per cm. A second order spectral line is found to be diffracted at an angle of 30°. Calculate the wavelength of light.

$$\lambda = \frac{\sin\theta}{Nm} = \frac{\sin 30°}{5\times10^5\times2}$$

$$\lambda = \frac{0.5}{10\times10^5}$$

$$\lambda = 0.05\times10^{-5}$$

$$\lambda = 5000 \text{ Å}$$

7. A soap film of refractive index 1.34 (1.33) is illuminated by white light incident at an angle 30°. The reflected light is examined by a spectroscope in which dark band corresponding to the wavelength 5893 Å (6000 Å) is found. Calculate the smallest thickness of the film

$2\mu t \cos r = n\lambda$

$$t = \frac{n\lambda}{2\mu\cos r}$$

$n = 1$, $\lambda = 5893\times10^{-10} m$

$\mu = 1.34$.

$\cos r = 0.8608$.

$$\therefore \lambda = \frac{1\times5893\times10^{-7}}{2\times1.34\times0.8608}$$

$$\lambda = 2.554\times10^{-7} m$$

$$\mu = \frac{\sin i}{\sin r}$$

$$\sin r = \frac{\sin i}{\mu} = \frac{\sin 30°}{1.34} = \frac{0.5}{1.34}$$

$\sin r = 0.3731$

$$\cos r = \sqrt{1-\sin^2 r} = \sqrt{1-(0.3731)^2}$$

$\cos r = 0.8608$

(1). Explain the spectral series of hydrogen atom.

(1) Lymen Series. when the electron jumps from any of the outer orbits to the first orbit the spectral lines emitted are in the ultraviolet region of the spectrum are called Lymen series.

Here, $n_1 = 1$, $n_2 = 2, 3, 4, \ldots$

The wave number of the Lymen Series is,

$$\bar{\nu} = R\left[1 - \frac{1}{n_2^2}\right]$$

(2). Balmer Series: when the electron jumps from any of the outer orbits to the second orbit, the spectral lines emitted are in the visible region of the spectrum are called Balmer Series.

Here, $n_1 = 2$, $n_2 = 3, 4, 5, \ldots$

The wave number of the Balmer series is,

$$\bar{\nu} = R\left[\frac{1}{4} - \frac{1}{n_2^2}\right]$$

(3). Paschen series: when the electron jumps from any of the outer orbits to the third orbit, the spectral lines emitted are in the infrared region of the spectrum are called Paschen series

Here, $n_1 = 3$ $n_2 = 4, 5, 6, \ldots$

The wave number of the Paschen Series is

$$\bar{\nu} = R\left[\frac{1}{9} - \frac{1}{n_2^2}\right]$$

(4) Brackett Series: when the electron jumps from any of the outer orbits to the fourth orbit, the spectral lines emitted are in the infrared region of the spectrum are called Brackett Series

Here, $n_1 = 4$, $n_2 = 5, 6, 7, \ldots$

The wave number of the Brackett Series is

$$\bar{\nu} = R\left[\frac{1}{16} - \frac{1}{n_2^2}\right]$$

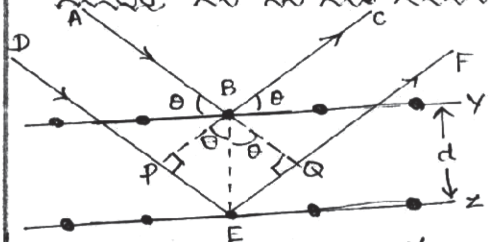
(5). Pfund Series: when the electron jumps from any of the outer orbits to the fifth orbit, the spectral lines emitted are in the infrared region of the spectrum are called Pfund Series.

Here, $n_1 = 5$, $n_2 = 6, 7, 8, \ldots$

The wave number of the Pfund Series is

$$\bar{\nu} = R\left[\frac{1}{25} - \frac{1}{n_2^2}\right]$$

(2). Bragg's law for Xray diffraction.




(1) Consider homogeneous Xrays of wavelength $\lambda$ incident on a rock salt crystal at a glancing angle $\theta$. (2). The incident rays AB and DE after reflection from the lattice planes Y and Z travel along BC and EF as shown in figure.

(3). Let the crystal lattice spacing between the planes be d. (4). BP and BQ are perpendiculars drawn from B on DE and EF respectively.

(5). Therefore the path difference between the two waves ABC and DEF is.

$$\delta = PE + EQ \quad \text{—— (1)}$$

In the $\Delta BPE$,

$$\sin\theta = \frac{PE}{BE}$$

or $PE = BE\sin\theta$

$PE = d\sin\theta$

$\Delta BQE$.

$$\sin\theta = \frac{EQ}{BE}$$

or. $EQ = BE\sin\theta$

$EQ = d\sin\theta$.

$\therefore$ The path difference

$$\delta = d\sin\theta + d\sin\theta = 2d\sin\theta \quad \text{—— (2)}$$

(6) If this path difference $2d\sin\theta$ is equal to integral multiple of wave length of X-ray

ie $\delta = n\lambda$ —— (3)

then Constructive interference will occur between the reflected beams and they will reinforce with each other.

2. Therefore the intensity of the reflected beam is maximum.

$$\therefore \boxed{2d\sin\theta = n\lambda} \quad \text{——— (3).}$$

Where. $n = 1, 2, 3, \ldots$

This is known as Bragg's law.

3). Properties of Cathode / Canal / X-rays.

1). They travel in straight lines.

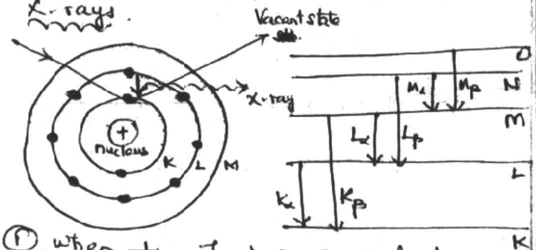
2). They affect photographic plates.

3). These rays can produce flourescence.

4). They ionize the gas through which they pass.

5). They are (not) deflected by electric and magnetic fields.

4). Explain the origin of characteristic X-rays.




(1). when the fast moving electrons knock off one electron from K-shell and the vacancy is filled by the nearby electron from the L shell

2). During this transition, the energy difference is radiated in the form of X-rays of very small wavelength.

ie $\boxed{E_K - E_L = h\nu,}$

This corresponds to $K_\alpha$-lines of the series

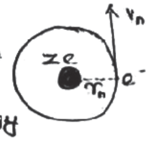
3). Suppose, the electron from M shell jumps to the K shell, it gives out $K_\beta$ line and so on.

4). If an electron jumps from the M-shell to the vacant state in L-shell it contributes $L_\alpha$ line and if the vacancy in L-shell is filled up by an electron in N-shell, it contributes $L_\beta$ and so on.

(5). The frequency of radiation depends upon the target material.

(6). The X-ray spectra consists of sharp lines and is the characteristic of target material. Hence this spectra is known as characteristic spectra.

(5). Energy of an electron in the $n^{th}$ orbit.




The total energy of the electron is the sum of its potential and kinetic energy in its orbit.

The potential energy of the electron in the $n^{th}$ orbit is given by,

$$E_p = \frac{-ze^2}{4\pi\epsilon_0 r_n} \quad \text{——— (1).}$$

The kinetic energy of the electron in the $n^{th}$ orbit is

$$E_K = \frac{ze^2}{8\pi\epsilon_0 r_n} \quad \text{——— (2).}$$

The total energy of an electron in its $n^{th}$ orbit is

$$E_n = E_p + E_K = \frac{-ze^2}{4\pi\epsilon_0 r_n} + \frac{ze^2}{8\pi\epsilon_0 r_n}$$

$$E_n = \frac{-ze^2}{8\pi\epsilon_0 r_n} \quad \text{——— (3).}$$

Substituting the value of $r_n$ and simplifying,

$$E_n = \frac{-z^2me^4}{8\epsilon_0^2 n^2 h^2} \quad \text{——— (4).}$$

For hydrogen atom $z = 1$.

$$\therefore \boxed{E_n = \frac{-me^4}{8\epsilon_0^2 n^2 h^2}} \quad \text{——— (5).}$$

Substituting the known values and calculating the energy in electron volt,

$$\boxed{E_n = \frac{-13.6}{n^2}\ eV.} \quad \text{——— (6).}$$

It is seen that the energy of the electron in its orbit increases as n increases.

#

① Explanation of BE/A Curve:

① The binding energy per nucleon increases sharply with number A upto 20. It increases slowly after A = 20. The curve becomes almost flat for mass number between 40 and 120. Beyond 120, it decreases slowly as A increases.

② The binding energy per nucleon reaches a maximum of 8.8 MeV at A = 56, corresponding to the iron nucleus $_{26}Fe^{56}$. Hence, iron nucleus is most stable.

③ The average binding energy per nucleon is about 8.5 MeV for nuclei having mass number ranging between 40 and 120. The elements are comparitively more stable non radioactive.

④ For higher mass numbers the curve drops slowly and the BE/A is about 7.6 MeV for uranium. Hence, they are unstable and radioactive.

⑤ The lesser amount of binding energy for lighter and heavier nuclei explains nuclear fusion and fission respectively.

② Properties of nuclear force.

① There is some other force in the nucleus which overcomes the electro-static repulsion between positivly charged protons and binds the protons and neutrons inside the nucleus. This force is called nuclear force.

② Nuclear force is charge independent. It is same for all the three types of pairs of nucleons (n-n), (p-p) and (n-p). This shows that nuclear force is not electrostatic in nature.

③ Nuclear force is the strongest known force in nature.

④ Nuclear for is not a gravitational force. It is about $10^{40}$ times stronger than the gravitational force.

⑤ Nuclear force is a short range force. ($10^{-15}$ m).

VIII. Nuclear Physics

③ Properties of α, β, γ rays, X-rays, Cathode rays, Canal rays

① They affect photographic plates

② They produce fluorescence.

③ They ionize the gas

④ They move along straight lines with high velocities. Velocity of light

⑤ They are (not) deflected by electric and magnetic fields.

④ Properties of neutrons

① Neutrons are the constituent particle of all nuclei, except hydrogen, $H^1$.

② Neutrons are neutral particles with no charge and mass slightly greater than that of protons.

③ They are not deflected by electric and magnetic fields.

④ They can easily penetrate any nucleus.

⑤ Neutrons are stable inside the nucleus. But outside the nucleus they are unstable. $T_{1/2}$ = 13 minutes.

⑥ Classification of neutrons

(i). Slow neutrons - 0 to 1000 eV

(ii). Fast neutrons - 0.5 MeV 10 MeV.

(iii). Thermal neutrons - 0.025 eV.

⑤ Discovery of neutrons

① Bothe and Becker found that when beryllium was bombarded with α-particles, a highly penetrating radiation was emitted.

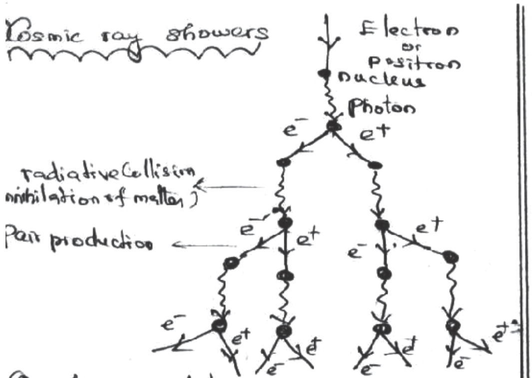
② Curie and Joliot found that these radiations were able to knockout protons from paraffin.

③ Chadwick discovered that the emitted radiation consists of particles of mass nearly equal to proton and no charge. He called them as neutrons

$$_4Be^9 + _2He^4 \longrightarrow _6C^{12} + _0n^1$$

where $_0n^1$ represents neutron.

## Cosmic ray showers




①. When a detecting device is used to study Cosmic ray intensities, it is observed that the intensity rises momentarily to several times its normal value, which indicates Sudden burst of radiation.

②. The Cascade theory of Cosmic ray shower shows that the shower production involves two processes, radiative Collision & annihilation of mater and Pair production.

③. An energitic electron or positron present in Cosmic rays loses energy, when it collides with nuclei of atoms in earth's atmosphere. This energy loss appears as high energy photon.

④. This photon interacts with an atomic nucleus and produce an electron positron pair.

⑤. When the process continues The result is the generation of a large number of photons, electrons and positron having a common origin like a shower and here it is known as Cosmic ray shower.

⑥. The multiplication will Continue until the energy of the particles fall below the Critical energy.

## ①. Spectral Series of Hydrogen atom

### ① Lyman Series:

When electrons jumps from any of the outer orbits to the first orbit, the spectral lines emitted are in the ultraviolet region of the spectrum are called Lymen Series.

Here, $n_1 = 1$, $n_2 = 2, 3, \ldots$

The wave number of the Lymen Series is given by,

$$\bar{\nu} = R\left(\frac{1}{1^2} - \frac{1}{n_2^2}\right)$$

### ②. Balmer series:

When electron jumps from any of the outer orbits to the Second orbit, the spectral lines emitted are in the Visible region of the spectrum are Called Balmer Series.

Here $n_1 = 2$, $n_2 = 3, 4, \ldots$

The wave number of the Balmer series is given by,

$$\bar{\nu} = R\left(\frac{1}{2^2} - \frac{1}{n_2^2}\right)$$

### ③. Pachen Series:

When electron jumps from any of the outer orbits to the third orbit, the spectral lines emitted are in the Infra red region of the spectrum are called Pashen Series.

Here $n_1 = 3$, $n_2 = 4, 5, \ldots$

The wave number of the Paschen series is given by,

$$\bar{\nu} = R\left(\frac{1}{3^2} - \frac{1}{n_2^2}\right)$$

### ④ Brackett Series:

When electron jumps from any of the outer orbits to the fourth orbit, the spectral lines emitted are in the Infra red region of the Spectrum are called Brackett Series.

Here, $n_1 = 4$, $n_2 = 5, 6, \ldots$

The wave number of the Brackett Series is given by

$$\bar{\nu} = R\left(\frac{1}{4^2} - \frac{1}{n_2^2}\right)$$

### ⑤ Pfund Series.

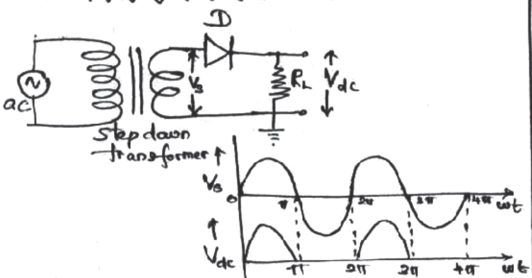
When electron jumps from any of the outer orbits to the fifth orbit, the spectral lines emitted are in the Infra red region of the Spectrum are Called Pfund Series.

Here $n_1 = 5$, $n_2 = 6, 7, \ldots$

The wave number of the Pfund Series is given by,

$$\bar{\nu} = R\left(\frac{1}{5^2} - \frac{1}{n_2^2}\right)$$

## ① Half wave Rectifier




① A circuit which rectifies half of the ac wave is called half wave rectifier.

② The ac voltage ($V_s$) to be rectified is obtained across the secondary ends $S_1S_2$ of the transformer.

③ The rectified output voltage $V_{dc}$ appears across the Load resistance $R_L$.

④ During the positive half cycle of the input ac voltage the diode is forward biased and hence it conducts.

⑤ During the negative half cycle of the input ac voltage the diode is reverse biased and hence it does not conduct.

⑥ Thus corresponding to an alternating input signal, unidirectional pulsating output is obtained.

⑦ The ratio of dc power output to the ac power input is known as rectifier efficiency.

⑧ The efficiency of half wave rectifier is 40.6%.

## ② Current amplification factors α and β and the relation between them.

① The current amplification factor of a transistor is the ratio of output current to the input current.

② If the transistor is connected in common base mode, the current gain $\alpha = \frac{I_C}{I_E}$.

③ And if the transistor is connected in common emitter mode, the current gain $\beta = \frac{I_C}{I_B}$.

④ For a transistor, $I_E = I_B + I_C$

Since, $\alpha = \frac{I_C}{I_E}$

$$\frac{1}{\alpha} = \frac{I_E}{I_C} = \frac{I_B + I_C}{I_C}$$

$$\frac{1}{\alpha} = \frac{I_B}{I_C} + 1$$

$$\frac{1}{\alpha} - 1 = \frac{1}{\beta}$$

$$\boxed{\beta = \frac{\alpha}{1-\alpha}} \quad \text{and} \quad \boxed{\alpha = \frac{\beta}{1+\beta}}$$

## ③ De Morgan's Theorems:

① The complement of a sum is equal to the product of their complements.

$$\boxed{\overline{A+B} = \overline{A}.\overline{B}}$$

② The complement of a product is equal to the sum of their complements.

$$\boxed{\overline{A.B} = \overline{A} + \overline{B}}$$

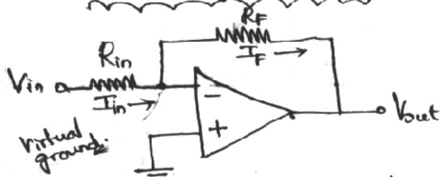
**Proof:**

| A | B | $\overline{A}$ | $\overline{B}$ | $\overline{A+B}$ | $\overline{A}.\overline{B}$ | $\overline{A.B}$ | $\overline{A}+\overline{B}$ |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

$\boxed{\overline{A+B} = \overline{A}.\overline{B}}$ First law is verified

$\boxed{\overline{A.B} = \overline{A}+\overline{B}}$ Second law is verified.

## ④ Inverting Amplifier:




① The input voltage $V_{in}$ is applied to the inverting input through the input resistor $R_{in}$.

② The non-inverting input is grounded.

③ The feedback resistor $R_F$ is connected between the output and the inverting input.

④ Since the input impedence of an op amp is considered very high, no current can flow into or out of the input terminals.

⑤ Therefore $I_{in}$ must flow through $R_F$ and is indicated by $I_F$.

⑥ Since $R_{in}$ and $R_F$ are in series, then

$$I_{in} = I_F$$

By Ohm's law,

$$\frac{V_{in}}{R_{in}} = -\frac{V_{out}}{R_F}$$

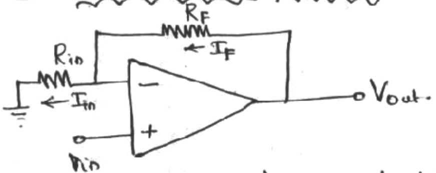
$$\boxed{V_{out} = -\frac{R_F}{R_{in}} V_{in}}$$

The voltage gain $A_v = \frac{V_{out}}{V_{in}}$

$$\boxed{A_v = \frac{-R_F}{R_{in}}}$$

The output voltage is out of phase with the input voltage.

## ⑤. Non-inverting amplifier




①. The input signal $V_{in}$ is applied to the non-inverting input terminal.

②. The resistor $R_{in}$ is connected from the inverting input to ground.

③. The feeback resistor $R_F$ is connected between the output and the inverting input.

④. The feedback voltage $V_A$ across $R_{in}$ is developed.

$$V_A = \left(\frac{R_{in}}{R_F + R_{in}}\right) V_{out}$$

Since $V_A = V_{in}$ the output voltage

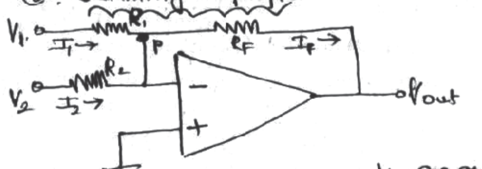
$$V_{out} = \left(\frac{R_F + R_{in}}{R_{in}}\right) V_{in}$$

$$\boxed{V_{out} = \left(1 + \frac{R_F}{R_{in}}\right) V_{in}}$$

It is seen that the output and input voltages are in same phase.

The voltage gain $\boxed{A_V = \frac{V_{out}}{V_{in}} = 1 + \frac{R_F}{R_{in}}}$

## ⑥. Summing amplifier




The input voltages $V_1$ and $V_2$ are applied through the resistors $R_1$ and $R_2$ to the summing junction P. and the $R_F$ is the feedback resistor.

At the point P,

$$I_1 + I_2 = I_F$$

$$\frac{V_1}{R_1} + \frac{V_2}{R_2} = -\frac{V_{out}}{R_F}$$

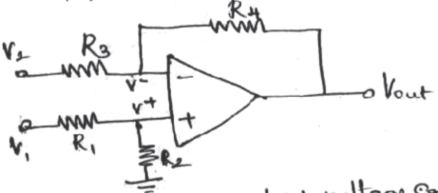
$$V_{out} = -\left(\frac{R_F}{R_1} V_1 + \frac{R_F}{R_2} V_2\right)$$

If $R_1 = R_2 = R_F$ then,

$$\boxed{V_{out} = -(V_1 + V_2)}$$

The negative sign indicates that OP-amp is used in the inverting mode.

## ⑥. Difference amplifier




The output voltage can be obtained by using superposition principle.

To find the output voltage $V_{01}$ due to $V_1$ alone, assume that $V_2$ is shorted to ground.

$$V_{01} = \left(\frac{R_3 + R_4}{R_3}\right)\left(\frac{R_2}{R_1 + R_2}\right) V_1$$

To find the output voltage $V_{02}$ due to $V_2$ alone, assume that $V_1$ is shorted to ground,

$$V_{02} = -\frac{R_4}{R_3} V_2$$

Therefore, with both inputs present, the output is,

$$V_{out} = V_{01} + V_{02}$$

$$V_{out} = \left(\frac{R_3 + R_4}{R_3}\right)\left(\frac{R_2}{R_1 + R_2}\right) V_1 - \frac{R_4}{R_3} V_2$$

If, $R_1 = R_2 = R_3 = R_4$ then

$$\boxed{V_{out} = V_1 - V_2}$$

③. Digital Communication.

Advantages:

①. The transmission quality is high and almost independent of the distance between the terminals.

②. The Capacity of the transmission System can be increased.

③. The newer types of transmission media such as light beams in optical fibres and wave guides use digital Communication.

Disadvantages:

①. A digital system requires larger bandwidth.

②. It is very difficult to gradually change over from analog to digital transmission.

④. RADAR

①. Radar works on the principle of Radio echoes.

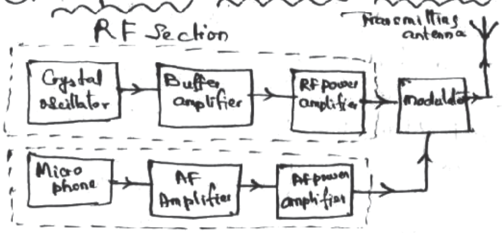
Uses: ①. Air and sea navigation is made entirely safe with radar installations.

②. Radar systems are used for the safe landing of air crafts.

③. The Radar pulses can be used for discovering the position of buried metals, oils and ores.

④. Radar systems are used in meteorology for forecasting.

⑤. Amplitude modulated transmitter




The block diagram of Amplitude modulated radio transmitter Consists two sections ①. AF Section. ②. RF Section.

AF Section:

①. The Conversion of Sound energy into electrical energy is performed by microphone.

②. The electrical energy available from the microphone is very low. Hence it is amplified through an amplifier.

③. The output from the AF amplifier is fed to the power amplifier and it gives the required audio frequency power.

④. The output of the AF power amplifier is given to the modulator.

RF Section:

①. In the RF Section, the high frequency Carrier wave is generated by a Crystal controlled oscillator.

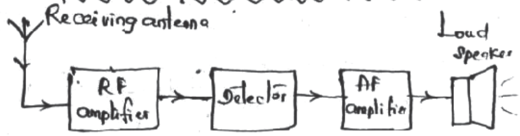
②. The output of the oscillator is power amplified by RF power amplifier.

③. The buffer isolates the RF power amplifier from the Oscillator.

④. In the modulator the RF wave and modulating AF signal are mixed to produce the amplitude modulated wave.

⑤. The output of this section is fed to the antenna for transmission.

⑥. A Simple or straight radio receiver:




①. The functional block diagram of a Simple radio receiver is shown in figure.

②. The receiving antenna receives the radiowaves from different broadcasting stations.

③. The desired radiowave is selected by the RF amplifier.

④. The amplified radiowave is fed to the PN diode detector.

⑤. This circuit extracts the audio signal from the radiowave.

⑥. The output of the detector is amplified by AF amplifier.

⑦. The amplified audio signal is given to the loudspeaker for sound reproduction.

Disadvantages: Simple radio receiver Circuit has ① poor sensitivity and ② poor Selectivity.

## (6) Einstein's mass - energy equivalence.

According to Newton's second law of motion, force is defined as the rate of change of momentum,

$$F = \frac{d}{dt}(mv) \quad \text{--- (1)}$$

According to the theory of relativity, both mass and velocity are variable, therefore,

$$F = m\frac{dv}{dt} + v\frac{dm}{dt} \quad \text{--- (2)}$$

∴ The increase in kinetic energy of the body is,

$$dE_K = F\,dx$$

$$= \left(m\frac{dv}{dt} + v\frac{dm}{dt}\right)dx$$

$$= m\frac{dv}{dt}dx + v\frac{dm}{dt}dx$$

$$dE_K = mv\,dv + v^2 dm \quad \text{--- (3)} \qquad \left(\frac{dx}{dt} = v\right)$$

From Einstein's theory of relativity,

$$m = \frac{m_0}{\sqrt{1 - v^2/c^2}}$$

$$m^2 = \frac{m_0^2 c^2}{c^2 - v^2}$$

$$m^2c^2 - m^2v^2 = m_0^2 c^2$$

On differentiating we get,

$$c^2\, 2m\,dm - v^2\, 2m\,dm - m^2\, 2v\,dv = 0$$

$$c^2 dm = mv\,dv + v^2 dm \quad \text{--- (4)}$$

Comparing equations (3) and (4) we get-

$$dE_K = c^2 dm.$$

On integrating we get,

$$\int_0^{E_K} dE_K = c^2 \int_{m_0}^{m} dm$$

$$E_K = c^2(m - m_0)$$

$$E_K = mc^2 - m_0c^2 \quad \text{--- (5)}$$

Total energy = Kinetic energy of the moving body + rest mass energy

$$E = E_K + m_0c^2$$

$$= mc^2 - m_0c^2 + m_0c^2$$

$$\boxed{E = mc^2} \quad \text{--- (6)}$$

This is Einstein's mass - energy equivalence.

## (7) Merits and demerits of Satellite Communication

**Merits**: (1). Mobile Communication can be easily established by Satellite Communication

(2) Satellite Communication is economical Compared with terrestrial communication particularly where long distances are involved.

(3). For thin traffic remote areas like north east regions in India, Ladakh etc. Satellite Communication is more economical.

(4). Compared to the optical fibre Communication, Satellite Communication has the advantages that quality of transmitted signal is independent of distance.

(5). For search, rescue and navigation, Satellite Communication is far superior and economical Compared to other Systems.

**Demerits**: (1). Repair of satellite is almost impossible, once it has been launched.

(2). A imperfect impedence match may Cause echo, received back after a delay

(3). Between talks there is a time gap becomes quite annoying.

## (8). Advantages of Fibre optic Communication

(1). An optical fibre is a thin transparent rod, usually made of glass or plastic through which light Can propagate.

(2). The principle of total internal reflection is used for the transmission of light signals through the optical fibre

**Advantages**:

(1). Transmission loss is low.

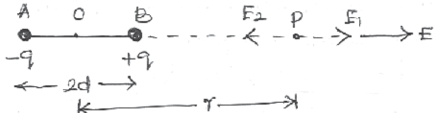
(2). Fibre is lighter and less bulky than equivalent Copper Cable.

(3). More information Can be Carried by each fibre than by equivalent Copper Cables.

(4). There is no interference in the transmission of light from electrical disturbances or electrical noise.

(1) **Electric field due to an electric dipole at a point on its axial line**

Consider an electric dipole AB. Let 2d be the dipole distance and p be the dipole moment. P is a point along the axial line of the dipole at a distance r from the midpoint O.




The electric field at P due to +q placed at B is,

$$E_1 = \frac{1}{4\pi\epsilon_0}\frac{q}{(r-d)^2} \text{ (along BP)} \quad (1)$$

The electric field at P due to -q placed at A is,

$$E_2 = \frac{1}{4\pi\epsilon_0}\frac{q}{(r+d)^2} \text{ (along PA)} \quad (2)$$

The resultant electric field at P is

$$E = E_1 + (-E_2) \quad (3)$$

$$= \frac{1}{4\pi\epsilon_0}\frac{q}{(r-d)^2} - \frac{1}{4\pi\epsilon_0}\frac{q}{(r+d)^2}$$

$$= \frac{q}{4\pi\epsilon_0}\left[\frac{1}{(r-d)^2} - \frac{1}{(r+d)^2}\right]$$

$$= \frac{q}{4\pi\epsilon_0}\left[\frac{(r+d)^2 - (r-d)^2}{(r^2-d^2)^2}\right]$$

$$= \frac{q}{4\pi\epsilon_0}\left[\frac{(r^2+d^2+2rd)-(r^2+d^2-2rd)}{(r^2-d^2)^2}\right]$$

$$= \frac{q}{4\pi\epsilon_0}\left[\frac{r^2+d^2+2rd-r^2-d^2+2rd}{(r^2-d^2)^2}\right]$$

$$E = \frac{q}{4\pi\epsilon_0}\left[\frac{4rd}{(r^2-d^2)^2}\right]$$

If $d << r$, $d^2$ is negligible

$$\therefore E = \frac{q}{4\pi\epsilon_0}\frac{4rd}{r^4}$$

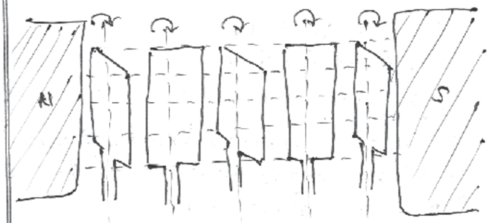
$$= \frac{q}{4\pi\epsilon_0}\frac{4d}{r^3} \qquad \because p = 2qd.$$

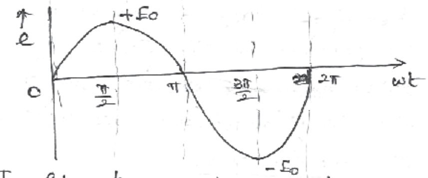
$$\boxed{E = \frac{2p}{4\pi\epsilon_0 r^3}} \quad (4) \text{ along BP.}$$

E acts along the direction of dipole moment.

(1) **Emf induced by changing the orientation of the coil**

PQRS is a rectangular coil of N turns and area A placed in a uniform magnetic filed B. The coil is rotated with an angular velocity ω in the clockwise direction.




The flux linked with the coil

$$\phi = NBA\cos\theta$$

Since $\theta = \omega t$, $\phi = NBA\cos\omega t$ — (1)

The emf induced is

$$e = -\frac{d\phi}{dt}$$

$$= -\frac{d}{dt}(NBA\cos\omega t)$$

$$= NBA\omega\sin\omega t$$

$$\boxed{e = E_0\sin\omega t} \quad (2)$$

Here, $E_0 = NBA\omega$ is the maximum value of the induced emf.

The emf induced varies sinusoidally with time.

1. When $\boxed{\omega t = 0}$, the plane of the coil is perpendicular to the filed B and hence $\boxed{e = 0}$.
2. When $\boxed{\omega t = \frac{\pi}{2}}$ the plane of the coil is parallel to the field B and hence $\boxed{e = +E_0}$
3. When $\boxed{\omega t = \pi}$ the plane of the coil is perpendicular to the filed B and hence $\boxed{e = 0}$
4. When $\boxed{\omega t = \frac{3\pi}{2}}$, the plane of the coil is parallel to the field and hence $\boxed{e = -E_0}$
5. When $\boxed{\omega t = 2\pi}$, the plane of the coil is perpendicular to the field B and hence $\boxed{e = 0}$

#.

① Types of Spectra

I. Emission Spectra : when the light emitted from a Source is directly examined with a Spectrometer, the obtained spectrum is called emission Spectrum.

The emission spectrum is of three types

(1). Continuous Spectrum
(2). Line Spectrum
(3). Band Spectrum.

(1). Continuous Spectrum :

It Consists of unbroken luminous bands of all wavelengths containing all the colours from violet to red.

~~These spectra~~ It depend only on the temperature of the source

~~Incandescent solids, liquids~~, Carbon arc, electric filament lamp gives Continuous Spectra.

(2). Line Spectrum:

~~Line Spectra are~~ It Consists of sharp lines of definite wavelengths.

It is the characteristic of emitting Substance

It is used to identify the gas.

Sodium in Sodium Vapour lamp, mercury in mercury Vapour lamp give line Spectra.

(3). Band Spectrum:

It Consist of a number of bright bands with a sharp edge at one end but fading out at the other end.

Band Spectra are Obtained from molecules.

It is the Characteristic of the molecule.

Calcium or Barium Salts in Bunsen flame give band Spectra.

II. Absorption Spectra :

when the light emitted from a Source is made to pass through an absorbing material and then examined with a Spectrometer, the obtained Spectrum is called absorption Spectrum.

Absorption Spectrum is also of three types

①. Continuous absorption spectrum
②. Line absorption Spectrum
③. band absorption Spectrum.

(1) Continuous absorption Spectrum

A pure green glass plate when placed in the path of white light, absorbs every thing except green and gives Continuous absorption spectrum.

(2) Line absorption Spectrum :

When ~~white~~ light from the Carbon arc is made to pass through Sodium vapour and then examined with Spectrometer Line absorption Spectrum is obtained.

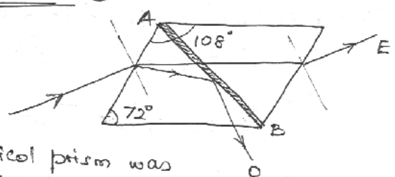
(3). Band absorption spectrum:

If white light is allowed to pass through iodine vapour dark bands on Continuous bright background are obtained.

The band absorption spectra are used for making dyes

#

Nicol Prism ⑤ mark.




①. Nicol prism was designed by William Nicol.

②. A Calcite crystal whose length is three times its breadth is cut into halves along the diagonal, so that their face angles are 72° and 108°.

③. And the two halves are joined together by a layer of Canada balsam.

④. A monochromatic beam of unpolarised light is incident on it, is split up into two rays as ordinary ray and extraordinary ray inside the nicol prism.

⑤. The ordinary ray is totally internally reflected at the layer of Canada balsam.

⑥. The extraordinary ray alone is transmitted through the crystal which is plane polarised.

⑦. The nicol prism serves as a polariser and also as analyser.

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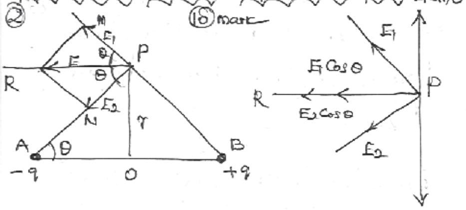
## Electric field due to an electric dipole at a point on the equatorial line

(2) (10 mark)




Consider an electric dipole AB.

Let 2d be the dipole distance and p be the dipole moment. P is a point on the equatorial line at a distance r from the midpoint O.

The electric field at P due to +q placed at B is,

$$E_1 = \frac{1}{4\pi\epsilon_0} \frac{q}{(r^2+d^2)} \text{ (along BP)} \quad \text{--- (1)}$$

The electric field at P due to −q placed at A is

$$E_2 = \frac{1}{4\pi\epsilon_0} \frac{q}{(r^2+d^2)} \text{ (along PA)} \quad \text{--- (2)}$$

The magnitudes of $E_1$ and $E_2$ are equal.

Resolving $E_1$ and $E_2$ into their horizontal and vertical components.

The vertical components $E_1 \sin\theta$ and $E_2 \sin\theta$ are equal and opposite, therefore they cancel each other.

The horizontal components $E_1 \cos\theta$ and $E_2 \cos\theta$ will get added along PR.

∴ The resultant electric field at P due to the dipole is,

$$E = E_1 \cos\theta + E_2 \cos\theta \text{ (along PR)}$$

Since $E_1 = E_2$

$$E = 2E_1 \cos\theta \quad \text{--- (3)}$$

$$= \frac{1}{4\pi\epsilon_0} \frac{q}{(r^2+d^2)} 2\cos\theta$$

$$= \frac{1}{4\pi\epsilon_0} \frac{q}{(r^2+d^2)} \frac{2d}{(r^2+d^2)^{1/2}}$$

$$E = \frac{2qd}{4\pi\epsilon_0 (r^2+d^2)^{3/2}}$$

For a dipole, d is very small when compared to r

$$\boxed{E = \frac{p}{4\pi\epsilon_0 r^3}} \quad \text{--- (4)} \qquad p = 2qd$$

(acts along PR)

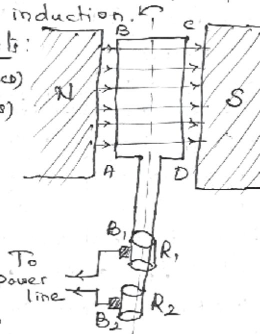
## (2) AC generator - Single phase (10 mark)

The ac generator is a device used for converting mechanical energy into electrical energy. It was designed by Nicola Tesla.

It is based on the principle of electromagnetic induction.

Essential parts:

1. Armature coil (ABCD)
2. Field magnets (NS)
3. Slip rings ($R_1, R_2$)
4. Brushes ($B_1, B_2$)




The direction of induced current is given by Flemings Right hand rule.

Suppose the armature ABCD is rotated in anticlockwise direction, the arm AB moves downwards and the arm DC moves upwards. Thus the induced current flows along DCBA in the coil. In the external circuit the current flows from $B_1$ to $B_2$.

On further rotation, the arm AB moves upwards and DC moves downwards. Now the current in the coil flows along ABCD. In the external circuit the current flows from $B_2$ to $B_1$.

As the rotation of the coil continues, the induced current in the external circuit keeps changing its direction for every half a rotation of the coil.

Hence the induced current is alternating in nature.

The induced emf at any instant is given by $\boxed{e = E_0 \sin\omega t}$

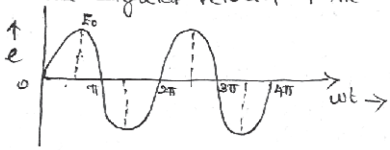
The peak value of the emf $\boxed{E_0 = NBA\omega}$

where, N is number of turns of the coil.

A is the area enclosed by the coil

B is the magnetic field and

ω is the angular velocity of the coil.



## Raman effect : (10) mark.

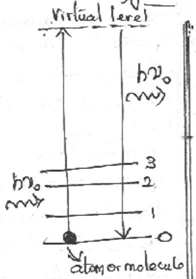
Raman discovered that the monochromatic light is scattered when it is allowed to pass through a substance. The scattered light contains some additional frequencies other than that of incident frequency. This is known as Raman effect.

The lines whose frequencies have been modified in Raman effect are called Raman lines ~~also known as~~ and the spectrum is called Raman Spectrum.

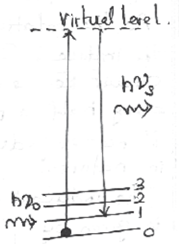
The lines having frequencies lower than the incident frequency are called Stoke's lines and the lines having frequencies higher than that incident frequency are called Anti-stoke's lines.

The Raman effect can be easily understood by considering the scattering of photon of the incident light with atom or molecules. Let the incident photons have energy $h\nu_0$

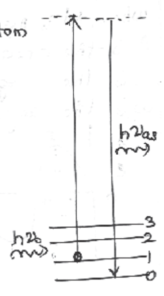
(1). In some cases, when a light photon strikes atoms or molecules, photons may scattered elastically. Then the photons neither gain nor lose energy. The spectral line will have unmodified frequency are called Rayleigh line.




(2). If a photon strikes an atom or a molecule ~~in a molecule~~, part of the energy of the incident photon may be used to excite the atom ~~at~~ and the rest is scattered. The spectral line will have lower frequency and it is called Stoke's lines.




(3). If a photon strikes an atom or a molecule in a liquid, which is in an excited state, the scattered photon gains energy. The spectral line will have higher frequency and it is called anti-stokes lines.




If $\nu_0$ is the frequency of incident radiation and $\nu_s$ the frequency of scattered radiation, then Raman shift or Raman frequency

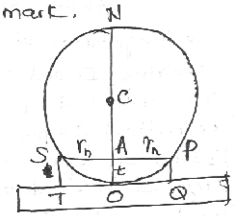
$$\Delta\nu = \nu_0 - \nu_s$$

For Stoke's lines, $\Delta\nu$ is positive and for Anti-stoke's lines $\Delta\nu$ is negative.

The Raman shift does not depend upon the frequency of the incident light but it is the characteristic of the substance producing Raman effect.

The intensity of Stoke's lines is always greater than the corresponding Anti-stoke's lines.

## Expression for the radius of the $n^{th}$ dark ring : (5) mark.




By the law of segments,

$$SA \cdot AP = NA \cdot AO$$

$$r_n \cdot r_n = (NO - AO) \cdot AO$$

$$r_n^2 = (2R - t)\, t$$

$$r_n^2 = 2Rt - t^2$$

(Neglecting $t^2$ comparing with $2R$)

$$r_n^2 = 2Rt$$

$$2t = \frac{r_n^2}{R} \quad \text{--- (1)}$$

According to the condition for darkness,

$$2t = n\lambda \quad \text{--- (2)}$$

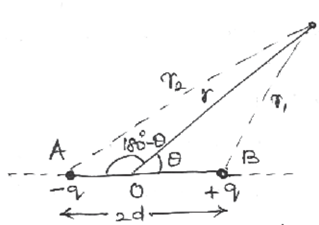
On comparing (1), and (2).

$$\frac{r_n^2}{R} = n\lambda$$

$$r_n^2 = nR\lambda$$

$$r_n = \sqrt{nR\lambda} \quad \text{--- (3)}$$

③ Electric potential at a point due to an electric dipole: ⑩ mark




Consider an electric dipole AB. Let 2d be the dipole distance and p be the dipole moment. P is a point at distance r from the midpoint O of the dipole.

Potential at P due to charge +q

$$V_1 = \frac{q}{4\pi\epsilon_0 r_1} \quad \text{—①}$$

Potential at P due to charge −q.

$$V_2 = \frac{-q}{4\pi\epsilon_0 r_2} \quad \text{—②}$$

Here,

$$\frac{1}{r_1} = \frac{1}{r}\left(1+\frac{d\cos\theta}{r}\right) \text{ and}$$

$$\frac{1}{r_2} = \frac{1}{r}\left(1-\frac{d\cos\theta}{r}\right)$$

Total potential at P due to dipole is

$$V = V_1 + V_2$$

$$= \frac{q}{4\pi\epsilon_0 r_1} - \frac{q}{4\pi\epsilon_0 r_2}$$

$$V = \frac{q}{4\pi\epsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right) \quad \text{—③}$$

Sub $\frac{1}{r_1}$, $\frac{1}{r_2}$ values in eqn. ③, we get

$$V = \frac{q}{4\pi\epsilon_0 r}\left[1+\frac{d\cos\theta}{r} - 1 + \frac{d\cos\theta}{r}\right]$$

$$= \frac{q}{4\pi\epsilon_0 r}\left(\frac{2d\cos\theta}{r}\right) \quad \because p = 2qd.$$

$$V = \frac{p\cos\theta}{4\pi\epsilon_0 r^2} \quad \text{—④}$$

Special Cases:

①. when the point P lies on the axial line of the dipole on the side of +q, then $\theta = 0°$. $V = \frac{p}{4\pi\epsilon_0 r^2}$

②. when the point P lies on the axial line of the dipole on the side of −q, then $\theta = 180°$

$$V = \frac{-q}{4\pi\epsilon_0 r^2}$$

③. when the point P lies on the equatorial line of the dipole, then $\theta = 90°$, $V = 0$

Eddy Currents and their uses ⑩ mark

Focault observed that when a mass of metal moves in a magnetic field induced current flows in the form of closed loops resembling eddies or whirlpool. Hence this current is called eddy current.

The direction of eddy current is given by Lenz's law.

Eddy current can be minimized by using thin laminated sheets instead of solid metal.

Applications:

①. Induction furnace:

The material to be melted is placed in a varying magnetic field of high frequency. Hence a strong eddy current is developed inside the metal. Due to the heating effect of the current, the metal melts.

②. Induction motors:

Eddy currents are produced in a metallic cylinder called rotor, when it is placed in a rotating magnetic field. As the magnetic field continues to rotate, the metallic cylinder is set into rotation. These motors are used in fans.

③. Electromagnetic brakes:

A metallic drum is coupled to the wheels of a train. The drum rotates along with the wheel when the train is in motion. when the brake is applied, a strong magnetic

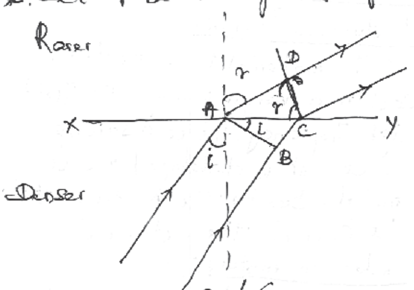
Field is developed and hence, eddy currents are produced in the drum, which oppose the motion of the drum. Hence, the train comes to rest.

Eddy currents are also used in Dead beat galvanometer and Speedometer.

## Total internal reflection by wave theory (10 mark).

Let XY be a plane surface which seperates a rarer medium (air) and a denser medium (water). Let the velocity of the wavefront in these media be $C_a$ and $C_m$ respectively.

A plane wavefront AB passes from denser medium to rarer medium. It is incident on the surface with angle of incidence $i$. Let $r$ be the angle of refraction.




$$\frac{\sin i}{\sin r} = \frac{BC/AC}{AD/AC} = \frac{BC}{AD}$$

$$= \frac{C_m t}{C_a t} = \frac{C_m}{C_a}$$

Since, $\frac{C_m}{C_a} < 1$, $i < r$. This means that the refracted wavefront is deflected away from the surface XY.

In the right angled triangle ADC

$$\sin r = \frac{AD}{AC}$$

There are three possiblities

(i). $AD < AC$ (ii). $AD = AC$ and (iii). $AD > AC$

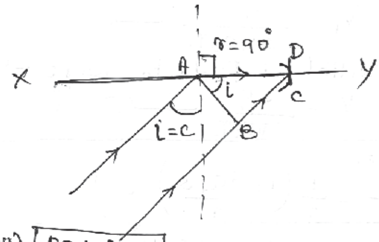
(i). $AD < AC$

When $AD < AC$ $\sin r < 1$ or $r < 90^\circ$ for each value of $i$, for which $r < 90^\circ$, a refracted wavefront is possible.

(ii). $AD = AC$

When $AD = AC$ $\sin r = 1$, or $r = 90^\circ$ i.e. a refracted wavefront is just possible. Now the refracted ray grazes the surface of seperation of the two media.

The angle of incidence at which the angle of refraction is $90^\circ$ is called the Critical angle 'C'

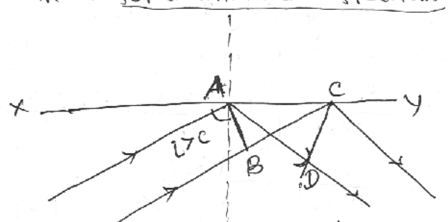



(iii) $AD > AC$

When $AD > AC$, $\sin r > 1$, or $r > 90^\circ$

This is not possible. Therefore no refracted wave front is possible, when the angle of incidence increases beyond the critical angle.

The incident wavefront is totally reflected into the denser medium itself. This is called total internal reflection.




### Condition for total internal reflection

(1) light must travel from a denser medium to a rarer medium.

(2) The angle of incidence inside the denser medium must be greater than the critical angle i.e $i > c$

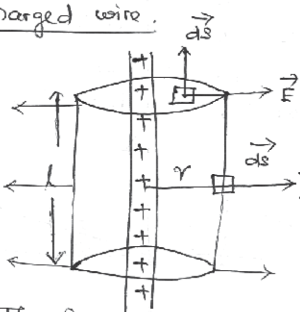
#

④ Gauss law

The total flux of the electric field E over any closed surface is equal to $\frac{1}{\epsilon_0}$ times the net charge enclosed by the surface.

$$\boxed{\phi = \frac{q}{\epsilon_0}}$$

Field due to an infinite long straight charged wire.



The flux through the curved surface $\phi_1 = \oint E\,ds\cos\theta$

here, $\theta = 0°$, $\cos\theta = 1$.

$\therefore \phi_1 = \oint E\,ds = E.2\pi r l$ —— ①

The flux through the plane caps

$\phi_2 = \oint E\,ds\cos\theta$.

here, $\theta = 90°$, $\cos\theta = 0$.

$\therefore \phi_2 = 0$ —— ②.

$\therefore$ The total flux through the Gaussian surface

$\phi = \phi_1 + \phi_2$

$\phi = E.2\pi r l$ —— ③.

By Gauss law, $\phi = \frac{q}{\epsilon_0}$

here, $q = \lambda l$.

$\therefore \phi = \frac{\lambda l}{\epsilon_0}$ —— ④.

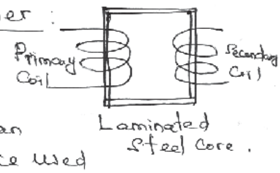
On comparing ③ and ④.

$E.2\pi r l = \frac{\lambda l}{\epsilon_0}$

$$\boxed{E = \frac{\lambda}{2\pi\epsilon_0 r}} \text{ —— ⑤.}$$

The direction of electric field is radially outward.

④. Transformer :




Transformer is an electrical device used for converting low alternating voltage into high alternating voltage and vice versa. It works on the principle of electromagnetic induction.

Let $E_p$ and $E_s$ be the induced emf in the primary and secondary coils and $N_p$ and $N_s$ be the number of turns in the primary and secondary coils respectively. Then,

$$\frac{E_s}{E_p} = \frac{N_s}{N_p} \text{ —— ①}$$

For an ideal transformer.

input power = output power

$$E_p I_p = E_s I_s$$

(or)

$$\frac{E_s}{E_p} = \frac{I_p}{I_s} \text{ —— ②}$$

Where $I_p$ and $I_s$ are currents in the primary and secondary coils.

From equations ① and ②

$$\frac{E_s}{E_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s} = K \text{ —— ③}$$

Where K is called transformer ratio

For step up transformer $K > 1$

For step down transformer $K < 1$.

Efficiency of a transformer :

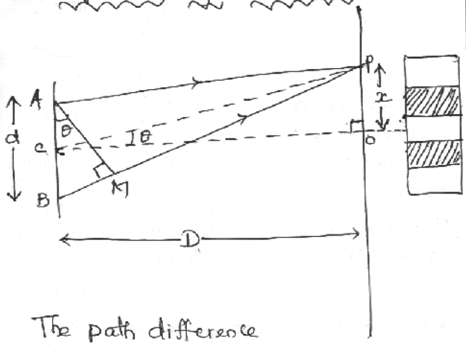
Efficiency of a transformer is defined as the ratio of output power to the input power.

$$\eta = \frac{\text{output power}}{\text{input power.}} = \frac{E_s I_s}{E_p I_p}$$

The efficiency $\eta = 1$ ie 100% only for an ideal transformer where there is no power loss.

#

## 4. Expression for bandwidth.




The path difference

$\delta = BP - AP = BM$

In right angled triangle ABM

$BM = d \sin\theta$.

If $\theta$ is small $\sin\theta \simeq \theta$.

$\therefore$ The path difference $\delta = \theta . d$ —— (1).

In right angled triangle COP

$\tan\theta = \frac{OP}{CO} = \frac{x}{D}$.

For small values of $\theta$, $\tan\theta \simeq \theta$.

$\theta = \frac{x}{D}$

$\therefore$ The path difference $\delta = \frac{x}{D} d$ —— (2)

**Condition for bright fringes.**

The path difference $\delta = n\lambda$ —— (3)

where, $n = 0, 1, 2, \ldots$ $n\lambda = \frac{x}{D} d$

$\boxed{x = \frac{n\lambda D}{d}}$

**Condition for dark fringes**

The path difference $\delta = (2n-1)\frac{\lambda}{2}$ —— (4)

where, $n = 1, 2, 3, \ldots$ $(2n-1)\frac{\lambda}{2} = \frac{x}{D} d$

$\boxed{x = (2n-1)\frac{\lambda D}{2d}}$

**Bandwidth :**

The distance between any two consecutive bright or dark bands is called bandwidth.

For bright band.

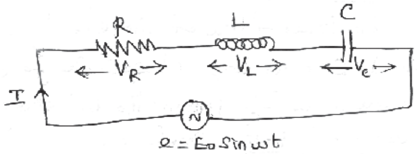
$\beta = x_{n+1} - x_n$

$= \frac{D}{d}(n+1)\lambda - \frac{D}{d} n\lambda$

$= \frac{D}{d} n\lambda + \frac{D}{d}\lambda - \frac{D}{d} n\lambda$

$\boxed{\beta = \frac{D\lambda}{d}}$ —— (5)

## 5. Series RLC Circuit




The voltage across the resistor is

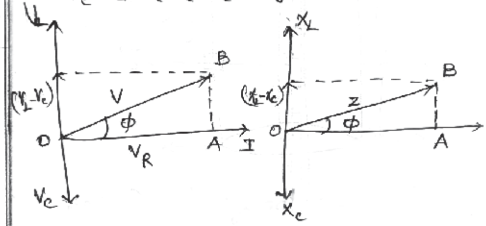
$V_R = IR$ ($V_R$ is in phase with I)

The voltage across the inductor coil is

$V_L = I X_L$ ($V_L$ leads I by $\pi/2$)

The voltage across the capacitor is

$V_C = I X_C$ ($V_C$ lags behind I by $\pi/2$)




$OB^2 = OA^2 + AB^2$

$V^2 = V_R^2 + (V_L - V_C)^2$

$V = \sqrt{V_R^2 + (V_L - V_C)^2}$

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

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

$\boxed{Z = \frac{V}{I} = \sqrt{R^2 + (X_L - X_C)^2}}$ —— (1)

Z is known as impedence of the circuit. Its unit is ohm.

Phase angle $\phi$ between the voltage and current is given by,

$\tan\phi = \frac{AB}{OA}$

$= \frac{V_L - V_C}{V_R}$

$= \frac{I X_L - I X_C}{IR}$

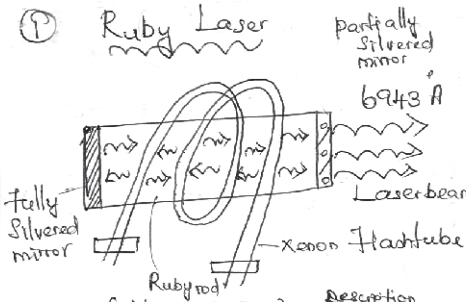
$\tan\phi = \frac{X_L - X_C}{R}$

$\boxed{\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)}$ —— (2).

$\boxed{i = I_0 \sin(\omega t \pm \phi)}$ is the instantaneous current flowing in the circuit.

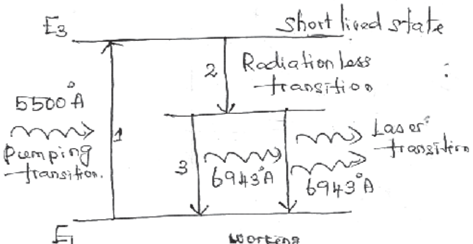
#.

## (1) Ruby Laser




**Description**

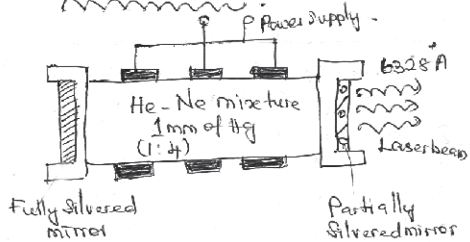
1. The Ruby laser was first developed by T. Meimen.
2. It consists of a single crystal of ruby rod of length 10 cm and 0.8 cm in diameter.
3. A ruby is a crystal of aluminium oxide $(Al_2O_3)$, in which some of aluminium ions $(Al^{3+})$ are replaced by the chromium ions $(Cr^{3+})$.
4. The opposite ends of ruby rod are flat and parallel. one end is fully silvered and the other is partially silvered.
5. The ruby rod is surrounded by a helical Xenon flash tube which provides the pumping light to raise the chromium ions to upper energy level.




**Working**

1. When the ruby rod is irradiated by a flash of light, the 5500 Å radiation photons are absorbed by the chromium ions which are pumped to the excited state $E_3$.
2. The excited ion gives up parts of its energy to the crystal lattice and decay without giving any radiation to the metastable state $E_2$.
3. Since, the state $E_2$ has a much longer lifetime ($10^{-3}$ s), the number of ions in this state goes on increasing.
4. Thus population inversion is achieved between the states $E_2$ and $E_1$.
5. When the excited ion from the metastable state $E_2$ drops down spontaneously to the ground state $E_1$, it emits a photon of wavelength 6943 Å.
6. This photon travels through the ruby rod and is reflected back and forth by the silvered ends until it stimulates other excited photon and causes it to emit a fresh photon in phase with stimulating photon.
7. This stimulated emission is the laser transition.
8. Finally a pulse of red light of wavelength 6943 Å emerges through the partalley silvered end of the crystal.

## (8) He-Ne Laser.




**Description:**

1. He-Ne laser system consists of a quartz discharge tube containing helium and neon in the ratio of 1:4 at a total pressure of about 1mm of Hg.
2. One end of the tube is fitted with a perfectly reflecting mirror and the other end with partially reflecting mirror.
3. A powerful RF generator is used to produce a discharge in the gas, so that the helium atoms are excited to a higher energy level.

**Working**

1. When an electric discharge passes through the gas, the electron in the discharge tube collide with the He and

Ne atoms and excite them to the metastable states of energy 20.61 eV and 20.66 eV respectively.

(2) Some of the excited helium atoms transfer their energy to unexcited Ne atoms by collision.

(3). Thus, He atom helps in achieving a population inversion in Ne atoms.

(4). When an excited Ne atom drops down spontaneously from the metastable state at 20.66 eV to lower energy state at 18.70 eV, it emits a 6328 Å photon in the visible region.

(5). This photon travelling through the mixture of the gas, it reflected back and forth by the reflector ends, until it stimulates an excited neon atom and causes it to emit a fresh 6328 Å photon in phase with the stimulating photon.

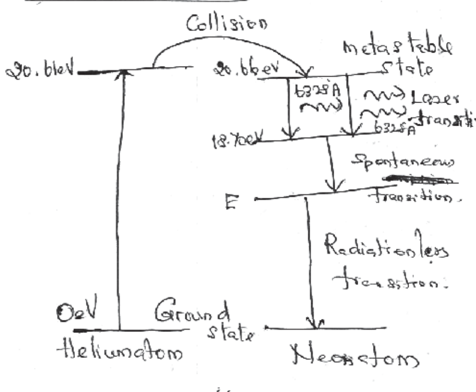
(6). This stimulated transition from 20.66 eV level to 18.70 eV level is the laser transition.

(7). The output radiations escape from the partially reflecting mirror.

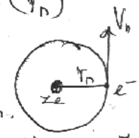
(8). ~~The output~~ The neon atoms drop down from the 18.70 eV level to lower state E, through spontaneous emission emitting incoherent light.

(9) From this level E, the Ne atoms are brought to the ground state through collision with the walls of the tube.

(10). Hence the final transition is radiationless.




(3). Radius of $n^{th}$ orbit ($r_n$)




Let an electron revolve around the nucleus in the $n^{th}$ orbit of radius $r_n$.

By Coulomb's law, the force of attraction between the nucleus and the electron is,

$$F = \frac{Ze^2}{4\pi\epsilon_0 r_n^2} \quad \text{--- (1)}$$

Since, the electron revolves in a circular orbit, it experiences centripetal force.

$$F = \frac{mv_n^2}{r_n} \quad \text{--- (2)}$$

Sub. here $v_n = r_n\omega_n$, we get,

$$F = m r_n \omega_n^2 \quad \text{--- (3)}$$

On comparing (1) and (3) we get,

$$m r_n \omega_n^2 = \frac{Ze^2}{4\pi\epsilon_0 r_n^2}$$

$$\omega_n^2 = \frac{Ze^2}{4\pi\epsilon_0 m r_n^3} \quad \text{--- (4)}$$

By Bohr's quantization condition,

$$mv_n r_n = \frac{nh}{2\pi} \quad \text{--- (5)}$$

Sub. here $v_n = r_n\omega_n$

$$m r_n^2 \omega_n = \frac{nh}{2\pi}$$

or $$\omega_n = \frac{nh}{2\pi m r_n^2}$$

On squaring,

$$\omega_n^2 = \frac{n^2h^2}{4\pi^2 m^2 r_n^4} \quad \text{--- (6)}$$

On comparing (4) and (6) we get,

$$\frac{n^2h^2}{4\pi^2 m^2 r_n^4} = \frac{Ze^2}{4\pi\epsilon_0 m r_n^3}$$

$$\frac{n^2h^2}{\pi m r_n} = \frac{Ze^2}{\epsilon_0}$$

$$\boxed{r_n = \frac{n^2h^2\epsilon_0}{\pi m Ze^2}} \quad \text{--- (7)}$$

From eqn. (7) it is seen that $\boxed{r_n \propto n^2}$.

Therefore the radii of the orbits are in the ratio 1 : 4 : 9 : ....

For hydrogen atom ~~Z~~ Z = 1.

$$\therefore \boxed{r_n = \frac{n^2h^2\epsilon_0}{\pi m e^2}} \quad \text{--- (8)}$$

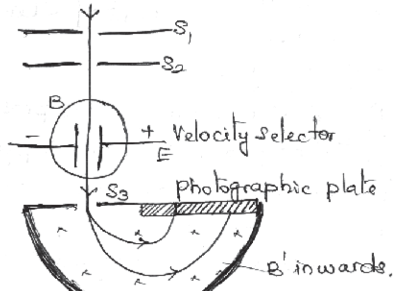
Substituting the known values in the above eqn. we get,

$$\boxed{r_n = 0.53\, n^2\, \text{Å}} \quad \text{--- (9)}$$

If $n = 1$, $\boxed{r_1 = 0.53\, \text{Å}}$ --- (10)

This is called Bohr radius.

## Bainbridge mass spectrometer ①




①. Bainbridge mass spectrometer is an instrument used for the accurate determination of atomic masses.

②. A beam of positive ions produced in a discharge tube is collimated into a fine beam by two narrow slits $S_1$ and $S_2$.

③. This fine beam enters into a velocity selector.

④. The velocity selector allows the ions of a particular velocity to come out of it, by the combined action of an electric field and a magnetic field.

⑤. These two fields are at right angles to each other and to the direction of the beam.

⑥. The electric field and magnetic field are so adjusted that the deflection produced by one field is nullified by the other, so that the ions do not suffer any deflection within the velocity selectors.

$$\therefore \quad qE = Bqv$$

$$\boxed{v = \frac{E}{B}} \quad \text{---} ①$$

⑦. Only those ions having this velocity v, pass out of the velocity selector and then through the slit $S_3$ to enter the evacuated chamber D.

⑧. These ions are deflected along circular path, due to the action of magnetic field B' acts inwards, and strike the photographic plate.

⑨. The force due to magnetic field B'qv provides the centripetal force.

⑩. $$B'qv = \frac{mv^2}{R}$$

$$m = \frac{B'qR}{v}$$

$$= \frac{B'qR}{(E/B)}$$

$$\boxed{m = \frac{BB'qR}{E}} \quad \text{---} ②$$

⑪. Ions of different masses trace semi-circular paths of different radii and produce dark lines on the plate.

## ② Radio-active law of disintegration

The rate of disintegration at any instant is directly proportional to the number of atoms of the element present at that instant.

$$-\frac{dN}{dt} \propto N.$$

$$\frac{dN}{dt} = -\lambda N \quad \text{---} ①$$

where λ is constant known as decay constant.

The negative sign indicates that N decreases with increase in time.

Eqn. ① can written as,

$$\frac{dN}{N} = -\lambda dt$$

On integrating.

$$\log_e N = -\lambda t + c \quad \text{---} ②$$

where, c is a constant of integration.

At $t = 0$, $N = N_0$

Then $\log_e N_0 = c \quad \text{---} ③$

Substituting for C, eqn. ② becomes,

$$\log_e N = -\lambda t + \log_e N_0$$

$$\log_e N - \log_e N_0 = -\lambda t$$

$$\log_e\left(\frac{N}{N_0}\right) = -\lambda t.$$

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

$$\boxed{N = N_0 e^{-\lambda t}} \quad \text{---} ④$$

Eqn. ④ shows that the number

of atoms of a radioactive substance decreases exponentially with increase in time.

~~Initially the disintegration takes place at a faster rate. As time increases, N gradually decreases~~

Theoritically, an infinite time is required for the Complete disintegration of all the atoms.

## Half life period:

Half life period of a radioactive element is defined as the time taken for one half of the radioactive element to undergo disintegration.

From the law of disintegration,

$$N = N_0 e^{-\lambda t} \quad \text{---} (1)$$

at $t = T_{1/2}$, $N = \frac{N_0}{2}$

Then,

$$\frac{N_0}{2} = N_0 e^{-\lambda T_{1/2}}$$

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

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

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

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

$$\boxed{T_{1/2} = \frac{0.6931}{\lambda}} \quad \text{---} (2).$$

The half life period is inversely proportional to its decay constant.

## (3) Applications of radio-isotopes

### Medical applications.

(1). Radio cobalt ($Co^{60}$) is used in the treatment of Cancer.

(2). Radio Sodium ($Na^{24}$) is used to detect the presence of blocks in blood vesseles.

(3). Radio Iodine ($I^{131}$) is used in the detection of the nature of thyroid gland and also for treatment.

(4). Radio-Iron ($Fe^{59}$) is used to diagnose anemia.

(5). Radio-phosphorous ($P^{32}$) is used in the treatment of skin diseases.

### Agriculture:

(1). In agriculture, radio phosphorous ($P^{32}$) help to increase the crop yields.

(2). Sprouting and spoilage of onions, potatoes, grams etc. are prevented by exposure to a very small amount of radiation.

(3). In industry, the lubricating oil containing radio-isotopes is used to study the wear and tear of the machinery.

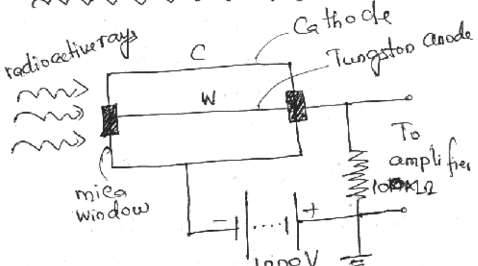
(4). In molecular biology radio isotopes are used in sterilising pharmaceutical and surgical instruments.

(5) Radio Carbon dating:

The $C^{14}$ is radioactive with half life of 5570 years.

The amount of $C^{14}$ in the sample will enable the calculation of time of death ie the age of the specimen could be estimated. This is called radio carbon dating.

## (4) Geiger-Muller Counter




(1). Geiger-Muller Counter is used to measure the intensity of radioactive radiation.

(2). When nuclear radiations pass through gas, ionisation is produced. This is the principle of this device.

3. The G.M. tube consists of a metal tube with glass envelope acting as the Cathode and a fine tungsten wire along the axis of the tube, which acts as anode.
4. The tube is well insulated from the anode wire.
5. The tube is filled with an inert gas like argon at a low pressure
6. One end is fitted with a thin mica sheet and this end acts as a window through which radiations enter the tube
7. A high potential difference of about 1000V is applied between the electrodes through a high resistance of about 100 mega ohm.

Operation:

1. When an ionizing radiation enters the counter, primary ionisation takes place and a few ions are produced.
2. These ions are accelerated with greater energy due to the high potential difference and they cause further ionisation and these ions are multiplied by further collisions.
3. Thus an avalanche of electrons is produced in a short interval of time.
4. This avalanche of electrons on reaching the anode generates a current pulse, which when passing through R develops a potential difference.
5. This is amplified by electronic circuits and is used to operate an electronic counter.
6. The counts in the counter is directly proportional to the intensity of the ionising radiation.
7. G.M. Counter does not distinguish the type of radiation that enters the chamber.

\#.

5. Nuclear reactor

A nuclear reactor is a device in which the nuclear fission reaction takes place in a self sustained and controlled manner.

Fissile material or Fuel:

1. The fissile material or nuclear fuel generally used is ${}_{92}U^{235}$.
2. Other than $U^{235}$, the fissile isotopes $U^{233}$ and $Pu^{239}$ are also used as fuel in some of the reactors.
3. In the pressurised heavy water reactors built in our country natural uranium oxide is used as fuel.
4. Kalpakkam mini reactor (Kamini) is the only operating reactor in the world which uses ${}_{92}U^{233}$ as fuel.

Moderator:

1. The function of a moderator is to slow down fast neutrons produced in the fission process having an average energy of about 2MeV to thermal neutrons with an average energy of about 0.025eV, which are in thermal equilibrium with the moderator.
2. Ordinary water and heavy water are the commonly used moderator.

Control rods:

1. The control rods are used to control the chain reaction.
2. They are very good absorbers of neutrons.
3. The commonly used control rods are made up of elements like boron or cadmium.
4. In our country, all the power reactors use boron carbide ($B_4C$) a ceramic material as control rod.

The Cooling System:

1. The cooling system removes the heat generated in the reactor core.
2. Ordinary water, heavy water and liquid sodium are the

Commonly used coolants.

⑤. A good coolant must possess large specific heat capacity and high boiling point.

Neutron reflectors:

① Neutron reflectors prevent the leakage of neutrons to a large extent, by reflecting them back.

②. In pressurised heavy water reactors the moderator itself acts as the reflector.

Breeder reactor

①. $_{92}U^{238}$ and $_{90}Th^{232}$ are not fissile materials but are abundant in nature.

②. In breeder reactor, these can be converted into a fissile material $_{94}Pu^{239}$ and $_{92}U^{233}$ respectively by absorption of neutrons.

#

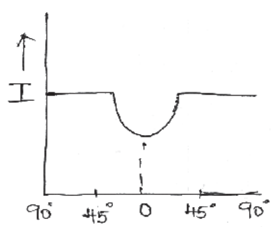
⑥ Cosmic rays

The ionising radiation many times stronger than gamma rays entering the earth from all the directions from cosmic or inter-stellar space is known as cosmic rays.

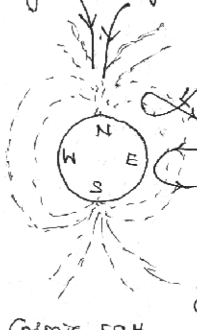
Type: ①. Primary cosmic rays

②. Secondary cosmic rays.

Latitude effect:




Latitude θ →




①. The variation of cosmic ray intensity with geomagnetic latitude is known as latitude effect and is shown in figure.

②. It shows that the intensity is maximum at the poles (θ = 90°) minimum at the equator (θ = 0°) and constant between latitudes of 42° and 90°.

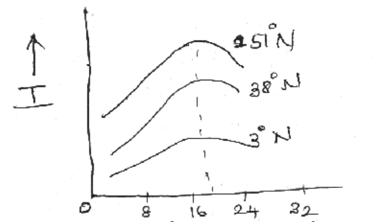
③. The decrease in cosmic ray intensity at the earth's equator is explained to be due to earth's magnetic field.

④. The charged particles approaching the earth near the poles travel almost along the direction of the magnetic lines of force. They experience no force and easily reach the surface of the earth and hence maximum intensity at poles.

⑤. But the charged particles that approach at the equator have to travel in a perpendicular direction to the field and are deflected away.

⑥. Only particles with sufficient energy can reach the equator, while the slow particles are deflected back into cosmos and hence minimum intensity at the equator.

Altitude effect




altitude (h) (km) →

①. The study of variation of cosmic ray intensity with altitude is known as altitude effect and is shown in figure.

②. It is seen that the intensity increases with altitude and reaches a maximum at a height of about 20 km.

③. Above this height there is a fall in intensity.

④. The experimental results are similar at different places of the earth.

#

A

பதிவு எண்
Register Number

# PART - III

# இயற்பியல் / PHYSICS

( தமிழ் மற்றும் ஆங்கில வழி / Tamil & English Versions)

நேரம் : 3 மணி ] [ மொத்த மதிப்பெண்கள் : 150

Time Allowed : 3 Hours ] [Maximum Marks : 150

அறிவுரை : (1) அனைத்து வினாக்களும் சரியாக பதிவாகி உள்ளதா என்பதனை சரிபார்த்துக் கொள்ளவும். அச்சுப்பதிவில் குறையிருப்பின் அறைக் கண்காணிப்பாளரிடம் உடனடியாகத் தெரிவிக்கவும்.

(2) நீலம் அல்லது கருப்பு மையினை மட்டுமே எழுதுவதற்குப் பயன்படுத்த வேண்டும். படங்கள் வரைவதற்கு பென்சில் பயன்படுத்தவும்.

**Instructions :** (1) Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately.

(2) Use Black or Blue ink to write and pencil to draw diagrams.

## பகுதி - I/PART - I

குறிப்பு : (i) **அனைத்து** வினாக்களுக்கும் விடையளிக்கவும். **30x1=30**

(ii) சரியான விடையைத் தேர்ந்தெடுத்து எழுதவும்.

**Note :** (i) Answer **all** the questions.

(ii) Choose and write the **correct** answer.

**1.** மேசர் பொருளாகப் பயன்படுவது :

(அ) டயா காந்த அயனிகள் (ஆ) பாரா காந்த அயனிகள்

(இ) ஃபெரோ காந்த அயனிகள் (ஈ) காந்தத் தன்மையற்ற அயனிகள்

Maser material is :

(a) diamagnetic ions (b) paramagnetic ions

(c) ferromagnetic ions (d) non-magnetic ions

2. கேத்தோடு கதிர்கள் என்பன :

(அ) எலக்ட்ரான் கற்றை (ஆ) நேர்மின் அயனிக்கற்றை

(இ) மின்னூட்டமற்ற துகள் கற்றை (ஈ) புழைக் கதிர்களைப் போன்றவை

The cathode rays are :

(a) a stream of electrons (b) a stream of positive ions

(c) a stream of uncharged particles (d) same as canal rays

3. ஃபோகால்ட், மைக்கல்சன் சோதனையின்படி அடர்வுகுறை ஊடகத்தில் ஒளியின் திசைவேகம் :

(அ) அடர்வு மிகு ஊடகத்தில் உள்ளதைவிட அதிகமாக இருக்கும்

(ஆ) அடர்வு மிகு ஊடகத்தில் உள்ளதைவிட குறைவாக இருக்கும்

(இ) அடர்வு மிகு ஊடகத்தில் உள்ளதற்கு சமமாக இருக்கும்

(ஈ) அடர்வு மிகு ஊடகத்தில் உள்ளதைவிட அதிகமாகவோ அல்லது குறைவாகவோ இருக்கும்.

According to Foucault and Michelson experiment the velocity of light in a rarer medium is :

(a) greater than in a denser medium

(b) lesser than in a denser medium

(c) equal to that in a denser medium

(d) either greater or lesser than in a denser medium

4. $_{26}Fe^{56}$ அணுக்கருவின் ஒரு அணுக்கருத் துகளுக்கான பிணைப்பு ஆற்றல் :

(அ) 8.8 MeV (ஆ) 88 MeV (இ) 493 MeV (ஈ) 413 MeV

The binding energy per nucleon of $_{26}Fe^{56}$ nucleus is :

(a) 8.8 MeV (b) 88 MeV (c) 493 MeV (d) 413 MeV

5. ரேடியோ பரப்பியில் உள்ள R-F அலைவரிசை உருவாக்குவது :

(அ) செவியுணர் சைகைகள்

(ஆ) உயர் அதிர்வெண் ஊர்தி அலைகள்

(இ) செவியுணர் சைகை மற்றும் உயர் அதிர்வெண் ஊர்தி அலைகள்

(ஈ) குறைந்த அதிர்வெண் உடைய ஊர்தி அலைகள்

The R-F channel in a radio transmitter produces :

(a) audio signals

(b) high frequency carrier waves

(c) both audio signal and high frequency carrier waves

(d) low frequency carrier waves

6. ஒரு தொடர் ஒத்திசைவு சுற்றின் தரக் காரணி :

(அ) $Q = \frac{1}{LC}$ (ஆ) $Q = \frac{1}{R}\sqrt{\frac{C}{L}}$ (இ) $Q = \frac{1}{\sqrt{LR}}$ (ஈ) $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

Q factor of series resonant circuit is :

(a) $Q = \frac{1}{LC}$ (b) $Q = \frac{1}{R}\sqrt{\frac{C}{L}}$ (c) $Q = \frac{1}{\sqrt{LR}}$ (d) $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

7. தன்மின்தூண்டல் எண் 0.03 H மதிப்புள்ள மின்தூண்டி மட்டும் இணைக்கப்பட்ட AC சுற்றின் அதிர்வெண் 50 Hz எனில், மின்தூண்டியின் மின்மறுப்பு :

(அ) 3.14 Ω (ஆ) 9.42 Ω (இ) 3 Ω (ஈ) 6.28 Ω

If the frequency of AC circuit connected with an inductor of inductance 0.03 H only is 50 Hz, then inductive reactance is :

(a) 3.14 Ω (b) 9.42 Ω (c) 3 Ω (d) 6.28 Ω

8. கொடுக்கப்பட்ட பரப்பு வழியே செல்லும் மின்விசைக் கோடுகளின் எண்ணிக்கையின் அலகு யாது?

(அ) அலகு இல்லை (ஆ) $NC^{-1}$

(இ) $Nm^2C^{-1}$ (ஈ) Nm

The unit of the number of electric lines of force passing through a given area is :

(a) No unit (b) $NC^{-1}$

(c) $Nm^2C^{-1}$ (d) Nm

9. பண்பேற்றம் செய்யப்படுவதன் முக்கிய நோக்கம் :

(அ) வெவ்வேறு அதிர்வெண் கொண்ட இரு அலைகளை இணைக்க

(ஆ) ஊர்தி அலையின் அலை வடிவத்தைப் பெற

(இ) குறைந்த அதிர்வெண் கொண்ட தகவலை நீண்ட தொலைவுகளுக்குத் திறம்பட அனுப்ப

(ஈ) பக்கப் பட்டைகளை உருவாக்க

The main purpose of modulation is to :

(a) combine two waves of different frequencies

(b) acquire wave shaping of the carrier wave

(c) transmit low frequency information over long distances efficiently

(d) produce side bands

10. N-வகை குறைக்கடத்தியில் உள்ளவை :

(அ) இயக்கமில்லா எதிர்மின் அயனிகள்

(ஆ) சிறுபான்மை ஊர்திகள் அல்ல

(இ) இயக்கமில்லா நேர்மின் அயனிகள்

(ஈ) மின்துளைகள் பெரும்பான்மை ஊர்திகள்

In an N-type semiconductor, there are :

(a) immobile negative ions
(b) no minority carriers
(c) immobile positive ions
(d) holes as majority carriers

11. ஹென்றி என்ற அலகினை இப்படியும் எழுதலாம் :

(அ) Vs $A^{-1}$ (ஆ) Wb $A^{-1}$ (இ) Ω s (ஈ) அனைத்தும்

The unit henry can also be written as :

(a) Vs $A^{-1}$ (b) Wb $A^{-1}$ (c) Ω s (d) all

12. இந்துப்புப் படிகத்தின் அணிக்கோவை இடைவெளி d = 2.82 Å எனில், இப்படிகத்தினைக் கொண்டு முதல் வரிசையில் கணக்கிடப்படும் பெரும அலை நீளம் :

(அ) 2.82 Å (ஆ) 5.64 Å (இ) 11.28 Å (ஈ) 21.76 Å

The longest wavelength that can be analysed by a rock salt crystal of spacing d = 2.82 Å in the first order is :

(a) 2.82 Å (b) 5.64 Å (c) 11.28 Å (d) 21.76 Å

13. கூலிட்ஜ் குழாயில் தோன்றும் சிறப்பு X - கதிர் ஃபோட்டானின் ஆற்றல் எவ்வாறு பெறப்படுகின்றது ?

(அ) இலக்கின் கட்டற்ற எலக்ட்ரான்களின் இயக்க ஆற்றலிலிருந்து

(ஆ) இலக்கின் அயனிகளின் இயக்க ஆற்றலிலிருந்து

(இ) மோதும் எலக்ட்ரான்களின் இயக்க ஆற்றலிலிருந்து

(ஈ) இலக்கின் அணு தாவும் போது

The energy of a photon of characteristic X-ray from a Coolidge tube comes from :

(a) the kinetic energy of the free electrons of the target
(b) the kinetic energy of ions of the target
(c) the kinetic energy of the striking electron
(d) an atomic transition in the target

14. பெரும அயனியாக்கும் திறனைப் பெற்றுள்ளவை :

(அ) நியூட்ரான்கள் (ஆ) $\alpha$ -துகள்கள்

(இ) $\gamma$ -கதிர்கள் (ஈ) $\beta$ -துகள்கள்

The ionisation power is maximum for :

(a) neutrons (b) $\alpha$ - particles

(c) $\gamma$-rays (d) $\beta$-particles

15. 1 kg நிறையுள்ள பொருள் முழுவதுமாக ஆற்றலாக மாற்றப்படும்போது உருவாகும் ஆற்றல் :

(அ) $9\times10^{16}$ J (ஆ) $9\times10^{24}$ J (இ) 1 J (ஈ) $3\times10^{8}$ J

If 1 kg of a substance is fully converted into energy then the energy produced is :

(a) $9\times10^{16}$ J (b) $9\times10^{24}$ J (c) 1 J (d) $3\times10^{8}$ J

16. அணுகுண்டு வெடித்தலில் பயன்படும் தத்துவம் :

(அ) கட்டுப்பாடற்ற அணுக்கரு பிளவை வினை

(ஆ) கட்டுப்பாடான அணுக்கரு பிளவை வினை

(இ) அணுக்கரு இணைவு வினை

(ஈ) வெப்ப அணுக்கரு வினை

The explosion of an atom bomb is based on the principle of :

(a) uncontrolled fission reaction

(b) controlled fission reaction

(c) fusion reaction

(d) thermonuclear reaction

17. தோல் நோய் சிசிச்சைக்குப் பயன்படும் கதிரியக்க ஐசோடோப்பு :

(அ) $Co^{60}$ (ஆ) $Na^{24}$ (இ) $Fe^{59}$ (ஈ) $P^{32}$

The radio-isotope used in the treatment of skin diseases is :

(a) $Co^{60}$ (b) $Na^{24}$ (c) $Fe^{59}$ (d) $P^{32}$

18. 60° தளவிளைவுக் கோணத்திற்கான ஒளிவிலகல் எண் யாது?

(அ) 1.732 (ஆ) 1.414 (இ) 1.5 (ஈ) 1.468

The refractive index of the medium for the polarising angle 60° is :

(a) 1.732 (b) 1.414 (c) 1.5 (d) 1.468

**19.** $\overline{ABC}$ என்ற பூலியன் சமன்பாட்டின் எளிமையாக்கம் :

(அ) $AB + \overline{C}$ (ஆ) $\overline{A} . \overline{B} . \overline{C}$

(இ) $AB + BC + CA$ (ஈ) $\overline{A} + \overline{B} + \overline{C}$

The Boolean expression $\overline{ABC}$ can be simplified as :

(a) $AB + \overline{C}$ (b) $\overline{A} . \overline{B} . \overline{C}$

(c) $AB + BC + CA$ (d) $\overline{A} + \overline{B} + \overline{C}$

**20.** சமமின்னழுத்தப் பரப்பில் உள்ள இரு புள்ளிகளுக்கு இடையே 500 μc மின்னூட்டத்தை நகர்த்த செய்யப்படும் வேலை :

(அ) சுழி (ஆ) வரம்புள்ள நேர்க்குறி மதிப்பு

(இ) வரம்புள்ள எதிர்க்குறி மதிப்பு (ஈ) முடிவிலி

The work done in moving 500 μc charge between two points on equipotential surface is :

(a) zero (b) finite positive

(c) finite negative (d) infinite

**21.** ஒளிவிலகலின் ஸ்நெல்விதியான $\mu = \frac{\sin i}{\sin r}$ -ல், μ -வானது

(அ) sin i -க்கு நேர்த்தகவில் இருக்கும்

(ஆ) sin r -க்கு எதிர்த்தகவில் இருக்கும்

(இ) (அ) மற்றும் (ஆ) ஆகிய இரண்டும்

(ஈ) (அ) மற்றும் (ஆ) -வைச் சார்ந்திராது

In Snell's law of refraction $\mu = \frac{\sin i}{\sin r}$, μ is :

(a) directly proportional to sin i

(b) inversely proportional to sin r

(c) both (a) and (b)

(d) independent of (a) and (b)

22. குறிப்பிட்ட நீளம் கொண்ட தாமிரக்கம்பியின் மின்தடை'R'. அதன் நீளம் இரு மடங்காக்கப்படும் போது, அதன் மின்தடை எண் :

(அ) இரு மடங்காகும் (ஆ) நான்கில் ஒரு பங்காகும்

(இ) நான்கு மடங்காகும் (ஈ) மாறுபடாது

If the length of a copper wire has a certain resistance R, then on doubling its length, its specific resistance :

(a) will be doubled (b) will become $\frac{1}{4}^{th}$

(c) will become 4 times (d) will remain the same

23. ஒரு கட்ட CE பெருக்கியின் நடுத்தர அதிர்வெண் மின்னழுத்தப் பெருக்கம் $A_M$ எனில், தாழ்வு வெட்டு அதிர்வெண்ணில் மின்னழுத்தப் பெருக்கம் :

(ஆ) $\frac{A_M}{2}$ (ஆ) $\sqrt{2}\,A_M$ (இ) $\frac{\sqrt{2}}{A_M}$ (ஈ) $\frac{A_M}{\sqrt{2}}$

In CE single stage amplifier, if the voltage gain at mid-frequency is $A_M$, then the voltage gain at lower cut off frequency is :

(a) $\frac{A_M}{2}$ (b) $\sqrt{2}\,A_M$ (c) $\frac{\sqrt{2}}{A_M}$ (d) $\frac{A_M}{\sqrt{2}}$

24. ஒரு புள்ளி மின்னூட்டத்திலிருந்து 2 m தொலைவில் மின்புலச் செறிவு 400 $Vm^{-1}$. எத்தொலைவில் அதன் மின்புலச் செறிவு 100 $Vm^{-1}$ ஆக அமையும்?

(அ) 50 cm (ஆ) 4 cm (இ) 4 m (ஈ) 1.5 m

Electric field intensity is 400 $Vm^{-1}$ at a distance of 2 m from a point charge. It will be 100 $Vm^{-1}$ at a distance :

(a) 50 cm (b) 4 cm (c) 4 m (d) 1.5 m

25. கம்பிச் சுருளில் இருந்து புறச்சுற்றுக்கு மின்னோட்டத்தை பாயச் செய்யும் மாறுதிசை மின்னியற்றியின் உறுப்பு :

(அ) புலக்காந்தம் (ஆ) பிளவுபட்ட வளையம்

(இ) நழுவு வளையங்கள் (ஈ) தூரிகைகள்

The part of the AC generator that passes the current from the coil to the external circuit is :

(a) field magnet (b) split rings

(c) slip rings (d) brushes

26. ஒரு சிவப்பு ஒளிக்கற்றையிலிருந்து விளிம்பு விளைவு பெறப்படுகின்றது. சிவப்பு ஒளிக்கு பதிலாக நீல ஒளியைப் பயன்படுத்தினால் ஏற்படுவது என்ன?

(அ) பட்டைகள் மறைந்து விடும்

(ஆ) எதுவும் மாறாது

(இ) விளிம்பு விளைவு வரிசை குறுகலடையும் மற்றும் கூட்டமாக ஒன்று சேரும்

(ஈ) விளிம்பு விளைவு வரிசை அகலமடையும் மற்றும் ஒன்றை விட்டு ஒன்று பிரியும்

A diffraction pattern is obtained using a beam of red light. What happens if the red light is replaced by blue light ?

(a) bands disappear

(b) no change

(c) diffraction pattern becomes narrower and crowded together

(d) diffraction pattern becomes broader and farther apart

27. பயட் - சாவர்ட் விதியின் சமன்பாடு :

(அ) $dB = \frac{\mu_0}{4\pi}\frac{Idl}{r^2}$

(ஆ) $\vec{dB} = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}$

(இ) $\vec{dB} = \frac{\mu_0}{4\pi}\frac{I\vec{dl} \times \vec{r}}{r^2}$

(ஈ) $\vec{dB} = \frac{\mu_0}{4\pi}\frac{I\vec{dl} \times \vec{r}}{r^3}$

Which of the following equations represents Biot - Savart law ?

(a) $dB = \frac{\mu_0}{4\pi}\frac{Idl}{r^2}$

(b) $\vec{dB} = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}$

(c) $\vec{dB} = \frac{\mu_0}{4\pi}\frac{I\vec{dl} \times \vec{r}}{r^2}$

(d) $\vec{dB} = \frac{\mu_0}{4\pi}\frac{I\vec{dl} \times \vec{r}}{r^3}$

28. இருபுள்ளி மின்னூட்டங்கள் $+q_1$ மற்றும் $+q_2$ காற்றில் 2 மீ தொலைவில் வைக்கப்பட்டுள்ளன. இதில் ஒரு மின்னூட்டத்தை மற்றொன்றை நோக்கி 1 மீ. தொலைவிற்கு நகர்த்த செய்யப்படும் வேலை :

(அ) $\frac{q_1q_2}{4\pi\epsilon_0}$ (ஆ) $\frac{2q_1q_2}{4\pi\epsilon_0}$ (இ) $\frac{q_1q_2}{8\pi\epsilon_0}$ (ஈ) $\frac{q_1q_2}{16\pi\epsilon_0}$

Two point charges $+q_1$ and $+q_2$ are placed in air at a distance of 2 m apart. One of the charges is moved towards the other through a distance of 1 m. The work done is :

(a) $\frac{q_1q_2}{4\pi\epsilon_0}$ (b) $\frac{2q_1q_2}{4\pi\epsilon_0}$ (c) $\frac{q_1q_2}{8\pi\epsilon_0}$ (d) $\frac{q_1q_2}{16\pi\epsilon_0}$

29. சீரான காந்தப்புலத்தில் செங்குத்தான திசையில் ஒரு புரோட்டானும், ஒரு $\alpha$ - துகளும் ஒரே திசைவேகத்தில் செலுத்தப்படும்போது, அவற்றின் மீது செயல்படும் காந்தவியல் லொரன்ஸ் விசைகளின் விகிதம் முறையே :

(அ) 1 : 1 (ஆ) 1 : 2 (இ) 2 : 1 (ஈ) 1 : 0

A proton and an $\alpha$ particle are projected with the same velocity normal to a uniform magnetic field. The ratio of the magnetic Lorentz force experienced by the proton and the $\alpha$ particle is :

(a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) 1 : 0

30. பருப்பொருளின் அலைநீளம் எதனைச் சார்ந்ததல்ல ?

(அ) நிறை (ஆ) திசைவேகம் (இ) உந்தம் (ஈ) மின்னூட்டம்

The wavelength of the matter wave is independent of :

(a) mass (b) velocity (c) momentum (d) charge

## பகுதி - II / PART - II

**குறிப்பு : எவையேனும் பதினைந்து** வினாக்களுக்கு விடையளிக்கவும். **15x3=45**

**Note :** Answer **any fifteen** questions.

31. நிலை மின்னியலில் காஸ் விதியைக் கூறுக.

State Gauss's law in electrostatics.

32. இடி மின்னலின் போது ஒரு மரத்தினடியில் இருப்பதை விட காரின் உள்ளே இருப்பது பாதுகாப்பானது ஏன்?

Why is it safer to be inside a car than standing under a tree during lightning ?

33. இழுப்பு திசைவேகம் என்றால் என்ன? அதன் அலகு யாது?
Define drift velocity. Give its unit.

34. 0°C -ல் நிக்ரோம் கம்பியின் மின்தடை 10 Ω. அதன் மின்தடை வெப்பநிலை எண் 0.004/°C. நீரின் கொதிநிலையில் அதன் மின்தடையைக் கணக்கிடுக.
The resistance of nichrome wire at 0°C is 10 Ω. If its temperature coefficient of resistance is 0.004/°C find its resistance at boiling point of water.

35. ஃபாரடேயின் மின்னாற்பகுத்தல் விதிகளைக் கூறுக.
State Faradays laws of electrolysis.

36. தாம்சன் குணகம் - வரையறு.
Define Thomson Coefficient.

37. மின்மாற்றியின் பயனுறு திறன் என்றால் என்ன?
What is efficiency of a transformer ?

38. ஒரு சுருளில் பாயும் 4 A மின்னோட்டம் 0.5 s காலத்தில் 8 A ஆக மாறும்போது மற்றொரு சுருளில் 50 mV மின்னியக்கு விசை தூண்டப்படுகிறது எனில், அவ்விரு சுருள்களுக்கிடையே உள்ள பரிமாற்று மின்தூண்டல் எண்ணைக் கணக்கிடுக.
Calculate the mutual inductance between two coils when a current of 4 A changing to 8 A in 0.5 s in one coil, induces an emf of 50 mV in the other coil.

39. மின்காந்த அலைகளின் சிறப்பியல்புகள் மூன்றினைக் கூறுக.
Mention any three characteristics of electromagnetic waves.

40. தளவிளைவு மானியில் 60 cc சர்க்கரைக் கரைசல் 300 மி.மீ. நீளம் கொண்ட சோதனைக் குழாயினுள் வைக்கப்படும்போது 9° சுழற்றப்படுகிறது. சுழற்சித் திறன் 60° எனில் கரைசலில் உள்ள சர்க்கரையின் அளவு என்ன?
A 300 mm long tube containing 60 cc of sugar solution produces a rotation of 9° when placed in a polarimeter. If the specific rotation is 60°, calculate the quantity of sugar contained in the solution.

41. மில்லிகனின் எண்ணெய்த் துளி ஆய்வின் தத்துவத்தினை எழுதுக.
Write the principle of Millikan's oil drop experiment.

**42.** மோஸ்லே விதியின் பயன்பாடுகளை எழுதுக.

Write the applications of Mosley's law.

**43.** எலக்ட்ரான் நுண்ணோக்கியின் வரம்புகள் யாவை?

What are the limitations of electron microscope ?

**44.** $_{84}Po^{214}$ கதிரியக்க ஐசோடோப்பு அடுத்தடுத்து இரு α-சிதைவுகளையும், இரு β-சிதைவுகளையும் ஏற்படுத்தும்போது உருவாகும் ஐசோடோப்பின் அணு எண் மற்றும் நிறை எண்ணைக் கணக்கிடுக.

The radioactive isotope $_{84}Po^{214}$ undergoes a successive disintegration of two α - decays and two β - decays. Find the atomic number and mass number of the resulting isotope.

**45.** உற்பத்தி உலை என்றால் என்ன?

What is a breeder reactor ?

**46.** பொது அடிவாய் டிரான்சிஸ்டர் சுற்றில் $I_c = 15$ mA மற்றும் $I_B = 30$ μA எனில், மின்னோட்டப் பெருக்கம். α-ன் மதிப்பைக் கணக்கிடுக.

The base current of a transistor is 30 μA and collector current is 15 mA. Determine the value of current gain α .

**47.** எதிர்பின்னூட்டத்தின் நற்பயன்கள் எவையேனும் மூன்றினை எழுதுக.

Write any three advantages of negative feedback.

**48.** ஒளி உமிழ் டையோடு என்பது யாது? அதன் பயன்களில் ஏதேனும் ஒன்றை எழுதுக.

What is light emitting diode ? Give any one of its uses.

**49.** NOT கேட்டாகப் பயன்படும் டிரான்சிஸ்டர் மின்சுற்றை வரைக.

Draw the circuit for NOT gate using transistor.

**50.** ஒளி இழைத் தகவல் தொடர்பின் நற்பண்புகளில் எவையேனும் மூன்றினைக் கூறுக.

Mention any three advantages of fibre optical communication system.

பகுதி - III / PART - III

குறிப்பு : (i) வினா எண் 56 -க்கு கண்டிப்பாக விடையளிக்கவும். 7x5=35

(ii) மீதமுள்ள 11 வினாக்களில் எவையேனும் ஆறு வினாக்களுக்கு விடையளிக்க வேண்டும்.

(iii) தேவையான இடங்களில் படங்களை வரைக.

Note : (i) Answer question No. 56 **compulsorily**.

(ii) Answer **any six** of the remaining **11** questions.

(iii) Draw diagrams wherever necessary.

51. ஒரு இணைத்தட்டு மின்தேக்கியின் மின்தேக்கு திறனுக்கான கோவையைப் பெறுக.

Derive an expression for the capacitance of a parallel plate capacitor.

52. வோல்ட் மீட்டரைப் பயன்படுத்தி மின்கலத்தின் அகமின்தடையைக் காணும் முறையை விவரி.

Describe the experiment to determine the internal resistance of a cell using voltmeter.

53. மின்னழுத்த மானியின் தத்துவத்தைப் படத்துடன் விவரி.

Explain the principle of a potentiometer with a neat diagram.

54. 100 சுற்றுகளும், 20 செ.மீ. ஆரமும் கொண்ட கம்பிச் சுருளின் வழியே, 5 A மின்னோட்டம் பாய்கிறது. கம்பிச்சுருளின் அச்சின் மீது அதன் மையத்திலிருந்து 20 செ.மீ. தொலைவில் காந்தத் தூண்டலின் மதிப்பினைக் கணக்கிடுக.

A circular coil of radius 20 cm has 100 turns wire and it carries a current of 5 A. Find the magnetic induction at a point along its axis at a distance of 20 cm from the centre of the coil.

55. ஒரு சுருள் உள்ளடங்கும் பரப்பளவை மாற்றுவதன் மூலம் அதில் மின்னியக்கு விசையைத் தூண்டும் விதத்தை விளக்குக.

Explain how an emf can be induced by changing the area enclosed by the coil.

56. 1 செ.மீ. அகலத்தில் 5000 கோடுகள் வரையப்பட்ட விளிம்பு விளைவுக் கீற்றிணியின் மீது ஓரியல் மூலத்தில் இருந்து இணைக்கற்றை ஒளியானது படும்படி வைக்கப்படுகின்றது. இரண்டாம் வரிசை பிம்பம் 30° கோணத்தில் ஏற்பட்டால் ஒளியின் அலைநீளம் என்ன?

**அல்லது**

யங் சோதனையில் $6 \times 10^{14}$ Hz அதிர்வெண் உடைய ஒளி பயன்படுத்தப்படுகிறது. அடுத்தடுத்த இருபட்டைகளின் மையங்களுக்கு இடைப்பட்ட தொலைவு 0.75 மி.மீ. 1.5 மீ. தொலைவில் திரை இருப்பின், பிளவுகளுக்கு இடைப்பட்ட தொலைவினைக் கணக்கிடுக.

A parallel beam of monochromatic light is allowed to incident normally on a plane transmission grating having 5000 lines per centimetre. A second order spectral line is found to be diffracted at an angle of 30°. Find the wavelength of the light.

**OR**

In Young's experiment a light of frequency $6 \times 10^{14}$ Hz is used. Distance between the centres of adjacent fringes is 0.75 mm. Calculate the distance between the slits if the screen is 1.5 m away.

57. X-கதிர் விளிம்பு விளைவிற்கான பிராக் விதியைக் பெறுக.
Derive Bragg's law for X-ray diffraction.

58. ஒளியின் விளைவு என்றால் என்ன? ஒளிமின் உமிழ்தலின் விதிகளைக் கூறுக.
What is photoelectric effect ? State the laws of photoelectric emission.

59. துகள் ஒன்றின் நிறை அதன் ஒய்வு நிறையைப் போல மூன்று மடங்கு எனில், துகள் இயங்கும் திசைவேகம் யாது?
At what speed is a particle moving if the mass is equal to three times its rest mass ?

60. $\alpha$ - கதிர்களின் (ஆல்ஃபா கதிர்களின்) பண்புகளில் எவையேனும் ஐந்தினை எழுதுக.
Write any five properties of $\alpha$ - rays (Alpha rays).

61. சௌனர் டையோடு மின்னழுத்த சீரமைப்பானாக செயல்படுவதை விவரி.
Describe the action of zener diode as a voltage regulator.

62. செயற்கைக்கோள் தகவல் தொடர்பின் நன்மைகள் மற்றும் குறைபாடுகள் யாவை?
What are the merits and demerits of satellite communication system ?

## பகுதி - IV / PART - IV

குறிப்பு : (i) எவையேனும் நான்கு வினாக்களுக்கு விடையளிக்கவும். 4x10=40

(ii) தேவைப்படும் இடங்களில் படங்கள் வரைக.

Note : (i) Answer any four questions in detail.

(ii) Draw diagrams wherever necessary.

63. மின் இருமுனை என்றால் என்ன? மின் இருமுனையின் நடுவரைக் கோட்டிலுள்ள ஒரு புள்ளியில் மின்புலத்திற்கான கோவையைப் பெறுக.

What is an electric dipole ? Derive an expression for the electric field due to an electric dipole at a point on the equatorial line.

64. சைக்ளோட்ரானின் தத்துவம், அமைப்பு மற்றும் இயங்கும் விதம் ஆகியவற்றை விவரி.

Explain in detail the principle, construction and working of a cyclotron.

65. மாறுதிசை மின்னியக்குவிசை மூலம் ஒன்று தொடர் இணைப்பிலுள்ள மின்தடையாக்கி 'R' மின்தூண்டி 'L' மற்றும் மின்தேக்கி 'C' ஆகியவற்றுடன் இணைக்கப்பட்டுள்ளது. மின்னழுத்த கட்டப்படம் மற்றும் மின்னெதிர்ப்பு படம் ஆகியவற்றைக் கொண்டு

(i) தொகுபயன் மின்னழுத்தம்

(ii) மின்னெதிர்ப்பு

(iii) மின்னோட்டம் மற்றும் மின்னழுத்தம் இடையேயான கட்டத்தொடர்பு ஆகியவற்றுக்கான சமன்பாடுகளை வருவி.

A source of alternating emf is connected to a series combination of a resistor 'R', an inductor 'L' and a capacitor 'C'. Obtain with the help of a voltage phasor diagram and impedance diagram an expression for :

(i) the effective voltage

(ii) the impedance

(iii) the phase relationship between the current and the voltage.

66. ஹைஜன்ஸ் தத்துவத்தைக் கூறுக. அலைக் கொள்கையைப் பயன்படுத்தி எதிரொளிப்பு விதிகளை நிரூபி.

State Huygen's principle. On the basis of wave theory prove the laws of reflection.

67. He - Ne லேசரின் தெளிவான படம் வரைந்து அதன் செயல்பாட்டை ஆற்றல் மட்ட வரைபடத்தின் உதவியுடன் விளக்குக.

Draw a neat diagram of He-Ne laser and explain its working with the help of energy level diagram.

68. கதிரியக்க சிதைவு விதியைக் கூறுக. $N = N_0 e^{-\lambda t}$ என்ற கோவையைப் பெறுக. அரை ஆயுட்காலம் மற்றும் சிதைவு மாறிலி இவற்றிற்கு இடைப்பட்ட தொடர்பை பெறுக.

State the radioactive law of disintegration. Establish the relation $N = N_0 e^{-\lambda t}$. Derive the relation between half life period and decay constant.

69. செயல்பாட்டுப் பெருக்கி என்றால் என்ன? மின்சுற்றுப்படத்துடன் ஒரு செயல்பாட்டுப் பெருக்கி எவ்வாறு கூட்டும் பெருக்கியாகச் செயல்படுகிறது என்பதை விவரி.

What is an operational amplifier ? With a circuit diagram, explain the working of an operational amplifier as a summing amplifier.

70. கருப்பு வெள்ளை தொலைக்காட்சி ஒளிபரப்பியின் செயல்பாட்டை கட்டப்படம் வரைந்து விளக்குக.

Describe monochrome TV transmission with a block diagram.

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