1. Electrostatics

1. What is meant by quantisation of charge ?

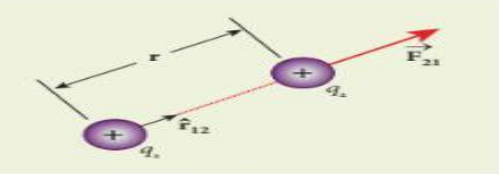
$$q = n e$$

The charge q on any object is equal to an integral multiple of fundamental unit of charge e . This is called quantisation of electric charge.

Charge of electron = - 1.6 X 10^{-19} C . n is any integer (0 , ± 1 , ± 2 , ± 3 …)

2.Write down the Coulomb's law in vector form and mention what each term represents.

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



$$\vec{F}_{21} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}\hat{r}_{12}$$

3.What are the differences between Coulomb force and gravitational force?

S.No	Coulomb Force	Gravitational Force
1.	It may be attractive or repulsive.	It is always attractive in nature
2.	It depends upon medium.	It does not depend upon the medium.
3.	It is always greater in magnitude . $K = 9 \times 10^9 \ N m^2 \ C^{-2}$	It is lesser than Coulomb force. $G = 6.67 \times 10^{-11} \ N m^2 \ kg^{-2}$

---

4. Write short note on superposition principle.

When a number of charges are interacting the total force of a given charge is the vector sum of the individual forces exerted on the given charge by all the other charges.

$$\vec{F}_{1\,tot} = \vec{F}_{12} + \vec{F}_{13} + \vec{F}_{14} + \ldots\ldots\ldots + \vec{F}_{1n}$$

$$F_{1\,tot} = K\left\{\frac{q_1 q_2}{r_{21}^2} r_{21} + \frac{q_1 q_3}{r_{31}^2} r_{31} + \ldots\ldots\ldots \frac{q_1 q_n}{r_{n1}^2} r_{n1}\right\}$$

---

5. Define electric field .

The electric field at the point P at a distance r from the point charge q is the force experienced by a unit charge and is given by

S I unit : N C^{-1}

$$\vec{E} = \frac{\vec{F}}{q_0} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2} r$$

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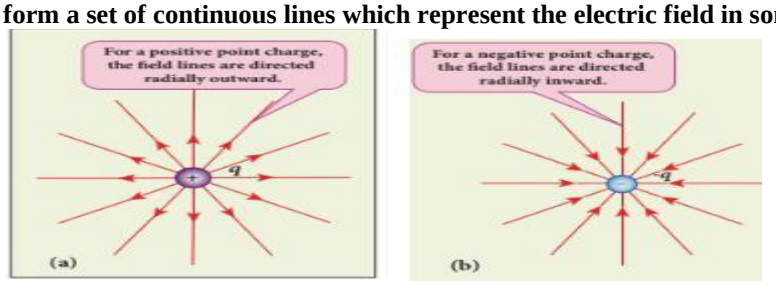
6. What is meant by " electric field lines " ?

- **Electric field vectors are visualized by the concept of electric field lines.**
- **They form a set of continuous lines which represent the electric field in some region of space visually.**



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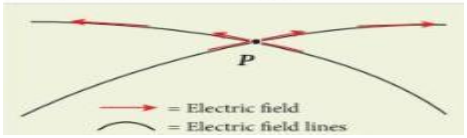
7. The electric field lines never intersect . Justify.

If some charge is placed in the intersection point , then it has to move in two different directions at the same time which is physically impossible. Hence , electric field lines do not intersect.



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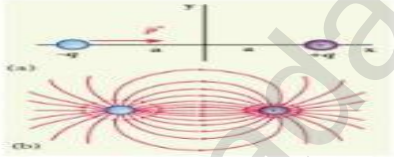
8. Define electric dipole . Give the expression for the magnitude of its electric dipole moment and the direction.

Electric Dipole :

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

Example : C o , H Cl , Ammonia

$$\vec{p} = 2\,q\,a\,\hat{i}$$



Magnitude of electric dipole moment :

The product of magnitude of one of the charges and distance between them. $|\vec{P}| = 2\,q\,a$

---

9. Write the general definition of electric dipole moment for a collection of point charge.

The electric dipole moment for a collection of ' n ' point charges is given by

$$\vec{p} = \sum_{i=1}^{n} q_i \, r_i$$

r_i → Position vector of charge qi . S I Unit : Coulomb meter (C m)

---

10. Define ' electrostatic potential ".

Electric potential at a point P is equal to the work done force to bring unit positive charge with constant velocity from infinity to the point P in the region of the external electric field.

$$V_P = -\int_{P}^{\infty} E \, .d\, r$$

$$V = \frac{1}{4\pi\epsilon_0}\,\frac{q}{r}$$

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11. What is an equipotential surface ?

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

---

12. What are the properties of an equipotential surface ?

1. The work done to move a charge q between any two points A and B , $W = q (V_A - V_B)$.

2. If the points A and B lie on same equipotential surface Work done is zero because $V_A = V_B$

3. The electric field is always normal to an equipotential surface.

---

13. Give the relation between electric field and electric potential.

- **Consider a positive charge q kept fixed at the origin .**
- **To move a unit positive charge by a small distance dx towards q in electric field E.**
- **The work done is given by $dW = - E\, dx$.**
- **The minus sign implies that work done against the electric field.**
- **This work done is equal to electric potential difference.**
- **The electric field is negative gradient of electric potential.**

$$1.\ dW = dV$$

$$2.\ dV = -E\, dx$$

$$3.\ E = -\frac{dV}{dx}$$

---

14. Define electrostatic potential energy.

Electric potential energy is defined as the work done in bringing the various charges to their respective positions from infinitely large mutual separation.

---

15. Define electric flux.

The number of electric field lines crossing given area kept normal to be electric field lines is called " electric flux " .

$$\phi_E = E \cdot A = E\, A \cos\theta$$

It is a scalar quantity . S I unit : $N\ m^2\ C^{-1}$.

---

16. What is meant by electrostatic energy density ?

$$u_E = \frac{U}{\text{Volume}} = \frac{1}{2}\varepsilon_0 E^2$$

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

---

17. Write a short note on electrostatic shielding.

- **The phenomenon of protecting a region of space from any external electric field is called as " electrostatic shielding "**
- **Consider a cavity inside the conductor whatever the charges at the surfaces and whatever the electrical disturbances outside , the electric field inside cavity is zero. Ex : Faraday Cage**

---

18. What is polarization ?

Polarization $\vec{p}$ is defined as the total dipole moment per unit volume of dielectric. $\vec{P} = \chi_e \vec{E}_{ext}$

$\chi_e \longrightarrow$ **Electric Susceptibility**

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19.What is dielectric strength ?

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

For example : Dielectric strength of air 3 X 10^6 V m^{-1}

---

20. Define capacitance . Give its unit.

The capacitance of a capacitor is defined as the ratio of the magnitude of charge on either of the conductor plates to the potential differences existing between them.

$$C = \frac{Q}{V}$$

SI unit : Coulomb per volt or farad (F)

---

21. What is corona discharge ?

- **The total charge of the charged conductor near the sharp edge reduces.**
- **Leakage of charges from the sharp points to the charged conductor.**
- **Corona discharge also known as " action of points "**

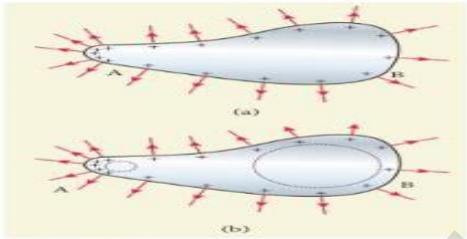

Figure 1.61 Action of points or corona discharge

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2. Current Electricity

1.Why current is a scalar ?

Current is defined as scalar product of current density and area vector in which charges cross. $I = \vec{J} \cdot \vec{A}$

2.Define current density.

The current per unit area of cross section of the conductor is called current density. $J = \frac{I}{A}$

SI Unit : A m^{-2}

---

3. Distinguish between drift velocity and mobility.

S.NO	Drift Velocity	Mobility
1.	Average velocity acquired by electron inside the conductor when it is subjected to an electric field.	Magnitude of drift velocity per unit electric field.
2.	It is a vector quantity.	It is a scalar quantity.
3.	S I Unit : m s^{-1}	S I Unit : $m^2 V^{-1} s^{-1}$
4.	$\vec{V_d} = a\vec{\tau} = = -\mu \vec{E}$	$\mu = \frac{\lvert \vec{V_d} \rvert}{\lvert \vec{E} \rvert} = \frac{-e\tau}{m}$

---

4. State microscopic form of Ohm's law.

Microscopic form of Ohm's law : $\vec{J} = \sigma \vec{E}$

J ⟶ Current density

σ ⟶ Conductivity

E ⟶ Electric field

---

5. State macroscopic form of Ohm's law.

The potential difference across a given conductor is directly proportional to the current passing through it when the temperature remains constant .

V ⟶ Potential Difference

I ⟶ Current

R ⟶ Resistance

$V = I R$

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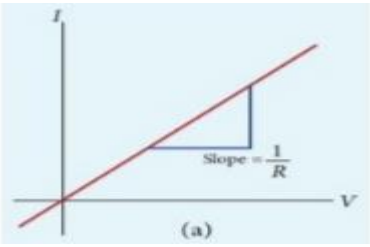
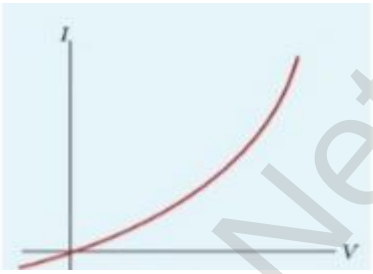
6. What are ohmic and non ohmic device ?

S.NO	Ohmic Device	Non Ohmic Device
1.	Material or devices that obey Ohm's law.	Material of devices that do not obey Ohm's law.
2.	A graph of I against V is linear .(straight line)	A graph of I against V is non-linear
3.		

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7. Define electrical resistivity .

$$\rho = \frac{R A}{l}$$

It is defined as resistance offered to current flow by a conductor of unit length having unit area of cross section. S I unit : Ω m

---

8.Define temperature coefficient of resistance.

It is defined as the ratio of increase in resistivity per degree rise in temperature to its resistivity.

$$\alpha = \frac{\rho_T - \rho_0}{\rho (T - T_0)} = \frac{\Delta \rho}{\rho \Delta T}$$

9.Write a short note on super conductor.

The resistance of certain materials become zero below certain temperature T_C . This temperature is known as critical temperature or transition temperature . The materials which exhibit this property are known as super conductor. Ex : Mercury exhibits super conductor at 4.2 K [R = 0]

10.What is electric power and electric energy?

Electric Power :

The rate at which the electrical potential energy is used. Unit : Watt

$$P = \frac{W}{t} = V I$$

Electrical Energy :

Electrical energy is the product of electric power and time. Unit : Watt hour (1 K W h = 3.6 X 10^6 J)

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11. Derive the expression for power P = V I in electrical circuit.

1. $P = \frac{dU}{dt}$ ($dU = V\,dQ$)

2. $P = V\frac{dQ}{dt} = V\,I$

---

12. Write down the various forms of expressions for power in electrical circuits.

Power : P = V I **Ohm's Law : V = I R**

1. $P = (I\,R)\,I = I^2\,R$ **2.** $P = V\left(\frac{V}{R}\right) = \frac{V^2}{R}$

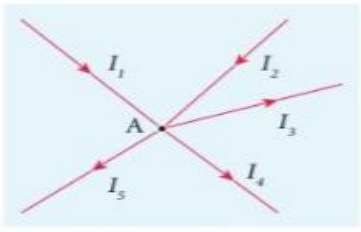
---

13. State Kirchoff's current rule.

Kirchhoff's First Rule: (Current rule or junction rule)

- **It states that the algebraic sum of currents of any junction of a circuit is zero.**
- **Charge enter a junction must leave the junction.**
- **Current enter junction as positive, current leave junction as negative.**

$I_1 + I_2 = I_3 + I_4 + I_5$



Kirchhoff's current rule

---

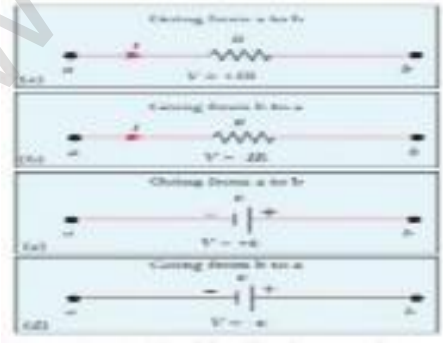
14. State Kirchhoff's voltage rule.

Kirchhoff's Second Rule: (Voltage rule or loop rule)

In a closed circuit the algebraic sum of the products of the current and resistance of each part of the circuit is equal to total emf included in the circuit.

Product of current and resistance is taken as positive V = + I R

Product of current and resistance is taken as negative V = - I R



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15. State the principle of potentiometer.

$\varepsilon \alpha l$
$\varepsilon = I r l$

The emf of the cell is directly proportional to the balancing length.

When constant current flows through a wire of uniform cross – sectional area , the potential drop across any length of the wire is directly proportional to that length.

---

16. What do you mean by internal resistance of a cell ?

The battery is made of electrodes and electrolyte , there is resistance to the flow of charges with in the battery This resistance is called " Internal resistance "

---

17. State Joule's law of heating.

It states that , Heat developed in an electrical circuit due to flow of current varies directly as, $H = I^2 R t$

1. Square of the current 2. Resistance of the circuit 3. Time of flow of current

---

18. What is Seeback effect.

- **Seeback discovered that in a closed circuit consisting of two dissimilar metals , when junctions are maintained at different temperatures an emf is developed.**
- **The current that flows due to the emf developed is called " thermoelectric current ".**
- **Two dissimilar metal connected to form two junctions is known as "Thermocouple"**

---

19. What is Thomson effect ?

- **If two points in a conductor are at different temperatures , the density of electrons at these points will be different.**
- **Due to difference in electron density , the potential difference is created.**

---

20. What is Peltier effect ?

When current is passed through a thermocouple , heat is evolved at one junction and absorbed at other junction. This is known as Peltier effect.

---

21. State the applications of Seeback effect.

1. **Used in thermoelectric generators to convert waste heat into electricity.**
2. **Used in automobiles for increasing fuel efficiency.**
3. **Used in thermocouples and thermopiles to measure the temperature difference.**

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3. Magnetism & Magnetic effects of electric current

1. What is meant by magnetic field ?

The magnetic field $\vec{B}$ at a point is defined as a force experienced by a bar magnet of unit pole strength. Its unit is $N\ A^{-1}\ m^{-1}$

$$\vec{B} = \frac{\vec{F}}{q_m}$$

---

2. Define magnetic flux.

The number of magnetic field lines crossing per unit area is called magnetic flux Φ_B .

- Scalar Quantity. Dimension : $M\ L^2\ T^{-2}\ A^{-1}$
- SI unit : weber CGS unit : maxwell

$$\Phi_B = \vec{B} \cdot \vec{A} = B\,A\,\cos\theta$$

1 weber = 10^8 maxwell

---

3. Define magnetic dipole moment.

$$\vec{p_m} = q_m \vec{d} = 2\,q_m\,l$$

- Product of pole strength and magnetic length.

It is a vector quantity. It is denoted by $\vec{P_m}$. SI Unit : $A\ m^2$

---

4. State Coulomb' s inverse law.

The force of attraction or repulsion between two magnetic poles is directly proportional to product of their pole strength and inversely proportional to square of distance between them.

$$F \propto \frac{q_{mA}\,q_{mB}}{r^2}\,\hat{r}$$

$$F = \frac{\mu_0}{4\pi}\frac{q_{mA}\,q_{mB}}{r^2}\,\hat{r}$$

$$K = \frac{\mu_0}{4\pi} = 10^{-7}\ H\ m^{-1}$$

---

5. What is magnetic susceptibility ?

It is defined as the ratio of the intensity of magnetization ($\vec{M}$) induced in the material to the applied magnetizing field $\vec{H}$. It is a dimensionless quantity.

$$\chi_m = \frac{|\vec{M}|}{|\vec{H}|}$$

---

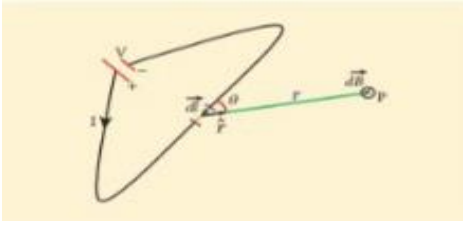
6. State Biot – Savart's law .

Magnetic field due to current element is

- Directly as strength of current I
- Directly as length of element dl
- Directly as sine of angle θ between dl and r
- Inversely as square as distance r

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

$$dB = \frac{\mu_0}{4\pi}\frac{I\,dl\,\sin\theta}{r^2}$$



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7. What is magnetic permeability ?

- **Measure of ability of the material to allow the passage of magnetic field lines.**
- **Measure of capacitance of the substance to take magnetisation.**
- **Degree of penetration of magnetic field through the substance.**

---

8. State Ampere's circuital law.

The line integral of the magnetic field over a closed loop μ_0 times net current enclosed by loop

$$\oint_C \boldsymbol{B}.d\boldsymbol{l} = \mu 0 \ I_{\text{enclosed}}$$

---

9. Compare dia , para, ferro magnetism. (or)18.Give the properties of dia , para ,ferro materials.

Properties	Dia Magnetism	Para Magnetism	Ferro Magnetism
1. Magnetic susceptibility	χ_m is negative	χ_m is positive & small	χ_m is positive & large
2.Susceptibility	Temperature independent	$\chi_m \ \alpha \ \frac{1}{T}$	$\chi_m = \frac{C}{T - T_C}$
3. Relative Permeability	μ_r less than unity	μ_r greater than unity	μ_r is large
4. Magnetic field lines	Repelled or expelled when placed in magnetic field .	Attracted when placed in magnetic field.	Strongly attracted when placed in a magnetic field.
5. Examples	Bismuth , Copper , Water	Aluminium , Platinum , Chromium , Oxygen	Iron , Nickel , Cobalt

---

10. What is meant by hysteresis ?

The phenomenon of lagging of magnetic induction behind the magnetising field is called hysteresis.

Hysteresis means " lagging behind " .

---

11. Define magnetic declination and inclination.

Magnetic Declination :

Angle between magnetic meridian at a point and geographical meridian.

Magnetic Inclination :

Angle subtended by Earth's total magnetic field with horizontal direction in magnetic meridian.

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12. What is resonance condition in cyclotron ?

When the frequency ' f ' at which the positive ion circulates in the magnetic field becomes equal to the constant frequency of the electrical oscillator f_{osc}. This is called as " resonance condition".

$$f_{osc} = \frac{q\ B}{2\ \pi\ m}$$

---

13. Define one ampere.

One ampere is defined as that constant current which when passed through each of the two infinitely long parallel straight conductor kept side by side parallelly at a distance of one meter apart in air or vacuum causes each conductor to experience force of 2×10^{-7} newton per meter length of conductor.

14.State Fleming's left hand rule.

Stretch out fore finger , the middle finger and the thumb of the left hand such that they are in three mutually perpendicular directions.

- **Fore finger points in the direction of magnetic field.**
- **Middle finger points in the direction of the electric current.**
- **Thumb points in the force experienced by the conductor.**

---

15. Is an ammeter connected in series or parallel in a circuit . why ?

The ammeter is connected in series in a circuit because it si a low resistance instrument. Such that it will not change the current passing through it.

---

16. Explain the concept of velocity selector.

By proper choice of electric field $\vec{E}$ and magnetic field $\vec{B}$ inside an arrangement

- **such as Bainbridge mass spectrometer.**
- **The particle with particular speed can be selected .**
- **This speed is independent of mass and charge.**
- **Such an arrangement of fields is called velocity selector**

$$V = \frac{E}{B}$$

---

17. Why is the path of a charged particle not a circle when its velocity is not perpendicular to the magnetic field ?

- **If a charged particle moves in uniform magnetic field , then velocity of a particle is split up into two components :**

1. **One component parallel to the field which remains unchanged.**
2. **Other component perpendicular to the field keeps changing due to Lorentz force.**
3. **Hence , the path of particle is not a circle. It is a helical around field lines.**

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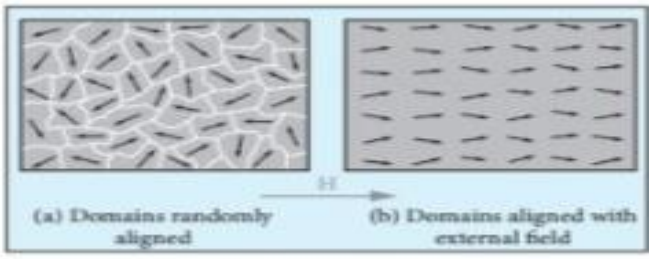
19. What happens to the domains in a ferromagnetic material in the presence of external magnetic field ?

1. The domains having magnetic moments parallel to the field grow bigger in size.

2. The other domains are rotated so that they are aligned with the field.



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20. How is a galvanometer converted into i) an ammeter ii) a voltmeter.

1. A galvanometer can be converted into an ammeter of given range by connecting a suitable low resistance S called shunt in parallel to the galvanometer.

2. A galvanometer can be converted into a voltmeter by connecting a suitable high resistance R called shunt in parallel to the galvanometer.

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5.Electromagnetic waves

1. What is displacement current ?

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

$$i_d = \varepsilon_0 \frac{d \Phi_E}{d t}$$

---

2. What are electromagnetic waves ?

1. Electromagnetic waves is a transverse wave. It travel with speed of light in vacuum.

2. EM waves are non mechanical waves they do not require any medium for propagation.

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

---

3. Write down the integral form of modified Ampere's circuital law.

$$\oint_l \vec{B} . \vec{dl} = \mu_0 i_c + \mu_0 \epsilon_0 \frac{d}{dt} \int_S \vec{E} . \vec{dA}$$

---

4. Write down the Gauss's law in magnetism.

The surface integral of magnetic field over a closed surface is zero.

$$\oint \vec{B} . \vec{dA} = 0$$

1. **Magnetic lines of force form continuous closed path.**
2. **No isolated magnetic monopole exists.**

5.Give two uses each of i) I R radiation ii) Micro waves iii) U V radiation

i) I R Radiation :

1. **T V remote as a signal carrier.**
2. **Produce dehydrated fruits.**
3. **Keep plants warm in green house.**

ii) Micro waves :

1. **Used in speed of the vehicle.**
2. **Used in radar system for air craft and navigation .**
3. **Used in microwave oven for cooking.**

iii) U V radiation :

1. **Used in burglar alarm.**
2. **Used to study atomic structure.**
3. **Used to detect invisible finger prints.**

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6. What are Fraunhofer lines ? How are they useful in the identification of elements present in the sun ?

- **Dark lines seen in the solar spectrum are known as Fraunhofer lines.**
- **It is used to identify the elements present in the sun.**

---

7. Write notes on Ampere – Maxwell law.

This law relates the magnetic field around any closed path to the conduction current and displacement current through the path.

$$\int_{l} \vec{B} \cdot \vec{dl} = \mu_0 i_c + \mu_0 \epsilon_0 \frac{d}{dt} \int_{S} \vec{E} \cdot \vec{dA}$$

---

8. Why are em waves are non – mechanical ?

- **Electromagnetic waves do not require any medium for propagation.**
- **So em waves are non – mechanical wave.**

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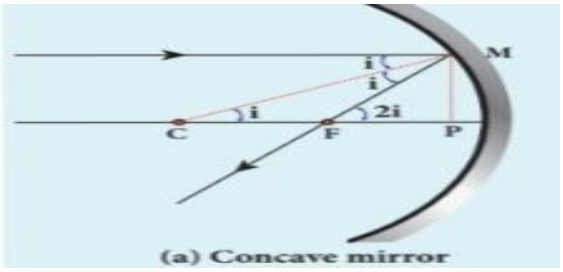
6. RAY OPTICS

1.What is angle of deviation due to reflection ?

The angle between the incident ray and deviated ray of light is called " angle of deviation ".

---

2. Derive the relation between f and R for a spherical mirror.



2 f = R

Consider a ray of light parallel to the principal axis is incident on the mirror at M.

- **Centre of curvature - C**
- **Principal Focus - F**
- **Angle of incidence - i**
- **Angle of reflection - r**
- **MP perpendicular from M**

- **< MCP = i and < MFP = 2 i**

△ MCP	△ MFP
$\tan i = \frac{PM}{PC}$	$\tan 2i = \frac{PM}{PF}$
$i = \frac{PM}{PC}$	$2i = \frac{PM}{PF}$

- **Angles are small , tan i = i and tan 2i = 2i.**

$$2i = \frac{PM}{PF}$$

$$2\frac{PM}{PC} = \frac{PM}{PF}$$

$$2\,PF = PC$$

2 f = R

- **Focal length PF = f ; Radius of curvature PC = R**

---

3. What are the Cartesian sign conventions for spherical mirrors ?

1. **Incident light is taken from left to right.**
2. **All distances are measured from pole of the mirror.**
3. **Distance measured to right of the pole is positive and to the left is negative.**
4. **Heights measured in the upward perpendicular direction is positive and downward is negative.**

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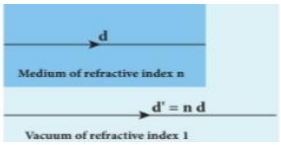
4. What is optical path ? Obtain the equation for optical path.

Optical path of a medium is defined as the distance d light travels in vacuum in the same time it travels a distance d in the medium.



- **Refractive index of a medium = n**
- **Thickness of a medium = d**

Speed of light through medium	Speed of light through vacuum
$v = \frac{d}{t}$	$c = \frac{d'}{t}$
$t = \frac{d}{v}$	$t = \frac{d'}{c}$

$$\frac{d'}{c} = \frac{d}{v}$$

$$d' = \frac{c}{v} d$$

$$\boxed{d' = n\ d}$$ **Here n > 1 then d′ > d**

---

5. State Snell's law / law of refraction.

1. The incident ray , refracted ray and normal to the refracting surface are all coplanar . (lie in same plane)

2. The ratio of sine of angle of incident i in the first medium to the angle of reflection r in the second medium is equal to the ratio of refractive index n_2 of the second medium to the refractive index n_1 of the first medium.

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} \quad ; \quad n_2 \sin i = n_1 \sin r$$

---

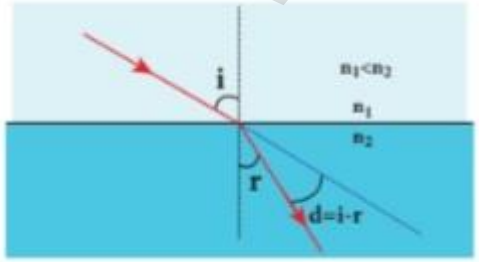
6. What is the angle of deviation due to refraction ?

- **When light travels from rarer to denser medium , it deviates towards normal.**

  Angle of deviation d = i - r

- **When light travels from denser to rarer medium , it deviates towards normal.**

  Angle of deviation d = r - i



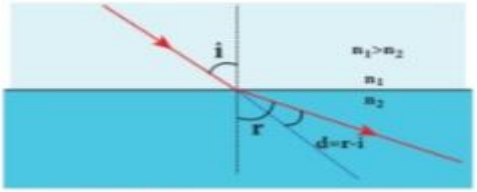


Figure 6.17 Angle of deviation due to refraction from denser to rarer medium

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7. What is principle of reversibility ?

The principle of reversibility states that light will follow exactly the same path if its direction of travel is reversed.

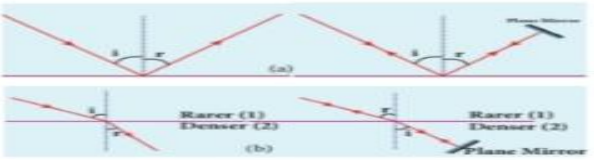

Figure 6.19 Principle of reversibility in (a) reflection and (b) refraction

---

8. What is relative refractive index ?

From Snell's law , $\frac{\text{Sin } i}{\text{Sin } r} = \frac{n_2}{n_1}$

$$n_{21} = \frac{n_2}{n_1}$$

The term n_2 / n_1 is called relative refractive index of second medium wrtfirst medium which is denoted as n_{21}.

---

9. Obtain the equation for apparent depth.

Light from the object O at the bottom of the tank passes from denser medium to rarer medium to reach our eyes for viewing the object.

- **Refractive index of denser medium ⟶ n_1**
- **Refractive index of rarer medium ⟶ n_2**
- **Angle of incidence ⟶ i**
- **Angle of refraction ⟶ r**

Diagram :

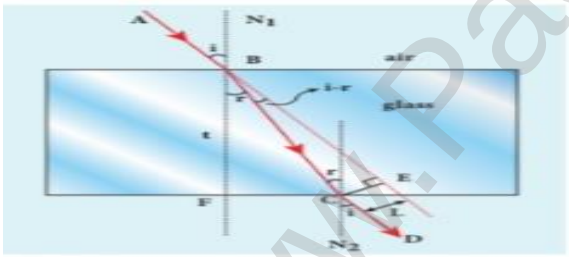

Figure 6.30 Refraction in glass slab

- **Snell's law in product form of reflection : $n_1 \sin i = n_2 \sin r$**
- **If angles are small then sin i = tan i ; sin r = tan r .**

$$n_1 \tan i = n_2 \tan r$$

Δ DOB

$$\tan i = \frac{DB}{DO}$$

Δ DIB

$$\tan r = \frac{DB}{DI}$$

$$n_1 \tan i = n_2 \tan r$$

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$$n_1 \frac{DB}{DO} = n_2 \frac{DB}{DI}$$

$$n_1 \frac{1}{d} = n_2 \frac{1}{d'}$$

$$\frac{d'}{d} = \frac{n_2}{n_1}$$

$$\boxed{d' = d \frac{n_2}{n_1}}$$

---

10. Why do stars twinkle ?

The stars actually do not twinkle. Due to refraction of light through different layers of atmosphere which vary in refractive index , the path of light deviates continuously when it passes through atmosphere.

---

11. What are critical angle and total internal reflection ?

Critical Angle :

The angle of incidence in the denser medium for which the angle of refraction is 90^0 (or) the refracted ray graces the boundary between the two media is called "critical angle" i_c .

$$\boxed{i_c = \sin^{-1} (1 / n)}$$

Total internal reflection :

For any angle of incidence greater than the critical angle , the entire light is reflected back into the denser medium itself. This phenomenon is called " total internal reflection "

Condition for total internal reflection :

1. Light travel from denser to rarer medium.

2. Angle of incidence in the denser medium must be greater than critical angle. ($i > i_c$)

---

12. Obtain the equation for critical angle.

- **When ray passes from an optically denser medium to rarer medium . (r > i)**
- **i gradually increased , r increases it becomes 90^0. ($r = 90^0$)**
- **Refracted ray graces the boundary between the two media is called "critical angle" $i = i_c$**

Snell's law in product form

$$n_1 \sin i = n_2 \sin r$$

$$n_1 \sin i_c = n_2 \sin 90^0$$

$$n_1 \sin i_c = n_2$$

$$\sin i_c = \frac{n_2}{n_1}$$

$$i_c = \sin^{-1} (n_2 / n_1)$$ **If $n_2 = 1$ and $n_1 = n$ then**

$$\boxed{i_c = \sin^{-1} (1 / n)}$$

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13 . Explain the reason for glittering of diamond.

1. Diamond appears dazzling because of total internal reflection happens inside it.

2. Refractive index of diamond is about 2.417 much greater than glass is about 1.5

3. Critical angle of diamond is about 24.4^0 much less than ordinary glass.

4.A skilled diamond cutter makes use of this large range of angle of incidence 24.4^0 to 90^0.

5. To ensure that light entering the diamond is total internally reflected from the many cut faces before getting out.

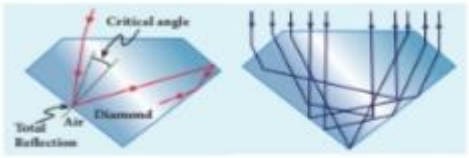
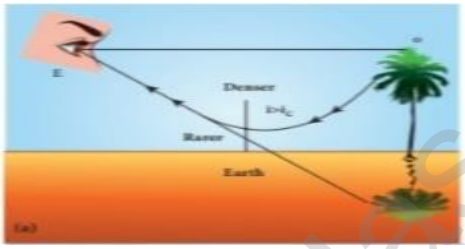


Figure 6.22 Total internal reflection in diamond

14.What are mirage and looming ?

Mirrage :



1. In hot places , air near the ground is hotter than air at height. Hot air is less dense.

2. Refractive index of air increases with height and its density.

3. Light from tall objects like a tree , pass through medium whose refractive index decreases towards ground.

4. Ray of light deviates away from normal at different layer of air.

5. It undergoes total internal reflection when the angle of incidence near the ground exceeds critical angle.

6. This gives an illusion as if the light comes from somewhere below the ground.

7. The shaky nature of the layers of air , the observer feels as if the object is getting reflected by pool of water.

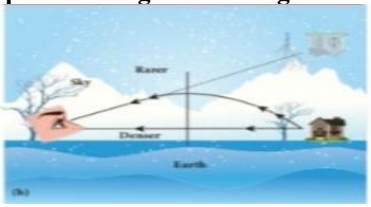
Looming :

1. In cold regions like glaciers and frozen lakes , the reverse effect of mirage will happen.

2. Hence an inverted image is formed little above the surface .

3. This phenomenon is called " looming "

4.It is also called as " superior mirage " towering and stooping .



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15. Write short note on the prism making use of total internal reflections.

- **Prisms can be designed to reflect light by 90^0 or 180^0 by making use of total internal reflection .**
- **$i_c < 45^0$, the critical angle i_c for the material of the prism must be less than 45^0.**

---

16. What is Snell's window ?

When the light entering the water from outside is seen from inside the water ,the view is restricted to a particular angle equal to the critical angle i_c . The restricted illuminated circular area is called " Snell's window "

17.How does an endoscope work ?

An endoscope has a bundle of optical fibres is an instrument used by doctors to see inside of a patient's body.

- **Endoscope work on the phenomenon of total internal reflection.**
- **Optical fibres are inserted into the body through mouth , nose (or) special hole made in the body.**
- **Even operations could be carried out with the endoscope cables which have the necessary instruments attached at their ends.**

---

18. What are primary focus and secondary focus of a lens ?

Primary Focus : F_1

It is defined as a point where a point source kept produces a parallel emergent rays to the principal axis after passing through lens.

Secondary Focus : F_2

It is defined as a point where all the parallel rays travelling close to the principal axis converge to form an image on the principal axis after passing through lens.

---

19. What are the sign conventions followed for lenses ?

1) **Incident light is taken from left to right.**
2) **All the distances measured from the pole.**
3) **Distance measured to the right of pole along the principal axis taken as positive.**
4) **Distance measured to the left of pole along the principal axis taken as negative.**
5) **Heights measured in the upward perpendicular direction to the principal axis taken as positive.**
6) **Heights measured in the downward perpendicular direction to the principal axis taken as negative.**

---

20. Arrive lens equation from lens maker's formula.

1. Len's maker's lens :

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

2. General equation for refraction at a spherical surface :

$$\frac{1}{v} - \frac{1}{u} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

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3. **Len's Equation :**

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

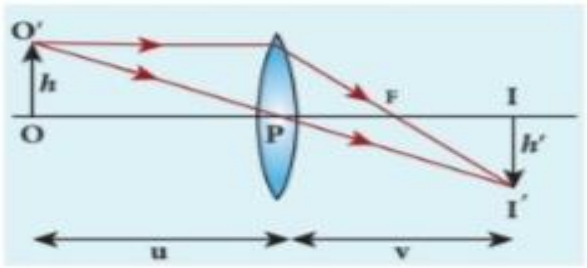
---

21. Obtain the equation for lateral magnification of thin lens.

Theory :

- Object ⟶ O O′
- Image ⟶ I I′
- Height ⟶ h , h′

Diagram :



Formula :

$$m = \frac{f}{f+u} = \frac{f-v}{f}$$

Lateral Magnification or Transverse magnification :

It is defined as the ratio of the height of the image to height of the object.

- Similar triangles Δ P O O′ and Δ P I I′

$$m = \frac{I\,I'}{O\,O'} = \frac{P\,I}{PO}$$

- On applying sign convention

$$m = -\frac{h'}{h} = \frac{v}{-u}$$

- Magnification :

$$m = \frac{h'}{h} = \frac{v}{u}$$

- Magnification is negative for real image. Magnification is positive for virtual image.
- Magnification always positive for concave lens and less than one.

---

22. What is power of a lens ?

1. The power of a lens is a measure of the degree of convergence or divergence the lens produces on the light falling on it.

2. The power of lens P is the reciprocal of focal length.

$$P = \frac{1}{f}$$ S I Unit : dioptre

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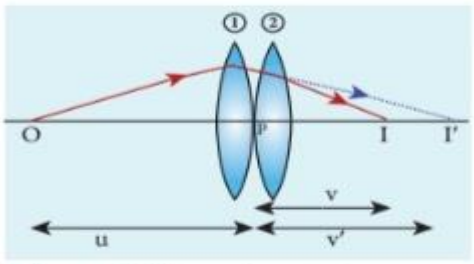
23. Derive the effective focal length for lenses in contact.

Diagram :



Lenses in contact

Theory :

1. Consider two lenses of focal length f_1 and f_2 in contact with each other and have a common principal axis.

2. An object placed at O beyond the focus of first lens , an image is formed by it at I'.

3.This image acts as an object for the second lens and the final image is formed at I.

4. As two lenses are thin , P is common optical centre in the middle of the two lenses.

Len's equation for lens 1

$$\frac{1}{v'} - \frac{1}{u} = \frac{1}{f_1} \longrightarrow (1)$$

Len's equation for lens 2

$$\frac{1}{v} - \frac{1}{v'} = \frac{1}{f_2} \longrightarrow (2)$$

Adding equation (1) & (2)

$$\frac{1}{v'} - \frac{1}{u} + \frac{1}{v} - \frac{1}{v'} = \frac{1}{f_1} + \frac{1}{f_2} \longrightarrow (3)$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f_1} + \frac{1}{f_2}$$

we know that , $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\boxed{\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}}$$

---

25. What is dispersion ?

Dispersion is splitting of white light into its constituent colours. This band of colours of light is called spectrum.

---

26. How are rainbows formed ?

1. Rainbow is an example of dispersion of sunlight through droplets of water during rainy days.

2.When sunlight falls on the water drop suspended in air , it splits into its constituent sevencolours . Thus , water drop suspended in air behaves as a glass prism.

3.There are two types primary rainbow and secondary rainbow.

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27. What is Rayleigh's scattering ?

$$I \alpha \frac{1}{\lambda^4}$$

1. If the scattering of light is by atoms and molecules which have size ' a ' very much less than that of the wavelength ' λ ' of light , (a < < λ) then the scattering is called " Rayleigh's scattering "

2. The intensity of Rayleigh's scattering is inversely proportional to fourth power of wavelength.

---

28. Why does sky appear blue ?

1. Violet colour which has the shortest wavelength gets much scattered during day time.

2. The next scattered colour is blue.As our eyes are more sensitive to blue colour than violet colour the sky appears blue during day time.

---

29. What is the reason for reddish appearance of sky during sunset and sunrise ?

1. During sunrise and sunset , the light from sun travels a greater distance through the atmosphere.

2.Hence , the blue light which has shorter wavelength is scattered away and the less scattered red light of longer wavelength to reach our eye.

---

30. Why do clouds appear white ?

1. Clouds contains large amount of dust and water droplets.

2. Thus , in clouds all the colours get equally scattered irrespective of wavelength . So it appears white.

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7. Wave Optics

1.What are the salient features of corpuscular theory of light ?

1.Light is emitted as tiny , massless and perfectly elastic particles called " corpuscles "

2. Corpuscles are very small , the source of light does not suffer loss of mass even if it emits light for long time.

3.They are unaffected by force of gravity , their path is a straight line in a medium of uniform refractive index.

4.The energy of light is the K.E of these corpuscles. It impinge on the retina of the eye , the vision is produced.

5. When it approach surface between two media , they are either repel or attract.

i) Reflection due to repulsion ii) Refraction due to attraction.

2.What are the important points of wave theory of light ?

1. Light is a disturbance from source travels that as longitudinal mechanical waves through the ether medium , as mechanical wave requires medium for propagation.

2.The wave theory explain the phenomenon of reflection , refraction , interference and diffraction of light.

---

3. What is the significance of electromagnetic wave theory of light ?

1. Maxwell proved that light is an em wave which is transverse in nature.

2.No medium is necessary for the propagation of em waves.

3. All the phenomenon of light could be successfully explained by this theory.

4.Write a short note on quantum theory of light.

1. It explain photoelectric effect in which light interacts with matter as photons to eject the electrons.

2. A photon is a discrete packet of energy $E = h\gamma$ [$h = 6.625 \times 10^{-34}$ J s . $\gamma \longrightarrow$ Frequency]

3.As light has both wave as well as particle nature it is said to have dual nature.

4.It is concluded that light propagates as a wave and interacts with matter as a particle.

---

5. Define wave front.

A wave front is the locus of points which are in the same state or phase of vibration.

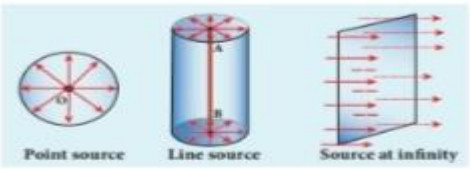
---

6. What are the shapes of wavefronts for a) source at infinite b) Point source c) Line source.

1. Source at infinite : Source is located at infinity gives plane wave front.

2. Point Source : A point source located at a finite distance gives spherical wavefronts.

3. Line Source : An extended (or) line source at finite distance gives cylindrical wavefront.



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7. State Huygen's principle.

According to Huygen's principle , each point of the wave front is the source of secondary wavelets . These wavelets are spreading out in all directions with the speed of the wave .These are called as secondary wavelets.

---

8. What is the interference of light ?

The phenomenon of super position of two light waves which produces increases in intensity at some points and decreases in intensity at some points called interference of light.

---

9. What is the phase of a wave ?

Phase is the angular position of a vibration. When a wave is progresses , there is a relation between phase of the vibration and path travelled by the wave.

---

10. Obtain the relation between phase difference and path difference.

1. In the path of the wave , one wavelength λ corresponds to a phase of 2 π .

2.A path difference δ corresponds to a phase difference Φ.

$$\Phi = \frac{2\pi}{\lambda} \times \delta$$

---

11. What are coherent sources ?

Two light sources are said to be coherent if they produce waves which have same phase or constant phase difference , same frequency or wavelength , same waveform and preferably same amplitude.

---

12. How does wavefront division provide coherent sources ?

1. Most common method to produce coherent source.

2.A point source produces spherical wavefront .

3.All the points on the wavefront are at the same phase.

4. If two points are chosen on the wavefront by using double slit , act as coherent source.

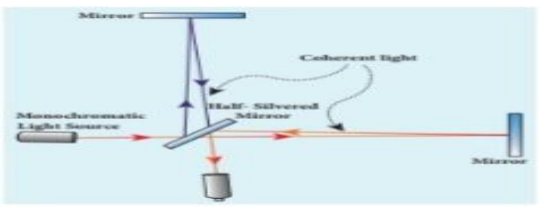
---

13. What is intensity (or) amplitude division ?

1. If we allow light to pass through partially silvered , both reflection and refraction take place.

2. As the two light beams obtain from same source , two divided light beams are coherent.

3. They will be in-phase or at constant phase difference. Ex : Michelson's Interferometer,Fabray – Perrot Etalon



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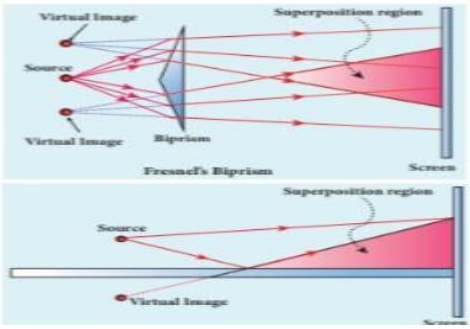
14. How do source and images behave as coherent source ?

1. Source and its image will have waves in phase or constant phase differences.

2. Fresnel's biprism uses two virtual images of the source as two coherent source.

3. Lloyd's mirror uses source and its one virtual image as two coherent source.



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15. What is bandwidth of interference pattern ?

The bandwidth (β) is defined as the distance between any two consecutive bright or dark fringes.

$$\beta = \frac{D\,\lambda}{d}$$

β ⟶ Bandwidth , λ ⟶ Wavelength

D ⟶ Distance between coherent source and screen

d ⟶ Distance between two coherent sources

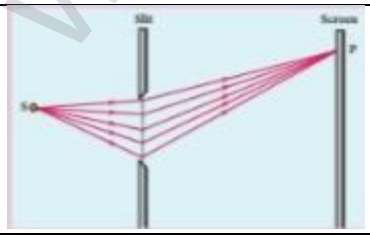
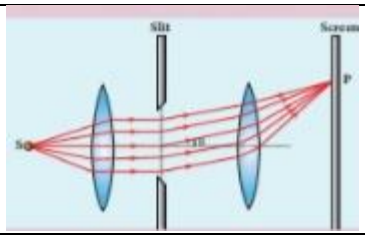
---

16. What is diffraction ?

Diffraction is bending of waves around sharp edges into the geometrically shadowed region.

---

17. Difference between Fresnel diffraction and Fraunhofer diffraction ?

S.NO	Fresnel Diffraction	Fraunhofer Diffraction
1.	Spherical or cylindrical wavefront undergoes diffraction.	Plane wavefront undergoes diffraction.
2.	Light wave is from a source at finite distance.	Light wave is from a source at infinity.
3.	For laboratory conditions , convex lenses need not be used .	For laboratory conditions , convex lenses need to be used .
4.	Difficult to observe and analyses.	Easy to observe and analyses.
5.		

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18. Discuss the special cases on first minimum in Fraunhofer diffraction.

- **The slit is to be divided into even number of equal parts for minimum condition in diffraction.**

Condition for first minimum

$$\delta = \frac{a}{2}\sin\theta = \frac{\lambda}{2}$$

$$a \sin\theta = \lambda$$

Condition for first minimum

$$\delta = \frac{a}{4}\sin\theta = \frac{\lambda}{2}$$

$$a \sin\theta = 2\lambda$$

Condition for n^{th} minimum $\quad a \sin\theta = n\lambda$

---

19. What is Fresnel's distance ? Obtain the equation for Fresnel's distance .

Fresnel's distance is the distance up to which the ray optics is obeyed and beyond which the ray optics is not obeyed. But , the wave optics becomes significant. Diffraction equation for first minimum $a \sin\theta = \lambda$

$$\sin\theta = \frac{\lambda}{a} \quad \theta \text{ is small , then}$$

$$\theta = \frac{\lambda}{a} \longrightarrow (1)$$

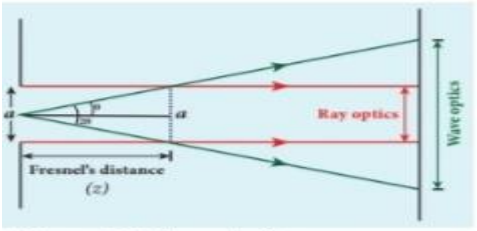

Figure 7.19 Fresnel's distance

From the definition of Fresnel's distance , $2\theta = \frac{a}{z}$

$$\theta = \frac{a}{2z} \longrightarrow (2)$$

Equating equation (1) and (2)

$$\theta = \frac{\lambda}{a} = \frac{a}{2z}$$

Fresnel Distance : $\quad z = \frac{a^2}{2\lambda}$

---

20. Mention the differences between interference and diffraction.

S.NO	Interference	Diffraction
1.	Super position of two waves .	Bending waves around edges.
2.	Equally spaced bright and dark fringes.	Central bright is double the size of other.
3.	Equal intensity for all bright fringes.	Intensity falls rapidly for higher order fringes.
4.	Large number of fringes are obtained.	Less number of fringes are obtained.

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21. What is a diffraction grating ?

The combined width of a ruling and a slit is called grating element e = a + b.

The points on the slit separated by a distance equal to the grating element are called corresponding points.

---

22. What is resolution ?

- **Resolution is the quality of image which is decided by diffraction effect and Rayleigh's criterion.**
- **Measured by the smallest distance which could be seen clearly without the blur due to diffraction.**

---

23. What is Rayleigh's criterion ?

According to Rayleigh's criterion , the two points on the image are said to be just resolved when the central maximum of one diffraction pattern coincides with the first minimum of the other and vice versa.

---

24. Difference between resolution and magnification ?

Resolution :

- **Quality of image which is decided by diffraction effect and Rayleigh's criterion.**
- **Measured by the smallest distance which could be seen clearly without the blur due to diffraction.**

Resolution	Magnification
Ability of optical instruments to produce clear , fine and sharper image.	Ability of optical instruments to make an object bigger.

---

25. What is polarization ?

The phenomenon of restricting the vibrations of light to any one direction perpendicular to the direction of propagation of wave is called polarization of light.

26.Difference between polarized and unpolarized light.

S.NO	Polarized Light	Unpolarized Light
1.	Consists of waves having their electric and magnetic field vibrations in a single normal to the direction of ray.	Consists of waves having their electric and magnetic field vibrations in all direction of ray.
2.	Asymmetrical about ray direction .	Symmetrical about the ray direction .
3.	Obtain by convert unpolarized light using polaroid.	Produced by conventional light sources.

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27. Discuss polarization by selective absorption.

1. It is the property of a material which transmit waves.

2. The electric field vibrations are in a plane parallel to certain direction of orientation.

3. It absorbs all other vibration. 4. It is also called as " Dichroism ".

5. Polaroids or polariser which make use of property of selective absorption to produce plane polarized light.

EX : 1. Tourmaline 2. Quinine iodosulphate 3. Polyvinyl Alcohol

---

28. What are polariser and analyser ?

<u>Polariser :</u> **The polaroid which polarises the light passing through it is called polariser.**

<u>Analyser :</u> **The polaroid which is used to examine whether a light is polarised or not is called an analyser.**

---

29. What are plane polarised , unpolarised and partially polarised light ?

<u>Plane polarised light</u>

A light is said to be plane polarised if the intensity varies from maximum to zero for 90^0 rotation of the analyser.

<u>Partially Polarised Light</u>

If the intensity of light varies between maximum and minimum for every 90^0 rotation of the analyser , the light is said to be partially polarised light.

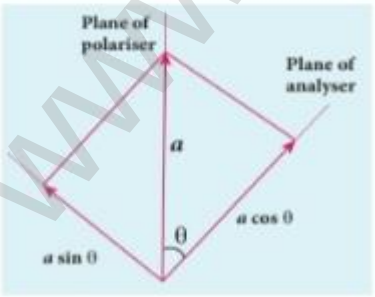
<u>Unpolarised Light</u>

An unpolarised light is a transverse wave which has vibrations in all directions in all directions in a plane perpendicular to the direction of propagation of wave.

---

30. State and obtain Maul's law.

In 1809 , Maull's discovered that when a beam of plane polarised light of intensity I_0 is incident on an analyser , the intensity of light I transmitted from the analyser varies directly as the square of the cosine of the angle θ between the transmission axes of polariser and analyser. This is known as " Maul's law "



$$I = I_0 \cos^2 \theta$$

---

31. List the uses of polaroid.

1. Used in googles and cameras to avoid glare of light.

2. Used to take 3D pictures i.e holography .

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3. Used in optical stress analysis.

4. Used as window glasses to control the intensity of incoming light.

5. Used to improve contrast in old oil paintings.

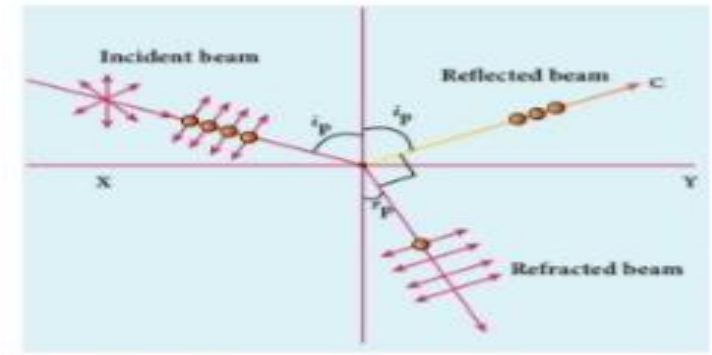
6. Polarised light is used in LCD.

7. Polarised laser beam acts as needle to read / write in compact discs CD.

---

32. State Brewster's law.

It states that the tangent of the polarising angle for a transparent medium is equal to refractive index.



$$\tan i_p = n$$

The polarising angle is known as Brewster's angle which depends on the nature of the refracting medium.

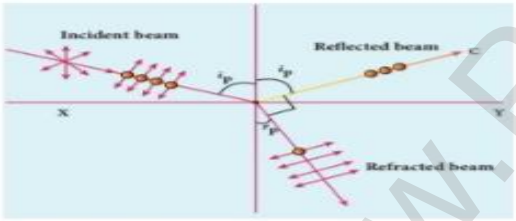
---

33. What is angle of polarisation and obtain the equation for angle of polarisation.

Angle of polarisation :

The angle of incidence for which the reflected light is found to be plane polarised is called polarising angle i_p.

Brewster 's Law



$$\tan i_p = n$$

From geometry : $r_p = 90^0 - r_p$

From Snell's law : $n = \frac{\sin i_p}{\sin r_p}$

$$n = \frac{\text{Sin } i_p}{\text{Sin } (90^0 - i_p)} = \frac{\text{Sin } i_p}{\text{Cos } i_p} = \tan i_p$$

---

34. Discuss the piles of plates.

1. Pile of plates makes use of Brewster's law to convert the partially polarised refracted light into plane polarised

2. It consists of several plates kept one behind the other at an angle $90^0 - i_p$ with the horizontal surface.

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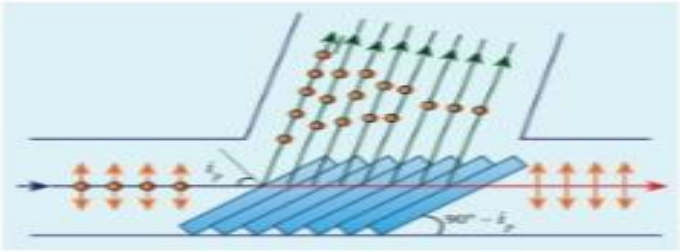

3. This arrangement ensures that the parallel falls on these plates at i_p.

4. Unpolarised light passes through these plates, few parallel vibrations to the surface which may present in refracted light further reflections at the succeeding plates.

5. Both reflected and refracted lights are found to be plane polarised.

---

35. What is double refraction ?

When a ray of unpolarised light is incident on a calcite crystal , two refracted rays are produced. Hence , two images of an object are formed. This phenomenon is called double refraction or birefringence.

---

36. Mention the types of optically active crystals with example.

S.NO	Uniaxial Crystal	Biaxial Crystal
1.	Having only one optic axis.	Having two optic axes.
2.	Ex : Calcite , Quartz , Tourmaline	Ex : Mica , Topaz , Selenite

---

37. Discuss about Nicol prism.

Nicol Prism :

1. **Nicol prism is an optical device .**
2. **It producing plane polarised light and also anlaysing.**

Principle :

- **Based on double refraction.**

Construction :

1. **Nicol prism is a calcite crystal .**
2. **Its length is three times of breadth.**
3. **Angles are 72^0 and 108^0.**
4. **It is cut into two halves along a diagonal .**
5. **And then pasted by Canada balsam cement.**
6. **Unpolarised light is incident on it.**
7. **Double refraction takes place.**
8. **The ray is split into ordinary ray and exordinary ray.**

S.NO	Rays	Refractive Index
1.	Ordinary Ray	1.658
2.	Exordinary Ray	1.486
3.	Canada Balsam	1.523

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38. How is polarisation of light obtained by scattering of light ?

1. Sunlight gets scattered by atmospheric molecules.

2. Electrons of the molecules influenced by vibrating component of electric field.

3. Unpolarised sunlight produces vibrations in all directions.

4. Vibrating electrons radiate energy only in perpendicular direction.

5. An observer views a beam of sun light perpendicular to its direction to travel.

6. Hence , light reaching the observer is plane polarised.

---

39. What are near point and normal focussing ?

Near point focussing :

- **The eye is least strained when image is formed at near point , i.e 25 cm**
- **The near point is also called as " least distance of distinct "**

$$m = 1 + \frac{D}{f}$$

Normal Focussing :

- **The eye is most relaxed when the image is formed at infinity.**
- **The focussing is called normal focussing when the image is formed at infinity.**

$$m = \frac{D}{f}$$

---

40. Why is oil immersed objective preferred in a microscope ?

1. Oil immersed objective contributes fine resolution and brightness.

2. These characteristics are most critical under high magnification.

3. So the objectives are designed for oil immersion.

---

41. What are the advantages and disadvantages of reflecting telescope ?

Advantages of reflecting telescope :

1. Only one surface is to be polished and maintained.

2.Support can be given from the entire back of the mirror rather than only at the rim for lens.

3.Mirrors weigh much less compared to lens.

Disadvantages of reflecting telescope :

1.The objective mirror would focus the light inside the telescope tube.

2.One must have an eye piece obstructing some light.

3. This problem could be overcome by introducing secondary mirror which would take the light outside the tube for view.

---

42. What is the use of an erecting lens in a terrestrial telescope ?

A terrestrial telescope has an additional erecting lens to make the final image to erect.

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43. What is the use of collimator in a spectrometer ?

The collimator is used for producing parallel beam of light.

---

44. What are the uses of spectrometer ?

1. To analyse the spectra of different sources of light .

2. To measure the wavelength of different colours.

3.To measure the refractive indices of materials of prism.

---

45. What is myopia ? What is its remedy ?

Myopia :

- **A person suffering from near sightedness.**
- **A person who can not see distant objects clearly.**
- **Due to thickening of eye lens.**
- **Due to larger diameter of eye ball.**

Remedy : By wearing concave lens.

---

46. What is hypermetropia ? What is its remedy ?

Hypermetropia :

- **A person suffering from far sightedness.**
- **A person who can not see close objects clearly.**
- **Due to thinning of eye lens.**
- **Due to shortening of eye ball.**

Remedy : By wearing convex lens.

---

47. What is astigmatism ? What is remedy ?

Astigmatism :

- **A person can not see all the directions equally well.**
- **Due to different curvature along different planes in the eye lens.**
- **This more serious than myopia and hypermetropia.**

Remedy :

- **Lenses with different curvatures in different in different planes to rectify this defect.**
- **Generally these lenes are called as cylindrical lenses.**

---

48. What is presbyopia ?

Presbyopia :

Far sightedness arising due to aging is called " Presbyopia ".

Remedy : By wearing convex lens.

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8.Dual nature of radiation & matter

1.Why do metals have a larger number of free electrons ?

- **In metals the electrons in the outer most shells are loosely bound to the nucleus.**
- **Even at room temperature , there are large number of free electrons which are moving inside the metal in a random manner.**

2.Define work function of a metal. Give its unit.

The minimum energy for an electron to escape from metal surface is called " work function " of that metal.

It is denoted by Φ_0. Measured in e V.

3.What is photo electric effect?

The ejection of electrons from a metal plate when illuminated by light or any other electromagnetic radiation of suitable wavelength is called " Photo electric effect ".

---

4. How does photo current vary with the intensity of the incident light ?

Photo current which is the number of electrons emitted per second is directly proportional to the intensity of the incident light.

---

5. Give the definition of intensity of light according to quantum concept and its unit.

Intensity of light is the energy delivered per unit area per unit time. Unit : W m^{-2} or candela.

6.How will you define threshold frequency ?

For a given surface , the emission of photo electrons takes place only if the frequency of incident light is greater than a certain minimum frequency called " threshold frequency "

---

7. What is photo cell ? Mention the different types of photo cells.

Photo electric cell / Photo cell :

A device which converts light energy into electrical energy.

Types of photo cell :

1. Photo emissive cell 2. Photo voltaic cell 3. Photo conductive cell.

---

8. Write the expression for the de Broglie wavelength associated with a charged particle of charge q and mass m when it is accelerated through potential V.

1. An electron of mass m is accelerated through a potential difference of V volt.

2. Kinetic Energy = Potential Difference

$$\frac{1}{2} m v^2 = e V$$

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3. Speed of electron $v = \sqrt{\frac{2eV}{m}}$

4. de Broglie wavelength

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2meV}} = \frac{12.27}{\sqrt{V}} \text{ Å}$$

---

9. State de Broglie hypothesis.

All matter particles like electron , protons , neutrons in motion are associated with waves.

These waves are called de Broglie waves or matter waves.

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

---

10. Why do not see the wave properties of base ball ?

1. de Broglie wavelength : $\lambda = \frac{h}{p} = \frac{h}{mv}$

2. Wavelength associated with base ball is small in the order of 10^{-34} and is difficult to observe.

3. As the value of Planck's constant is very small i.e h = 6.626×10^{-34}

4. Momentum of base ball is very low.

5. So , We can not see the wave properties of base ball.

---

11. A proton and an electron have same kinetic energy. Which one has greater de Broglie wavelength . Justify.

1. de Broglie wavelength : $\lambda = \frac{h}{\sqrt{2mK.E}}$

2. Kinetic energy : $K.E = \frac{h^2}{2m\lambda}$

3. Kinetic energy of proton : $K.E_p = \frac{h^2}{2m_p\lambda_p}$

4. Kinetic energy of electron : $K.E_e = \frac{h^2}{2m_e\lambda_e}$

5. Proton and an electron have same kinetic energy.

$$K.E_p = K.E_e$$

$$\frac{h^2}{2m_p\lambda_p} = \frac{h^2}{2m_e\lambda_e}$$

$$\frac{\lambda_e}{\lambda_p} = \frac{m_p}{m_e}$$

6. m_p / m_e is greater than one then $\lambda_e > \lambda_p$.

7. Hence , electron has greater de Broglie wavelength.

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12. Write the relationship of de Broglie wavelength λ associated with a particle of mass m in terms of its kinetic energy K.

1. Kinetic Energy = Potential Difference

$$\frac{1}{2} m v^2 = e V$$

2. Speed of electron

$$v = \sqrt{\frac{2 e V}{m}}$$

3. de Broglie wavelength

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2meV}}$$

$$\lambda = \frac{h}{\sqrt{2 m K}}$$

4. Kinetic energy of electron K = e V.

---

13. An electron and alpha particle have same kinetic energy . How are the de Broglie wavelength associated with them related.

1. de Broglie wavelength : $\lambda = \frac{h}{\sqrt{2mK}}$

2. For electron : $\lambda_e = \frac{h}{\sqrt{2 m_e K_e}}$

3. For alpha particle : $\lambda_\alpha = \frac{h}{\sqrt{2 m_\alpha K_\alpha}}$

4. An electron and alpha particle have same kinetic energy .

$$\frac{h}{\sqrt{2 m_e K_e}} = \frac{h}{\sqrt{2 m_\alpha K_\alpha}}$$

5. $\lambda_e = \lambda_\alpha$ then $m_e < m_\alpha$ and $K_e > K_\alpha$

6. Kinetic energy of electron is greater than kinetic energy of alpha particle.

---

14. Define stopping potential.

The minimum negative potential given to the anode which stops the emission of photo electrons and make photo electric current zero.

---

15. What is surface barrier ?

The potential barrier which prevents free electrons from leaving the metallic surface is called Surface barrier.

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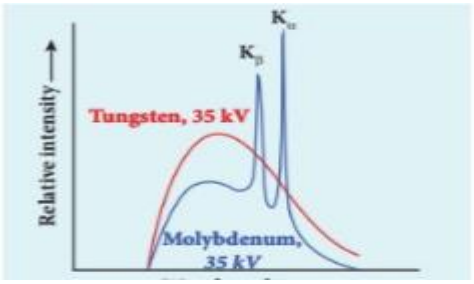
16. Mention two features of x- ray spectra , not explained by classical electromagnetic theory.

1. For a given accelerating voltage , the lower limit for the wavelength of continuous X – ray spectra is same for all targets. This minimum wavelength is called " cut – off wavelength ".

2. The intensity of X – ray is increased at certain well defined wavelength of characteristics X – ray spectra for molybdenum.



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17. What is Bremsstrahlung ?

<u>In continuous X – ray spectra :</u>

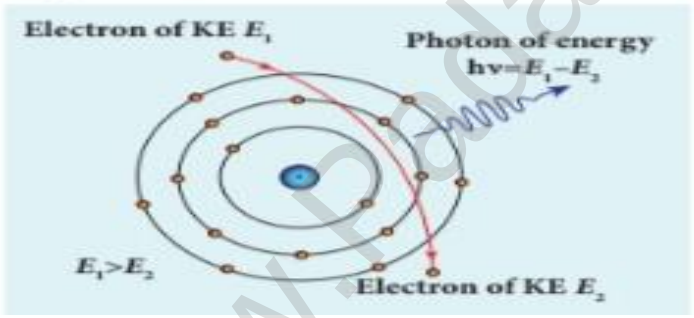
1. When a fast moving electron penetrates and approaches a target nucleus.

2. The interaction between electron and nucleus either accelerates or decelerates.

3. In which results in a change of path of the electron.

4. The radiation produced from such decelerating electron is called " Bremsstrahlung ".

5. It is also known as " braking radiation "



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9. Atomic And Nuclear Physics

1. What are cathode rays ?

1. In the discharge tube , when pressure reaches around 0.01 mm of Hg , positive column disappears .

2. At this time , dark space is formed between cathode and anode.It is known as Crooke's dark space .

3. The walls of the tube appear with green colour.

4. Invisible rays emanate from cathode called as cathode rays i.e beam of electrons.

---

2. Write the properties of cathode rays.

1. Cathode rays ionize the gas through which they pass.

2.The speed of cathode rays is up to (1 / 10 th) of the speed of light.

3. When cathode rays fall on a material of high atomic weight , X – rays are produced .

4. When the cathode rays are allowed to fall on matter , heat is produced. It affect the photographic plate and produce fluorescence.

5. It posses energy and momentum and travel in a straight line with high speed 10^7 ms^{-1} . It can be deflected by the application of electric and magnetic field. It indicates negatively charged particle.

---

3. Give the results of Rutherford alpha scattering experiment.

1. Most of the alpha particles were in deflected through the gold foil and went straight.

2. Some of the alpha particles were deflected through a small angle.

3. A few alpha particles were deflected through the angle more than 90^0.

---

4. Write down the postulates of Bohr atom model.

1. The electron in an atom moves around the nucleus in circular orbit under the influence of Coulomb electrostatic force of attraction . This Coulomb force gives necessary centripetal force for the electron to under go circular motion.

2. Electrons in an atom revolve around the nucleus only in certain discrete orbits called stationary orbits and electron in such orbits do not radiate electromagnetic energy.Only those discrete orbits allowed are stable orbits.

---

5. What is meant by excitation energy ?

The energy required to excite an electron from lower energy state to higher energy state is known as " Excitation energy ". For hydrogen atom $E = E_2 - E_1 = -3.4$ e V – (- 13.6 e V) = 10.2 e V.

---

6. Define ionization energy and ionization potential.

Ionization Energy :

The minimum energy required to remove an electron from an atom in the ground state is known as binding energy or ionization energy. $I_{ionization} = E_\infty - E_1 = 0 - (-13.6\ e\ V) = 13.6\ e\ V$

Ionization Potential : Ionization energy per unit charge is called as ionization potential.

$$V_{ionization} = \frac{1}{e} E_{ionization} = \frac{13.6}{n^2} Z^2\ V$$

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7. Write down the drawbacks of Bohr atom model.

1. Bohr atom model is valid only for hydrogen atom or but not for complex atoms.

2. When spectral lines are closely examined ,individual lines of hydrogen spectrum are accompanied by number of faint lines. This is called fine structure. This can not be explained by Bohr atom model.

3. Bohr atom model fails to explain the intensity variations in the spectral lines.

4. The distribution of electrons in various levels cannot be completely explained by Bohr atom model.

---

8. What is distance of closest approach ?

The minimum distance between the centre of the nucleus and alpha particle just before it gets reflected back through 180^0 .It is the defined as the distance of "closest approach" (r_0)

$$r_0 = \frac{1}{4\pi\varepsilon_0}\frac{2Ze^2}{E_K}$$

Also known as " contact distance "

9.Define impact parameter.

The impact parameter is defined as the perpendicular distance between the centre of the gold nucleus and the direction of velocity vector of alpha particle when it is at a large distance.

$$b = K \cot(\theta/2)$$

---

10. Write a general notation of nucleus of element X . What does each term denotes.

General notation of nucleus of element : $_ZX^A$ A - Mass number Z - Atomic number

---

11. What is isotope ? Give an example.

Isotopes are the atoms of same element having same atomic number Z but different mass number A .

Example : $_1H^1$ (Hydrogen) , $_1H^2$ (Deuterium) , $_1H^3$ (Tritium)

---

12. What is isotone ? Give an example.

Isotones are the atoms of the different element having same number of neutrons . Ex: $_5B^{12}$ and $_6C^{13}$ 7 neutrons.

---

13. What is isobar ? Give an example.

The atoms of the different elements having same mass number A but different atomic number Z .

Ex : $_{16}S^{40}$ and $_{17}Cl^{40}$.

---

14. Define atomic mass unit.

One atomic mass unit (u) defined as the 1 / 12^{th} of the mass of the isotope of carbon $_6Cl^{12}$ which is more abundant in naturally occurring isotope of carbon.

$$1\,u = 1.66 \times 10^{-27}\ kg$$

$$\text{One amu} = 1\,u = \frac{\text{mass of } {}_6Cl^{12} \text{ atom}}{12} = \frac{1.9926 \times 10^{-26}}{12} = 1.66 \times 10^{-27}\ kg.$$

---

15. Show that nuclear density is almost constant for nuclei with Z > 10.

1. The nuclei of atoms are found to be approximately spherical in shape .

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2. It is experimentally found that radius of nuclei for Z > 10 , satisfies the empirical formula $R = R_0 A^{1/3}$

Mass number $\longrightarrow A$; $R_0 = 1.2\ F = 1.2 \times 10^{-15}\ m$

3. Nuclear density $= \dfrac{\text{Mass of the nuclei}}{\text{Volume of the nuclei}} = \dfrac{m}{\frac{4}{3}\pi R_0^3}$

4. Nuclear density is independent of the mass number A.

5. All the nuclei Z > 10 have same density and it is an important characteristics property of all nuclei.

---

16. What is mass defect ?

The mass of any nucleus is less than the sum of the mass of its individual constituents. This difference in mass Δm is called as " mass defect ".

Mass Defect : $\Delta m = (Z m_p + N m_n) - M$

- $m_p \longrightarrow$ **Mass of the proton** $m_e \longrightarrow$ **Mass of the electron**
- **M** $\longrightarrow$ **Mass of the nucleus** **Z** $\longrightarrow$ **Atomic number**

---

17. What is the binding energy of a nucleus ? Give its expression.

When the protons and neutrons combine to form a nucleus , mass equal to mass defect disappears and the corresponding energy is released .The energy equivalent of mass defect is known as " Binding energy ".

- **From the Einstein mass – energy relation :** $B.E = \Delta m c^2 = (Z m_p + N m_n - M) c^2$

---

18. Calculate the energy equivalent of 1 atomic mass unit ?

From the Einstein mass – energy relation we can able to calculate the energy equivalent of one atomic mass unit

$E = m c^2 = 1.66 \times 10^{-27} \times 3 \times 10^8 = 14.94 \times 10^{11}\ J.$

$E = \dfrac{14.94 \times 10^{11}}{1.6 \times 10^{-19}}\ eV = 931 \times 10^6\ eV = 931\ MeV.$

---

19. Give the physical meaning of binding energy per nucleon.

The average binding energy per nucleon is the energy required to separate single nucleon from the particular nucleus.

$$\overline{B.E} = \Delta m c^2 = \frac{(Z m_p + N m_n - M) c^2}{A}$$

---

20. What is meant by radioactivity ?

The phenomenon of spontaneous emission of highly penetrating radiations such as α , β and γ rays by an element is called " radioactivity " and the substances which emit these radiations are called as radioactivity elements . (Z > 82)

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21. Give the symbolic representation of alpha decay , beta decay and gamma emission.

1. Alpha Decay :

$$_{Z}X^{A} \longrightarrow {}_{Z-2}Y^{A-4} + {}_{4}He^{2}$$

X ⟶ Parent nucleus ; Y ⟶ Daughter nucleus ; $_{4}He^{2}$ ⟶ Alpha particle ;

2. Beta Decay :

$$_{Z}X^{A} \longrightarrow {}_{Z+1}Y^{A} + e^{-} + \bar{\upsilon}$$

e^{-} ⟶ Positron ; $\bar{\upsilon}$ ⟶ Anti neutrino

3. Gamma Emission :

$$_{Z}X^{*A} \longrightarrow {}_{Z}X^{A} + \gamma \text{ rays}$$

X^{*} ⟶ Excited state of nucleus

---

22. In alpha decays, why the unstable nucleus emits $_{4}He^{2}$ nucleus ? Why it does not emit four separate nucleons ?

1. $_{4}He^{2}$ nucleus consists of two protons and two neutrons.

2. If $_{92}U^{228}$ nucleus decay into $_{90}Th^{224}$ by emits four separate nucleons then disintegration energy Q for this process turn to negative.

3. It implies that the total mass of product is greater than that of parent nucleus.

4. This kind of process cannot occur in nature because it would violate conservation of energy.

5. In any decay process , the conservation of energy , conservation of linear momentum and angular momentum must be obeyed.

---

23. What is mean life of a radioactive nucleus ? Give its expression.

$$\tau = \frac{\int_{0}^{t} t\,[\lambda N_0 e^{-\lambda t}\, dt]}{N_0}$$

The mean life of radioactive nucleus is defined as the ratio of sum or integration of life times of all nuclei to the total number nuclei present initially.

---

24. What is half – life of a radioactive nucleus ? Give the expression.

$$T_{1/2} = \frac{0.6931}{\lambda} = 0.6931\,\tau$$

The half – life of radioactive nucleus is defined as the time required for the number of atoms initially present to reduce to one half of the initial amount.

---

25. What is meant by activity or decay rate ? Give its unit.

At any instant t , the number of decay per unit time called rate of decay is proportional to the number of nuclei at the same instant.

$$\frac{dN}{dt} \alpha N \quad ; \quad \frac{dN}{dt} = -\lambda N$$

λ Decay constant

---

26. Define curie.

Number of decays per second in 1 gram of radius is defined as one curie and is equal to 3.7×10^{10} decays per second. 1 Curie = 1 Ci = 3.7×10^{10} decays per second = 3.7×10^{10} Becquerel.

27.What are constituent particles of neutron and proton ?

Protons and neutrons are not fundamental particles.They are made up of quarks.There are six types of quarks.

- **They are namely up , down , charm , strange , top and bottom and their anti particles.**

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10. Electronics and Communication

$E_g = E_c - E_v$

1.Define forbidden energy .

The energy gap between valence band and conduction band is called " forbidden energy gap".

---

2. Why is temperature co – efficient of resistance of resistance for semiconductor ?

1. The resistivity value of semiconductor is from 10^{-5} Ω m to 10^{6} Ω m.

2. When the temperature is increased further more number of electrons are promoted to the conduction band and increase conduction.

3. Electrical conduction increases with the increase in temperature.

4. Resistance decreases with increase in temperature.

5. So, semiconductors said to have negative temperature co efficient of resistance.

---

3. What do you mean by doping ?

1. Process of adding impurities to the intrinsic semiconductors.

2. The impurity atoms are called dopants in 100 ppm.

---

4. Distinguish between intrinsic and extrinsic semiconductors .

S. NO	Intrinsic semiconductors	Extrinsic Semiconductors
1.	Pure form of semiconductor without any impurity.	Adding impurity to intrinsic semiconductors
2.	No doping takes place here.	Here , doping takes place.
3.	It has bad electrical characteristics.	It has good electrical conductivity.
4.	Number of free electrons in conduction is equal to number of holes in valence band.	Number of free electrons and holes are not equal.
5.	Ex : Pure Si , Pure Ge	Ex : n – type and p - type semiconductor

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5. A diode is called as unidirectional device. Explain.

Current flows in only one direction.When forward voltage is applied the diode conducts and when reverse voltage is applied there is no conduction. So , diode conducts only one direction , it is a unidirectional device.

---

6. What do you mean by leakage current in diode ?

1. When the junction diode is under reverse bias condition , a very small current in the range of μ A , flows across the junction.

2. This is due to flow of minority charge carrier.

3.This current is called as leakage current or reverse saturation current.

4. Leakage current is independent of applied voltage.

---

7. Draw the input and output of a full wave rectifier.

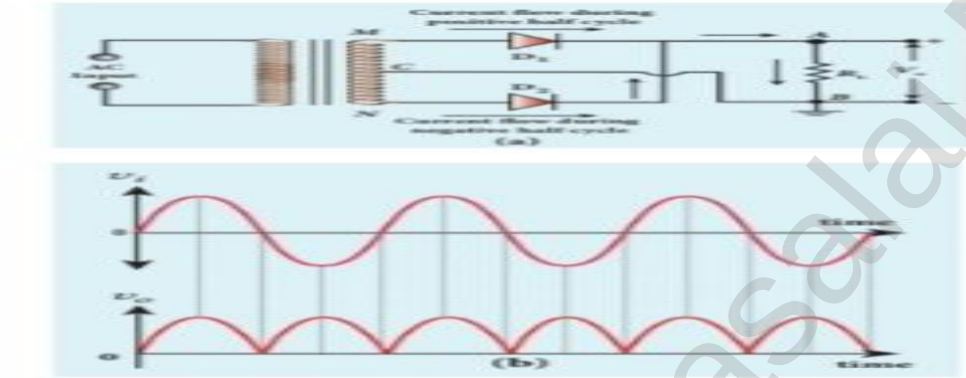

Figure 10.18 (a) Full wave rectifier circuit (b) Input and output waveforms

---

8. Distinguish between avalanche breakdown and Zener breakdown.

1.	**It occurs in lightly doped p-n junction.**	**It occurs in heavily doped p-n junction.**
2.	**It has wide depletion layer.**	**It has narrow depletion layer. (> 10^{-6} m)**
3.	**Electric field is weak.**	**Electric field is strong. (3 X 10^{7} V m^{-1})**
4.	**Breakdown voltage vary.**	**Breakdown voltage constant.**

---

9. Give the Barkhausen conditions for sustained oscillations.

1. There should be positive feedback.

2. Loop phase shift must be 0^0 .

3.Integral multiples of 2π .

4. Loop gain must be unity $|A\beta| = 1$.

5. Voltage gain of amplifier ⟶ A

6. Feed back ratio ⟶ β (the fraction of the output that is fed back to the input)

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10. Explain the current flow in a N P N transistor.

1. In N P N transistor electron flow from emitter to collector. So conventional current flow from collector to emitter.

2. Electrons from emitter region flow towards base region constitute emitter current (I_E)

3. Electrons after reaching base region recombine with holes.

4. Most of electrons reach collector region.

$$I_E = I_B + I_C$$

5. This constitute collector current . (I_C).

6. After recombination of holes in base region by bias voltage constitute base current . (I_B)

---

11. What are logic gates ?

1. It is an electronic circuit whose function is biased on digital signals. They are binary in nature.

2. The logic gates are considered as the basic building blocks of most of the digital systems.

3. They have one output with one or more inputs.

4. There are three types of basic logic gates : AND , OR , NOT

5. There are two types of universal logic gates : NAND , NOR.

---

12. Explain the need for a feedback circuit in a transistor oscillator.

1. Feedback is the fraction of output from an amplifier circuit is returned or fed to the input.

2. If the portion of the output fed to the input is in phase with the input , then the magnitude of the input signal increases.

3. It is necessary for sustained oscillations.

---

13. Write a short note on diffusion current across p-n junction.

1. A single piece of semiconductor crystal is suitably doped such that its one side is p – type semiconductor and the other side is n – type semiconductor.

2. The contact surface between the two sides is called p-n junction.

3. Whenever p-n junction is formed , some of the free electron diffuse from the n – side to the p – side while the holes from p – side to the n – side.

4. The diffusion of the majority charge carriers across the junction gives to an electric current called diffusion current.

---

14. What is meant by biasing ? Mention its types.

Biasing :

Biasing means providing external energy to charge carriers to overcome the barrier potential and make them move in a particular direction.

Types of biasing :

1. Forward Bias 2. Reverse Bias

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15. Why can't we interchange the emitter and collector even though they are made up of the same type of semiconductor material ?

1. Emitter is more heavily doped than the other two regions.

2. Collector is made physically larger than other two as it has to dissipate more power. It is moderately doped.

3. Because of the differing size and the amount of doping , the emitter and collector cannot be interchanged.

---

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

1. NOR and NAND gates are called universal gates because they perform all the logical operations of basic gates like AND , OR , NOT.

2. It can be used to form any other logic or Boolean function.

---

17. Define barrier potential.

The internal repulsion of the depletion layer stops further diffusion of free electrons across the junction. This difference in potential across the depletion layer is called " barrier potential "

---

18. What is rectification ?

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

---

19. List the application of light emitting diode.

1. Remote controller of television , air conditioner etc. 2. Seven segment displays.

3. Traffic signals , emergency vehicle lighting. 4. Indicator lamps on the front of scientific lab.

---

20. Give the principle of solar cells.

1. A solar cell also known as photovoltaic cell works on the principle of " photovoltaic effect "

2. Accordingly , the p-n junction of the solar cell generates emf when solar radiation falls on it.

---

21. What is an integrated circuit ?

1. An integrated circuit is also referred as an IC or a chip or a microchip.

2. It consists of thousands to millions of transistors , resistors , capacitors etc.

3. They are integrated on a small flat piece of semiconductor material that is normally silicon.

4. Main merits over ordinary circuits : 1.cost & performance. 2. size , speed capacity of chips.

---

22. What is modulation ?

For long distance transmission , the low frequency base band signal is superimposed onto a high frequency radio signal by a process called " modulation ".

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23. Define bandwidth of transmission system.

The range of frequencies required to transmit a piece of specified information in a particular channel is called " bandwidth " or the bandwidth of the transmission system.

---

24. What do you mean by skip distance ?

The shortest distance between the transmitter and the point of reception of the sky wave along the surface is called as the " skip distance ".

---

25. Give applications of RADAR.

1. Used for locating and detecting the targets.

2. Used to locate and rescue people in emergency situations.

3. Used to measure precipitation rate and wind speed in meteorological observations.

4. Used in navigation systems such as ship borne surface search , air search and missile guidance systems.

---

26. Explain centre frequency or resting frequency in frequency modulation.

When the frequency of the baseband signal is zero , there is no change in the frequency of the carrier wave. It is at its normal frequency and is called as " centre frequency " or " resting frequency " .

---

27. What des RADAR stand for ?

Radio Detection And Ranging system stands for RADAR.

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11. Recent Development In Physics

1. Distinguish between Nanoscience and Nanotechnology.

Nano science :

Nanoscience is the science of objects with typical sizes of 1 – 100 nm. One nano meter = 10^{-9} meter.

Nano technology :

Nanotechnology is a technology involving in the design , production , characterization and application of nano structured materials.

---

2. What is the difference between Nanomaterials and bulk materials ?

Nanomaterials :

If the particle of a solid is of size less than 100 nm , it is said to be a non solid or nano materials.

Bulk materials :

When the particle size exceeds 100 nm , it is a bulk solid or bulk material.

---

3. Give any two examples for nano in nature.

Single strand of DNA , peacock feather , morpho butterfly , parrot fish and lotus leaf surface.

---

4. Mention any two advantages and disadvantages of robotics.

Advantages of Robotics :

1. The robots are much cheaper than humans.

2. Robots never get tired like humans.

3. Stronger and faster than humans.

4. IN warfare , robots can save human lives.

5. Robots are more precise and error free in performing the task.

Disadvantage of Robotics :

1. Robots have no sense of emotions or conscience.

2. They lack empathy and hence create an emotionless workplace.

3. Unemployment problem will increase.

4. The robots are well programmed to do a job if small thing goes wrong it ends up in a big loss to the company.

5. Human cannot be replaced by robots in decision making.

---

5. Why steel is preferred in making robots ?

In general robots are made up of common metals like aluminium and steel which are the most common metals . Aluminium is a softer metal and is therefore easier to work with , but steel is several times stronger.

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