KENDRIYA VIDYALAYA SANGATHAN

STUDY cum SUPPORT MATERIAL

2014-15

CLASS: XII

PHYSICS

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One Paper

Time: 3 hrs.
Max Marks: 70

		No. of Periods	Marks
Unit I	Electrostatics	22	15
Unit II	Current Electricity	20	
Unit III	Magnetic Effect of Current and Magnetism	22	16
Unit IV	Electromagnetic Induction and Alternating Current	20	
Unit V	Electromagnetic Waves	04	17
Unit VI	Optics	25	
Unit VII	Dual Nature of Matter	08	10
Unit VIII	Atoms and Nuclei	14	
Unit IX	Electronic Devices	15	12
Unit X	Communication Systems	10	
	Total	160	70

QUESTION WISE BREAK UP

Type of Question	Mark per Question	Total No. of Questions	Total Marks
VSA	1	5	05
SA-I	2	5	10
SA-II	3	12	36
VBQ	4	1	04
LA	5	3	15
Total		26	70

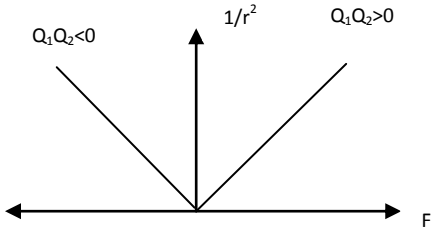
1. *Internal Choice: There is no overall choice in the paper. However, there is an internal choice in one question of 2 marks weightage, one question of 3 marks weightage and all the three questions of 5 marks weightage.*
2. *The above template is only a sample. Suitable internal variations may be made for generating similar templates keeping the overall weightage to different form of questions and typology of questions same.*

1. ELECTROSTATICS

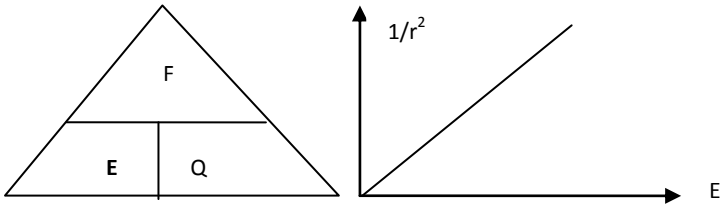
GIST

- Electrostatics is the study of charges at rest.
- Charging a body can be done by friction, induction and conduction.
- Properties of charges:
  - Like charges repel and unlike charges attract.
  - Charges are additive in nature i.e., Q=$\sum_{i=1}^{n} q_i$
  - Charges are quantized. i.e., Q= ± ne [n=1,2,3,… & e=1.602 X10^{-19} C]
  - Charge in a body is independent of its velocity.
  - Charge is conserved.
- To measure charge electroscopes are used.
- Coulomb's law: $\vec{F} = \frac{kq_1q_2}{r^2}\hat{r}$ k=$\frac{1}{4\pi\varepsilon_0}$ = 9X10^9 Nm^2c^{-2}

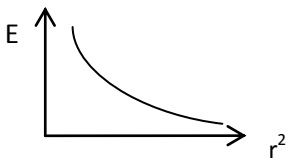
  Where, ε_0= permittivity of free space



  $F_{total} = F_{12} + F_{13} + ...$
- Principle of superposition: $Ftotal = \sum_{i=1}^{n} \vec{F_i}$ [vector sum of individual forces] $= \frac{1}{4\pi\varepsilon_o}\frac{q_1q_2}{r_{12}^2}\hat{r_{12}} + \frac{1}{4\pi\varepsilon_o}\frac{q_1q_3}{r_{13}^2}\hat{r_{13}} + ...$
-

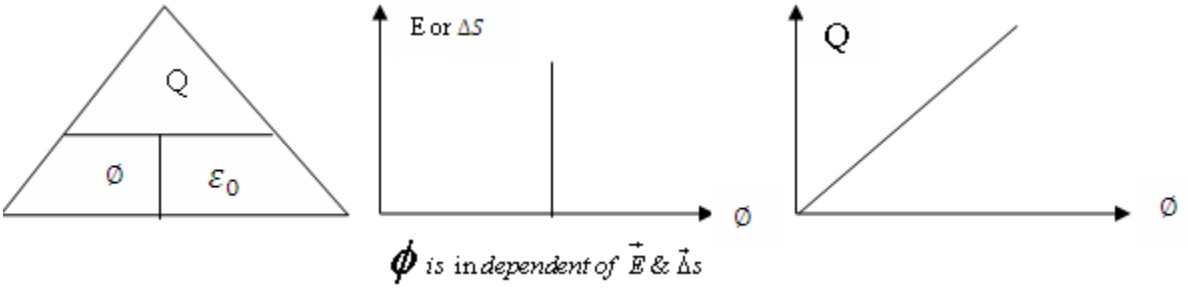


  Note**: In the above triangle the quantity shown at the vertex, could be arrived by multiplying the quantities shown at the base, ie F=E X Q. Any one of the quantity shown at the base is given by the ratio of the quantities shown at vertex & the other quantity shown at the base, ie E=F/Q or Q= F/E**
- Electric field: Force experienced by a unit positive (or test) charge. It is a vector. SI unitNC^{-1}.
- $\vec{E} = \frac{kQ}{r^2}\hat{r}$
- $\vec{E} = \underset{q_o \to 0}{Lt} \frac{\vec{F}}{q_o}$



- Field due to a point charge: $\vec{E} = \frac{kQ}{r^2}\hat{r}$
- Principle of superposition: $\vec{E}_{total} = \sum_{i=1}^{n} \vec{E}_r$ [vector sum of individual fields]
- Dipole: Two equal and opposite charges separated by a small distance.
- Dipole moment: Product of magnitude of charge and distance of separation between them. It is a vector. SI unit: Cm, $\vec{p}$=Q.2$\vec{a}$; direction of $\vec{p}$ is negative to positive charge.

- Dipole in a uniform electric field experiences no net force and instead experiences a torque. $\vec{\tau}=\vec{p}\times\vec{E}\Rightarrow\vec{\tau}=|\vec{p}||\vec{E}|\sin\theta\,\hat{n}$
- If θ= 0° ⇒ stable equilibrium; If θ= 180° ⇒ unstable equilibrium.
- Electric field due to a dipole
  - **<u>at a point on the axial line</u>**:$\frac{2k\vec{p}}{r^3}$ along the direction of dipole moment
  - **<u>at a point on the equatorial line</u>**: $\frac{k\vec{p}}{r^3}$ opposite to the direction of dipole moment.
- Electric flux: $\emptyset=\overrightarrow{\Delta S}.\vec{E}=|\vec{E}||\overrightarrow{\Delta S}|\cos\theta$; It is a scalar; SI unit: $NC^{-1}m^2$ or Vm.
- Gauss' theorem in electrostatics:$\emptyset_{total}=\frac{q_{total}}{\varepsilon_0}$



- <u>Uniform Charge distribution</u>:

  Linear charge distribution: $\lambda=\frac{\Delta q}{\Delta l}$ [λ ⇒ linear charge density Unit Cm^{-1}]

  Surface charge distribution: $\sigma=\frac{\Delta q}{\Delta S}$ [σ ⇒ surface charge density Unit Cm^{-2}]

  Volume charge distribution: $\rho=\frac{\Delta q}{\Delta V}$ [ρ ⇒ Volume charge density Unit Cm^{-3}]

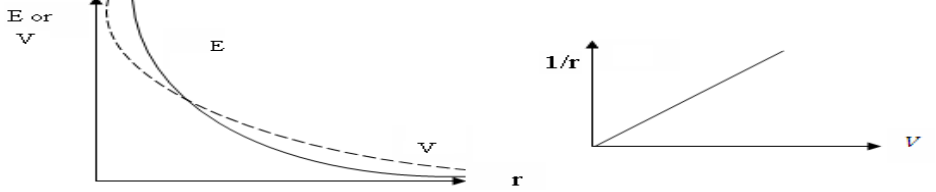
- Applications of Gauss' theorem for uniform charge distribution:

Expression for	**Infinite Linear**	**Infinite plane sheet**	**Thin spherical shell**
Flux Ø	$\frac{\lambda l}{\varepsilon_0}$	$\frac{\sigma S}{\varepsilon_0}$	$\frac{\sigma 4\pi r^2}{\varepsilon_0}$
Magnitude of Field E	$\frac{\lambda}{2\pi r\varepsilon_0}$	$\frac{\sigma}{\varepsilon_0}$	$\frac{Q}{4\pi r^2\varepsilon_0}$ [for points on/outside the shell] =0 [for points inside the shell]
Charge density	$\lambda=\frac{\Delta q}{\Delta l}$	$\sigma=\frac{\Delta q}{\Delta S}$	$\frac{\sigma}{4\pi r^2}$

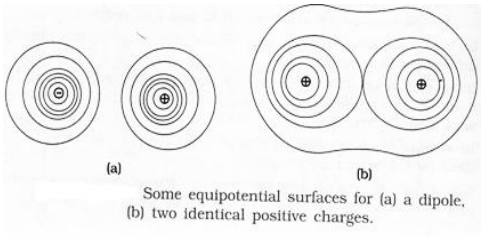
- Properties of electric field lines:
  - ✓ Arbitrarily starts from +ve charge and end at –ve charge
  - ✓ Continuous, but never form closed loops
  - ✓ Never intersect
  - ✓ Relative closeness of the field lines represents the magnitude of the field strength.
  - ✓ For a set of two like charges – lateral pressure in between
  - ✓ For a set of two unlike charges – longitudinal contraction in between.
- Electrostatic Potential: Work done per unit positive Test charge to move it from infinity to that point in an electric field. It is a scalar. SI unit: J/C or V

  $V = W / q_o$

  Electric potential for a point charge: $V=\frac{kq}{r}$



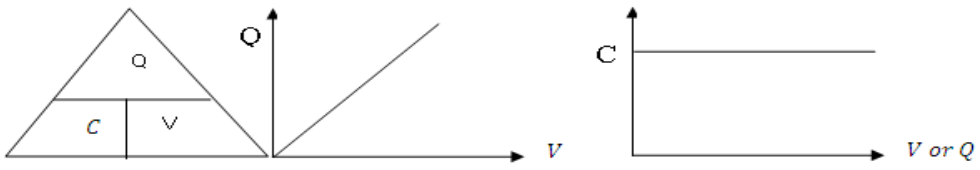
- Electric field is conservative. This means that the work done is independent of the path followed and the total work done in a closed path is zero.
- Potential due to a system of charges: $V_{total} = \sum_{i=1}^{n} \frac{kq_i}{r_i}$
- Potential due to a dipole at a point
  - **<u>on its axial line</u>**: $V_{axial} = \frac{k\,|\vec{p}|}{r^2}$ [or] $\frac{k|\vec{p}|}{r^2} cos\theta$
  - **<u>on its equatorial line</u>**: $V_{eq} = 0$
- Potential difference $V_A - V_B = kq\left[\frac{1}{r_A} - \frac{1}{r_B}\right]$
- Potential energy of two charges: $U = \frac{kq_1q_2}{r}$
- Potential energy of a dipole : $U = \vec{p}.\vec{E} = pE\ [cos\theta_0 - cos\theta_1]$
- Electrostatics of conductors
  (i) Inside a conductor Electrostatic field is zero
  (ii) On the surface E is always Normal
  (iii) No charge inside the conductor but gets distributed on the surface
  (iv) Charge distribution on the surface is uniform if the surface is smooth
  (v) Charge distribution is inversely proportional to '*r*' if the surface is uneven
  (vi) Potential is constant inside and on the surface
- Equipotential surfaces: The surfaces on which the potential is same everywhere.
  - ✓ Work done in moving a charge over an equipotential surface is zero.
  - ✓ No two equipotential surfaces intersect.
  - ✓ Electric field lines are always perpendicular to the equipotential surfaces.



Some equipotential surfaces for (a) a dipole, (b) two identical positive charges.

As $E = -\frac{dV}{dr}$ If Vis constant, $E \propto \frac{1}{r}$ **and if E is constant, V**$\propto r$

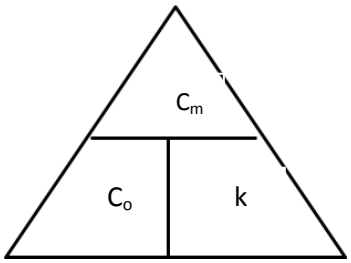
- Capacitor: A device to store charges and electrostatic potential energy.
- Capacitance: $C = \frac{Q}{V}$, Ratio of charge and potential difference. Scalar,
- SI unit: farad [F]



Capacitance of a parallel plate capacitor: $C = \frac{\varepsilon_0 \times A}{d}$

Capacitance of a parallel plate capacitor with a dielectric medium in between:

- $C_m = \frac{\epsilon_o A}{\left(d - t + \frac{t}{k}\right)}$
- If t=0 =>$C_0 = \frac{\epsilon_o A}{(d)}$
- If t=d =>C_0 =k $\frac{\epsilon_o A}{(d)}$ =>C_m = k C_0

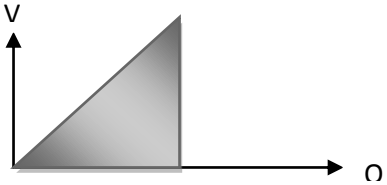


- Combination of capacitors:

Capacitors in series: $\frac{1}{c} = \sum_{i=1}^{n} \frac{1}{c_i}$

Capacitors in parallel : $c = \sum_{i=1}^{n} c_i$

- Energy stored in capacitors: $U = \frac{1}{2} CV^2 = \frac{1}{2} QV = \frac{1}{2} \frac{Q^2}{C}$



- Area shaded in the graph = U = $\frac{1}{2} QV$
- Energy density : $U_d = \frac{1}{2} \varepsilon_0 E^2 = \frac{\sigma^2}{2\varepsilon_0}$
- Introducing dielectric slab between the plates of the charged capacitor with:

Property↓	**Battery connected**	**Battery disconnected**
Charge	K Q_0	Q_0
Potential difference	V_0	V_0/K
Electric field	E_0	E_0/K
Capacitance	KC_0	KC_0
Energy	K times $\frac{1}{2} \varepsilon_0 E^2$ [Energy is supplied By battery]	1/K times $\frac{1}{2} \varepsilon_0 E^2$ [Energy used for Polarization]

- On connecting two charged capacitors:

Common Potential: $V = \frac{C_1 V_1 + C_2 V_2}{V_1 + V_2}$

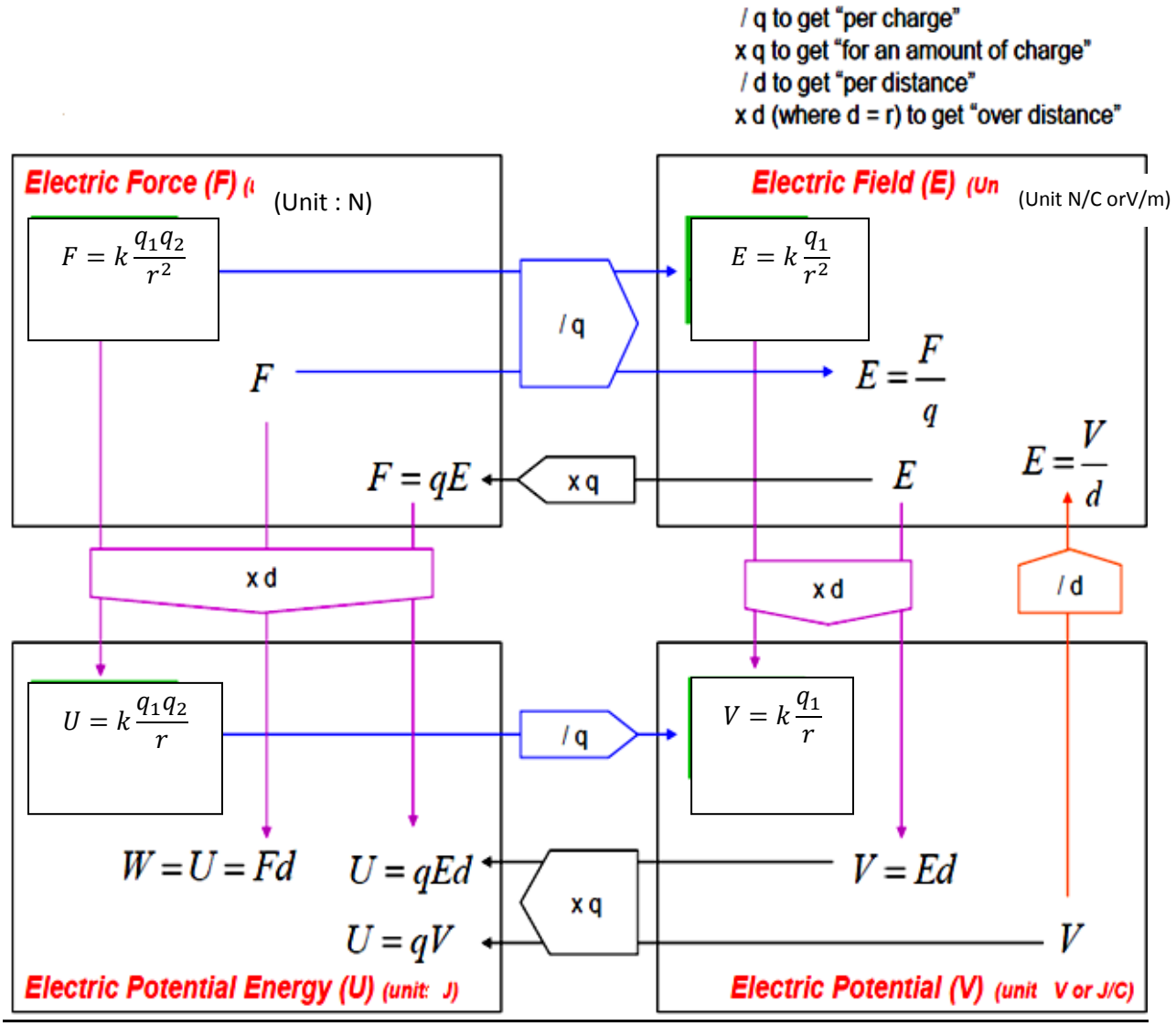
Loss of energy: $\Delta U = \frac{1}{2} \frac{C_1 \times C_2}{C_1 + C_2} (V_1 - V_2)^2$

- Van de Graff generator:-

- ✓ is an electrostatic machine to build very high voltages.
- ✓ works on the Principle $V(r) - V(R) = kq\left(\frac{1}{r} - \frac{1}{R}\right)$;
  - ✓ Corona discharge is the electrical discharge through the defected part of the spherical conductor, where the surface is not smooth. Hence, the hollow spherical conductor in the Van de Graff generator should have a smooth outer surface.

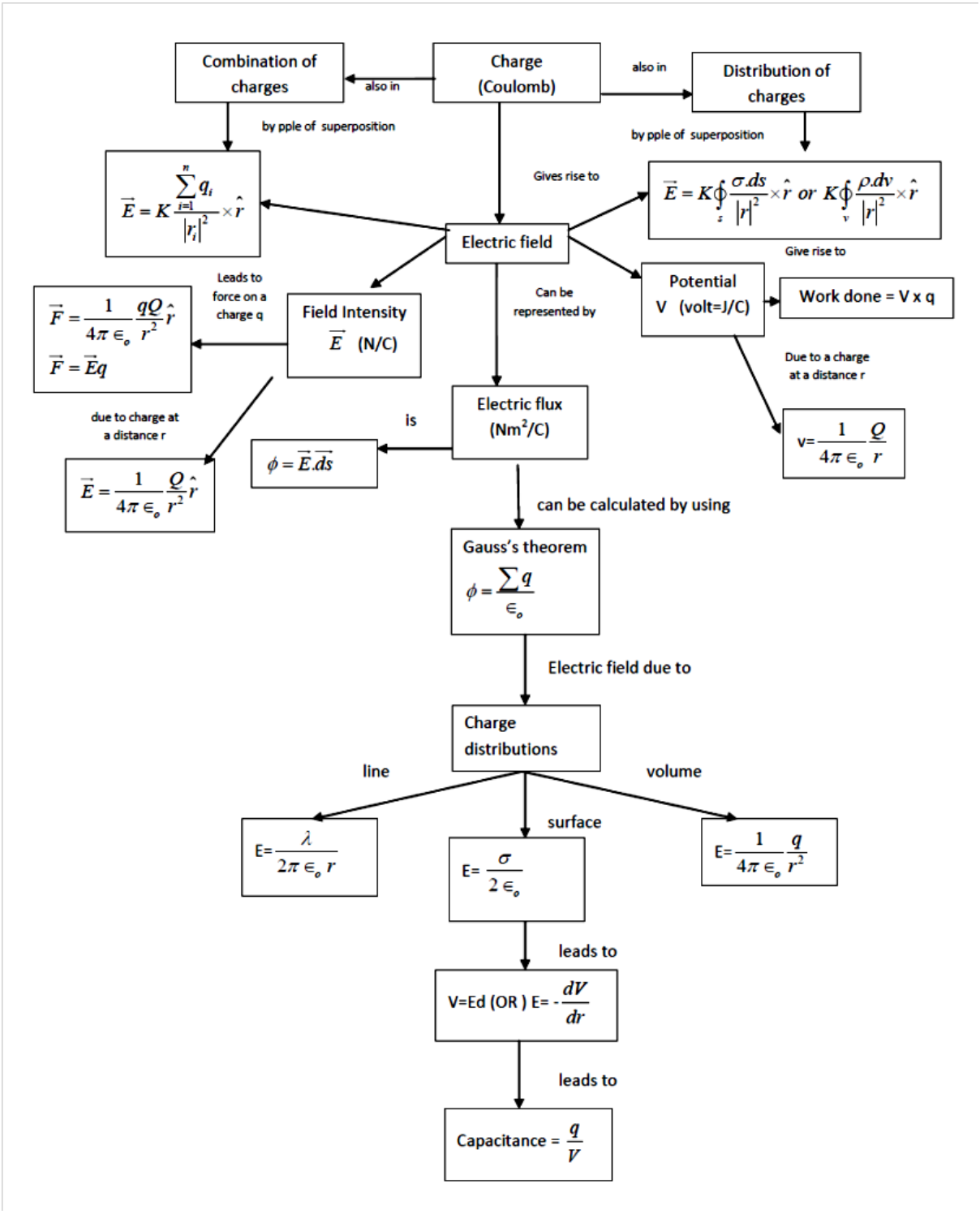
CONCEPT MAP

Electric Force/Field/Potential/P. E.

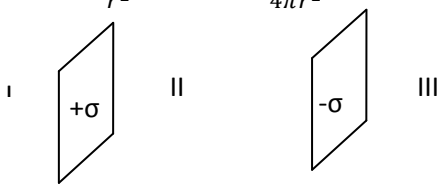


CONCEPT MAP

Charge and it's impact



CHARGES AND COULOMB'S LAW

QNo	**QUESTIONS**	Marks
1.	What is the work done in moving a test charge 'q' through a distance of 1 cm along the equatorial line of an electric dipole? [Hint : on equatorial line V=0]	1
2.	Why in Millikan's Oil Drop experiment, the charge measured was always found to be of some discrete value and not any arbitrary value? Ans: Because charge is always quantized ie., $Q = n \times e$	1
3.	What is meant by electrostatic shielding? Ans: Electric filed inside a cavity is zero. To protect any device from electric field , it is to be placed inside the cavity. It is called electrostatic shielding.	1
4.	Why an electric dipole placed in a uniform electric field does not undergoes acceleration? Ans: Because the net force on the dipole is zero. $F_{net} = 0$ as $F=\pm qE$	1
5.	Why electric field lines (i) Can never intersect one another? (ii) Cannot form closed loop? (iii) Cannot have break in between? Ans : Because (i) Electric field has an unique direction at any given point (ii) Monopoles or single isolated charges exist unlike magnetism (iii) Start from +ve charges and terminate at –ve charges	1
6.	Show that at a point where the electric field intensity is zero, electric potential need not be zero. Ans: If E = 0⇒ $V = constant$ according to the equation E=-dV/dr	2
7.	What is the electric flux through the surface S in Vacuum? 	2
8.	Write the expression for the electric field, charge density for a uniformly charged thin spherical shell. Ans: $E = \frac{kQ}{r^2}$; $\sigma = \frac{Q}{4\pi r^2}$	2
9.	 Write the expression for the electric field in the regions I, II, III shown in the above figure. Ans: $E_I = E_{III} = 0$ $E_{II} = \sigma/\varepsilon_0$	2
10.	Two free protons are separated by a distance of 1 A^o. if they are released, what is the kinetic energy of each proton when at infinite separation.[Hint : at inifinte distance $K.E = \frac{e^2}{4\pi\epsilon_o r}$]	2
11.	How does the electric flux, electric field enclosing a given charge vary when the area enclosed by the charge is doubled? Ans: (a) Ø= constant (b) E is halved	2
12.	The electric field in a certain region of space is $\vec{E} = 10^4 \hat{\imath} NC^{-1}$. How much is the flux passing through an area 'A' if it is a part of XY plane, XZ plane, YZ plane, making an angle 30^0 with the	2

axis?

Ans: Φ_{XY} =10A Vm E ΔS COSϕ [ϕ=0] $\phi_{XZ}= \phi_{YZ}$ = 0 Vm (ϕ =90^O) =10^4 A cos30^O Vm

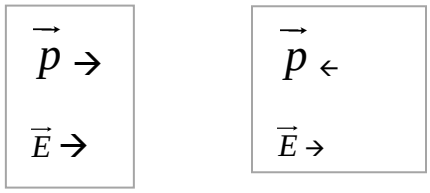
13. An electric dipole ±4μC is kept at co-ordinate points (1, 0, 4) are kept at (2,-1, 5), the electric field is given by $\vec{E}$ = 20 $\hat{\imath}$ NC^{-1}. Calculate the torque on the dipole. 2

Ans: Calculate first dipole moment using $\vec{p}$ =q.2$\vec{a}$

Then calculate torque using $\vec{\tau} = \vec{p} \times \vec{E}$ and hence find $|\vec{\tau}|$ =13.4 N m

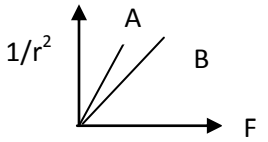
14. Show diagrammatically the configuration of stable and unstable equilibrium of an electric dipole ($\vec{p}$) placed in a uniform electric field ($\vec{E}$). 2

Ans:



Stable Unstable

15. Plot a graph showing the variation of coulomb force F versus $\frac{1}{r^2}$ where r is the distance between the two charges of each pair of charges: (1μC, 2μC) and (2μC, -3μC) Interpret the graphs obtained. 2



[Hint : graph can be drawn choosing –ve axis for force only]

Ans: $|\overrightarrow{F_B}| > |\overrightarrow{F_A}|$

16. A thin straight infinitely long conducting wire having charge density λ is enclosed by a cylindrical surface of radius r and length l, its axis coinciding with the length of the wire. Find the expression for electric flux through the surface of the cylinder. 2

Ans: Using Gauss's Law obtain: $\Phi = \frac{\lambda l}{\varepsilon_0}$

17. Calculate the force between two alpha particles kept at a distance of 0.02mm in air. 2

Ans: $\boldsymbol{F = 9 \times 10^9 \frac{4\times(1.6\times10^{-19})^2}{(2\times10^{-5})^2}}$

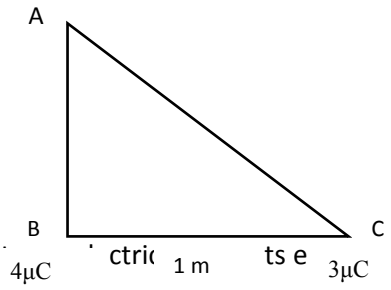
18. Explain the role of earthing in house hold wiring. 2

Ans: During short circuit, it provides an easy path or emergency way out for the charges flowing to the ground, preventing the accidents.

19. What is the difference between charging by induction and charging by friction? 2

* In frictional method, transfer of charges takes place from one object to the other.
* During induction, redistribution of charges takes place within the conductor.

20. Two electric charges 3μC, -4μC are placed at the two corners of an isosceles right angled triangle of side 1 m as shown in the figure. What is the direction and magnitude of electric field at A due to the two charges? 2



Ans: E=45×⟦10⟧^3 NC^(-1)
θ=36.9° from line AB

21. A sensitive instrument is to be shifted from a ctric ts e nt. Suggest a possible way. 2

[Hint : Electrostatic shielding]

22. A charge +Q fixed on the Y axis at a distance of 1m from the origin and another charge +2Q is fixed on the X axis at a distance of √2 m from the origin. A third charge – Q is placed at the 3

origin. What is the angle at which it moves?

Ans: Force due to both the changes are equal = KQ^2 & $\perp^r$ to each other so the resultant force will make 45^o with X-axis.

23. Two charges 5μC, -3μC are separated by a distance of 40 cm in air. Find the location of a point on the line joining the two charges where the electric field is zero. 3

Ans: Solve for x from the equation: $k\frac{5X10^{-6}}{x^2} = k\,\frac{3X10^{-6}}{(40-x)^2}$

24. Deduce Coulomb's law from Gauss' law. 3

Ans: $\emptyset = E^{\rightarrow}.S^{\rightarrow} = Q/\varepsilon_0$ $\quad E\times 4\pi r^2 = Q/\varepsilon_0$

$F = Eq_0 \therefore F = \llbracket Qq_o/(4\pi\varepsilon_0 r^2)$

25. State Gauss's law and use this law to derive the electric filed at a point from an infinitely long straight uniformly charged wire. 3

Ans: Statement $\int \overline{E}.\overline{ds} = \frac{q}{\varepsilon_o}$ Derivation for E = $\frac{\lambda}{2\prod\varepsilon_o r}$

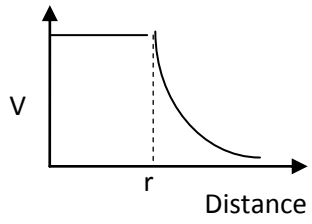
26. Three charges –q, Q and –q are placed at equal distances on a straight line. If the potential energy of system of these charges is zero, then what is the ratio of Q:q [Ans : 1:4] 3

ELECTRIC POTENTIAL

1. Is it possible that the potential at a point is zero, while there is finite electric field intensity at that point? Give an example. 1
   Ans: Yes , Centre of a dipole
2. Is it possible that the electric field $\vec{E}$ at a point is zero, while there is a finite electric potential at that point. Give an example. 1
   Ans: Yes, Inside charged shell
3. Can two equipotential surfaces intersect? Justify your answer. 1
   Ans: No. Otherwise it would mean two directions for force at a point.
4. Is potential gradient a vector or a scalar quantity? 1
   Ans: Scalar quantity
5. Write the dimensional formula of 'ϵ_0 'the permittivity of free space. 1
   Ans: $[M^{-1}L^{-3}T^4A^2]$
6. An electric dipole is placed in an electric field due to a point charge. Will there be a force and torque on the dipole? 1

   Ans: Yes, Both force and torque will act as the Electric Field is non uniform.
7. Draw the graph showing the variation of electric potential with distance from the centre of a uniformly charged shell. 1

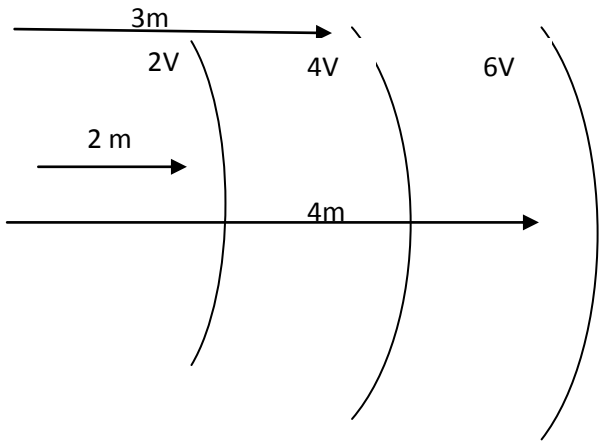
Ans



8. Find the ratio of the electric field lines starting from a proton kept first in vacuum and then in a medium of dielectric constant 6. 1

Ans: 6 : 1

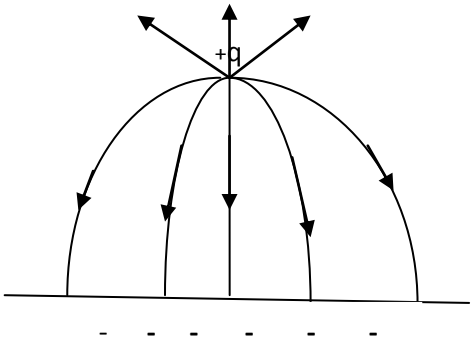
9. Calculate the electric field from the equipotential surface shown below. 1



Ans: 2 V $[E = \frac{-dv}{dr}, dv = 2V, dr = 1m]$

10. Sketch the electric field lines, when a positive charge is kept in the vicinity of an uncharged conducting plate. 1

Ans



11. Two charges are kept as shown. Find dipole moment. 1

Ans: (0,0,2)-q ……. +q(0,0,-2)

-15 μc +15 μc

12. Compare the electric flux in a cubical surface of side 10 cm and a spherical surface of radius 10 cm, when a change of 5μC is enclosed by them. 1

Ans: Electric flux will be same in both the cases.

13. Explain why the electric field inside a conductor placed in an external electric field is always zero. 1

Ans: Charge lies on the surface of a conductor only

14. Two identical metal plates are given positive charges Q_1 and Q_2,where $Q_1 > Q_2$. Find the potential difference between them, if they are now brought together to form a parallel plate capacitor with capacitance C. 2

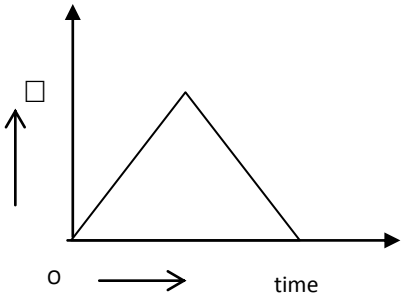
Ans: $(Q_1 – Q_2)/2C$

15. 27 small drops of mercury having the same radius collage to form one big drop. Find the ratio of the capacitance of the big drop to small drop. 2

Ans: [3:1]

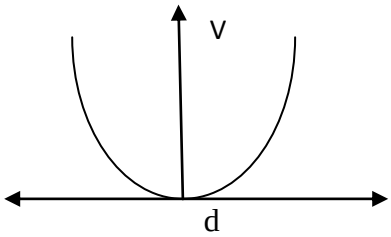
16. A uniformly charged rod with linear charge density λ of length L is inserted into a hollow cubical structure of side 'L' with constant velocity and moves out from the opposite face. Draw the graph between flux and time. 2

Ans



17. Draw a graph showing the variation of potential with distance from the positive charge to negative charge of a dipole, by choosing the mid-point of the dipole as the origin. 2

Ans 2



18. If $\vec{E} = 3\hat{\imath} + 4\hat{\jmath} - 5\hat{k}$, calculate the electric flux through a surface of area 50 units in z-x plane 2

Ans: 200 unit

19. Name the physical quantities whose SI units are Vm, Vm^{-1}. Which of these are vectors? 2

Ans: Vm → electric flux, scalar ; Vm^{-1}→electric field, vector

20. The spherical shell of a Van de Graff generator is **to** be charged to a potential of 2 million volt. Calculate the minimum radius the shell can have, if the dielectric strength of air is 0.8 kV/mm. 2

Ans: [2.5m]

21. How will you connect seven capacitors of 2μf each to obtain an effective capacitance of 10/11 μf. 2

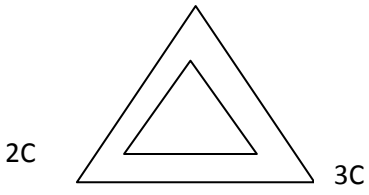
Ans: 5 in parallel and 2 in series

22. A proton moves with a speed of 7.45 x 10^5m/s directly towards a free proton initially at rest. Find the distance of the closest approach for the two protons. 2

Ans: 5.56 x 10^{-23}m

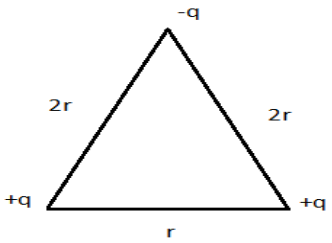
23. Three point charges of 1C, 2C & 3C are placed at the corners of an equilateral triangle of side 1m. Calculate the work done to move these charges to the corners of a smaller equilateral triangle of sides 0.5m. 2

Ans: 9.9 x 10^{10} J



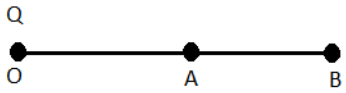
2

24. Suggest an arrangement of three point charges, +q,+q, -q separated by finite distance that has zero electric potential energy



25. A point charge Q is placed at point O as shown. Is the potential difference (V_A-V_B) positive, negative or zero if Q is (i) positive (ii) negative 2

Ans:



26. Show that the potential of a charged spherical conductor, kept at the centre of a charged hollow spherical conductor is always greater than that of the hollow spherical conductor, irrespective of the charge accumulated on it. 3
Ans: $Va-V_b=(q/4\pi\epsilon)\ (1/r-1/R)$
(Principle of Van de Graff generator)

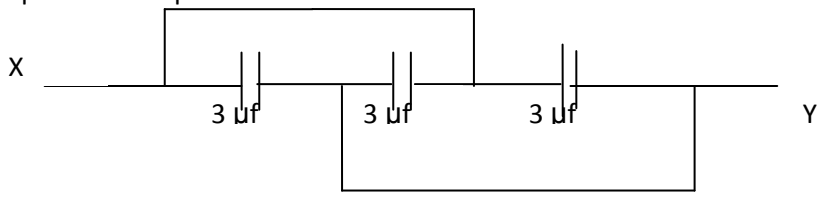
CAPACITORS

S.No

1 What happens to the capacitance of a capacitor when a copper plate of thickness one third of the separation between the plates is introduced in the capacitor? 2
Ans: 1.5 times C_o

2 A parallel plate capacitor is charged and the charging battery is then disconnected. What happens to the potential difference and the energy of the capacitor, if the plates are moved further apart using an insulating handle? 2
Ans: Both Increases

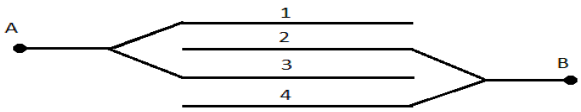
3 Find the equivalence capacitance between X and Y. 2



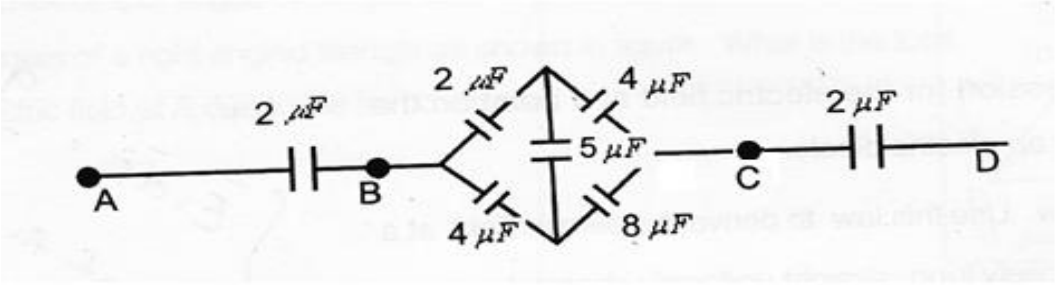
Ans: 9 µf

4 A pith ball of mass 0.2 g is hung by insulated thread between the plates of a capacitor of separation 8cm. Find the potential difference between the plates to cause the thread to incline at an angle 15^0 with the vertical, if the charge in the pith ball is equal to 10^{-7}C. 2
Ans: 429 V

5. Find the capacitance of arrangement of 4 plates of Area A at distance d in air as shown. 2



6. What is an equivalent capacitance of the arrangement the shown below 3



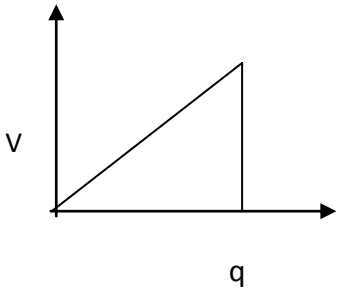
If 6V cell is connected across AD. Calculate the potential difference between B&C.

7. A parallel plate capacitor is charged to a potential difference V by d.c. source and then disconnected. The distance between the plates is then halved. Explain with reason for the change in electric field, capacitance and energy of the capacitor. 3
Ans: Use the formulae - Electric field remains same, Capacitance doubled, Energy halved

8. Derive an expression for capacitance of parallel plate capacitor, when a dielectric slab of dielectric constant k is partially introduced between the plates of the capacitor. 3

9. A potential difference of 1200 V is established between two parallel plates of a capacitor. The plates of the capacitor are at a distance of 2 cm apart. An electron is released from the negative plate, at the same instant, a proton is released from the +ve plate. 3
(a)How do their (i) velocity (ii) Energy compare, when they strike the opposite plates.
(b) How far from the positive plate will they pass each other?
Ans a. (i)42.84 (ii)equal b. 2.7cm

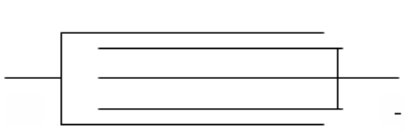
10. Draw a graph to show the variation of potential applied and charge stored in a capacitor. Derive the expression for energy stored in a parallel plate capacitor from the capacitor. 3



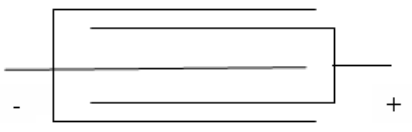
11. Find the capacitance of a system of three parallel plates each of area A m^2 separated by d_1 and d_2 m respectively. The space between them is filled with dielectrics of relative dielectric constant ϵ_1 and ϵ_2. 2

12. Two parallel plate capacitors A and B having capacitance 1μF and 5 μF are charged separately to the same potential 100V. They are then connected such that +ve plate of A is connected to –ve plate of B. Find the charge on each capacitor and total loss of energy in the capacitors. 3
Ans: 400μC, 500μC and 5/3 x 10J

13. Calculate the capacitance of a system having five equally spaced plates, if the area of each plate is 0.02 m^2 and the separation between the neighboring are 3 mm. in case (a) and (b) 3



(a)



(b)

Ans: (Hint: Capacitance of a parallel plate capacitor $\varepsilon_o A/d$)

1.18×10^{-4} μ F and 2.36 x 10 μ F

14. Net capacitance of three identical capacitors in series is 1μf. What will be their net capacitance if connected in parallel? 2

Find the ratio of energy stored in the two configurations, if they are both connected to the same source.

Ans: 9μf 1 : 9

15. Two parallel plate capacitors X and Y have the same area of plates and the same separation between them. X has air between the plates and Y contains a dielectric medium of εr=4. Calculate Capacitance of X and Y if equivalent capacitance of combination is 4 μF.

(i) Potential Difference between the plates of X and Y

(ii) What is the ration of electrostatic energy stored in X and Y

[Ans : 5 μF, 20 μF, 9.6 V, 2.4 V, 4:1]

2. CURRENT ELECTRICITY

GIST

- Current carriers – The charge particles which flow in a definite direction constitutes the electric current are called current carriers. E.g.: Electrons in conductors, Ions in electrolytes, Electrons and holes in semi-conductors.
- Electric current is defined as the amount of charge flowing through any cross section of the conductor in unit time. $I = Q/t$.
- Current density $\vec{J} = I/A$.
- Ohm's law: Current through a conductor is proportional to the potential difference across the ends of the conductor provided the physical conditions such as temperature, pressure etc. Remain constant. $V \alpha I$ i.e. $V = IR$, Where R is the resistance of the conductor. Resistance R is the ratio of V & I
- Resistance is the opposition offered by the conductor to the flow of current.
- Resistance $R = \rho l/A$ where ρ is the resistivity of the material of the conductor- length and A area of cross section of the conductor. If l is increased n times, new resistance becomes n^2R. If A is increased n times, new resistance becomes $\frac{1}{n^2}R$
- Resistivity $\rho = m/ne^2\tau$, Where m, n, e are mass, number density and charge of electron respectively, τ- relaxation time of electrons. ρ is independent of geometric dimensions.
- Relaxation time is the average time interval between two successive collisions
- Conductance of the material G =1/R and conductivity σ=1/ρ
- Drift velocity is the average velocity of all electrons in the conductor under the influence of applied electric field. Drift velocity $V_d = (eE/m)\tau$ also $I = neAv_d$
- Mobility (μ) of a current carrier is the ratio of its drift velocity to the applied field $\mu = \frac{V_d}{E}$
- Effect of temperature on resistance: Resistance of a conductor increase with the increase of temperature of conductor $R_T = R_o(1+\alpha T)$, where α is the temperature coefficient of resistance of the conductor. α is slightly positive for metal and conductor, negative for semiconductors and insulators and highly positive for alloys.
- Combination of resistors: $R_{series} = R_1 + R_2 + ...R_n$, $\frac{1}{R_{Parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + ...\frac{1}{R_n}$
- Cells: E.M.F of a cell is defined as the potential difference between its terminals in an open circuit. Terminal potential difference of a cell is defined as the p.d between its ends in a closed circuit.
- Internal resistance r of a cell is defined as the opposition offered by the cell to the flow of current. r = $\left(\frac{E}{V} - 1\right)R$ where R is external resistances.
- Grouping of cells :

  i) In series grouping circuit current is given by $I_s = \frac{nE}{R + nr}$,

  ii) In parallel grouping circuit current is given by $I_p = \frac{mE}{r + mR}$ where n, m are number of cells in series and parallel connection respectively.
- Kirchhoff's Rule:

  i) Junction Rule:-The algebraic sum of currents meeting at a point is zero. $\sum I = 0$

  ii) Loop rule:-The algebraic sum of potential difference around a closed loop is zero $\sum V = o$
- Wheatstone bridge is an arrangement of four resistors arranged in four arms of the bridge and is used to determine the unknown resistance in terms of other three resistances. For balanced Wheatstone Bridge, $\frac{P}{Q} = \frac{R}{S}$

- Slide Wire Bridge or Metre Bridge is based on Wheatstone bridge and is used to measure unknown resistance. If unknown resistance S is in the right gap, $S = \left(\frac{100-l}{l}\right)R$
- Potentiometer is considered as an ideal voltmeter of infinite resistance.
- Principle of potentiometer: The potential drop across any portion of the uniform wire is proportional to the length of that portion of the wire provided steady current is maintained in it i.e. $v \alpha l$
- Potentiometer is used to (i) compare the e.m.f.s of two cells (ii) determine the internal resistance of a cell and (iii) measure small potential differences.
- Expression for comparison of e.m.f of two cells by using potentiometer, $\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$ where l_1, l_2 are the balancing lengths of potentiometer wire for e.m.fs ε_1 and ε_2 of two cells.
- Expression for the determination of internal resistance of a cell I is given by $\left(\frac{l_1 - l_2}{l_2}\right)R$

  Where l_1 is the balancing length of potentiometer wire corresponding to e.m.f of the cell, l_2 that of terminal potential difference of the cell when a resistance R is connected in series with the cell whose internal resistance is to be determined
- Expression for determination of potential difference $V = \varepsilon\left(\frac{\varepsilon}{R+r}\right)\frac{rl}{L}$. where L is the length of the potentiometer wire, l is balancing length, r is the resistance of potentiometer wire, R is the resistance included in the primary circuit.
- Joule's law of heating states that the amount of heat produced in a conductor is proportional to (i) square of the current flowing through the conductor,(ii) resistance of the conductor and (iii) time for which the current is passed. Heat produced is given by the relation $H=I^2Rt$
- Electric power: It is defined `as the rate at which work is done in maintaining the current in electric circuit. $P = VI = I^2R = V^2/R$. Power P is the product of V & I
- Electrical energy: The electrical energy consumed in a circuit is defined as the total work done in maintaining the current in an electrical circuit for a given time. Electrical energy = $VIt = I^2Rt = (V^2/R)t = Pt$
- Commercial unit of energy 1KWh= 3.6×10^6J
- Colour coding : **B**lack **B**rown **R**ed **O**range **Y**ellow **G**reen **B**lue **V**iolet **G**ray **W**hite

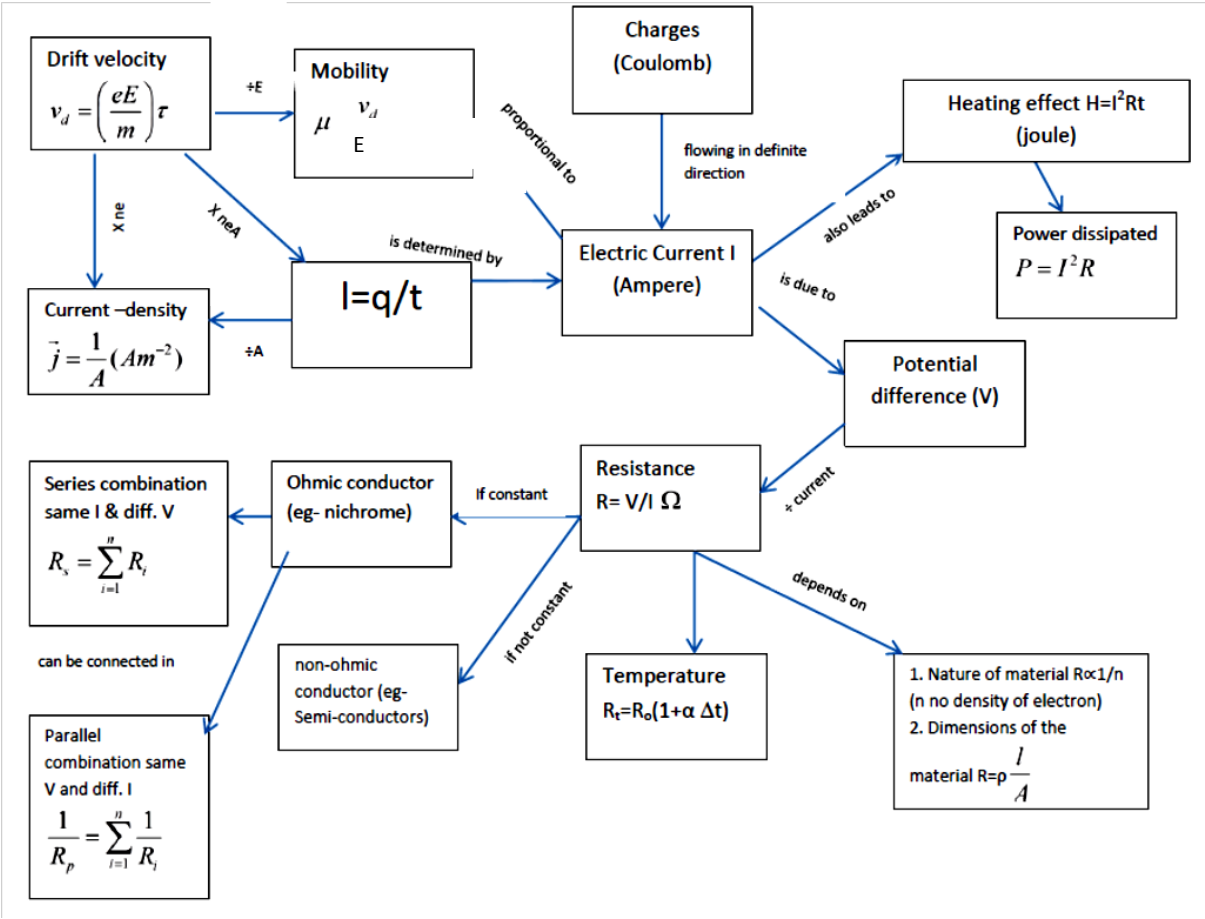
  0 1 2 3 4 5 6 7 8 9

  Tolerance (i) Gold 5% (ii) Silver 10% (iii) No Color 20%

  Example: if colour code on carbon resister is Red Yellow and Orange with tolerance colour as silver, the resistance of the give resister is $(24\times10^3 \pm 10\%)\Omega$

CONCEPT MAP

Flow of Charges



QUESTIONS

DRIFT VELOCITY, CURRENT, POTENTIAL DIFFERENCE, OHM'S LAW AND RESISTANCE

1. How does the drift velocity of electrons in a metallic conductor vary with increase in temperature? (1)
   Ans. Decreases.

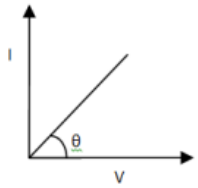
2. Two different wires X and Y of same diameter but of different materials are joined in series and connected across a battery. If the number density of electrons in X is twice that of Y, find the ratio of drift velocity of electrons in the two wires. (1)
   Ans: Ans: $I \alpha$ nv_d i.e. $V_{dx}/V_{dy} = n_y/n_x = ½$)

3.* A 4Ω non insulated wire is bent in the middle by 180^0 and both the halves are twisted with each other. Find its new resistance? (1)
   Ans: 1Ω

4. Can the terminal potential difference of a cell exceed its emf? Give reason for your answer. (1)
   Ans: Yes, during the charging of cell.

5. Two wires of equal length one of copper and the other of manganin have the same resistance. Which wire is thicker? (1)
   Ans: Manganin.

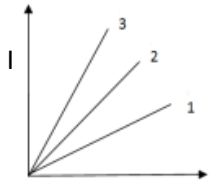
6. The V-I graph for a conductor makes angle Θ with V- axis, what is the resistance of the conductor? (1)
   Ans: R = Cot Θ



7. It is found that 10^{20} electrons pass from point X towards another point Y in 0.1s. How much is the current & what is its direction? Ans: 160A; from Y to X

8. Two square metal plates A and B are of the same thickness and material. The side of B is twice that of side of A. If the resistance of A and B are denoted by R_A and R_B, find R_A/ R_B. Ans: 1 (1)

9*.The V-I graph of two resistors in their series combination is shown. Which one of these graphs shows the series combinations of the other two? Give reason for your answer. (1)



Ans: 1 (2)

10. Plot a graph showing the variation of conductivity σ with the temperature T in a metallic conductor.
    (Ans: see fig1)

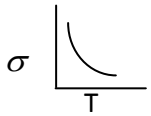


Fig 1

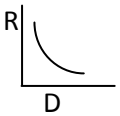


fig2

(2)

11. Draw a graph to show the variation of resistance R of the metallic wire as a function of its diameter D keeping the other factor constant. (Ans: see fig2)

12 A pd of 30V is applied across a colour coded carbon resistor with rings of blue, black and yellow colours. What is the current to the resistor? Ans: $R = 60 \times 10^4 \Omega$, $I = 5 \times 10^{-5} A$ (2)

13. A non-conducting ring of radius r has charge q distribute over it. What will be the equivalent current if it rotates with an angular velocity ω? Ans: $I = q/t = q\omega/2\pi$ (2)

14.* Two cells each of emf E and internal resistances r_1 and r_2 are connected in series to an external resistance R. Can a value of R be selected such that the potential difference of the first cell is 0. (2)

Ans: $I = 2\mathcal{E}/(R + r_1 + r_2)$ Potential diff. for first cell $V_1 = \mathcal{E} - I r_1 = 0$

$\mathcal{E} = (2\mathcal{E} r_1)/R + r_1 + r_2$ Solving these we get, $R = r_1 - r_2$

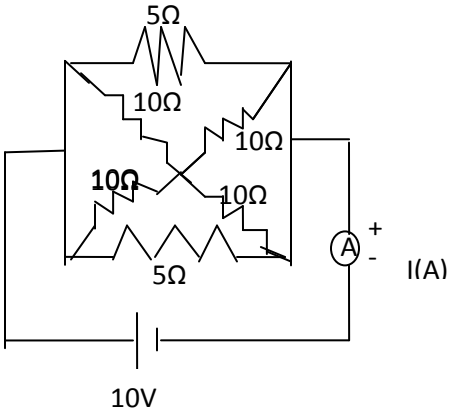
15. Why does Resistance increase in series combination and decrease in parallel combination (2)

Ans: Effective length increases in series combination ($R \alpha l$).

In parallel combination area of cross section increases ($R \alpha 1/A$)

16. A piece of silver wire has a resistance of 1Ω. What will be the resistance of the constantan wire of one third of its length and one half of its diameter if the specific resistance of the constantan wire is 30 times than that of the silver? Ans: 40Ω (2)

17. Calculate the current shown by the ammeter in the circuit in fig 1 (2)



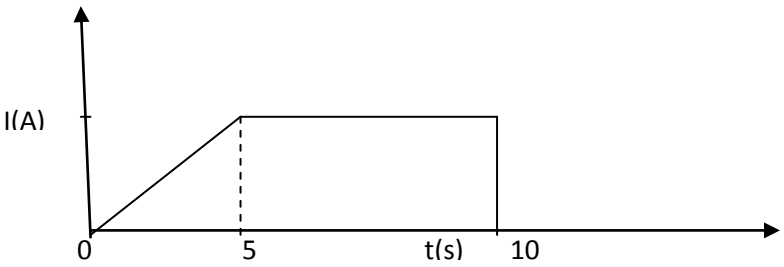
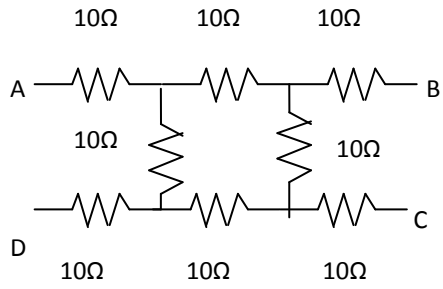


Fig 1. Fig 2.

Ans: R = 2Ω and I = 5A

18.* The plot in fig 2 given above shows the variation of current I through the cross section of a wire over a time interval of 10s. Find the amount of charge that flows through the wire over this time period. Ans: Area under the I-t graph, q = 37.5C (2)

19. Find the resistance between the points (i) A and B and (ii) A and C in the following network (2)



(2)

Ans: (i) $R_{AB} = 27.5\Omega$ (ii) $R_{AC} = 30\Omega$

20. Two wires of the same material having lengths in the ratio 1:2 and diameter 2:3 are connected in series with an accumulator. Compute the ratio of p.d across the two wires (2)

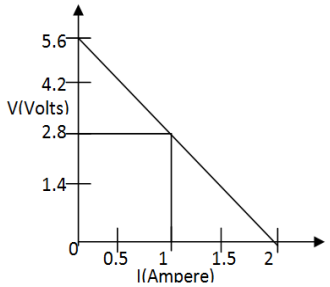
Ans: $R = \rho l/A = 4\rho l/\pi d^2$ $R_A/R_B = 9/8$ $V_A/V_B = I_A R_A/I_B R_B = 9/8$

21. 4 cells of identical emf E_1, internal resistance r are connected in series to a variable resistor. The following graph shows the variation of terminal voltage of the combination with the current output. (3)

(i)What is the emf of each cell used?

(ii)For what current from the cells, does maximum power dissipation occur in the circuit?

(iii)Calculate the internal resistance of each cell



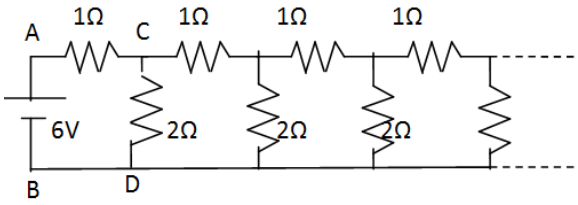
Ans: 4E = 5.6 E = 1.4 V

When I = 1A, V = 2.8/4 = 0.7V

Internal resistance, r= (E – V)/I = 0.7Ω

The output power is maximum when internal resistance = external resistance = $4r.I_{max} = 4E/(4r+4r) = 1A$

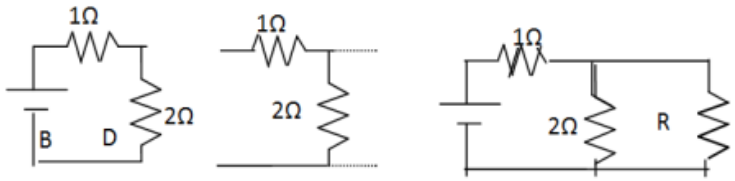
22.* An infinite ladder network of resistances is constructed with 1Ω and 2Ω resistances shown (3)



A 6V battery between A and B has negligible resistance.

(i) Find the effective resistance between A and B.

Ans: Since the circuit is infinitely long, its total resistance remains unaffected by removing one mesh from it. Let the effective resistance of the infinite network be R, the circuit will be



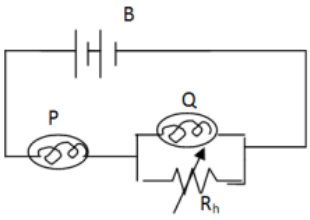
$R = \frac{2R}{R+2} + 1$ $R = 2\Omega$

23. The resistance of a tungsten filament at 150°C is 133Ω. What will be its resistance at 500^0C? The temperature coefficient of tungsten is 0.0045^0C^{-1} at 0^0C. (3)

Ans: Use $R_t = R_0(1+\alpha t)$ $R_{500} = 258\Omega$

24. The circuit shown in the diagram contains two identical lamps P and Q. What will happen to the brightness of the lamps, if the resistance R_h is increased? Give reason. (3)

Ans: Brightness of P and Q decrease and increase respectively.

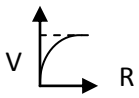


26. A battery has an emf E and internal resistance r. A variable resistance R is connected across the terminals of the battery. Find the value of R such that (a) the current in the circuit is maximum (b) the potential difference across the terminal is maximum. (c)Plot the graph between V and R (3)

Ans: (a) $I = \mathcal{E} / (r + R)$ $I = I_{max}$ when $R = 0$ $I_{max} = \mathcal{E} / r$

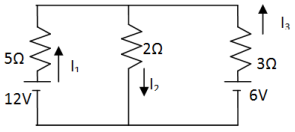
(b) $V = \mathcal{E} R/(r + R) = \mathcal{E} /(r/R + 1)$ $V = V_{max}$ when $r/R + 1$ = minimum, $r/R = o$, $V = \mathcal{E}$

(c)



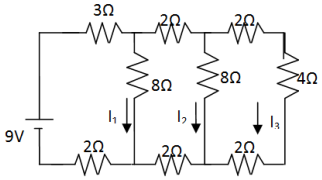
II. KIRCHHOFF'S RULE AND APPLICATIONS

1. Using Kirchhoff's laws, calculate I_1, I_2 and I_3 (3)



Ans: $I_1 = 48/31A$ $I_2 = 18/31A$ $I_3 = 66/31A$

2. In the circuit, find the current through the 4Ω resistor. (3)



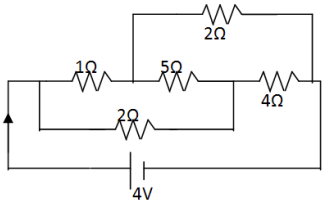
Ans: I = 1A

III. WHEATSTONE BRIDGE AND POTENTIOMETER

1. The emf of a cell used in the main circuit of the potentiometer should be more than the potential difference to be measured. Why? (1)

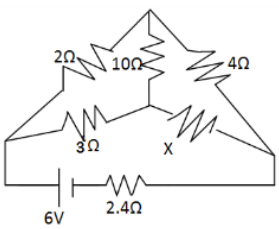
2. The resistance in the left gap of a metre bridge is 10Ω and the balance point is 45cm from the left end. Calculate the value of the unknown resistance. Ans S = 12.5Ω (1)

3. How can we improve the sensitivity of a potentiometer? (1)
4. Why is potentiometer preferred over a voltmeter? (1)
5. Write the principle of (2)
   (i) a meter bridge.
   (ii) a potentiometer.
6. How does the balancing point of a Wheatstone bridge get affected when (2)
   i) Position of cell and Galvanometer are interchanged?
   ii) Position of the known and unknown resistances is interchanged?
7. Explain with a neat circuit diagram, how will you compare emf of two cells using a potentiometer? (3)
8. With the help of a circuit diagram, describe the method of finding the internal resistance of the Primary Cell using a potentiometer. (3)
9. With the help of a neat circuit diagram describe the method to determine the potential difference across the conductor using a potentiometer. (3)
10. Calculate the current drawn from the battery in the given network.



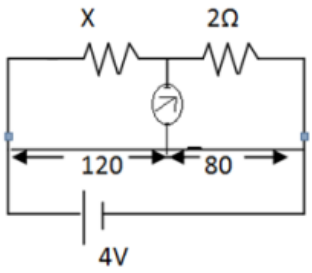
Ans: I = 2A

11. Find the value of X and current drawn from the battery of emf 6V of negligible internal resistance (3)



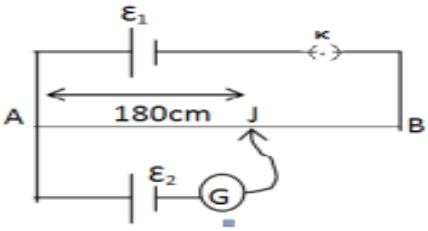
Ans: X = 6Ω and I = 1A

12. Find the value of the unknown resistance X and the current drawn by the circuit from the battery if no current flows through the galvanometer. Assume the resistance per unit length of the wire is $0.01\Omega cm^{-1}$. (3)



Ans: X = 3Ω

13. In the circuit shown, AB is a resistance wire of uniform cross – section in which a potential gradient of $0.01V\ cm^{-1}$ exists. (3)



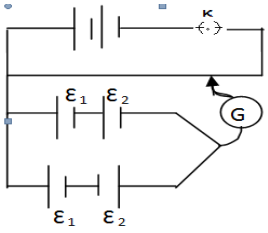
(a)If the galvanometer G shows zero deflection, what is the emf ε_1 of the cell used?

(b)If the internal resistance of the driver cell increases on some account, how will it affect the balance point in the experiment?

Ans: (a) PD V_{AB} = 1.8 V (b) Balance pt. will shift towards B since V/I decreases.

14.* In a potentiometer circuit, a battery of negligible internal resistance is set up as shown to develop a constant potential gradient along the wire AB. Two cells of emfs ε_1 and ε_2 are connected in series as shown in the combination (1) and (2). The balance points are obtained respectively at 400cm and 240cm from the point A. Find (i) $\varepsilon_1/\varepsilon_2$ and (ii) balancing length for the cell ε_1 only. (3)

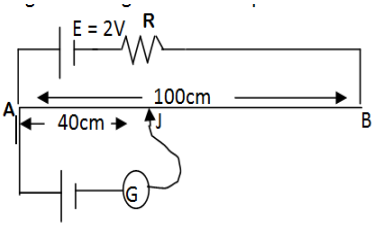
battery



Ans : $\varepsilon_1 + \varepsilon_2 \propto 400$, $\varepsilon_1 - \varepsilon_2 \propto 240$, Solving $\varepsilon_1/\varepsilon_2 = 4$, $\varepsilon_1 \propto l_1$,

$(\varepsilon_1 + \varepsilon_2)/\varepsilon_1 = 400/l_1$, $l_1 = 320cm$

15.* A potentiometer wire of length 100cm having a resistance of 10Ω is connected in series with a resistance and cell of emf 2V of negligible internal resistance. A source emf of 10mV is balanced against a length of 40cm of potentiometer wire. What is the value of the external resistance?



Ans: I = E/(R + 10) = (2/R + 10)

Resistance of 40cm

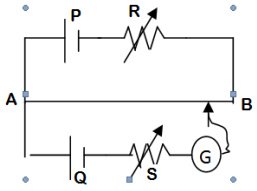
wire is 4Ω. At J, (2/R +10) x 4 = 10

x 10^{-3} R = 790Ω

16.* In the potentiometer circuit shown, the balance point is at X. State with reason where the balance point will be shifted when (3)

(i)Resistance R is increased, keeping all parameters unchanged.

(ii)Resistance S is increased keeping R constant.

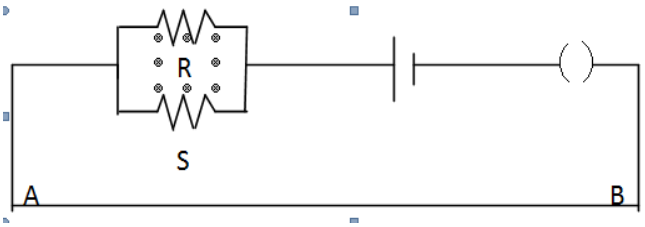


(iii)Cell P is replaced by another cell whose emf is lower than that of that cell Q.

Ans: (i) As R is increased V/I will decrease hence X will shift towards B.

(ii)No effect (iii) Balance point is not found.

17.* A potentiometer wire has a length L and resistance R_0. It is connected to a battery and a resistance combination as shown. Obtain an expression for the potential difference per unit length of the potentiometer wire. What is the maximum emf of a 'test cell' for which one can get a balance point on this potentiometer wire? What precautions should one take while connecting this test cell to the circuit? (3)



Ans: Total resistance of potentiometer wire $R = R_0 + RS/(R+S)$

Current in the circuit $I = E/ (R_0 + (RS/R+S))$

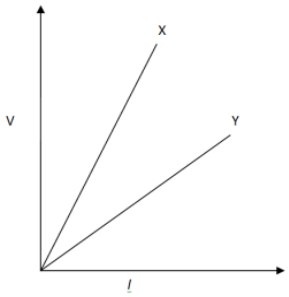
Total potential difference across AB $V = I R_0 = E R_0/ (R_0 + (RS/R+S))$

Therefore, PD per unit length is $V/L = E R_0/L (R_0 + (RS/R+S))$

Max emf of a test cell should be less than V.

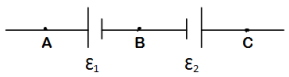
<u>Precaution:</u> Positive terminal of the test cell must be connected to positive terminal of the battery.

18. The variation of potential difference V with length *l* in case of two potentiometers X and Y as shown. Which one of these will you prefer for comparing emfs of two cells and why? (3)



Ans : The potentiometer Y is preferred, as it has low potential gradient (V/*l*)

19. Two cells of emfs ε_1 and ε_2 ($\varepsilon_1 > \varepsilon_2$) are connected as shown in figure



When a potentiometer is connected between A and B, the balancing length of the potentiometer wire is 300cm. On connecting the same potentiometer between A and C, the balancing length is 100cm. Calculate the ratio of ε_1 and ε_2.

Ans: $\varepsilon_1 \alpha 300$, $\varepsilon_1 - \varepsilon_2 \alpha 100$, $\varepsilon_1/\varepsilon_2 = 3/2$

IV. <u>ELECTRIC ENERGY AND POWER</u>

1. What is the largest voltage you can safely put across a resistor marked 98Ω - 0.5W? (1)

2. Which lamp has greater resistance (i) 60W and (ii) 100W when connected to the same supply? (1)

Ans: $R = V^2/P$, R α 1/P, 60 lamp has more resistance

3. Nichrome and Cu wires of the same length and same diameter are connected in series in an electric circuit. In which wire will the heat be produced at a higher rate? Give reason. (2)

Ans: $P = I^2R$ P α R Heat produced is higher in Nichrome wire.

4.* An electric bulb rated for 500W at 100V is used in circuit having a 200V supply. Calculate the resistance R that must be put in series with the bulb, so that the bulb delivers 500W. (2)

Ans: Resistance of bulb=V^2/P = 20Ω, I = 5A, for the same power dissipation, current should be 5A when the bulb is connected to a 200V supply. The safe resistance R' = V'/I = 40Ω. Therefore, 20Ω resistor should be connected in series.

5. Two bulbs are marked 220V-100W and 220V-50W. They are connected in series to 220V mains. Find the ratio of heat generated in them. (2)

Ans: $H_1/H_2 = I^2R_1 /I^2R_2 = R_1/ R_2$= ½

6.* Can a 30W, 6V bulb be connected supply of 120V? If not what will have to be done for it? (3)

Ans: Resistance of bulb R= V^2/P = 36/30 = 1.2Ω Current capacity of the bulb I = P/V = 5A

A resistance R' to be added in series with the bulb to have current of 5 A, I = V'/R + R' =5, R' = 22.8Ω

3.MAGNETIC EFFECTS OF CURRENT AND MAGNETISM

GIST

MAGNETIC EFFECTS OF CURRENT AND MAGNETISM:

1. Magnetic field:
   It is a region around a magnet or current carrying conductor in which its magnetic influence can be felt by a magnetic needle.
2. Biot-Savart Law
   $dB = \mu_0 \mathbf{I} dl \sin\theta / 4\pi r^2$
   $\mu_0 = 4\pi \times 10^{-7}$ Tm/A
   [Direction of dB can be found by using Maxwell's Right hand thumb rule.]
3. Applications :
   Magnetic field at a centre of a current carrying circular coil $B = \mu_0 I/2a$
   Magnetic field at a point on the axis of current carrying coil. $B = \mu_0 N i a^2/2(a^2+x^2)^{3/2}$ (N=no. of turns in the coil)
4. Ampere's circuital law
   It states that the line integral of magnetic field around any closed path in vacuum/air is μ_0 times the total current threading the closed path.
   $\oint B.dl = \mu_0 \mathbf{I}$
5. Applications
   i) Magnetic field due to straight infinitely long current carrying straight conductor.
   $B = \mu_0 \mathbf{I}/2\pi r$
   ii) Magnetic field due to a straight solenoid carrying current
   $B = \mu_0 n \mathbf{I}$
   n= no. of turns per unit length
   iii) Magnetic field due to toroidal solenoid carrying current.
   $B = \mu_0 N \mathbf{I} / 2\pi r$
   N= Total no. of turns.
6. Force on a moving charge [Lorentz Force]
   (i) In magnetic field F=q(V x B)
   (ii) In magnetic and electric field F=q[E+(v x B)] Lorentz force
7. Cyclotron
   (i) Principle
   (a) When a charged particle moves at right angle to a uniform magnetic field it describes circular path.

(b) An ion can acquire sufficiently large energy with a low ac voltage making it to cross the same electric field repeatedly under a strong magnetic field.

(ii) Cyclotron frequency or magnetic resonance frequency

$v=qB/2\pi m$, $T=2\pi m/Bq$; $\omega=Bq/m$

(iii) Maximum velocity and maximum kinetic energy of charged particle.

$V_m=Bqr_m/m$

$E_m=B^2q^2r_m^2/2m$

8. Force on a current carrying conductor in uniform
   $F= (I l \times B)$
   l=length of conductor
   Direction of force can be found out using Fleming's left hand rule.
9. Force per unit length between parallel infinitely long current carrying straight conductors.
   $F/l= \mu_0 I_1 I_2/2\pi d$
   (a) If currents are in same direction the wires will attract each other.
   (b) If currents are in opposite directions they will repel each other.
10. 1 Ampere – One ampere is that current, which when flowing through each of the two parallel straight conductors of infinite length and placed in free space at a distance of 1m from each other, produces between them a force of $2x10^{-7}$ N/m of their length.
11. Torque experienced by a current loop in a uniform B.

    $\tau = NIBA \sin\theta$

    $\tau=MXB$

    Where M=NIA

12. Motion of a charge in
    (a) Perpendicular magnetic field F=q(vxB),F=qvBSin90=qvB (circular path)
    (b) Parallel or antiparallel field F=qvBSin0 (or) qvBSin180=0(Straight-line path)

        If $0<\theta<90$, the path is helix

        v Cosθ is responsible for linear motion v, v Sinθ is responsible for circular motion

        Hence trajectory is a helical path

13. Moving coil galvanometer

It is a sensitive instrument used for detecting small electric Currents.

Principle: When a current carrying coil is placed in a magnetic field, it experiences a torque.

$I \alpha \theta$ and $I = K \theta$ where $K= NAB / C$

Current sensitivity, $I_s= \theta / I=NBA/K$
voltage sensitivity, $Vs= \theta /V=NBA/KR$

Changing N -> Current sensitivity changes but Voltage Sensitivity does not change

(a) Conversion of galvanometer into ammeter

A small resistance S is connected in parallel to the galvanometer coil

$S=I_gG/(I - I_g)$; $R_A=GS/(G+S)$

(b) Conversion of galvanometer into a voltmeter.

A high resistance R is connected in series with the galvanometer coil.

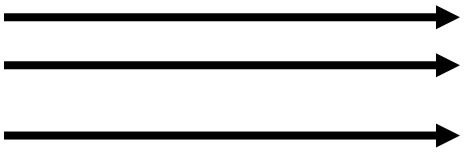
$R=(V/I_g) –G$; $R_v=G+R$

Current loop as a magnetic dipole

Magnetic dipole moment $M = \frac{evr}{2}$

$M=n(eh / 4\pi m_e)$

14. Representation of uniform magnetic field.



15. Magnetic dipole moment of a magnetic dipole.

M=m (2l) SI unit of M -> ampere metre m= pole strength.

16. Work done in rotating a magnetic dipole in a magnetic field.

$W = MB(\cos\theta_1 - \cos\theta_2)$

$W = -\vec{M}.\vec{B}$

17. Magnetic field due to magnetic dipole

a) at any point on axial line (P)

$$B = \frac{\mu_0 2M}{4\pi(r^2 - l^2)^2}$$ 2

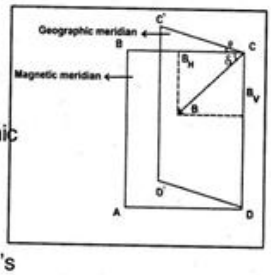
b) at any point on equatorial line

$$B = \frac{\mu_0 M}{4\pi(r^2 + l^2)^{3/2}}$$

Torque experienced by a magnetic diploe in uniform magnetic field

$\tau = MXB$

18. Elements of earth's magnetic field



a) Declination (θ)

It is the angle between the magnetic meridian and geographic meridian

b) Inclination (or) Dip (δ)

It is the angle between the direction of total intensity of earth's magnetic field and its horizontal component.

c) Horizontal component of earths magnetic field (B_H)

It is the component of total intensity of earth's magnetic field along the horizontal.

$$\tan\delta = B_V / B_H \qquad B = \sqrt{B_V^2 + B_H^2}$$

19. a) Intensity of magnetisation I

$$I = \frac{M}{V} = \frac{Magnetic\ moment}{Volume}$$

$I = \frac{m}{a}$ where m is pole strength

b) Magnetic induction B

$B = \mu_0 (H+I)$

H = strength of the magnetising field

c) Permeability

The magnetic permeability of a material may be defined as the ration of magnetic induction B to the magnetic intensity H

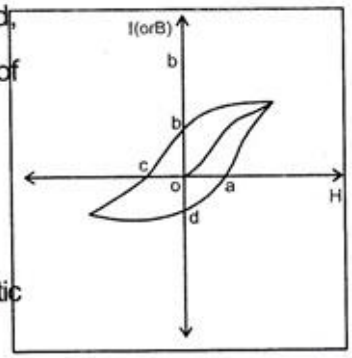
$\mu = B/H$

d) Susceptibility

$$\chi = \frac{I}{H}$$

20. Hysteresis

Intensity of magnetisation lags behind the magnetising field, when a magnetic substance is taken through a complete cycle of magnetisation.



a) Retentivity or remanance

ob (or) od

It is the value of magnetic field intensity retained by the magnetic substance when the magnetising field is reduced to zero.

b) Coercivity:- (oc (or) oa):- It is the value of magnetizing field required to reduce the residual intensity of magnetisation of sample to zero.

c) Hysteresis loss:- It is the loss of energy which takes place when a magnetic substance is taken over a complete cycle of magnetisation.

21. a) Electromagnet:- It is a magnet whose magnetism is due to current flowing through a coil wound over a soft iron. It maintains **magnetic** strength till the current is on in the coil. (eg) Soft iron

b) Permanent magnet:- It is a magnet which owes its strength due to the alignment of its molecules.

eg. steel

Properties to make

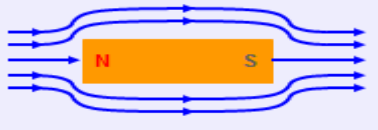
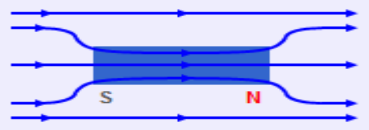
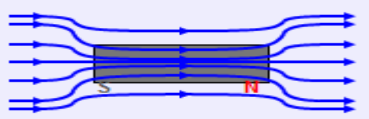
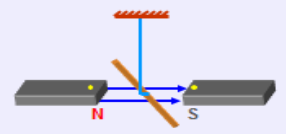
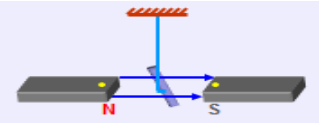
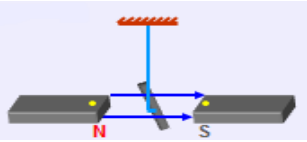
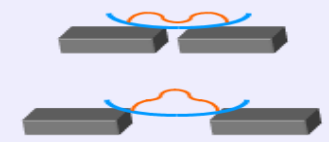
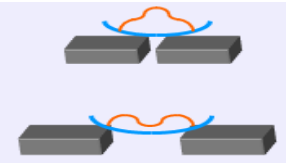
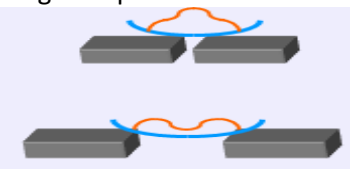
1) Electro magnet

High retentivity and low coercivity

2) Permanent magnet

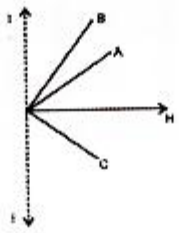
High retentivity and high coercivity

22. Properties of magnetic substances

DIA	PARA	FERRO
1. Diamagnetic substances are those substances which are feebly repelled by a magnet. Eg. Antimony, Bismuth, Copper, Gold, Silver, Quartz, Mercury, Alcohol, water, Hydrogen, Air, Argon, etc.	Paramagnetic substances are those substances which are feebly attracted by a magnet. Eg. Aluminium, Chromium, Alkali and Alkaline earth metals, Platinum, Oxygen, etc.	Ferromagnetic substances are those substances which are strongly attracted by a magnet. Eg. Iron, Cobalt, Nickel, Gadolinium, Dysprosium, etc.
2. When placed in magnetic field, the lines of force tend to avoid the substance. 	The lines of force prefer to pass through the substance rather than air. 	The lines of force tend to crowd into the specimen. 
3. When placed in non-uniform magnetic field, it moves from stronger to weaker field (feeble repulsion).	When placed in non-uniform magnetic field, it moves from weaker to stronger field (feeble attraction).	When placed in non-uniform magnetic field, it moves from weaker to stronger field (strong attraction).
4. When a diamagnetic rod is freely suspended in a uniform magnetic field, it aligns itself in a direction perpendicular to the field. 	When a paramagnetic rod is freely suspended in a uniform magnetic field, it aligns itself in a direction parallel to the field. 	When a paramagnetic rod is freely suspended in a uniform magnetic field, it aligns itself in a direction parallel to the field very quickly. 
5. If diamagnetic liquid taken in a watch glass is placed in uniform magnetic field, it collects away from the centre when the magnetic poles are closer and collects at the centre when the magnetic poles are farther. 	If paramagnetic liquid taken in a watch glass is placed in uniform magnetic field, it collects at the centre when the magnetic poles are closer and collects away from the centre when the magnetic poles are farther. 	If ferromagnetic liquid taken in a watch glass is placed in uniform magnetic field, it collects at the centre when the magnetic poles are closer and collects away from the centre when the magnetic poles are farther. 
6. Induced Dipole Moment (M) is a small – ve value.	Induced Dipole Moment (M) is a small + ve value.	Induced Dipole Moment (M) is a large + ve value.

7. Intensity of Magnetisation (I) has a small – ve value.	Intensity of Magnetisation (I) has a small + ve value.	Intensity of Magnetisation (I) has a large + ve value.
8. Intensity of Magnetisation (I) has a small – ve value.	Intensity of Magnetisation (I) has a small + ve value.	Intensity of Magnetisation (I) has a large + ve value.
9. Magnetic permeability μ is always less than unity.	Magnetic permeability μ is more than unity.	Magnetic permeability μ is large i.e. much more than unity.
10. Magnetic susceptibility c_m has a small – ve value.	Magnetic susceptibility c_m has a small + ve value.	Magnetic susceptibility c_m has a large + ve value.
11. They do not obey Curie's Law. i.e. their properties do not change with temperature.	They obey Curie's Law. They lose their magnetic properties with rise in temperature.	They obey Curie's Law. At a certain temperature called Curie Point, they lose ferromagnetic properties and behave like paramagnetic substances.

Graph between H and I

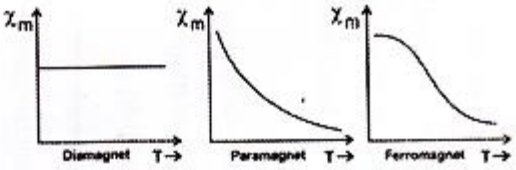


A = Paramagnet

= Ferro magnet

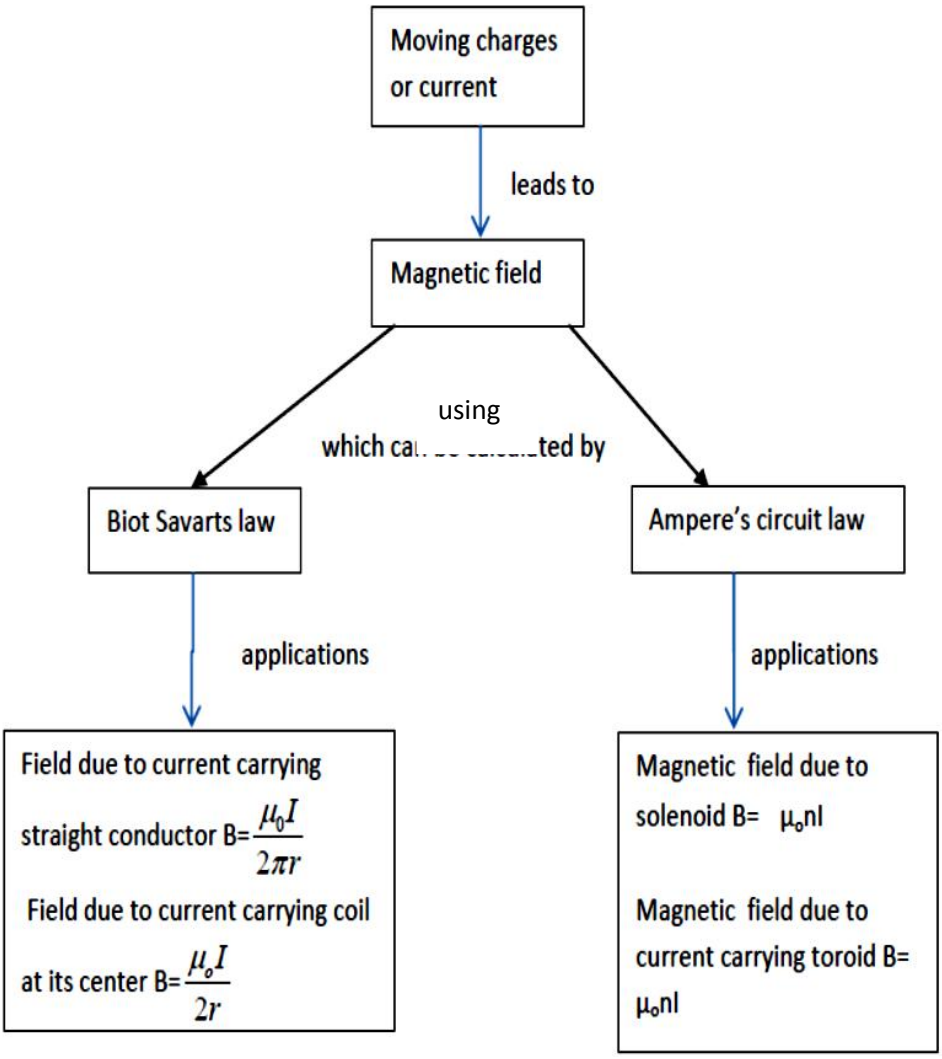
= Diamagnet

. Graph between χm and Temperature



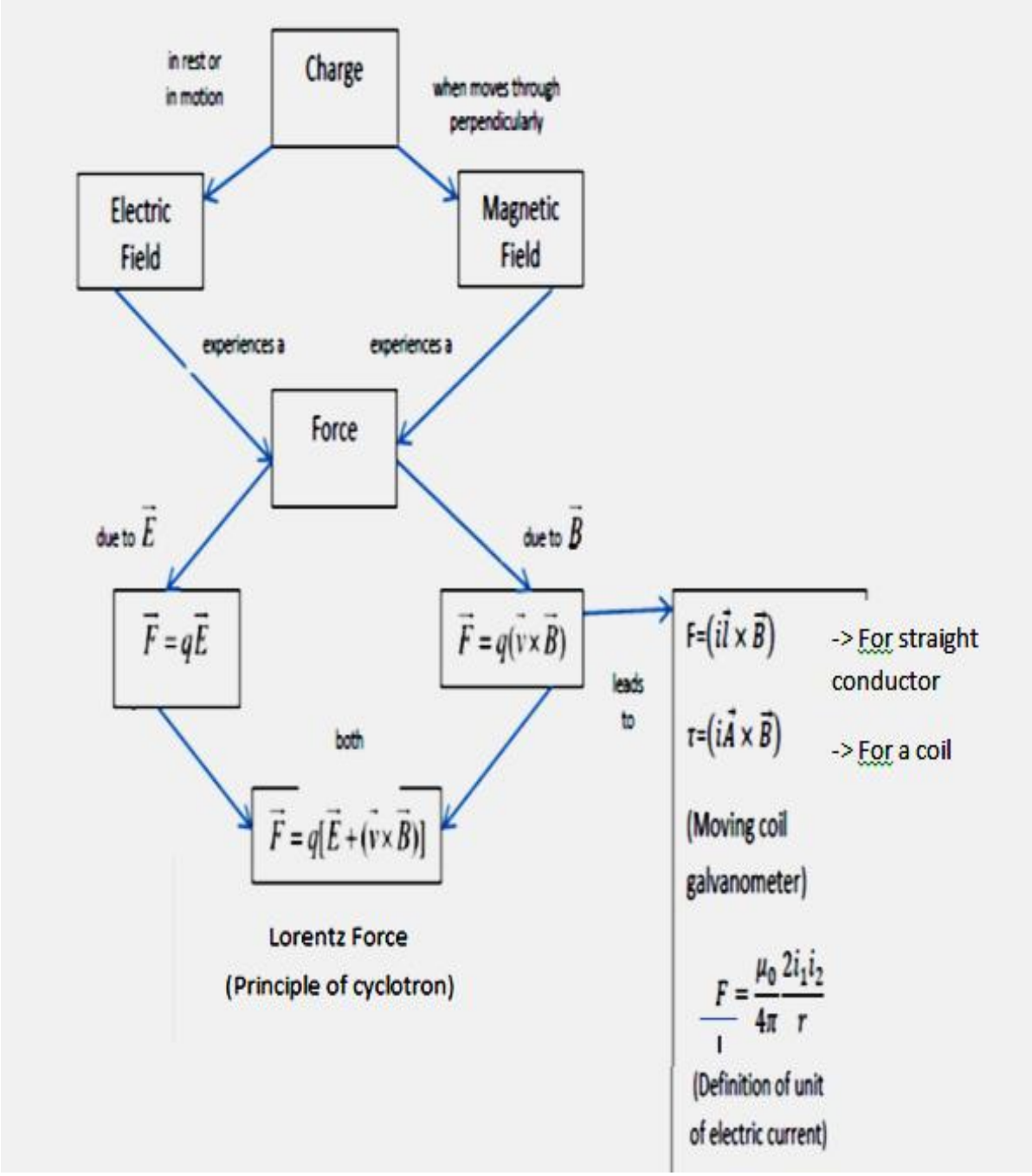
CONCEPT MAP

Moving Charges



CONCEPT MAP

Moving Charge and Force



QUESTIONS

MAGNETIC FORCE

1* In a certain arrangement, a proton does not get deflected while passing through a magnetic field region. State the condition under which it is possible. 1

Ans: **v** is parallel or antiparallel to **B**

2 An electron beam is moving vertically upwards. If it passes through a magnetic field directed from South to North in a horizontal plane, in what direction will the beam be deflected? 1

Ans:-Towards geographical East in the horizontal plane

3 What is the work done by the magnetic force on a charged particle moving perpendicular to the magnetic field? 1

Ans: Zero

4 A wire of length 0.04m carrying a current of 12 A is placed inside a solenoid, making an angle of 30^0 with its axis. The field due to the solenoid is 0.25 T. Find the force on the wire. 2

Ans; 0.06N

5 A circular loop of radius 0.1 m carries a current of 1A and is placed in a uniform magnetic field of 0.5T. The magnetic field is perpendicular to the plane of the loop. What is the force experienced by the loop? 2

Ans: The magnetic dipole does not experience any force in a uniform magnetic field.
Hence, the current carrying loop (dipole) does not experience any net force.

6* A proton, alpha particle and deuteron are moving in circular paths with same kinetic energies in the same magnetic fields. Find the ratio of their radii and time periods.

Ans: $R_p : R_\alpha : R_d = 1:1:\sqrt{2}$ 2

$T_p : T_\alpha : T_d = 1:2:2$

7 An electron moving with Kinetic Energy 25 keV moves perpendicular to a uniform magnetic field of 0.2 mT. Calculate the time period of rotation of electron in the magnetic field. 2

Ans: $T = 1.79 \times 10^{-7}$ S

8 A charged particle of mass 'm' charge 'q' moving at a uniform velocity 'v' enters a uniform magnetic field 'B' normal to the field direction. Deduce an expression for Kinetic Energy of the particle. Why does the Kinetic Energy of the charged particle not change when moving through the magnetic field? 3

9 An electron is revolving around the nucleus of an atom in an orbit of radius 0.53 Å. Calculate the equivalent magnetic moment, if the frequency of revolution of the electron is 6.8×10^9 MHz.

Ans: $p_m = 9.6 \times 10^{-24}$ A m^2 3

BIOT-SAVART LAW AND ITS APPLICATIONS

1 A current is set up in a long copper pipe. What is the magnetic field inside the pipe?

Ans: Zero 1

2 A wire placed along north south direction carries a current of 5 A from South to North. Find the magnetic field due to a 1 cm piece of wire at a point 200 cm North East from the piece. 2

Ans: 8.8×10^{-10} T, acting vertically downwards.

3 How will the magnetic filed intensity at the centre of a circular coil carrying current change if the current through the coil is doubled and the radius of the coil is halved. 2

Ans: $B = \mu_0 n \times 2I / 2 \times (R/2) = 4B$

4 A circular coil of 500 turns has a radius of 2 m, and carries a current of 2 A. What is the magnetic field at a point on the axis of the coil at a distance equal to radius of the coil from the center? 2

Ans: $B = 1.11 \times 10^{-4}$ T

5* The strength of magnetic induction at the center of a current carrying circular coil is B_1 and at a point on its axis at a distance equal to its radius from the center is B_2. Find B_1/B_2. 2

Ans: $2\sqrt{2}$

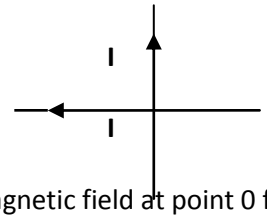
6* A current is flowing in a circular coil of radius 'r' and magnetic field at its center is B_0. At what distance from the center on the axis of the coil, the magnetic field will be $B_0/8$? 2

Ans: x = √3r

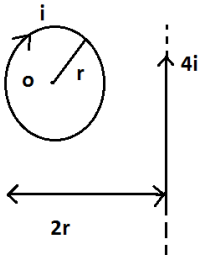
7* A straight wire of length' $\frac{\pi}{2}'m$, is bent into a circular shape. if the wire were to carry a current of 5 A, calculate the magnetic field due to it, before bending, at a point 0.01 times the radius of the circle formed from it. Also calculate the magnetic field at the center of the circular loop formed, for the same value of current. 3

Ans: $B_1 = 4 \times 10^{-4}$ T, $B_2 = 1.256 \times 10^{-5}$ T

8 Two insulated wires perpendicular to each other in the same plane carry equal currents as shown in figure. Is there a region where the magnetic field is zero? If so, where is the region? If not, explain why the field is not zero? 3



9 What is the net magnetic field at point 0 for the current distribution shown here?



ans $(\mu_0 I / 2r)=(\mu_o i/\pi r)$

AMPERE'S CIRCUITAL LAW AND APPLICATIONS

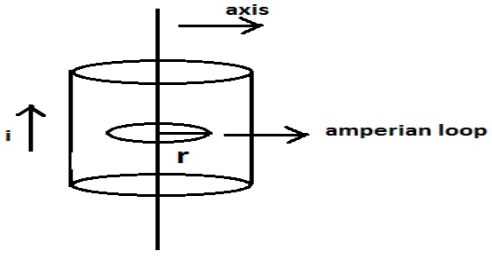
1 A long straight solid metal wire of radius 'R' carries a current 'I', uniformly distributed over its circular cross section. Find the magnetic field at a distance 'r' from the axis of the wire (a) inside and (b) outside the wire 2

Ans; (a) $\mu_0\mu_r Ir/2\pi R^2$ (b) $\mu_0 2I/ 4\pi r$

2 A solenoid is 1m long and 3 cm in mean diameter. It has 5 layers of windings of 800 turns each and carries a current of 5 A. Find Magnetic Field Induction at the center of the solenoid. 2

Ans: 2.5×10^{-2} T, parallel to the axis of the solenoid.

3 Find the value of magnetic field inside a hollow straight current carrying conductor at a distance r from axis of the loop. 2

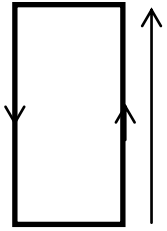


Ans B=0

FORCE BETWEEN TWO PARALLEL CURRENTS, TORQUE ON A CURRENT LOOP, MOVING COIL GALVANOMETER

1* A rectangular loop of size 25 cm x 10 cm carrying a current of 15A is placed 2 cm away from a long, straight conductor carrying a current of 25 A. What is the direction and magnitude of the net Force acting on the loop?

Ans: F =7.8175 x 10^{-4} N



2* A long straight conductor PQ , carrying a current of 60 A, is fixed horizontally. Another long conductor XY is kept parallel to PQ at a distance of 4 mm, in air. Conductor XY is free to move and carries a current 'I' . Calculate the magnitude and direction of current 'I' for which the magnetic repulsion just balances the weight of the conductor XY. 2

Ans: I = 32. 67 A, The current in XY must flow opposite to that in PQ, because only then the force will be repulsive.

3 A circular coil of 200 turns, radius 5 cm carries a current of 2.5 A. It is suspended vertically in a uniform horizontal magnetic field of 0.25 T, with the plane of the coil making an angle of 60^0 with the field lines. Calculate the magnitude of the torque that must be applied on it to prevent it from turning. 2

Ans: 0.49Nm

4* A Galvanometer of resistance 3663 ohm gives full scale deflection for a certain current I_g.Calculate the value of the resistance of the shunt which when joined to the galvanometer coil will result in 1/34 of the total current passing through the galvanometer. Also find the total resistance of the Galvanometer and shunt. 3

Ans: 111 ohm, 107.7 A.

MAGNETISM AND MATTER

BAR MAGNET

1 A short bar magnet has magnetic moment of 50 A m^2. Calculate the magnetic field intensity at a distance of 0.2 m from its centre on (1) its axial line (2) its equitorial line. 2

Ans: B_1 = 1.25 x 10^{-3} T , B_2 = 0.625 x 10^{-3} T.

2 Calculate the torque acting on a magnet of length 20 cm and pole strength 2 x 10^{-5} Am, placed in the earth's magnetic field of flux density 2 x 10^{-5} T, when (a) magnet is parallel to the field (b) magnet is perpendicular to the field. 2

Ans: (a) Zero (b) 0.8 x 10^{-10} Nm

MAGNETISM AND GAUSS LAW

1 What is the significance of Gauss's law in magnetism? 1

Ans: Magnetic monopoles do not exist.

THE EARTH'S MAGNETISM

1 How the value of angle of dip varies on moving from equator to Poles? 1

2 A compass needle in a horizontal plane is taken to geographic north / south poles. In what direction does the needle align? 1

3 The horizontal component of earth's magnetic field is 0.2 G and total magnetic field is 0.4 G. Find the angle of Dip. 1

Ans: 60. 25^0

4* A long straight horizontal table carries a current of 2.5 A in the direction 10^0 south of west to 10^0 north of east. The ,magnetic meridian of the place happens to be 10^0 west of the geographic meridian. The earth's magnetic field at the locations 0.33G and the angle of dip is zero. Ignoring the thickness of the cable, locate the line of neutral points.

Ans: r = 1.5 cm ($B_H = B \cos \delta$, $B_H = \mu_0 I / 2\pi r$) 2

5 The vertical component of earth's magnetic field at a place is √3 times the horizontal component. What is the value of angle of dip at this place? 2

Ans: 60^0

6* A ship is sailing due west according to mariner's compass. If the declination of the place is

15^0east, what is the true direction of the ship? 2
Ans: 75^0 west of north.

IMPORTANT TERMS IN MAGNETISM

1 A magnetising field of 1600 A/m produces a magnetic flux of 2.4 x 10^{-5} Wb in a bar of iron of cross section 0.2 cm^2. Calculate permeability and susceptibility of the bar.
Ans: Permeability = 7.5 x 10^{-4} T A^{-1} m, Susceptibility =596.1 2

2 The maximum value of permeability of μ-metal is 0.126 Tm/A. Find the maximum relative permeability and susceptibility.
Ans: 10^5 each. 2

MAGNETIC PROPERTIES OF MATERIALS

1 The susceptibility of para magnetic material at 300K is 1.2 x 10^5. At what temperature will the susceptibility be equal to 1.44 x 10^{-5} . 1
Ans: 250 K

2 An iron bar magnet is heated to 1000^0C and then cooled in a magnetic field free space. Will it retain its magnetism? Ans: No it is above curie temperature. 1

3 What is the net magnetic moment of an atom of a diamagnetic material? 1
Ans : Zero

4 Which materials have negative value of magnetic susceptibility? 1
Ans : Diamagnetic materials.

5 Why permanent magnets are made of steel while the core of the transformer is made of soft iron? 1

6* An iron rod of volume 10^{-4} m^3 and relative permeability 1000 is placed inside a long solenoid wound with 5 turns/cm. If a current of 0.5A is passed through the solenoid , find the magnetic moment of the rod. 2

7* The susceptibility of a magntic mateial is 0.9853. Identify the type of the magnetic material.Draw the modification of the field pattern on keeping a piece of this material in a uniform magnetic field. 2
Ans : paramagnetic

8 Two similar bars, made from two different materials P and Q are placed one by one in a non uniform magnetic field. It is observed that (a) the bar P tends to move from the weak to the strong field region. (b) the bar Q tends to move from the strong to the weak field region. What is the nature of the magnetic materials used for making these two bars? 2

4. ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTS

GIST

1 The phenomenon in which electric current is generated by varying magnetic fields is called electromagnetic induction.

2 Magnetic flux through a surface of area A placed in a uniform magnetic field B is defined as
$\Phi_B = B.A = BACos\theta$ where θ is the angle between B and A.

3 Magnetic flux is a scalar quantity and its SI unit is weber (Wb). Its dimensional formula is $[\Phi] = ML^2T^{-2}A^{-1}$.

4 Faraday's laws of induction states that the magnitude of the induced e.m.f in a circuit is equal to the time rate of change of magnitude flux through the circuit.

$\varepsilon = -\frac{d\phi_B}{dt}$

5 According to Lenz law, the direction of induced current or the polarity of the induced e.m.f is such that it tends to oppose the change in magnetic flux that produces it. (The negative sign in Faraday's law indicates this fact.)

6 Lenz law obeys the principle of energy conservation.

7 The induced e.m.f can be produced by changing the (i) magnitude of B (ii) area A (iii) angle θ between the direction of B and normal to the surface area A.

8 When a metal rod of length l is placed normal to a uniform magnetic field B and moved with a velocity v perpendicular to the field, the induced e.m.f is called motional e.m.f produced across the ends of the rod which is given by ε = Blv.

9 Changing magnetic fields can setup current loops in nearby metal bodies (any conductor). Such currents are called eddy currents. They dissipate energy as heat which can be minimized by laminating the conductor.

10 Inductance is the ratio of the flux linkage to current.

11 When a current in a coil changes it induces a back e.m.f in the same coil. The self induced e.m.f is given by $\varepsilon = -L\frac{dI}{dt}$ where L is the self-inductance of the coil. It is a measure of inertia of the coil against the change of current through it. Its S.I unit is henry (H).

12 A changing current in a coil can induce an e.m.f in a nearby coil. This relation, $\varepsilon = -M_{12}\frac{di_2}{dt}$, shows that Mutual inductance of coil 1 with respect to coil 2 (M_{12}) is due to change of current in coil 2. ($M_{12} = M_{21}$).

13 The self-inductance of a long solenoid is given by $L = \mu_0 n^2 Al$ where A is the area of cross-section of the solenoid, l is its length and n is the number of turns per unit length.

14 The mutual inductance of two co-axial coils is given by $M_{12} = M_{21} = \mu_0 n_1 n_2 Al$ where n_1& n_2 are the number of turns per unit length of coils 1 & 2. A is the area of cross-section and l is the length of the solenoids.

15 Energy stored in an inductor in the form of magnetic field is $U_B = \frac{1}{2}Li_{\max}^{\ 2}$ and

Magnetic energy density $U_B = \frac{B^2}{2\mu_0}$

16 In an A.C. generator, mechanical energy is converted to electrical energy by virtue of electromagnetic induction.

* Rotation of rectangular coil in a magnetic field causes change in flux (Φ = NBACosωt).

* Change in flux induces e.m.f in the coil which is given by

ε= -dΦ/dt = NBAωSinωt ε ε= ε_0Sinωt

* Current induced in the coil $I = \varepsilon/R = \varepsilon_0 Sin\omega t/R = I_0 Sin\omega t$

17 An alternating voltage ε=ε_0Sinωt, applied to a resistor R drives a current $I = I_0 Sin\omega t$ *in* the resistor, $I_{0} = \varepsilon_0/R$ where ε_0& I_0 are the peak values of voltage and current. (also represented by V_m & I_m)

18 The root mean square value of a.c. may be defined as that value of steady current which would generate the same amount of heat in a given resistance in a given time as is done by the a.c. when passed through the same resistance during the same time.

$I_{rms} = I_0/\sqrt{2} = 0.707 i_0$

Similarly, $v_{rms} = v_0/\sqrt{2} = 0.707 v_0$.

For an a.c. $\varepsilon = \varepsilon_m$ Sin ωt applied to a resistor, current and voltage are in phase.

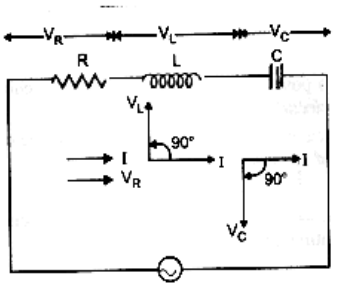
19 In case of an a.c. circuit having pure inductance current lags behind e.m.f by a phase angle 90°. $\varepsilon = \varepsilon_m$ Sin ωt and $i = i_m$ Sin (ωt-Π/2)

$I_m = \varepsilon_m/X_L$; $X_L = \omega L$ is called inductive reactance.

20 In case of an a.c. circuit having pure capacitance, current leads e.m.f by a phase angle of 90°.

$\varepsilon = \varepsilon_m \text{Sin}\omega t$ and $I = I_m \text{Sin}(\omega t + \pi/2)$ where

$I_m = \varepsilon_m/X_C$ and $X_C = 1/\omega C$ is called capacitive reactance.

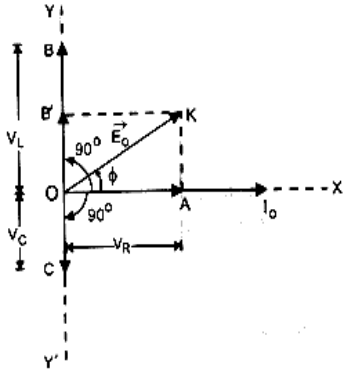


21 In case of an a.c. circuit having R, L and C, the total or effective resistance of the circuit is called impedance (Z).

$$Z = \varepsilon_m / I_m = \sqrt{R^2 + (X_C - X_L)^2}$$

$$\tan\Phi = \frac{X_C - X_L}{R}$$ where ϕ is the phase difference between current and voltage.

$\varepsilon = \varepsilon_m \text{Sin}\omega t$, $I = I_m \text{Sin}(\omega t + \Phi)$



23 Average power loss over a complete cycle in an LCR circuit is

$P = \varepsilon_{rms} I_{rms} \text{Cos}\Phi$

* In a purely resistive circuit Φ = 0; $P = V_{RMS} I_{RMS}$.
* In a purely inductive circuit Φ = Π/2; P = 0.
* In a purely capacitive circuit Φ = Π/2; P = 0.

24 In an LCR circuit, the circuit admits maximum current if $X_C = X_L$, so that Z = R and resonant frequency $\omega_r = \frac{1}{\sqrt{LC}}$ and $\vartheta_R = \frac{1}{2\pi\sqrt{LC}}$

25 Q factor of series resonant circuit is defined as the ratio of voltage developed across the inductance or capacitance at resonance to the applied voltage across 'R',
$Q = \frac{\omega_r L}{R}$ or $\frac{1}{\omega_r CR}$ also $Q = \frac{\omega_r}{2\Delta\omega}$ where $2\Delta\omega$ is bandwidth.

26 for a transformer, $\frac{E_s}{E_p} = \frac{N_s}{N_p} = \frac{i_p}{i_s} = K$

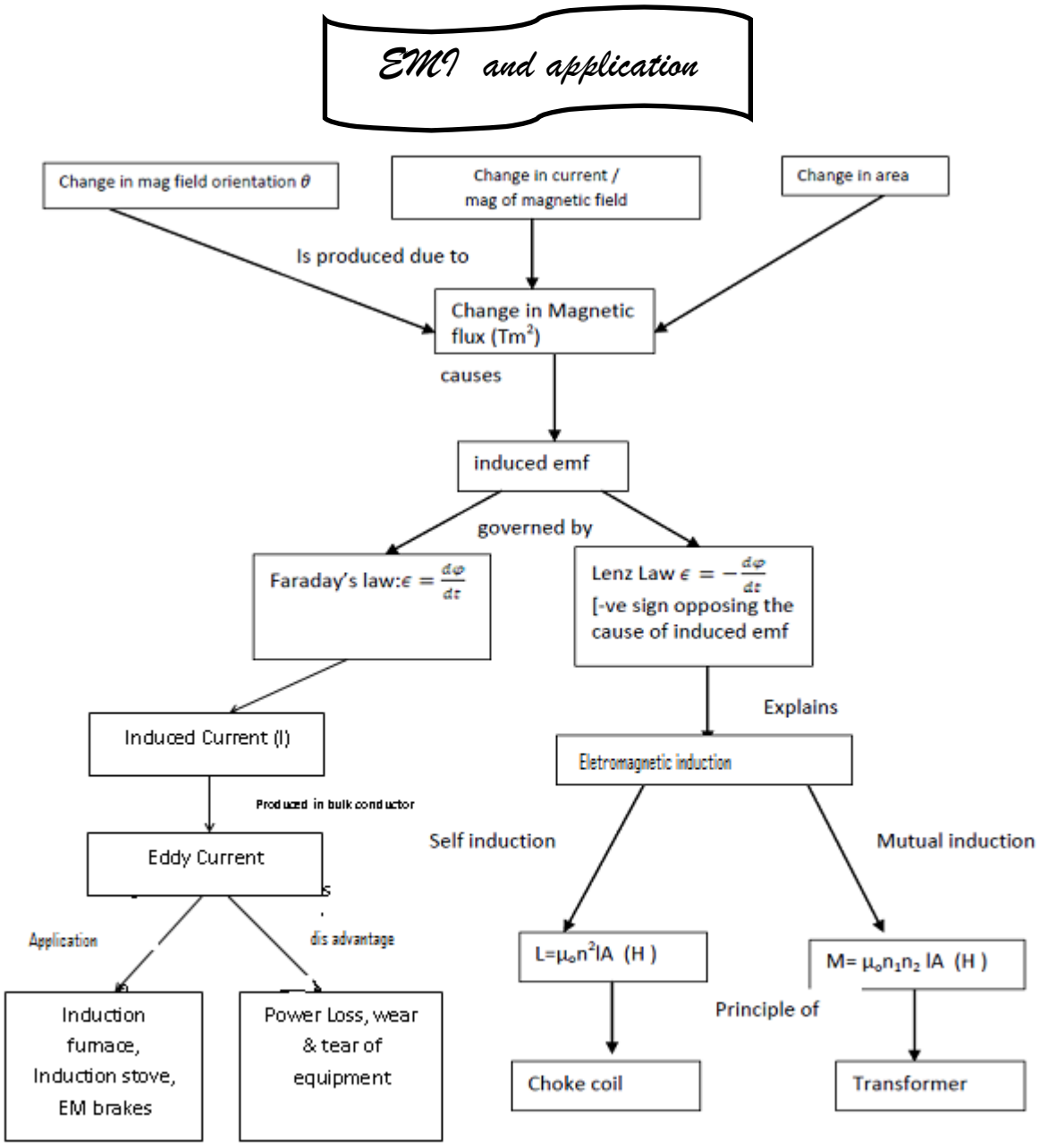
In an ideal transformer, $\varepsilon_P I_P = \varepsilon_S I_S$. i.e

If $N_S > N_P$; $\varepsilon_S > \varepsilon_P$ & $I_S < I_P$ – step up. If $N_P > N_S$; $\varepsilon_P > \varepsilon_S$ & $I_P < I_S$ – step down.

27 A circuit containing an inductor L and a capacitor C (initially charged) with no a.c. source and no resistors exhibits free oscillations of energy between the capacitor and inductor. The charge q satisfies the equation

$$\frac{d^2q}{dt^2} + \frac{1}{LC} q = 0$$

CONCEPT MAP


EMI and application
Change in mag field orientation θ
Change in current / mag of magnetic field
Change in area
Is produced due to
Change in Magnetic flux (Tm²)
causes
induced emf
governed by
Faraday's law:ϵ = dφ/dt
Lenz Law ϵ = −dφ/dt [-ve sign opposing the cause of induced emf
Induced Current (I)
Explains
Eletromagnetic induction
Produced in bulk conductor
Eddy Current
Self induction
Mutual induction
Application
dis advantage
L=μ₀n²lA (H)
M= μ₀n₁n₂ lA (H)
Induction furnace, Induction stove, EM brakes
Power Loss, wear & tear of equipment
Principle of
Choke coil
Transformer

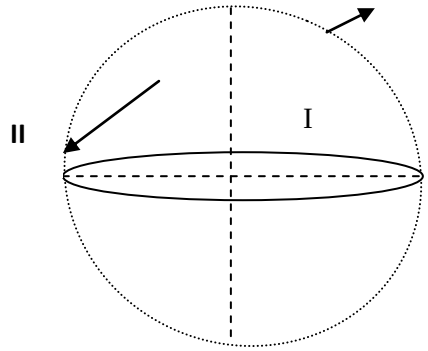
(I) Parameters of various combinations of components in ac circuits

S. No.	Circuit containing	Alt. e.m.f fed	Alt. current developed	Impedance Z	Phase relation between E and I	Average Power	Power factor
1.	Resistance only	$E=E_0 \sin \omega t$	$I = I_0 \sin \omega t$	$Z = R$	In phase	$I_v^2 R$	$\cos \phi = 1$
2.	Pure inductor	$E=E_0 \sin \omega t$	$I = I_0 \sin (\omega t - 90°)$	$Z = X_L = \omega L$	I lags behind E by 90°	Zero	$\cos \phi = 0$
3.	Pure capacitor	$E=E_0 \sin \omega t$	$I = I_0 \sin (\omega t + 90°)$	$Z = X_C = \frac{1}{\omega C}$	I leads E by 90°	Zero	$\cos \phi = 0$
4.	RL circuit	$E=E_0 \sin \omega t$	$I = I_0 \sin (\omega t - \theta)$	$Z = \sqrt{R^2 + X_L^2}$	$\tan \phi = \frac{X_L}{R}$ (current lags)	$E_v I_v \cos \phi$	$\cos \phi = \frac{R}{\sqrt{R^2 + X_L^2}}$
5.	RC circuit	$E=E_0 \sin \omega t$	$I = I_0 \sin (\omega t + \theta)$	$Z = \sqrt{R^2 + X_C^2}$	$\tan \phi = \frac{X_C}{R}$ (current leads)	$E_v I_v \cos \phi$	$\cos \phi = \frac{R}{\sqrt{R^2 + X_C^2}}$
6.	RLC circuit	$E=E_0 \sin \omega t$	$I = I_0 \sin (\omega t \pm \theta)$	$Z = \sqrt{R^2 + (X_L - X_C)^2}$	$\tan \phi = \frac{X_C - X_L}{R}$	$E_v I_v \cos \phi$	$\cos \phi = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}}$

QUESTIONS

MAGNETIC FLUX, INDUCED E.M.F,

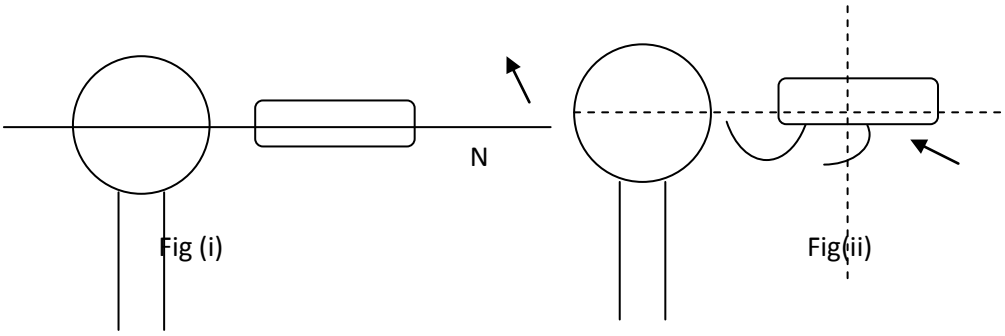
1 Two concentric circular coils are perpendicular to each other. Coil I carries a current i. If this current is changed, will this induce a current in the coil II? 1



[No- Field due to one coil is parallel to the plane of the second coil. So flux does not change.]

2 A closed loop of wire is being moved with constant velocity without changing its orientation inside a uniform magnetic field. Will this induce a current in the loop? 1
[Ans: No there is no change in Φ_B]

3 A cylindrical bar magnet is kept along the axis of a circular coil and near it as shown in the fig. Will there be any induced current at the terminals of the coil when the magnet is rotated a) about its own axis b) about an axis perpendicular to the length of the magnet? 1



Ans Fig. (i) No e.m.f will be induced, as these is no change in flux.

Fig (ii) Yes, Φ changes continuously. So e.m.f is induced in the coil.

4 A conducting wire is kept along the N→S direction and is allowed to fall freely. Will an e.m.f be induced in the wire? 1
(Yes)

5 A conducting wire is kept along the E→W direction and is allowed to fall freely. Will an e.m.f be induced in the wire? 1
(Yes)

6 A vertical magnetic pole falls down through the plane of magnetic meridian. Will any e.m.f be induced between its ends? 1
Ans: No, because the pole intercepts neither B_v or B_H

7 A wheel with a certain number of spokes is rotated in a plane normal to earth's magnetic field so that an emf is induced between the axle and rim of the wheel, keeping all other things same, number of spokes is changed. How is the e.m.f affected? (Hint: Number of spokes does not affect the net emf) 1

8 What are eddy currents? 1

9 Explain any two applications of eddy current. 2

10 The magnetic flux linked with a coil passing perpendicular to the plane of the coil changes with time $\Phi = 4t^2 + 2t + 3$, where "t" is the time in seconds. What is magnitude of e.m.f induced at t = 1 second? 3

Ans: ($e = d\Phi/dt = \frac{d}{dt}\left(4t^2 + 2t + 3\right)$, $e = 8t + 2$ If t = 1s e= 10V)

11 A wheel fitted with spokes of radius 'r' is rotating at a frequency of n revolutions per second in a plane perpendicular to magnetic field B Tesla. What is the e.m.f induced between the axle and rim of the wheel? 3

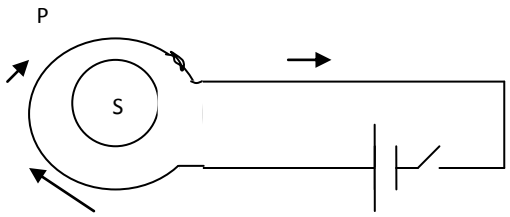
[2]

$\Phi = BA$

$e = d(BA)/dt = B\, dA/dt$, $dA/dt = \Pi r^2 x\, n$

$e = B.\, \Pi r^2 n$

12 Two coils P and S are arranged as shown in the figure. 2
(i) What will be the direction of induced current in S when the switch is closed?
(ii) What will be the direction of induced current in S when the switch is opened?



Ans: (i) anticlockwise (ii) clockwise

13 A conducting circular loop is placed in a uniform magnetic field B = 0.020T with its plane perpendicular to the field. Somehow, the radius of the loop starts shrinking at a constant rate of 1mm/s. Find the induced current in the loop at an instant when the radius is 2cm. 2
Ans. ($\Phi = \Pi r^2 B$ $d\Phi/dt = 2\Pi rB\, dr/dt$ e= 25μV

14 A 12V battery is connected to a 6Ω; 10 H coil through a switch drives a constant current in the circuit. The switch is suddenly opened. Assuming that it took 1ms to open the switch calculate the average e.m.f induced across the coil. 2

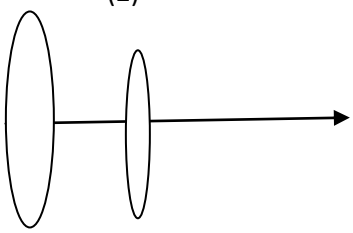
Ans. (I initial=2A I final= 0 ε=-Ldi/dt = 20000V)

15 A coil of mean area 500 cm^2 having 1000 turns is held perpendicular to a uniform magnetic field of 0.4 G. The coil is turned through 180 ^{o} in 1/10 seconds. Calculate the average induced e.m.f. 2
Ans. (0.04 V)

16 A conducting rod of length l with one end pivoted is rotated with a uniform angular speed ω in a Vertical plane normal to uniform magnetic field B. Deduce an expression for e.m.f induced in this rod. 2

17 Two identical co-axial coils carry equal currents. What will happen to the current in each loop if the loops approach each other? 2

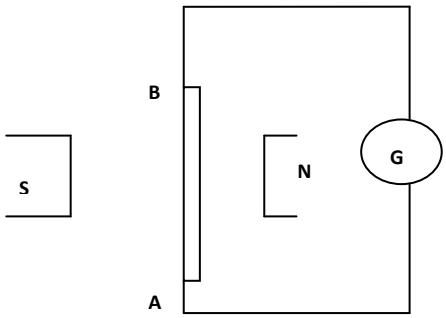
(2)



Ans. (Acc to Lenz's law current in each coil will decrease)

18 Obtain the direction of induced current and e.m.f when the conductor AB is moved at right angles to a stationary magnetic field (i) in the upward direction (ii) in the downward direction. 2

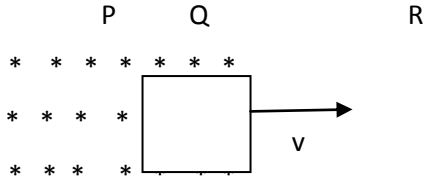
(i) B to A (ii) A to B)



19 A fan blade of length 0.5 m rotates perpendicular to a magnetic field of $5x10^{-5}$ T. If the e.m.f induced between the centre and the end of the blade is 10^{-2} V . Find the rate of rotation. 3

Ans. (e=B dA/dt ; dt= 1/n ; n=254.7 rev/s)

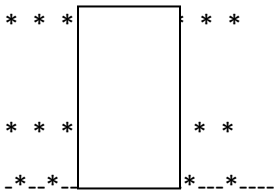
20 The figure shows a square loop having 100 turns an area of $2.5x10^{-3}$ m^2 and a resistance of 100Ω . The magnetic field has a magnitude of B= 0.4 T. Find the work done in pulling the loop out of the field slowly and uniformly in 1 second. 3



Also draw graph showing the variation of power delivered when the loop is moved from P to Q to R. ($1x\ 10^{-6}$J)

21 Two coils have a mutual inductance of 0.005H. The current changes in the first coil according to the equation $I= I_0$ Sin ωt where I_0 =10A and ω=100∏ rad/s. Calculate the maximum value of e.m.f in the second coil. (5 π volts) 3

22 A long rectangular conducting loop of width L mass m and resistance R is placed partly above and partly below the dotted line with the lower edge parallel to it. With what velocity it should continue to fall without any acceleration? 3



(mg = B^2l^2v/r ; v=mgr/ B^2l^2)

INDUCTANCE

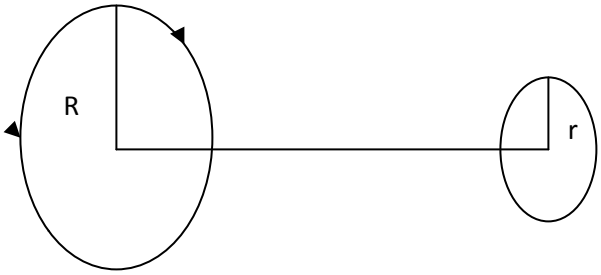
1 Two conducting circular loops of radii R_1 and R_2 are placed in the same plane with their centres coinciding. Find the mutual inductance between them assuming $R_2 << R_1$. 2
($M=\mu_0 \pi R_2^2 / 2R_1$)

2 Prove that the total inductance of two coils connected in parallel is $\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2}$ 2

3 Two circular loops are placed with their centres at fixed distance apart. How would you orient the loops to have (i) maximum (ii) minimum Mutual inductance? 2

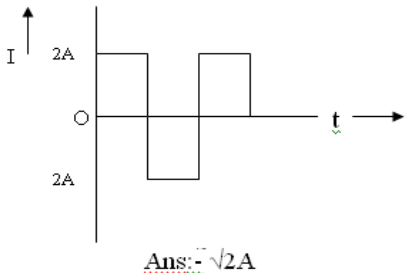
4 A coil of wire of certain radius has 600 turns and inductance of 108mH. What will be the inductance of another similar coil with 500 turns? (75mH) 2

5 Obtain the mutual inductance of a pair of coaxial circular coils kept separated by a distance as shown in fig:- 2



ALTERNATING CURRENT - RMS CURRENT AND VOLTAGE

1 Find the RMS value of A.C shown in the figure. 1



Ans:- √2A

2 The instantaneous value of e.m.f is given by ε= 300sin 314t. What is the rms value of emf ? 1

Ans:- ε_0=300 units ε_{rms}=212.1 units

3 Why a 220 V AC is considered to be more dangerous than 220 V DC? 1

Ans: peak value of AC is more than rms value which is equal to 311V.

4 An AC current flows through a circuit consisting of differerent elements connected in series. 1
(i) Is the applied instantaneous voltages equal to the algebraic sum of instantaneous voltages across the series elements of the circuit? (ii) Is it true for rms voltages?

Ans: (i) yes (ii) no

5 A capacitor blocks DC. Why? 1

Ans: $X_C=1/(2\pi fC)$, for D.C f=0, therefore $X_c=\infty$

6 What is the phase relationship between e.m.f across L and C in a series LCR circuit connected to an A.C source? 1

Ans:-The phase difference between V_L and $V_C=180^0$

7 Two alternating currents are given by $I_1=I_0Sin\omega t$ and $I_2= I_0Sin(\omega t+\pi/3)$. Will the rms value of I_1 & I_2 be equal or different? 1

Ans: The rms value will be equal.

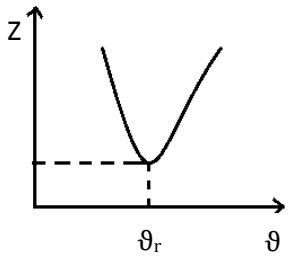
8 An alternating current is given by $i=i_1Cos\omega t+i_2Sin\ \omega t$. Find the rms current in the circuit. (2) 2

Ans: $\sqrt{\frac{(i_1^2+i_1^2)}{2}}$

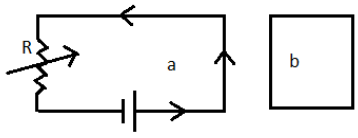
9 An alternating current having a peak value of 14A is used to heat a metal wire. What is the value of steady current which can produce the same heating effect as produced by AC? Why? Ans: i_{rms}=10A 2

10 If a constant current of 2.8A exists in a resistor, what is the rms value of current? Why? (2) 2
Ans: 2.8A

11 Sketch a graph showing the variation of impedance of LCR circuit with the frequency of applied voltage. (1) 1



12 If resistance R in circuit 'a' be decreased, what will be the direction of induced current in the circuit 'b'. 2



AC CIRCUITS

1 What is meant by wattless current? 1

2 Define: Q factor in LCR series circuit 1

3 Why is choke coil preferred over resistor to reduce a.c? 1

4 How do R, X_L and X_C get affected when the frequency of applied AC is doubled? 3

Ans: a) R remains unaffected
b) $X_L=2\pi fL$, so doubled
c) $X_C=1/2\pi fC$, so halved

5 For circuits for transporting electric power, a low power factor implies large power loss in transmission line. Why? 2
(2)

Ans: $i_{rms} = \dfrac{P}{V_{rms} Cos\phi}$

6 In an AC circuit there is no power consumption in an ideal inductor. Why? 2
Ans: $P= V_{rms} I_{rms} \cos \pi/2 =0$

7 An LCR series circuit is connected to an AC source. Which of its components dissipates power? 2
L or C or R? Justify your answer.

Ans: Resistance, Power in L and C = 0

8 An electric lamp connected in series with a capacitor and an AC source is glowing with certain brightness. How does the brightness of the lamp change on reducing the capacitance? 2
Ans: Brightness decreases. (As C decreases, X_C increases. Hence Z increases and I decreases.)

9 The power factor of an AC circuit is lagging by a factor 0.5. What does it mean? (2) 2
Ans: $\cos\Phi=0.5$, ie, $\Phi =60^0$. This implies that the current lags behind applied voltage by a phase angle of 60^0

10 The peak value of an AC is 5A and its frequency is 60Hz. Find its rms value. How long will the current take to reach the peak value starting from zero? 2
Ans: I_{rms}= 3.5A . Time period T=(1/60)s . The current takes one fourth of the time period to reach the peak value starting from zero. t =T/4 =(1/240)s.

11 The voltage and current in a series AC circuit are given by $V= V_0 \cos\omega t$ & $I= I_0 \sin\omega t$. What is the power dissipated in the circuit? 2

Ans:- $I=I_0\sin\omega t$ & $V=V_0\sin(\omega t+\pi/2)$, since V leads current by a phase angle $\pi/2$, it is an inductive circuit . So, P=0

12 When an AC source is connected to a capacitor with a dielectric slab between its plates, will the rms current increase or decrease or remain constant? 2

Ans: The capacitance increases, decreasing the reactance X_c . Therefore the rms current increases.

13 Can peak voltage across an inductor be greater than the peak voltage supplied to an LCR? 2

Ans: Yes, at the time of break of a circuit, a large back e.m.f is set up across the circuit.

14 Write any two differences between impedance and reactance. 2

15 A 100 Ω resister is connected to 220V, 50 cycles per seconds. What is (i) peak potential difference (ii) average potential difference and (iii) rms current? 2

Ans. ε_o=311.08V, ε_m =197.9V, I_v= 2.2 A

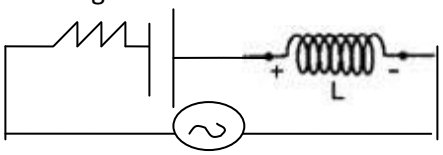
16 Define and derive the root mean square value of a.c voltage 3

RESONANCE in LCR Circuits

1 An inductor of inductance 100mH is connected in series with a resistance, a variable capacitance and an AC source of frequency 2 kHz. What should be the value of the capacitance so that maximum current may be drawn into the circuit? 2

Ans: $1/\omega C=\omega L$; $C=1/\omega^2 L$=63nF.

2 In the circuit shown below R represents an electric bulb. If the frequency of the supply is doubled, how the valves of C and L should be changed so that the glow in the bulb remains unchanged? 2



Hint: $X_L=2\pi fL$ $X_C=1/2\pi fC$

3 Draw phasor diagram for an LCR circuit for the cases (i) the voltage across the capacitor is greater than that across the inductor (ii) voltage across inductor is greater than that across the capacitor. 2

4 Does current in AC circuit lag, lead or remain in phase with voltage of frequency υ applied to a series LCR circuit when (i) $\upsilon = \upsilon_r$ 1
(ii) $\upsilon < \upsilon_r$ (iii) $\upsilon > \upsilon_r$, where υ_r resonant frequency?

5 11kw of electric power can be transmitted to a distant station at (i) 220V and (ii) 22kV. 2
Which of the two modes of transmission should be preferred and why?

6 In an AC circuit V and I are given by V=100Sin100t volts and I= 100 Sin(100t+π/3)mA 2
respectively. What is the power dissipated in the circuit?

Ans: V_0=100V I_0=100A $\Phi= \pi/3$ $P=V_{rms}\, I_{rms}\, \text{Cos}\, \Phi$=2500W

7 The potential across a generator is 125V when it is suppling10A. When it supplies 30A, the potential is 120V. What is the resistance of the armature and induced e.m.f? 2

Ans: E=127.5V

8 In an LCR circuit the potential difference between terminals of inductance 60V, between terminals of capacitor 40V and between the terminals of resistor is 40V. Find the supply voltage. (3) 3
Ans: In series LCR circuit voltage across capacitor and inductor are in opposite phase, so net voltage across the combination of L and C becomes 60-30=30V. Total voltage across R and L = 50V

9 The natural frequency of an LC circuit is 1,25,000 Hz. Then the capacitor C is replaced by another capacitor with a dielectric medium k, which decreases the frequency by 25 KHz. What is the value of k? 3

Ans: $\upsilon_1=1/2\pi\sqrt{LC}$ $\upsilon_2=1/2\pi\sqrt{kLC}$ $k=(\upsilon_1/\upsilon_2)^2=(1.25)^2=1.56$.

10 Obtain the resonant frequency and Q factor of a series LCR circuit with L= 3H, C= 27μF and R= 7.4 Ω. Write two different ways to improve quality factor of a series LCR circuit 3

Ans: Q=45,ω_0=111rad/s

11 An A.C source of voltage V= V_m Sinωt is connected one-by-one to three circuit elements X, Y and Z. It is observed that the current flowing in them 5

i. is in phase with applied voltage for X
ii. Lags applied voltage in phase by π /2 for elements Y.
iii. Leads the applied voltage in phase by π /2 for element Z.

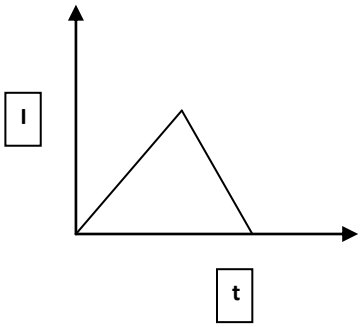
Identify the three circuit elements.

TRANSFORMER

1 Why is the core of a transformer laminated? 1

2 Why can't a transformer be used to step up dc voltages? 1

3 The graph below shows the variation of I with t. If it is given to the primary of a transformer, what is the nature of induced e.m.f in the secondary? 3



(Hint: e has constant positive value in the first part and a constant negative value in the second part)

1. The turn ratio of a transformer is 10. What is the e.m.f in the secondary if 2V is supplied to primary?

2. A transformer has an efficiency of 80% It works at 4kW and 100V. If the secondary voltage Is240V find the primary current.

(40 A)

4 When a voltage of 120V is given to the primary of a transformer the current in the primary is 1.85mA. Find the voltage across the secondary when it gives a current of 150mA. The efficiency of the transformer is 95% 3

(1406V)

GENERATOR

1 If the speed of rotation of armature is increased twice how would it affect the (a) maximum e.m.f produced (b) frequency of the e.m.f? 1

(e=NBAω ;f=ω/2Π)

2 A coil of area $0.2m^2$ and 100 turns rotating at 50 revolutions per second with the axis perpendicular to the field. If the maximum e.m.f is 7kV determine the magnitude of magnetic field. (1.1 Tesla) 2

3 An ac generator consists of a coil of 50 turns and an area of $2.5m^2$ rotating at an angular speed of 60 rad/s in a uniform magnetic field of B= 0.3T between two fixed pole pieces. The resistance of the circuit including that of the coil is 500Ω 3

(i) What is the maximum current drawn from the generator?
(ii)What is the flux through the coil when current is zero?
(iii)What is the flux when current is maximum?

(4.5A, 375Wb, zero)

5. ELECTRO MAGNETIC WAVES

GIST

1. Conduction current and displacement current together have the property of continuity.
2. Conduction current & displacement current are precisely the same.
3. Conduction current arises due to flow of electrons in the conductor. Displacement current arises due to electric flux changing with time.
4. $\boldsymbol{I_D = \varepsilon_0 \int \frac{d\phi_E}{dt}}$
5. Maxwell's equations

- **Gauss's Law in Electrostatics**
  $\oint \vec{E}.\overrightarrow{dS}=\frac{Q}{\varepsilon_0}$
- **Gauss's Law in Magnetism**
  $\oint \vec{B}.\overrightarrow{dS}=0$
- **Faraday's -Lenz law of electromagnetic induction.**
  $\oint \vec{E}\,.\overrightarrow{dl}=\int \frac{\vec{B}}{dt}.\overrightarrow{dS}$
- **Ampere's – Maxwell law**
  $\int \vec{B}\,.\overrightarrow{dl} = \mu_0 I + \mu_0 \varepsilon_0 \int \frac{\vec{E}}{dt}\,.\overrightarrow{dS}$

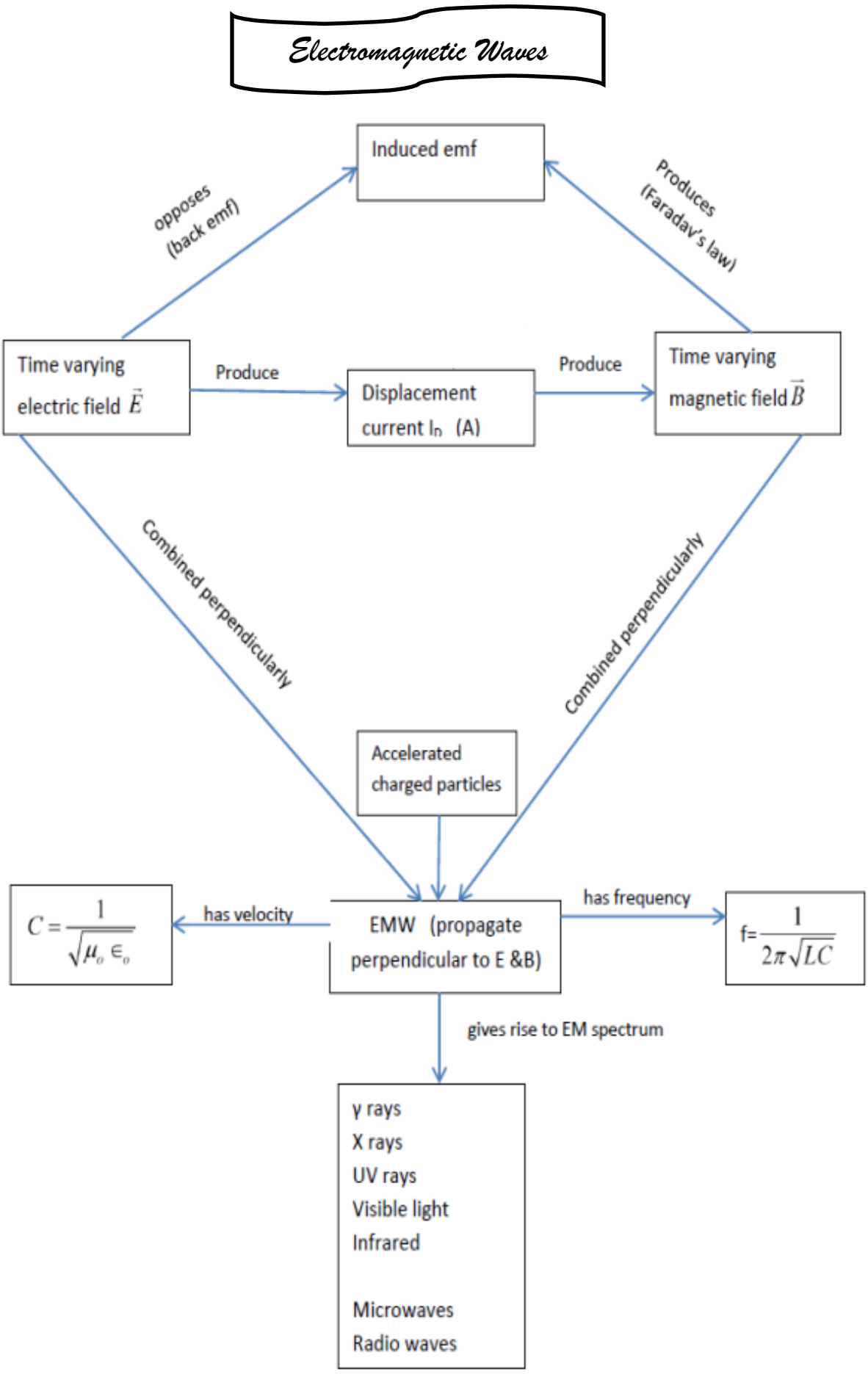
6. **Electromagnetic Wave :-** The wave in which there are sinusoidal variation of electric and magnetic field at right angles to each others as well as right angles to the direction of wave propagation.
7. Velocity of EM waves in free space: $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$ 3x10^8 m/s
8. The Scientists associated with the study of EM waves are Hertz, Jagdish Chandra Bose & Marconi.
9. EM wave is a transverse wave because of which it undergoes polarization effect.
10. Electric vectors are only responsible for optical effects of EM waves.
11. The amplitude of electric & magnetic fields are related by $\frac{E}{B} = c$
12. Oscillating or accelerating charged particle produces EM waves.
13. Orderly arrangement of electro magnetic radiation according to its frequency or wavelength is electromagnetic spectrum.
14. **Hint to memorise the electromagnetic spectrum in decreasing order of its frequency.**
    Gandhiji's X-rays Used Vigorously InMedical Research
15. EM waves also carry energy, momentum and information.

ELECTRO MAGNETIC SPECTRUM, ITS PRODUCTION, DETECTION AND USES IN GENERAL

Type	Wave length Range Frequency Range	Production	Detection	Uses
Radio	>0.1m 10^9 to 10^5Hz	Rapid acceleration / deceleration of electrons in aerials	Receiver's aerials	Radio, TV Communication
Microwave	0.1mm 10^{11} to10^9 Hz	Klystron valve or magnetron valve	Point contact diodes	Radar, TV communication

Infrared	1mm to 700nm 10^{11} to10^{14} Hz	Vibration of atom or molecules	Thermopiles, Bolometer Infrared Photographic Film	Green House effect, looking through haze, fog and mist, Ariel mapping.
Light	700nm to 400nm $8x10^{14}$ Hz	Electron in an atom during transition	Eye, Photocell, Photographic Film	Photography, Illuminations, Emit & reflect by the objects.
Ultraviolet	400nm to 1nm $5x10^{14}$ to $8x10^{14}$	Inner Shell electron in atom moving from one energy level to a lower energy level	Photocell & photographic film	Preservation of food items, Detection of invisible writing, finger print in forensic laboratory. Determination of Structure of molecules & atoms.
X-rays	1nm to 10^{-3}nm 10^{16} to 10^{21} Hz	X-ray tube or inner shell Electrons	Photographic film, Geiger tube, ionization chamber.	Study of crystal structure & atom, fracture of bones.
Gamma ray	$<10^{-3}$nm 10^{18} to 10^{22} Hz	Radioactive decay of the nucleus	Photographic film, Geiger tube, ionization chamber	Nuclear reaction & structure of atoms & Nuclei. To destroy cancer cells.

CONCEPT MAP


Electromagnetic Waves
Induced emf
opposes (back emf)
Produces (Faradav's law)
Time varying electric field $\vec{E}$
Produce
Displacement current I_D (A)
Produce
Time varying magnetic field $\vec{B}$
Combined perpendicularly
Combined perpendicularly
Accelerated charged particles
$C = \frac{1}{\sqrt{\mu_o \in_o}}$
has velocity
EMW (propagate perpendicular to E &B)
has frequency
$f = \frac{1}{2\pi\sqrt{LC}}$
gives rise to EM spectrum
γ rays
X rays
UV rays
Visible light
Infrared
Microwaves
Radio waves

QUESTIONS

1. Write the SI unit of displacement current? 1

   Ans : Ampere

2. If $\vec{E}, \vec{B}$ represent electric and magnetic field vectors of the electromagnetic waves, then what is the direction of propagation of the electromagnetic wave? 1

   Ans: $\vec{E} \times \vec{B}$

3. Can the velocity of light in vacuum be changed? 1

   Ans: Not possible

4 Calculate the wavelength of EMW emitted by the oscillator antenna system, if L= 0.253 μH & C = 25Pf ? 1

Ans $$\frac{1}{2\pi\sqrt{LC}}$$

5. The magnetic component of polarized wave of light is
   $B_X = (4 \times 10^{-6} T)\text{Sin}\,[(1.57 \times 10^{7} m^{-1})y + (4.5 \times 10^{11} t)]$
   (a) Find the direction of propagation of light
   (b) Find the frequency
   (c) Find intensity of light 3

Ans Y axis
f = (4.5 x 10^{11})/2π Hz
I ∝ A^2

6. What physical quantity is same for X-rays of wavelength 10^{-10} m, red light of wavelength 6800 Å and radio wave of wavelength 500 m? 1

Ans Velocity

7. The amplitude of $\vec{B}$ of harmonic electromagnetic wave in vacuum is B_o=510 n T. What is the amplitude of the electric field part of the wave? 1

Ans 153 N/C

8. Suppose E_o =120 N/C and its frequency ν = 50Hz. Find B_o, ω, k and λ and write expression for E and B ? 2

Ans $\vec{E}_y = 120\, Sin[1.05x - 3.14 \times 10^8 t]\hat{j}$NC^{-1}
$\vec{B}_Z = 400\, Sin[1.05x - 3.14 \times 10^8 t]\hat{k}$nT
B_o = 400 n T ; ω = 10^8 rad/s, k=1.05 rad/m , λ = 6m

9. The charging current for a capacitor is 0.25 A. what is the displacement current across its plates? 1

Ans 0.25 A

10. A variable frequency a.c source is connected to a capacitor. Will the displacement current increase or decrease with increasing frequency? 1

Ans Increases

11. EMW travel in a medium at a speed of $2x10^8$ m/s. the relative permeability of the medium is 1.0. Calculate the relative permittivity?

Ans $\varepsilon_r = 2.25$

$$V = \frac{C}{\sqrt{\mu_r \varepsilon_r}}$$

12. How does a charge q oscillating at certain frequency produce electromagnetic wave? 1

Ans Oscillating charge produces oscillating E which produces oscillating B and so on

13. How would you establish an instantaneous displacement current of 1A in the space between the parallel plates of 1μF capacitor? 1

Ans By changing the voltage $dv/dt = 10^6$ V/s

14. Name the Maxwell's equation among the four which shows that the magnetic monopole does not exist? 1

Ans Gauss's theorem of Magnetism

15. Write the unit of $\mu_o\varepsilon_o$? 1

Ans $(m/s)^{-2}$

16. Give reason for decrease or increase in velocity of light, when it moves from air to glass or glass to air respectively? 1

Ans The velocity of light depends on ε & μ of the medium.

17. A parallel plate capacitor made of circular plates each of radius 10 cm has a capacitance 200pF. The capacitor is connected to a 200V a.c. supply with an angular frequency of 200 rad/s.
    a) What is the rms value of conduction current
    b) Is the conduction current equal to displacement current 2
    c) Peak value of displacement current
    d) Determine the amplitude of magnetic field at a point 2cm from the axis between the plates

Ans a) $I_{rms} = 8\mu A$
b) $I_c = I_d$
c) $I_o = 2^{1/2} I_{rms}$
$B = 4.525 \times 10^{-12}$ T

18. Electromagnetic waves with wavelength
(i) λ_1, are used to treat muscular strain.
(ii) λ_2, are used by a FM radio station for broadcasting..
(iii) λ_3, are produced by bombarding metal target by high speed electrons. 3
(iv) λ_4, are observed by the ozone layer of the atmosphere.
Identify and name the part of electromagnetic spectrum to which these radiation belong. Arrange these wave lengths, in decreasing order of magnitude.

Ans $\lambda_1 \longrightarrow$ Infra red radiation.
$\lambda_2 \longrightarrow$ VHF / Radiowaves.
$\lambda_3 \longrightarrow$ X – rays
$\lambda_4 \longrightarrow$ UV $\lambda_2 > \lambda_1 > \lambda_4 > \lambda_3$

19. a) Which of the following if any, can act as a source of electromagnetic waves.
(i) A charge moving with constant velocity.
(ii) A charge moving in circular orbit.
(iii)A charge at rest. Give reason 3
(b) Identify the part of electromagnetic spectrum to which the waves of frequency
(i) 10^{20} Hz (ii) 10^{9} Hz belong.

Ans a) Can't produce em waves because no accelration.
(ii) It is accelrated motion - can produce em waves.
(iii)Can't produce em waves because no accelration.
b) (i) Gamma rays.
(ii) Micro waves

6. OPTICS

RAY OPTICS

GIST

1 **REFLECTION BY CONVEX AND CONCAVE MIRRORS.**

a. Mirror formula $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$, where u is the object distance, v is the image distance and f is the focal length.

b. Magnification $m=-\frac{v}{u}=\frac{f-v}{f}=\frac{f}{f-u}$.

m is **-ve** for **real images** and **+ve** for **virtual images**.

2 **REFRACTION**

c. Ray of light bends when it enters from one medium to the other, having different optical densities.

d. Sun can be seen before actual sunrise and after actual sunset due to Atmospheric refraction

e. An object under water (any medium) appears to be raised due to refraction when observed inclined

$n=\frac{\text{Re}al\ depth}{apparent\ depth}$ and

Shift in the position (apparent) of object is

X = t { 1 – 1/n) where t is the actual depth of the medium

f. Snell's law states that for a given colour of light, the ratio of sine of the angle of incidence to sine of angle of refraction is a constant, when light travels from rarer to denser,

$\frac{Sini}{\sin r}=\frac{n_2}{n_1}$

g. Absolute refractive index is the ratio between the velocities of light in vacuum to the velocity of light in medium. For air n=1.

$n=\frac{c}{v}$

3 h. When a ray of light travels from denser to rarer medium and if the angle of incidence is greater than critical angle, the ray of light is reflected back to the denser medium. This phenomenon is called Total internal reflection.

$SinC=\frac{n_R}{n_D}$

i. Diamond has a high refractive index, resulting with a low critical angle ($C=24.4^0$). This promotes a multiple total internal reflection causing its brilliance and luster. Some examples of total internal reflection are formation of mirage and working of an optical fibre.

4 When light falls on a convex refracting surface, it bends and the relation between U, V and R is given by $\frac{n_2}{V}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$

5 Lens maker's formula or thin lens formula is given by

$$\frac{1}{f}=\left(\frac{n_2-n_1}{n_1}\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

For Convex Lens R_1 +ve ;R_2 –ve Concave lens R_1-ve; R_2 +ve

The way in which a lens behaves as converging or diverging depends upon the values of n_L and n_m.

6 When two lenses are kept in contact the equivalent focal length is given by

$$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2} \qquad \& \qquad \mathrm{P}=\mathrm{P}_1+P_2$$

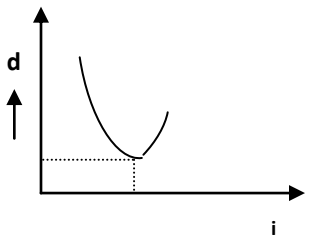
7 The lens formula is given by $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

8 When light passes through a glass prism it undergoes refraction.

The expression for refractive index is $n=\dfrac{Sin\left(\dfrac{A+D_m}{2}\right)}{Sin\left(\dfrac{A}{2}\right)}$

As the angle of incidence increases, the angle of deviation decreases, reaches a minimum value and then increases. This minimum value is called angle of minimum deviation "D_m".

9



where d is minimum, i=e, refracted ray lies parallel to the base. For a small angled prism d=(n-1)A

10 When white light (poly chromatic or composite) is passed through a glass prism, It splits up into its component colours (Monochromatic). This phenomenon is called Dispersion.

11 Rainbow is formed due to a combined effect of dispersion, refraction and reflection of sunlight by spherical water droplets of rain.

12 Scattering of light takes place when size of the particle is very small when compared to the wavelength of light

Intensity of scattered light is $I\alpha\dfrac{1}{\lambda^4}$

The following properties or phenomena can be explained by scattering.

(i) Sky is blue.
(ii) Sky is reddish at the time of sunrise and sunset
(iii) Infra-red photography used in foggy days.
(iv) Orange colour of black Box
(v) Yellow light used in vehicles on foggy days.
(vi) Red light used in signals.

QUESTIONS: REFLECTION:

1 One half of the reflecting surface of a concave mirror is coated with black paint. How will the image be affected?

Brightness decreases

2 Why a concave mirror is preferred for shaving?

Enlarged VIRTUAL

3 Mirrors in search lights are parabolic and not spherical. Why?

Produce intense parallel beam) eliminating spherical aberration

4 Using the mirror formula show that a virtual image is obtained when an object is placed in between the principal focus and pole of the concave mirror.

$$\frac{1}{v}=\frac{1}{u}-\frac{1}{f} \quad u<f \Rightarrow \frac{1}{u}>\frac{1}{f} \Rightarrow v \text{ is } +ve)$$

5 Using the mirror formula show that for a concave mirror, when the object is placed at the centre of curvature, the image is formed at the centre of curvature.

6 Find the position of an object, which when placed in front of a concave mirror of focal length 20cm, produces a virtual image which is twice the size of the object.

Ans. 10cm

7 Plot a graph between 1/u and 1/v for a concave mirror. What does the slope of the graph yield?

Ans. Straight line, slope =u/v=1/m

8 **REFRACTION AND LENSES**

Which of the following properties of light: Velocity, wavelength and frequency, changes during the phenomenon (i) reflection (ii) refraction

Ans. (i) No change (ii) velocity, wavelength change)

9 A convex lens is combined with a concave lens. Draw a ray diagram to show the image formed by the combination, for an object placed in between f and 2f of the convex lens. Compare the Power of the convex and concave lenses so that the image formed is real.

Ans: f of convex lens must be less than f of concave lens to produce real image. So power of Convex greater than that of concave)

10 Derive a relation between the focal length and radius of curvature of a Plano convex lens made of glass. Compare the relation with that of a concave mirror. What can you conclude? Justify your answer.

Ans. (f=2R) both are same. But applicable always in mirrors, but for lenses only in specific cases, the relation can be applied.)

11 In the given figure an object is placed at O in a medium ($n_2>n_1$). Draw a ray diagram for the image formation and hence deduce a relation between u, v and R

$$\frac{n_1}{v}-\frac{n_2}{u}=\frac{n_1-n_2}{R}$$

12 Show that a concave lens always produces a virtual image, irrespective of the position of the object.

Ans. $v = \frac{uf}{u+f}$ *But u is −ve and f is −ve for concave lens*

Hence v is always -ve. that is virtual

13 Sun glasses are made up of curved surfaces. But the power of the sun glass is zero. Why?

Ans. It is convex concave combination of same powers. So net power zero

14 A convex lens is differentiated to n regions with different refractive indices. How many images will be formed by the lens?

Ans. n images but less sharp

15 A convex lens has focal length f in air. What happens to the focal length of the lens, if it is immersed in (i) water (n=4/3) (ii) a medium whose refractive index is twice that of glass.

Ans. 4f, -f

16 Calculate the critical angle for glass air surface, if a ray falling on the surface from air, suffers a deviation of 15^0 when the angle of incidence is 40^0.

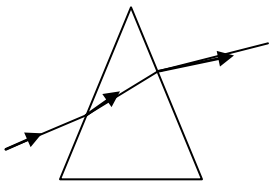
Find n by Snell's law and then find c=41.14^0

17 Two thin lenses when in contact produce a net power of +10D. If they are at 0.25m apart, the net power falls to +6 D. Find the focal lengths of the two lenses

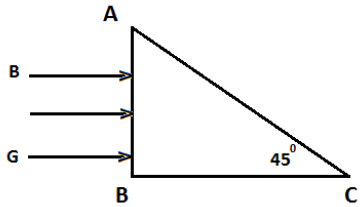
Ans. 0.125m, 0.5m)

18 A glass prism has an angle of minimum deviation D in air. What happens to the value of D if the prism is immersed in water? Ans. Decreases

19 Draw a ray diagram for the pat followed by the ray of light passing through a glass prism immersed in a liquid with refractive index greater than glass.



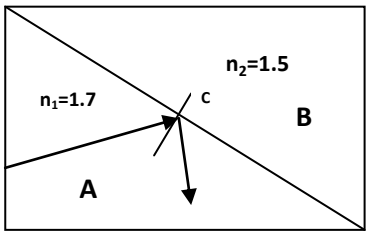
Three rays of light red (R) green (G) and blue (B) are incident on the surface of a right angled prism as shown in figure. The refractive indices for the material of the prism for red green and blue are 1.39, 1.43 and 1.47 respectively. Trace the path of the rays through the prism. How will the situation change if the rays were falling normally on one of the faces of an equilateral prism?



(Hint Calculate the critical angle for each and if the angle of incidence on the surface AC is greater, then TIR will take place.)

20 Show that the angle of deviation for a small angled prism is directly proportional to the refractive index of the material of the prism. One of the glass Prisms used in Fresnel's biprism experiment has refractive index 1.5. Find the angle of minimum deviation if the angle of the prism is 3^0. (3)
(D= (n-1) A, 1.5^0)

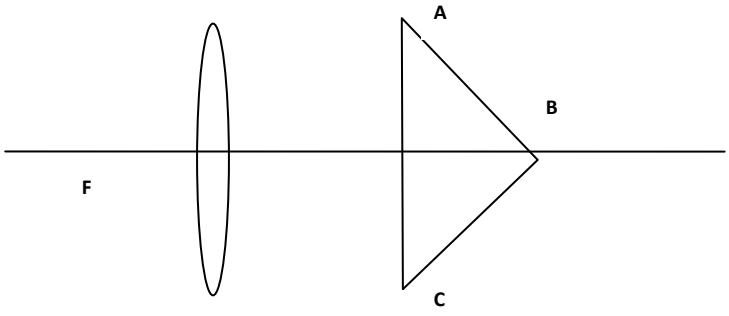
21 In the given diagram, a ray of light undergoes total internal reflection at the point C which is on the interface of two different media A and B with refractive indices1.7 and 1.5 respectively. What is the minimum value of angle of incidence? Can you expect the ray of light to undergo total internal reflection when it falls at C at the same angle of incidence while entering from B to A. Justify your answer?



Ans. Use $SinC = \frac{n_r}{n_d} = 0.88$ *and* C=61.7^0 so i=61.8^0 no for TIR ray of light must travel from denser to rarer from B to A)

22 The velocity of light in flint glass for wavelengths 400nm and 700nm are $1.80x10^8$m/s and $1.86x10^8$ m/s respectively. Find the minimum angle of deviation of an equilateral prism made of flint glass for the given wavelengths.
(For 400nm D=52^0 and for 700nm D=48^0)

23 In the given diagram a point object is kept at the Focus F of the convex lens. The ray of light from the lens falls on the surfaces AB and BC of a right angled glass prism of refractive index 1.5 at an angle 42^0.Where will be the final image formed? Draw a ray diagram to show the position of the final image formed. What change do you expect in your answer if the prism is replaced by a plane mirror? Given C = 41-8˚



Ans- at F itself, no change

OPTICAL INSTRUMENTS

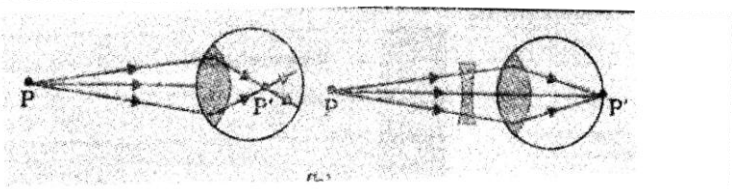
GIST

1 ➢ Human eye:

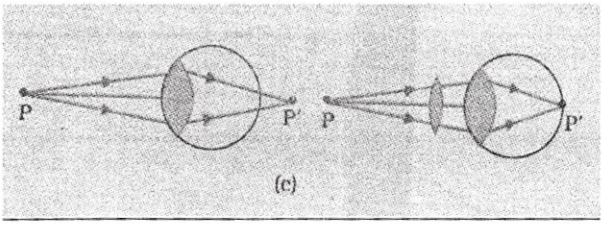
- Eye lens: crystalline
- Cilliary muscles: lens is held in position by these.
- Iris: Circular contractible diaphragm with an aperture near the centre.
- Pupil: the circular aperture is pupil. It adjusts controlling light entering the eye.
- Power of accommodation: ability of pupil for adjusting focal length.
- Far point: the maximum distant point that an eye can see clearly.
- Near point: closest distant that eye lens can focus on the retina.
- Range of vision: distant between near point and far point.

2 ➢ Defects of vision:

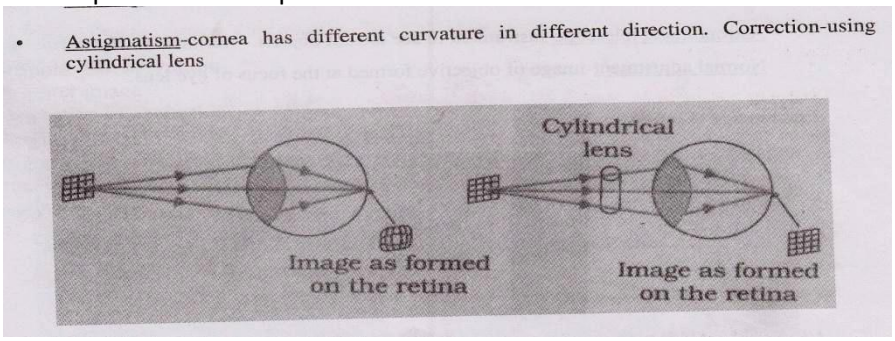
Myopia: image formed in front of the retina. Correction-using concave lens.



Hypermetropia- image behind the retina. Correction-using convex lens.



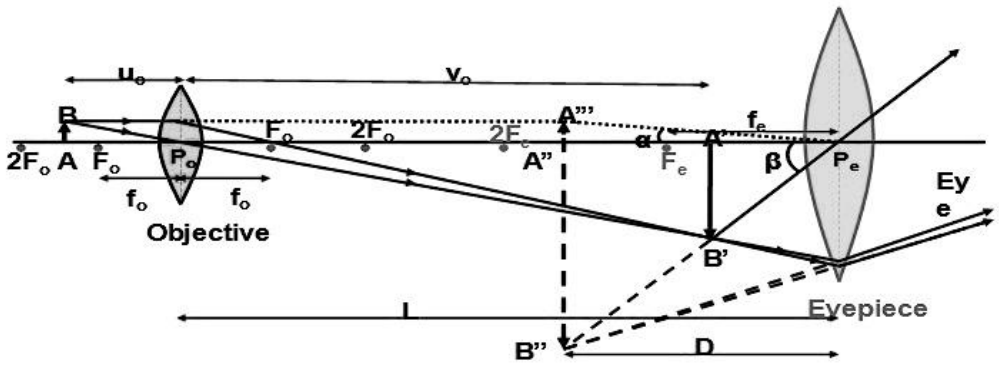
Presbiopia-low power of accommodation. Correction-bifocal lens.



Astigmatism-cornea has different curvature in different direction. Correction-using cylindrical Lens.

3

Compound Microscope:



Objective: The converging lens nearer to the object.
Eyepiece: The converging lens through which the final image is seen.
Both are of short focal length. Focal length of eyepiece is slightly greater than that of the objective.

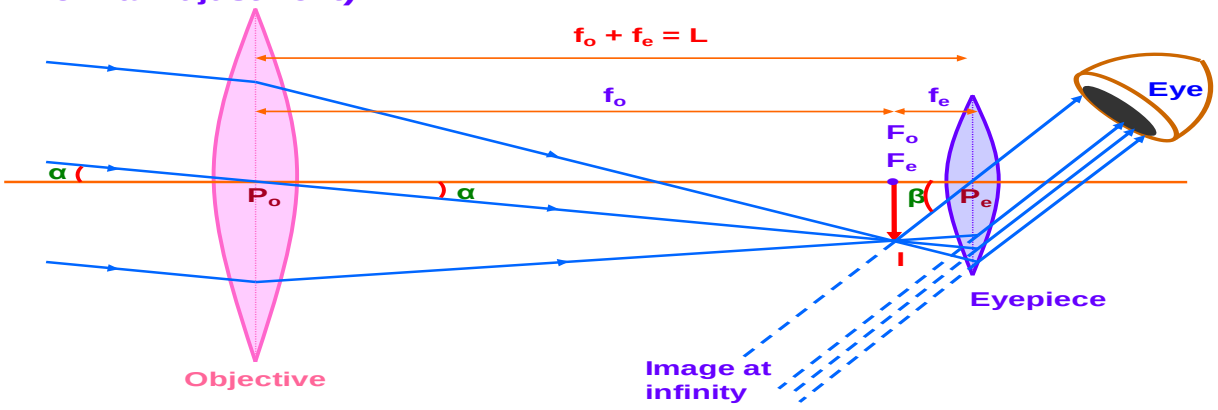
4 **Angular Magnification or Magnifying Power (M):**

$M = M_e \times M_o$

$$M = \frac{v_o}{-u_o}\left(1 + \frac{D}{f_e}\right) \qquad M = \frac{-L}{f_o}\left(1 + \frac{D}{f_e}\right)$$

or $$M \approx \frac{-L}{f_o} \times \frac{D}{f_e}$$ (Normal adjustment i.e. image at infinity)

5 **Astronomical Telescope: (Image formed at infinity – Normal Adjustment)**



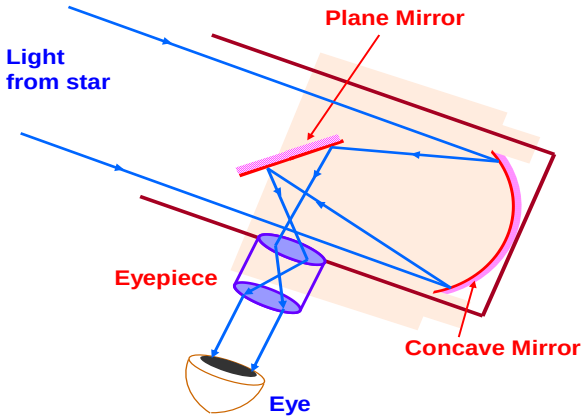
Focal length of the objective is much greater than that of the eyepiece.
Aperture of the objective is also large to allow more light to pass through it.

6 **Angular magnification or Magnifying power of a telescope in normal adjustment**

$$M = \frac{\beta}{\alpha} \qquad M = \frac{-f_o}{f_e}$$

($f_o + f_e = L$ is called the length of the telescope in normal adjustment).

7 **Newtonian Telescope: (Reflecting Type)**



Magnifying Power:

$$M = \frac{f_o}{f_e}$$

8 Cassegrain telescope refer from NCERT / refer Page no 83

$$\text{Resolving Power} = \frac{1}{\Delta d} = \frac{2\mu \sin\theta}{\lambda}$$

Resolving power depends on i) wavelength λ, ii) refractive index of the medium between the object and the objective and iii) half angle of the cone of light from one of the objects θ.

Resolving Power of a Telescope:

$$\text{Resolving Power} = \frac{1}{d\theta} = \frac{a}{1.22\lambda}$$

Resolving power depends on i) wavelength λ, ii) diameter of the objective a.

QUESTIONS

MICROSCOPE AND TELESCOPE

*1. You are given following three lenses. Which two lenses will you use as an eyepiece and as an objective to construct an astronomical telescope? 2

Lens	Power (P)	Aperture (A)
L1	3D	8 cm
L2	6D	1 cm
L3	10D	1 cm

Ans- The objective of an astronomical telescope should have the maximum diameter and its eyepiece should have maximum power. Hence, L1 could be used as an objective and L3 could be used as eyepiece.

2. Draw a ray diagram of a reflecting type telescope. State two advantages of this telescope over a refracting telescope. 2

3. Draw a ray diagram of an astronomical telescope in the normal adjustment position, state two drawbacks of this type of telescope. 2

4. Draw a ray diagram of a compound microscope. Write the expression for its magnifying power. 2

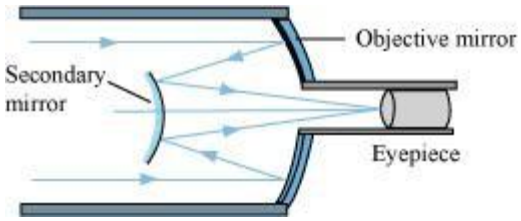
5. The magnifying power of an astronomical telescope in the normal adjustment position is 100. The distance between the objective and the eyepiece is 101 cm. Calculate the focal lengths of the objective and of the eye-piece. 2

6. How does the 'resolving power' of an astronomical telescope get affected on (i) Increasing the aperture of the objective lens? (ii) Increasing the wavelength of the light used? 2

7. What are the two ways of adjusting the position of the eyepiece while observing the Final image in a compound microscope? Which of these is usually preferred and why? 5
Obtain an expression for the magnifying power of a compound microscope. Hence explain why (i) we prefer both the 'objective' and the 'eye-piece' to have small focal length? and (ii) we regard the 'length' of the microscope tube to be nearly equal to be separation between the focal points of its objective and its eye-piece? Calculate the magnification obtained by a compound microscope having an objective of focal length 1.5cm and an eyepiece of focal length 2.5 cm and a tube length of 30.

8. What are the two main considerations that have to be kept in mind while designing the 'objective' of an astronomical telescope? 5
Obtain an expression for the angular magnifying power and the length of the tube of an astronomical telescope in its 'normal adjustment' position.
An astronomical telescope having an 'objective' of focal length 2m and an eyepiece of focal length 1cm is used to observe a pair of stars with an actual angular separation of 0.75. What would be their observed angular separation as seen through the telescope?
Hint- observed angular separation = 0.75' ×200 = 150'

*9. Cassegrain telescope uses two mirrors as shown inFig. Such a telescope is built with the mirrors 20 mm apart. If the radius of curvature of the large mirror is 220 mm and the small mirror is 140mm,where will the final image of an object at infinity be? The following figure shows a Cassegrain telescope consisting of a concave mirror and a convex mirror.



Distance between the objective mirror and the secondary mirror,d = 20 mm
Radius of curvature of the objective mirror,R_1=220 mm

Hence,focal length of the objective mirror, $f_1 = \frac{R_1}{2} = 110 \text{ mm}$

Radiusof curvature of the secondary mirror,R_1=140 mm

Hence,focal length of the secondary mirror, $f_2 = \frac{R_2}{2} = \frac{140}{2} = 70 \text{ mm}$

The image of an object placed at infinity,formed by the objective mirror, will act as a virtual object for the secondary mirror.

Hence,the virtual object distance for the secondary mirror, $u = f_1 - d$

$= 110 - 20$

$= 90 \text{ mm}$

Applying the mirror formula for the secondary mirror,we can calculate image distance(*v*)as:

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

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

$$= \frac{1}{70} - \frac{1}{90} = \frac{9-7}{630} = \frac{2}{630}$$

$$\therefore v = \frac{630}{2} = 315 \text{ mm}$$

Hence,the final image will be formed315 mm away from the secondary mirror. Light incident normally on a plane mirror attached to a galvanometer coil retraces backwards as shown in

*10. The best position of the eye for viewing through a compound microscope is at the eye-ring attached to the eye piece. The precise location of the eye depends on the separation between the objective lens and the eye piece. An angular magnification (magnifying power) of 30X is desired using an objective of focallength1.25 cm and an eyepiece of focal length 5 cm. How will you set up the compound microscope? 5

Ans - Separation between the objective lens and the eyepiece

$= 4.17 + 7.5$

$= 11.67 \text{ cm}$

DEFECTS OF VISION

1. A myopic person has been using spectacles of power −1.0 dioptre for distant vision.During old age healso needs to use separate reading glass of power + 2.0 dioptres. Explain what may have happened.

Ans -

The power of the spectacles used by the myopic person,*P* = −1.0 D

Focal lengthof the spectacles, $$f = \frac{1}{P} = \frac{1}{-1 \times 10^{-2}} = -100 \text{ cm}$$

Hence, the far point of the person is 100 cm. He might have a normal near point of 25 cm.When he uses the spectacles, the objects placed at infinity produce virtual images at 100 cm.He uses the ability of accommodation of the eye-lens to see the objects placed between 100 cm and 25 cm.

During old age, the person uses reading glasses of (power, P=100/50) $P' = +2 \text{ D}$

The ability of accommodation is lost in old age.This defect is called presbyopia.As a result, he is unable to see clearly the objects placed at 25 cm.

2. Answer the following questions:

(a) The angle subtended at the eye by an object is equal to the angle subtended at the eye by the virtual image produced by a magnifying glass. In what sense then does a magnifying glass provide angular magnification?

(b) In viewing through a magnifying glass, one usually positions one's eyes very close to the lens. Does angular magnification change if the eye is moved back?

(c) Magnifying power of a simple microscope is inversely proportional to the focal length of the lens. What then stops us from using a convex lens of smaller and smaller focal length and achieving greater and greater magnifying power?

(d) Why must both the objective and the eye piece of a compound microscope have short focal lengths?

(e) When viewing through a compound microscope, our eyes should be positioned not on the eyepiece but a

short distance away from it for best viewing. Why? How much should be that short distance between the eye and eyepiece?

Ans -

(a) Though the image size is bigger than the object, the angular size of the image is equal to the angular size of the object. A magnifying glass helps one see the objects placed closer than the least distance of distinct vision (i.e.,25 cm).A closer object causes a larger angular size. A magnifying glass provides angular magnification. Without magnification, the object cannot be placed closer to the eye. With magnification, the object can be placed much closer to the eye.

(b) Yes, the angular magnification changes. When the distance between the eye and a magnifying glass is increased, the angular magnification decreases a little. This is because the angle subtended at the eye is slightly less than the angle subtended at the lens. Image distance does not have any effect on angular magnification.

(c) The focal length of a convex lens cannot be decreased by a greater amount. This is because making lenses having very small focal lengths is not easy. Spherical and chromatic aberrations are produced by a convex lens having a very small focal length.

$$\left[\left(\frac{25}{f_e}\right)+1\right]$$

(d) The angular magnification produced by the eye piece of a compound microscope is

Where,

f_e=Focal length of the eyepiece

It can be inferred that if $f_e$is small, then angular magnification of the eye piece will be large.

The angular magnification of the objective lens of a compound microscope is given as

Where,

u_o =Object distance for the objective lens

f_o =Focal length of the objective

In the case of a microscope, the object is kept close to the objective lens. Hence, the object distance is very little.

Since u_o is small, f_o will be even smaller. Therefore, f_e and f_o are both small in the given condition.

(e) When we place our eyes too close to the eyepiece of a compound microscope, we are unable to collect much refracted light. As a result, the field of view decreases substantially. Hence, the clarity of the image gets blurred.

3. A man with normal near point (25 cm)reads a book with small print using a magnifying glass: a thin convex lens of focal length 5 cm.

(a) What is the closest and the farthest distance at which he should keep the lens from the page so that he can read the book when viewing through the magnifying glass?

(b) What is the maximum and the minimum angular magnification (magnifying power) possible using the above simple microscope?

Ans -

(a) Focal length of the magnifying glass, f = 5 cm Least distance of distance vision, d = 25 cm Closes to object distance= u

Image distance, $v = -d = -25$ cm

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

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

$$=\frac{1}{-25}-\frac{1}{5}=\frac{-5-1}{25}=\frac{-6}{25}$$

$$\therefore u=-\frac{25}{6}=-4.167 \text{ cm}$$

According to the lens formula,we have:

Hence,the closest distance at which the person can read the book is 4.167 cm. For the object at the farthest distant(*u*'), the image distance $(v')=\infty$ According to the lens formula, we have:

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

$$\frac{1}{u'}=\frac{1}{\infty}-\frac{1}{5}=-\frac{1}{5}$$

$$\therefore u'=-5 \text{ cm}$$

Hence,the farthest distance at which the person can read the book is 5cm.

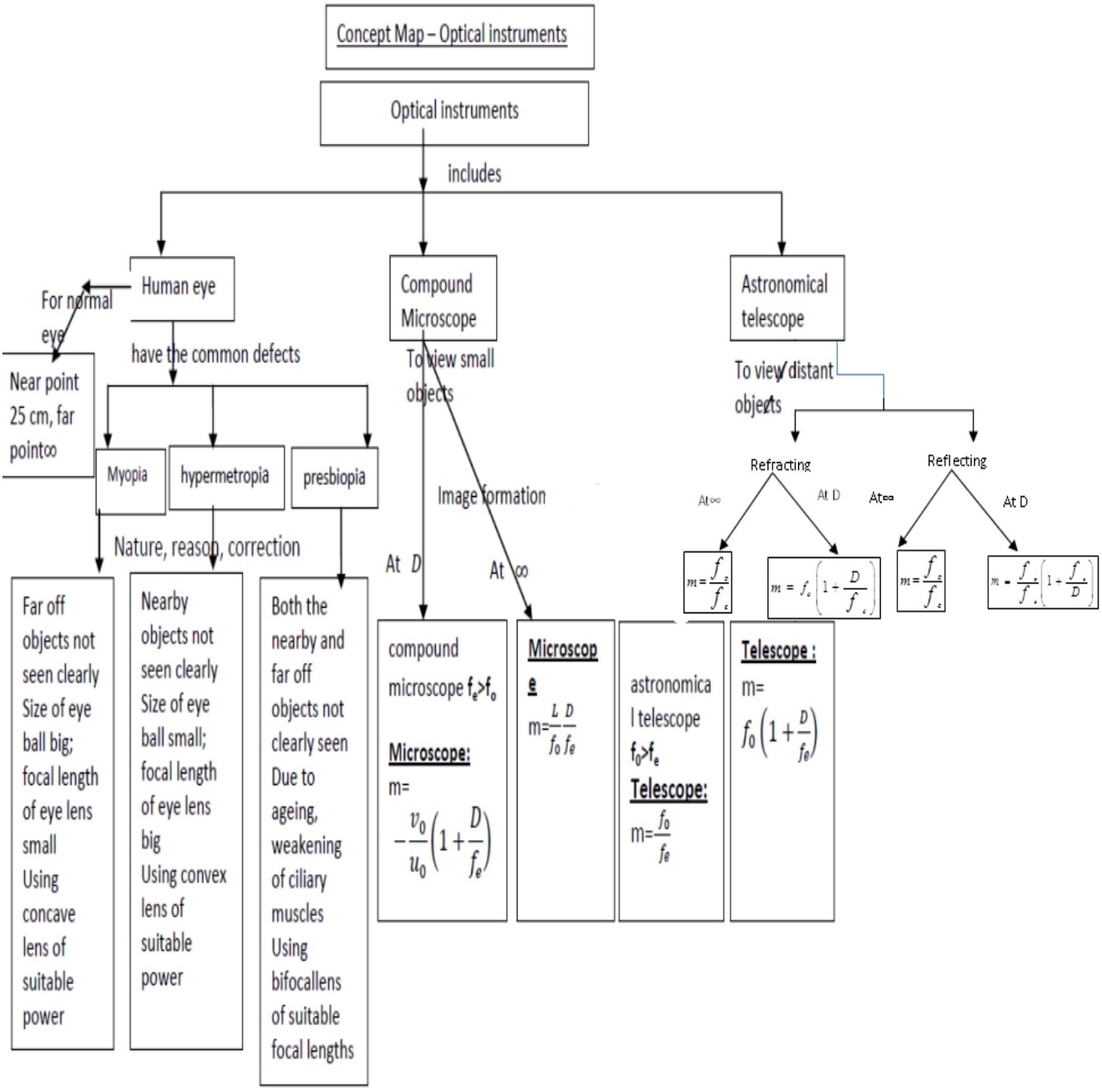
(b) Maximum angular magnification is given by the relation:

$$\alpha_{\max}=\frac{d}{|u|}$$

$$=\frac{25}{\frac{25}{6}}=6$$

CONCEPT MAP

Optical Instruments



Wave Optics

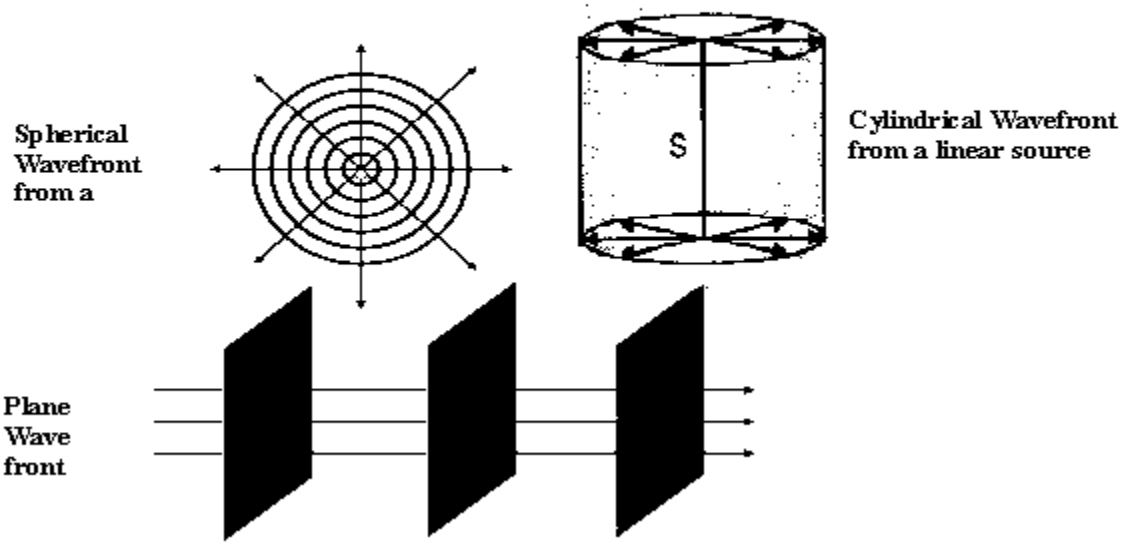
GIST

Wavefront:

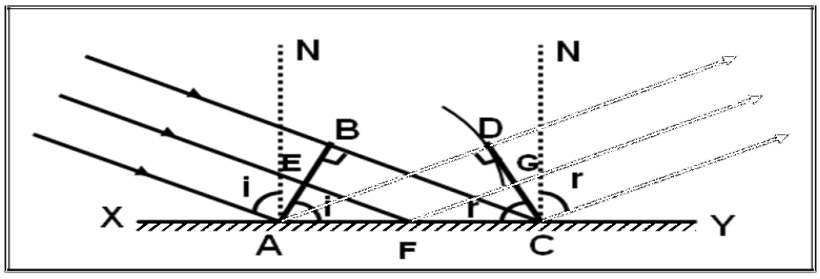
A wavelet is the point of disturbance due to propagation of light.

A wavefront is the locus of points (wavelets) having the same phase of oscillations.

A line perpendicular to a wavefront is called a 'ray'.



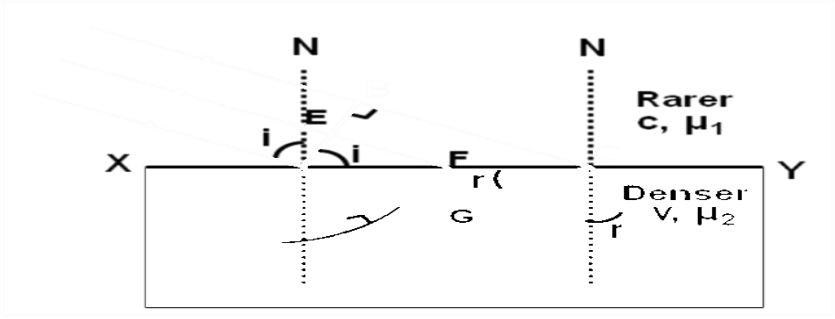
Laws of Reflection at a Plane Surface (On Huygens' Principle):



AB – Incident wavefront CD – Reflected wavefront XY – Reflecting surface

$\sin i - \sin r = 0.$ **sin i = sin r or i = r**

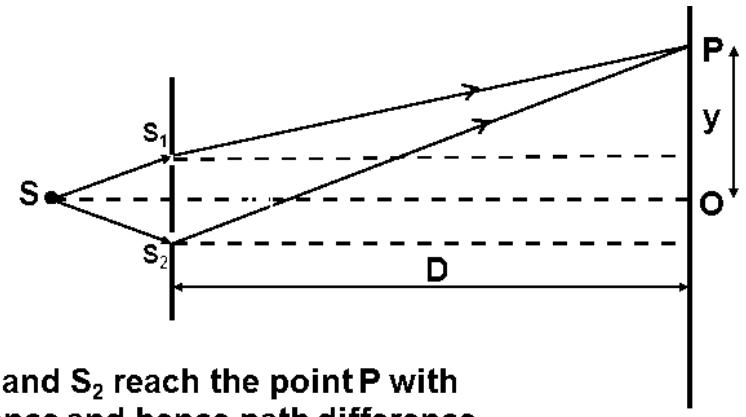
Laws of Refraction at a Plane Surface (On Huygens' Principle):



AB – Incident wavefront CD – Refracted wavefront XY – Refracting surface

$$\frac{\sin i}{c} - \frac{\sin r}{v} = 0 \quad \text{or} \quad \frac{\sin i}{c} = \frac{\sin r}{v} \quad \text{or} \quad \frac{\sin i}{\sin r} = \frac{c}{v} = \mu$$

INTERFERENCEOF WAVES



The waves from S_1 and S_2 reach the point P with some phase difference and hence path difference

$\Delta = S_2P - S_1P$

$S_2P^2 - S_1P^2 = [D^2 + \{y + (d/2)\}^2] - [D^2 + \{y - (d/2)\}^2]$

$(S_2P - S_1P)(S_2P + S_1P) = 2\,yd \qquad \Delta(2D) = 2\,yd \qquad \Delta = yd / D$

Comparison of intensities of maxima and minima:

$$\frac{I_{max}}{I_{min}} = \frac{(a+b)^2}{(a-b)^2} = \frac{(a/b+1)^2}{(a/b-1)^2}$$

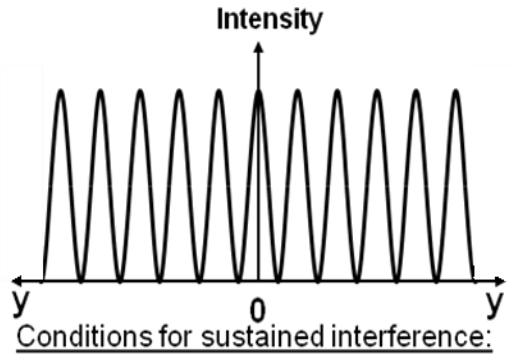
Relation between Intensity (I), Amplitude (a) of the wave and Width (w) of the slit:

$I \propto a^2$

$a \propto \sqrt{w}$

$$\frac{I_1}{I_2} = \frac{(a_1)^2}{(a_2)^2} = \frac{w_1}{w_2}$$

Distribution of Intensity:

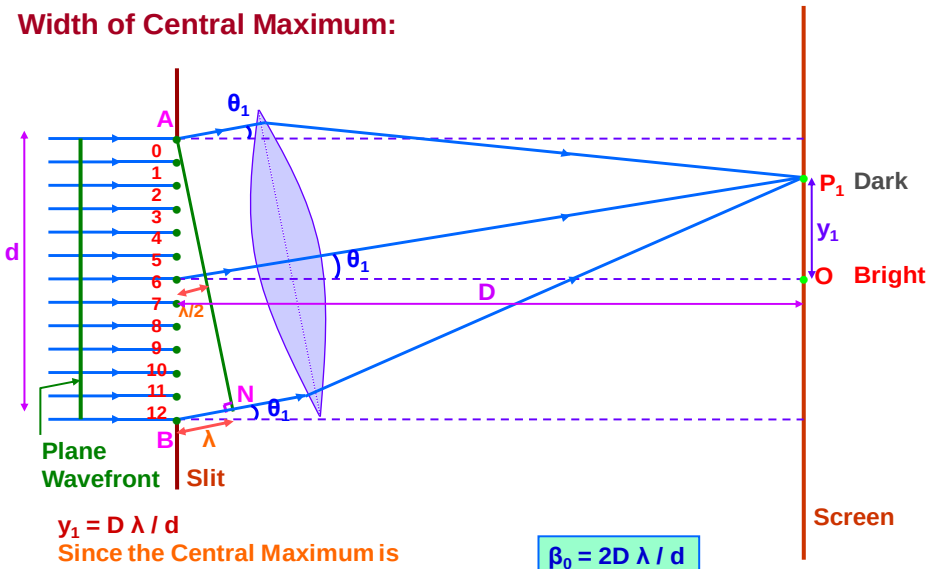


Conditions for sustained interference:

1. The two sources producing interference must be coherent.
2. The two interfering wave trains must have the same plane of polarisation.
3. The two sources must be very close to each other and the pattern must be observed at a larger distance to have sufficient width of the fringe. ($D\lambda / d$)
4. The sources must be monochromatic. Otherwise, the fringes of different colours will overlap.
5. The two waves must be having same amplitude for better contrast between bright and dark fringes.

DIFFRACTION OF LIGHT AT A SINGLE SLIT ;

Width of Central Maximum:



$y_1 = D\lambda / d$

Since the Central Maximum is spread on either side of O, the width is

$\beta_0 = 2D\lambda / d$

Fresnel's Distance:

$y_1 = D\lambda / d$

At Fresnel's distance, $y_1 = d$ and $D = D_F$

So, $D_F \lambda / d = d$ or $D_F = d^2 / \lambda$

POLARISATION OF LIGHT WAVES :

Malus' Law:

When a beam of plane polarised light is incident on an analyser, the intensity I of light transmitted from the analyser varies directly as the square of the cosine of the angle θ between the planes of transmission of analyser and polariser.

Intensity of transmitted light from the analyser is

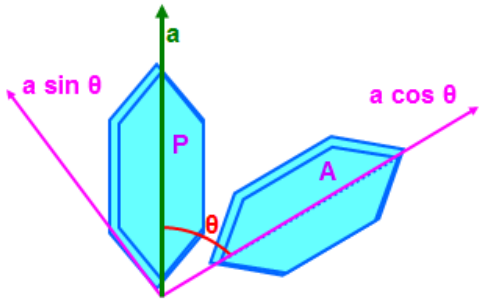
$I \alpha \cos^2 \theta$

$I = k (a \cos \theta)^2$

or $I = k a^2 \cos^2 \theta$

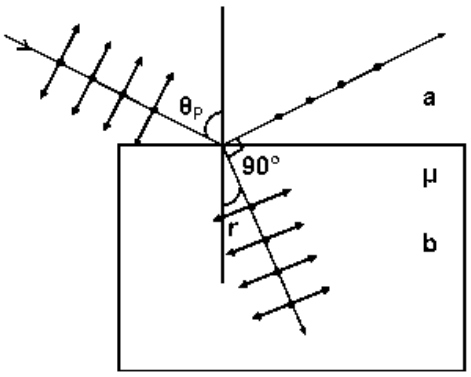
$I = I_0 \cos^2 \theta$

(where $I_0 = k a^2$ is the intensity of light transmitted from the polariser)



(2)

Polarisation by Reflection and Brewster's Law:



$\theta_P + r = 90°$ or $r = 90° - \theta_P$

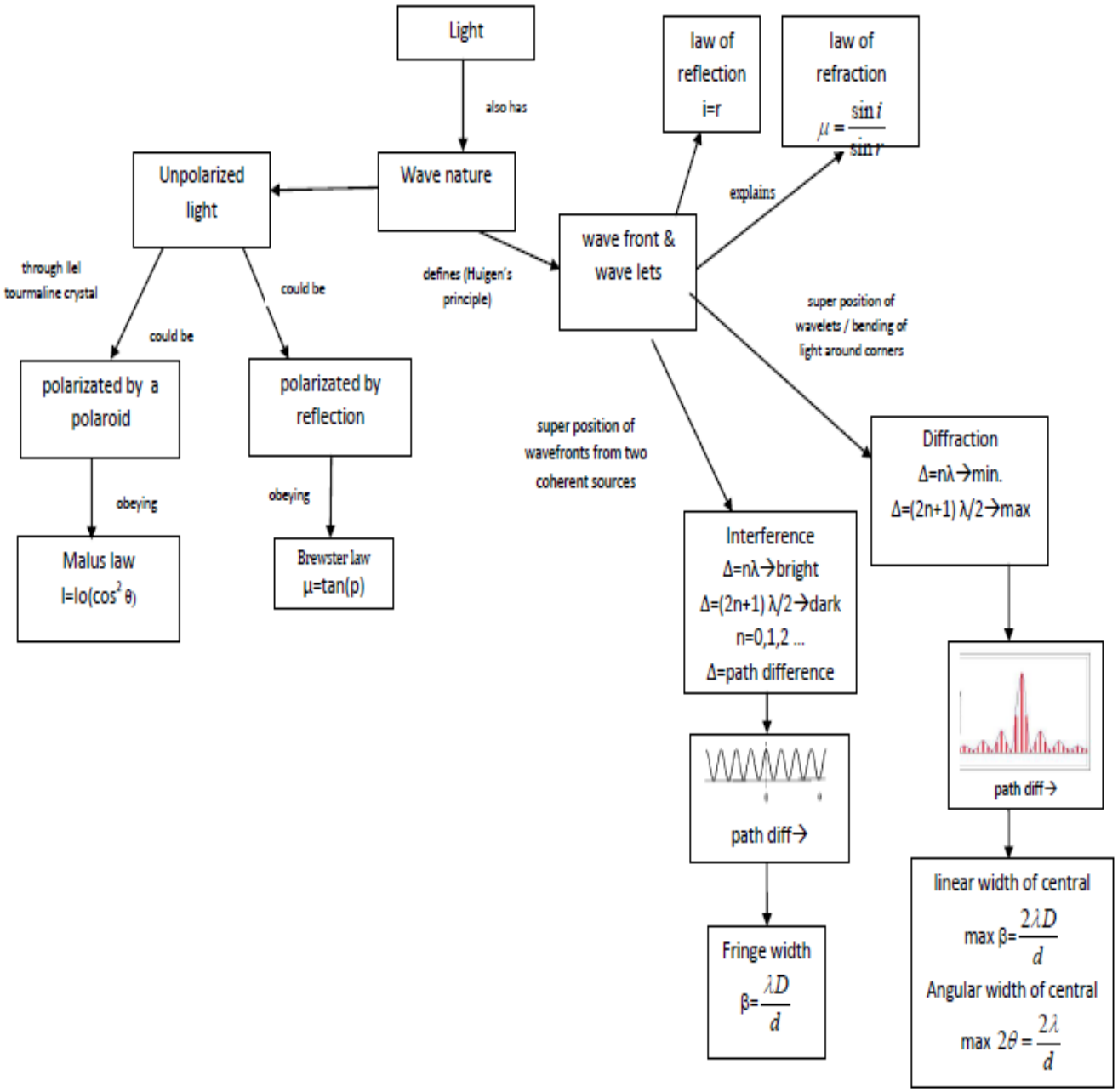
$${}_a\mu_b = \frac{\sin \theta_P}{\sin r}$$

$${}_a\mu_b = \frac{\sin \theta_P}{\sin 90° - \theta_P}$$

$${}_a\mu_b = \tan \theta_P$$

CONCEPT MAP

WAVE NATURE OF LIGHT



QUESTIONS

Huygen's Principle

1. Draw a diagram to show the refraction of a plane wave front incident on a convex lens and hence draw the refracted wave front. 1

2. What type of wave front will emerge from a (i) point source, and (ii) distance light source? 1

3. Define the term wave front? Using Huygen's construction draw a figure showing the propagation of a plane wave reflecting at the interface of the two media. Show that the angle of incidence is equal to the angle of reflection. 3

4. Define the term 'wavefront'. Draw the wavefront and corresponding rays in the case of a (i) diverging spherical wave (ii) plane wave. Using Huygen's construction of a wavefront, explain the refraction of a plane wavefront at a plane surface and hence deduce Snell's law. 3

Interference

1. How does the angular separation of interference fringes change, in Young's experiment, when the distance between the slits is increased? 1
   Ans-when separation between slits (d) is increased, fringe width β decreases.

2. How the angular separation of interference fringes in young would's double slit experiment change when the distance of separation between the slits and the screen is doubled? 1
   Ans-No effect (or the angular separation remains the same)

*3. In double-slit experiment using light of wavelength 600 nm, the angular width of a fringe formed on adjacent screen is 0.1˚. What is the spacing between the two slits? 2

   Ans- The spacing between the slits is 3.44×10^{-4} m

*4. If the path difference produced due to interference of light coming out of two slits for yellow colour of light at a point on the screen be 3λ/2, what will be the colour of the fringe at that point? Give reasons. 2
   Ans. The given path difference satisfies the condition for the minimum of intensity for yellow light, Hence when yellow light is used, a dark fringe will be formed at the given point. If white light is used, all components of white light except the yellow one would be present at that point.

5. State two conditions to obtain sustained interference of light. In Young's double slit experiment, using light of wavelength 400 nm, interference fringes of width 'X' are obtained. The wavelength of light is increased to 600 nm and the separation between the slits is halved. In order to maintain same fringe with, by what distance the screen is to be moved? Find the ration of the distance of the screen in the above two cases. 3
   Ans-Ratio-3:1

6. Two narrow slits are illuminated by a single monochromatic source. Name the pattern obtained on the screen. One of the slits is now completely covered. What is the name of the pattern now obtained on the screen? Draw intensity pattern obtained in the two cases. Also write two differences between the patterns obtained in the above two cases. 3

*7. In Young's double-slit experiment a monochromatic light of wavelength λ, is used. The intensity of light at a point on the screen where path difference is λ is estimated as K units. What is the intensity of light at a point where path difference is λ /3? 3
   Ans-K/4

*8. A beam of light consisting of two wavelengths,650 nm and 520 nm, is used to obtain interference fringes in a Young's double-slit experiment.**(a)**Find the distance of the third bright fringe on the screen from the central maximum for wavelength 650 nm.**(b)**What is the least distance from the central maximum where the bright fringes due to both the wavelengths coincide? 3
   Ans-a)

$$x = n\lambda_1\left(\frac{D}{d}\right)$$

For third bright fringe, $n = 3$

$$\therefore x = 3\times 650\frac{D}{d} = 1950\left(\frac{D}{d}\right) \text{ nm}$$

b)

$$x = n\lambda_2\frac{D}{d}$$

$$= 5\times 520\frac{D}{d} = 2600\frac{D}{d} \text{ nm}$$

*9. In a double-slit experiment the angular width of a fringe is found to be0.2° on a screen placed 1 m away. The wavelength of light used is 600 nm. What will be the angular width of the fringe if the entire experimental apparatus is immersed in water? Take refractive index of water to be 4/3. 3

Ans-

$$\mu = \frac{\theta_1}{\theta_2}$$

$$\theta_2 = \frac{3}{4}\theta_1$$

$$= \frac{3}{4}\times 0.2 = 0.15^{\circ}$$

*10 A narrow monochromatic beam of light of intensity I is incident a glass plate. Another identical glass plate is kept close to the first one and parallel to it. Each plate reflects 25% of the incident light and transmits the reaming. Calculate the ratio of minimum and maximum intensity in the interference pattern formed by the two beams obtained after reflection from each plate. 3

Ans. Let I be the intensity of beam I incident on first glass plate. Each plate reflects 25% of light incident on it and transmits 75%.

Therefore,

I1 =I; and I2 = 25/100I = I/4;I3 =75/100 I = 3/4I;I4 = 25/100 I3 = 1⁄4 x 3⁄4 I = 3/16 I

I5= 7/100 I4= 3⁄4 x 3/16 I = 9/64 I

Amplitude ratio of beams 2 and 5 is R = √ I2/I5 = √I/4 x 64/91 = 4/3

Imin/ Imax = [r-1/r+1]2 = [4/3-1 / 4/3+1]2 = 1/49 = 1:49

*11 In a two slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance D from the slits. If the screen is moved 5 x 10^{-2} m towards the slits, the charge in fringe width is 3 x 10^{-5} m. If the distance between the slit is 10^{-3} m. Calculate the wavelength of the light used.

Ans. The fringe width in the two cases will be β = Dλ/d;β '= D'λ/d

β - β' = (D-D')λ/d; or wavelength λ = (β - β')d / (D-D') But D-D' = 5 x 10^{-2} m

β - β' = 3 x 10^{-5} m , d= 10^{-3}m;λ = 3 x 10^{-5} x 10^{-3} / 5 x 10^{-2} = 6 x 10^{-7}m= 6000A

12. Two Sources of Intensity I and 4I are used in an interference experiment. Find the intensity at points where the waves from two sources superimpose with a phase difference (i) zero (ii) π/2 (iii) π.

Ans-The resultant intensity at a point where phase difference is Φ is $I_R = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\Phi$

As I1 =I and I_2 = 4I therefore I_R = I +4I+2√1.4I Cos Φ = 5I +4I cos Φ

(i) when Φ =0 , I R = 5I +4I cos 0 = 9 I;(ii) when Φ =π/2 , I R = 5I +4I cos π/2 = 5 I

(iii) when Φ =π , I R = 5I +4I cos π = I

13. What are coherent sources of light? Two slits in Young's double slit experiment are 5

illuminated by two different sodium lamps emitting light of the same wavelength. Why is no interference pattern observed?
(b) Obtain the condition for getting dark and bright fringes in Young's experiment. Hence write the expression for the fringe width.
(c) If S is the size of the source and its distance from the plane of the two slits, what should be the criterion for the interference fringes to be seen?

Ans-c) $\frac{S}{d} < \frac{\lambda}{a}$

14. What are coherent sources? Why are coherent sources required to produce interference of light? Give an example of interference of light in everyday life. In Young's double slit experiment, the two slits are 0.03 cm apart and the screen is placed at a distance of 1.5 m away from the slits. The distance between the central bright fringe and fourth bright fringe is 1 cm. Calculate the wavelength of light used. 5
Ans-(Numerical part)

$$\lambda = \frac{dx}{4D} = \frac{0.03\times10^{-2}\times1\times10^{-2}}{4\times1.5} = 5\times10^{-7}\ \text{m}$$

15. What is interference of light? Write two essential conditions for sustained interference pattern to be produced on the screen. Draw a graph showing the variation of intensity versus the position on the screen in Young's experiment when (a) both the slits are opened and (b) one of the slit is closed. What is the effect on the interference pattern in Young's double slit experiment when: (i) Screen is moved closer to the plane of slits? (ii)Separation between two slits is increased. Explain your answer in each case. 5

Diffraction

***1.** Why a coloured spectrum is seen, when we look through a muslin cloth and not in other clothes? **2**
Ans. Muslin cloth is made of very fine threads and as such fine slits are formed. White light passing through these silts gets diffracted giving rise to colored spectrum. The central maximum is white while the secondary maxima are coloured. This is because the positions of secondary maxima (except central maximum) depend on the wavelength of light. In a coarse cloth, the slits formed between the threads are wider and the diffraction is not so pronounced. Hence no such spectrum is seen.

2. A parallel beam of light of wavelength 600 nm is incident normally on a slit of width 'a'. If the distance between the slits and the screen is 0.8 m and the distance of 2nd order maximum from the centre of the screen is 15 mm, calculate the width of the slit. **2**
Ans-Difference between interference and diffraction: Interference is due to superposition of two distinct waves coming from two coherent sources. Diffraction is due to superposition of the secondary wavelets generated from different parts of the same wavefront.
Numerical: Here, λ = 600 nm = 600 × 10−19 = 6 × 10−7 m
D = 0.8 m, x = 15 mm = 1.5 × 10−3 m,n = 2, a = ?

$$\because a\frac{x}{D} = n\lambda$$

$$a = \frac{n\lambda D}{x} = \frac{2\times6\times10^{-7}\times0.8}{1.5\times10^{-3}}$$

$$= \frac{9.6\times10^{-4}}{1.5} = 6.4\times10^{-4}\ \text{mm}$$

3. Answer the following questions: **2**
(a) How does the size and intensity of the central maxima changes when the width of the slit is double in a single slit diffraction experiment?
(b) In what way is diffraction from each slit related to the interference pattern in a double-slit experiment?
(c) When a tiny circular obstacle is placed in the path of light from a distant source,a bright spot

is seen at the centre of the shadow of the obstacle. Explain why?

(d) Two students are separated by a 7 m partition wall ina room 10 mhigh. If both light and sound waves can bend around obstacles, how is it that the students are unable to see each other even though they can converse easily?

Ans-

(a) In a single slit diffraction experiment, if the width of the slit is made double the original width, then the size of the central diffraction band reduces to half and the intensity of the central diffraction band increases up to four times.

(b) The interference pattern in a double-slit experiment is modulated by diffraction from each slit. The pattern is the result of the interference of the diffracted wave from each slit.

(c) When a tiny circular obstacle is placed in the path of light from a distant source, a bright spot is seen at the centre of the shadow of the obstacle. This is because light waves are diffracted from the edge of the circular obstacle, which interferes constructively at the centre of the shadow. This constructive interference produces a bright spot.

(d) Bending of waves by obstacles by a large angle is possible when the size of the obstacle is comparable to the wavelength of the waves.

On the one hand, the wavelength of the light waves is too small in comparison to the size of the obstacle. Thus, the diffraction angle will be very small. Hence, the students are unable to see each other. On the other hand, the size of the wall is comparable to the wavelength of the sound waves. Thus, the bending of the waves takes place at a large angle. Hence, the students are able to hear each other.

4. Why light ways do not diffracted around buildings, while radio waves diffract easily? **2**

Ans- For diffraction to take place the wave length should be of the order of the size of the obstacle. The radio waves (particularly short radio waves) have wave length of the order of the size of the building and other obstacles coming in their way and hence they easily get diffracted. Since wavelength of the light waves is very small, they are not diffracted by the buildings.

5. Draw the diagram showing intensity distribution of light on the screen for diffraction of light at a single slit. How is the width of central maxima affected on increasing the (i) Wavelength of light used (ii) width of the slit? What happens to the width of the central maxima if the whole apparatus is immersed in water and why? **3**

6. State the condition under which the phenomenon of diffraction of light takes place. Derive an expression for the width of central maximum due to diffraction of light at a single slit. A slit of width 'a' is illuminated by a monochromatic light of wavelength 700 nm at normal incidence. Calculate the value of 'a' for position of **5**

* (i) first minimum at an angle of diffraction of 30°

(ii) first maximum at an angle of diffraction of 30°

Ans-i) $$a = \frac{\lambda}{\sin\theta} = \frac{700}{\sin 30} = 1400\,\text{nm}$$

ii) $$a = \frac{3\lambda}{2\sin\theta} = \frac{3\times 700}{2\times \sin 30} = 2100\,\text{nm}$$

Polarisation

1. At what angle of incidence should a light beam strike a glass slab of refractive index √3, such that the reflected and the refracted rays are perpendicular to each other? **1**

Ans-$i=60^0$

*2. What does the statement, "natural light emitted from the sun is unpolarised" mean in terms of the direction of electric vector? Explain briefly how plane polarized light can be produced by reflection at the interface separating the two media. **2**

Ans-The statement "natural light emitted from the sun is unpolarised" means that the natural light coming from sun is a mixture of waves, each having its electric vectors directed in random direction. When light falls on the interface separating two media, electrons start oscillating,

which produces reflected ray in addition to refracted ray. As light is a transverse wave, therefore, oscillation in the transverse direction will produce a light wave. Parallel oscillations will not contribute to the light wave. When a light ray strikes an interface, the component of electric vector, which is parallel to the interface, gets reflected. Therefore, the reflected light wave is plane polarised light.

3. What is an unpolarized light? Explain with the help of suitable ray diagram how an unpolarized light can be polarized by reflection from a transparent medium. Write the expression for Brewster angle in terms of the refractive index of denser medium. 3

4. The critical angle between a given transparent medium and air is denoted by i_c, A ray of light in air medium enters this transparent medium at an angle of incidence equal to the polarizing angle(i_p). Deduce a relation for the angle of refraction (r_p) in terms of i_c. 3

5 What is meant by 'polarization' of a wave? How does this phenomenon help us to decide whether a given wave is transverse or longitudinal in nature? 5

QUESTIONS (HOTS)

VERY SHORT ANSWER QUESTIONS (1 MARK)

1. Air bubble is formed inside water. Does it act as converging lens or a diverging lens? 1
   Ans : [Diverging lens]
2. A water tank is 4 meter deep. A candle flame is kept 6 meter above the level. μ for water is $4/3$. Where will the image of the candle be formed?. Ans : [6m below the water level] 1

SHORTANSWER QUESTIONS (2 MARKS)

1. Water is poured into a concave mirror of radius of curvature 'R' up to a height h as shown in figure 1. What should be the value of x so that the image of object 'O' is formed on itself? 2

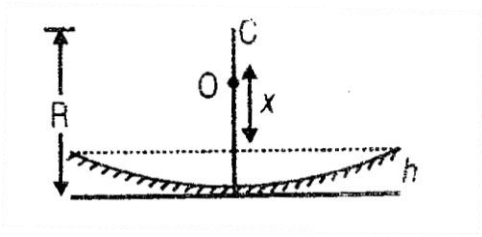


Fig 1

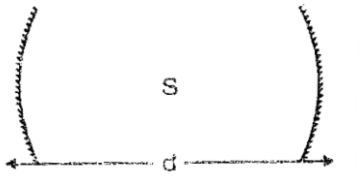
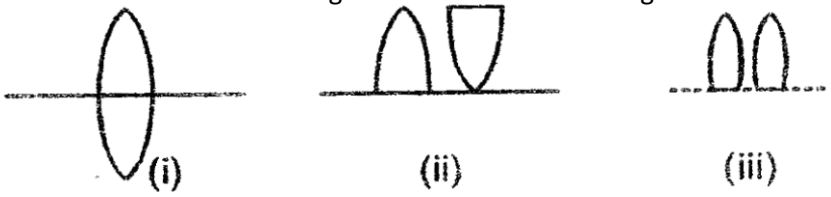


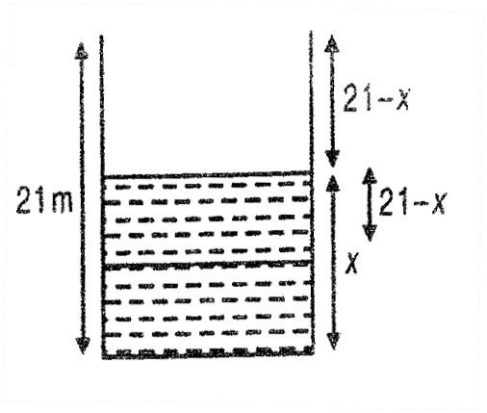
Fig 2

2. A point source S is placed midway between two concave mirrors having equal focal length *f* as shown in Figure 2. Find the value of *d* for which only one image is formed. 2

3. A thin double convex lens of focal length *f* is broken into two equals halves at the axis. The two halves are combined as shown in figure. What is the focal length of combination in (ii) and (iii).



2

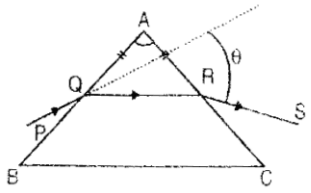


$$\frac{\text{Real depth}}{\text{Apparent depth}} = \mu$$

$$\frac{x}{21-x} = \frac{4}{3} \quad \Rightarrow \quad x = 12 \text{ cm.}$$

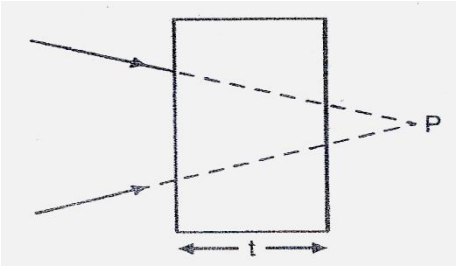
4. How much water should be filled in a container 21cm in height, so that it appears half filled when viewed from the top of the container $\left({}^{a}\mu_{\omega} = 4/3\right)$? 2

5. A ray PQ incident on the refracting face BA is refracted in the prism BAC as shown in figure and emerges from the other refracting face AC as RS such that AQ= AR. If the angle, of prism A= $60°$ and μ of material of prism is $\sqrt{3}$ then find angle θ. 2
   Hint : This a case of min .deviation $\theta = 60°$



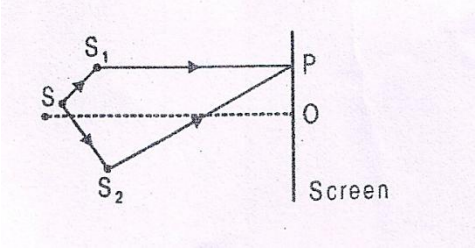
SHORT ANSWER QUESTIONS (3 MARKS)

1. A converging beam of light is intercepted by a slab of thickness t and refractive index μ. By what distance will the convergence point be shifted? Illustrate the answer. 3



$$X = \left(1 - \frac{1}{\mu}\right)t$$

2. In double slit experiment SS_2 is greater than SS_1 by 0.25λ. calculate the path difference between two interfering beam from S_1 and S_2 for maxima on the point P as shown in Figure. 3



7. DUAL NATURE OF MATTER & RADIATION

GIST

ELECTRON EMISSION

1. There are three types of electron emission, namely, Thermionic Emission, Photoelectric Emission and Field Emission.
2. The minimum energy required by an electron to escape from the metal surface is called work function.
3. Work function is conveniently expressed in electron volts (e V)
4. One electron volt is the energy gained or lost by an electron while passing through a potential difference of one volt.

PHOTOELECTRIC EFFECT

1. The minimum energy required by an electron to come out from metal surface is called the work function of a metal.

2. Photo electric effect is the phenomenon of electrons by metals when illuminated by light of suitable frequency

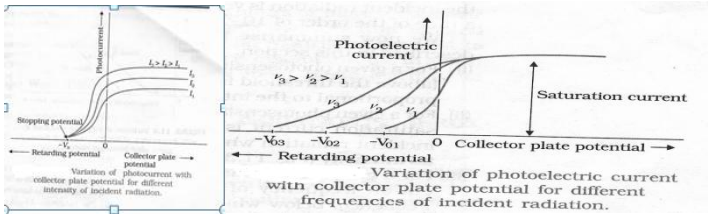
3. Photo electric current depends on

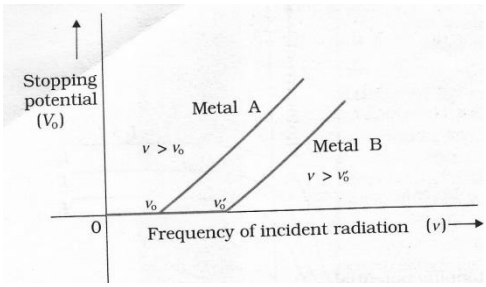
i) The intensity of incident light

ii) The potential difference applied between two electrodes

iii) The nature of the emitter material

EXPERIMENTAL STUDY OF PHOTOELECTRIC EFFECT





1. The minimum negative potential given to the anode plate for which the photo electric current becomes zero is called stopping potential.

2. The stopping potential V_o depends on i) The frequency of incident light and ii) the nature of emitter material. For a given frequency of incident light, the stopping potential is independent of its intensity.

$eV_o = (1/2)m v_{max}^2 = K_{max}$

2. Below a certain frequency (threshold frequency) γ_0 , characteristics of the metal , no photo electric emission takes place, no matter how large the intensity may be.

EINSTEINS PHOTO ELECTRIC EQUATION: ENERGY QUANTUM OF RADIATION

1. Light is composed of discrete packets of energy called quanta or photons.

2. The energy carried by each photon is E = hν, where ν is the frequency and momentum p= h/λ. The energy of the photon depends on the frequency γ of the incident light and not on its intensity.

3. Photo electric emission from the metal surface occurs due to absorption of a photon by an electron

4. Einstein's photo electric equation: $K_{max} = h\nu - \phi_0$ or $eV_0 = h\nu - \phi_0$.

PARTICLE NATURE OF LIGHT: THE PHOTON

1. Radiation has dual nature: wave and particle. The wave nature is revealed in phenomenon like interference, diffraction and polarization. The particle nature is revealed by the phenomenon photo electric effect.

2. By symmetry, matter also should have dual nature: wave and particle. The waves associated with the moving material particle are called matter waves or De Broglie waves.

3. The De Broglie wave length (λ) associated with the moving particle is related to its moment p as: $\lambda = h/p = h/mv$

4.An equation for the De Broglie wavelength of an electron accelerated through a potential V. Consider an electron with mass 'm' and charge 'e' accelerated from rest through a potential V.

$K = eV$

$K = 1/2mv^2 = p^2/2m$

$P^2 = 2mK$

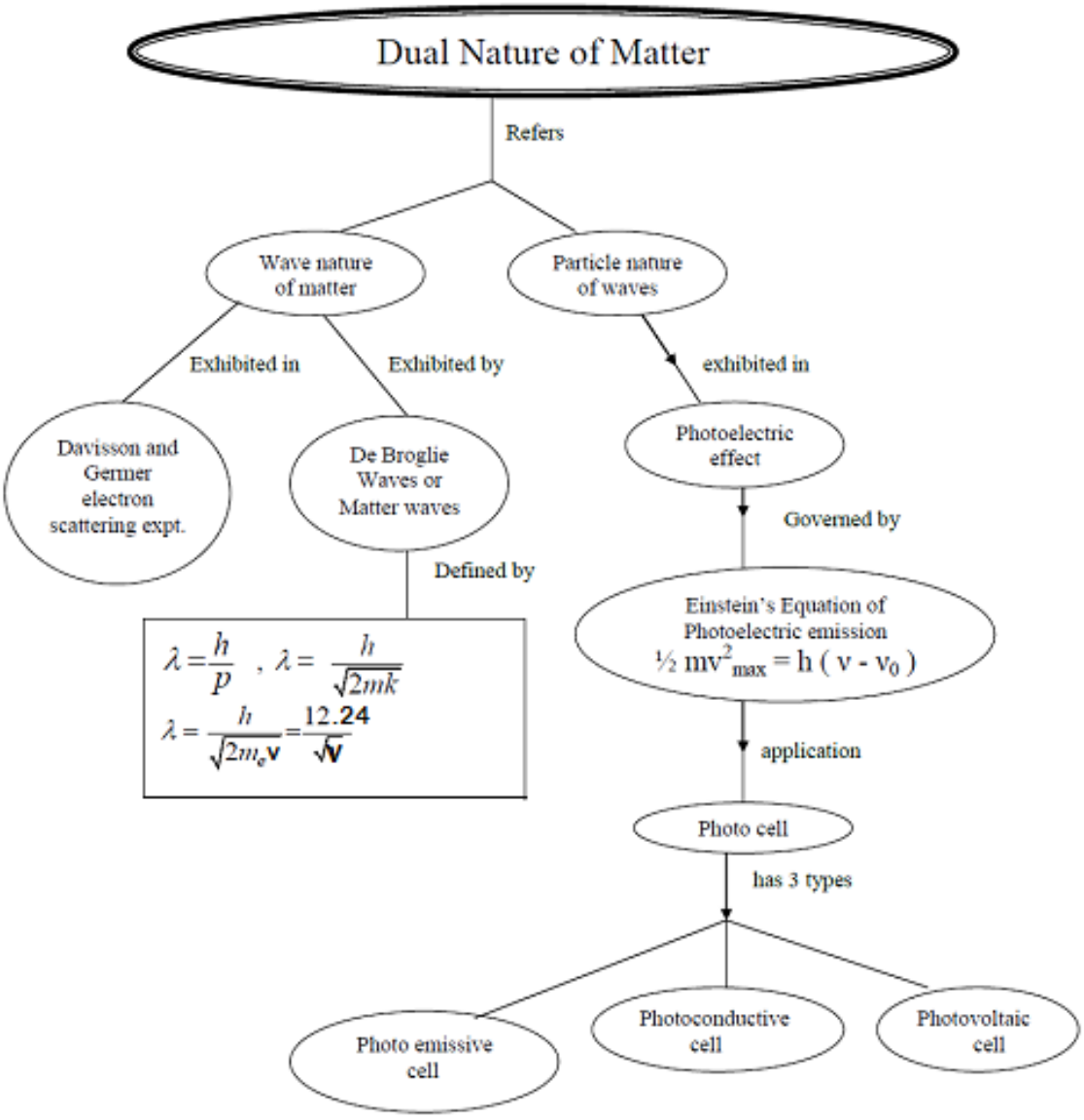
$P = \sqrt{2mK} = \sqrt{2meV}$

$\lambda = h/\sqrt{2meV}$

Substituting numerical values of h, m and e

$\lambda = (1.227/\sqrt{V})$ nm.

CONCEPT MAP


Dual Nature of Matter
Refers
Wave nature of matter
Particle nature of waves
Exhibited in
Exhibited by
exhibited in
Davisson and Germer electron scattering expt.
De Broglie Waves or Matter waves
Photoelectric effect
Governed by
Defined by
$\lambda = \frac{h}{p}$, $\lambda = \frac{h}{\sqrt{2mk}}$
$\lambda = \frac{h}{\sqrt{2m_e V}} = \frac{12.24}{\sqrt{V}}$
Einstein's Equation of Photoelectric emission
$\frac{1}{2} mv^2_{max} = h (\nu - \nu_0)$
application
Photo cell
has 3 types
Photo emissive cell
Photoconductive cell
Photovoltaic cell

QUESTIONS

ELECTRON EMISSION, PHOTO ELECTRIC EFFECT

1* If the intensity of incident radiation in a photoelectric experiment is doubled what, happens to kinetic energy of emitted photo electrons? 1

2* Calculate the frequency associated with photon of energy 3.3×10^{-10} J? Ans: $\nu = 5 \times 10^{23}$Hz. 1

3 What is the momentum of a photon of energy 1 MeV? 1
Energy E = 1 MeV = 1.6×10^{-13}J, p = E/c= 5.33×10^{-22} Kgm/s

4* What happens to the velocity of emitted electrons when the wave length of incident light is decreased?

5 If the frequency of incident radiation in a photocell is increased, does it affect the stopping potential? If so how? 1

6 On what factor does the energy carried by a quantum of light depend? 1

7* The threshold wave length for photoelectric emission from a given surface is 5200Å. Will photo electric emission takes place, if an ultra violet radiation of one watt power is incident on it? 1

8 Name the element with highest work function and also the element with lowest work function.
Highest work function – Platinum (5.65eV)
Lowest work function – Caesium (2.14eV) 2

9* Calculate the work function of a metal in eV if its threshold wavelength is 6800Å.
Ans: Work function = $hc / \lambda_0 = 1.825$eV. 2

10 Work function of aluminium is 4.2eV. If two photons each of energy 2.5eV are incident on its surface, will the emission of electrons take place? 2

11 A source of light is placed at a distance of 50cm from a photocell and the cut off potential is found to be V_0. If the distance between the light source and the cell is made 20cm, what will be the new cut off potential?
Ans: Stopping potential is still V_o. 2

EINSTEIN'S PHOTO ELECTRIC EQUATION :ENERGY QUANTUM OF RADIATION

12 Which of the two photons is more energetic: red light or violet light? 1

13 What will be the stopping potential when a photon of 25eV is incident of metal surface of work function 6eV? Ans : 19 volt 1

14 Why is alkali metal surfaces better suited as photosensitive surfaces? 1

15 Blue light can eject electrons from a photo-sensitive surface while orange light can not. Will violet and red light eject electrons from the same surface? 1

16 Two metals A & B have work functions 4eV & 10eV respectively. In which case the threshold wave length is higher? 1

17* A radio transmitter at a frequency of 880 kHz and a power of 10kW. Find the number of photons emitted per second. 2
Ans: n = energy emitted per second/energy of one photon = 1.716×10^{31}.

18 A parallel beam of light is incident normally on a plane surface absorbing 40% of the light and reflecting the rest. If the incident beam carries 10W of power, find the force exerted by it on the surface. 2
Ans : 5.33×10^{-8} N

19* No photoelectrons are emitted from a surface, if the radiation is above 5000 Å. With an unknown wavelength, the stopping potential is 3V. Find the wave length. 3
Ans : 2262Å

20* Illuminating the surface of a certain metal alternately with light of wave lengths0.35μm and 0.54μm, it was found that the corresponding maximum velocities of photoelectrons have a ratio 2. Find the work function of that metal. 3
Ans: 5.64eV

21* A beam of light consists of four wavelengths 4000Å, 4800Å, 6000Å & 7000Å, each of intensity $1.5 mW/m^2$. The beam falls normally on an area $10^{-4} m^2$ of a clean metallic surface of work function 1.9eV.Assuming no loss of kinetic energy, calculate the number of photoelectrons emitted per second. 3

Ans :$E_1 = 3.1eV$, $E_2 = 2.58eV$, $E_3 = 2.06eV$, $E_4 = 1.77eV$

Only the first three wave lengths can emit photo electrons.

Number of photo electrons emitted per second = $IA (1/E_1+1/E_2+1/E_3)$

$= 1.12 \times 10^{12}$.

(Hint – convert eV into joule before substitution)

22 In an experiment on photo electric emission , following observations were made;

(i) wave length of incident light = $1.98 \times 10^{-7} m$

(ii) stopping potential = 2.5 V.

Find (a) kinetic energy of photo electrons with maximum speed

(b) work function & (c) threshold frequency 3

Ans; (a) $K_{max} = 2.5eV$ (b) work function = 3.76eV

(c) threshold frequency = $9.1 \times 10^{14} Hz$

WAVE NATURE OF MATTER

1 What is the de Broglie wavelength (in Å) associated with an electron accelerated through a potential of 100 V? 1

Ans: $\lambda = 1.227 A^{o}$

2 Matter waves associated with electrons could be verified by crystal diffraction experiments .Why?

Ans: The wave length of the matter waves associated with electrons has wave lengths comparable to the spacing between the atomic planes of their crystals. 1

3 How do matter waves differ from light waves as regards to the velocity of the particle and the wave? 1

Ans: In case of matter waves, the wave velocity is different from the particle velocity. But in case of light, particle velocity and wave velocity are same.

4 An electron and an alpha particle have same kinetic energy. Which of these particles has the shortest de- Broglie wavelength? 1

Ans: Alpha particle

5 The de Broglie wavelength of an electron is $1 A^0$. Find the velocity of the electron. 1

Ans: $7.3 \times 10^{6} m/s$

6* Find the ratio of wavelength of a 10 k eV photon to that of a 10 keV electron. 2

Ans: 10 (Hint: $\lambda_{photon} = 1.24 A^0$, $\lambda_{electron} = 0.1227 A^0$)

7* A proton and an alpha particle are accelerated through the same potential difference. Find the ratio of the wavelengths associated with the two. 2

Ans: (Hint $\lambda = h/ \sqrt{2meV}$), $\lambda_p : \lambda_\alpha = 2\sqrt{2} : 1$

8 Why macroscopic objects in our daily life do not show wave like properties? OR

Why wave nature of particles is significant in the sub-atomic domain only? 2

Macroscopic objects in our daily life do not show wave like properties because the wave length associated with them is very small and beyond the scope of any measurement.

In the sub- atomic world, masses of the particles are extremely small leading to a wave length that is measurable.

9* Show that Bohr's second postulate 'the electron revolves around the nucleus only in certain fixed orbits without radiating energy can be explained on the basis of de Broglie hypothesis of wave nature of electron. 2

Ans. The de Broglie wavelength for electron in orbit $mvr = nh/ 2\pi$

This is Bohr's second postulate. As complete de-Broglie wavelength may be in certain fixed orbits, non-radiating electrons can be only in certain fixed orbits.

10* The de-Broglie wavelength associated with an electron accelerated through a potential difference V is λ. What will be the de-Broglie wavelength when the accelerating p.d. is increased to 4V? 2

$$\lambda \ \alpha \ \frac{1}{\sqrt{V}}, \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}} = \frac{\lambda}{\lambda_2} = \sqrt{\frac{4}{1}} \Rightarrow \ \lambda_2 = \frac{\lambda}{2}$$

11 Determine the accelerating potential required for an electron to have a de-Broglie wavelength of 1 Å 2

Ans: V = 150.6 V

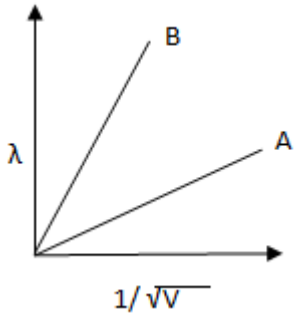
12 An electron, an alpha particle and a proton have the same kinetic energy, which one of these particles has (i) the shortest and (ii) the largest, de, Broglie wavelength? 2

Ans:

$$\lambda = \frac{h}{\sqrt{2mE_k}} \ \alpha \ \frac{1}{\sqrt{m}}$$

13 The two lines A and B shown in the graph plot the de-Broglie wavelength λ as function of 1/ √V (V is the accelerating potential) for two particles having the same charge. Which of the two represents the particle of heavier mass?

3



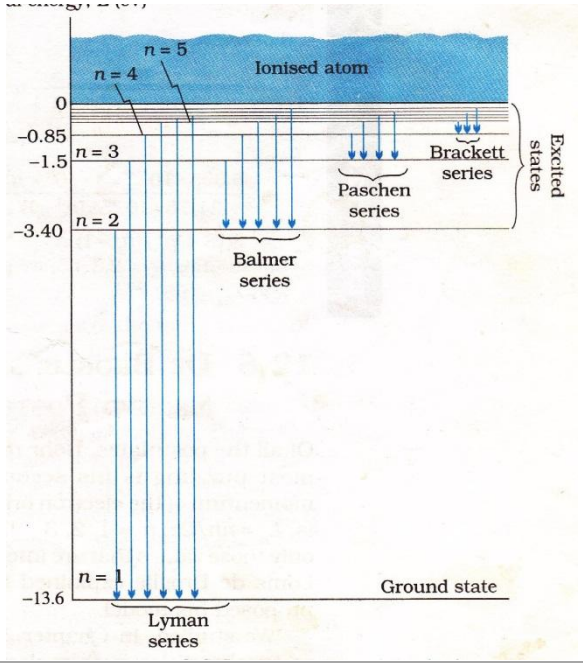
Ans: Slope of the graph is h/√2me.
Slope of A is smaller, so A represents heavier particle.

14* Find the ratio of de-Broglie wavelength of molecules of Hydrogen and Helium which are at temperatures 27^0C and 127^0C respectively. 3

Ans: de- Broglie wavelength is given by $\lambda_{H2} / \lambda_{He} = \sqrt{(m_{He} T_{He}/m_H T_H} = \sqrt{(8/3)}$

8. ATOMS & NUCLEI

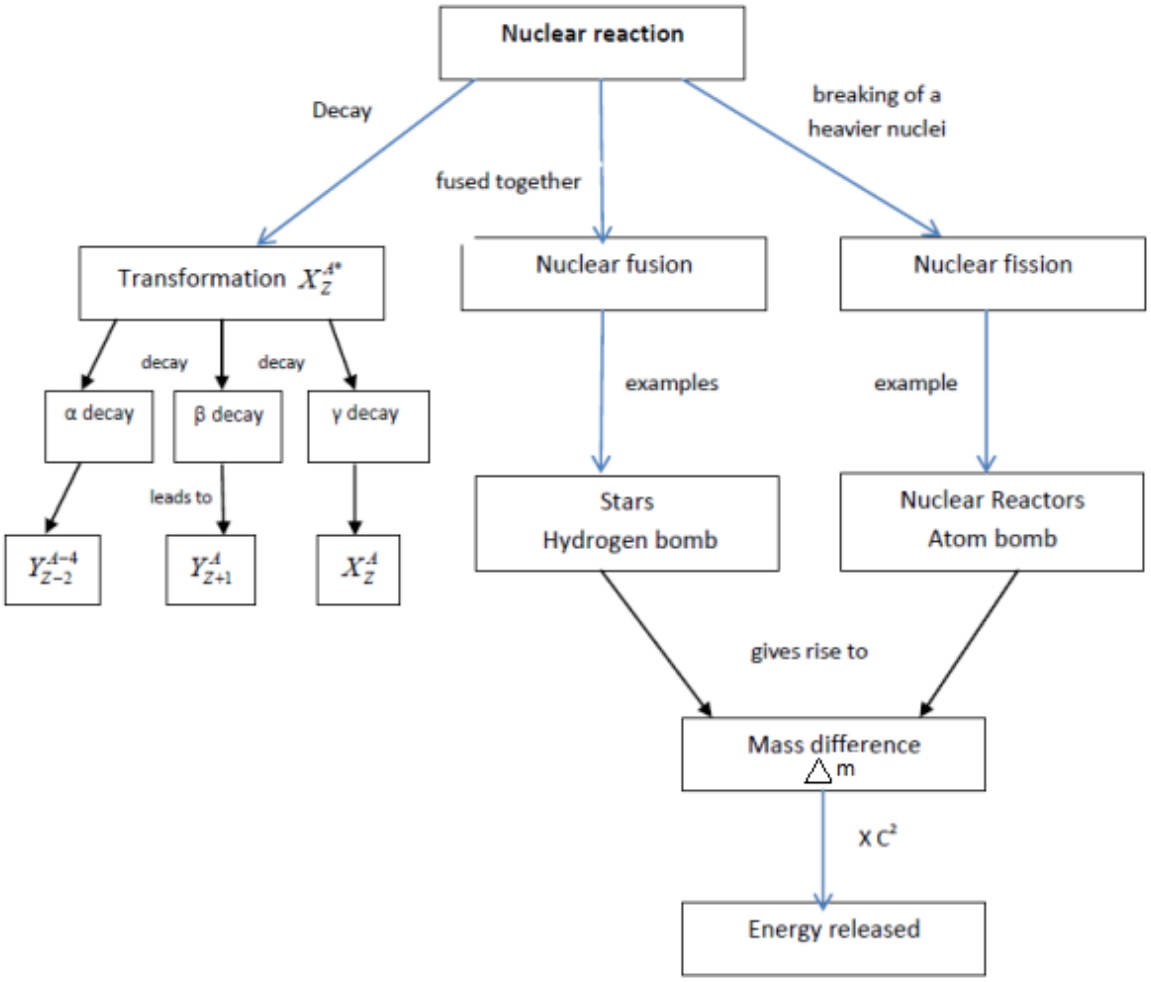
GIST	
Thomson's model of atom- Every atom consists of fuels charged sphere in which electrons are embedded like seeds in water melon.	Its drawbacks: couldn't explain large angle scattering & the origin of spectral series.
Rutherford's model of atom- i) Every atom consists of a tiny central core, called the atomic nucleus, in which the entire positive charge and almost entire mass of the atom are concentrated. ii) The size of nucleus is of the order of 10^{-15}m , which is very small as compared to the size of the atom which is of the order of 10^{-10}m. iii)The atomic nucleus is surrounded by certain number of electrons. As atom on the whole is electrically neutral, the total negative charge of electrons surrounding the nucleus is equal to total positive charge on the nucleus. iv)These electrons revolve around the nucleus in various circular orbits as do the planets around the aun. The centripetal force required by electron for revolution is provided by the electrostatic force of attraction between the electrons and the nucleus.	Limitations: couldn't explain the stability of the nucleus & the emission of line spectra of fixed frequencies.
Distance of closest approach of the alpha particle in the α particle scattering experiment	$r_0=\frac{2kZe^2}{1/2mv^2}$
Impact parameter of the alpha particle	$b=\frac{kZe^2\cot\theta/2}{1/2mv^2}$
Bohr's model of atom	Limitations-applicable only for hydrogen like atoms & couldn't explain the splitting of spectral lines. (not consider electro static force among the electrons)
Orbit radius of the electron around the nucleus	$r=e^2/4\pi\epsilon_0 mv^2$, $v=2\pi ke^2$ / nh, $r=n^2h^2mke^2$
Energy of the electron in the nth orbit of hydrogen atom	$E_n= -me^4/8\epsilon_0^2n^2h^2 = -13.6/n^2$ eV $E=-2.18*10^{-18}$ J / n^2
• Angular momentum of electron in any orbit is	$L = mvr = nh/2\pi$, n=1,2,3,…

integral multiple of h/2π	
• Wave number $\bar{\nu}$ 	$1/\lambda = R(1/n_1^2 - 1/n_2^2)$ $R=1.097 * 10^{+7} m^{-1}$
Atomic Number (Z)	No of protons in a nucleus
Mass Number (A) Number of neutrons	No. of nucleons(protons + neutrons) in a nucleus A-Z
Nuclear radius	$R=R_0 A^{1/3}$
Nuclear density	$P= 3m/4\pi R_0^3$
Isotopes	Same Z & different A Ex, $^1H_2$,$^1H_3$,$^1h_1$, & C^{12},C^{14},C^{16}
Isobars	Same A & different Z [$_{18}Ar^{40}$,$_{20}Co^{40}$] & ($_1H^3$, $_2H^3$)
Isotones Map defect Δ m	Same no. of neutrons Mass of neutrons – $_1H^3$, $_2He^4$
Binding energy E_b	$E= \Delta$ m x Δ^2 (m= mass of reactants – mass of products) 1 a.m.u.= 931.5 Mev
Radioactive decay law	dN/dt=-λN -dW/dt= R= Activity unit Bq.
No: of nuclei remaining un-decayed at any instant of time	$N =N_0e^{-\lambda t}$ OR $N=N_0(\frac{1}{2})^n$, $n = t/t_{1/2}$
Half life	$t_{1/2}=\frac{0.693}{\lambda}$
Mean life	$\tau= 1/\lambda$
3 types of radiations	Alpha,beta,gamma

Nuclear fission	Splitting of a heavy nucleus into lighter elements.This process is made use of in Nuclear reactor & Atom bomb Nuclear Reactor is based upon controlled nuclear chain reaction and has 1) Nuclear fuel 2) modulator 3) control rods 4) coolant 5) shielding
Nuclear fusion	Fusing of lighter nuclei to form a heavy nucleus.This process takes place in Stars & Hydrogen bomb. <u>Controlled Thermonuclear Fusion</u> In a fusion reactor- a) high particle density is required b) high plasma temperature of 10^9K c) a long confinement time is required

CONCEPT MAP

Nuclear energy



QUESTIONS

ALPHA PARTICLE SCATTERING

1. What is the distance of closest approach when a 5Mev proton approaches a gold nucleus (Z=79) (1)

Ans $r_{0=} \frac{1}{4\pi\varepsilon \circ} \frac{Ze^2}{F_2}$ = 2.3 * 10^{-14}m.

2. Which has greater ionizing power: alpha or beta particle? (1)

BOHR'S ATOMIC MODEL

1. In Bohr's theory of model of a Hydrogen atom, name the physical quantity which equals to an integral multiple of h/2∏? (1)

***Ans**: Angular momentum*

2. What is the relation between 'n' & radius 'r' of the orbit of electron in a Hydrogen atom according to Bohr's theory? (1)

***Ans**: r α n^2*

3. What is Bohr's quantization condition? (1)

*4. For an electron in the second orbit of hydrogen, what is the moment of linear momentum as per the Bohr's model? (2)

***Ans**: L=2(h/2∏) =h/∏ (moment of linear momentum is angular momentum)*

5. Calculate the ratio of energies of photons produced due to transition of electron of hydrogen atoms from 2nd level to 1st and highest level to second level. (3)

E_{2-1} = Rhc[$1/n_1^2 - 1/n^2$] = ¾ Rhc

E∞ - E1 = Rhc($1/2^2 - 1/\infty$) = Rhc / 4

SPECTRAL SERIES

*1. What is the shortest wavelength present in the Paschen series of hydrogen spectrum? (2)

***Ans**: n_1=3, n_2=infinity, λ=9/R=8204Å*

2. Calculate the frequency of the photon which can excite an electron to -3.4 eV from -13.6 eV.

***Ans**: 2.5x10^{15}Hz* (2)

3. The wavelength of the first member of Balmer series in the hydrogen spectrum is 6563Å.Calculate the wavelength of the first member of Lyman series in the same spectrum.

***Ans**: 1215.4Å* (2)

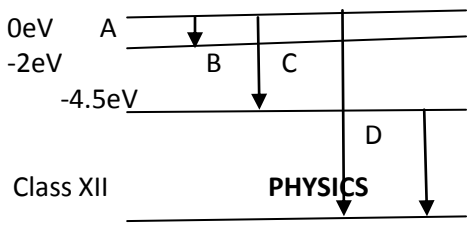
4. The ground state energy of hydrogen atom is -13.6eV.What is the K.E & P.E of the electron in this state? (2)

***Ans**: K.E=-E=13.6 eV, P.E=-2K.E=-27.2 eV*

*5. Find the ratio of maximum wavelength of Lyman series in hydrogen spectrum to the maximum wavelength in Paschen Series? (2)

***Ans**: 7:108*

*6. The energy levels of an atom are as shown below. a) Which of them will result in the transition of a photon of wavelength 275 nm? b) Which transition corresponds to the emission of radiation maximum wavelength? (3)



-10eV

***Ans**: E=hc/λ=4.5eV, transition B Eα1/λ, transition A*

*7. The spectrum of a star in the visible & the ultraviolet region was observed and the wavelength of some of the lines that could be identified were found to be 824Å,970Å,1120Å,2504Å,5173Å &6100Å.Which of these lines cannot belong to hydrogen spectrum? (3)

***Ans**: 970Å*

(3)

9. What is the energy possessed by an ē for n=∞ ?

Ans E=0 (1)

10. Calculate the ratio of wavelength of photon emitted due to transition of electrons of hydrogen atom from

i) Second permitted level to first level

ii) Highest permitted level to second level (3)

11. The radius of inner most electron orbit of H_2 atom is 5.3 x 10^{-11}m. What are radii for n=2, 3, 4? (3)

Ans: $r_n = n^2 r_1$

COMPOSITION OF NUCLEUS

1. What is the relation between the radius of the atom & the mass number? (1)

***Ans**: size α $A^{1/3}$*

2. What is the ratio of the nuclear densities of two nuclei having mass numbers in the ratio 1:4?

***Ans**: 1:1* (1)

3. How many electrons, protons & neutrons are there in an element of atomic number (Z) 11& mass number (A) 24? (1)

Hint: $n_e = n_p = 11$, $n_n = (A - Z) = 24 - 11 = 13$

4. Select the pairs of isotopes & isotones from the following: (2)

i. $^{13}C_6$ ii.$^{14}N_7$ iii.$^{30}P_{15}$ iv. $^{31}P_{15}$

***Ans**: isotopes-iii &iv ,isotones-i& ii*

5. By what factor must the mass number change for the nuclear radius to become twice? (2)

$\sqrt[3]{2}$ *or* $2^{\frac{1}{3}}$ *time A*

NUCLEAR FORCE & BINDING ENERGY.

1. What is the nuclear force? Mention any two important properties of it.

(2)

2. Obtain the binding energy of the nuclei $^{56}Fe_{26}$ &$^{209}Bi_{83}$ in MeV from the following data: m_H=1.007825amu,m_n=1.008665amu, m($^{56}Fe_{26}$)=55.934939amu, m(^{209} Bi $_{83}$)=208.980388amu, 1amu=931.5MeV

3. Which nucleus has the highest binding energy per nucleon? (3)

***Ans**: Fe →492.26MeV,8.79MeV/A Bi →1640.3MeV,7.85 MeV*

Hence$^{56}Fe_{26}$

4. From the given data, write the nuclear reaction for α decay of $^{238}_{92}U$ and hence calculate the energy released. $^{238}_{.92}U$ = 238.050794u $^{4}_{2}He$ = 4.00260u $^{234}_{90}Th$ = 234.04363u (3)

5Binding Energy of $_8O^{16}$ & $_{17}C^{35}$ one 127.35 Mev and 289.3 Mev respectively. Which of the two nuclei is more stable stability & BE/N? (2)

RADIOACTIVITY

1. How is a β particle different from an electron? (1)

2. Draw graph between no. of nuclei un-decayed with time for a radioactive substance (1)

3. Among the alpha, beta & gamma radiations, which are the one affected by a magnetic field? (1)

***Ans**: alpha & beta*

4. Why do α particles have high ionizing power? (1)

***Ans**: because of their large mass & large nuclear cross section*

5. Write the relationship between the half life & the average life of a radioactive substance. (1)

***Ans**: $T = 1.44 t_{1/2}$*

6. If 70% of a given radioactive sample is left un-decayed after 20 days, what is the % of original sample will get decayed in 60 days? (2)

7. How does the neutron to proton ratio affected during (i)β decay ii) α decay (2)

8. A radioactive sample having N nuclei has activity R. Write an expression for its half life in terms of R & N. (2)

***Ans**: $R=N\lambda$, $t_{1/2}=0.693/\lambda = 0.693N/R$*

9. Tritium has a half life of 12.5 years against beta decay. What fraction of a sample of pure tritium will remain un-decayed after 25 years? (2)

***Ans**: $N_0/4$*

10. What percentage of a given mass of a radioactive substance will be left un-decayed after 5 half-life periods? (2)

***Ans**: $N/N_0 = 1/2^n = 1/32 = 3.125\%$*

11. A radioactive nucleus 'A' decays as given below:

$$A \xrightarrow{\beta} A_1 \xrightarrow{\gamma} A_2$$

If the mass number & atomic number of A_1 are 180 & 73 respectively, find the mass number & atomic number of A & A_2 (2)

***Ans**: A—180 & 72, A2—176 & 71*

12. Two nuclei P & Q have equal no: of atoms at t=0.Their half lives are 3 & 9 hours respectively. Compare the rates of disintegration after 18 hours from the start. (2)

***Ans**: 3:16*

*13. Two radioactive materials X_1& X_2 have decay constants 10λ & λ respectively. If initially they have the same no: of nuclei, find the time after which the ratio of the nuclei of X_1 to that of X_2 will be 1/e?

Ans: $N=N_0e^{-\lambda t}$, $t=1/9\lambda$ (3)

*14. One gram of radium is reduced by 2.1mg in 5 years by decay. Calculate the half-life of Uranium.

***Ans:** 1672 years* (3)

*16. At a given instant there are 25% un-decayed radioactive nuclei in a sample. After 10 seconds the number of un-decayed nuclei reduces to 12.5 %.calculate the i) mean life of the nuclei ii) the time in which the number of the un-decayed nuclei will further reduce to 6.25 % of the reduced number.

***Ans**: $t_{1/2}=10s$, $\lambda=.0693/s$, $\tau=1/\lambda=14.43s$, $N=1/16(N_0/8) \rightarrow t=4x10=40s$* (3)

17. Half lives of two substances A and B are 20 min and 40 min respectively. Initially the sample had equal no of nuclei. Find the ratio of the remaining no: of nuclei of A and B after 80 min.

***Ans*:** 1:4 (3)

<u>NUCLEAR REACTIONS</u>

1. Why heavy water is often used in a nuclear reactor as a moderator? (1)

2. Why is neutron very effective as a bombarding particle in a nuclear reaction? (1)

***Ans**: Being neutral it won't experience any electrostatic force of attraction or repulsion.*

3. Why is the control rods made of cadmium? (1)

***Ans**: They have a very high affinity on neutrons.*

4. Name the phenomenon by which the energy is produced in stars. (1)

***Ans**: Uncontrolled Nuclear fusion*

5. Name the physical quantities that remain conserved in a nuclear reaction? (1)

6. What is neutron multiplication factor? For what value of this, a nuclear reactor is said to be critical?

Ans: K=1 (2)

7. 4 nuclei of an element fuse together to form a heavier nucleus .If the process is accompanied by release of energy, which of the two: the parent or the daughter nuclei would have higher binding energy per nucleon. Justify your answer. (2)

8. If 200MeV energy is released in the fission of single nucleus of $^{235}_{92}U$, how much fission must occur to produce a power of 1 kW. (3)

9. ELECTRONIC DEVICES

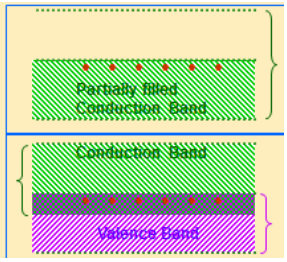
GIST

ENERGY BAND DIAGRAMS

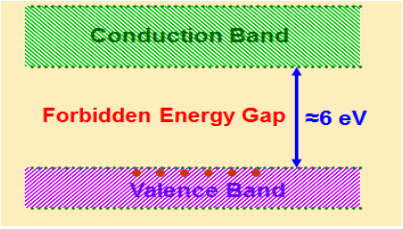
- In metals, the conduction band and valence band partly overlap each other and there is no forbidden energy gap.

- In insulators, the conduction band is empty and valence band is completely filled and forbidden gap is quite large = 6 eV. No electron from valence band can cross over to conduction band at room temperature, even if electric field is applied. Hence there is no conductivity of the insulators.

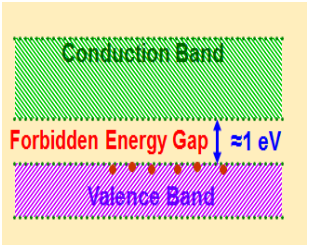
- In semiconductors, the conduction band is empty and valence band is totally filled. But the forbidden gap between conduction band and valence band is quite small, which is about 1 eV. No electron from valence band can cross over to conduction band. Therefore, the semiconductor behaves as insulator. At room temperature, some electrons in the valence band acquire thermal energy, greater than energy gap of 1 eV and jump over to the conduction band where they are free to move under the influence of even a small electric field. Due to which, the semiconductor acquires small conductivity at room temperature



Metals



Insulators



Semiconductors

Differences

Distinction between Intrinsic and Extrinsic Semiconductor

Intrinsic		Extrinsic	
1	It is pure semiconducting material and no impurity atoms are added to it	1	It is prepared by doping a small quantity of impurity atoms to the pure semiconducting material.
2	Examples are crystalline forms of pure silicon and germanium.	2	Examples are silicon and germanium crystals with impurity atoms of arsenic, antimony, phosphorous etc. or indium, boron, aluminum etc.
3	The number of free electron in conduction band and the number of holes in valence band is exactly equal and very small indeed.	3	The number of free electrons and holes is never equal. There is excess of electrons in n-type semiconductors and excess of holes in p-type semiconductors.
4	Its electrical conductivity is low	4	Its electrical conductivity is high.
5	Its electrical conductivity is a function of temperature alone.	5	Its electrical conductivity depends upon the temperature as well as on the quantity of impurity atoms doped in the structure.

Distinction between n-type and p-type semiconductors

n-type semiconductors		p-type semiconductors	
1	It is an extrinsic semiconductors which is obtained by doping the impurity atoms of Vth group of periodic table to the pure germanium or silicon semiconductor.	1	It is an intrinsic semiconductors which is obtained by doping the impurity atoms of III group of periodic table to the pure germanium or silicon semiconductor.
2	The impurity atoms added, provide extra electrons in the structure, and are called donor atoms.	2	The impurity atoms added, create vacancies of electrons (i.e. holes) in the structure and are called acceptor atoms.
3	The electrons are majority carriers and holes are minority carriers.	3	The holes are majority carriers and electrons are minority carriers.
4	The electron density (n_e) is much greater than the hole density (n_h)i.e. $n_e >> (n_h)$	4	The hole density (n_e) is much greater than the electron density (n_h)i.e. $n_h >> n_e$
5	The donor energy level is close to the conduction band and far away from valence band.	5	The acceptor energy level is close to valence band and is far away from the conduction band.
6	The Fermi energy level lies in between the donor energy level and conduction band.	6	The Fermi energy level lies in between the acceptor energy level and valence band.

P-n junction diode

Two important processes occur during the formation of p-n junction diffusion and drift.

the motion of majority charge carriers give rise to diffusion current.

Due to the space charge on n-side junction and negative space charge region on p-side the electric field is set up and potential barrier develops at the junction Due to electric field e- on p-side moves to n and holes from n-side to p-side which is called drift current.

In equilibrium state, there is no current across p-n junction and potential barrier across p-n junction has maximum value .

The width of the depletion region and magnitude of barrier potential depends on the nature of semiconductor and doping concentration on two sides of p-n junction –

Forward Bias

P-n junction is FB when p-type connected to the +ve of battery and n-type connected to –ve battery

Potential barrier height is reduced and width of depletion layer decreases.

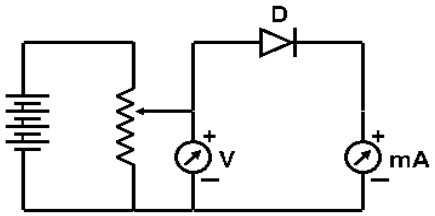
Reverse Bias

P-n junction in RB p-type connected to the –ve battery and n-type connected to +ve

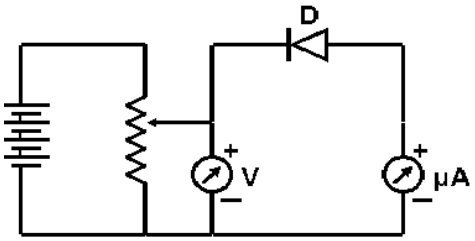
Resistance of p-n junction is high to the flow of current.

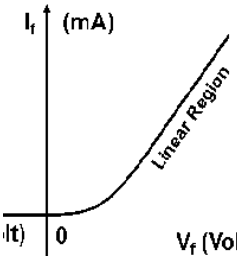
Diode Characteristics:

Forward Bias:

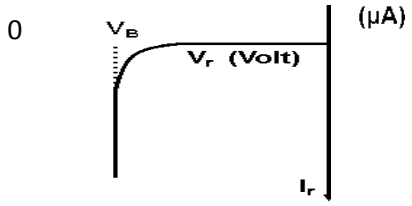


Reverse Bias:



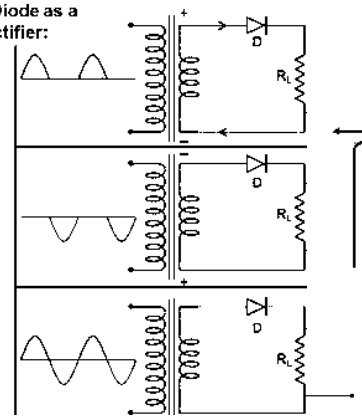


Rectification



I_f (mA)

PN Junction Diode as a Half Wave Rectifier:

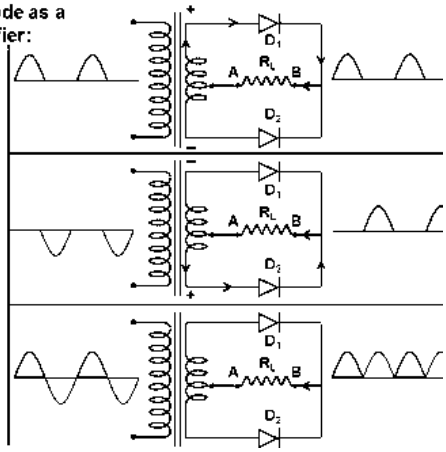


The process of conversion of alternating current into direct current is called **rectification**

The device used for rectification is called 'rectifier'.

The p-n junction diode offers low resistance in forward bias and high resistance in reverse bias.

PN Junction Diode as a Full Wave Rectifier:

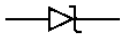


When a diode rectifies both the half cycles of the AC wave it is called **full wave rectifier**.

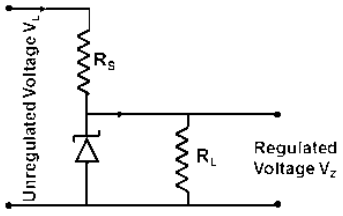
During the positive half cycle of the input ac signal, the diode D_1 conducts and current is through BA.

During the negative half cycle, the diode D_2 conducts and current is through **BA**.

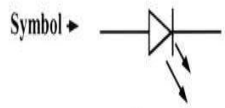
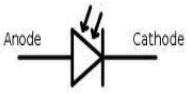
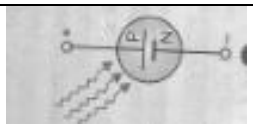
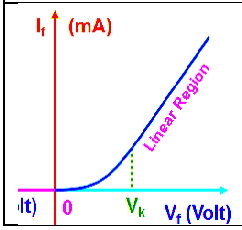
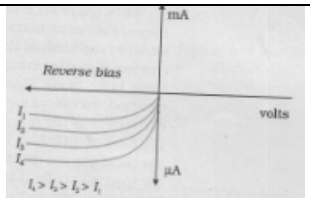
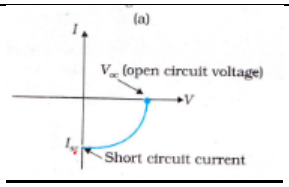
Zener Diode



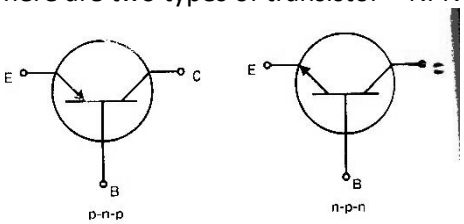
- Heavily doped
- Depletion Region is $< 10^{-6}$ m
- Electric Field is very high (5×10^{6} V/m)
- Reverse biased
- Internal Field emission or field ionisation



Zener Diode as a Voltage Regulator

LED	PHOTODIODE	SOLARCELL
		
Forward biased	Reverse biased	No external baising,It generates emf when solar radiation falls on it.
Recombination of electrons and holes take place at the junction and emits e m radiations	Energy is supplied by light to take an electron from valence band to conduction band.	Generation of emf by solar cells is due to three basic process generation of e-h pair,separation and collection
It is used in Burglar alarm, remote control	It is used in photo detectors in communication	It is used in satellites,space vechicles calculators.
		

- There are two types of transistor – NPN & PNP



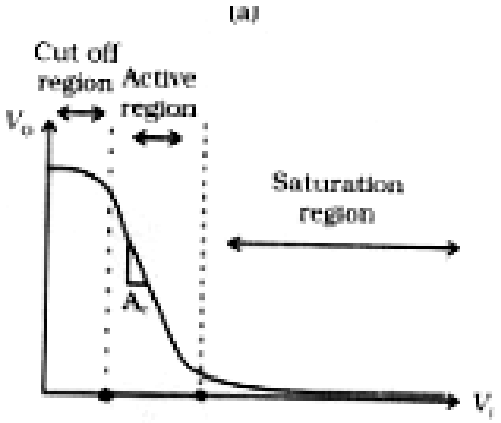
- Applications of transistor

(1) Transistor as a switch- (2) Transistor as an amplifier

- Transistor as an oscillator

Transistor- Switch

When a transistor is used in cut off or saturated state, it behaves as a switch.



Transistor-Amplifier_ An amplifier is a device which is used for increasing the amplitude of variation of alternating voltage or current or power,thus it produces an enlarged version of the input signal. For Circuit diagram refer Ncert diagram

Common emitter amplifier

Current gain $\beta_{a.c} = \frac{\Delta I_C}{\Delta I_B}$

$\beta_{d.c} = \frac{I_C}{I_B}$

Voltage gain $A_v = \frac{V_o}{V_i} = -\beta_{ac} \times \frac{R_o}{R_i}$

Power gain $A_p = \frac{P_o}{P_i} = \beta_{ac} \times A_v$

Transistor-Oscillator-

- In an oscillator, we get ac output without any external input signal. In other words, the output in an oscillator is self- sustained. Oscillator converts D.C into A.C

Digital Electronics –Logic Gates

- The three basic Logic Gates are

(1) OR Gate

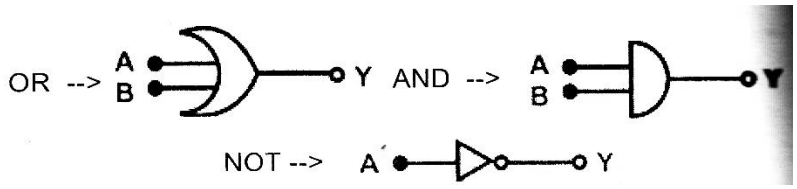
OUTPUT Y= A + B

(2) AND Gate

OUTPUT Y=A.B

(3) NOT GATE

OUTPUT Y= $\bar{Y}$

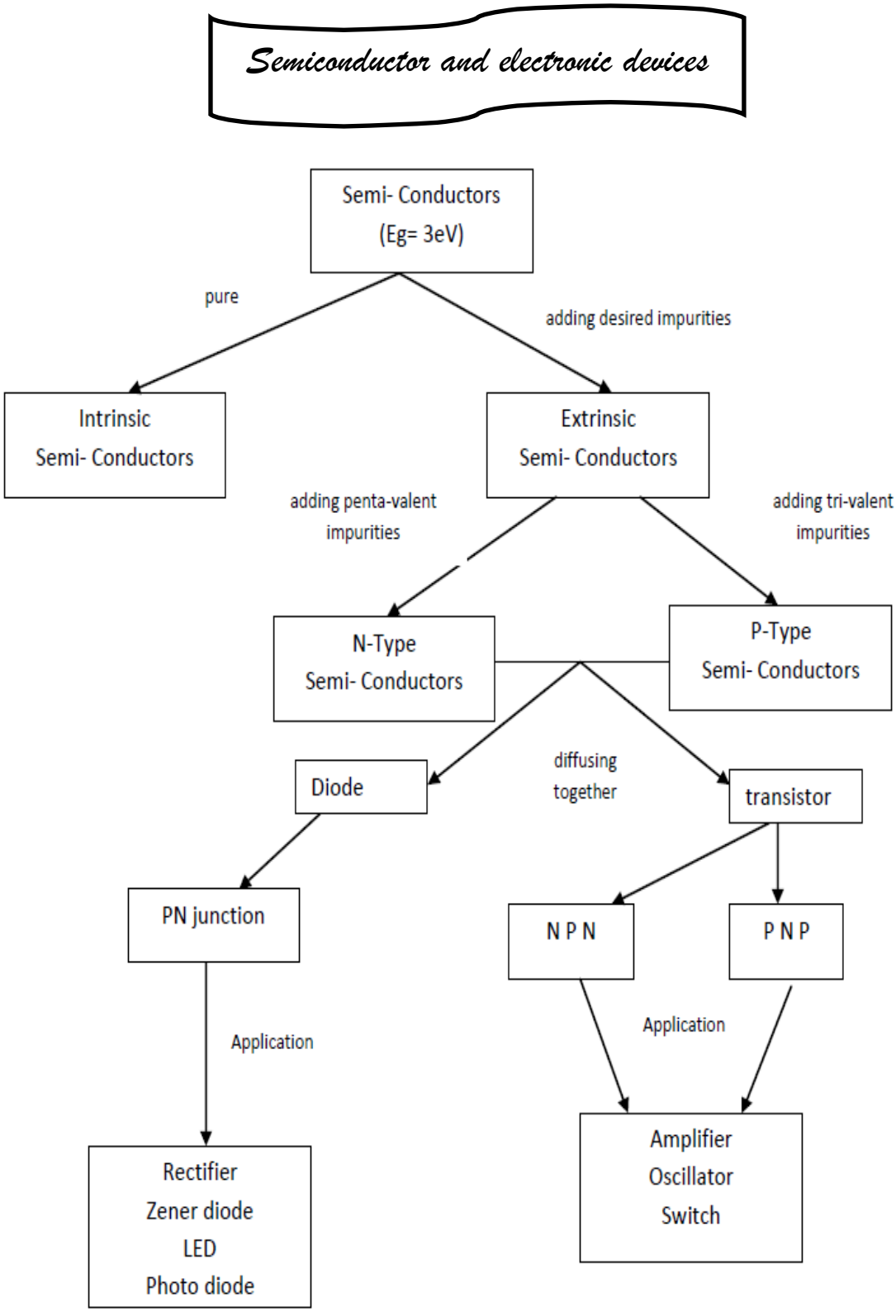


COMBINATION OF GATES

(1) NOR GATE--OUT PUT Y = $\overline{A+B}$

(2) NAND GATE--OUT PUT Y= $\overline{A.B}$

CONCEPT MAP


Semiconductor and electronic devices
Semi- Conductors
(Eg= 3eV)
pure
adding desired impurities
Intrinsic
Semi- Conductors
Extrinsic
Semi- Conductors
adding penta-valent
impurities
adding tri-valent
impurities
N-Type
Semi- Conductors
P-Type
Semi- Conductors
Diode
diffusing
together
transistor
PN junction
N P N
P N P
Application
Application
Rectifier
Zener diode
LED
Photo diode
Amplifier
Oscillator
Switch

QUESTIONS

SEMICONDUCTORS

1. What is the order of energy gap in an intrinsic semiconductor? (1)

2. How does the energy gap vary in a semiconductor when doped with penta -valent element? (1)

3. How does the conductivity change with temperature in semiconductor? (1)

4. What type of semiconductor we get when: Ge is doped with Indium? Si is doped with Bismuth? (1)

5. In a semiconductor concentration of electron is $8 \times 10^{13} cm^{-3}$ and holes $5 \times 10^{12} cm^{-2}$: is it P or N type semiconductor? (1)

6. Draw energy gap diagram of a P Type semiconductor? (1)

7. What is Fermi energy level? (1)

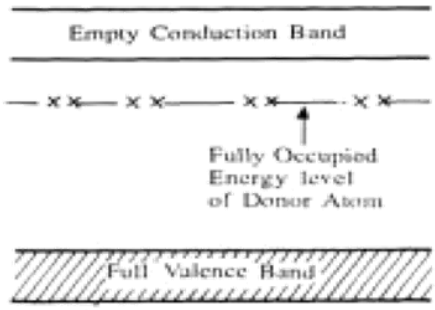
8. Energy gap of a conductor, semiconductor, insulator are E1, E2, E3 respectively. Arrange them in increasing order. (1)

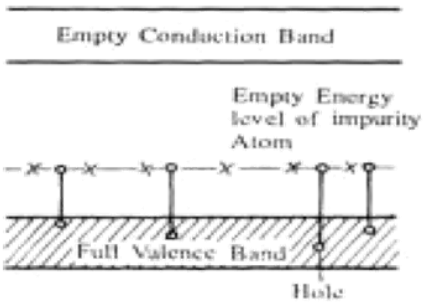
9. Name the factor that determines the element as a conductor or semiconductor? (1)

10. Why semiconductors are opaque to visible light but transparent to infrared radiations? (2)
Ans: The photons of infrared radiation have smaller energies, so they fall to excite the electrons in the valence band. Hence infrared radiations pass through the semiconductors as such; i.e. a semiconductor is transparent to infrared radiation

11. The ratio of number of free electrons to holes n_e/n_h for two different materials A and B are 1 and <1 respectively. Name the type of semiconductor to which A and B belongs. (2)
Ans: If $n_e/n_{h=1}$. Hence A is intrinsic semiconductor. If $n_e/n_h<1$, $n_e<n_h$ hence B is P-type.

12. Differentiate the electrical conductivity of both types of extrinsic semiconductors in terms of the energy band picture. (2)



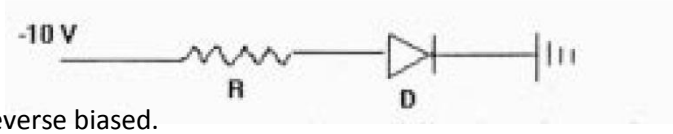


P-N JUNCTION DIODE

1. How does the width of depletion layer change, in reverse bias of a p-n junction diode? (1)

2. Draw VI characteristic graph for a Zener diode? (1)

3. In a given diagram, is the diode reverse (or) forward biased? (1)



Ans: Reverse biased.

4. Why Photo diode usually operated at reverse bias? (2)

5. State the factor which controls wave length and intensity of light emitted by LED. (2)
Ans: (i) Nature of semi-conductor
(ii) Forward Current

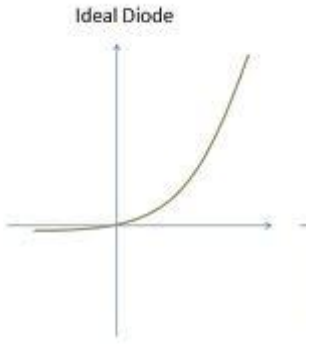
6. With the help of a diagram show the biasing of light emitting diode. Give two advantages over conventional incandescent Lamp. (2)
Ans: Mono chromatic, Consume less power.

8. Draw a circuit diagram to show, how is a photo diode biased? (2)

9. Pure SI at 300K have equal electron and holes concentration 1.5 x 10^{16} per m^3. Doping by Indium increases hole concentration to 4.5 x 10^{22} per m^3. Calculate new electron concentration.

Ans: $n_e n_h = n_i^2$ (2)

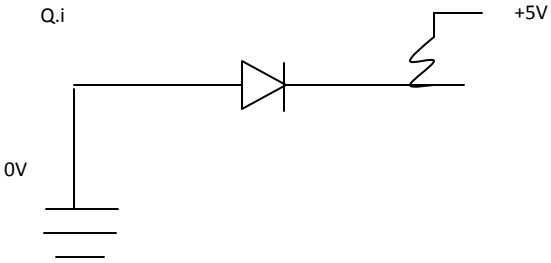
10. V-I characteristics of SI diode is given. Calculate diode resistance for bias voltage 2V. (2)

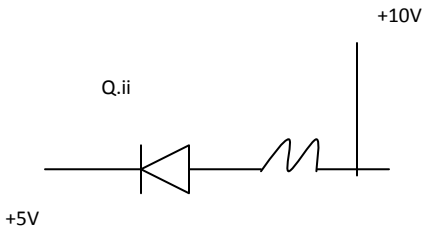


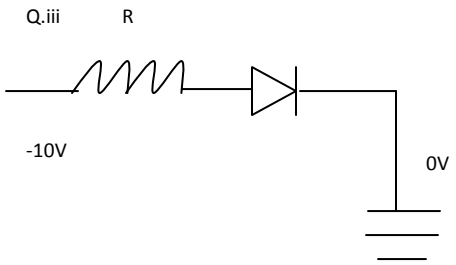
Ans: R = V / I = 2/70 x 10^3 Ohms

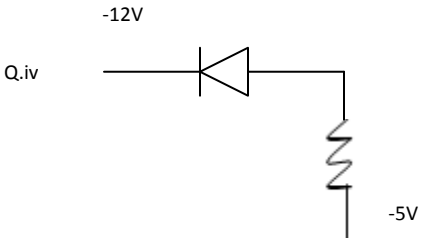
11. What is an ideal diode? Draw its output wave form.

13. In the following diagram, identify the diodes which are in forward biased and which are in reversed biased.









*14. A semiconductor has equal electron and hole concentrations of 6x10^8/m^3. On doping with a certain impurity, the electron concentration increases to 9x10^{12}/ m^3. (2)

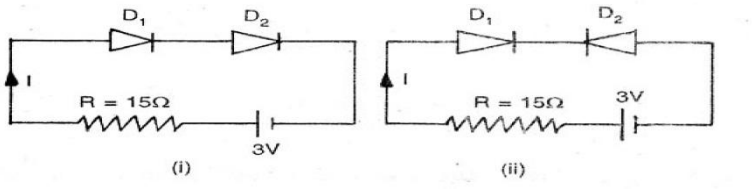
(i) Identify the new semiconductor obtained after doping.

(ii) Calculate the new hole concentrations.

Ans: (i) n-type semiconductor.

(ii) $n_e n_h = n_i^2$ => $n_h = \frac{6x10^8 \, x6x10^8}{} = 4x10^4$ perm^2

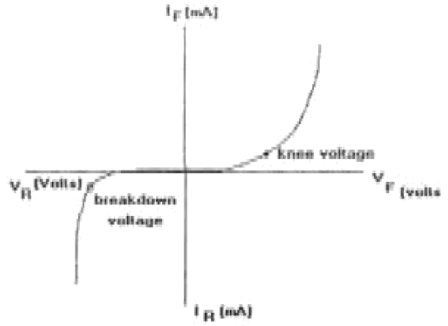
*15. Determine the current through resistance "R" in each circuit. Diodes D1 and D2 are identical and ideal.



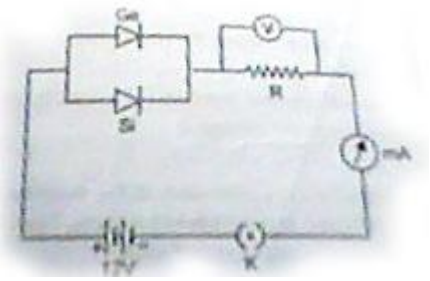
Ans: In circuit (i) Both D1 and D2 are forward biased hence both will conduct current and resistance of each diode is "0".Therefore I = 3/15 = 0.2 A

(iii) Diode D1 is forward bias and D2 is reverse bias, therefore resistance of diode D1 is "0" and resistance of D2 is infinite. Hence D1 will conduct and D2 do not conduct. No current flows in the circuit.

16. From the given graph identify the knee voltage and breakdown voltage. Explain? (2)



*17. Germanium and silicon junction diodes are connected in parallel. A resistance R, a 12 V battery, a milli ammeter (mA) and Key(K) is closed, a current began to flow in the circuit. What will be the maximum reading of voltmeter connected across the resistance R? (2)



Ans: The potential barrier of germanium junction diode is 0.3v and silicon is 0.7V, both are forward biased. Therefore for conduction the minimum potential difference across junction diode is 0.3V.Max.reading of voltmeter connected across R=12-0.3=11.7V.

18.A Zener diode has a contact potential of .8Vin the absence of biasing .It undergoes breakdown for an electricfield of 10V/m at the depletion region of p-n junction.If the width of the depletion region is 2.4μm?What should be the reverse biased potential for the Zener breakdown to occur? 2

*18. A germanium diode is preferred to a silicon one for rectifying small voltages. Explain why? (2)

Ans: Because the energy gap for Ge (Eg = 0.7 ev) is smaller than the energy gap for Si (Eg = 1.1eV) or barrier potential for Ge<Si.

19. On the basis of energy band diagrams, distinguish between metals, insulators and semiconductors. (3)

SPECIAL DEVICES

*1. A photodiode is fabricated from a semiconductor with a band gap of 2.8eV.can it Can it detect a wavelength of 600nm?Justify? (2)

Ans: Energy corresponding to wavelength 600 nm is

$E=hc/\lambda = \frac{6.6\times10^{-34} \times 3\times10^{8}}{600\times10^{-9}}$ joule = 0.2eV.

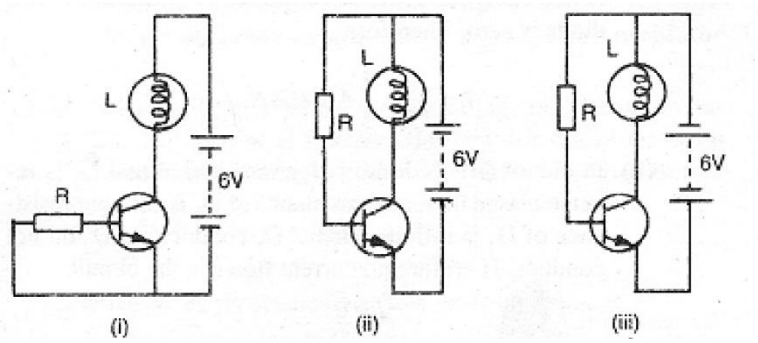
It cannot detect because $E<E_g$

2. Which special type of diode acts as voltage regulator? Give the symbol. Draw its V-I characteristics. (3)

TRANSISTORS

1. How does the dc current gain of a transistor change, when the width of the base region is increased? (1)

*2. In only one of the circuits given below, the lamp "L" glows. Identify the circuit? Give reason for your answer? (2)



Ans: In fig (i) emitter –base junction has no source of emf. Therefore Ic =0, bulb will not glow. In fig (ii) emitter – base junction is forward biased; therefore lamp "L" will glow.
(iii) emitter – base junction is received biased so the bulb will not glow.

*3. Why do we prefer NPN transistor to PNP for faster action? (2)

Ans: For faster action NPN Transistor is used. In an NPN transistor, current conduction is mainly by free electron, whereas in PNP type transistor, it is mainly holes. Mobility of electrons is greater than that of holes.

4. In which mode, the cut off, active or saturation, the transistor is used as a switch? Why? (2)

Ans: Cut off & saturation

5. In NPN transistor circuit, the collector current is 5mA. If 95% of the electrons emitted reach the collector region, what is the base current? (2)

Here,

I_c=95% of Ie = (95 / 100) I_e

I_e = (100 / 95) × 5 mA = 5.26mA,

$I_e=I_c+ I_b$

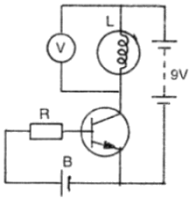
I_b = 0.25 mA

6. A student has to study the input and output characteristics of a n-p-n silicon transistor in the common emitter configuration. What kind of a circuit arrangement should she use for this purpose? Draw the typical shape of input characteristics likely to be obtained by that student.
(Ans: Fig 14.29, pg 493 & 494 NCERT-Part-2 physics

7. Which of input and output circuits of a transistor has a higher resistance and why? (3)

Ans: The output circuit of a transistor has a higher resistance. Hint: The ratio of resistance of output circuit (r_0) is 10^4 times that of input circuit ie $r_o = 10^4 r_i$;

*8. In the circuit diagram given below, a volt meter is connected across a lamp. What changes would occur at lamp "L" and voltmeter "V", when the resistor R is reduced? Give reason for your answer. (3)



Ans: In the given circuit, emitter –base junction of N-P-N transistor is forward biased.

When "R" decreases, I_E increases. Because $I_C = I_E - I_B$. Therefore I_C will also increase. Hence bulb will glow with more brightness and voltmeter reading will increase.

9. The base current of a transistor is 105 μA and collector current is 2.05 mA. (3)

a) Determine the value of β , Ie , and α

b) A change of 27 μA in the base current produces a change of 0.65 mA in the collector current. Find β a.c.

$Ib = 105 \times 10^{-6}$ A $Ic = 2.05 \times 10^{-3}$A

$\beta = Ic / Ib = 19.5$

Also,

$Ie = Ib + Ic = 2.155 \times 10^{-3}$ A

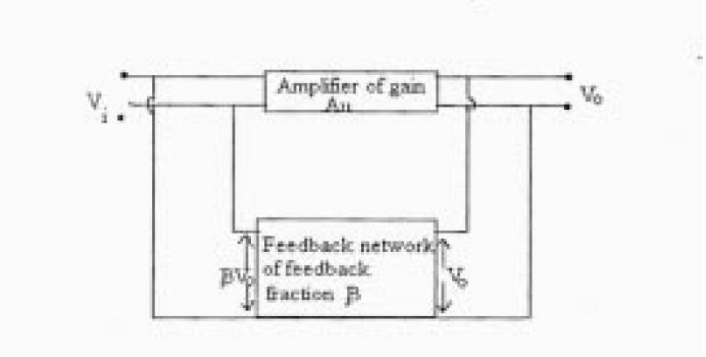
$\alpha = Ic / Ie = 0.95$

$\Delta Ib = 27\mu A = 27 \times 10^{-6}$ A

$\beta^{ac} = \Delta Ic / \Delta Ib = 24.1$

10. Under what conditions an amplifier can be converted in to an oscillator? Draw a suitable diagram of an oscillator. (3)

Hint: 1. when feedback is positive. 2. When feedback factor k is equal to l / A_v.



11. Explain through a labeled circuit diagram, working of a transistor, as an amplifier in common emitter configuration. Obtain the expression for current gain, voltage gain and power gain. (3)

12. Draw a circuit diagram to study the input and output characteristic of an NPN transistor in common emitter configuration. Draw the graphs for input and output characteristics. (3)

13. Define trans conductance of a transistor. (2)

Ans: $g_m = \Delta I_C / \Delta V_B$

14. How does the collector current change in junction transistor if the base region has larger width?

Ans: Current decreases. (2)

15. The input of common emitter amplifier is 2KΩ. Current gain is 20. If the load resistances is

5KΩ. Calculate voltage gain trans conductance. (3)

16. Define input, output resistance, current amplification factor, voltage amplification factor, for common emitter configuration of transistor. (3)

17. A change 0.2 mA in base current, causes a change of 5mA in collector current in a common emitter amplifier.

(i) Find A.C current gain of Transistor.

(ii) If input resistance 2KΩ and voltage gain is 75. Calculate load resistance used in circuit.

β AC current gain = β **ΔIc / Δ Ib** **(3)**

19. In a transistor the base current is changed by 20μa. This results in a change of 0.02V in base emitter voltage and a change of 2ma in collector current. (3)

(i) Find input resistance,

(ii) Trans conductance.

20. With the help of circuit diagram explain the action of a transistor. (3)

21. Draw the circuit diagram to study the characteristic of N-P-N transistor in common emitter configuration. Sketch input – output characteristic for the configuration. Explain current gain, voltage gain. (3)

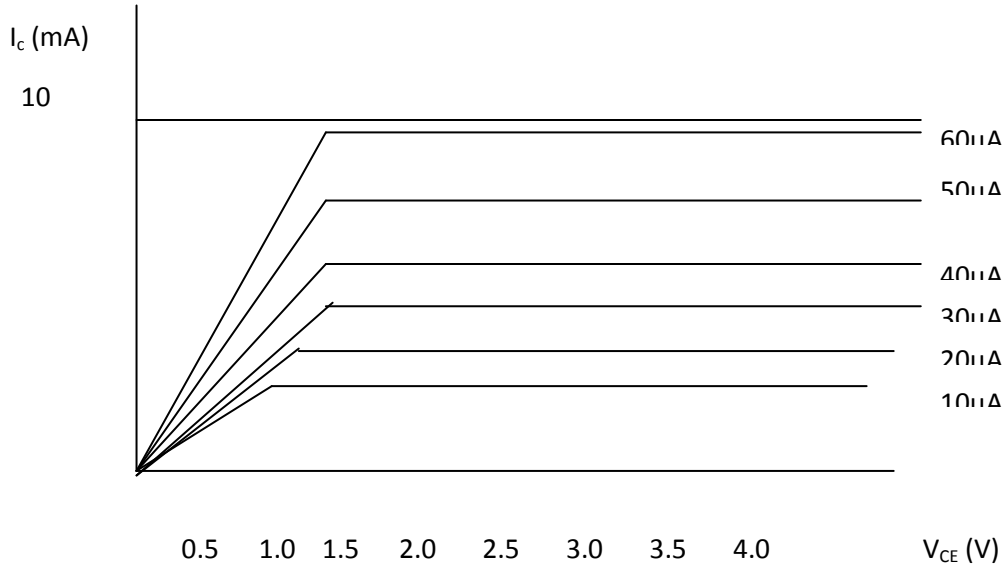
22. Draw the transfer characteristics of a transistor in common emitter configuration. Explain briefly the meaning of the term active region and cut off region in this characteristic. (3)

23. Explain with the help of a circuit diagram the working of N-P-N transistor as a common emitter amplifier. Draw input and output wave form. (3)

24. Draw a labeled circuit diagram of common emitter amplifier using P-N-P transistor. Define voltage gain and write expression. Explain how the input and output voltage are out of phase 180^{o} for common emitter transistor amplifier. (3)

25. The output characteristic of transistor is shown.

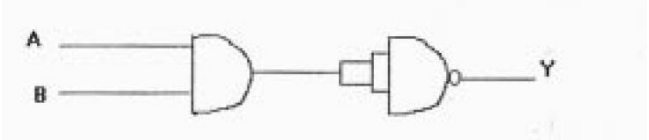
(i) Find current amplification(ii) Output Resistance



LOGIC GATES

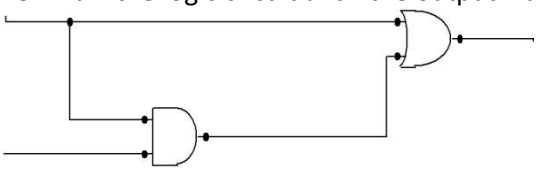
*1. Modern technology use poly silicon instead of metal to form the gate. Why? (1)
Ans: Poly silicon has high conductivity compared to metal.

2. Identify the logic gate; Give its truth table and output wave form? (1)



Ans: NAND GATE.

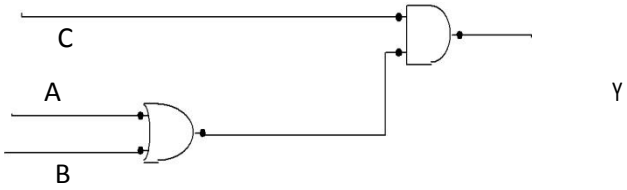
*3. Draw the logic circuit and the output wave form for given output Y=0, 0, 1, 1 (2)



Ans: The output of the AND gate is Y = A.B consequently the input of the OR gate are A and A.B . Then the final Y = A + A.B

Input for AND gate		Output of AND gate	Input of OR gate		output of OR gate
A	B	Y= A.B	A	Y	Y = A + Y
0	0	0	0	0	0
0	1	0	0	0	0
1	0	0	1	0	1
1	1	1	1		1

*4. Construct the truth table for the Boolean equation Y=(A+B).C and represent by logic circuit. (2)



Ans: The output of OR gate is A+B. Consequently, the inputs of AND gate are A+B & C Hence the Boolean equation for the given circuit is Y=(A+B).C

A	B	C	Y'=A+B	Y=(A+B).C=Y'.C
0	0	0	0	0
0	0	1	0	0
0	1	0	1	0
0	1	1	1	1
1	0	0	1	0
1	0	1	1	1
1	1	0	1	0
1	1	1	1	1

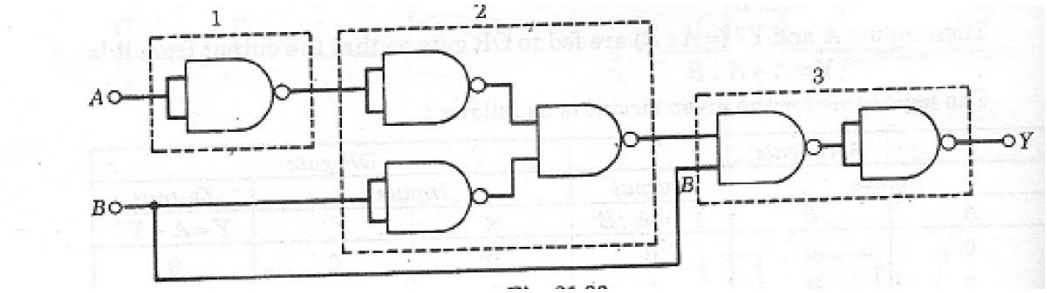
*5. Construct AND gate using NAND GATE and give its truth table? (2)

Ans: AND Gate using NAND GATE:-

A	B	Y= A.B

0	0	0
0	1	0
1	0	0
1	1	1

6. Identify which basic gate OR, AND and NOT is represented by the circuits in the dotted lines boxes 1,2 and 3. Give the truth table for the entire circuit for all possible values of A and B? (3)

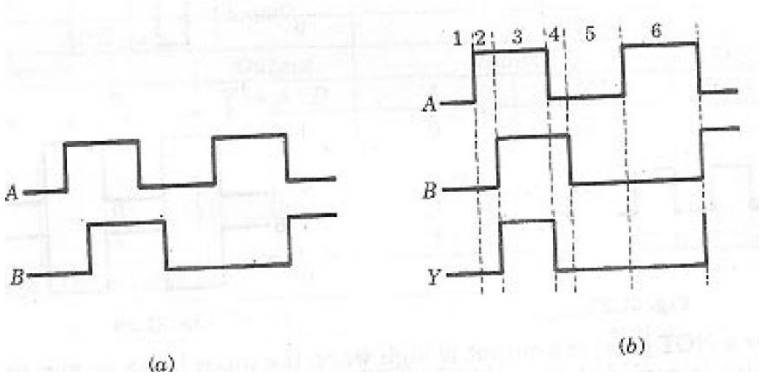


Ans: The dotted line box 1 represents a NOT gate. The dotted line box 2 represents an OR gate.. The dotted line 3 represents AND gate.

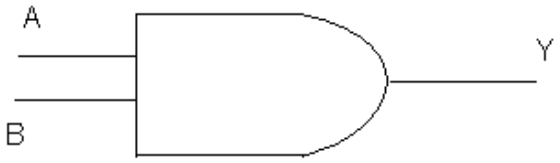
7. Two input waveforms A and B shown in figure (a) and (b) are applied to an AND gate. Write the output (3)

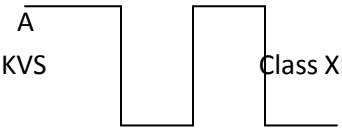
Time interval	1	2	3	4	5	6
Input A	0	1	1	0	0	1
Input B	0	0	1	1	0	0
Output Y = A.B	0	0	1	0	0	0

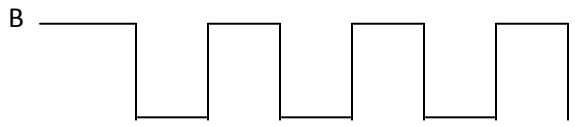
Input waveform.



8. A circuit symbol of a logic gate and two input wave forms A and B are shown.
   a) Name the logic gate
   b) Give the output wave form





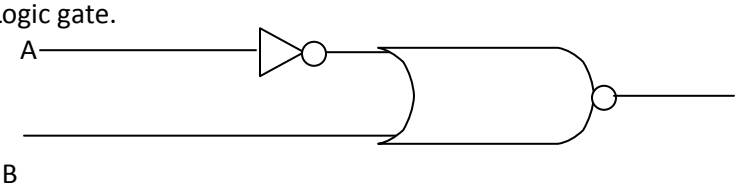


a. Name the logic gate

b. Give the output wave form (3)

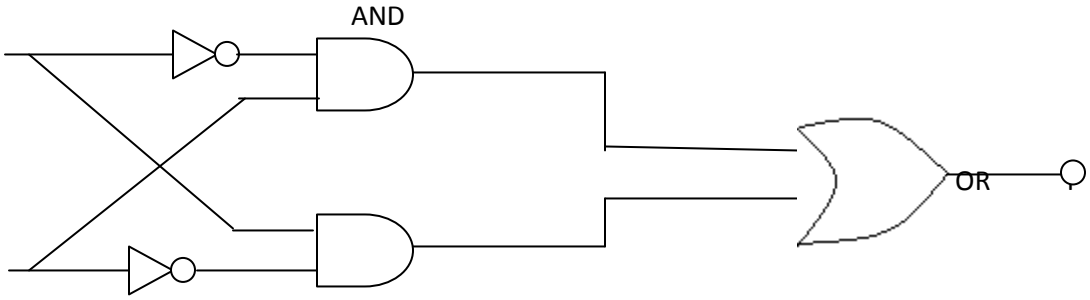
Ans: Current amplifier = **$\Delta Ic / \Delta Ib = 9.5 - 2.5 / 50 \times 10^{-6}$**

1. Identify the Logic gate.



Y = $\overline{\overline{A} + \mathbf{B}}$

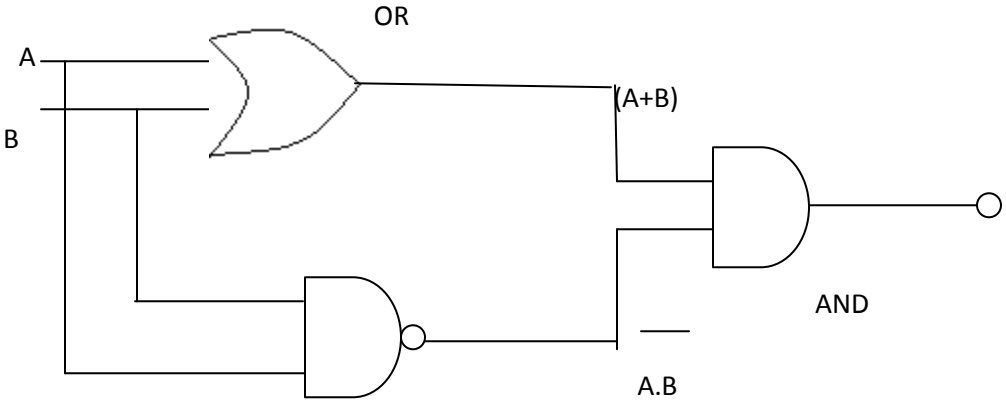
2. Draw the circuit of XOR gate.



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

(3)

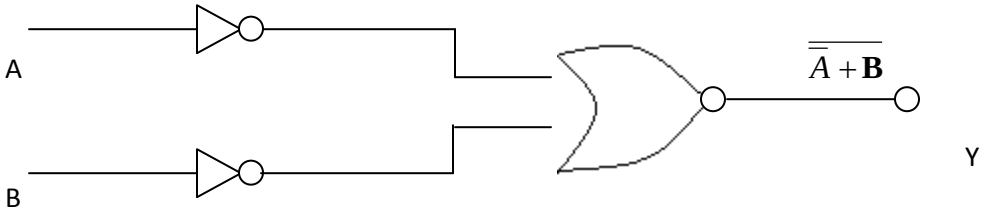
3. Identify the Logic gate



NAND

Ans: Y = (A+B) AB

4. Identify the gate:



Ans: AND Gate

10. COMMUNICATION SYSTEMS

GIST

1. COMMUNICATION

The sending and receiving of message from one place to another is called communication. Two important forms of communication systems are (i) Analog and (ii) digital.

In analog communication the signal is continuous while in digital communication the signal is discrete.

2. THREE BASIC ELEMENTS OF COMMUNICATION

(i) Transmitter (ii) Communication channel (iii) Receiver

3. MODULATION

The superposition of (audio frequency) message signal (20 Hz-20 kHz) over (high frequency) carrier wave (≈ 1MHz) is called modulation.

4. NEED FOR MODULATION:

* Size of antenna h= λ/4 so, for high frequency. Height will be large which is impossible.
* Effective power radiated by an antenna P α $\frac{1}{\lambda^2}$
* Mixing up of signals from different transmitters.

5. TYPES OF MODULATION

There are two broad types of modulation: (i) Continuous wave modulation

(ii) Pulse modulation.

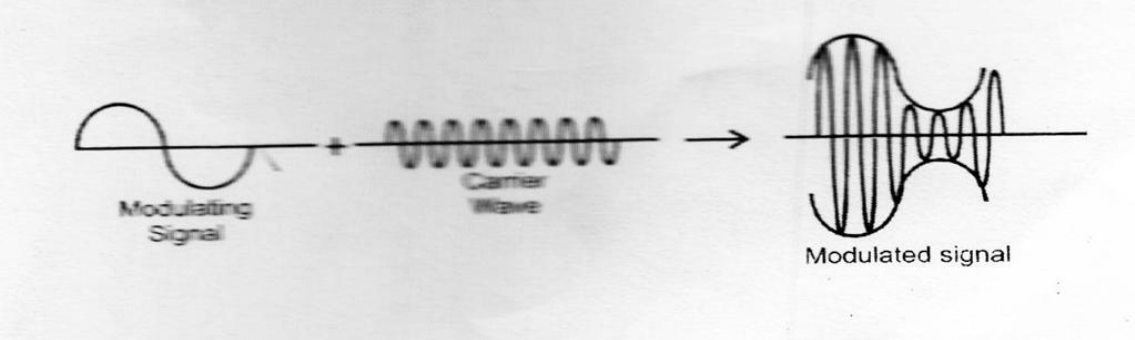
1. Continuous wave modulation is of three types:

(i) Amplitude modulation (AM): In amplitude modulation, the amplitude of carrier wave varies in accordance with instantaneous voltage of information (or message) signal.

(ii) Frequency modulation (FM): In frequency modulation the frequency of carrier wave is varied in accordance with instantaneous voltage of information signal.

(iii) Phase modulation (PM): In phase modulation, the phase of carrier wave is varied in accordance with the information signal.

6. Amplitude modulation

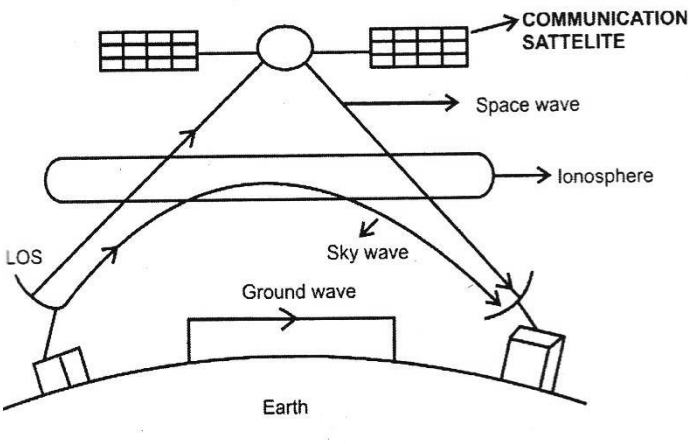


8. SPACE COMMUNICATION

Space communication uses free space between transmitter and receiver.

Space communication is via:

(i) ground waves (ii) space waves (iii) sky waves



9. GROUND OR SURFACE WAVE PROPAGATION is a mode of wave propagation in which the ground has a strong influence on the propagation of signal wave from the transmitting antenna to receiving antenna .In this propagation ,the signal waves glides over the surface of earth, Ground waves are heavily absorbed by earth and not suitable for long range communication. Ground wave propagation can be sustained only at low frequencies (500 kHz-1500 kHz).

10. SKY WAVE PROPAGATION is a mode of wave propagation in which the radiowave emitted from the transmitter antenna reach the receiving antenna after reflection by ionosphere. Sky wave propagation is possible because of reflection of carrier signals from ionosphere or satellite.

11. SPACE WAVE PROPAGATION higher than 30MHz is that mode of wave propagation in which the radiowaves emitted from the transmitter antenna reach the receiving antenna through space. These radiowaves are called space waves. It is also called **line of sight** communication. Space wave is suitable for UHF/VHF regions.

Band width of the signal

Type of signal	**Band width**
Speech	2800 Hz
Music	20 KHz
Video	42 MHz
Video & Audio (T.V)	6.0 MHz

12. COVERING RANGE OF T.V. TRANSMITTING TOWER is $d=\sqrt{2R_e}h$, where h is height of tower and R_e radius ofearth. T.V. waves are frequency modulated waves. VHF T.V. waves range from 47 to 230 MHz and UHF T.V. waves have range from 470 to 960 MHz.

Maximum line of sight distance $d_m = \sqrt{2Rh_T} + \sqrt{2Rh_R}$.

14. MAXIMUM USABLE FREQUENCY

It is that highest frequency of radio waves which when sent at some angle towards the ionosphere, gets reflected from that and returns to the earth.

16. SATELLITE COMMUNICATION

The communication satellite is used for reflecting sky waves without any disturbance. Its height is 35800 km above earth's surface. To cover entire globe of earth simultaneously 3-satellites are employed.

II. IMPORTANT FORMULAE

1. Marconi antenna is grounded, and its ***length = λ/4,*** where λ is wavelength of the waves transmitted. It is called quarter wave antenna.

2. Hertz antenna is not grounded, and its ***length = λ/2.*** It is called half wave antenna.

3. Side band frequencies in AM wave are $\boldsymbol{\upsilon_{SB} = \upsilon_{c} \pm \upsilon_{m}}$where υ_m is frequency of modulating (audio) signal.

4. **Modulation index,** $\mathbf{m_a = E_m / E_c}$

Modulation index, $\mathbf{m_a = E_{max} - E_{min} / E_{max} + E_{min}}$

6. Coverage range (*d*) for a given height (*h*) of antenna

d = √2hR where R = radius of earth.

d = $\sqrt{2Rh_r} + \sqrt{2Rh_R}$, where h_T, h_R are the heights of transmitter and receiver antennas.

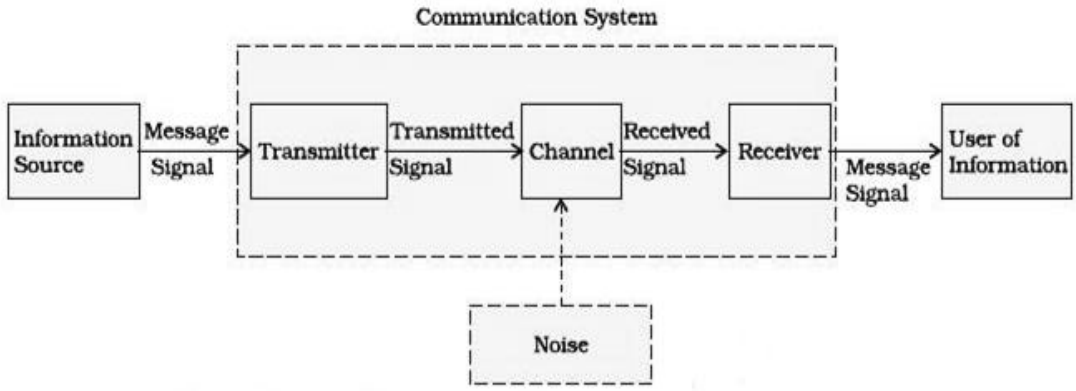
7. Population covered = population density x area covered.

8**. Number of channels,**

N = Total band width of channels / Band width per channel

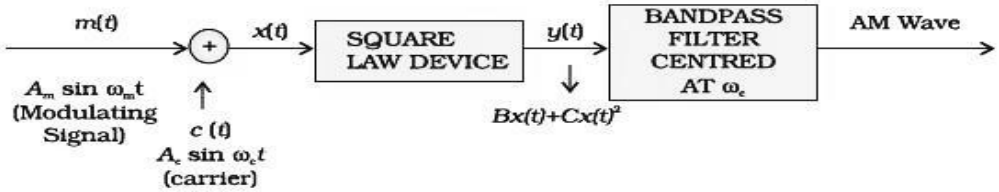
III. Communication System – Block Diagrams

1)

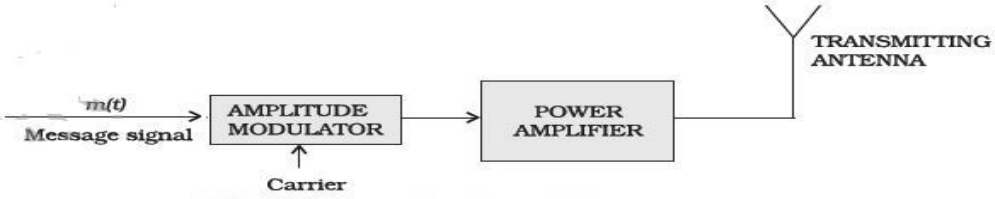


Block diagram of a generalised communication system.

2)



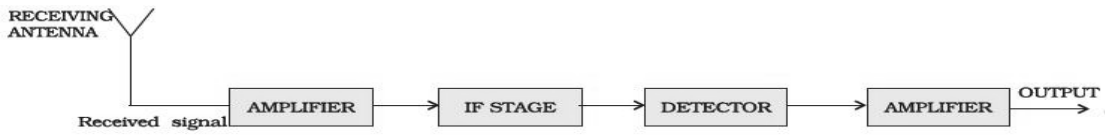
Block diagram of a simple modulator for obtaining an AM signal.



Block diagram of a transmitter.

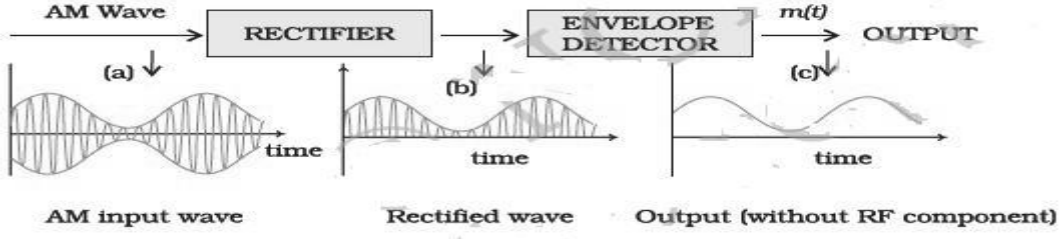
3)

4)



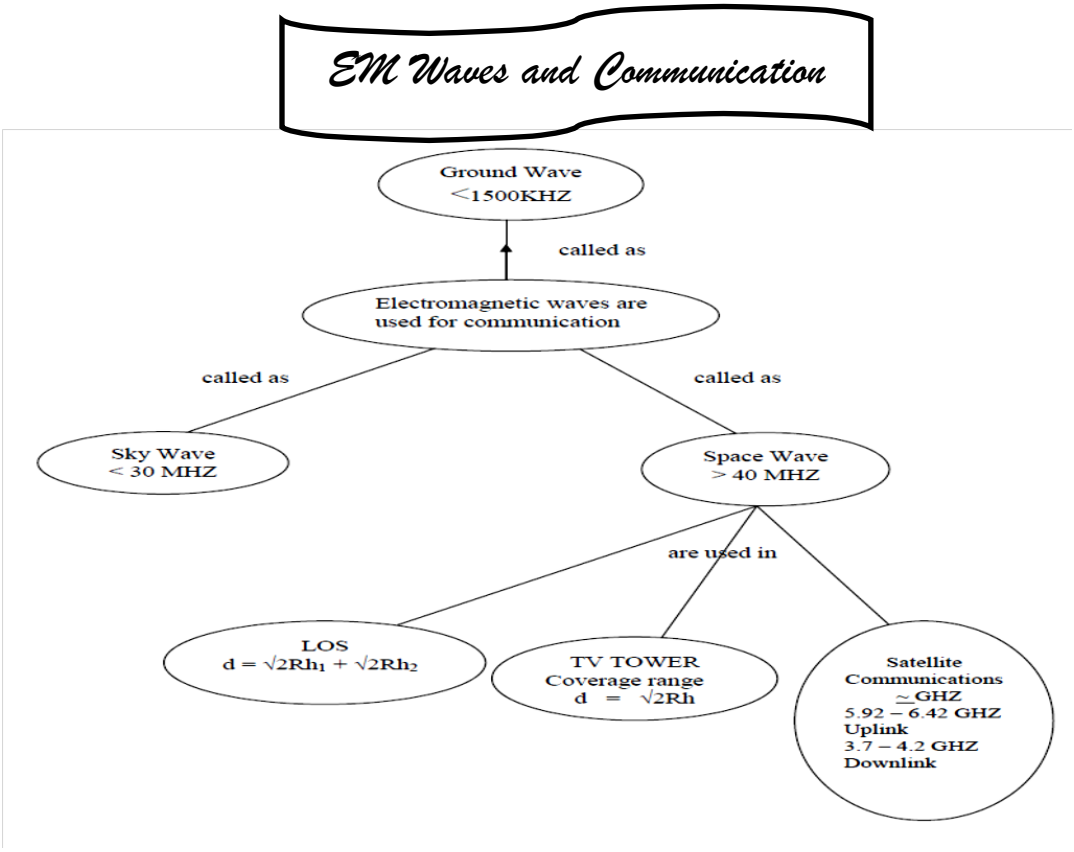
Block diagram of a receiver.

5)



Block diagram of a detector for AM signal. The quantity on y-axis can be current or voltage.

CONCEPT MAP



QUESTIONS

ELEMENTS OF COMMUNICATION SYSTEMS

1. Mention the functions of the transponder? (1)

Ans: A device fitted on the satellite which receives the signal and retransmits it after amplification.

2. What should be the length of dipole antenna for a carrier wave of 5×10^8 Hz? (1)

Ans: L = λ\2 = c\v x 2 = $3 \times 10^8 / 5 \times 10^8 \times 2$ = 0.3m.

3. ***A device X can convert one form of energy into another. Another device Y can be regarded as a combination of a transmitter and a receiver. Name the devices X and Y. (1)

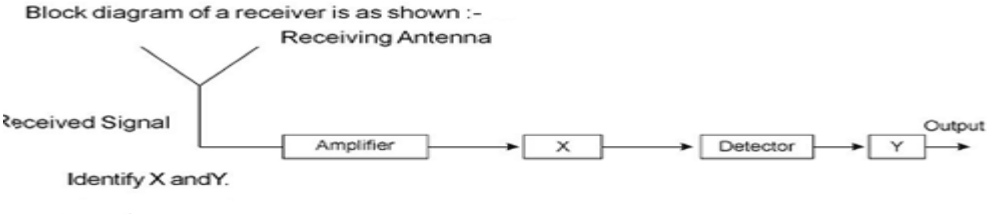
(a) Transducer (b) Repeater

4. Name the two basic modes of communication. Which of these modes is used for telephonic communication? (2)

HINT:

Two basic modes of transmission are (i) Point-to-point and (ii) broad cast mode.
Point-to-point mode is used for Telephonic communication.

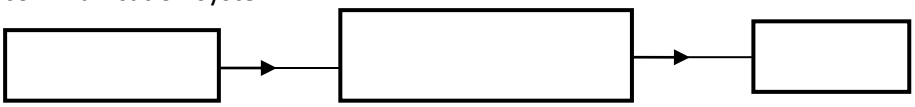
5. Differentiate an analog signal and a digital signal. How can an analog signal converted into a digital signal?
6. (2)



(2)

Hint: X= IF STAGE, Y = Amplifier

7.***** Complete the following block diagram depicting the essential elements of a basic communication system. (3)



ANS:TRANSMITTER,MEDIUM AND RECIEVER

8.Calculate the length of a half wave dipole antenna at (3)
(a) 1 MHz (b) 100 MHz (c) 1000MHz
What conclusion you draw from the results?
Hint: Length of dipole antenna, L = λ/ 2
(a) **150m** (b) **1.5m** (c) **15 cm**

II. PROPAGATION OF EM WAVES

1. Name the types of communication that uses carrier waves having frequencies in the range 10^{12} to 10^{16} Hz.
Ans. Optical communication (1)
2. Write the expression for band width in FM. (1)
Ans. width = 2 times frequency of modulating signal
3. What is attenuation? (1)
4. What is the role of band pass filter in modulation circuit? (1)
Ans. If filters out low and high frequencies and only allow band of frequencies ($w_c - w_m$) to ($w_c + w_m$)
5. Distinguish between analog and digital communication. (1)
6. State the facts by which the range of transmission of signals by a TV tower can be increased?
Ans. by increasing height of transmitting antenna (1)
by increasing height of receiving antenna
7. What % of AM wave power is carried by side bands for m=1? (1)
8. Why moon cannot be used as a communicate satellite? (1)
9. Explain why medium waves are better parries of signals than radio waves? (1)
Hint: Uni-directional propagation.
10. What is the requirement of transmitting microwaves from one to another on the earth?
Ans: The transmitting and receiving antennas must be in line of sight. (1)
11. Name the type of radio waves propagation involved when TV signals broadcast by a tall antenna are intercepted directly by the receiver antenna. (1)
12. Why sky waves are not used for the transmission of TV signals? (1)

13. A TV tower has a height of 300m. What is the maximum distance upto which this TV transmission can be received?

Ans: $d = \sqrt{2Rh} = \sqrt{2 \times 6400 \times 1000 \times 300} = 62km$ (1)

14. How does the effective power radiated by an antenna vary with wavelength? (1)

15.* Why ground wave propagation is not suitable for high frequency? (OR)Why is ground wave propagation restricted to frequency up to 1500 kHz? **(1)**

Hint: It is because radio waves having frequency greater than 1500MHz are strongly absorbed by the ground.

16.* Why are signals not significantly absorbed by ionosphere in satellite communication?

Hint: It is because satellite communication employs HF carrier i.e. microwaves **(1)**

17. How many geostationary satellites are required to provide communication link over the entire globe and how should they be parked? **(1)**

18.* Why is the orbit of a remote sensing satellite called sun synchronous? **(1)**

Hint: it is because when ever such a satellites passes over a particular area of the Earth, the position of the sun with respect to that area remains the same.

19.At a particular place at a distance of 10km from a transmission station a person can receive signals but not able to receive signals at 100km, suggest a method how he can receive signal at 11 km By using antenna. **(1)**

20. The tuned circuit of oscillator in a single AM transmitter employs 50 uH coil and 1nF capacitor. The oscillator output is modulated by audio frequency up to 10KHz. Determine the range of AM wave. (2)

Hint: $\upsilon_c = 1/2\pi\sqrt{LC}$; USF = $\upsilon_c + \upsilon_m$; LSF = $\upsilon_c - \upsilon_m$

21. The TV transmission tower at a particular station has a height of 160 m. What is the Coverage range? (2)

22. What is the population covered by the transmission, if the average Population density around the tower is $1200km^{-2}$? (2)

Hint: **d** = $\sqrt{2Rh}=\sqrt{2\times6.4\times10^3 \times160\times10^{-3}}$ =45km Range 2d=2×45=90km

Population covered=area × population density=1200×6359= 763020

23. A transmitting antenna at the top of tower has a height of 36m and the height of the receiving antenna is 49m. What is the maximum distance between them, for the satisfactory communication in the LOS mode? (Radius of the earth =6400km). (2)

Hint. Using $d= \sqrt{2Rh_t} + \sqrt{2Rh_r}$ we get =46.5km

24. Derive an expression for covering range of TV transmission tower (2)

25. * What is space wave propagation? Which two communication methods make use of this mode of propagation? If the sum of the heights of transmitting and receiving antennae in line of sight of communication is fixed at *h*, show that the range is maximum when the two antennae have a height h/2 each. (3)

Ans: Satellite communication and line of sight (LOS) communication make use of space waves.

Here $d_1=\sqrt{2Rh_2}$ and $d_2= \sqrt{2Rh_2}$

For maximum range,

$D_m=\sqrt{2Rh_1} + \sqrt{2Rh_2}$

where $d_m = d_1 + d_2 = d$

Given $h_1 + h_2 = h$

Let $h_1 = x$ then $h_2 = h-x$

Then $d_m = \sqrt{2Rx} + \sqrt{2R(h-x)}$,

$d\, d_m /dx = \sqrt{R}/2x - \sqrt{R}/2(h-x) = 0$

i.e., $1/2x = 1/2(h-x)$ i.e., $x = h/2$

=> $h_1 = h_2 = h/2$.

26. * A ground receiver station is receiving signals at (i) 5 MHz and (ii) 100 MHz, transmitted from a ground transmitter at a height of 300 m located at a distance of 100km. Identify whether the signals are coming via space wave or sky wave propagation or satellite transponder. Radius of earth = 6400 km; Maximum electron density in ionosphere, $N_{max} = 10^{12} m^{-3}$ (3)

Solution:

Maximum coverage range of transmitting antenna, $d = \sqrt{2R_e h}$

Therefore $d = \sqrt{2} \times 6400 \times 10^3 \times 300 = 6.2 \times 10^4$

The receiving station (situated at 100 km) is out of coverage range of transmitting antenna, so space wave communication is not possible, in both cases (i) and (ii) The critical frequency (or maximum frequency) of ionospheric propagation is $f_c = 9(N_{max})^{1/2} = 9 \times \sqrt{10^{12}} = 9 \times 10^6$ Hz = 9 MHz Signal (i) of 5MHz (< 9 MHz) is coming via ionosphere mode or sky wave propagation, while signal (ii) of 100MHz is coming via satellite mode.

27. * By what percentage will the transmission range of a TV tower be affected when the height of the tower is increased by 21%. ? (3)

Solution:

Transmission range of TV tower = $d = \sqrt{2hR}$ If the height is increased by 21%, new height

$h' = h + 21\backslash 100h = 1.21h$

If d' is the new average range, then $d'/d = \sqrt{h'} / \sqrt{h} = 1.1$% increase in range $\Delta d \backslash d \times 100\% = (d' - d \backslash d) \times 100\% = (d'/ d - 1) \times 100\% = (1.1 - 1) \times 100\% =$ **10%**

MODULATION

1. What type of modulation is used for commercial broadcast of voice signal? (1)

**2. ***Over modulation result in distortion of the signal in amplitude modulation. Why? (1)

Ans: When carrier wave is over modulated (i.e. $m_a > 1$), the modulated wave will be absent at negative peak of modulating signal. This results in distortion of the signal.

3.*An AM wave contains more power than the carrier wave. Why? **(1)**

Ans: An AM wave contains three components, the carrier components and the two side band components (LSB and USB). It therefore contains more power than the carrier wave.

4.* Why is frequency modulation better than amplitude modulation? **(1)**

5.* What would be the modulation index for an amplitude modulated wave for which the maximum amplitude is '*a*' while the minimum amplitude is '*b*'? **(2)**

Ans. Modulation index, $a_m = E_m/E_c$ … (1)

Maximum amplitude of modulated wave $a = E_c + E_m$ .....(2)

Minimum amplitude of modulated wave $b = E_c - E_m$ …(3)

From (2) and (3), $E_c = a+b/2$, $E_m = a-b/2$

From (1), modulation index, $a_m = E_m/E_c = (a-b)/2 / (a+b)/2 = a-b/ a+b$

6. A carrier wave of peak voltage 20 V is used to transmit a message signal. What should be the peak voltage of the modulating signal, in order to have a modulation index of 80% ? (2)

Hint: Modulation index, $m_a = E_m / E_c$

$E_m = m_a \times E_c = 0.80 \times 20$ V = **16 V**

7. A message signal of frequency 10 kHz and peak value of 8 volts is used to modulate a carrier of frequency 1MHz and peak voltage of 20 volts. Calculate: (i) Modulation index

(ii) The side bands produced. (2)

Solution: (i) Modulation index, $m_a = E_m / E_c = 8/20 = 0.4$

(ii) Side bands frequencies = $f_c \pm f_m$

Thus the side bands are at 1010KHz and 990 kHz.

8.An amplitude modulation diode detector, the output circuit consists of resistance R = 1kΩ and capacitance C = 10pf. It is desired to detect a carrier signal of 100 kHz by it. Explain whether it is a good detector or not? If not what value of capacitance would you suggest? (3)

Solution: The satisfactory condition for demodulation is that reactance at carrier frequency must be

much less than R.

Reactance = $1 / \omega C = 1 / 2\pi f_C C = 1/ 2 \times 3.14 \times 100 \times 10^3 \times 10 \times 10^{-12}$

$= 1.59 \times 105\ \Omega = 159\ k\Omega$

This is much greater than the given resistance, so it is not a good detector. For detection, the condition is $1 / 2\pi f_C C << R = C >> 1 / 1.59 \times 10^{-9}$ fared or C >> 1.59 nF.

Thus for proper detection the capacitance of output circuit must be much greater than 1.59 nF. The suitable capacitance is 1μF.

FREQUENTLY ASKED QUESTIONS

UNIT I

ELECTROSTATICS

2 MARKS

1) Force of attraction between two point charges placed at a distance of'd' is 'F'. What distance apart they are kept in the same medium, so that, the force between them is 'F/3'?

2) Define electric field intensity. Write its S I unit. Write the magnitude and direction of electric field intensity due electric dipole of length 2a at the midpoint of the line joining the two charges.

3) Define electric field intensity. Write its S.I unit. Write the magnitude and direction of electric field intensity due to an electric dipole of length2a at the midpoint of the line joining the two charges.

4) Sketch the electric lines of force due to point charges $q > 0$, $q < 0$ and for uniform field.

5) Define electric flux. Give its S.I unit and dimensional formula.

6) Two point charges 4μc and -2μc are separated by a distance of 1 m in air. At what point on the line joining the charges is the electric potential zero?

7) Depict the equipotential surfaces for a system of two identical positive point charges placed at distance d apart.

8) Deduce the expression for the potential energy of a system of two point charges q_1 and q_2 brought from infinity to that points r_1 and r_2.

3 MARKS

9) Derive an expression for electric field intensity at a point on the axial line and on the equatorial line of an electric pole.

10) Derive an expression for torque acting on an electric dipole in a uniform electric filed.

11) Derive an expression for total work done in rotating an electric dipole through an angle 'θ' in uniform electric field.

12) A sphere 'S_1' of radius 'r_1' encloses a charge 'Q'. If there is another concentric sphere S_2 of the radius r_2 ($r_2 > r_1$) and there be no additional charges between S_1 and S_2, find the ratio of electric flux through S_1 and S_2.

13) State Gauss's Theorem in electrostatics. Using this theorem, find the electric field strength due to an infinite plane sheet of charge.

14) State Gauss' theorem. Apply this theorem to obtain the expression for the electric field intensity at a point due to an infinitely long, thin, uniformly charged straight wire.

15) . Using Gauss's theorem, show mathematically that for any point outside the shell, the field due to a uniformly charged thin spherical shell is the same as if the entire charge of the shell is concentrated at the centre. Why do you expect the electric field inside the shell to be zero according to this theorem?

16) Deduce an expression for the electric potential due to an electric dipole at any point on its axis. Mention one contrasting feature of electric of a dipole at a point as compared to that due to single charge.

17) Define dielectric constant in terms of the capacitance of a capacitor.

5 MARKS

18) Give the principle and working of a Van de Graff generator. With the help of a labelled diagram, describe its construction and working. How is the leakage of charge minimised from the generator?

19) Briefly explain the principle of a capacitor. Derive an expression for the capacitance of a parallel plate capacitor, whose plates are separated by a dielectric medium.

20) Derive an expression for the energy stored in a parallel plate capacitor with air between the plates. How does the stored energy change if air is replaced by a medium of dielectric constant 'K'? ; Also show that the energy density of a capacitor is.

21) A parallel-plate capacitor is charged to a potential difference V by a dc source. The capacitor is then disconnected from the source. If the distance between the plates is doubled, state with reason how the following change
(i) electric field between the plates
(ii) capacitance, and
(iii) energy stored in the capacitor

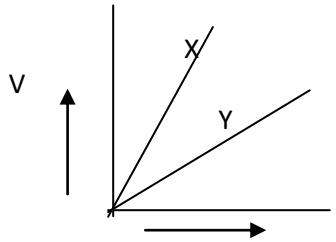
22) Explain the underlying principle of working of a parallel plate capacitor. If two similar plates, each of area 'A' having surface charge densities '+ σ' & '-σ' are separated by a distance 'd' in air, write expressions for (i) the electric field at points between the two plates, (ii) the potential difference between the plates & (iii) the capacity of the capacitor so formed

23) A parallel plate capacitor is charged by a battery and the battery remains connected, a dielectric slab is inserted in the space between the plates. Explain what changes if any , occur in the values of
(I) potential difference between the plates
(II) electric field between the plates
(III) energy stored in the capacitor.

UNIT II
CURRENT ELECTRICITY

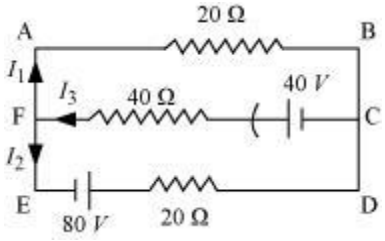
2 MARKS

1. Two wires 'A' & 'B' are of the same metal and of the same length. Their areas of cross-section are in the ratio of 2:1. if the same potential difference is applied across each wire in turn, what will be the ratio of the currents flowing in 'A' & 'B'?
2. Explain, with the help of a graph, the variation of conductivity with temperature for a metallic conductor.
3. Draw V-I graph for ohmic and non-ohmic materials. Give one example for each.
4. Explain how does the resistivity of a conductor depend upon (i) number density 'n' of free electrons, & (ii) relaxation time't'.
5. Define the term 'temperature coefficient of resistivity'. Write its SI unit. Plot a graph showing the variation of resistivity of copper with temperature.
6. A cell of emf (E) and internal resistance (r) is connected across a variable external resistance (R) Plot graphs to show variation of (i) E with R (ii) terminal p.d. of the cell (V) with R.
7. Explain how electron mobility changes from a good conductor
(i) when temperature of the conductor is decreased at constant potential difference and (ii) applied potential difference is doubled at constant temperature.
8. Write the mathematical relation between mobility and drift velocity of charge carriers in a conductor. Name the mobile charge carriers responsible for conduction of electric current in: (i) an electrolyte, & (ii) an ionised gas.
9. Define drift velocity. Establish a relation between current & drift velocity.
10. Define the term current density of a metallic conductor. Deduce the relation connecting current density 'J' & the conductivity 'σ' of the conductor when an electric field 'E' is applied to it.
11. Why do we prefer potentiometer to compare the e.m.f of cells than the voltmeter. Why?
12. State Kirchhoff's rules of current distribution in an electric network.
13. The variation of potential difference "V' with length 'l' in the case of two potentiometers 'X' & 'Y' is as shown in figure. Which one of these two will you prefer for comparing 'emf's of two cells and why?

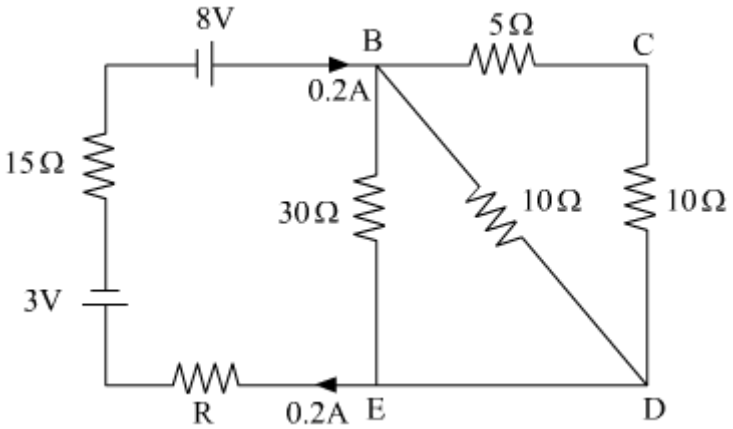


3 MARKS

14. Draw a circuit diagram using a metre bridge and write the necessary mathematical relation used to determine the value of an unknown resistance. Why cannot such an arrangement be used for measuring very low resistance?
15. With the help of a circuit diagram, explain in brief the use of a potentiometer for comparison of 'emf's of two cells.
16. Prove that the current density of a metallic conductor is directly proportional to the drift speed of electrons.
17. A number of identical cells, n, each of emf E, internal resistance r connected in series are charged by a d.c. source of emf E', using a resistor R.
    (i) Draw the circuit arrangement.
    (ii) Deduce the expressions for (a) the charging current and (b) the potential difference across the combination of the cells.
18. Derive the principle of wheatstone bridge using Kirchoff's law.
19. State Kirchhoff's rules of current distribution in an electrical network.
    Using these rules determine the value of the current I1 in the electric circuit given below.



20. Write the mathematical relation for the resistivity of material in terms of relaxation time, number density and mass and charge of charge carriers in it.Explain, using this relation, why the resistivity of a metal increases and that of semi-conductor decreases with rise in temperature.
21. Calculate the value of the resistance R in the circuit shown in the figure so that the current in the circuit is 0·2 A. What would be the potential difference between points A and B?



UNIT III
MAGNETIC EFFECTS OF CURRENT AND MAGNETISM

2 MARKS

1. A circular coil of radius 'R' carries a current 'I'. Write the expression for the magnetic field due to this coil at its centre. Find out the direction of the magnetic field.
2. Write the expression for the force on the charge moving in a magnetic field. Use this expression to define the SI unit of magnetic field.

3. Define magnetic susceptibility of a material. Name two elements, one having positive susceptibility and the other having negative susceptibility. What does negative susceptibility signify?
4. Define the term magnetic dipole moment of a current loop. Write the expression for the magnetic moment when an electron revolves at a speed around an orbit of radius in hydrogen atom..
5. Explain with the help of a diagram the term 'magnetic declination' at a given place.
6. Define the term 'angle of dip'. What is the value of the angle of dip at the magnetic equator? What does it mean?
7. Two wires of equal lengths are bend in the form of two loops. One of the loop is square shaped where as the other loop is circular. These are suspended in a uniform magnetic field and the same current is passed through them. Which loop will experience greater torque? Give reasons.
8. Explain why steel is preferred for making permanent magnets while soft iron is preferred for making electromagnets.
9. Draw diagram to show behavior of magnetic field lines near a bar of 1)copper2)aluminum and3)mercury cooled at a very low temperature(4.2K)
10. How will the magnetic field intensity at the centre of the circular coil carrying current will change, if the current through the coil is doubled and radius of the coil is halved?
11. What do you mean by current sensitivity of a moving coil galvanometer? On what factors does it depend?
12. Derive an expression for the force experienced by a current carrying straight conductor placed in a magnetic field. Under what condition is this force maximum?

3 MARKS

13. Obtain the force per unit length experienced by two parallel conductors of infinite length carrying current in the same direction. Hence define one ampere.
14. A) If χ -stands for the magnetic susceptibility of a given material, identify the class of materials for which (a) $-1 \geq \chi < 0$, and (b) $0 < \chi < \acute{\varepsilon}$ [$\acute{\varepsilon}$ is a small positive number]. Write the range of relative magnetic permeability of these materials.
    B) Draw the pattern of the magnetic field lines when these materials are placed on a strong magnetic field.
15. Derive an expression for the force acting on a current carrying conductor in a magnetic field. Under what conditions this force is maximum and minimum?
16. Define the term magnetic moment of current loop. Derive the expression for the magnetic moment when an electron revolves at a speed 'v' around an orbit of radius r in hydrogen atom. Also calculate the value of Bohr's magnetic moment.
17. With the help of diagram explain how a galvanometer can be converted into an ammeter and a voltmeter.
18. To increase the current sensitivity of a moving coil galvanometer by 50%, its resistance is increased so that the new resistance becomes twice its initial resistance. By what factor does its voltage sensitivity change?

5 MARKS

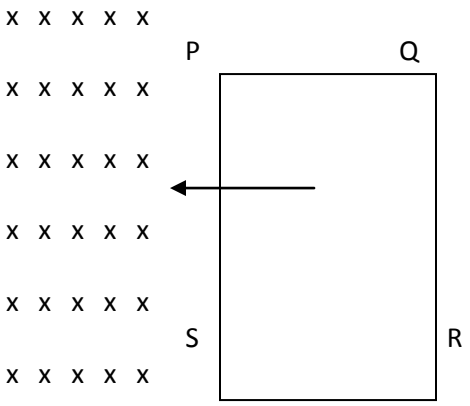
19. Write an expression for force experienced by a charged particle moving in a uniform magnetic field? With the help of labeled diagram, explain principle and working of a cyclotron. Show that cyclotron frequency does not depend upon the speed of particles. Write its two limitations.
20. State Ampere's Circuital Law. Derive an expression for the magnetic field at a point due to straight current carrying conductor.
21. Derive an expression for the magnetic field at a point along the axis of an air cored solenoid using a Ampere's circuital law..

22. Derive an expression for torque acting on a rectangular current carrying loop kept in a uniform magnetic field B. Indicate the direction of torque acting on the loop.
23. With neat diagram, describe the principle, construction and working of a moving coil galvanometer. Explain the importance of radial field.
24. State Biot Savart Law. Use this law to obtain a formula for magnetic field at the centre of a circular loop of radius R ,number of turns N carrying current I. Sketch the magnetic field lines for a current loop clearly indicating the direction of the field.
25. Distinguish the magnetic properties of dia, para- and ferro-magnetic substances interms of (i) susceptibility, (ii) magnetic permeability and (iii) coercivity. Give one example of each of these materials.Draw the field lines due to an external magnetic field near a (i) diamagnetic,(ii) paramagnetic substance.

UNIT IV
ELECTROMAGNETIC INDUCTION & ALTERNATING CURRENT

2 MARKS

1. How does the self-inductance of an air core coil change, when (i) the number of turns in the coils is decreased & (ii) an iron rod is introduced in the coil.
2. What is the effect on the mutual inductance between the pair of coil when
   (i) the distance between the coils is increased?(ii) the number of turns in each coil is decreased? Justify your answer in each case.
3. State Lenz's law. Show that it is in accordance with the law of conservation of energy.
4. The closed loop PQRS is moving into a uniform magnetic field acting at right angles to the plane of the paper as shown. State the direction of the induced current in the loop.



5. Define mutual inductance and give its S.I. unit.Write two factors on which the mutual-inductance between a pair of coil depends.
6. What is the power dissipated in an ac circuit in which voltage & current are given by V = 230 sin $(\omega t + \pi/2)$ and I = 10 sin ωt?
7. The instantaneous current & voltage of an ac circuit are given by:
   i = 10 sin 314t ampere, & V = 50 sin 314t volt.
   What is the power dissipation in the circuit?
8. The coils in certain galvanometers have fixed core made of a non-magnetic material. Why does the oscillating coil come to rest so quickly in such a core?
9. What are eddy currents. How are these produced? in what sense are eddy currents considered undesirable in a transformer and how are these reduced in such a device?
10. Prove that average power consumed over a complete cycle of ac through an ideal inductor is zero.

11. Prove that an ideal capacitor in an ac circuit does not dissipate power.
12. Distinguish resistance,reactance and impedance.
13. What is an induced emf? Write Faraday's law of electromagnetic induction Express it mathematically.
14. Two identical loops, one of copper and the other of aluminum, are rotated with the same angular speed in the same magnetic field. Compare (i) the induced emf and (ii) the current produced in the two coils. Justify your answer.

3 MARKS

15. Derive an expression for: (i) induced emf & (ii) induced current when, a conductor of length is moved into a uniform velocity v normal to a uniform magnetic field B. Assume resistance of conductor to be R.
16. Derive an expression for average power consumed over a complete cycle of ac through an LCR circuit.
17. Define mutual inductance and give its SI unit. Derive an expression for the mutual inductance of two long coaxial solenoids of same length wound over the other.
18. . Define self-inductance and give its S. I. Unit. Derive an expression for self- inductance of a long, air-cored solenoid of length *l,* radius r, and having N number of turns

5 MARKS

19. Explain the term 'capacitive reactance'. Show graphically the variation of capacitive reactance with frequency of the applied alternating voltage.An a.c. voltage $E=E_0 \sin\omega t$ is applied across a pure capacitor of capacitance C. Show mathematically that the current flowing through it leads the applied voltage by a phase angle of $\pi/2$. .
20. Explain the term 'inductive reactance'. Show graphically the variation of inductive reactance with frequency of the applied alternating voltage.
    An a.c. voltage $E=E_0 \sin\omega t$ is applied across a pure inductor of inductance L. Show mathematically that the current flowing through it lags behind theapplied voltage by a phase angle of $\pi/2$.
21. An AC source of voltage $V = V_m \sin \omega t$ is applied across a series LCR circuit. Draw the phasor diagrams for this circuit, when:
    a) Capacitive impedance exceeds the inductive impedance AND
    b) Inductive impedance exceeds capacitive impedance.
22. A coil of inductance 'L', a capacitor of capacitance 'C', & a resistor of resistance 'R' are all put in series with an alternating source of emf $E = E_0 \sin \omega t$. Write expressions for a) total impedance of circuit, and (b) frequency of source emf for which circuit will show resonance.

23. A circular coil of N-turns & radius 'R' is kept normal to a magnetic field, given by: $B = B_0 \cos \omega t$. Deduce an expression for the emf induced in this coil. State the rule which helps to detect the direction of induced current.
24. Discuss a series resonant circuit. Derive an expression for resonant frequency and show a graphical variation between current and angular frequency of applied ac. Define quality factor and derive an expression for it.
25. Explain with help of a labelled diagram the principle, construction and working of a transformer. Mention the various energy losses in a transformer? Explain the role of transformer in long distance transmission of power ?
26. With the help of a neat diagram, explain the principle construction and working of an a.c generator.

UNIT V
ELECTROMAGNETIC WAVES

2 MARKS

1. A plane monochromatic light wave lies in the visible region. It is represented by sinusoidal variation with time by the following components of electric field:
   $E_X = 0$, $E_Y = 4 \sin [2\pi/\lambda (x - vt)]$, $E_z = 0$
   Where, $v = 5 \times 10^{14}$ Hz and λ is the wave length of light.
   (i) What is the direction of propagation of the wave?
   (ii) What is its amplitude? And
   (iii) Compute the components of magnetic field.
2. Give two characteristics of electromagnetic waves. Write the expression for the velocity of electromagnetic waves in terms of permittivity and magnetic permeability of free space.
3. Find wavelength of electromagnetic waves of frequency 5×10^{19} Hz in free space. Give its two applications.
4. Name the characteristics of e. m. waves that: (i) increases, & (ii) remains constant in e. m. spectrum as one moves from radiowave region towards ultraviolet region.

3 MARKS

5. Which constituent radiation of electromagnetic spectrum is used: (i) in radar? (ii) To photograph internal parts of human body? & (iii) for taking photographs of the sky during night and foggy condition? Give one reason for your answer in each case.
6. Write any four characteristics of e. m. waves. Give two uses of: (i) Radio waves & (ii) Microwaves.
7. Name the following constituent radiations of e. m. spectrum which, (i) produce intense heating effect? (ii) is absorbed by the ozone layer, &(iii) is used for studying crystal structure.
8. Experimental observations have shown: (i) that X-rays travel in vacuum with a speed of 3×10^8 m s^{-1}, & (ii) the phenomenon of diffraction and can be polarized. What conclusion is drawn about the nature of X-rays from each of these observations?
9. Why are infrared radiations referred to as heat waves? Name the radiations which are next to these radiations in e. m. spectrum having: (i) shorter wavelength, & (ii) longer wavelength.
10. The oscillating magnetic field in a plane electromagnetic wave is given by:
    $B_y = 8 \times 10^{-6} \sin [2 \times 10^{11} t + 300 \pi x]$ T
    (i) Calculate the wavelength of the electromagnetic wave &
    (ii) Write down the expression for oscillating electric filed.
11. Identify the following electromagnetic radiation as per the wavelengths given below:
    (a) 10^{-3} nm, & (b) 10^{-3} m, & (c) 1 nm; Write one application of each.
12. Name the constituent radiation of electromagnetic spectrum which
    (a) is used in satellite communication.
    (b) is used for studying crystal structure.
    (c) is similar to the radiations emitted during decay of radioactive nuclei.
    (d) has its wavelength range between 390 nm and 770 nm.
    (e) is absorbed from sunlight by ozone layer.
    (f) produces intense heating effect.
13. What is meant by the transverse nature of electromagnetic waves? Drawdiagram showing the propagation of the an electromagnetic wave along X direction, indicating clearly the directions of oscillating electric and magnetic fields associated with it.

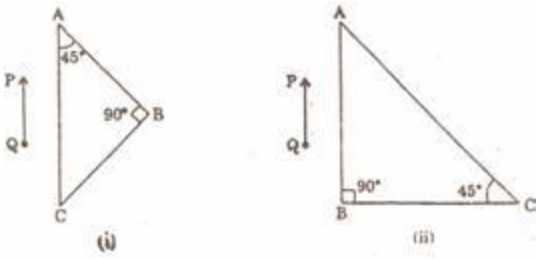
UNIT VI
OPTICS

2 MARKS

1. What is the geometrical shape of the wavefront when a plane wave passes through a convex lens?
2. What is total internal reflection? Under what condition does it take place.
3. A convex lens made up of a material of refractive index n_1, is immersed in a medium of refractive index n_2. Trace the path of a parallel beam of light passing through the lens when: (i) (i) $n_1 > n_2$, (ii) $n_1 = n_2$, & (iii) $n_1 < n_2$. Explain your answer.
4. A concave lens made of material of refractive index n_1 is kept in a medium of refractive index n_2. A parallel beam of light is incident on the lens. Complete the path of rays of light emerging from the concave lens if: (i) $n_1 > n_2$, (ii) $n_1 = n_2$, & (iii) $n_1 < n_2$.
5. Draw a ray diagram to show how an image is formed by a compound microscope. ?
6. A microscope is foucssed on a dot at the bottom of a beaker. Some oil is poured into the beaker to a height of 'y' cm & it is found necessary to raise microscope through a vertical distance of 'x' cm to bring the dot again into focus. Express refractive index of oil in terms of 'x' & 'y'.
7. How does the (i) magnifying power & (ii) resolving power of a telescope change on increasing the diameter of its objective? Give reasons for your answer.
8. How will magnifying power of a "refracting type astronomical telescope" be affecting on increasing for its eye piece: (i) the focal length, & (ii) the aperture. Justify your answer.
9. Draw a labelled ray diagram showing the formation of image of a distant object using an astronomical telescope in the 'normal adjustment position'
10. Draw a labelled ray diagram showing the formation of image of a distant object using an astronomical telescope in the near point adjustment.
11. Draw a ray diagram to illustrate image formation by a Cassegrain type reflecting telescope.
12. Explain with reason, how the resolving power of an astronomical telescope will change when (i) frequency of the incident light on objective lens is increased (ii) the focal length of the objective lens is increased & (iii) aperture of the objective lens is halved.
13. Draw a graph to show variation of angle of deviation 'D' with that of angle of incidence 'i' for a monochromatic ray of light passing through a glass prism of reflecting angle 'A'.

3 MARKS

14. Derive lens/mirror formula in case of a convex/concave mirror.
15. Stating the assumptions and sign conventions, derive expression for lens maker's formula.
16. A right-angled crown glass prism with critical angle 41° is placed before an object, 'PQ' in two positions as shown in the figures (i) & (ii). Trace the paths of the rays from 'P' & 'Q' passing through the prisms in the two cases.



17. (a) Draw a labelled ray diagram to show the formation of an image by a compound microscope. Write the expression for its magnifying power.
18. (b) Define resolving power of a compound microscope.

How does the resolving power of a compound microscope change, when (i) refractive index of the medium between the object and the objective lens increases and (ii) Wavelength of the radiation used is increased?

19. Define the term wave front? Using Huygen's construction draw a figure showing the propagation of a plane wave reflecting at the interface of the two media. Show that the angle of incidence is equal to the angle of reflection.

20. Define the term 'wavefront'. Draw the wavefront and corresponding rays in the case of a (i) diverging spherical wave (ii) plane wave. Using Huygen's construction of a wavefront, explain the refraction of a plane wavefront at a plane surface and hence deduce Snell's law.

21. What is meant by 'interference of light'? Write any two conditions necessary for obtaining well-defined and sustained interference pattern of light.

22. What is the effect on the interference fringes in a Young's double slit experiment due to each of the following operations? Give reason for your answer: (i) Separation between two slits is increased & (ii) monochromatic source is replaced by a source of white light.

23. Draw the curve depicting variation of intensity in the interference pattern in Young's double slit experiment. State conditions for obtaining sustained interference pattern of light.

24. In a single slit diffraction pattern, how is angular width of central bright maximum changed when (i) the slit width is decreased, (ii) the distance between the slit and the screen is increased, & (iii) light of smaller wavelength is used? Justify your answers.

25. Why is diffraction of sound waves easier to observe than diffraction of light waves? What two main changes in diffraction pattern of a single slit will you observe when the monochromatic source of light is replaced by a source of white light?

26. In a single slit diffraction experiment, if the width of the slit is doubled, how does the (i) intensity of light and (ii) width of the central maximum change? Give reason for your answer.

27. What is wavefront? What is the geometrical shape of a wavefront emerging from a convex lens when point source is placed at the focus?

28. What is wavefront? Distinguish between a plane wavefront and a spherical wavefront. Explain with the help of a diagram, the refraction of a plane wavefront at a plane surface using Huygens's construction.

29. Using Huygens's principle show that for parallel beam incident on a reflecting surface the angle of reflection is equal to the angle of incidence.

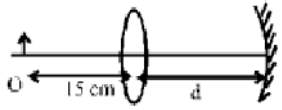
30. Distinguish between unpolarised and plane polarised light. An unpolarised light is incident on the boundary between two transparent media. State the condition when the reflected wave is totally plane polarised. Find out the expression for the angle of incidence in this case.

31. The following data was recorded for values of object distance and the corresponding values of image distance in the experiment on study of real image formation by a convex lens of power +5D. One of the observations is incorrect. Identify the observation and give reason for your choice.

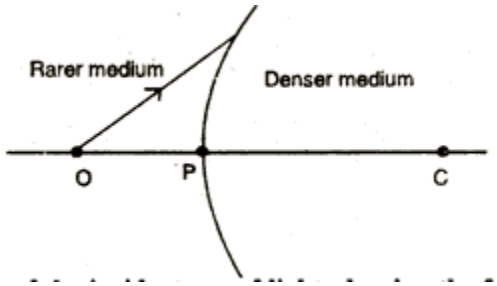
S. No.	1	2	3	4	5	6
Object distance (cm)	25	30	35	45	50	55
Image distance (cm)	97	6	37	35	32	30

5 MARKS

32. (i) Derive the mirror formula which gives the relation between f, v and u. What is the corresponding formula for a thin lens? (ii) Calculate the distance d, so that a real image of an object at O, 15cm in front of a convex lens of focal length 10cm be formed at the same point O. The radius of curvature of the mirror is 20cm. Will the image be inverted or erect?



33. A spherical surface of radius of curvature 'R' separates a rarer and a denser medium as shown in the figure.



Complete the path of the incident ray of light, showing the formation of real image. Hence derive the relation connecting object distance 'u', image distance 'v' radius of curvature 'R' and the refractive indices 'n_1' & 'n_2' of the media.
Briefly explain how the focal length of a convex lens changes with Increase in wavelength of incident light.

34. State the assumptions and sign conventions in deriving the Lens maker's formula and also derive an expression for it.
35. Derive an expression for thin lens formula.
36. (a) In Young's double slit experiment, deduce the conditions for: (i) constructive and (ii) destructive interference at a point on the screen. Draw a graph showing variation of the resultant intensity in the interference pattern against position 'x' on the screen.
(b) Compare and contrast the pattern which is seen with two coherently illuminated narrow slits in Young's experiment with that seen for a coherently illuminated single slit producing diffraction.
37. State Huygens principle. Using the geometrical construction of secondary wavelets, explain the refraction of a plane wavefront incident at a plane surface. Hence verify Snell's law of refraction. Illustrate with the help of diagrams the action of: (i) convex lens and (ii) concave mirror on a plane wavefront incident on it.
38. What is interference of light? Write two essential conditions for sustained interference pattern to be produced on the screen. Draw a graph showing the variation of intensity versus the position on the screen in Young's experiment when (a) both the slits are opened and (b) one of the slit is closed. What is the effect on the interference pattern in Young's double slit experiment when: (i) Screen is moved closer to the plane of slits? (ii)Separation between two slits is increased. Explain your answer in each case.
39. What are coherent sources of light? Two slits in Young's double slit experiment are illuminated by two different sodium lamps emitting light of the same wavelength. Why is no interference pattern observed?
(b) Obtain the condition for getting dark and bright fringes in Young's experiment. Hence write the expression for the fringe width.
(c) If S is the size of the source and its distance from the plane of the two slits, what should be the criterion for the interference fringes to be seen?
40. What do we understand by 'polarization of wave'? How does this phenomenon help us to decide whether a given wave is transverse or longitudinal in nature?
41. Light from an ordinary source (say, a sodium lamp) is passed through a Polaroid sheet 'P_1'. The transmitted light is then made to pass through a second Polaroid sheet P_2 which can be rotated so that the angle θ between the two Polaroid sheets varies from $0^\bullet$ to $90^\bullet$. Show graphically the variation of intensity of light, transmitted by P_1& P_2 as a function of the angle

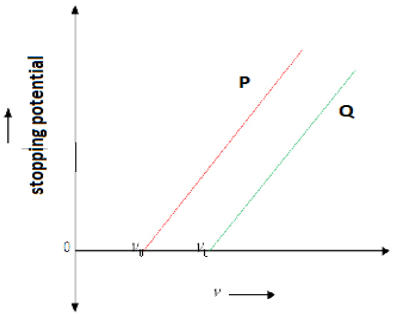
θ. Take the incident beam intensity a I_0. Why does the light from a clear blue portion of the sky, show a rise and fall of intensity when viewed through a Polaroid which is rotated?

42. (a) Draw a ray diagram to show the refraction of light through a glass prism. Hence obtain the relation for the angle of deviation in terms of the angle of incidence, angle of emergence and the angle of the prism. (b) A right angled isosceles glass prism is made from glass of refractive index When a monochromatic yellow coloured light beam is incident on a given photosensitive surface, photoelectrons are not ejected, while the same surface gives photoelectrons when exposed to green coloured monochromatic beam. What will happen if the surface is exposed to: (i) red coloured, monochromatic beam of light? Justify your answer.

UNIT VII
DUAL NATURE OF MATTER

2 MARKS

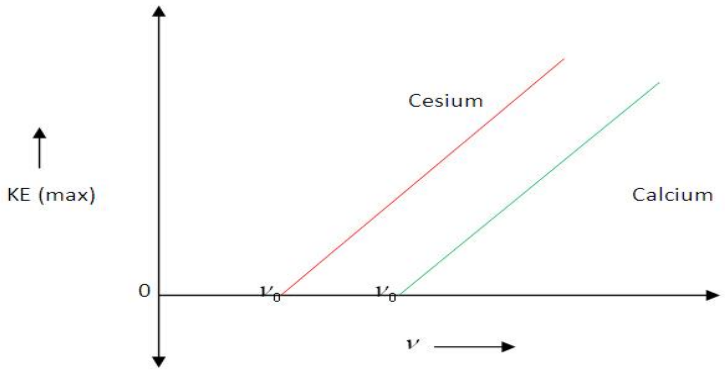
1. When a monochromatic yellow coloured light beam is incident on a given photosensitive surface, photoelectrons are not ejected, while the same surface gives photoelectrons when exposed to green coloured monochromatic beam. What will happen if the surface is exposed to: (i) red coloured, monochromatic beam of light? Justify your answer.
2. What is meant by work function of a metal? How does the value of work function influence the kinetic energy of electrons liberated during photoelectric emission?
3. Define the terms: (i) work function, (ii) threshold frequency & (iii) stopping potential with reference of photoelectric effect.
4. The work function of lithium is 2.3 eV. What does it mean? What is the relation between the work function 'ω_o' and threshold wavelength 'λ_o' of a metal?
5. Red light, however bright, cannot cause emission of electrons from a clean zinc surface. But, even weak ultraviolet radiations can do so. Why?
6. An electron and a proton have same kinetic energy. Which of the two has a greater wavelength? Explain.
7. Define the term threshold frequency & work function in relation to photoelectric effect.
8. An electron and a proton are moving in the same direction and possess same kinetic energy. Find the ratio of de-Broglie wavelengths associated with these particles.
9. In the photoelectric effect experiment, the graph between the stopping potential 'V' and frequency 'v' of the incident radiation on two different metal plates P and Q are shown in the figure. (i) Which of the two metal plates, P & Q has greater value of work function? & (ii) What does the slope of the line depict?



3 MARKS

10. What is photoelectric effect? Write Einstein's photoelectric equation and use it to explain: (i) independence of maximum energy of emitted photoelectrons from the intensity of incident light. (ii) Existence of a threshold frequency for the emission of photoelectrons.
11. Draw the variation of maximum kinetic energy of emitted electrons with frequency of the incident radiation on a photosensitive surface. On the graph drawn, what do the following indicate: (i) slope of the graph & (ii) intercept on the energy axis.

12. Obtain Einstein's photoelectric equation. Explain how it enables us to understand the (i) linear dependence of the maximum kinetic energy of the emitted electrons, on the frequency of the incident radiation & (ii) existence of a threshold frequency for a given photo emitter.
13. Given below is the graph between frequency (v) of the incident light and maximum kinetic energy (E) of emitted photoelectrons. Find the values of: (i) threshold frequency and (ii) work function from the graph.



14. Sketch a graph between frequency of incident radiations and stopping potential for a given photosensitive materials. What information can be obtained from the value of intercept on the potential axis? A source of light of frequency greater that the threshold frequency is replaced at a distance of 1 m *from* the cathode of a photo cell. The stopping potential is found to be V. If the distance of the light source from the cathode is reduced, explain giving reason, what change you will observe in the (I0 photoelectric current & (ii) stopping potential.
15. Explain the laws of photoelectric emission on the basis of Einstein's photoelectric equation. Write one feature of the photoelectric effect which cannot be explained on the basis of wave theory of light.
16. Draw graphs showing the variation of photoelectric current with anode potential of a photocell for (i) the same frequency but different intensities $I_1 > I_2 > I_3$ of incident radiation, & (ii) the same intensity but different frequencies $v_1 > v_2 > v_3$ of incident radiation. Explain why the saturation current is independent of the anode potential?

UNIT VIII
ATOMS & NUCLEI

2 MARKS

1. Define disintegration constant and mean life of a radioactive substance. Give the unit of each.
2. What is impact parameter? What is the value of impact parameter for a head on collision? The sequence of the stepwise decays of radioactive nucleus is:

$$D \xrightarrow{\alpha} D1 \xrightarrow{\beta} D2 \xrightarrow{\alpha} D3 \xrightarrow{\alpha} D4.$$

If the nucleon number and atomic number for D2 are respectively 176 & 71, what are the corresponding values for D and D4 nuclei? Justify your answer.

3. Draw a diagram to show the variation of binding energy per nucleon with mass number for different nuclei. Explain with the help of this plot the release of energy in the processes of nuclear fission and fusion?
4. The value of ground state energy of hydrogen atom is: -13.6 eV; (i) What does the negative sign signify? & (ii) How much energy is required to take an electron in this atom from the ground state to the first excited state?

5. Give one point of difference between 'nuclear fission' & 'nuclear fusion'. Will neutron to proto ratio increase or decrease in a nucleus when: (i) an electron, (ii) a positron is emitted?
6. Sketch the graph showing the variation of potential energy of a pair of nucleons as a function of their separation. Write three characteristic properties of nuclear force which distinguish it from the electrostatic force.
7. State two characteristics of nuclear force. Why does the binding energy per nucleon decrease with increase in mass number for heavy nuclei like ^{235}U?
8. State the condition for controlled chain reaction to occur in a nuclear reactor. Heavy water is often used as a moderator in thermal nuclear reactors. Give reason.
9. Define activity of a substance. State its S.I unit. Derive an expression for activity of a substance.
10. Define average or mean value of a radioactive substance, and derive an expression for it.

3 MARKS

11. State the basic postulates of Bohr's atomic model & derive an expression for the energy of an electron in any orbit of hydrogen atom.
12. Derive an expression for the radius of stationary orbit. Prove that the various stationary orbits are not equally spaced.
13. Derive mathematical expressions for: (i) kinetic energy, & (ii) potential energy of an electron revolving in an orbit of radius 'r'; how does the potential energy change with increase in principal quantum number (n) for the electron and why?
14. Define the decay constant for a radioactive sample. Which of the following radiations α, β, & λ rays are: (i) similar to X-rays? (ii) easily absorbed by matter? & (iii) similar in nature to cathode rays?
15. Define the terms: half life period and decay constant of a radioactive sample. Derive the relation between these terms.
16. In Rutherford's scattering experiment, mention two important conclusions which can be drawn by studying the scattering of α particles by an atom. Draw the schematic arrangement of Geiger and Marsden experiment showing the scattering of α particle by a thin foil of gold. How does one get the information regarding the size of the nucleus in this experiment?
17. Sketch the energy level diagram for hydrogen atom. Mark the transitions corresponding to Lyman and Balmer series.
18. Prove that the instantaneous rate of change of the activity of a radioactive substance is inversely proportional to the square of its half life.

(3)

UNIT IX
ELECTRONIC DEVICES

2 MARKS

1. How is a p-type semiconductor formed? Name the majority carriers in it. Draw the energy band diagram of a p-type semiconductor.
2. How is an n-type semiconductor formed? Name the majority carriers in it. Draw the energy band diagram of a n-type semiconductor.
3. With the help of a diagram, show the biasing of a light emitting diode (LED). Give its two advantages over conventional incandescent lamps.
4. Draw a circuit diagram to show how a photodiode is biased. Draw its characteristic curves for two different illumination intensities.
5. Give the logic symbol for an AND gate. Draw the output wave form for input wave forms for this gate.

3 MARKS

6. What is rectification? How can a diode valve be used as half wave rectifier and full wave rectifier?
7. Explain how the depletion layer and the barrier potential are formed in a p-n junction diode.

8. Draw a circuit diagram for use of NPN transistor as an amplifier in common emitter configuration. The input resistance of a transistor is $1000\,\Omega$ On changing its base current by $10\mu A$, the collector current increases by 2 m A. If a load resistance of $5K\,\Omega$ is used in the circuit, calculate (i) the current gain & (ii) voltage gain of the amplifier
9. The output of an AND gate is connected to both the inputs of a NAND gate. Draw the logic circuit of this combination of gates and write its truth table.

10. What is a Zener diode? How it is symbolically represented? With the help of a circuit diagram, explain the use of Zener diode as a voltage stabilizer.

11. With the help of a suitable diagram, explain the formation of depletion region in a p-n junction. How does its width change when the junction is: (i) forward biased? & (ii) reverse biased?

5 MARKS

12. With the help of a circuit diagram explain the working of a transistor as an oscillator.

13. Explain briefly with the help of a circuit diagram how V-I characteristics of a p-n junction diode are obtained in: (i) forward bias & (ii) reverse bias.
14. Explain the function of base region of a transistor. Why this region is made thin and lightly doped? Draw a circuit diagram to study the input and the output characteristics of n-p-n transistor in a common emitter (CE) configuration. Show these characteristics graphically. Explain how current amplification factor of the transistor is calculated using output characteristics.
15. Draw the energy bands of p-type and n-type semiconductors. Explain with a circuit diagram the working of a full wave rectifier.
16. Explain with the help of a circuit diagram the use of an n-p-n transistor as an amplifier in common emitter configuration. Draw the input and output wave forms of the signal. Write the expression for its voltage gain.
17. What is an n-p-n transistor? How does it differ from p-n-p transistor? Give their symbols. Explain transistor action.
18. Explain the working of transistor as a switch. Draw transfer characteristic curve by showing 1) Cutoff region 2) Active region and 3) Saturation region.

UNIT X
COMMUNICATION SYSTEMS

2MARKS

1. Draw a block diagram of communication system.

2. Distinguish between point to point and broadcast communication modes. Give one example of each.

3. Explain the following terms.

a) Ground waves b) Space waves and c) sky waves.

4. What does the term LOS communication mean? Name the types of waves that are used for this communication. Give typical examples, with the help of a suitable figure, of communication systems that use space wave mode propagation.
5. Write the function of 1) Transducer and 2) repeater in the context of communication system.
6. What is modulation? Explain the need of modulating a low frequency information signal.
7. We do not choose to transmit an audio signal by just directly converting it to an E.M wave of the same frequency. Give two reasons for the same.

8. Explain briefly with the help of diagrams the terms (i) amplitude modulation and (ii) Frequency modulation. Which of these (i) gives better quality transmission? (ii) Has a larger coverage
9. Why is short wave bands used for long distance transmission of signals?
10. Optical and radio telescope are built on the ground but x-ray astronomy is possible only from satellite?
11. Draw a block diagram for a transmitter and a receiver of AM wave.

3 MARKS

12. Define the term modulation index for an AM wave. What would be the modulation index for an AM wave for which the maximum amplitude is 'a' and the minimum amplitude is b'
13. A TV tower has a height 'h'. Derive an expression for maximum distance up to which the signal can be received from the earth.
14. What is meant by the term modulation? Explain with the help of a block diagram, how the process of modulation is carried out in AM broadcasts?
15. What is meant by 'production' of a modulated carrier wave? Describe briefly the essential steps with block diagram production.
16. What is meant by 'detection' of a modulated carrier wave? Describe briefly the essential steps with block diagram detection.

SAMPLE QUESTION PAPER
(AS PER NEW PATTERN-MARCH 2015)

MAX.MARKS- 70 TIME- 3 HOURS

General Instructions :

(i) All questions are compulsory.

*(ii) Question numbers **1** to **5** are very short answer type questions, carrying **one** mark each.*

*(iii) Question numbers **6** to **10** are short answer type questions, carrying **two** marks each.*

*(iv) Question numbers **11** to **22** are also short answer type questions, carrying **three** marks each.*

(v) Question number 23 is value based question, carrying 4 marks.

*(vi) Question numbers **24** to **26** are long answer type questions, carrying **five** marks each.*

(vii) Use of calculators is not permitted. However, you may use log tables, if necessary.

(viii) You may use the following values of physical constants wherever necessary

$c = 3 \times 10^8$ *m/s*

$h = 6.6 \times 10^{-34}$ *Js*

$e = 1.6 \times 10^{-19}$ *C*

$\mu_o = 4\pi \times 10^{-7}$ *Tm/A*

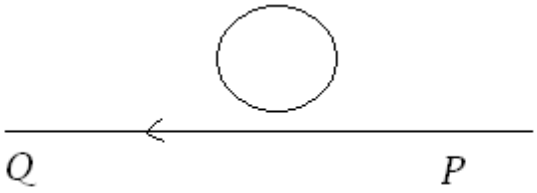
Mass of neutron $m_n = 1.6 \times 10^{-27}$ *kg*

Boltzmann,s constant $k = 1.38 \times 10^{-23}$ *J/K*

Avagadro's number $N_A = 6.023 \times 10^{23}$ */mole*

1) Draw the graph between electric field strength and distance from the centre of the hollow conducting charged sphere.

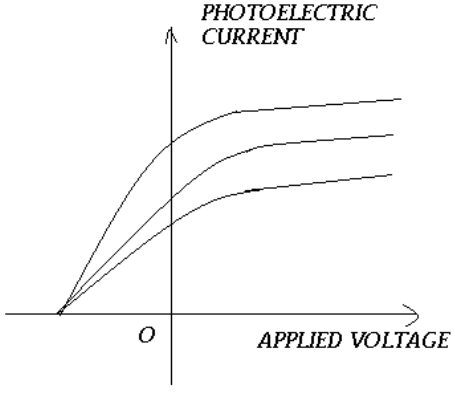
2) The electric current passing through a wire in the direction from P to Q is decreasing. What is the direction of induced current in the metallic loop kept above the wire as shown in the figure?



3) Which among X-rays, sound waves and radio waves can be polarized?

4) What is photodiode? Draw its symbol.

5) In a photoelectric effect experiment, the following graphs were obtained between the photoelectric current and the applied voltage. Name the characteristic of the incident radiation that was kept constant in this experiment.



6) Two capacitors of capacitances 3μF and 6μF are charged to potentials of 2V and 5V respectively. These two charged capacitors are connected in series. Find the potential across each of the two capacitors now?

7) Length of a given conductor is increased to 3 times by stretching it. What is its effect on drift velocity and resistivity?

(Assume potential difference across the conductor is kept constant).

8) What is potential gradient? Write its unit . Write its expression in terms of specific resistance of the wire.

(OR)

Draw the graphs showing variation of resistivity with temperature for metals and silicon.

9) State Biot –Savart's law. Using it, write the expression for the magnetic field at the centre of the circular current carrying coil of radius 'a'.

10) A circular copper disc, 10cm in radius rotates at 20π rad/s about an axis through its centre and perpendicular to the disc. A uniform magnetic field of 0.2 T acts perpendicular to the plane of the disc.

(i) Calculate the potential difference developed between the axis of the disc and the rim.

(ii) What is the induced current if the resistance of the disc is 2 ohm.

11) The threshold frequency for a certain metal is 3.3×10^{14} Hz. If light of frequency 8.2×10^{14} Hz is incident on the surface of the metal. Find (i) work function (ii) maximum K.E of photoelectron ejected,(iii) threshold frequency.

12) (i) If the base region of a transistor is made large as compared to the usual transistor, how does it affect (a) collector current (b) current gain?(ii)Write the biasing conditions for a transistor.

13) A set of 4 cells each of emf 2V and internal resistance 1 ohm are connected across an external load of 10 ohms with 2 rows, 2 cells in each branch. Calculate the current in each branch and the potential difference across 10 ohms.

14) What is the force on a wire of length 2 cm placed inside a solenoid near its centre (a) making an angle of 60° with the axis (b) parallel to the axis (c) perpendicular to the axis? The wire carries a current of 1A and the magnetic field inside the solenoid is 0.4T.

15) Compare the any three properties of ferro, para and dia magnetic substances.

16) A 100V,50Hz source is connected to a series combination of an inductance of 100mH and resistance 20 ohms. Calculate the magnitude and phase of current. (Or) A 25μF capacitor,0.1H inductor and 25 ohms resistor are connected in series with an ac source whose emf is given by E = 310 Sin (314t)

Calculate (a) frequency of the ac power supply?

(b) Impedance.

(c)Peak current in the circuit.

17) Explain various series of spectral lines of Hydrogen atom and draw energy level diagram.

18) Using the data given below, state which of the two given lenses will you prefer to construct the best possible

(i) Telescope (ii) Microscope. Also indicate which of the selected lenses is to be used as objective and as eyepiece in each case.

Lens	Power(P)	Aparture(A)
L_1	6D	1 cm
L_2	3 D	8 cm
L_3	10 D	1 cm

19)A star converts all its hydrogen to helium achieving 100% helium composition. It then converts helium to carbon via the reaction

$_2He^4 + {}_2He^4 + {}_2He^4 \text{ ----------} \rightarrow {}_6C^{12} + 7.27$ MeV

The mass of the star is 5×10^{12} kg and it generates energy at the rate of 5×10^{30} W. Calculate (i) Total number of nuclear reactions, (ii) Total energy released

And (iii) How long will it take to convert all the helium to carbon at this rate.

20) Explain the following (a) ground wave communication (b) Sky wave communication and (c) space wave communication.

21) Define polarization of light .State and prove Brewster's law.

22) What is the power dissipated in the pure inductor circuit & derive the equation for energy stored in an inductor?.

23) In the famous conversation, Rakesh Sharma, the first Indian Astronaut in space, was asked by the then Prime Minister Indira Gandhi as to how India looked from space. To which he replied '*Sare Jahan Se Achcha*' (better than the whole world).Answer the following questions based on above passage:

a. Which scientific mode of communication enabled The Prime Minister to speak to the Astronaut?

b. Name the scientific values displayed in this anecdote.

c. Which values are being reflected in the reply given by the astronaut?

24) Write the principle of a capacitor? Deduce the expression for the capacitance of a PPC and hence derive the expression for the energy stored in a capacitor.

(Or)

a) State Gauss's theorem in electrostatics.

b) Obtain expression for electric field at a point which is at a perpendicular distance 'r' from a plane infinite sheet of charge with uniform charge density.

25) a)State Huygen's principle.

b) Describe the single slit diffraction experiment and obtain the expression for fringe width.

(Or)

a) Derive the relation between the focal length of a convex lens in terms of the radii of curvature of the two surfaces and refractive index of its material. Write the sign conventions and two assumptions used in the derivation of the relation.

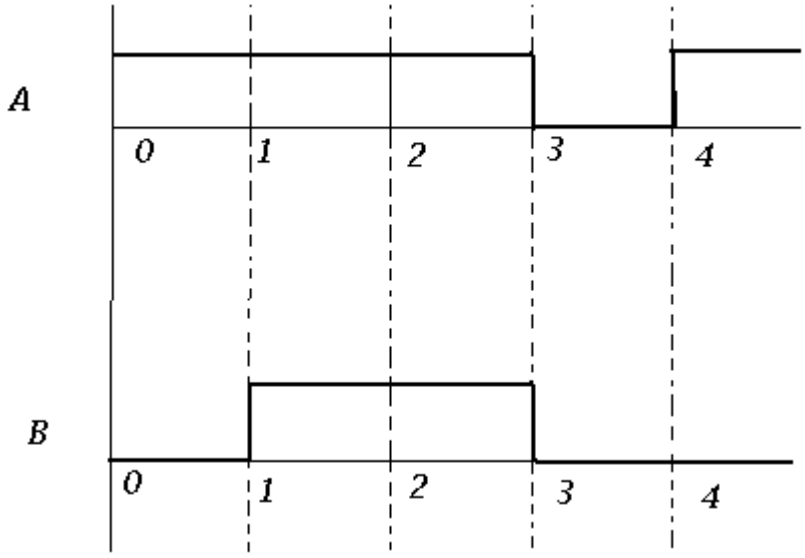
b) A convex lens of focal length 40 cm and a concave lens of focal length -25 cm are kept in contact with each other. What is the value of power of this combination?

26) a) With the help of a labeled diagram, explain how n-p-n transistor is used as an amplifier in CE configuration. Explain how the input and output in this case are out of phase.

b)A transistor operated in CE configuration at Vc=2V such that change in base current from 100μA to 200 μA produces change in the collector current from 9mA to 16.5mA.Calculate the current gain. OR

a) Explain the working of n-p-n transistor as an oscillator with the help of a labeled diagram.

b) Sketch the output waveform for the following inputs A and B obtained from NAND gate.



VALUE BASED QUESTIONS

ELECTROSTATICS

1. An elderly woman went alone to the Registrar's office to disburse her property. When she enquired in the office she was asked to get a Xerox copy of the document which works under electrostatic induction. The Xerox shop was far away and across the road. She took the help of the passer-by and got her Xerox done.

a. What values did the passer-by have?

b. How does a neutral body get charged by electrostatic induction?

Ans: a. Helping, sharing, respect for elderly people.

b. For a body to get positively charged, a negatively charged body has to be brought close to the neutral body which after earthing gets charged uniformly.

2. Ram and Shyam went to the trade fair. They were busy in a crowded corner. Balloons were sold. A child was seen troubling his parent and crying for something. On seeing this, Ram went to the child and said that he would perform a trick with balloons. Ram took two balloons and Shyam helped him to inflate and tie. When the balloons were rubbed with the sweater he was wearing, they were attracted. When taken nearer to wall, the balloons got stuck. The child enjoyed and stopped crying.

a. Give two values of Ram and Shyam.

b. How did the balloons get attracted? Will they repel also?

Ans: a. Presence of mind and knowledge of static electricity.

b. When balloons were rubbed with woollen sweater, it becomes negatively charged. When taken nearer the wall, positive charges are induced by electrostatic induction on that part of the wall, so gets attracted. ie, when the bodies are similar charged they repel.

3. Arun had to repaint his car when he was reminded by the car company for his regular car service. He told them to do spray painting of mountain dew colour. The company also replied that they usually perform spray painting only as wastage is minimized and even painting is achieved.

a. What values did the car service company have?

b. If spray painting is done by electrostatic induction, how is even painting achieved?

Ans: a. Customer care, commitment, concern and truthfulness

b. Droplets of paint are charged particles which get attracted to any metallic objects by electrostatic forces.

4. In Akash's classroom the fan above the teacher was running very slowly. Due to which his teacher was sweating and was restless and tired. All his classmates wanted to rectify this. They called for an electrician who came and changed the capacitor only after which the fan started running fast.

a. What values did Akash and his classmates have?

b. What energy is stored in the capacitor and where?

Ans: a. Team work, concern, respect to teacher and responsibility

b. Electrical energy in the dielectric of the capacitor.

5. Aswin asked his Physics teacher why are voltmeter, galvanometer and ammeter kept in a cavity inspite of its outer covering being made of an insulator

a. What values did Aswin have?

b. Explain Faraday's cage or electrostatic shielding

Ans: a. inquisitiveness, to improve his knowledge in Physics, willingness to gain knowledge
c. These sensitive instruments should not be disturbed by external electric field.
6. Vijay was preparing an electronic project for science exhibition. He required a capacitance of 2μF having a capacity to operate under 1 kV potential. He went to a shop to purchase it. Shopkeeper was having only 1μF capacitors of 400 V rating. Vijay calculated minimum number of capacitors of 1 μF so that he could arrange them to form a capacitor of 2μF value.

(a) What values do you judge in Vijay?
(b) Show the calculations done by Vijay
Ans: a. Scientific attitude and hard working nature
7. During a thunderstorm Rohan and his friends were in the middle of a jungle. His friends were standing under a tree. Rohan advised them not to stand there. Rather he suggested they should move back to the bus. He explained them that they are safe inside the bus due to electrostatic shielding.

(a) What are the values exhibited by Rohan ?
(b) What is electrostatic shielding?
Ans: a. Scientific temper and care and concern
b. explanation of electrostatic shielding.

CURRENT ELECTRICITY

1. That night Vaikunth was preparing for his physics exam. Suddenly the light in his room went off and he could not continue his studies. His cousin brother Vasu who had come to visit him was quick to react. Vasu using the torch (an android application) installed in his mobile phone found that the fuse had blown out. He checked the wiring and located a short circuit. He rectified it and put a fuse wire. The light came to life again. Vaikuth heaved a sigh of relief, thanked Vasu and continued his studies.
a. What are the values projected by Vaikunth and Vasu? (Any two)
b. What is an electric fuse? What characteristics you would prefer for a fuse wire?

Ans: a. Vaikunth: acknowledging the help from others with gratitude.
Vasu: awareness of the technology, helping tendency, practical knowledge of the subject.
b. An electric fuse is a wire used as a safety device which melts when current exceeds the limit. Low melting point, high resistivity.
2. Kumaran wanted to pay electricity bill that day. He realized that the consumption shown by the meter was unbelievably low. He thought that the meter must have been faulty. He wanted to check the meter. But unfortunately he did not have any idea as to how to do this. There came his friend Subhash to help him. He told Kumaran to run only the electric heater rated 1kW, 220 V in his house for some time keeping other appliances switched off. He also calculated the power consumed in kilowatt hour and compared the value with the meter. Kumaran was happy and thanked Subhash for his timely help and the knowledge.
a. What are the values displayed by the friends?
b. Express kWh in joules. Find the resistance of the heater.

Ans: a. Honesty, sharing of knowledge, willingness to help
b. 1kWh= 3.6×10^6 J. , R = V2 /P= 48.4Ω

3. Raghav lives in an area where birds in large groups play around producing pleasing humming sounds. One day he notices that the high power lines soon after a strong wind have come too close which may prove fatal for the birds that would sit on them and flutter their wings for some reason or other. He complained to the authorities and the lines were set at the proper distance once again

a. What are the values possessed by Raghav and the authorities?(any two) b. What is the danger that could happen to the innocent birds in Raghav's view? c. How did distancing the lines solve the problem? Ans: a. Raghav: affection towards birds, taking appropriate action, Authorities: conscious b. The bird may get electrocuted; avoid sparking as shown in the diagrams below.

4. Supraja was doing an experiment (Comparison of emfs) using potentiometer in Physics lab. She could not take the readings because the galvanometer showed same side deflection. She checked the circuit and the connections were correct. Her friend Manasa who was doing her experiment nearby came to help Supraja. Manasa increased the voltage of the eliminator (by turning the knob) supplying current to the potentiometer. Supraja tried the experiment again and got the readings. She thanked Manasa for her help. a. What are the values displayed by both Supraja and Manasa? b. State any one reason why the galvanometer showed same side deflection.c. Distinguish between emf and terminal pd. Ans: a. Sharing of knowledge, caring for and helping others b. The emf of the driving cell should be greater than the emf of the experimental cells c. The potential difference between the terminals of a cell when the cell is in the open circuit and` the potential difference between the terminals of a cell when the cell is in the closed circuit

5. Ramaniamma was a childless widow. She ran her life only by the pension for the Senior citizens from the Government. When she switches of one bulb in her house all the other appliances get switched off. She could not even spend for an electrician. Sujatha living nearby decided to do something about this. She referred to Physics books and learnt that the series combination for the household connection should be the reason. She called an electrician and had the circuit changed to parallel combination. The problem was solved and Ramaniamma was happy. She thanked Sujatha for her help to solve the problem. a. What are the values possessed by Sujatha? b. Why for household a parallel combination used? What are its advantages. Ans: a. care for elderly people, empathy, willingness to gain knowledge b. same voltage for all appliances, even if one appliance is not working the others can work.

6. Rakesh purchased cells for his transistor. He felt that cells are not working properly. He wanted to check their e.m.f. So, he took the cell to the physics lab and with the help of potentiometer found their e.m.f. To his surprise e.m.f. was less than the value claimed by the manufacturer. He lodged the complaint with consumer forum and received the deserving response. (a) What values are displayed by Rakesh ? (b) What do you think why Rakesh used potentiometer instead of voltmeter to find out e.m.f. of the cell ? For more precise measurement the potential gradient of the potentiometer should be high or low ?Ans: a. Responsibility and timely actionb. Potentiometer draws no current from the cell. Low potential gradient.

7. Laxmi and her mother went to the market to purchase some household articles. Laxmi's mother was going to purchase 100 W electric bulb. Laxmi advised her to purchase CFL. She told her mother that it will consume less amount of power and will save electricity.(a) What qualities do you notice in Laxmi ? (b) A 100 W bulb and a 500 W bulb are joined in parallel to the mains. Which bulb will draw more current ? Ans: a. Energy saving, concern for society

MAGNETIC EFFECTS OF ELECTRIC CURRENT AND MAGNETISM

1. MrNarasimhan a 65 year old person often complained of neck pain. One day his grandson Avinash, suggested that magnetic therapy is very effective in reducing such pains. He said that the permanent magnet/electromagnet, used in the device will help to produce Joule's heating effects in the blood stream, which helps the blood flow better. He immediately contacted his friend in Chennai, who was running Magnetic Therapy Clinic. Mr. Narasimhan felt better.

a. What two values did Avinash exhibit towards his grandfather? Mention any two

Ans. Responsible behavior, concern and awareness

b. What is the SI unit of magnetic induction and define it?

Ans. Tesla (defn)

2. Ms Udaya joined a PG course in Nanotechnology lab in IIT Chennai. The first day, when she went to the lab, she met Mr. Antonio, the lab assistant.He greeted her and advised her not to touch the wires which were suspended from the roof at every part of the lab as they were from high voltage lines. He also told her not to bring any of the two wires closer to each other during any experimental applications. He helped her in understandingabout the precautions that has to be taken in the lab.

a. What value did Mr. Antonio exhibit towards Ms. Udaya? Mention any two

(Responsible behavior, sensitivity, concern for others and alerting the people)

b. Why two high voltage power transmission lines should not be close to eachother?

(Hint: like currents attract)

C.Give an expression for the magnetic force that acts between the wires?

3. In the birthday party of Bharat, a class 7student, his parents gave big slinky to all his friends as return gifts. The next day, during the physics class Mr Mohan, the teacher explained them about the production of magnetic fields using current carrying coil and also said that they can make permanent magnets, using such coils by passing high currents through them. That night Sumanth, a friend of Bharat, asked his father about the
coils, and their shape. His father asked him to bring the slinky, that his friend gave and explained the uses of toroid and solenoid.

a. What value did Sumanth's father exhibit towards his son?

(Responsibility, makes his child to understand the concepts and to generateinterest in the subjects)

b. What is the difference in the fields produced by the solenoid and Toroid?

The magnetic field lines in a toroid is concentric circles whereas in solenoidit is straight within the turns.

4. Ms Nita chander found that her son could not hear properly. Mother took her to the specialist who prescribed hearing aid for her son. Hearing aids consist of electromagnets in the loudspeakers used in the device.

a. What two values does Ms Nita exhibit towards her son and students? Mention any two

(caring attitude, sensitive towards society, concern for others

c. What is an electromagnet? In what way its hysteresis curve is different from that used for permanent magnets?

Ans. Electromagnet- temporary magnet.Hysteresis curve has small area, small coercivity, small retentivity.

5. MsSumathy wife of Mr.Varadan complained about the non availability of gas cylinders and explained to him to look out for alternate methods for cooking. Mr.Varadan bought an induction

stove to overcome the fuel problem. The next day Sumathy used her copper bottom cooker and kept it on the induction stove. But even after using it for half an hour she found that the cooker was not hot and food not cooked. As she was not aware of themethod to use the induction stove, she asked her elder daughter Dhanya, studying first year engineering about it. She told her, that some vessels cannot be used on this stove. She took the instruction manual and explained to her mother, that the stove works on magnetic induction, and copper being a dia magnetic material, will not respond to it.

a. What values did Mr.varadan and Dhanya exhibit towards Ms.Sumathy? Mention any two

(Awareness, concern for conservation of energy and fossil fuels, sharing the knowledge)

b. Give few examples of diamagnetic materials and explain how their susceptibility varies with temperature?

Ans.Susceptibility is independent of temperature as they have no permanent dipoles.

6. Bala and Rama class X students were assigned a project based on magnetism. In their project work, they had calculated the value of earth's magnetic field. When they submitted their project for verification. MrSantosh, their physics teacher, corrected the mistakes. He also suggested few books which could be of use to them.

a. .What values did Mr.Santosh exhibit towards his students? Mention any two

(Honesty, helpfulness, responsible behaviour towards students, concern for the student to create interest in the subject)

b. .Mention the three magnetic elements required to calculate the value of earth's magnetic field.

Ans. Magnetic declination, magnetic inclination and horizontal component of earth's magnetic field.

7.MrSairam the chief development officer, in southern railway went on an official tour to attend a seminar on fast moving trains. He met his friend Ontosaki in Tokyo after he finished his seminar there. His friend explained to Sairam, how Japanese people are concentrating on energy conservation and saving of fossil fuels using Maglev trains. Mr sairam travelled from Tokyo to Osaka in maglev train and found that sound is less, traveliing is smooth and understood in what way we are lagging behind Japanese in mass transporting systems. This works on the principle of Meissner's effect a. What values did Mr sairam found from Ontosaki? Mention any two.

(Awareness about new technology, concern for energy conservation, decrease
of noise pollution and air pollution i.e, concern for environment)

b. What is Meissner's effect?

Ans. When a superconductor is cooled in a magnetic field below its critical temperature the magnetic field lines are expelled showing diamagnetic property. This is called Meissner effect.

8.MsLavanya a house wife aged 42 years complained of stomach ache one day. Her husband Mr Srinivas took her to a nearby hospital. The doctor observed her and found something wrong near her liver and suspected malignancy. There after checking her MRI scan, a team of doctors advised her to go through Carbon radio therapy which is very safe. They said using cyclotron, high speed ions can be generated that directly attack thecancerous tissues and destroy them.

a. What values did Mr Srinivas and the doctor have exhibited? Mention any two.

Ans. concern for others, helpfulness, presence of mind, responsible citizen

b. What are the roles played by Electric field and magnetic field in Cyclotron?

Ans. The charged particles are accelerated by the electric field with the magnetic field bringing them again and again to the electric field that is the region between the 'Dee'.

9.Mrs. Gupta family was fast asleep during Night. They had no clue that there living room has caught fire due to a short circuit. Suddenly they heard sound of alarm and woke up. They were surprised to see that the sound was coming from the model of fire alarm prepared by their son. They were all happy that a small science model has saved their life

(i) Give the values displayed by the parents and son.
(ii) Name the device use in the model.
Ans: (i) Knowledge, Scientific thinking
(ii) photo cell

10. Mrs Thakur left her car headlights on while parking. The car would not start when she returned. Seeing her struggle, Mohit went to her help. Not knowing much about cars, he ran and brought a mechanic Raju from a garage nearby. Raju realized that the battery had got discharged as the headlight had been left on for a long time. He brought another battery and connected its terminals to the terminals of the car battery to get the engine started. Once the engine was running, he disconnected this second battery. This is known as "JUMP STARTING". Mrs. Thakur thanked both Mohit and Raju for helping her.
(i)What values did Mohit have?
(ii) A storage battery of emf 8.0 volts and internal resistance 0.5 ohm is being charged by a 120 volt DC supply using a series resistor of 15.5 ohms. What is the terminal voltage of the battery during charging? What is the purpose of having a series resistor in the charging circuit?
Ans: (i)Helpful, aware of his weakness, decision making ability.

ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTS

1. Krishnan a retired science teacher was walking with his grandson Munna by the side of a paddy field. Munna noticed power grids carrying thick wires. He was curious to know what the structure was and what the wires were for. So he asked his grandfather about it. He also wanted to know if the tower could be removed so that there would be more space for
crops. Krishnan explained in detail about the tower and the need for the wires.
QUESTIONS: a) Why is the voltage stepped up for long distance transmission?
b) What are the values exhibited by Krishnan and Munna?
ANSWERS:
a) Less power loss
b) Concern for saving energy and greenery.

2. Nita switched on the radio set to listen to her favourite music but found the reception was not clear. Also there was overlapping of signals. So she adjusted the tuner in the set till she heard the music clear.
QUESTIONS:
a) What are the components of tuning circuit in a radio?
b) Name the phenomenon involved here?
c) What value can be associated with this?
ANSWERS:
a) By adjusting the tuner, she would have changed the capacitance value and adjusted the frequency.
b) Resonance.
c) Harmony. By being in harmony with nature, life would be beautiful and easy for the future generation.

3. Anand on entering his apartment, switched on the tube light, but it did not work. So he called the electrician. The electrician inspected the tube light and suggested a replacement of the choke. On replacing the choke Anand found the tube light working.
QUESTIONS:
a) What is the function of a choke?
b) Identify the value exhibited here.
ANSWERS:
a) To reduce the current in the circuit without any heat loss.
b) Concern for conserving energy.

4. Monica had come from Singapore on a holiday to her grandmother's place. She had heard a lot about Tirupathi temple and so she went to Tirupathi with her grandmother. She walked through a metal detector and heard a beep sound as she walked through it. When

she went back to Singapore she asked her father about the metal detector and its working. Her father explained the working in detail and also the need for installing metal detectors in places where people visited in huge numbers.

QUESTIONS:

a) Name the components present in the detector .

b) What is the phenomenon involved?

c) What value can be attached with this?

ANSWERS:

a) An inductor and a capacitor.

b) Resonance.

c) Concern for social security and curiosity.

5. During the Physics period, the teacher had started with alternating current. She recalled the concepts of AC and DC. She also asked the students to draw the graphs of AC/DC in their notebook. Ramaa did the work. But Leena was not able to draw. She struggled but Ramaa helped her in the completion of the graph.

Questions: i. What values were displayed by Ramaa?

Sharing the knowledge, helping nature.

ii. Draw graphically AC & DC

iii. Why do we prefer AC to DC?

Less loss of power in AC.

6. A visit to science exhibition was arranged for class XII. They saw the process of electroplating. The students exhibited the electro plating with the help of DC source. Immediately students raised the doubt, "Why don't we use AC instead of DC?" The teacher in charge explained and cleared their doubts.

Questions:

i) What values were displayed by these students?

Curiosity, critical thinking and understanding

ii) Why should we use dc instead of ac?

Because in AC, direction of current changes periodically whereas the electrodes are with fixed polarities.

7. Subhash wanted to see the work of a transformer. He bought a transformer from a shop. He connected the primary to an AC supply. At that time an aluminum ring in his hand falls into the core of the transformer. Without noticing that he switched on the power

supply. The aluminum ring flew up into the air. He became panic. His father, an electrical engineer in EB explained the reason.

Questions:

i. What value does he exhibit?

Curiosity, awareness.

ii. Bring out the reason for the above activity.

Induced current in the aluminum ring acts in the opposite direction to those in Coil and so magnetic field of the ring repels the magnetic field due to the coil.As a result of it the ring shoots up in air.

8. Raj is in XII standard. His Physics teacher demonstrated an experiment to explain Faraday's laws of electromagnetic induction. Raj interrupted her lecture and asked "Is there any possibility of induced emf due to earth's magnetism"? The teacher was stunned for a moment and gave this question for group discussion. Finally the students came out with correct answer.

Questions:

i. Write the values that you learnt from this incident.

Team spirit ,curiosity, scientific aptitude.

ii. What can be reason for Raj's question?

When the wire in N-S direction is dropped freely, none of the components of earth's magnetic field is intercepted. So no induced emf is produced. When the Wire is dropped freely in E-W

direction horizontal component of earth's magnetic field isintercepted. So emf is induced in the coil.
9. Lakshika used to go to her school on bicycle. She studied electromagnetic induction in her physics class. An idea occurred to her. She attached a small dynamo and an LED with the axel of the cycle.(2)
This way during the ride she used to enjoy the glowing of LED. (a) What values do you think is inculcated in Lakshika after understanding physics ?
(b) What is the principle on which dynamo is based ? Does this device obey principle of conservation of energy.
Ans. (a) Capability to use the understanding of a concept for innovation, scientific temper, ability to correlate.
(b) Dynamo is based on the principle of electromagnetic induction.It converts mechanical energy into electrical energy. Yes, it obeys the principle of conservation of energy.
10. Mr. Dixit purchased heater marked with 80V – 800 W. He wanted to operate it on 100V – 50Hz a.c.
supply. He calculated inductance of the choke required for operating that heater.
(a) Specify the nature of Mr. Dixit.
(b) How Mr. Dixit could have calculated the value of inductance ? Explain.
Ans. a) He seems to be a techno friendly having confidence and knowledge of electrical gadgets.

ELECTROMAGNETIC WAVES

1. Clinical microscopes are used to diagnose diseases based on blood and urine samples. Mr. Bajaj does not believe in such tests. He prefers to go to doctors who diagnose on the basis of pulse check only. He fell ill and his temperature persisted for more than a month. Anurag a student of class twelfth resides near Mr. Bajaj house, convinced Mr. Bajaj and got his examination conducted. How X ray is produced? What are the values exhibited by Anurag?

Ans.X-rays are produced by accelerated charged particles.
Values; Caring nature, sympathy, general awareness.
2. Sushma's mother suffers from cancer of third stage. She has been advised a therapy in which cancerous growth will be burnt by atomic radiations. She is told that her beautiful hair will fall in this therapy and she is liable to become bald. Sushma's mother refuses the therapy which is otherwise must for her. Sushma talked to her mother explaining the need of the therapy and could convince her. What are the values exhibited by Sushma? Which electromagnetic radiation is used in cancer treatment?

Ans; Sympathy, caring nature, ability to react to situations.
Radition used; Gamma radiation.
3. As water nowadays is more contaminated Ritesh's father decided to install a water purifier. When the technician installed the purifier, Ritesh asked him whether it is capable of killing the bacteria and other germs also apart from suspended particles.The technician replied that they are killed by a radiation which is emitted from one of the compartments and explained the whole process of purification.
a) What kind of quality is shown by Ritesh?
b) What radiation does the technician refer to? Mention two more applications of such a radiation.
Ans: UVRadition. Also used in crack detection, forensic lab for detection of finger prints, in sterilization of surgical instruments.
4. Pramila was gifted with a box like oven on her birthday and she began to cook food extremely fast. Her son Ramu got surprised by the speed with which the food items getting cooked and he enquired about the working of the device as her mother is an engineer. Then his mother explained the importance of a particular type of radiation employed in the system and the principle behind it.

a) What was the quality exhibited by Ramu.
Ans; Curiosity, Scientific temper
b) What kind of radiation does Pramila refer to and mention one more application of that radiation?
Ans: Microwaves. Also used in radar operations and in Communication.

OPTICS

1. Ravi is using yellow light in a single silt diffraction experiment with silt width of 0.6 mm. The teacher has replaces yellow light by x-rays. Now he is not able to observe the diffraction pattern. He feels sad. Again the teacher replaces x-rays by yellow light and the diffraction pattern appears again. The teacher now explains the facts about the diffraction and
• Which value is displayed by the teacher?
• Give the necessary condition for the diffraction.

Ans: Inculcating scientific temper and curiosity among students, increasing understanding levels of students.
Condition: The wavelength of light must be comparable with the size of the slit
2. Aditya participated in a group discussion in his school on "Human eye and its defects" .In the evening he noticed that his father is reading a book by placing it at a distance of 50 cm or more from his eye. He advised him for his eye check-up.
• Suggest the focal length/power of the reading spectacle for him, so that he may easily read the book placed at 25 cm from eye.
• Name the value displayed by Aditya.
Ans: Determining 'focal length using lens formula and finding power 'P'
Ans: caring nature, Sympathy
3. Vinod was watching a program on the topic MOON on the Discovery channel. He came to know from the observations recorded from the surface of Moon that the sky appears dark from there. He got surprised and wanted to know the reason behind it. He discussed it with his friends, and they explained the reason behind it.
a) Name the value that was displayed by Vinod and his friends.
Ans. Vinod : Curiosity, Scientific temper.
Friends: helping nature
b) State the reason why sky appears dark from the moon.
Ans: No atmosphere hence no scattering.
4) Ramesh and Arwind were playing near a river. The river appeared shallow to them .Hence they decided to have fun by playing in the river water. Ramesh's friend Madan happened to pass through. He noticed the intention of the children .Immediately he instructed them not to indulge in adventure and explained them that the river was much deeper than it appeared. This way he avoided a mishappening.
a) What qualities do Madan displayed.
Ans: Caring nature, Social responsibility.
b) With the help of a ray diagram explain why water appeared less deep?
Ans: Correct diagram showing real depth and apparent depth.
5) Balan was very much fascinated towards astronomy that he decided to make a telescope He carefully studied about the construction of telescope and prepared his own model and presented his ideas in a science seminar and got first prize.
a) What qualities do Balan posses?
Ans: Scientific temper, curiosity, in depth understanding of the concept.
b) What kind of telescope he might have made and draw ray diagram for the same
Ans: Astronomical telescope, Ray diagram.
6) A teacher has given three lenses 0.5D, 4.0D and 10.0D to a student. He is not sure as to which lens would be used for constructing a good astronomical telescope. So he consulted his seniors

and the teacher and construct a telescope. Later he showed the telescope to the junior classes and explained about the choice of lenses.
(a) What value has he shown by doing these?
(b) Which lenses are used as objective and which one is an eye piece?
Ans: a) Curiosity, Scientific temper.
b)Objective-0.5D eyepiece -10D
7) . A child is observing a thin film such as a layer of oil on water show beautiful colours when illuminated by white light. He feels happy and surprised to see this. His teacher explains him the reason behind it. The child then gives an example spreading of kerosene oil on water to prevent malaria and dengue. (a) What value was displayed by his teacher?
(b) Name the phenomenon involved.
Ans: (a) Curiosity, Scientific temper.
(b) Interference of light.
8) Ramu while doing the experiment for determination of focal length of a convex lens ,suddenly dropped the lens and it got broken into to two halves along its axis .Then Ramu asked the teacher whether even the broken piece will form the image, the teacher answered in the affirmative and showed the image also.
a) What qualities are exhibited by Ramu?
Ans: Curiosity, Scientific temper.
b) What will be the nature of the image formed?
Ans: Same size, Less intensity.
9). Suman and Arti are friends, both studying in class 12th .Suman is a science student and Arti is a arts student .both of them go to market to purchase sun glasses. Arti feels that any colored glasses with fancy look are good enough. Suman tells her to look for UV protection glasses, Polaroid glasses and photo-sensitive glasses.
Read the following passage and answer the following questions:
(a) What are UV protection glasses, Polaroid glasses and photo sensitive glasses?
(b) What values are displayed by Suman?
Ans. (a) UV protection glasses are those which filter ultra violet rays they are harmful to our eyes. Polaroid glasses help in reducing the glare. Photo sensitive glasses get darker in strong day light. They protect our eyes from strong sunlight especially at noon.
(b) Suman has displayed concern for her friends. She has put to use the knowledge she acquired in her science. Mugging up things for examination is of no use. What we are taught in the class room must be used in practice.
10) During summer vacation Radha and Rani decided to go for a 3 D FILM. They have heard about this film through their friends. They were asked buy special glasses to view the film. Before they go for a movie, they approached their Physics teacher to know about these glasses. Physics teacher explained when two polarizer's are kept perpendicular to each other(crossed polarizer's) the left eye sees only the image from the left end of the projector and the right eye sees only the image from the right lens. The two images have the approximate perspectives that the left and right eyes would see in reality the brain combine the images to produce a realistic 3-D effect.
a) What qualities do these girls possess?
b) What do you mean by Polarization?
c) Mention the other applications of polarization.

ANS: a) Curiosity to learn, approaching the teacher to learn new things, inquisitiveness
b)Refer NCERT text book) & c) Sun glasses, LCD,CD players.
DUAL NATURE OF RADIATION AND MATTER
1. A function was organized in the village hall with 500 sitting arrangement. When people started entering in groups the counting became difficult. The village head asked Rahul and his friends to take the responsibility at the gate. The boys took the responsibility and people started

entering one by one . The disciplined entering of the people helped in easy counting with the help of a scientific device given by the village head to boys.

(a) What values are shown by the boys?
(b) Name the scientific device which is based on application of photoelectric effect
(c) What is the principle of such scientific device?
Sol (a) The values shown by boys are :
(1) High degree of general awareness
(ii) Sense of responsibility
(b) Photocell
(c) A person approaching a door way may interrupt a light beam which is incident on a photocell. The abrupt change in photocurrent records every interruptions of the light beam caused by a person passing across the beam. In this way it helps count the person entering the hall provided they enter the hall one by one.
2. Rohit one day thought if radiation has a dual (wave particle) nature, might not the particle of nature (the electrons, protons etc,) exhibit wave like character. So he consulted his physics teacher for its answer, who explained the facts properly.

(a) What are the values displayed by Rohit?
(b) According to your point of view how teacher explained such thing properly?
(c) Why is de – Broglie wave associated with the moving football not visible?
Sol (a) The values displayed by Rohit are :
(i) Curiosity
(ii) Creativity
(b) The moving particles of matter display wave like properties under suitable conditions. Because nature is symmetrical and that the two basic physical entities matter and energy must have symmetrical character. If radiation shows dual aspects so should matter.
(c) The de-Broglie wave length associated with moving football is of extremely short wavelength. Thus, it cannot be detected.
3. Meena thought that there are materials which absorb photons of shorter wavelength and emit photons of longer wavelength. But can there be stable substances which absorb photons of larger wavelength and emit light of shorter wavelength? She got confused and could not find its answer. Then she requested her friend Seema to explain her. The first case, energy given out is less than the energy supplied. But in the second case the material has to supply the energy as the emitted photons has more energy which cannot happen for stable substances.

(a) What values do you notice in Meena?
(b) Consider a metal exposed to light of wavelength 600 nm. The maximum energy of the electrons doubles when light of wave length 400 nm is used. Find the work function in eV
Sol (a) The values noticed in Meena are
(i) High degree of general awareness
(ii) Concern for her friend
(iii) Helping and caring nature
4. It is seen that gases are insulators at ordinary pressures and start conducting at very low pressures. Sunny was interested to know the reason behind it. So he requested his friend Amit to explain the concept behind it properly . Amit explained that at low pressure ions are far away, so they have possibility to reach their respective electrodes and constitute the current, but at ordinary pressure ions collide frequently and recombine with the opposite charged ions.

(a) What values are displayed by Amit ?

(b) An electron is accelerated through a potential difference of 100 V. What is the de Broglie wavelength associated with it? To which part of the electromagnetic spectrum does this value of wavelength correspond?
Sol (a) The values displayed by Amit are :
(i) High degree of general awareness
(ii) Concern for his friend
(iii) Helping and caring nature.

6. Shyam knows that red light has greater intensity and so it is much bright but in case of photoelectric emission it cannot produce the emission of electrons from a clean zinc surface while even weak ultra violet radiation can do so. He could not know specific cause of such thing. Then he went to his friend Kumar for its specific explanation. Kumar explained him that the photoemission of electron does not depend on the intensity while it depends on the frequency and the energy of photon of incident light. The energy of photon of red light is less than the work function of zinc, so red light cannot emit photoelectrons. Similarly, the energy of photon of ultraviolet light is greater than the work function of zinc, so ultraviolet light can emit photoelectrons.

(a) What values are noticed in Kumar?
(b) The work functions of lithium and copper are 2.3 eV and 4 eV respectively. Which of these metals are useful for the photoelectric cell working with visible light? Explain
Sol (a) The values noticed in Kumar are :
(i) High degree of general awareness
(ii) Concern for his friend
(iii) Helping and caring nature
7. Smitha wanted to give a gift to her cousin a burglar alarm. But she did not know about its working principle and its significance. She discussed it with her friend Shruthi. Shruthi explained her that in burglar alarm, ultraviolet light is continuously made to fall on a photocell installed at the doorway. A person entering the door interrupts the beam falling on the photocell. The abrupt change in photocurrent is used to start an electric bell ringing.

(a) What are the values shown by Shruthi?
(b) An electron and a photon each have a wavelength of 1.00 nm. Find (i) their momenta (ii) the energy of the photon, and (iii) the kinetic energy of electron
Sol (a) The values shown by Shruthi are :
(i) High order general awareness
(ii) Able to convince someone
(iii) Helping and caring nature

ATOMS AND NUCLEI

1. Kala's uncle who was a kabadiwalah was getting weak day by day. His nails were getting blue, he stated losing his hair. This happened immediately after he purchased a big container of heavy mass from Delhi University Chemistry Department. Doctors advised him hospitalization and suspected he has been exposed to radiation. His uncle didn't know much about radiations but Kala immediately convinced her uncle to get admitted and start treatment.

(i) What according to you are the values utilized by Devi to convince her uncle to get admitted in hospital
(ii)Name the radioactive radiations emitted from a radioactive element.
Ans : Caring nature and sympathy
Gamma radiation.
2. Selvi's grandfather was reading article is newspaper. He read that after so many years of atomic bombing is Hiroshima or Nagasaki, Japan National census indicated that children born

even now are genetically deformed. His grandfather was not able to understand the reason behind it. He asked his Granddaughter Selvi who is studying in class XII science. Selvi sat with her grandfather and showed him pictures from some books and explained the harmful effects of radiations.

(i) What are the values/ skills utilized by Selvi to make her grandfather understand the reason for genetical deformity?
(ii) Name the nuclear reactions that occurred is atom bomb.
Ans : Better understanding of the subject and helping nature.
Nuclear fission reaction
3. Kannan a resident of Kundakulam was all set to leave everything and shift to another place in view of the decision of Govt. to start nuclear thermal power plant at Kundakulam. His granddaughter Prachi, a science student, was really upset on the ignorant decision of her grandfather. She could finally convince him not to shift, since adequate safety measures to avoid any nuclear mishap have already been taken by the
Govt. before starting nuclear thermal plants.

• What is the value displayed by Prachi in convincing her grandfather
• What is the principle behind working of nuclear reactor
• What are the main components of nuclear reactor
• Why is heavy water used as moderator?
Ans :(i) Awareness, social responsibility
(ii) Controlled chain reaction
(iii)Nuclear Fuel, Moderator, Control rods, Coolant, Shielding
(iv) Neutrons produced during fission get slowed if they collide with a nucleus of same mass. As ordinary water contains hydrogen atoms so it can be used as a moderator. But it absorb neutron at a fast rate. To overcome this difficulty, Heavy waters is used as a moderator which has negligible cross sections for neutron absorption
4. Rahu and Rohan got a golden opportunity to attend a 3 days camp at IGCAR, Kalpakam. Rohu was excited about this camp, but Rohan was little disturbed about the camp. When Rahu asked about Rohan's concern, he expressed his fear about the absorption of harmful radiations emitted from the reactor by them. Immediately Rahu explained about the safety measures taken at the reactor site. Rohan was convinced with his reply and started preparing for his camp.

a)What moral would you derive from Rahu?
b) The fission properties of Pu239 are very similar to those of U235. The average energy released/fission is 180 MeV. How much energy, in MeV, is released if all the atoms in 1Kg of pure Pu undergo fission?
Ans: a) Care for his friend and positive attitude towards technology.
5. A farmer in a village was worried about the poor yield of the soil. Kannan , during his visit to his native place happened to meet this farmer and suggested him to use a phosphate fertilizer incorporated with Radio Phosphorous. He also explained that Phosphorous will be taken by the plant for its growth and radio phosphorous will increase the yield. The farmer thanked him for his valuable suggestion. a) Suggest the moral value that you derive out of Kannan,

b) A radioactive isotope has a half life of T years. How long will it take, the activity to reduce to i) 3.125% ii)1% of its original value?
Ans:a) Concern for the society/locality., awareness, presence of mind.
6. Raman and Nikhil are arguing about the estimation of age of specimen by any scientific

method. Raman said that there is no way of finding the age of a specimen scientifically. But Nikhil argued that there should be one method to find the age of specimen, but he is not aware of that method. Sekar, who is witnessing this argument, convinced them not to proceed with the argument. He said that the age of the specimen can be estimated by noting the drop in the activity of carbon C14 , when the organism is dead. Listening to the explanation given by Sekar, both of them were convinced and also felt happy as they have learnt a new concept.

a)What moral value do you observe in Sekar?

b) Obtain the amount of Co60 necessary to provide a radioactive source of 8mCi strength. The half life of Co60 is 5.3 years.

Ans : a) Readiness to teach his juniors, concern of juniors towards learning.

7. a) Sekar saw his younger brother wondering with a question which deals with emission of light from a vapour lamp. He was anxious to know how different colors were being emitted by different light. He also saw mercury and sodium vapour lamps in the physics lab and was curious to know what is inside the lamps. On seeing his anxiety to know more about it Sekar explained about absorption of energy and reemission of photons in the visible region. He also advised him not to touch or break any items in the lab for the thirst of knowledge.

a) What is the moral you derive from Sekar?

Ans: Concern for his brother/ care about the school property.

b) Which series in the hydrogen spectrum is in the visible region?

Ans. Balmer.

8. Mr. Rana a daily wages worker got affected by cancer. On knowing about it all his coworkers started avoiding him, fearing that it was contagious. Mr.Rana felt very depressed. Mr. Rana a close friend immediately took Mr.Rana to a radiologist who examined him and said it was the beginning stage of cancer and it can be easily cured and he also certified that it is not a communicable disease.

(i) What moral values did Mr. Rana exhibit ?

Ans. Positive attitude, encouraging nature, timely help, creating awareness. (ii) A radioactive substance 'X' has a half life of 140 days. Initially it is 8g. Calculate the time for this substance 'X' when it reduces to 1 g.

Ans. $N / No = (1/2)^n$

$= (1/8)^n$

$= (1/2)^3$

Therefore n= 3

T = 3 x 140

= 420 days

9. Rutherford and his team performed the Gold foil experiment that provided a new insight into the structure of an atom. Their findings were not recognized by the scientific community in that period of time. Still this did not deter them from making further path breaking discoveries in the field of Physics.

(i)What were the qualities that can be imbibed by us from Rutherford and his team?

Ans :Ability to remain undaunted even if others do not recognize the validity of research, to forge ahead with what we believe is the truth inspite of opposition.

(ii)What were the conclusions of the gold foil experiment? Draw the graph showing the relationship between the number of alpha particles scattered and the angle of scattering.

10. Eight year old Johnson and his father were waiting to board a bus at the bus stop on a hot scorching summer day. Johnson was feeling faint with thirst and the heat. His anxious father asked the nearby person for water. On seeing this, a tender coconut vendor gave a tender coconut to Johnson who drank it and felt better. Both father and son thanked the coconut vendor who refused to take money.

(i)What are the qualities that you would associate with coconut vendor?
Ans: warm hearted, caring for fellowmen, resourcefulness.
(ii)Name the nuclear reaction taking place in the sun. (Nuclear fusion reaction)
11. Mohini's mother was gaining weight and her body was becoming bulky. She was also experiencing more than normal hunger. Mohini was worried about this. She talked to her friends who suggested her to take her mother to a doctor. Mohini's mother was not willing to go to doctor. Mohini told her friends about this. One day Mohini's friends came to Mohini's house and persuaded her mother to go to doctor. Doctor administered a radioisotope of Iodine and diagnosed the problem. Mohini's mother was prescribed
appropriate medicines. a) What according to you, are the values displayed by Mohini and her friends? b) Give some information about the radioisotope of iodine?

Ans : Concern sympathy for her brother.

SEMI CONDUCTOR DEVICES

1. Ajay observed that there is fluctuation in D c power supply and he made a circuit by using one special semi conductor and regulated the power supply. What values he has shown and name the semiconductor and draw the circuit diagram for regulating power supply.

Ans:Rising to the occasion, finding solutions to the existing problems.
Zener diode is used to regulate the power supply.
2. when power supply in the home is stopped at night 8 pm Sita immediately switched the light of her mobile phone and could find the sufficient light to see the things. What values that she has shown. What kind of diode is there with the cell phone and what are the advantages of it over incandescent bulb?

Ans: Sita has shown presence of mind, application of knowledge.
Light Emitting Diodes are used
Advantages 1) low operational voltages and less power consumption.
2) Fast action and no warm up time required
3) Long time and rugged life.
3. A physics teacher explained that electronic components work with D C. Albert ,a student of his class observed that cell phone is charged by connecting charger to A C in his home. Next day he asked the teacher about the same.

What values the student has shown?
How the conflict would have been resolved by the teacher.
Ans: Albert has applicative mind, curious to learn, reasoning ability. The cell phone charger has the rectifier which converts A C to DC.
4. Father prepared to purchase a LCD TV but his son after studying the semiconductors, could convince his father to purchase an LED TV?

What values the son has shown? Also write any two points where LED is better than LCD TV?
Ans: Application of learning content in day to day life, convincing skills.
LED TV consumes less power and gives more picture clarity than LCD TV.
5. After reading an article on the generations of computers Abhay asked his teacher how it is possible to reduce the size of the computer so less and much efficient?

What values the student has shown?
What component made the computer size so small and what are its advantages and limitations?
Ans: Connect outer experience with class room learning, eager to find the reasons for things happening around.

Integrated chips could make the size of Computer so small.
6. Teacher said that it is difficult to install the electric polls in the hilly stations as the surface is not flat. Then a student asked the teacher how the people are able to maintain their lives in night. The teacher while explaining took the name of an optoelectronic device.

What values the student has shown?
Name the device that has used to clarify the doubt asked by the student?
Ans:Thinking about other's needs, interested to know the alternate ways and means.
Solar cells
7. Raghu's grand father has shown one radio that he purchased with his first salary in 1960, which is bigger than the present portable T V.

Next day Raghu asked his teacher what made the size of the radio so big and how it is possible to make palm size radios now.
What values that Raghu has shown? Write the correct answer for his doubt.
Ans: Raghu was eager to know and curious to learn.
Transistor and IC have made these changes to enable to make palm size radios.
8. After attending the class of semiconductors especially silicon,Rohit asked the teacher is there any relation between this semiconductor silicon and silicon valley?

What values Rohit has shown and what do you think about the relation between Silicon Valley and silicon.
Ans: Enthusiastic and love for learning knowledge and able to connect the outside knowledge to the class room content.
` Silicon Valley is famous for producing Silicon chips and large business activities take place due to this production.
9. A gardener wanted an alarm to make sound when the airtemperature is less than 00 and more than 300 and he told the same to his son, an electrical engineer. His son prepared as per his father's requirement.

What values the son has shown?
How he could design to meet the required needs and what logic gates he must have used?
Ans: Son is very caring and attends to the needs of old people.
The logic gate was OR gate
10. Grand mother of Harish expressed her worry about the theft of valuable articles in home.Harish mad a burglar's alarm and shown his grand mother and explain the function of it?Grand mother appreciated the efforts of harish.

What value harish has shown?
What logic gate has he used in the device?
Ans: Harish is very caring towards old people and respect and attends the needs of old people.
The logic gate used is AND gate.
11. Ram was excited to know about the function of traffic signals .His father has prepared a board and explained the working of traffic signals?

What values the father has shown?
What components he must have used to show the working of traffic lights?
Ans: Father is very caring and affectionate towards his son.
He must have used LEDs and other simple electronic components.

COMMUNICATION SYSTEMS

1. During a class discussion regarding the bandwidth of transmission medium, group A was of the opinion that message signals could be transmitted at any bandwidth. They were not aware of the transmission media to be used. Group B gave information about the commonly used transmission media while group C informed about the government procedures to be followed.

(a)What was the information given by group B and group C?
(b)What values do you observe in this class discussion?
Ans: Team Work, Togetherness, Awareness.

2. Two students of class 12 were interested in doing a project on 'transmitting signals of different frequencies'. They completed their project without any help but found that (i) the transmission is attenuated and (ii) the various information signals transmitted at low frequencies got mixed up.

(a)Identify the solution for the problem
(b)What values can we learn from those students?
Ans: Eagerness / Curiosity to learn more and scientific attitude.

3. A TV tower has a height of 70m with an average population density around the tower as 1000 per km^2. In about 5 years the CITY LIMIT the place doubled and the residents were not able to get the broadcast clearly. Niharika, a student, identified the problem and notified the Government saying that the height of the tower should be increased to double its coverage.

(a) By how much should the height of the tower be increased?
(b) What values would you appreciate in Niharika?
Ans : Awareness, Concern for public and Helping the society / being helpful to the society, initiative.

4. Raman went to the market to purchase a T.V. set. He got confused with so many features and functions of electronic appliances. He took the help of his friend Raman, a science student. Shankar explained him about the communication system, digital and analogue signals. This knowledge proved of great help to Raman in purchasing a colour T.V.

(*a*) What type of nature Sankar has?
(*b*) What do you mean by the term communication? Which types of signals are better? Ans : (*a*) Sandeep is friendly, helping and well aware having a vast knowledge of subject.
(*b*) Truthful, intact and speedy transfer of knowledge or data from one place to other is called Communication. Digital signals are better. These are disturbance free, clear and sharp.

5. Chitra was watching her favorite TV serial suddenly the picture started shaking on TV screen. She asked her brother to check the dish antenna. Her brother found no problem in dish. Chitra noticed the same problem in TV picture again after some time. At the same time she heard the sound of low flying air craft passing over their house. She asked her brother again. He explained the cause of shaking picture on TV screen when air craft passes over head.

(a) Name the values used by Chitra's brother?
(b) Why the picture on the TV screen was shaking when air craft was passing over head?
Ans : (i) Critical thinking and problem solving
(ii) Low lying air crafts reflect TV signals. Due to interference between direct signal received by antenna and reflected signal the picture on TV shakes

6. One day Ravi has observed that the radio in his uncle' house was tuned. But two programmes were coming at a time. Then he opened the radio set and he adjusted the coil properly again it was closed by Rahul. Mention a) scientific value exhibited by Ravi. B) What is the property which he changed and how was it corrected?

Ans :(a) Critical thinking and awareness of subject

7. One morning during school assembly the S U P W teacher who looks after the microphone arrangement was absent. Principal felt inconvenient without microphone to run assembly program. Then a boy of class XII came up on the assembly and he set right the microphone by rotating the knob of the amplifier. Then it started to function properly and loudly. (a) Mention one problem that might have caused to the amplifier

(b) Write the values of the student shown in the above situation?
Ans : (a)Mismatch of resistance of the amplifier with output
: (b) Critical thinking and problem solving
8. Television is theater at home. A TV is a basically a receiver which can be tuned to transmitter of our choice. Younger generation says that T V has merits for the society but elders do not agree to it.

Assuming yourself to be young and then old list two reasons favouring each concept.
Ans : Young- It is the useful tool to gain knowledge through news media
Old : Children tend to over utilize the entertainment component.
9. Kannan lives in a house which is located just beside of a hill in outskirts of the town. He is very interested to listen the music especially of Ghantasala. Recently he purchased a radio set but unluckily he is not able to listen the music. Then a student named Sushil who resides in the neighborhood adjusted by putting one long wire over a wall could succeed the music to listen.

(a)Explain what may be the reason for not being received the signal initially?
(b) What is the scientific attitude shown by the student in solving the above problem?
Ans: (a) Problem in the receiving part.
(b)Awareness and Curiosity
10. Rekha is a late riser. Her grandfather observes that she remains awake late night listening to radio on mobile is also a receiver. Where you have to listen and not to observe anything. Thus you're capable of doing other things simultaneously. Rekha does not ignore her works. But her grandfather blames the FM radio which has made her late riser. What is FM? Why is her grandfather worried?

Ans: Frequency Modulation
He fears distraction of concentration level.

GRADED EXERCISE QUESTIONS
ELECTROSTATICS

LEVEL -1

1. How many electrons will have a total charge of 1 coulomb?
2. Find the electric field intensity due to a charge of 5 X 10^{-8} C at a point 50 cm from it in vacuum
3. An electric charge of 2 μ c experience an electric force of 3.2 x 10^{-3} N when kept at a point in vacuum. What is the electric field intensity at that point?
4. An electric dipole consists of two charges of magnitude 1 μ c. They are placed 3 cm apart in a uniform electric field of 100 N C^{-1} acting at right angles to the axis of dipole. Calculate
a. dipole moment of electric dipole
b. electric force acting on either charge
c. Torque acting on dipole
5. An electric dipole is held at an angle of 30˚ with respect to a uniform electric field of 2 x 10^4 NC^{-1} experiencing a torque of 18 x 10^{-25} Nm. Calculate the dipole moment of the dipole
6. Electric potential at a point is 200 Volt. How much work will be down in bringing an α particle from infinity to that point (Charge on an α - particle is 3.2 x 10^{-19} C)
7. Find the potential at a point 30 cm from a point charge of 2 x 10^{-8} C in vacuum
8. An electric field at a point due to a point charge is 20 N / C and the electric potential at that point is 10 J / C. Calculate the distance of the point from the charge and also the magnitude of the charge.
9. A Cube of side b has a charge q at each of its eight vertices. Determine the potential and electric field due to these array at the centre of the cube.
10. A uniformly charged conducting sphere of 2.4 m diameter has a surface charge density of 80.0 μ C. m^{-2}. Find (a) The charge on the sphere and (b) total electric flux leaving the surface of sphere.
11. What is the area of the plate of a 2 F parallel plate capacitor with plate separation of 0.5 cm? Why does ordinary capacitor have capacitance of order of microfarads?
12. A 4 μ F capacitor is connected in parallel with a 8 μ F capacitor. The combination is charged at 300 volt. Calculate (i) the total charge on the combination (ii) the total energy stored in the combination
13. The plates of a parallel plate capacitor have an area of 90 cm^2 each and are separated by 2.5 mm. (a) Find the capacitance of capacitor (b) If the capacitor is charged by connecting it to a 400 V supply, how much energy is stored by the capacitor? (c) Calculate the energy stored per unit volume of the capacitor
14. Two parallel plate capacitors of 20 μ F and 30 μ F are charged to 30 V and 20 V respectively. If the plates of these capacitors with same type of charge are connected together. Find
a. The common potential of the capacitor
b. Charges on the capacitor at common potential
c. Loss of energy in the process
15. An infinite line charge producer a field of 9 x 10^4 N / C at a distance of 2 cm. Calculate the charge density.

ELECTROSTATICS

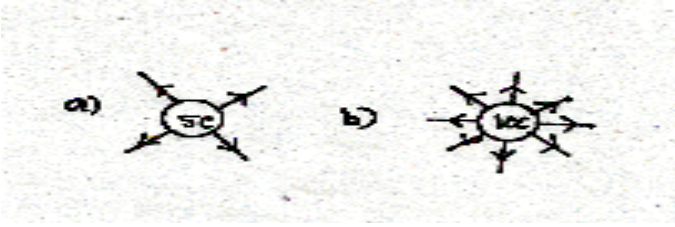
QUESTIONS FOR PRACTICE

1. Coulomb's law in vector form: 1

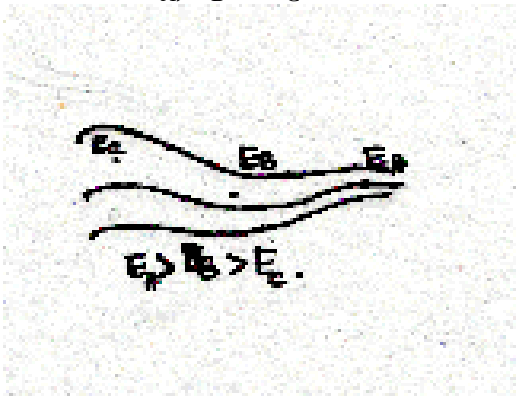
$$F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$$

2. In a medium the force of attraction between two point charges, distance d apart is F. What distance apart should these be kept in the same medium so that the force between them become (a) 5 F (b) F/5 ?

(a) For the force to become 5 F, the separation of must become $d\sqrt{5}$
(b) For the force to become F / 5, the separation d must become d / 5
3. Sketch the electric lines of force for (a) 5 C (b) 10 C
a) Less lines of force b) More lines of Force



4. What is the relation between E_A, E_B & E_C.

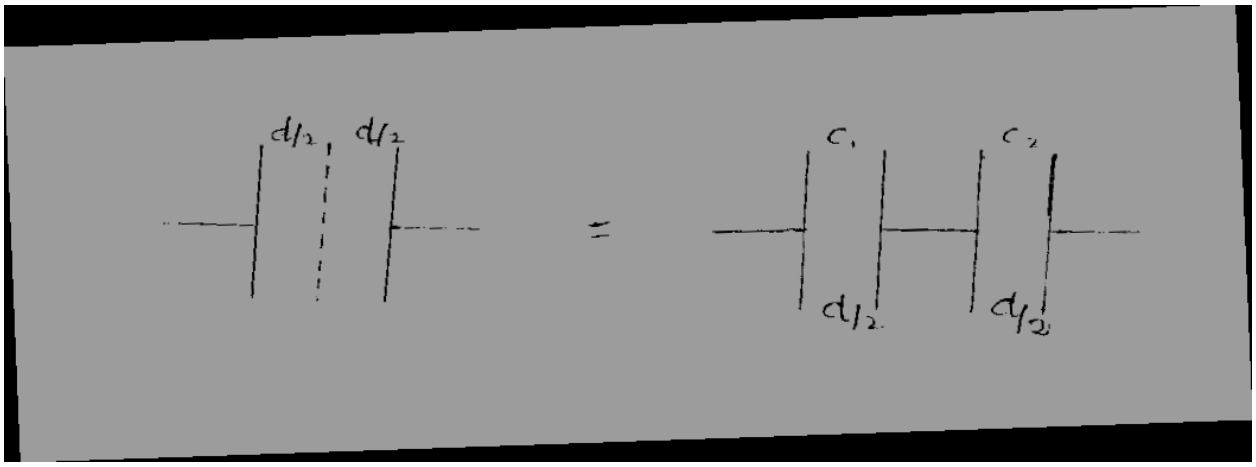


$E_A > E_B > E_C$
5. If a point charge +q, is taken first from A to C and then from C to B of a circle drawn with another point charge + q as centre, then along which path more work will be done?

WD will be same, as the distance is same.
6. An uncharged insulated conductor A is brought near a charged insulated conductor B. What happens to charge and potential of B?
Potential decreases but charge remains small as both are insulated.
7. A and B are two conducting spheres of same radius, A being solid and B hollow. Both are charged to the same potential. What will be the relation between the charges on the two spheres?
As charges resides on the surface of the conductors, both the spheres contains same amount of charges.
8. A conductor with a cavity in it is given a charge Q. What will be the total charge on the surface of this conductor if another conductor carrying charge q is placed in the cavity without touching the cavity?

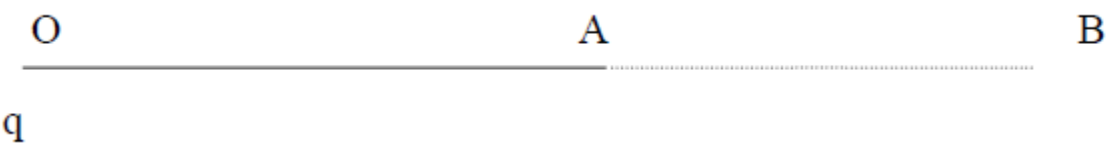
The charges get added up i.e., q + Q is the charge.

9. A capacitor of capacitance c has distance between plate is d. A very thin wire mesh is placed as shown in figure. Calculate new capacitance.

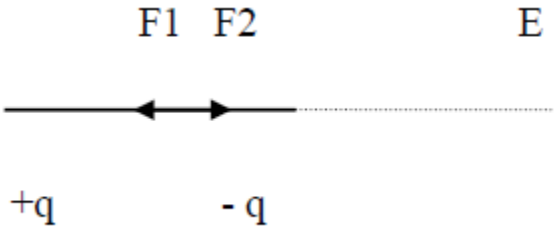


2 MARKS & 3 MARKS

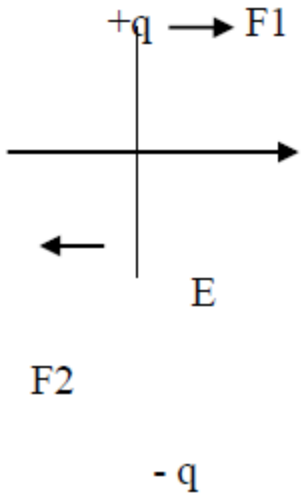
1. A point charge 'q' is placed at O as shown. Is $V_A - V_B$ positive, negative or zero, if 'q' is a (i) positive (ii) negative charge?



2. An electric dipole is free to move in a uniform electric field. Explain its motion when it is placed (1) parallel to the field and (ii) perpendicular to the field (1)

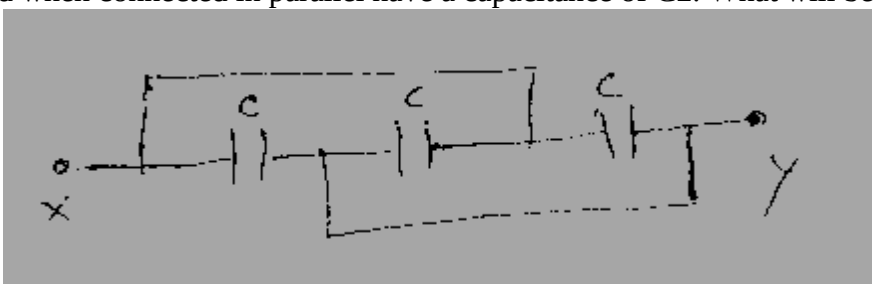


Either it may be stable or unstable equilibrium. Also, there is no torque or translatory force. (2)



The dipole will experience a torque. As EF is uniform, there is no translatory force.

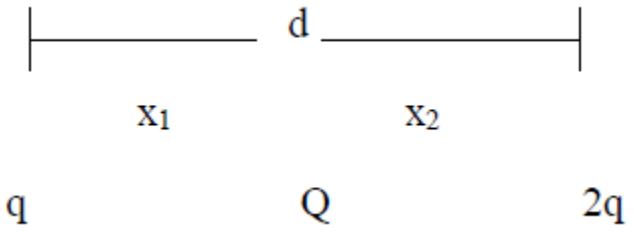
3. Two capacitors of equal capacitance, when connected in series, have a net capacitance of C, and when connected in parallel have a capacitance of C2. What will be the value of C1 / C2.

4. 

Find the resultant capacitance

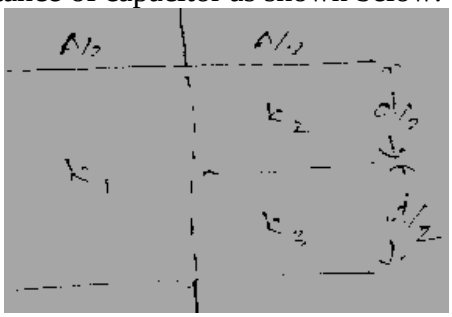
5. A spherical Gaussian surface encloses a charge of 17.7 X 10^{-8} C. (i) Calculate the electric flux passing through the Gaussian Surface. (ii) If the radius of the Gaussian surface is doubled, how much flux would pass through the surface?

6. Two point charges q and 2q are kept at a distance d apart from each other in air. A third charge Q is to be kept along the same line in such a way that the net force acting on q and 2q is zero. Calculate the position of charge Q in terms of q and d.

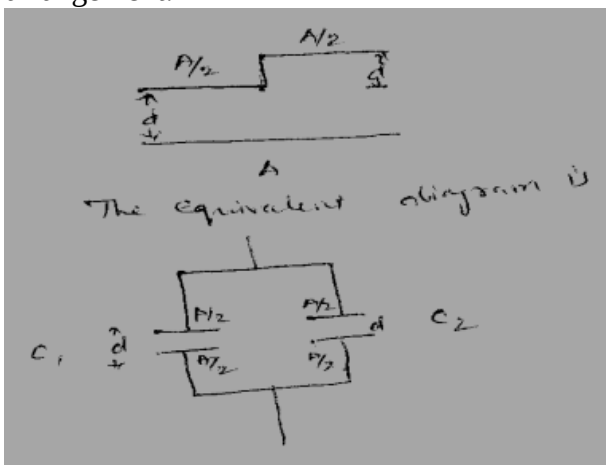


7. Show that the force on each plate of a parallel plate capacitor has a magnitude equal to (1/2) QE, where Q is the charge on the capacitor and E is the magnitude of EF between the plates. Explain the origin of the factor ½.

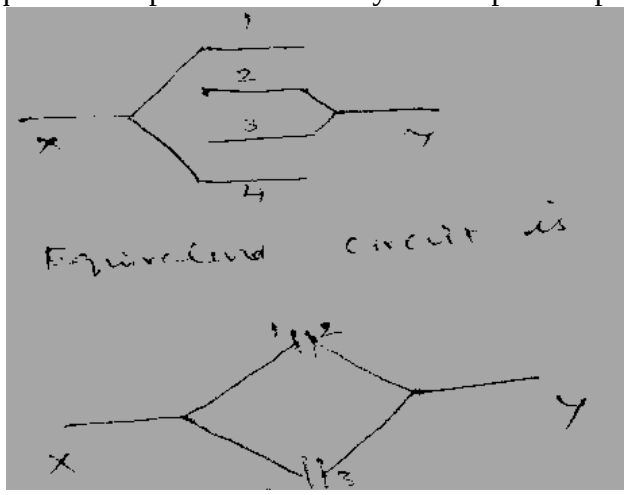
8. Calculate capacitance of capacitor as shown below.



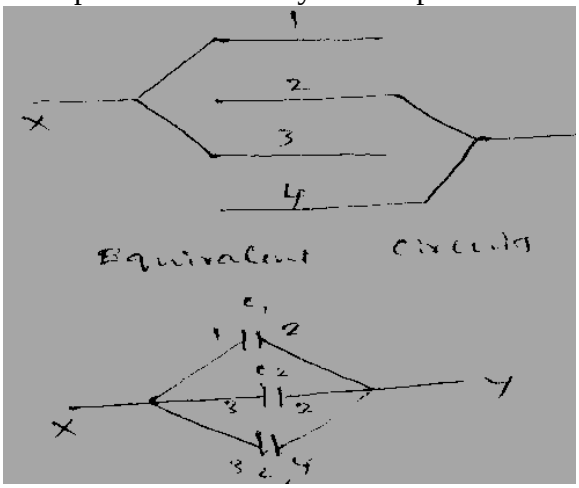
9. Derive the expression for 'Energy Density' in a parallel plate capacitor.
10. Derive Energy stored in series combination of capacitors.
11. Derive the Energy stored in parallel combination of capacitors.
12. Discuss the concept of common potential (Sharing of charges) in combination of capacitors.
13. Derive the relation for the loss of energy while sharing of charges when two capacitors are connected in parallel.
14. Derive the relation between electric susceptibility and relative permeability.
15. The diagram shows the arrangement of plates of a parallel plate capacitor. Find the resultant capacitance of this arrangement.



16. What is the equivalent capacitance of the system of parallel plates?

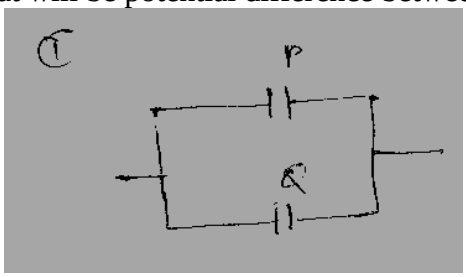


17. What is the equivalent capacitance of the system of plates shown below?



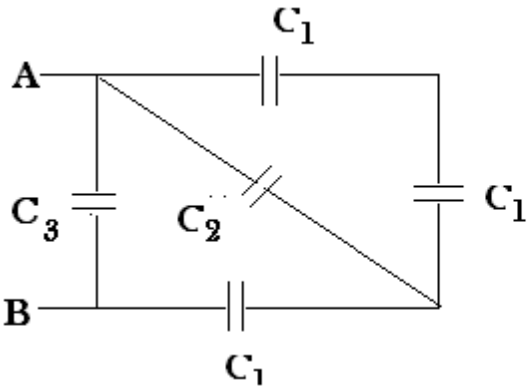
18. Capacitors P, Q and R have each a capacitance C. A battery can charge the capacitor P to a potential difference V. If after charging P, the battery is disconnected from it and the charged

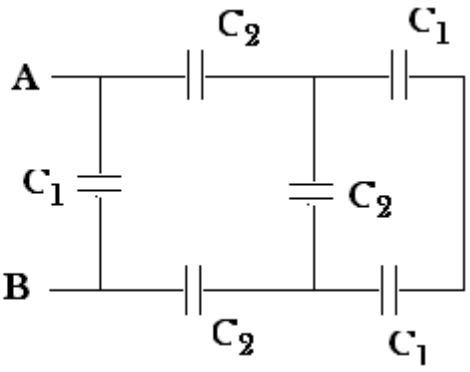
capacitor P is connected in following separate instances to Q and R (i) to Q in parallel and (ii) to R in series, then what will be potential difference between the plates of P in the two instances.



More Questions

1. State Gauss' theorem. Using it, find the strength of electric field at a distance r from the center of a conducting sphere of radius R carrying charge Q, where (i) r < R and (ii) r > R.
2. Define dielectric constant in terms of the capacitance of a capacitor? On what factor does the capacitance of a parallel plate capacitor with dielectric depend?
3. State Gauss' Theorem in electrostatics? Using this theorem define an expression for the field intensity due to an infinite plane sheet of charge density σ C/m^2?
4. Find an expression for the electric field strength at a distant point situated along the equatorial line of an electric dipole.
5. What is equipotential surface? Show that electric field is always perpendicular to the equipotential surface.
6. Define 'electric line of force' and give its two important properties.
7. Derive an expression for the total energy stored in a parallel plate capacitor and related to the electric field.
8. Define "intensity of electric field" at a point. At what points in the electric dipole field intensity is parallel to the line joining the charges.
9. State the principle of quantization of electric charges.
10. Define dipole moment. What is its unit in SI system?
11. Two electric lines never cross each other why?
12. What is the direction and magnitude of the electric field at the midpoint of an electric dipole made of length 2a?
13. Derive the expression for the energy density of a charged parallel plate capacitor.
14. . Show that work done in carrying electric charge on an equipotential surface is zero.
15. A spherical Gaussian surface encloses a charge of 8.85×10^{-10}C.
(i) Calculate the electric flux passing through the surface.
(ii) How would the flux change if the radius of the Gaussian surface is doubled and why?
16. Can two equi-potential surfaces intersect each other? Give reasons.
17. A 500 μC charge is at the centre of a square of side 10 cm. Find the work done in moving a charge of 10 μC between two diagonally opposite points on the square.
18. A 12 pF capacitor is connected to a 50V battery. How much electrostatic energy is stored in the capacitor?
19. Define capacitance and write its SI unit.
20. Explain the principle of capacitor
21. Derive an expression for capacitance of a parallel plate capacitor with vacuum as medium between the plates.
22. Derive expression for equivalent capacitance when three C1, C2 and C3 are connected in (i) Series (ii) parallel
23. Calculate equivalent capacitance between A and B in the given fig if C1 = 6μF, C2 = 3μF and C3 = 2μF.





24. Three capacitors of capacitances 2 pF, 3 pF and 4 pF are connected in parallel.
(a) What is the total capacitance of the combination?
(b) Determine the charge on each capacitor if the combination is connected to a 100 V supply.
25. Three capacitors each of capacitance 9 pF are connected in series.
(a) What is the total capacitance of the combination?
(b) What is the potential difference across each capacitor if the combination is connected to a 120 V supply?
26. Sketch electric lines of force due to (i) isolated positive change (ie q>0) and (ii) isolated negative charge (ie q<0)
27. Draw equipotential surfaces for an isolated point charge
28. An electric dipole with dipole moment 4×10^{-9} C m is aligned at 30° with the direction of a uniform electric field of magnitude 5×10^{4} N C^{-1}. Calculate the magnitude of the torque acting on the dipole.

LEVEL-2

1 MARK QUESTIONS

01 In a parallel plate capacitor the capacitance increases from 4 μF to 80 μF on introducing a dielectric slab of thickness equal to plate separation. Calculate the dielectric constant of the medium.
02 Force between two point electric charges kept at a distance d apart in air is F. If these charges are kept at the same distance in water, how does the force between them change?
03 In a medium, the force of attraction between two point electric charges, distance d apart, is F. What distance apart should these be kept in the same medium so that the force between them becomes 3F?
04 Name & define the physical quantity whose S I unit is C/V.
05 What is the amount of work done in moving a 100nC charge between two points 5cm apart on an equipotential surface?

2 MARK QUESTIONS

01 At a point in the electric field of a point charge, the intensity of the field is 32 N/C and electric potential is 16 J/C respectively. What is the distance of the point from the point charge? 2
02 Calculate the electric flux through a spherical surface of radius 10 cm enclosing a negative charge of 8.854 μC. What happens to the flux when the radius of the surface is doubled?
03 Two capacitors 6 μF and 2 μF are connected in series with a battery. The voltage across 6 μF capacitor is 2V. Compute the total battery voltage.
04 A parallel plate capacitor with air between the plates has a capacitance of 8 μF. The separation between the plates is now reduced by half and the space between them is filled with a medium of dielectric constant 5. Calculate the value of the capacitance in the second case.

05

A point charge `q' is placed at `O' as shown in the figure. Is $V_P - V_Q$ positive or negative when (i) $q > 0$ and (ii) $q < 0$? Justify your answer.

06 Define electric field intensity. Write its S I unit. Write the magnitude and direction of electric field intensity due to an electric dipole of length 2a at the midpoint of the line joining the two charges.

07 A parallel plate capacitor is to be designed with a voltage rating 1kV using a material of dielectric constant 3 and dielectric strength of about 10^7 Vm-1 For safety we would like the field never exceed say, 10% of the dipole strength. What minimum area of the plates is required to have a capacitance of 50pF?

08 A 4 μF capacitor is charged by a 200V supply. The supply is then disconnected and the charged capacitor is connected to another uncharged 2 μF capacitor. How much electrostatic energy of the first capacitor is lost in the process of attaining the steady situation?

09 Two fixed point charges +4e and +e units are separated by a distance `a'. Where should a third positive point charge be placed for it to be in equilibrium?

10 Obtain the energy, in joules and in electron volts, acquired by an electron beam when accelerated through a potential difference of 2000V.

11 An electric dipole is held at an angle θ with a uniform electric field. What is the torque acting on it? Explain what happens to the dipole on being released.

12 What is capacitance? State its SI unit. Define it.

13 Two identical point charges `Q' are kept at a distance `r' from each other. A third point charge is placed on the line joining the two charges such that all the three charges are in equilibrium. What is the magnitude, sign and position of the third charge?

14 Draw lines of force to represent a uniform electric field. List the properties of electric field lines.

15 Derive an expression for the work done in rotating an electric dipole through an angle θ in a uniform electric field.

16 The electric field at a point due to a point charge is 20N/C and electric potential at the point is 10J/C. Calculate the distance of the point from the point charge and the magnitude of the charge.

17 Two point electric charges of unknown magnitude and sign are placed at a distance d apart. The electric field intensity is zero at a point, not between the charges but on the line joining them. Write two essential conditions for this to happen.

18 Two point charges `q' and `2q' are kept at a distance `r' from each other in air. A third point charge Q is to be placed on the line joining the two charges such that the net force acting on q and 2q is zero. What is the magnitude, sign and position of the third charge in terms of q and r ?

19 An infinite plane sheet of charge density 10^{-8} Cm^{-2} is held in air. In this situation how far apart are two equipotential surfaces, whose p d is 5V?

20 An electric dipole of length 2cm is placed with its axis making an angle of 60˚ to a uniform electric field of 105N/C. If it experiences a torque of $8\sqrt{3}$ Nm, calculate;

a) magnitude of the charge on the dipole

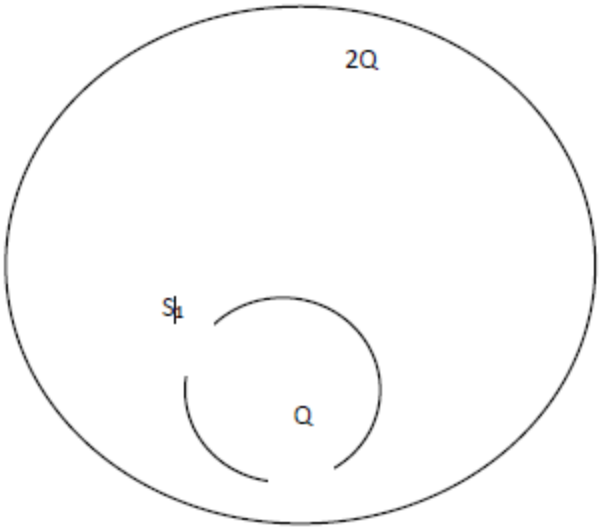
b) potential energy of the dipole.

21 What orientation of an electric dipole in a uniform electric field corresponds to its (i)stable and (ii) unstable equilibrium? Explain.

22 Two capacitors 3 μF and 6 μF are charged to potentials 2 V and 5 V respectively. These two charged capacitors are connected in parallel. Find the charge across each of the two capacitors now.

23 S1 and S2 are two hollow spheres enclosing charges 2Q and Q respectively as shown in figure (i) What is the ratio of electric flux through S1 and S2

(ii) How will the electric flux through S2 change if a medium of dielectric constant 5 is introduced in the space inside S2 in place of air?



24 Two point charges 4 μC and -2 μC are separated by a distance of 1m in air. Calculate at what point on the line joining the two charges is the electric potential zero?

25 Keeping the voltage of the charging source constant, what would be the percentage change in the energy stored in a parallel plate capacitor, if the distance between the plates were to be reduced by 10%?

3 MARK QUESTIONS

26 Derive an expression for the energy stored in a charged parallel plate capacitor. What happens to this energy when the capacitor is made to discharge by connecting the two plates using a conducting wire?

27 An electric dipole of length 8 cm, when placed with its axis making an angle of 60o with a uniform electric field experiences a torque of $8\sqrt{3}$ Nm. Calculate the (i) magnitude of the electric field and (ii) the potential energy of the dipole, if the dipole has charges 4 nC.

28 Two identical plane metallic plates A and B are kept parallel to each other in air, separated by a distance of 1 cm between them. A is given a positive potential of 10 V and the outer surface of B is earthed.

i) What is the magnitude and direction of the uniform electric field between the two plates?

ii) What is the work done in moving a charge of 20 μC from A to B?

29 Derive an equation for the effective capacity of a series combination of three capacitors.

30 Three hollow concentric spheres A, B and C having radii a, b and c respectively (a<b<c) have uniform surface charge densities +σ, -σ and +σ respectively. Compute the electric potential at the surface of the spheres.

31 A point charge of +2 μC is kept fixed at a point O. another point charge of +4 μC is brought from a far off point to a point distant 50cm from O. Calculate the potential energy of the system of the two charges.

Another point charge of +1 μC is brought to a point distant 100 cm from each of the above charges (assumed to be kept fixed). What is the work done in doing so?

32 Derive an expression for the electric field intensity at any point along the perpendicular bisector of an electric dipole.

33 11 A 20 μF capacitor is charged by a 30 V d c supply and then connected across an uncharged 50 μF capacitor. Calculate the final potential difference across the combination and the initial and final energies. How will you account for the difference in energy

34 Use Gauss's theorem to find the electric field at a point near a charged infinitely long thin conducting wire.

35 State Coulomb's law. Write its mathematical form. Define one coulomb.

36 For a parallel plate capacitor prove that the total energy stored is ½ CV^2 and hence derive the expression for its energy density.

37 How does the total energy stored in a parallel plate capacitor with air as the dielectric medium change when a dielectric medium of dielectric constant κ is introduced between the plates?
38 A capacitor is charged from a battery. Assuming that the capacitor is disconnected from the charging battery, explain how;
a) the capacitance, b) p. d. across the plates and c) energy stored in the capacitor change, when a medium of dielectric constant `k' is introduced between the plates.
39 A capacitor is charged from a battery. Assuming that the capacitor remains connected to the charging battery, explain how;
a) the capacitance, b) p. d. across the plates and c) energy stored in the capacitor change, when a medium of dielectric constant `k' is introduced between the plates.
40 Two point charges +4μC and -2 μC are separated by a distance of 1m in air. At what point on the line joining the two charges is the electric potential zero?
41 Two point charges +4μC and -2 μC are separated by a distance of 1m in air. At what point on the line joining the two charges is the electric field zero?
42 A 600 pF capacitor is charged by a 200V supply. It is then disconnected from the supply and is connected to another uncharged 600 pF capacitor. How much electrostatic energy is lost in this process?
43 A point charge of +2 μC is kept fixed at the origin. Another point charge of +4 μC is brought from a far off point to a point distant 50 cm from the origin. Calculate the electrostatic potential energy of this two charge system.
Another charge of+1 μC is brought to a point distant 100 cm from each of these two charges (assumed to be kept fixed). What is the work done?
44 An electric dipole of moment *p* is placed in a uniform electric field of intensity, E. Write the expression for the torque τ experienced by the dipole. Identify two pairs of perpendicular vectors in the expression.
Show diagrammatically, the orientation of the dipole in the field for which the torque is; (i) maximum, (ii) half the maximum value and (iii) zero.
45 A charge Q located at a point r is in equilibrium under the combined electric field of three charges q1,q2, q3. If the charges q1, q2 are located at points r1 and r2 and respectively, find the direction of the force on Q, due to q3 in terms of q1,q2, r1, r2 and r3
46 Explain the underlying principle of working of a parallel plate capacitor.
If two similar plane plates, each of area A having surface charge densities + σ and – σ are separated by a distance d in air, write the expressions for : i) the electric field at points between the plates ii) potential difference between the plates and iii) the capacitance of the capacitor so formed.
47. When two capacitors are connected in series, the effective capacitance is 2.4μF and when connected in parallel, the effective capacitance is 10μF. Calculate the individual capacitances.
5 MARK QUESTIONS
48 State the theorem which relates the enclosed charge, inside a closed surface, with the electric flux through it. Use this theorem to obtain the electric field due to a uniformly charged thin spherical shell at an (i) outside point (ii) inside point.
An electric charge of 8.85×10^{-13} C is placed at the centre of a sphere of radius 1m. What is the total electric flux linked with the sphere? How will the electric flux change if another equal and dissimilar charge is introduced at a distance of
(i) 0.5m from the centre, (ii) 1.5m from the centre?
49 State Gauss's theorem in electrostatics. Using this theorem, derive an expression for the electric field intensity due to a charged metallic spherical shell. Write the special cases. Draw the graph showing the variation of the field with distance from the centre of the conductor.
50 Define Capacity. Name the factors on which the capacity of a parallel plate capacitor depends.
Derive the expression for the capacity of a parallel plate capacitor with a dielectric slab between the plates.

A parallel plate capacitor has a capacity of 100 μF with air in between the plates. What happens to the capacity when the plates are introduced in a medium of dielectric constant 80 without changing the plate separation?

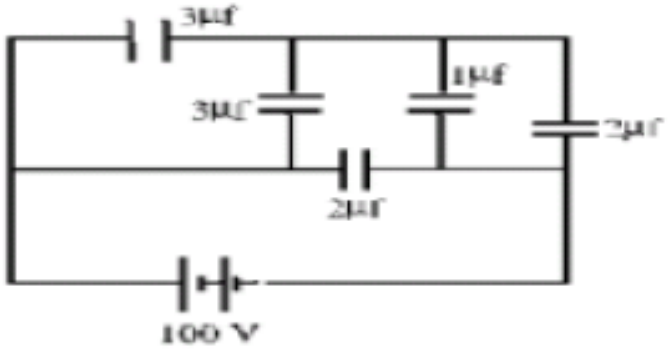
51 Explain the effect of introducing a dielectric slab between the plates of a parallel plate capacitor on its capacitance. Derive an expression for its capacitance with a dielectric as the medium between the plates.

52 With the help of a neat labelled diagram explain the principle, construction and working of a Van de Graff Generator.

53 Show mathematically that the electric field intensity due to a short dipole at a distance `d' along its axis is twice the intensity at the same distance along the equatorial axis.

54 Obtain an expression for the capacitance of a parallel plate (air)capacitor.

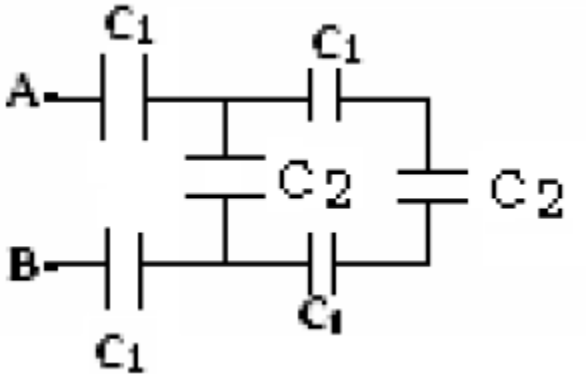
The given figure shows a network of five capacitors connected to a 100V supply. Calculate the total charge and energy stored in the network.



MORE QUESTIONS

1. Draw two equipotential due to a point charge. (ii) What is the amount of work done in moving a 100nC charge between two points 5cm apart on an equipotential surface?

2. If C1 = 3pF and C2 = 2pF, calculate the equivalent capacitance of the given network between points A & B?



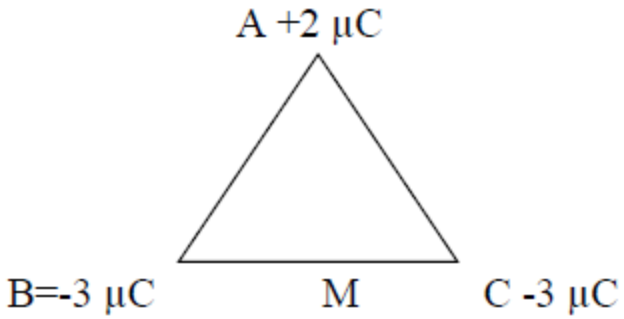
3. An electric dipole is held in uniform electric field.

(i) Show that net force acting on it is zero.

(ii) The dipole is aligned parallel to the field. Find the work done in rotating it through 1800.

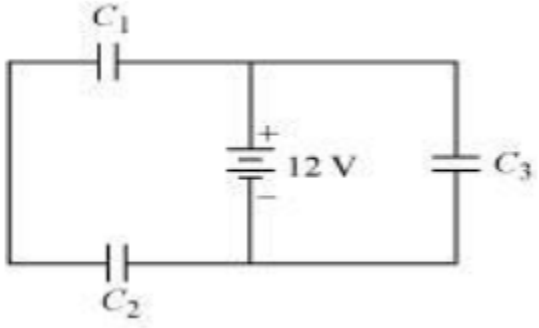
4. (a) Using Gauss' law derive the expression for electric field intensity at a point outside a uniformly charged spherical cell.

(b) Three charges +2μC, -3μC and -3μC are kept at three vertices A, B and C of an equilateral triangle of side 20cm as shown in the figure. Find the charge to be placed at mid point M of BC so that charge at A remains in equilibrium.

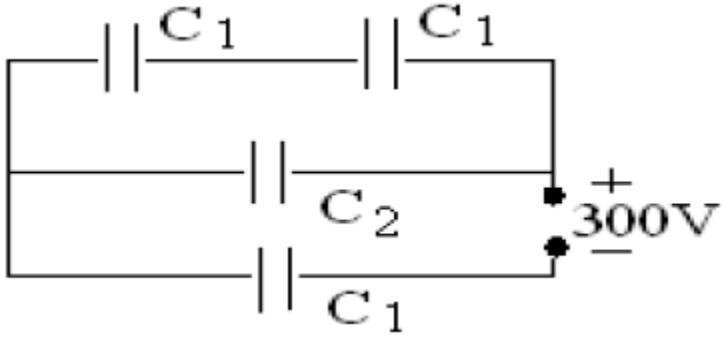


5. Define equipotential surfaces and draw the equipotential surfaces for uniformly increasing electric field along +yaxis.
6. State Coulombs law for electrostatics. Two fixed charges +4q and +q are separated by a distance `a`. Where should the third point charge be placed on the line joining two charges so that the third point charge is in equilibrium?
7. Why does the electric field inside a dielectric decrease when it is placed in an external electric field?
8. A parallel plate capacitor with air between the plates has a capacitance of 8 pF. What will be the capacitance if the distance between the plates be reduced by half and the space between them is filled with a substance of dielectric constant K = 6 ?
9. Two charges q and -2q are placed at points A and B on a line XY. State whether the points at which (i) E =0 (ii) V=0 will be located (a) to the left of A (b) between A and B? (c) To the right of B? Justify your answer
10. Using Gauss' theorem obtain an expression for the electric field intensity at a distance r from an infinitely long line of charge with uniform linear charge density λ Cm^{-1}
11. An electric dipole of dipole moment p is placed in a uniform electric field E. Write the expression for the potential energy of the dipole in the field. Show diagrammatically the orientation of the dipole in the field for which the potential energy is - (i) minimum (ii) maximum (iii) Half the maximum (iv) Zero
12. Sketch the equi -potential surfaces due to a line charge.
13. A parallel plate capacitor of plate area A and separation d is charged to a potential V. The battery is then disconnected and a dielectric slab of thickness d and dielectric constant K is inserted in the capacitor. What change if any, will take place in
(a) Charge on the plates.
(b) Voltage across the capacitor.
(c) Electric field between the plates.
(d) Capacitance of the capacitor.
(e) Energy stored. Justify your answer in each case.
14. On the basis of Gauss' theorem prove that, for a point outside a charged spherical shell it behaves as a point charge.
15. Draw the graph between electric field strength and distance from the centre of the hollow conducting charged sphere.
16. Two capacitors of capacitances 3μF and 6μF, are charged to potentials of 2V and 5V respectively. These two charged capacitors are connected in series. Find the potential across each of the two capacitors now?
17. P&Q are two conducting spheres of the same radii, P being solid and Q hollow. Both are charged to the same potential. What will be the relation between the charges on the two spheres?
18. What is the angle between the directions of electric field at any point on the 1) axial line 2) equatorial line of the dipole?
19. How does the force between the two charges vary when(a) The system is immersed in a medium. (b) When the distance between them is halved?

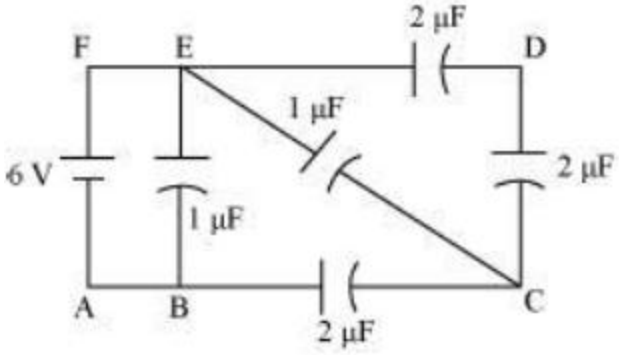
20. How does the electric flux, electric field enclosing a given charge vary when the area enclosed by the charge is doubled?
21. Write the expression for electric flux for a uniform (a) Linear charge distribution? (b) Areal charge distribution?
22. Show that at a point where the electric field intensity is zero, electric potential need not be zero.
23. Show diagrammatically the stable and unstable equilibrium of an electric dipole placed in a uniform electric field
24. Derive the expression for the potential due to a dipole. Find the ratio of potential along the equatorial and axial line of a dipole.
25. Derive an expression for the potential energy of a system of two electric charges in an external electric field.
26. Define electric flux. Write its mathematical form. A spherical rubber balloon carries a charge that is uniformly distributed over its surface. As the balloon is blown up and increased in size. How does the total electric flux coming out the surface change? Give reason
27. In a parallel plate capacitor the capacitance increases from 4Mf to 80μF, on introducing a dielectric medium between the plates. What is the dielectric constant of the medium?
28. An electric dipole of length 4 cm, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of Nm. Calculate the magnitude of the electric field if the dipole has charges of ± 8 μC
29. A thin conducting spherical shell of radius R has charge Q spread uniformly over its surface. Draw a graph of electric field $E(r)$ with distance r from the centre of the shell for $0 \leq r \leq \infty$.
30. Three identical capacitors C1, C2 and C3 of capacitance 6 μF each are connected to a 12 V battery as shown.
Find (i) charge on each capacitor
(ii) equivalent capacitance of the network



31. A 10 μF capacitor is charged by a 30 V d.c. supply and then connected across an un-charged 50 μF capacitor. Calculate (i) the final potential difference across the combination, and (ii) the initial and final energies. How will you account for the difference in energy?
32. In the given network C1 =200pF and C2 = 100pF. Calculate (i) equivalent capacitance of the network and (ii) energy stored in the network of capacitors



33. Find the total energy stored in the capacitors in the given network.



34. The equivalent capacitance of the combination between A and B in the given figure is 4μF.

(i) Calculate capacitance of the capacitor C.
(ii) Calculate charge on each capacitor if a 12 V battery is connected across terminals A and B.
(iii) What will be the potential drop across each capacitor?

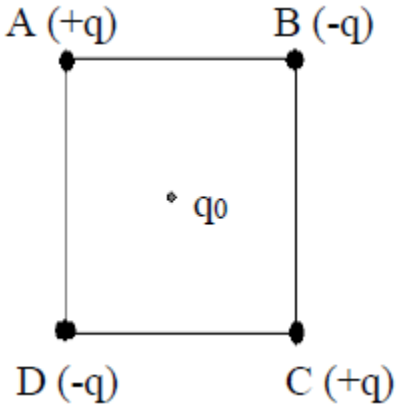
LEVEL-3

1. An electric dipole of dipole moment 20×10^{-6} Cm is enclosed by a closed surface. What is the net electric flux coming out of the surface?

2. a. Derive the formula for the capacitance of a parallel plate capacitor having a dielectric slab of thickness '**t**' the plates.

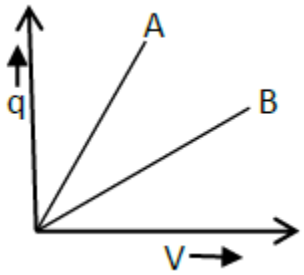
b. A point charge **q** is placed at O as shown in the figure. Is V_A-V_B positive or negative when, i) q > 0 and ii) q < 0 .q_____A _____ B

3. Four charges are arranged at corners of a square ABCD of side "d" as shown



Find the work done to put together this arrangement. If a charge q_0 is brought at its centre keeping the four charges at the corners, how much extra work is needed to do this?

4. The given graph shows the variation of charge q versus potential difference V for capacitance C1 and C2. The two capacitors have the same plate separation, but the plate area of C2 is double that of C1. Which of the lines in the graph correspond to C1 and C2 and why ?



5. Two point charges are placed at a distance r in air exert a force F on each other. At what distance will these charges experience the same force F in a medium of dielectric constant K?

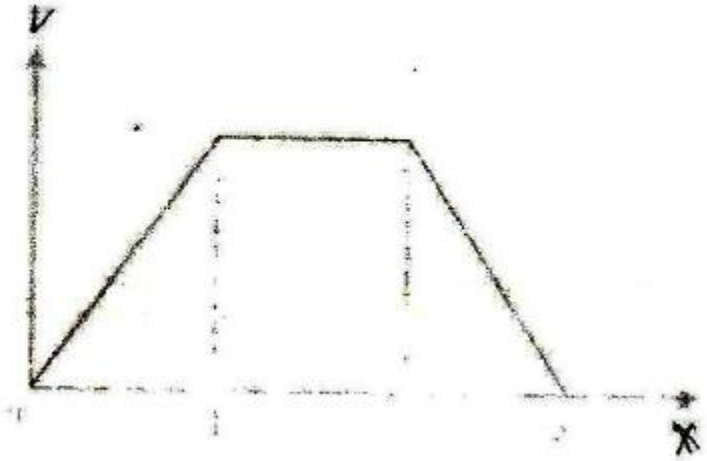
6. Two circular metal plates each of radius 10cm are kept parallel 10 each other at distance of 1mm.

i) If radius of each plate is increased by factor 2 and their distance of separation decrease to half its initial value, calculate the ratio of capacitance in the two cases?

ii) Suggest one possible method by which capacitance in the 2nd case can be increased by n times.

7. Define electric potential at a point. Show that electric field at a point is equal to the negative of the potential gradient at that point.

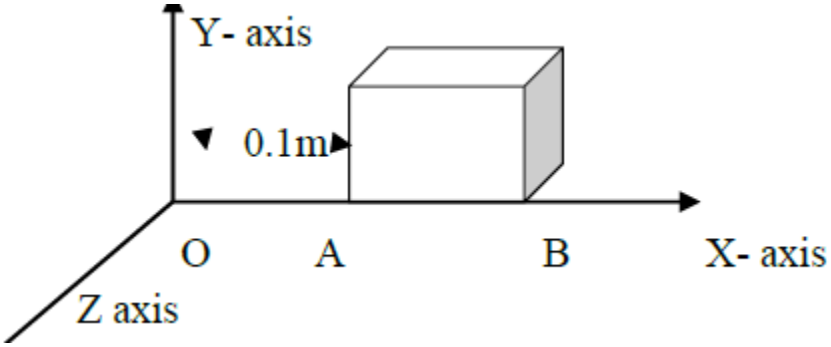
The electric potential 'V' as a function of distance X is as shown. Construct a corresponding graph of the electric field strength E.



8. The electric field component in figure are $Ex = \alpha\ x^{1/2}$, Ey=Ez =0; in which α = 800 $N/Cm^{1/2}$.calculate :

(a) The flux through the cube and

(b) The charge within the cube .Assume that a = 0.1 m



9. What will be the electric field intensity at the center of a uniformly charged circular wire of linear charge density λ?

10. A small metal ball is suspended in a uniform electric field with the help of an insulated thread. If high energy X-rays falls on the ball in which direction will the ball be deflected?

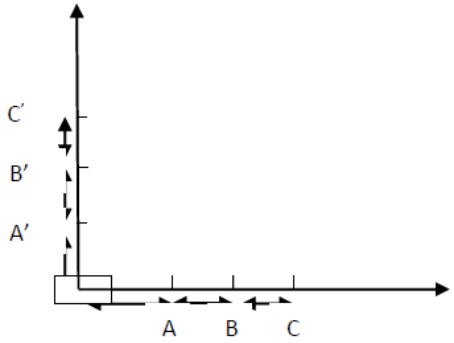
11. Name the physical quantity where the SI unit is Vm, Vm^{-1}. Which of these are vectors?

12. The following data was obtained for the dependence of the magnitude of electric field, with distance, from a reference point 0, within the charge distribution in the shaded region

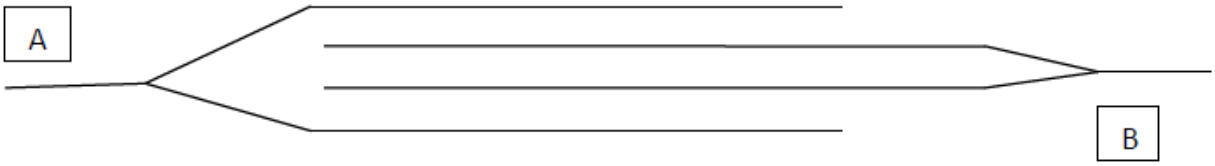
Fixed Point	A	B	C	A'	B'	C'
Magnitude of electric field	E	E/8	E/27	E/2	E/16	E/64

(i) Identify the charge distribution and justify your answer.

(ii) If the potential due to this charge distribution has a value V at the point A, what is its value at point A?



13. Calculate the capacitance between A & B if the area of each plate is A and distance between successive plates is ‘d’.



14. Determine the electrostatic potential energy of a system containing 2 charges 7μc and -2 μc separated by a distance of 18cm. How much work is required to separate the two charges infinitely away from each other?

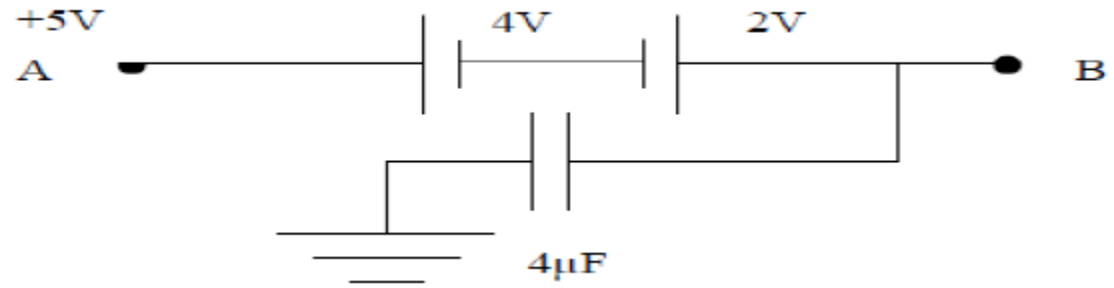
15. An isolated air capacitor of capacitance C0 is charged to a potential V0. Now if a dielectric slab of dielectric slab of dielectric constant K is inserted between its plates completely filling the space between the plates, then how do the following change, when the battery is disconnected (i) capacitance (ii) potential difference (iii) energy stored by the capacitor.

16. A conducting stab of thickness ‘t’ is introduced without touching between the plates of a parallel plate capacitor separated by a distance d (t<d). Derive an expression for the capacitance of a capacitor?

17. An air capacitor is given a charge of 2 mC raising its potential to 200 V. If on inserting a dielectric medium, its potential falls to 50 V, what is the dielectric constant of the medium?

18. In a Van de Graaff type generator a spherical metal shell is to be a 15×10^6 V electrode. The dielectric strength of the gas surrounding the electrode is 5×10^7 Vm^{-1}. What is the minimum radius of the spherical shell required?

19. Calculate the p.d across each capacitor in the given fig



20. Is the capacitance of a capacitor proportional to the charge Q ? Sketch a graph to show how the capacitance C of a capacitor varies with the charge given to it.

LEVEL 1

1) State Ohm's law

2) Define resistance. What are the factors on which the resistance of conductor depend on?

3) What are the factors on which the drift velocity of electrons in a metal depends?

4) Define electrical resistance of a material.

Defined as the resistance offered by a block of that material of unit length and unit area of cross-section.

5) Name two physical conditions on which the resistivity of a material depends.

6) What is the effect of rise in the temperature on the electrical conductivity of (a) metals (b) Semi conductor (c) Electrolytes?

7) Why is alloy manganin used to make standard resistance?

8) A wire of resistivity ρ is stretched to double of its length . What is new resistivity?

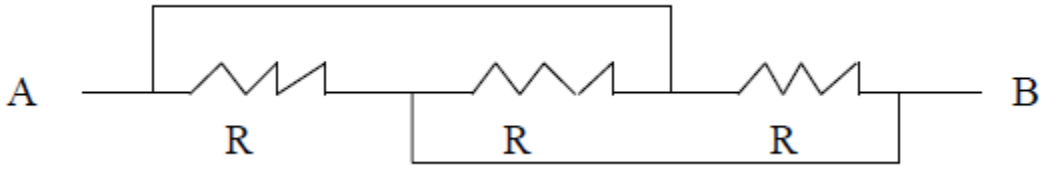
Remains the same because it is a property of material.

9) Why is a Potentiometer preferred to measure the emf of a cell over a Voltmeter?

As Potentiometer does not draw any current we prefer potentiometer to measure emf. More over we are taking ready only on null deflection ie. Without drawing current.

10) What is the emf of following battery if the emf of each cell is 2 V

11) Find equivalent resistance?



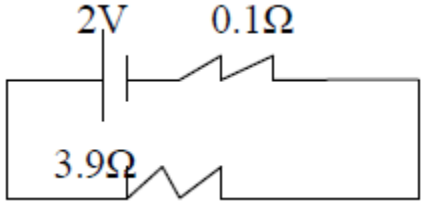
12) Why is a Voltmeter always connected parallel with a circuit element across which voltage is to be measured?

13) If the length of a wire doubled, what will happen to the drift speed of electrons in the wire?

14) How does the drift velocity of electrons in a metallic conductor vary with increase in temperature?

15) A Carbon resistor is marked in coloured bands of red, black, orange and Silver. What is the resistance tolerance value of the resistor

16) A cell of emf 2V and internal resistance 0.1Ω is connected to a 3.9 Ω external resistance. What will be Pd across the terminals of the cell?



17) Which has greater resistance (i) milliammeter or (ii) ammeter

18) Which has greater resistance (i) millivoltmeter or (ii) Voltmeter?

19) How can we increase the sensitivity of a Potentiometer?

20) What do you mean by end error in a meter bridge?

21) What is the average velocity of free electrons in a conductor in the absence of an external electric field?

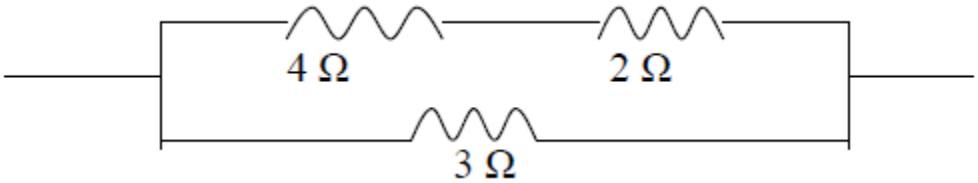
22) Under what conditions will the terminal potential Pd of a cell (i) greater (ii) lesser that its emf.

QUESTIONS FOR PRACTICE

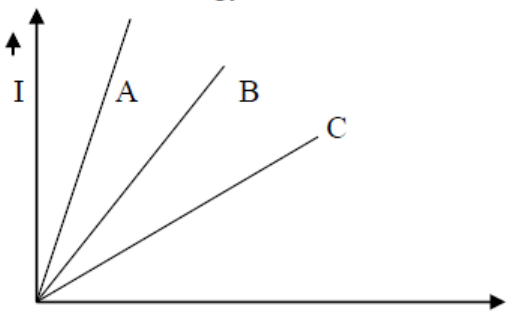
1.Derive the relation between Drift Velocity & Current.
2. Derive Ohm's law in terms of material constant or expression for resistivity in terms of material constant.
3. What are non ohmic material.Explain.
4. Explain the Temperature dependence of Resistivity in caser of conductors, insulators and semiconductors .
5. Why are Manganin and Constantan used to prepare standard resistance?
6. Why does Nichrome is preferred to prepare heating element.
7. Explain Meissner Effect:-
8. Obtain the relation for the combination of resistances in Series: -
9.. Obtain the relation for the combination of resistances in parallel: -
10. Write the differences between emf and Terminal potential
11. Write the factors on which the Internal resistance of the cell depends.
12. Derive the relation for the internal resistance of a cell in terms emf and terminal potential difference.
13. Obtain the equivalent emf of cells grouped in series and in parallel.
14. State the Kirchhoff's Laws:
15. Obtain the balanced condition in Wheatstone Bridge:
16. Explain the experimental method for determining the Temperature of the given resistor using Wheatstone bridge.
17. Explain the experimental method for determining the unknown resistance by using metre bridge and hence find its resistivity.
18. State and explain the 'Principle of Potentiometer'.
19. Explain the experimental method for determining Potential difference of a primary cell using potentiometer.
20. Compare the emf's of two primary cells using potentiometer.
21. Explain Joules law of Heating
22. What is Electric Power. Write its S.I units.

LEVEL -3

01 How does the conductivity of a semiconductor depend on temperature? Give reason.
02 Draw a graph representing the variation of resistivity of mercury with temperature at low temperatures.
03 If the temperature of a good conductor increases, how does the relaxation time of electrons in it change?
04 Explain how does the resistivity of a conductor depend upon (i) number density `n' of electrons and (ii) relaxation time `τ'.
05 Explain with the help of a graph, the variation of conductivity with temperature for a metallic conductor.
06 In a part of the circuit shown in the figure the rate of heat dissipation in the 4 Ω resistor is 100 J/s. calculate the heat dissipated in the 3 Ω resistor in 10 s.



07 A heater coil is rated 100W, 200V. It is cut into two identical parts. Both parts are then connected together in parallel, to the same source of 200V. Calculate the energy liberated per second in the new combination.
08 The V-I graph for two resistors and their series combination are shown in the adjoining figure. Which one of these graph represents the series combination of the other two?
Give reasons for your answer.



9 Draw the circuit diagram of a metre bridge and explain its use to find the resistance of a conductor. State the formula used.

10 Under what condition is the heat produced in an electric circuit is (i) directly proportional and (ii) inversely proportional to resistance of the circuit?

11 Three identical cells of e m f 2V and unknown internal resistance are connected in parallel. This combination is connected to a 5 ohm resistor. If the terminal voltage across the cells is 1.5 V, what is the internal resistance of each cell?

12 State Kirchoff's laws in electric circuits. Use the laws to derive the balancing condition of a Wheatstone's bridge.

13 Are the path of electrons straight lines between two successive collisions in a conductor (with positive ions of the metal) (i) in the absence of electric field and (ii) in the presence of electric field? Establish the relationship between the current flowing through a conductor, the drift velocity of electrons and the number density of free electrons in it. Hence obtain the relation between current density and drift velocity.

14 A storage battery of e m f 8V and internal resistance 1 Ω, is being charged by a 120V d.c. source, using a 15Ω resistor in series in the circuit. Calculate:

(i) the current in the circuit.

(ii) terminal voltage across the battery during charging and

(iii) chemical energy stored in the battery in 5 minutes.

15 Write the principle and theory of a potentiometer.

With a neat circuit diagram explain the use of a potentiometer for comparing the e m f of two primary cells.

Write the advantages of a potentiometer over a voltmeter as a voltage measuring device.

16 State Ohm's law and define the term resistance. What are the factors on which the resistance of a conductor depends?

Define the following: (i) resistivity (ii) one ampere. What are the characteristic features of a fuse wire?

Two metallic wires of same material and same length but different cross sectional areas are joined together (i) in series and (ii) in parallel, to a source of e m f. In which of the two wires will the drift velocity of electron be more and why? Support your answer with proper equations.

17 A heater coil is rated 100W, 200V. It is cut into two identical parts. Both parts are then connected together in parallel, to the same source of 200V. Calculate the energy liberated per second in the new combination.

18 A voltmeter of resistance R_V is connected across a resistor R which is to be measured. An ammeter of resistance R_A is in series with this combination. The arrangement is then connected across a battery and the ratio of the readings in the meters give a value R' for R. Show that R and R' are related as $1/R = 1/R' - 1/R_V$.

19 Two bulbs one of 200W, 220V and the other of 100W, 220V are connected in series and the combination is connected across a 220V supply. With the support of relevant equations and calculations, state which bulb would glow brighter.

20 Two cells of e m f 1.5V and 2V and internal resistance 1ohm and 2ohm respectively are connected in parallel to pass a current in the same direction through an external resistance of 5ohm.

a) Draw a circuit diagram.
b) Using Kirchoff's laws, calculate the current through each branch of the circuit and potential difference across the 5ohm resistor.
21 Establish the relation between current and drift velocity.
22 The potential difference across the terminals of a battery of e m f 12V and internal resistance 2 ohm drops to 10V when it is connected to a resistor. Calculate the value of the resistance.
23 A series battery of lead accumulators of e m f 2V and internal resistance of 0.5 Ω is charged by a 100 V d c supply. What series resistance should be used in the charging circuit in order to limit the current to 8A? Using the required resistor, obtain i) the power supplied by the d. c. source and ii)the power dissipated as heat.
24 Name the two factors on which the resistivity of a given material depends. A carbon resistor has a value of 62 kΩ with a tolerance of 5%. Give the colour code for this resistor.
25 Draw a circuit diagram of a metre bridge to determine the unknown resistance of a resistor. Obtain the balance condition for a metre bridge. Why are the connections between the resistors in a metre bridge made of thick copper strips?
26 Find the shift in the balance point of a metre bridge, when the two resistors in the two gaps, are interchanged. Take the values of the two resistors as R and S.
27 A cell, of e m f 4V and internal resistance 0.5 Ω, is connected across a load of resistance (i) 7.5 Ω and (ii) 11.5 Ω. Calculate (i) the ratio of the differences in the e m f of the cell and the potential drop across the load and (ii) the ratio of the currents in the two cases.
28 A carbon resistor is marked in green, red and orange bands. What is the approximate resistance of the resistor? 1
29 A carbon resistor is marked in red, yellow and orange bands. What is the approximate resistance of the resistor?
30 A carbon resistor is marked in red, green and orange bands. What is the approximate resistance of the resistor?

MAGNETIC EFFECTS OF CIURRENT AND MAGNETISM

LEVEL - I

1. Define the SI unit of current.
2. State Biot- Savart Law.
3. What is the value of Magnetic Permeability of Free space?
4. Name the rule by which the direction of magnetic field of a circular coil is explained and state it also.
5. What is the nature of the magnetic field due to a current flowing in a very long straight thin wire?
6. What is the nature of the magnetic field at the centre of a circular loop carrying current? Draw the diagram of it.
7. Define the unit of magnetic field in terms of magnetic force exerted in a current carrying conductor of length l.
8. The equation F = q (v x B) involves three vectorsF , v andB . What is the angle between F andv ,F andB ?
9. Does a magnetic field exert a force on a still charge?
10. Does a magnetic field exert a force on an electron moving parallel to the direction of the magnetic field?
11. Derive an expression for magnetic field on a point on the axial line of circular coil.
12. State and prove Ampere's Circuital law.
13. Obtain an expression for the magnetic field due to a solenoid carrying the current.
14. What is the nature of the magnetic field due to a solenoid carrying current?
15. Obtain an expression for the magnetic field due to a toroid carrying the current.
16. What is the nature of the magnetic field due to a toroid carrying current?

17. An electron is not deflected in passing through a certain region of space. Can we be sure that there is no magnetic field in that region?
18. What is the nature of the force between two conductors carrying currents in the opposite direction separated by a distance r?
19. Obtain an expression for torque experienced by a current carrying conductor placed in uniform magnetic field.
20. Explain the principle, construction and working of moving coil galvanometer.
21. Define Current sensitivity and voltage sensitivity.
22. Write the factors on which current sensitivity of galvanometer depends.
23. What is a radial field in Moving coil galvanometer?
24. Equal currents I, I are flowing through two infinitely long parallel wires. What will be the magnetic field at a point midway, when the currents are flowing in the same direction?
25. State two properties of the material of the wire used for suspension of the coil in a moving coil galvanometer.
26. How a galvanometer is connected to (a) ammeter and (b) Voltmeter.
27. If a particle of charge q is projected into a magnetic field with an angle, what is the trajectory of it?
28. Write the limitations of Cyclotron.
29. Explain the principle, construction and working of Cyclotron.
30. An alpha particle and a proton are moving in the plane of the paper in a region where there is uniform magnetic field B directed normal to the plane of paper. If two particles have equal linear momenta, what will be the ratio of the radii of their trajectories in the field?
31. A galvanometer of resistance 15□ gives a full scale deflection for a current of 2mA. Calculate the shunt resistance needed to convert it into an ammeter of range 0-5A.
32. Derive an expression for Force per unit length due to two straight current carrying wires .Hence define Ampere.
33. Using Biot-Savart law, derive an expression for the Magnetic field due to a current carrying circular loop at its centre.
34. Using Biot-Savart law, derive an expression for the Magnetic field due to a current carrying circular loop at its centre.
35. State Ampere's circuital law. Using it, derive an expression for the magnetic field due to a straight long current carrying wire
36. What is Bohr's magneton? Derive an expression for the magnetic moment associated with a revolving electron.
37. Discuss the construction, working and theory of cyclotron. State its limitations.
38. Explain with the help of a labeled diagram, the underlying principle, construction and working of a moving coil galvanometer .How its sensitivity can be increased. What is the use of radial magnetic field?
39. State the properties of magnetic lines of force.
40. Compare the magnetic field lines of a bar magnet and solenoid.
41. Write three magnetic elements of earth. What is the cause of earth magnetism?
42. State Tangent law.
43. How does angle of dip change from pole to equator.
44. Write the properties of the material used in making (a) an electromagnet (b) soft iron.
45. Define neutral points. Write the positions of the neutral points when North Pole of the magnet is placed along (a) North geographical axis and (b) south geographical axis.
46. An iron bar magnet is heated to 1000°C and then cooled in a magnetic Yield free space. Will it retain magnetism?
47. If toroid uses zinc for its core, will the field in the core be greater or lesser than when the core is empty?
48. Find dip when horizontal and vertical component of magnetic field are equal?
49. What happens when a diamagnetic substance is placed in varying field?

50. Name any three
(a) Paramagnetic materials
(b) Ferromagnetic material
(c) Diamagnetic material

LEVEL-II: 01. Can a magnetic field independent of time change the velocity of a charged particle? What about its K.E.?

02. .How will an electron move in a homogeneous magnetic field if the velocity of the electron at the initial moment is perpendicular to the force lines of the field ?

03. The net charge in a current carrying conductor is zero; even then it experiences force in a magnetic field. Why?

04. An electron is deflected in a given field. How will you detect whether the given field is a uniform magnetic field or a uniform electric field?

05. How will an electron move in a homogeneous magnetic field if the velocity of the electron at the initial moment forms an angle θ with the force lines of the field?

06. In a certain arrangement, a proton does not get deflected while passing through a magnetic field region. State the condition under which it is possible.

07. What is the work done by the magnetic force on a charged particle moving perpendicular to the magnetic field?

08. A wire of length 0.04m carrying a current of 12 A is placed inside a solenoid, making an angle of 300 with its axis. The field due to the solenoid is 0.25 T. Find the force on the wire.

09. A circular loop of radius 0.1 m carries a current of 1A and is placed in a uniform magnetic field of 0.5T. The magnetic field is perpendicular to the plane of the loop. What is the force experienced by the loop?

10. A proton, alpha particle and deuteron are moving in circular paths with same kinetic energies in the same magnetic fields. Find the ratio of their radii and time periods.

11. How will the magnetic field intensity at the centre of a circular coil carrying current change if the current through the coil is doubled and the radius of the coil is halved.

12. Two similar bars, made from two different materials P and Q are placed one by one in a non uniform magnetic field. It is observed that (a) the bar P tends to move from the weak to the strong field region. (b) the bar Q tends to move from the strong to the weak field region. What is the nature of the magnetic materials used for making these two bars?

13. An electron travelling west to east enters a chamber having a uniform electrostatic field in north to south direction. Specify the direction in which a uniform magnetic field should be set up to prevent the electron from deflecting from its straight line path.

14. Establish the relation between magnetic permeability and Magnetic susceptibility.

15. Angle of dip at a place is 30degrees. If the vertical component of earth's magnetic field at that place is $0.16\sqrt{3}$ X 10^{-4}T. Calculate the horizontal component.

LEVEL-III

1. An electron beam is moving vertically upwards. If it passes through a magnetic field directed from South to North in a horizontal plane, in what direction will the beam be deflected?

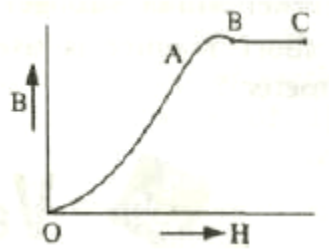
2. A current is set up in a long copper pipe. What is the magnetic field inside the pipe?

3. A wire placed along north south direction carries a current of 5 A from South to North. Find the magnetic field due to a 1 cm piece of wire at a point 200 cm north East from the piece.

4. A circular coil of 200 turns, radius 5 cm carries a current of 2.5 A. It is suspended vertically in a uniform horizontal magnetic field of 0.25 T, with the plane of the coil making an angle of 600 with the field lines. Calculate the magnitude of the torque that must be applied on it to prevent it from turning.

5. A long straight conductor PQ , carrying a current of 60 A, is fixed horizontally. Another long conductor XY is kept parallel to PQ at a distance of 4 mm, in air. Conductor XY is free to move and carries a current 'I' . Calculate the magnitude and direction of current 'I' for which the magnetic repulsion just balances the weight of the conductor XY.

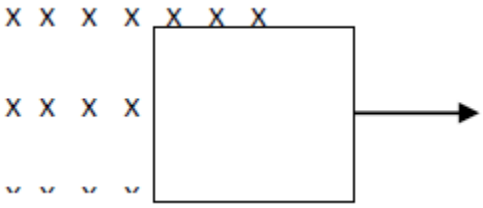
6. A Ferromagnetic displaying a hysteresis loop acts as a device for storing memory. Explain how?
7. The hysteresis loop of a soft iron piece has a much smaller area than that of a steel piece. If the materials are given repeated cycles of magnetisation which piece will dissipate greater heat energy?
8. An unmagnetised ferromagnetic substance is magnetised. Given Figure shows the B-H curve. Identify the stage of saturation,reversible region and irreversible region.



9. Why are electromagnets made of soft iron?
10. Permanent magnets are made of steel while core of a transformer is made of soft iron. Why?
11. Why is large area of hysteresis loop not a disadvantage for steel used for making permanent magnets?
12. Why is diamagnetism independent of temperature?
13. Among steel, soft iron and silicon steel, which is suitable for?Making permanent magnets and why?
14. Establish relationship between magnetic inclination and horizontal component of Earth's magnetic field at a place with the help of a diagram.
15. Suppose you have two bars of identical dimensions, one made of paramagnetic and the other diamagnetic substance. If you place the bars along a uniform magnetic field. Show diagrammatically what modification in the field would take each case?
16. Classify material on the basis of their behavior in a magnetic field . Under which category does iron come? How does the magnetic property of iron change with increase of temperature?

ELECTRO MAGNETIC INDUCTION AND AC
LEVEL -I
1. The instantaneous current from an ac source is I = 5 sin 314 t . What is the rms value of current ?
2. Define self inductance . Write down the expression for it for a long solenoid of length *l* with number of turns N
3. Distinguish between the terms reactance and impedance of an ac circuit . Prove that an ideal capacitor connected to an ac source does not consume any power
4. The instantaneous emf of an ac source is given by E =300 sin 314 t .What is the rms value of emf ?
5. Prove that an ideal resistance connected to an ac source dissipates power = V_{eff}^2 / R
6. If a rate of change of current 2 A/s induces an emf of 10 mV in a solenoid , what is the self inductance of the solenoid ?
7. What type of materials are used for making permanent magnets ?
8. Prove that an ideal inductor connected to an ac source does not dissipate any power
9. Give the phase difference between the applied ac voltage and the current in an LCR circuit at resonance .
10. Mathematically prove that average value of alternating current over one complete cycle is zero
11. Distinguish between average value and rms value of an alternating current . A 60 V-10 W electric lamp is to be run on 100 V - 60 Hz mains .
a. calculate the inductance of choke coil required
b. If a resistor is to be used in place of choke coil to achieve the same result , calculate

its value
12. Draw the graph showing the variation of reactance of a)a capacitor , and b) an inductor with the frequency
13. Prove that an ideal inductor does not dissipate power in an ac circuit .
14. A sinusoidal voltage V = 200 sin 314 t is applied to a resistor of 10 Ω resistance . Calculate a. rms value of the voltage b) rms value of the current c) power dissipated as heat in watts
15. How does the self inductance of a coil change when
One) the number of turns in the coil is decreased
Two) an iron rod is introduced into it ? Justify your answer in each case
16. Why does the acceleration of the magnet falling through a long solenoid decrease ?
17. How are eddy currents produced ?Give two applications of eddy currents
18. What is the power factor of an LCR series circuit at resonance ?
19. A rectangular coil of N turns , area A is held in a uniform magnetic field B . If the coil is rotated at a steady angular speed ω , deduce an expression for the induced emf in the coil at any instant of time
20. Define mutual induction . state two factors on which the mutual inductance between a pair of coils depends
21. Draw the curve showing the variation of inductive reactance and capacitive reactance with applied frequency of an ac source .
22. A capacitor , resistor of 5 Ω , and an inductor of 50 mH are in series with an ac source marked 100 V , 50 Hz . It is found that the voltage is in phase with current . Calculate the capacitance of the capacitor and the impedance of the circuit
23. State Lenz's law . A square loop of wire PQRS is moved at a constant speed from a uniform magnetic field acting normal to the plane of the paper as shown in the figure . State with reason , the direction in which the induced current flows in the loop



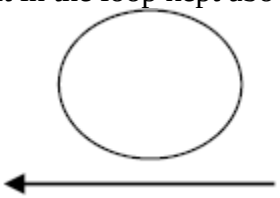
24. A 28 turn coil with average diameter of 0.02 m is placed perpendicular to a magnetic field of 8000 T . If the magnetic field changes to 3000 T in 4s , What is the magnitude of the induced emf ?
25. A student connects a long air core coil of manganin wire to a 100 V d.c source and records a current of 1.5A When the same coil is connected across 100 V, 50 Hz a.c source , the current reduces to 1.0 A .
a. Give reason for this observation b) Calculate the value of the reactance of the coil .
26. Which device will you use to step up a.c voltage . Can we use the same device to step up d.c ?
27. A wheel with 40 metallic spokes each 0.5 m long is rotated with an angular speed of 10 radian/s in a plane normal to the earth's magnetic field . If the magnitude of the field is 0.4×10^{-4} T , calculate the emf induced between the axle and rim of the wheel .
28. Calculate the capacitance of the capacitor , which when connected in series with an inductor of inductance 4 henry will cause the circuit to resonate at 50 Hz
29.Derive an expression for the impedance of the an ac circuit for an inductor and a resistor in series .
30. A 15 μF capacitor has a capacitive reactance of 12 Ω . What is the frequency of the source ? If the frequency of the source is doubled , what will be the capacitive reactance ?
31. Establish the relationship between peak value and rms value of alternating current .
32. A 0.3 H inductor , 60 μF capacitor and a 50 Ω resistor are connected in series with a 120 V , 60 Hz supply Calculate the (i) impedance of the circuit (ii) current flowing in the circuit

33. Prove mathematically that the average value of alternating current over one complete cycle is zero .
34. With the help of a labelled diagram , explain the construction , principle and working of a step down transformer Why is the core laminated
35. When 200 V dc is applied across a coil , a current of 2 a flows through it . When 200 V ac of 50 Hz is applied to the same coil , only 1 A flows . calculate the resistance , the impedance and the inductance of the coil .
36. When a capacitor is added in series to an LR series circuit the alternating current flowing in the circuit increases . Give reason Explain with the help of a labelled diagram , the principle , construction and working of an ac generator .
37. Calculate the current flowing through a solenoid of self inductance 30 mH in which a magnetic flux of 15 mWb is linked .
38. Show that the work done in maintaining a steady current i0 in an inductor L is ½ Li02
39. What is self inductance of a coil , in which magnetic flux of 40 mWb is produced when 2 A current flows through it ?
40. What is meant by resonance in LCR circuit ? State the essential conditions for resonance . A 50 mH inductor, a capacitor of capacitance 20 □F and a 10 ohm resistor are connected in series across 220 V ac source of variable frequency . calculate (i) the resonant frequency of the circuit (ii) current amplitude at resonance and (iii) maximum power dissipation
41. When a current of 3 A flows through a primary coil , a magnetic flux of 30 mWb is linked with the secondary coil . What is the mutual inductance between the pair of coils
42. A coil when connected across a 10 V d.c source draws a current of 2 A . When it is connected across a 10 V - 50 Hz a.c supply , the same coil draws a current of 1 A . Explain why it draws lesser current in the second case . hence determine the self inductance of the coil
43. Name the SI unit of magnetic flux and show that it equals volt -second . Give three possible ways of producing an induced emf in a coil giving an example in each case . A copper loop and an aluminium loop , identical in shape and size , are removed from identical magnetic fields , from identical positions , in equal time intervals .Compare the induced emf and currents produced in the two loops .
44. Explain the nature of variation in magnetic flux as represented by the graph in first case
45. Distinguish between the terms resistance and impedance of an a.c circuit . A capacitor C and a resistor R are connected in series in an a.c circuit . Deduce by drawing phasor diagram , a mathematical expression for the impedance of this circuit . How will this impedance be affected when the frequency of the applied signal is decreased and why ?
46. An inductor L , a capacitor C and a resistor R are connected in series in an a.c circuit . deduce with the help of a suitable phasor diagram , a mathematical expression for impedance of this circuit .What is meant by resonance of this circuit ? Prove that this circuit exhibits resonance at a frequency given by $\frac{1}{2\pi\sqrt{LC}}$
47. What is meant by root mean square value or effective value of a.c ? Derive a relation between the it and its peak value .

LEVEL-II

1. Show that Lenz's law is in accordance with the law of conservation of energy
2. A capacitor , a resistor and a 40 mH inductor are connected in series to an ac source of frequency 60 Hz . Calculate the capacitance of the capacitor, if the current is in phase with the voltage
3. Distinguish between reactance and impedance . When a series combination of a coil of inductance L and a resistor of R is connected across a 12 V , 50 Hz supply a current of 0.5 A flows through the circuit . The current differs in phase from the applied voltage by π/3 radian . Calculate the value of L and R

4. The electric current in a wire in the direction from B to A is decreasing. What is the direction of induced current in the loop kept above the wire as shown in figure ?



5. An ideal inductor is in turn put across 220 V , 50 Hz and 220 V , 100 Hz supplies . Will the current flowing through it in the two cases be the same or different ?

6. When a capacitor is connected in series with a series LR circuit , the alternating current flowing in the circuit increases . Explain why ?

7. An a.c generator has a coil of N turns each of area A , rotating with angular velocity ω in a uniform magnetic field B

a) What is the maximum emf between its slip rings ?

b)What is the flux associated with the coil when the emf across it is zero

8. How does the mutual inductance of a pair of coils change when a) the distance between the coils is increased b) the number of turns in each coil is increased Justify your answer in each case

9. A capacitor of capacitance 100 µF and a coil of resistance 50 Ω and inductance 0.5 H are connected in series with a 110 V, 50 Hz source . Calculate the rms value of the current in the circuit

10 . A series combination of L = 5.0 H , C = 80 µF and R = 40 Ω is connected across a variable frequency 230 V main source . Calculate(i)the frequency in radians per second of the source which drives the circuit in resonance

(ii) The impedance of the circuit and the amplitude of the current at resonant frequency

(iii) rms value of potential drop across the inductor at resonant frequency

11. Distinguish between reactance and impedance .

When a series combination of inductance and resistance are connected with a 10 V, 50 Hz ac source , a current of 1 A flows in the circuit . The voltage leads the current by a phase angle of □/3 radian . Calculate the value of resistance and inductance

12. For an ac circuit , distinguish between resistance and impedance . An iron - cored inductor and a bulb are connected in series to an ac source . Explain with reason , how the brightness of the bulb change in the following situations

a) Iron core is removed from the inductor

b) The number of turns of the inductor is doubled

c) If a capacitor is included in series with the circuit such that $X_C = 2\ X_L$

12. An ac circuit having an inductor and a resistor in series draws a power of 560 W from an ac source marked 210 V 60 Hz . If the power factor of the circuit is 0.8 , calculate

(i) the impedance of the circuit (ii) the inductance of the inductor used

13. Which is the best method of reducing current in an ac circuit and why ?

14. Calculate the r.m.s value of the current in an a.c circuit containing a capacitor of 40µF and a resistor of 10 Ω in series . The power supply in the circuit is rated as 230 V , 50 Hz .

15. An alternating current of 1.5 mA and angular frequency 100 rad/sec flows through a 10 kΩ resistor and a 0.05 µF capacitor in series . Calculate the value r.m.s voltage across the capacitor and the impedance of the circuit .

16. An electric lamp which runs at 80 V d.c , consumes 10 A current . The lamp is connected to a 100 V , 50 Hz a.c source . Calculate the inductance of the choke required .

17. Why does the acceleration of a bar magnet decrease , while falling through a solenoid connected to a closed circuit ?

18. An arc lamp operates at 80 V , 10 A . Suggest a method to use it with a 240 V dc source . calculate the value of the electric component required for this purpose .

19. A series LCR circuit consists of a resistance of 10 Ω , a capacitor of reactance 60 Ω and an inductor coil .
20. The circuit is found to resonate when put across 300 V , 100 Hz supply . calculate
i) the inductance of the coil (ii) current in the circuit at resonance
21. If the speed of rotation of the armature of a generator is increased , how would it affect (i) the maximum emf produced and (ii) the frequency of emf
22. In a series LCR circuit , the voltages across an inductor , capacitor and resistor are 40 V , 20 V and 20 V respectively . What is the total voltage operative across the combination
23. A capacitor , a resistance of 20 Ω and an inductor of 30 mH are connected in series to an ac source 110 V , 60 Hz . calculate the capacitance of the capacitor if the current is in phase with the voltage
24. A rectangular loop of wire KLMN is moved with a velocity 'v' right angles to a uniform magnetic field 'B' as shown in figure .
a) What is the magnitude of current induced in the loop ?
b)Will there be any work done on the loop ? Give reason for your answer
26. An a.c generator has a coil of N turns each of area A , rotating with angular velocity
 in a uniform magnetic field B
a) What is the maximum emf between its slip rings ?
b)What is the flux associated with the coil when the emf across it is zero ?

LEVEL - 3

1. The Magnetic Flux through a coil perpendicular to its plane and directed into the paper is varying according to the relation: $\varphi = 5t2 + 10t+5$ mWeber. Calculate the E.M.F. induced in the loop at t = 5 seconds.
2. A uniform magnetic field B exists in a cylindrical region of radius r = 10 cm. A uniform wire of length 80 cm and resistance R = 4Ω is bent into a square frame and is placed with one side along the diameter of the cylindrical region. If the magnetic field increases at a constant rate of 0.01 T/sec, find current induced in the frame.
3. A long solenoid with 15 turns per cm has a small loop of area 2.0 cm^2 placed inside, normal to the axis of the solenoid. If the current carried by the solenoid changes steadily from 2A to 4A in 0.1 sec, what is the induced voltage in the loop, while the current is changing?
4.(a) A toroidal solenoid with an air core has an average radius of 15 cm, area of cross section 2 cm2 and 1200 turns. Obtain the self-inductance of the solenoid.
(b) A second coil of 300 turns is wound closely on the toroid above if current in the primary coil is increased from 0 to 2.0A in 0.05 sec. Obtain E.M.F. induced in the second coil.
6. (a) The peak voltage of an A.C. supply is 300 V. What is its r.m.s. voltage?
(b) The r.m.s. value of current in an A.C. circuit is 10A. What is its peak current?
7. A coil of inductance 0.5 H and resistance 100 is connected to a 240V, 50Hz A.C. supply.
a. What is the maximum current in the coil?
b. What is the time lag between the voltage maximum and the current maximum?
8. A resistor of 12Ω, a capacitor of reactance 14Ω and a pure inductor of inductance 0.1H are joined in series and placed across a 200V, 50 Hz A.C. supply. Calculate (i) current in the circuit, (ii) phase angle between current and voltage. Take $\pi = 3$.
9. 11kW of electric power can be transmitted to distant station at (i)220V or (ii)22000V. Which of the two modes of transmission should be preferred and why?
10. The output voltage of an ideal transformer, connected to a 240V A.C. Mains is 24V. When this transformer is used to light a bulb with a rating 24V - 24W, Calculate the current in the primary coil of the circuit.
11. At a hydroelectric powerplant, the water pressure head is at a height of 300m and the water flow available is 100m3/s. If the turbine generator efficiency is 60%, estimate the electric power available from the plant.
12. A 100μF capacitor in series with a 40 resistance is connected to a 110 v, 60 Hz supply
(a) What is the maximum current in the circuit?

(b) What is the time log between current maximum and voltage maximum?
13. A coil of inductance 0.4 mH is connected to a capacitor of capacitance 400pF. To what wavelength is this circuit tuned?
14. A series LCR circuit with L = 0.12 H , C = 480 nF , R = 23Ω is connected to a 230 V variable frequency supply.
a) What is the source frequency for which current amplitude is maximum?
b) What is the source frequency for which avg power absorbed by the circuit is maximum? Obtain the value of this max power.
c) What is the Q factor of the given circuit?
15. A series LCR circuit is connected to an a.c. source of 220V-50HZ.if the readings of voltmeters across resistor, capacitor and inductor are 65V,415V,204V and r=100□.calculate
i) current in the circuit
ii) value of L&C
iii) capacitance required to produce resonance with the given inductor L.
16. A resistor of 12Ω, a capacitor of reactance 14Ω and an inductor of reactance 30Ω are joined in series and placed across a 230V-50Hz supply.
Calculate i) current in circuit ii) phase angle between current and voltage and iii) power factor
17. An inductor coil stores 32J of magnetic field energy and dissipates energy as heat at the rate of 320W when a current of 4A is passes through it. Find the time constant of the circuit when the coil is joined across an ideal battery.
18. When an alternating voltage of 220 V is applied across a device X , a current of 0.5 A flows through the
circuit and is in phase with the applied voltage . When the same voltage is applied across another device Y , the same current again flows through the circuit but it leads the applied voltage by □/2 radians .
One) name the devices X and Y
Two) calculate the current flowing in the circuit when same voltage is applied across the series combination of X and Y
19. A radio frequency choke is air cored coil whereas an audio frequency choke is iron cored . Give reason.
20. An electric lamp connected in series with a variable capacitor and an ac source is glowing with some brightness . How will the brightness change on increasing the value of capacitance and why?

ELECTRO MAGNETIC WAVES

LEVEL -1

1) State Ampere's Circuital law and give its mathematical form.(2)
2) What is the inconsistency which Maxwell observed in Ampere's Circuital law?(2)
3) What is Displacement current? Explain.(2)
4) Write Maxwell's equations and explain the existence of EM waves.(3)
5) Explain how EM waves are produced?(2)
6) Write the properties of EM waves.(3)
7) Define the term electromagnetic spectrum and mention its components? (2)
8)What are the components of the invisible parts of electromagnetic spectrum?(2)
9) Write wavelength ranges of following electromagnetic radiations
(a) Radio waves (b) micro waves (c) ultraviolet(uv) radiation (d) visible light (e) infrared radiation (f) X – rays and (g) gamma rays. (3)
(10) Mention any one use of the following radiations.
(a) Radio waves (b) micro waves (c) ultraviolet(uv) radiation (d) infrared radiations
(f) X – rays and (g) gamma rays. (3)
11) Write frequency ranges of following electromagnetic radiations
(a) radio waves (b) micro waves (c) ultraviolet(uv) radiation (d) visible light (e) infrared radiation (f) x – rays and (g) gamma rays. (3)

12) Arrange the following em waves in increasing order of their frequency
Gamma rays, UV rays, visible radiation, IR radiation (2)

LEVEL -2

1) Draw the diagram of electromagnetic plane polarized electromagnetic wave travelling in the forward direction and mark the directions of electric and magnetic field vectors and also the direction of propagation of the wave.(3)
2) What is the relation between the magnitudes of electric field and magnetic field in an em wave? Define the term radiation pressure and explain with an example.(3)
3) The amplitude of magnetic field part of a harmonic em wave in vacuum is Bo=510nT.What is the amplitude of electric field part of the wave?
4) Electric field vector is along the X direction and Magnetic field vector is along Y direction .What do you say about the direction of propagation of the wave?(1)
5) Identify the type of em wave associated with the following
a) used to take photograph under foggy conditions b)radiation emitted during welding
c) emitted during radioactive decay (3)
6) Identify the type of e.m wave associated with the following wavelength/frequency ranges.
a) 0.1 to 1m b) 10^{14}Hz c) 10 *A* to 1000 A (3)
7) Name the em radiation is in electric ovens and mention its other uses.(3)
8) What physical quantity is same for gamma rays of wavelength 10-13m and red light of wavelength 6800A0 (1)
9) What are the physical quantities a) that remain constant b) increase and c) decease as one moves from Gamma rays to Radio waves in an em spectrum.(3)
10) What does an em wave consist of? On what factors does the velocity of em wave depend?(3)
11) Why did Maxwell introduce the concept of displacement current? Explain.(2)
12) How does a Microwave oven work? (2)
13) What type of em radiation is used in the following?
a) Resource mapping of the earth b) TV transmission c) Radar systems for aircraft navigation. d) used in water purifiers to kill germs (2)
14) A radio can tune into any station 7.5MHz to 12MHz band.What is the corresponding wavelength band?(2)
15) Scientists predict a 'Nuclear winter 'if there is a global nuclear war which may have a devastating effect on earth.What might be the basis of this prediction? (2)
16) Optical and radio telescopes are built on the ground but X-Ray astronomy is possible only from satellite orbiting the earth.Why?(2)

LEVEL - 3

(1) The electric field of a plane electromagnetic wave in vacuum is represented by Ex=0, Ez=0 and $Ey=0.7\cos[2\Pi x10^{8}(t-x/c)]$ (3)
a) What is the direction of propagation of em wave?
b) Determine the wavelength of the wave.
c) Compute the component of associated magnetic field.
2) A plane em wave is travelling along the X – direction has a wavelength of 3mm .The variation in the electric field occurs in the Y direction with the amplitude of 66V/m .What is the equation for the variation of electric and magnetic fields as a function of x and t. (3)
3) Show that the energy of em wave is equally divided between electric and magnetic fields. (3)
4) An em wave of frequency n=3MHz passes from vacuum into a dielectric medium with permittivity ε=4.What will happen to its frequency and wavelength? (2)
5) What might be the frequency of em wave which is best suited to observe a particle of size $3x10^{-4}$m?(2)
6) Suppose the electric field amplitude of em wave is E0=150N/C and its frequency n=70MHz.Find the expression for electric and magnetic field vectors. (3)
7) An ammeter is connected with a battery , switch and capacitor .When switch is put on, explain your observations.

OPTICS

LEVEL –1

1. Draw a ray diagram to show the formation of image of an object placed between f and 2f of a thin convex lens. Deduce the relation between the object distance, the image distance and the focal length of the lens under this condition

2. By stating sign conventions and assumptions, derive the relation between u, v and f in case of a concave mirror?Derive an expression for the refractive index of the prism in terms of angle of prism and angle of minimum deviation

3. How does the focal length of the lens change when red light is replaced by blue light?

4. How is a wave front different from a ray? Draw the geometrical shape of the wave fronts when (i) light diverges from a point source (ii) light emerges out of the convex lens when a point source is placed at its focus.

5. Show with a ray diagram, how an image is produced in total reflecting prism?

6. State Huygens's principle.

7. What are coherent sources? Why are coherent sources required to produce interference of light?

8. What is interference of light? Using Young's double slit experiments deduce the conditions for (i) constructive and (ii) destructive interference at a point on the screen.

9. Draw the diagram showing intensity distribution of light on the screen for the interference of light in Young's double slit experiment.

10. Draw labeled ray diagram of compound microscope.

11. Write the expression for magnifying power and resolving power of i) microscope ii) telescope

12. Draw a labeled diagram of telescope when the image is formed at the least distance of distinct vision? Hence derive the expression for its magnifying power?

13. State Brewster law? Using this law prove that, at the polarizing angle of incidence, the reflected and transmitted rays are perpendicular to each other?

14. State any two essential conditions for observing sustained interference of light.

15. Explain the phenomenon of diffraction of light at a single slit, to show the formation of diffraction fringes. Show graphically the variation of the Intensity, with angle, in this single slit diffraction pattern.

16. A convex lens made up of refractive index n1 is kept in a medium of refractive index n2. Parallel rays of light are incident on the lens. Complete the path of rays of light emerging from the convex lens if (1) $n1 > n2$ (2) $n1 = n2$ (3) $n1 < n2$

17. Give reasons for the following in one word or sentence: (a) Sky appears blue during day time as seen from the earth. (b) A rainbow is never observed from the surface of moon. (c) Sunset and sunrise are abrupt as seen from moon.

18. Derive the expression for the fringe width in young's double slit experiment.

19. How does the fringe width in the interference pattern change, when the Whole apparatus is immersed of refractive index 4/3?

20. State any two differences between interference and diffraction.

21. When a monochromatic light travels from one medium to another, why its wavelength changes but frequency remains the same.

22. Why does bluish colour predominate in a clear sky.

23. No interference pattern is detected when two coherent sources are infinitely close to each other

24. State the essential condition for diffraction of light to take place.

25. What is the shape of wave front on earth for sunlight

26. What type of lens is an air bubble inside water?

27. Define magnifying power of a telescope. Write its expression.

28. What is power of a lens? State its unit.
29. Draw a ray diagrams for the following:
a. Image formed by concave mirror when the object is placed between centre of curvature and principle focus
b. Image formed by convex mirror when the object is placed at a distance.
c. Image formed by convex lens when the object is placed beyond 2F
d. Image formed by concave lens when the object is placed at certain distance
e. Lens maker's formula
f. Image formed by convex spherical refracting surface when the object is placed in rarer medium
g. Simple microscope – image is formed at least distance of distinct vision
h. Compound microscope – image is formed at least distance of distinct vision and at infinity
i. Astronomical telescope - image is formed at least distance of distinct vision and at infinity.
j. Reflecting telescope
k. Young's double slit experiment – for fringe width derivation
l. Interference pattern – for constructive and destructive interference.
m. Diffraction through a single slit.
n. Brewster's law
o. Verification of reflection and refraction of light using Huygen's principle.
p. Graph on interference – distance, diffraction – angle, law of malus
q. Refraction through prism and its graph

LEVEL-2

1 Mark Question
1) Give the ratio of velocities of light rays of wavelengths 4000 Å and 8000 Å in vacuum.
2) What is the principle of reversibility of light?
3) Define critical angle for total internal reflections
4) Define power of a lens.
5) Why dose sky appear blue?
6) What should be the position of an object relative to a convex lens so that it behaves like a magnifying lens?
7) For which colour in visible region, the refractive index of glass is maximum?
8) Define refractive index of a medium in terms of wavelength of light.
9) State the factors on which the refractive index of a medium depends.
10) Do the frequency and wavelength change when light passes from a rarer to a denser medium and vice-versa?
11) For the same angle of incidence, the angles of refraction in three different media A,B, and C are 15° , 20° and 30° respectively . In which medium will the velocity of light be minimum?
12) Does critical angle depend on colour of light?
13) What is the value of critical angle for a material of refractive index $\sqrt{2}$?
14) If ang=3/2 and anw=4/3, then what will be the value of wng?
15) What type of a lens is an air-bubble inside water?
16) A convex lens is held in water what change, if any, do you expect in its focal length?
17) A equiconvex lens of focal length 15cm is cut into two equal halves as shown in fig. What is the focal length of each half?
18) Name the factors on which the angle of deviation produced by a prism depends.
19) A lens immersed in a transparent liquid is not visible. Under what condition can it happen?
20) An object is first seen in red light through a simple microscope. In which case is the magnifying power bigger?
21) Write the expression for linear magnification produced by a convex lens and a concave lens.
22) A ray of light is incident normally on the glass slab. What will be the angle of refraction?
23) State the expression for magnifying power of a simple microscope.
24) Can a microscope function as a telescope by inverting it?

25) What is the effect of increasing the diameter of the objective of a telescope on its (i) magnifying power (ii) resolving power?
26) How can we increase the resolving power of a microscope?
27) What is the use of inverting lens in an astronomical telescope?

Short Answer Type Questions

2Marks Each

1. Why does a ray of light having oblique incidence deviate towards the normal as it passes from air to glass? Explain.
2. What is the twinkling effect of a star due to?
3. A microscope is focused on a dot at the bottom of a beaker. Some oil is poured into the beaker to a height of y cm and it is found necessary to raise the microscope through a vertical distance of x cm to bring the dot again into the focus. Express refractive index of oil in terms of x and y.
4. The Sun near horizon appears flattened at Sunset and Sunrise. Why?
5. Why does the rising Sun appear bigger?
6. Mention two important applications of the optic fibers.
7. A lens whose radii of curvature are different is forming the image of an object placed on its axis. If the lens is reversed, will the position of the image change? Explain.
8. A ray of light after refraction through a concave lens becomes parallel to the principal axis. Explain with a ray diagram when this can happen.
9. A convex lens (ng=1.5) behave as a converging lens when dipped in water (nw=1.33) whereas it behaves as a divergent lens when dipped in carbon disulphide (ne=1.65). Why?

SHORT ANSWER TYPE QUESTIONS

3 Marks Each

1) Define 'critical angle of incidence' .Establish relationship between the critical angle of incidence and speed of light in the two media.
2) What is an optical fibre? On what principle does it work? Explain by drawing a ray diagram how optical fibres transmit signals without any significant absorption.
3) A concave lens made of a material of refractive index n1 is kept in a medium of refractive index n2. A parallel beam of light incident on the lens. Complete the path of the rays of light from the concave lens if (a) n1 > n2 (b) n1 = n2 (c) n1 < n2.
4) A ray of light passes through an equilateral glass prism, such that angle of incidence is equal to the angle of emergence. If the angle of emergence is ¾ times the angle of prism. Calculate the refractive index of the glass prism.
5) Draw a ray diagram to show the formation of the image of an object placed between f and 2f of a thin concave lens. Deduce the relation between the object distance, the image distance and the focal length of the lens under this condition.
6) Draw ray diagrams to show how a right angled isosceles prism can be used
(i) To deviate a ray of light through 90˚
(ii) To deviate a ray of light through 180˚

Also name the instrument in such prisms used.
7) Deduce lens maker's formula for a thin biconvex lens.
8) If a ray of light undergoing refraction through a combination of three media, show that

$$^{1}n_{2} \times {}^{2}n_{3} \times {}^{3}n_{1} = 1$$

9) With the help of a ray diagram, explain the construction and working of a Newtonian reflecting telescope. Write the formula for its magnifying power.
10) A tank is filled with water to a height of 12.5cm. The apparent depth of a needle lying at the bottom of full tank is measured by a microscope to be 9.4cm. What is the refractive index of water? If water is replaced by a liquid of refractive index 1.63 up to the same height, by what distance would the microscope have to be moved to focus the needle again?

11) A converging lens has a focal length of 20cm in air. It is made of a material of refractive index 1.6. If the lens is immersed in a liquid of refractive index 1.3. What will be the new focal length of the lens?
12) Draw a neat and labeled ray diagram of an astronomical telescope when the image is formed at the least distance of distinct vision . State the expression for its magnifying power.
Long-Answer Questions
5 MARKS EACH
1) You are given two convex lenses of focal length 80mm &800mm. Which one will you use as an objective & which one as eye piece for constricting an astronomical telescope? Trace the course of ray through the two lenses to show the formation of images of a distant object in normal adjustment. Derive an expression for the magnifying power of the telescope.
2) Draw a neat & labeled ray diagram showing the formation of image in a compound microscope. Derive an expression for its magnifying power. How can its magnifying power be increased?

Magnifying power can be increased by taking lenses of small focal length.
WAVE - OPTICS
1) Sound waves are not electromagnetic in nature. What is the evidence?
2) What is plane polarized light?
3) The polarizing angle of a medium is 600 what is the refractive index of the medium?
4) What is a Polaroid?
5) The phase difference between two waves reaching a point is □/2 what is the resultant amplitude if the individual amplitudes are 3mm and 4mm?
6) A young's slit set up is immersed completely in water without any other change.
What happens to the fringe width?
7) A plane wave front is incident normally on a convex lens sketch the refracted wave front.
8) What happens to the frequency when light travels from one medium to another?
9) A soap bubble or oil on water shows beautiful colour in sunlight. Why?
10) Give one basic difference between interference and diffraction.
11) When light travels from a rarer to a denser medium it loses some speed. Does the reduction in speed imply a reduction in the energy carried by the light wave?
12) Define wave front
13) When a low flying aircraft passes overhead we sometimes notice slight shakening of the picture on our TV screen. Why?
2 marks Question.
1) What are coherent sources? Can two different bulbs similar in all respects act as coherent sources?
2) State and explain Huygens principle. Name the type of wave front that corresponds to a beam of light (i) coming from a very far off source (ii) diverging radically from a point.
3) Determine the angular separation between central maximum and first order maximum of the diffraction pattern due to single slit of width 0.25 mm when light of wavelength 5890 A0 is incident on it normally on it.
4) What is meant by polarizing angle (or) Brewster angle?
5) Give two examples of commonly used devise which makes use of polaroids.

3 Marks Question
1) Deduce the law of reflection on the basis of Huygens's principle.
2) Mention the basic condition for-permanent interference of light waves.
3) Derive the expression for fringe width in young's double slit experiment.
4) Derive an expression for the angular width of the central maximum of the diffraction pattern produced by a single slit illuminated with monochromatic light.

5) Define polarizing angle. Derive the relation between polarizing angle and refractive index of the medium.

LEVEL – 3

REFLECTION AT A SPHERICAL SURFACE:

1. If you look into a shiny spoon, you see an inverted image on one side and an upright image on the other side. Why? Could you see upright image on both sides?

2. A moth flies towards a concave mirror. Does its image become larger or smaller as it approaches the mirror's focal point? What kind of image is it? What happens when the moth is at the focal point? REFRACTION AT A PLANE SURFACE:

3. For the same angle of incidence, the angles of refraction in three media A,B and C are 15˚, 25˚and 35˚ respectively. In which medium would the velocity of light be minimum?

4. In the H.G.Wells novel, THE INVISIBLE MAN, a person becomes invisible by altering his index of refraction to match that of air. If the invisible man could actually do this, would he be able to see? Explain.

5. The length of a wave in water diminishes μ times, μ being the refractive index of water. Does this mean that a diver cannot see surrounding objects in their natural colours?

6. The covered print is not visible from any of the four sides of a glass cube placed on a book. Explain what happens by a simple diagram. (for air to glass, when i = 90˚ , r = 42˚) REFRACTION AT SPHERICAL SURFACES AND LENSES:

7. A man wishing to get a picture of a zebra photographed a white donkey after fitting a glass with black streaks on the objective of his camera. What will be on the photograph?

8. Why do the sunglasses (goggles) which have curved surfaces, not have any power?

9. A concave mirror and a convex lens are held in water. What change, if any, do you expect to find in the focal length of either?

10. A virtual image, we always say, cannot be caught on a screen. Yet when we 'see' a virtual image, we are obviously bringing it on to the 'screen' (i.e., the retina) of our eye. Is there a contradiction?

11. A convex lens made of a variety of glass of high dispersive power has a focal length of 15 cm. A parallel beam of white light is incident on one side of the lens and a screen is placed on the other side. Describe the chromatic aberration of the lens i.e, describe the colours on the spot focused on the screen as the screen is moved away from the lens.

OPTICAL INSTRUMENTS:

12. What is the minimum distance between two points that you are able to resolve from a distance of 100 m, if you have normal visual acuity? Could you recognize a familiar face 100 m away?

13. The angle subtended at the eye by an object is equal to the angle subtended at the eye by the virtual image produced by a magnifying glass. In what sense then does a magnifying glass provide angular magnification?

14. If your near point distance is N, how close can you stand to a mirror and still be able to focus on your image?

15. Magnifying power of a simple microscope is inversely proportional to the focal length of the lens. What then stops us from using a convex lens of smaller and smaller focal length and achieving greater and greater magnifying power?

16. Four double convex lenses, with the following specifications are available:

lens	Focal length	aperture
A	100 cm	10 cm
B	100 cm	5 cm
C	10 cm	2 cm
D	5 cm	2 cm

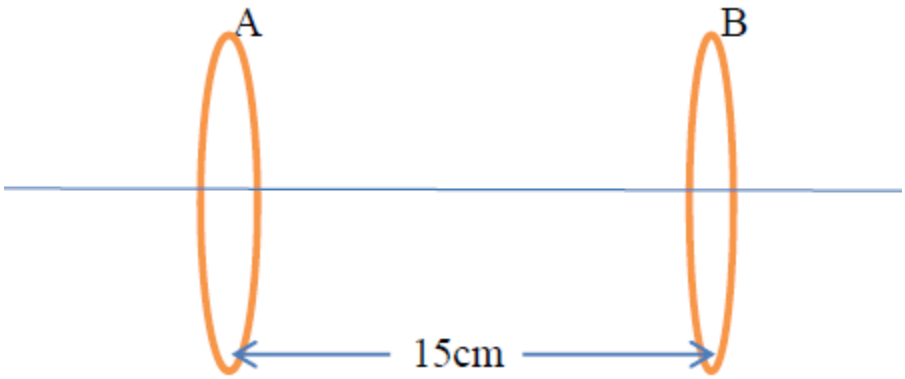
Which two of the given four lenses should be selected as the objective and eyepiece to construct an astronomical telescope and why? What will be the magnifying power and normal length of the telescope so constructed?

17. Which of the four lenses (Q.No.16) should be selected as objective and eyepiece of a compound microscope and why? How can the magnifying power of such a microscope be increased?

18. Which of two main considerations are kept in mind while designing the objective of an astronomical telescope?

19. The Mt. Palomar telescope is used to observe Moon, 3.8 × 108 m away. The objective has a focal length of 17 m and the eyepiece has a focal length of 17 cm. find the minimum distance between object points on the moon that are just barely resolved by an eye looking through the telescope. Assume that the resolution is limited by the eye's acuity and that the minimum angle of resolution is 5.0 × 10⁻4 rad.

20. Two convex lenses A and B of an astronomical telescope having focal length 5 cm and 20 cm respectively, are arranged as shown in fig. (3m)



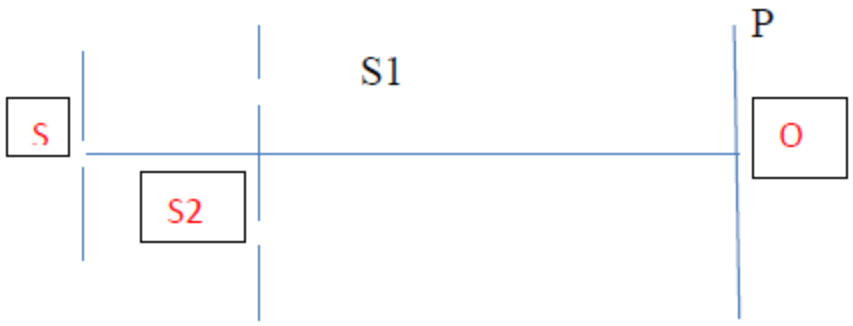
(i) Which one of the two lenses you will select to use as the objective lens and why? (ii) What will be the change in the distance between the lenses to have the telescope in normal adjustment?(iii) Calculate the magnifying power of the telescope in the normal adjustment position.

21. How does diffraction limit the resolving power of an optical instrument?

WAVE OPTICS:

22. The speed of light in still water is c/μ, where μ is the refractive index of water. What is the speed of light in a stream of water flowing at a steady of speed of 'v' relative to the observer?

23. Fig shows an experimental set up similar to Young's double slit experiment to observe interference of light. Here, SS2 – SS1 = λ/4. Write the condition of (i) constructive (ii) destructive interference at any point P in terms of path difference = S2P – S1P. Does the central fringe observed in the above set lie above or below O? Give reason in support of your answer.



24. White light is used to illuminate two slits in Young's double-slit experiment. The separation between the slits is 'b', and the screen is at a distance d(>>b) from the slits. At a point on the screen directly in front of one of the slits, which wavelengths are missing?

25. Suppose a sheet of glass is placed in front of one of the slits in a Young's double slit experiment. If the thickness of the glass is such that the light reaching the two slits is 180˚ out of phase, how does this affect the interference pattern?

26. You want to check the time while wearing your Polaroid sunglasses. If you hold your forearm horizontally, you can read the time easily. If you hold your forearm vertically, however, so that you are looking at your watch sideways, you notice that the display is black. Explain.

27. The electromagnetic waves we pick up on our radios are typically polarized. In contrast, the indoor light we see every day is typically unpolarised. Explain.

28. Modern day 3-D movies are produced by projecting two different images onto the screen, with polarization directions that are 900 relative to one another. Viewers must wear headsets with polarizing filters to experience the 3-D effect. Explain how this works.

29. While you drive through a city or mountain areas, the quality of your radio reception varies sharply from place to place, with stations seeming to fade out and reappear. Could diffraction be a cause of this? Which of the following bands would you expect to be least affected by it:

(a) 162 MHz (b) (88-108 MHz) (c) (525-1610 KHz)

30. Light from sodium lamp is passed through two Polaroid sheets P1 and P2 kept one after the other. Keeping P1 fixed, P2 is rotated so that its pass-axis can be at different angles θ with respect to the pass-axis of P1. An experimentalist records the following data for the intensity of light coming out of P2 as a function of θ.

s.no.	θ(angle between the pass-axis of two polaroids)	I (intensity of light coming out of P_2)
1.	0^0	$I_0/2$
2.	30^0	$(3/8)I_0$
3.	45^0	$(1/2\sqrt{2})I_0$
4.	60^0	$I_0/8$
5.	90^0	0

Here I0= intensity of beam falling on P1.
One of these observations is not in agreement with the expected theoretical variation of I. Identify the observation and write the correct expression.

DUAL NATURE OF MATTER AND RADIATION

LEVEL -1

1. Write down the relation between wavelength and momentum of a photon.
2. What happens to the wavelength of a photon after it collides with an electron?
3. Write Einstein's photoelectric equation.
4. Define the threshold wavelength for photoelectric effect.
5. What is the stopping potential in photoelectric effect?
6. What is de-Broglie wave length?
7. What is the de-Broglie wavelength of an electron accelerated through a Potential difference of V volts.
8. Show graphically how stopping potential for the given photosensitive surface varies with frequency of incident radiation.
9. If 'h' is Planck's constant, find the momentum of a photon of wavelength $0.01A^0$.
10. State and explain the laws of photoelectric emission.
11.Derive the relation for deBroglie wavelength.
12. Explain the experimental demonstration to explain photo electric effect..Hence explain Stopping potential.
13. What is the momentum of energy 1MeV?
14. How many photons are effective in the emission 1 photoelectron?
15. Draw the graphs showing the variation of photoelectric current with potential for varying intensities and hence explain the effect of intensity of incident radiation on photoelectric current.
16. Plot a graph showing the variation of stopping potential with frequency of incident radiation and hence obtain the Planck's constant.

LEVEL-2

1. If the wavelength of the EM radiation is doubled, what will happen to the energy of the photons.
2. Does the 'stopping potential' in the photoelectric emission depend upon a) the intensity of the incident radiation.
b) the frequency of the incident radiation
3. An electron is accelerated through a potential difference of 300V.What is its energy in electron volt?
4. What is the rest mass of a photon?
5. What is the momentum p of a photon from UV light of wavelength 332nm.
6. How many electron volt make one Joule.
7. How will the photoelectric current change on decreasing the wavelength of incident radiation for a given photosensitive material.
8. The stopping potential in an experiment on photoelectric effect is 1.5V.What is the maximum kinetic energy of the photoelectrons emitted.
9. It is difficult to eject out an electron from copper than sodium. Which of the two metal has greater work function and has greater threshold wavelength.
10. de-Broglie wavelength associated with an electron accelerated through a potential difference V is λ. What will be its wavelength when the accelerating potential is increased to 4V.
11. .Sketch the graphs showing the variation of stopping potential Vs with frequency of the incident radiations for two photosensitive materials A and B having threshold frequencies $\gamma 0 > \gamma 0'$
(i)Which of the two metals A or B has higher work function.
(ii)What information do you get from the slopes of the graph

(iii)What is the value of intercept of graph A

12.A photon and an electron have the same deBroglie wavelength. Which has greater total energy? Explain.

13.Show that deBroglie hypothesis of matter wave supports the Bohr's concept of stationary orbit.

14.Work function of Sodium is 2.3eV.Does Sodium show Photoelectric emission for orange light(λ=6800 A^0)

LEVEL-3

1. Two beams, one of red light and other of blue light, of the same intensity is incident on a metallic surface to emit photo electrons. Which one of the two beams emit electrons of greater frequency.

A. Blue emits electrons of greater kinetic energy because its frequency is greater than that of red light.

2. The most probable kinetic energy of thermal neutrons at a temperature of T Kelvin, may be taken as equal to kT, where k is Boltzmann constant. Taking the mass of a neutron and its associated de-Broglie wavelength as m and λB respectively, state the dependence of λB and m on T.

3. The maximum kinetic energy of photoelectrons emitted from a surface, when a photon of energy 6eV fall on it is 4eV.What is the stopping potential in volt for the fastest electrons.

4. The wavelength λ of a photon and the de- Broglie wavelength of an electron have the same value. Show that the energy of the photon is $2\lambda mc/h$ times the kinetic energy of electron, where m,c, and h have their usual meaning.

5. An X ray operates at 10KV.What is the ratio of X-ray wavelength to that of de-Broglie wavelength.

6.If the frequency of the incident light on a metal surface is doubled, will the kinetic energy of the photoelectrons be doubled? Give reasons.

7. Show that the wavelength of the EM radiation is equal to the de-Broglie wavelength of its quantum (photon).

8. A particle of a mass M at rest decays into two particles of masses m1 and m2 having nonzero velocities. What is the ratio of the de-Broglie Wavelengths of the two particles?

9. The de-Broglie wavelength of a particle of kinetic energy K is λ. What would be the wavelength of the particle, if its kinetic energy were K/4.

10. Xrays of wavelength 0.82 A0 fall on a metal plate. Find the wavelength associated with photoelectrons emitted. Neglect the work function of the metal. Given h=6.634x10 $^{-34}$Js (Ans.0.099 A^0)

ATOMS AND NUCLEUS

LEVEL - 1

1. Name the experiment which is associated with the discovery of atomic nucleus.
2. What will be the ratio of radii of two nuclei with mass numbers A1 & A2?
3. What is binding energy?
4. Name some important characteristics of nuclear forces.
5. What is the atomic & mass numbers of element 'X'?

$$_0n^1 + {}_{80}Hg^{198} \longrightarrow X + {}_1H^1$$

6. Define radioactive decay constant.
7. What is half life of a radioactive substance?
8. What is average life of a radioactive substance?
9. How is the half life of a radioactive substance related to its average life?
10. Why do we use neutrons for causing nuclear reactions?
11. Name the SI unit of radioactivity.
12. Plot the graph between the binding energy per nucleon & the mass number . Hence explain nuclear fission & fusion based on this graph.

13. What is radioactivity? Draw the radioactive decay curve.
14. What is the SI unit of decay rate?
15. Establish the relationship between decay constant &half life of a radioactive substance.
16. Explain the origin of spectral lines. Obtain an expression for Rydberg's constant & write its value.
17. Draw energy level diagram for hydrogen atom.
18. State the limitations of the Bohr's theory.
19. Draw a labeled diagram of experimental setup of Rutherford 's alpha particle scattering experiment. Write two important inferences drawn from this experiment.
20. What is the nuclear force? Mention any two important properties of it.
21. If 70% of a given radioactive sample is left un-decayed after 20 days, what is the % of original sample will get decayed in 60 days?
22. 4 nuclei of an element fuse together to form a heavier nucleus .If the process is accompanied by release of energy, which of the two: the parent or the daughter nuclei would have higher binding energy per nucleon. Justify your answer.

***LEVEL* -2**

1.The sequence of stepwise decays of a radioactive nucleus is

$$D \xrightarrow{\alpha} D_1 \xrightarrow{\beta} D_2 \xrightarrow{\alpha} D_3$$

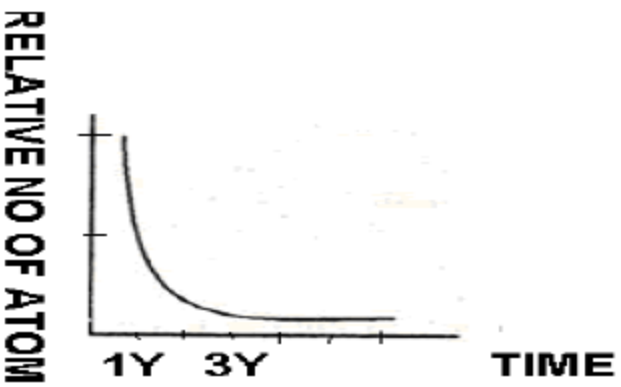
If the nucleon number and atomic number for D2 are 176 and 71 respectively, what are the corresponding values of D and D3 ? Justify your answer in each case.
2. The half life of a radioactive substance is 30 s.Calculate i.)Decay constant. ii.)Time taken by the sample to become one-fourth of its initial value.
3. A neutron is absorbed by a nucleus $^{6}_{3}Li$ with the subsequent emission of an alpha particle. (i) Write the corresponding nuclear reaction. (ii) Calculate the energy released, in MeV, in this reaction

$Given: mass\ ^{6}_{3}Li = 6.015126\,u; mass(neutron) = 1.0086654\,u;$
$mass\ (alpha\ particle) = 4.0026044\,u\ and\ mass\ (triton) = 3.0100000\,u.$
$Take\ 1\,u = 931\ MeV/c^2.$

4. In the series of radioactive disintegration of $^{Z}_{A}X$ first an alpha-particle and then a beta-particle is emitted. What is the atomic number and mass number of the new nucleus formed by these successive disintegrations?
5. A nucleus $^{23}_{10}Ne$ undergoes β decay to give the nucleus $^{23}_{11}Na$ Write down the equation. Calculate the kinetic energy of the electron emitted, assuming the mass of as $^{23}_{10}Ne$ 22.994466 u and that of as $^{23}_{11}Na$ 22.989770 u. Rest mass of the electron may be ignored.
6. State the radioactive disintegration law & deduce exponential law from it.
7. Deduce expression for mean life.

***LEVEL* - 3**

1. The graph shows how the activity of a sample of radon-220 changes with time. Use the graph to determine its half-life. Calculate the value of decay constant of radon-220.



2. Thehalf life of a radioactive substance is 4 hours.

a.) In how much time will 7/8th of the material decay? B.)Tritium has a half life of 12.5 years against the beta decay. What fraction of the sample of tritium will remain un-decayed in 25 years?

3. Explain how radioactive nuclei can emit β particles even though atomic nuclei do not contain these particles. Hence explain why the mass number of a radioactive nuclide does not change during β decay. Use the basic law of radioactive decay, to show that radioactive nuclei follow an exponential decay law. Hence obtain a formula, for the half-life of a radioactive nuclide, in terms of its disintegration constant.

4.For scattering by an inverse square field (such as that produced by a charged nucleus in Rutherford's model)the relation between the impact parameter 'b' & the scattering angle 'θ' is given by $b=(Ze^2\cot\theta/2) / (2\pi\varepsilon_0 mv^2)$

a.)What is the scattering angle for b=0?

b.)For a given impact parameter 'b', does the angle of deflection increase or decrease with the increase of energy?

c.)What is the impact parameter at which scattering angle is 90˚ for Z= 79 and initial energy = 10MeV

d.)Why is it that the mass of the nucleus does not enter the formula above, but its charge does?

e.)For a given energy of the projectile, does the scattering angle increase or decrease with the decrease in impact parameter?

5. A muon is a particle that has the same charge as an electron but is 200 times heavier than it. If we had an atom in which the muon revolves around a proton instead of an electron, what would be the magnetic moment of the muon in the ground state of such an atom?

6. In a hydrogen atom, electron moves from second excited state to first excited state then from first excited state to ground state. Find ratio of wavelength obtained.

7. An electron in hydrogen atom makes transition from an excited state of energy 0.85eV to its ground state. Find out energy of photon emitted in this transition.

8. According to the classical electromagnetic theory, calculate the initial frequency of the light emitted by the electron revolving around a proton in hydrogen atom. Given: The velocity of electron moving around a proton in hydrogen atom in an orbit of radius 5.3 X 10^{-11} m is 2.2 X 10^{-6} ms^{-1}.

9. In the Rutherford's nuclear model of the atom, the nucleus (radius about 10-15m) is analogous to the sun about which the electron moves in orbit (radius about 10^{-10}m) like the earth orbits around the sun. If the dimensions of the solar system had the same proportion as those of the atoms would the earth be closer to or farther away from the sun than actually it is? The radius of earth's orbit is about 1.5 X 10^{11}m. The radius of the sun is taken as 7 X 10^{8}m.

10. A 10 kg satellite circles earth once every 2h in an orbit having a radius of 8000 km. Assuming that Bohr's angular momentum postulates applies to satellite just as it does to an electron in the hydrogen atom .Find the Quantum number of the orbit of the satellite.

SEMICONDUCTOR DEVICES

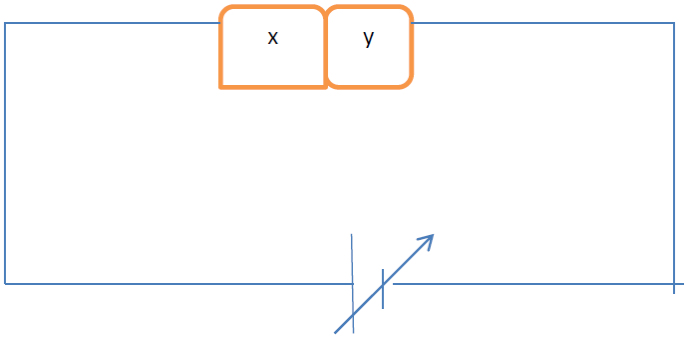
LEVEL – 1

1. What is the net charge on p-type semi conductors?
2. What is the net charge on an n-type semi conductor?
3. Write the full form of LCD?
4. Write the difference between intrinsic and an extrinsic semi conductor? Name the process in which the intrinsic semiconductor can be converted to an extrinsic semi conductor?
5. How n-type semiconductors and p-type semiconductors are formed?
6. Write two important processes in the formation of p-n junction diode?
7. State which factor controls the wave length of an LED?
8. Name the impurity, which when added to pure Si to produce n-type semiconductor
9. How the depletion layer is formed? What is the order of the thickness of it?
10. What do you understand by forward and reverse biasing of a diode.
11. What is the advantage of semiconductors over diode valves? 12) Write the full forms of CRT and LCD?
12. Give two examples for elemental semiconductors
13. Give two examples of compound semiconductors.
14. Draw the schematic diagram for energy band gaps for metals, insulators and semiconductors.
15. Draw the symbols of p-n junction diode.
16. what are photo diodes? Why they are used in reverse biased? What are the applications of it? Draw I-V charecterestic curves for it? 18) explain the fabrication & functioning of LEDs and write the applications and advantages?
17. explain the fabrication & functioning of Solar cells and write the applications and advantages?Why GaAs are considered for the fabrication of solar cells?Why I-V charecterestic curves are drawn in IVquadrants for Solar cells.
18. What are transistors?What are the three elements of transistor?What are the types of transistors?
19. Draw the symbols ,truth tables and realization of OR,AND and NOT gates.
20. what are ICs ? Write the advantages and limitations of ICs.
21. Write the differences between the analogue and digital signals.
22. Which naturally occurring lead compound acts as detector in radio receiver?
23. What are energy bands and how they are formed?
24. How metals act as conductors?
25. At what temperature the conduction band is completely empty inSi.
26. What do you mean by energy band gap?
27. What is the unique property that Semiconductor show and conductors do not show?
28. What is doping?
29. Penta valent dopant is called donor impurity and trivalent dopant is called acceptor dopant .Why?
30. What is the dominating current in Forward bias and in Reverse bias? In forward bias diffusion current is larger than that of drift current and in reverse bias the drift current dominates
31. What are the orders of diffusion and drift current in a p-n junction diode
32. What is breakdown voltage of a p-n junction diode?
33. What property of diode allows it to uses it as rectifier.
34. Why in rectifiers step down transformers are used?
35. Is it compulsory to use Centre-tap transformer in full wave rectifier?
36. What is use of the filters in rectifier circuits?
37. Who was the inventor of ZENER diode
38. What are the criteria for selecting the material for solar cell?
39. How GaAs is better choice than Si for fabricating a solar cell in spite of its higher band gap?

40. Why do not we select PbS whose band gap is 0.4 eV.
41. Why it is enough to draw only one line in input characteristic curves and many in output characteristic curves?
42. Amplifier is not a power generating device. Then how the output is amplified?

LEVEL –2

1. C,Si Ge have the same lattice structures. Why C an insulator but why Si and Ge are intrinsic semi conductors?
2. Draw the schematic diagrams for n-type and p type semiconductor?
3. Can we join p-type and n-type slabs to form p-n junction diode?
4. What do you understand by forward and reverse bias? Draw the diagrams and also draw the model graphs.
5. How the zener diode acts as voltage stabilizer?
6. Describe the action of transistor and draw the input and output charecterstic curves?
7. Explain the active region,cut off region and saturation region with respect to the charecterestic curves of transistor?
8. What is an amplifier?In which region of the transistor is operated as amplifier? Explain the working of npn transistor as an amplifier under common emitter mode? Why npn is prferred over pnp transistor?How in C-E mode the gains are high when compared to C-B mode?derive the expression for current,voltage and power gains. Explain the phase reversal in c-e configuration.
9. which is the universal gate and why it is so called?
10. Can we interchange the emitter and collector in atransistor?
11. Why a transistor can not be used as rectifier?
12. Draw the circuit diagram fo realising the NOT gate?
13. Show that $\alpha = \beta/(1+\beta)$ where $\alpha = Ic/Ie$ and $\beta = Ic/Ib$
14. Derive the expression for the conductivity of p-n junction diode and what is the effect of temperature on the conductivity of p-n junction diode?
15. In half-wave rectification, what is the output frequency if the input frequency is 50 Hz. What is the output frequency of a full-wave rectifier for the same input frequency?
16. Two semiconductor materials X and Y shown in the figure are made by doping germanium crystal with indium and arsenic. The two are joined as shown in fig.

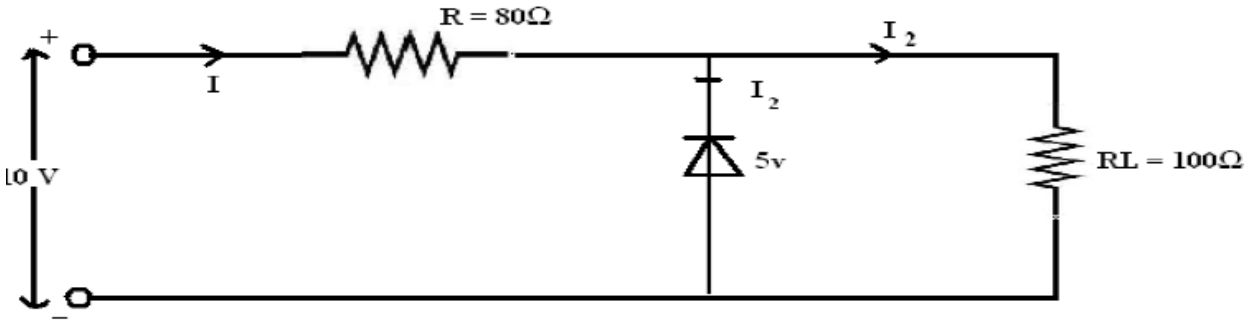


a) Will the junction be forward biased or reverse biased?
b) Sketch V-I graph for this arrangement.
17. Draw the out put wave form for the given input wave form for a NOT gate?

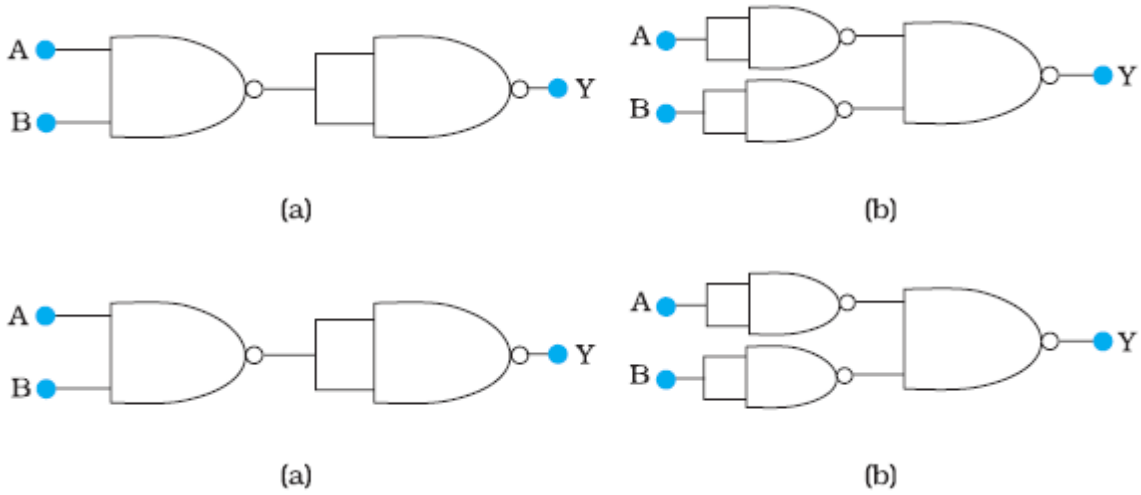
LEVEL -3

Q.1. When the voltage drop across a p-n junction diode is increase from 0.65 v to 0.70 v, the change in the diode current is 5mA. What is the dynamic resistance of the diode?
Ans : Dynamic resistance = change in voltage / change in current

= (0.70- 0.65)/5x10^{-3}
= 0.05/ 5 x 10^{-3}
= 10
Q.2. In the figure shown, find out the current passing through RL and Zener diode :
Ans : Here, V2 = 5V
Voltage drop across R = Input voltage – V2
= 10 – 5 = 5v
I2= 5/100
= 5x10^{-2} A
Here, I = I2 + IL I2 = I - IL
= (6.25-5) 10^{-2}
= 1.25 x 10 $^{-2}$ A.
Q.3. A common emitter transistor has current gain of 100. If emitter current is 8.08 m A, find the base and collector current.



Ans: Here, β = 100 Ie = 8.08 mA β = Ic/Ib We get Ic = βIB = 100 IB
Using, Ie =Ib + Ic
We get Ie = 101 Ib
Or, Ib = Ie/101= 0.08mA
Therefore Ic = 100 x 0.08 = 8mA.
Q4 Write the truth table for the following combination of gates.

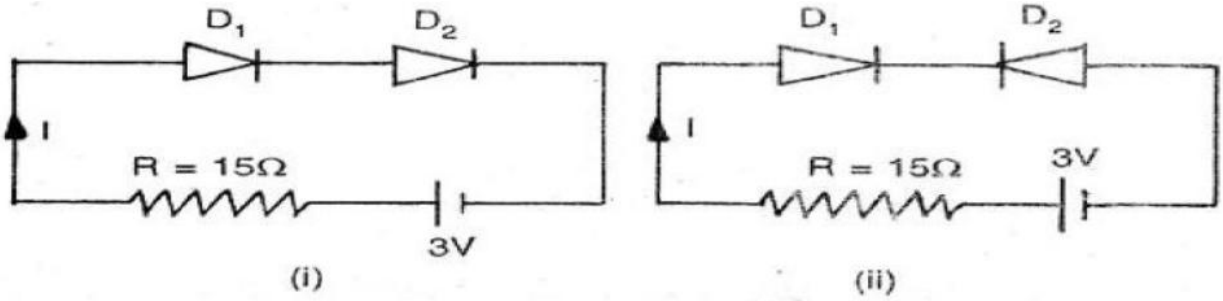


Q5) An a.c power supply of 230V is supplied to a half wave rectifier circuit through a transformer of turn ratio 10: 1.Find the out put d.c voltage Assume the diode is an ideal diode.
Q6) The resistance of the p-n junction diode increases when it is reverse biased. Explain?
Q7) Why silicon devices are preferred to germanium devices?Silicon devices have higher break down voltages than that of germanium diodes (1.5 times)
Q8) In a transistor, reverse bias is very high as compared to the forward bias. Why?In a transistor, charge carriers move from emitter to collector through the base. The reverse bias on collector is made quite high so that it may exert a large attractive force on the charge carriers to enter the collector region. These moving carriers in the collector constitute a collector current.

Q9) The out put of an unregulated d. c power supply needs to be regulated. Name the device that can be used for this purpose and draw the relevant circuit diagram.The device is ZENER diode.Ref 14.22 of NCERT TEXT BOOK.

Q10) Zener diodes have higher dopant densities as compared to ordinary p-n junction diodes. How does it affect the width of the depletion layer and the electric field of the potential barrier?The Depletion region is very thin in the order of micro meter and the electric field is very high $5X10^6$ V/m

Q11) Determine the current through resistance "R" in each circuit. Diodes D1 and D2 are identical and ideal.



Ans: In circuit (i) Both D1 and D2 are forward biased hence both will conduct current and resistance of each diode is "0".Therefore I = 3/15 = 0.2 A

(iii) Diode D1 is forward bias and D2 is reverse bias, therefore resistance of diode D1 is "0" and resistance of D2 is infinite. Hence D1 will conduct and D2 do not conduct. No current flows in the circuit.

Q12) In a transistor the base current is changed by 20μa. This results in a change of 0.02V in base emitter voltage and a change of 2ma in collector current.

(i) Find input resistance,

(ii)Transconductance.

Input resistance = change in voltage/change in current'

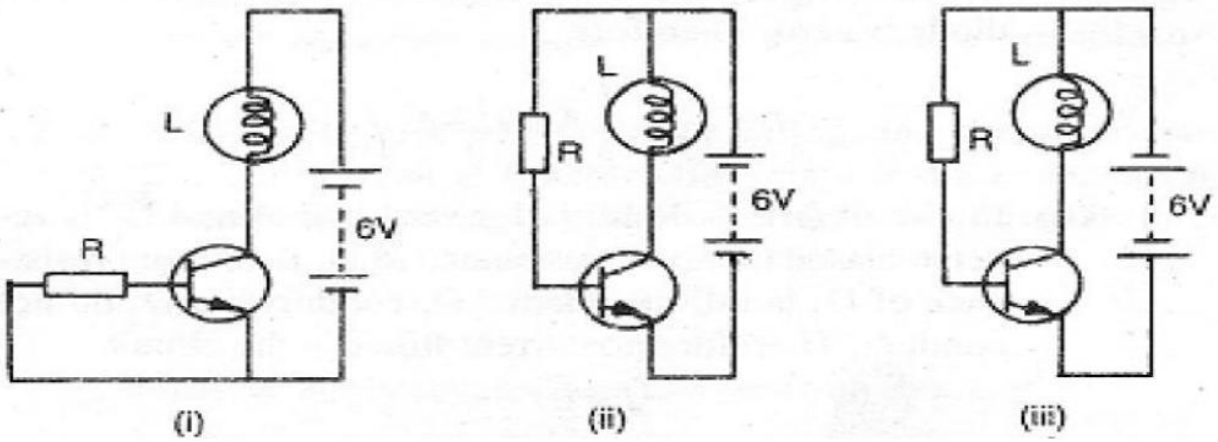
Amplification factor μ =rpXgm

Q13) A semiconductor has equal electron and hole concentrations of $6x10^8$/m3. On doping with a certain impurity, the electron concentration increases to $9x10^{12}$/ m3. (ii) Calculate the new hole concentrations.

Ans: (i) n-type semiconductor.

(ii) (ne)(nh) $=ni^2$ => $nh=(6x10^8 \text{ x} 6x10^8)/9x10^{12} = 4x10^4$ $perm^2$

Q14) In only one of the circuits given below, the lamp "L" glows. Identify the circuit? Give reason for your answer?



Ans: In fig (i) emitter –base junction has no source of emf. Therefore Ic =0, bulb will not glow. In fig (ii) emitter – base junction is forward biased; therefore lamp "L" will glow.

(iii) Emitter – base junction is received biased so the bulb will not glow.

Q15)
In half-wave rectification, what is the output frequency if the input frequency is 50 Hz. What is the output frequency of a full-wave rectifier for the same input frequency.

Ans: 100 Hz

Q16) A logic gate is obtained by applying output of OR gate to a not gate .Name the gate so formed .Write the symbol and truth table of it?

NOR gate.

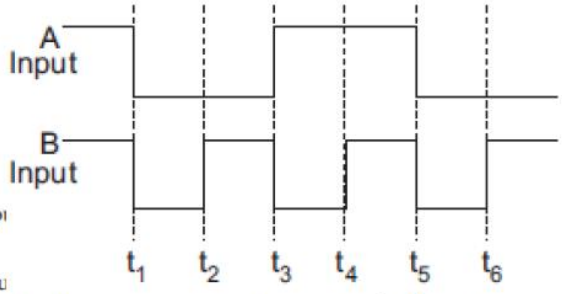
Q17) A p-n photo diode is fabricated from a semiconductor with a band gap of 2.8 eV.Can it detect a wave length of 600 nm.

$E = h_\gamma = 2.8$ eV but $_\gamma = c/\lambda$ so we can calculate wave length and tell whether it detects or not.

Q 18) We have valence electrons and conduction electrons in a semi conductor. Do we have also valence holes and conduction holes in a semi conductor?

In a semiconductor the valance band is the highest filled band and then conduction band. For the conduction in a semiconductor electron jumps from the valance band to conduction band and left a vacancy called hole.However,energy states in conduction band are of higher energy and Pauli's exclusion principle do not allow them to fall back in the valance band.Therfore we do not have holes in conduction band.

Q19) Draw the output form for NAND gate for the given input?



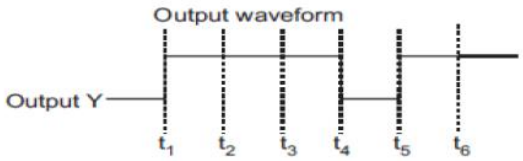
The outp

i.e., outpu

Accordingly the output waveform $Y = \overline{AB}$ is shown in fig.

i.e., output is zero between intervals 0 to t_1 and t_4 to t_5 and in all other intervals it is '1'.

The output waveform is shown in fig.



COMMUNICATION SYSTEMS

LEVEL – I

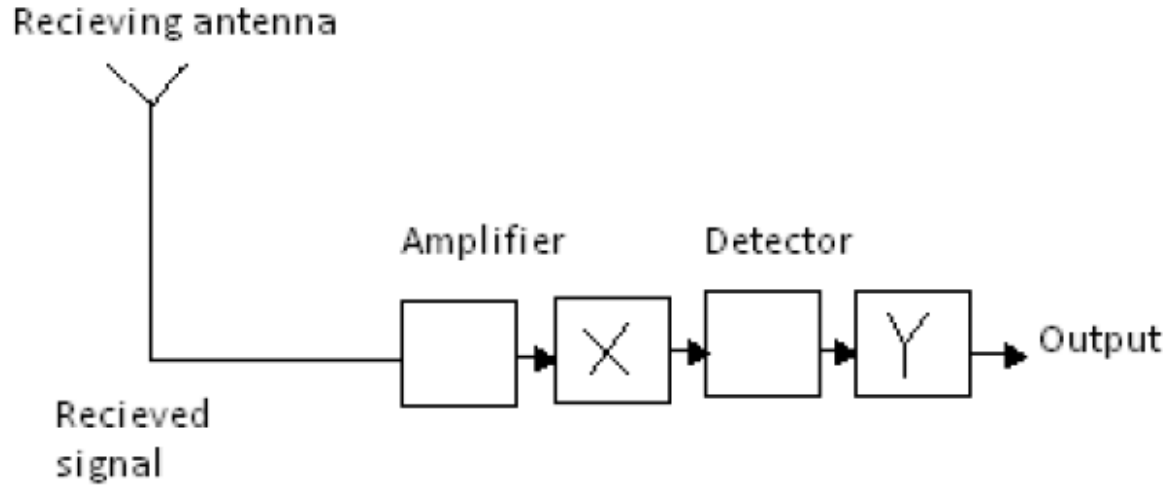
1. Give two applications of geostationary satellite?
2. Why is it necessary to use satellite for the long distance T V transmission?
3. Name the process of superimposing signal frequency on the carrier wave.
4. Which wavelengths are reflected by the ionosphere?
5. What is the necessasity for modulation?
6. Define modulation?
7. Name the type of the radio wave of frequency 300 MHz to 3000 MHz?
8. Draw the diagram of AM modulated wave?
9. Write the block diagram of communication system?
10. What are called ground waves?
11. What is meant by demodulation?
12. What is meant by noise?
13. What is a carrier wave?
14. Why ground wave propagation is not suitable for high frequency?

15. What should be the length of dipole antenna for a carrier wave of frequency 6 x 10^8 Hz?
16. Name the band to which the electromagnetic waves of frequency 120MHz belong.
17. What should be the length of dipole antenna for a carrier wave of frequency 3 x 10^8 Hz?
18. What is the purpose of modulating a signal in transmission?
19. What is sky wave propagation?
20. What is meant by term 'modulation'? Draw a block diagram of a simple modulator for obtaining an AM signal.

LEVEL-2

1. Name the device which is fitted in the satellite to receive signals from the earth stations?,
2. Why are the transmission signals using ground waves restricted up to a frequency of 1500 kHz?
3. Write the block diagram of detector for AM signal?
4. What is meant by amplification?
5. What is meant by base band signal? Describe briefly with the help of a block diagram the arrangement for the transmission and reception of the message signal.
6. Explain briefly with the help of diagrams, the terms: (i) amplitude modulation, (ii) frequency modulation. Which of these (a) gives better quality transmission, (b) has a larger coverage?
7. What is meant by the term 'modulation'? Explain with the help of a block diagram, how the process of modulation is carried out in radio broadcasts.
8. What is an 'analog signal' and a 'digital signal'?
9. What should be the length of the dipole antenna for a carrier wave of Frequency 3 X $1O^8$ Hz?
10. Explain the types of communication systems according to the mode of the transmission.
11. What is the wavelength of TV station which transmits on 500MHz?
12. Define the term 'Transducer' for a communication system.
13. "A Radar using wavelength 5cm and having an antenna disc of a diameter 10m has an angular resolution smaller than 0.01 radian". Is this statement correct?
14. Why sky waves are not used in the transmission of TV signals?
15. "Greater the height of a TV transmitting antenna, greater is its coverage". Comment
16. What do you mean by the following? a) ground waves b) sky waves
17. Write four important applications of remote sensing?
18. A carrier wave of 200V amplitude is modulated by a 40V, I kHz sine wave signal. Calculate the modulation factor?
19. Why ground wave propagation is not suitable for high frequency?
20. What do you mean by "base band signals"?
21. What do you mean by noise in communication?
22. What is Modulator?
23. By what percentage will the transmission range of a TV tower be affected when the height of the tower is increased by 21%?
24. Why do we need a higher bandwidth for transmission of music compared to that for commercial telephone communication?
25. Why high frequency carrier waves are employed for transmission of signals?
26. Write two factors justifying the need of modulation for the transmission of a signal?
27. Write the function of 1) transducer 2) repeater in the context of communication system?
28. State the two main reasons explaining the need of modulation for transmission of audio signal?
29. Name any two types of transmission media that are commonly used for transmission of signals. Write the range of frequencies of signals for which these transmission media are used?
30. What is the range of frequencies used in satellite communication? What is common between these waves and light waves?
31. Why is communication using' line of sight mode' limited to frequencies above 40 MHz?

32. What does the term LOS communication mean? Name the types of waves that are used for this communication. Which of the two heights of transmitting antenna and height of receiving antenna can effect range over which this mode of communication remains effective?
33. Distinguish between 'Point to point' and 'broad cast' communication modes. Give one example of each?
34. 1) Define Modulation index 2) Why is the amplitude of modulating signal kept less than the amplitude of carrier wave?
35. A carrier wave of peak voltage 12 V is used to transmit a message signal. Calculate the peak voltage of the modulating signal in order to have a modulation index of 75%?
36. On a particular day, the maximum frequency reflected from the ionosphere is 10 MHz. On another day, it was found to decrease to 8 MHz. Calculate the ratio of maximum electron densities of the ionosphere on the two days?
37. What is a digital signal? Explain the function of modem in data communication? Write two advantages of digital communication?
38. Explain the function of a repeater in a communication system?
39. A transmitting antenna at the top of a tower has a height 32 meters and the height of the receiving antenna is 50 meters. What is the maximum distance between them for satisfactory communication in line of sight mode?
40. In the given block diagram of a receiver, identify the boxes labeled as X and Y and write their functions.



41. a) What is space wave propagation? Give two examples of communication system which use space wave mode. b) A TV tower is 80 meter tall. Calculate the maximum distance up to which the signal transmitted from the tower can be received?
42. Which mode of propagation is used by short wave broad cast services having frequency range from a few MHz to 30 MHz? Explain diagrammatically how long distance communication can be achieved by this mode. Why is there an upper limit to frequency of waves used in this mode?
43. What is space wave propagation? Which two communication methods make use of this mode of propagation? If the sum of the heights of transmitting and receiving antenna in line of sight of communication is fixed at H, show that the range is maximum when the two antennas have a height H/2 each.
44. What is ground wave communication? At what factor does the maximum range of propagation in this mode depends?
45. Draw schematic diagrams showing the 1) Ground wave 2) Sky wave and 3) Space wave propagation modes for em waves. Write the frequency range for each of the following 1) standard AM broad cast 2) TV 3) Satellite communication.
46. Explain briefly the following terms used in communication system 1) Transducer 2) Repeater 3) Amplification.

47. Write short notes on (a) Internet, (b) Mobile telegraphy and (c) Global positioning system(GPS).

LEVEL-3

1. a) A TV tower has height of 80 meters. Find the radius of the circle within which the transmission can be observed, if the radius of the earth is 6400 km? b) How much population is covered by the TV broad cast if the average population density around the tower is 800 per km2?
2. A TV tower has a height of 500 meters at a given place. Calculate its coverage range, if the radius of the earth is 6400 km?
3. Which mode of wave propagation is suitable for TV broad cast and satellite communication and why? Draw a suitable diagram depicting this mode of propagation of the wave.
4. Write briefly any two factors which demonstrate the need for modulating a signal. Draw a suitable diagram to show amplitude modulation using a sinusoidal signal as the modulating signal.
5. a) Draw a schematic diagram describing the three modes of propagation of em waves in the atmosphere? Indicate clearly which one of these 1) achieving long distance communication by ionosphere reflection and 2) is used for line of sight (LOS) as well as satellite communication. b) Write an expression for the maximum LOS distance dm between the two antennas having heights H1 and H2 above the earth's surface.
6. a) The RMS value of carrier voltage is 100 V. After amplitude modulation the RMS value becomes 110 V. Find the modulation index? b) A message signal of 12 kHz and peak voltage 20 V is used to modulate a carrier wave of frequency 12 MHz and peak voltage 30 V. Calculate the 1) modulation index and 2) side band frequencies?
7. What should be the length of the dipole antenna for a carrier wave of Frequency 3 X $1O^8$ Hz?
8. Give reasons for the following:

a. Long distance radio broadcasts use short-wave bands.

b. The small ozone layer on top of the stratosphere is crucial for human survival.

c. Satellites are used for long distance TV transmission. Consider an optical communication system operating at nm. Suppose, only 1% of the optical source frequency is the available channel band-width for optical communication. How many channels can be accommodated for transmit ting

i. audio-signals requiring a band-width of 8 kHz,

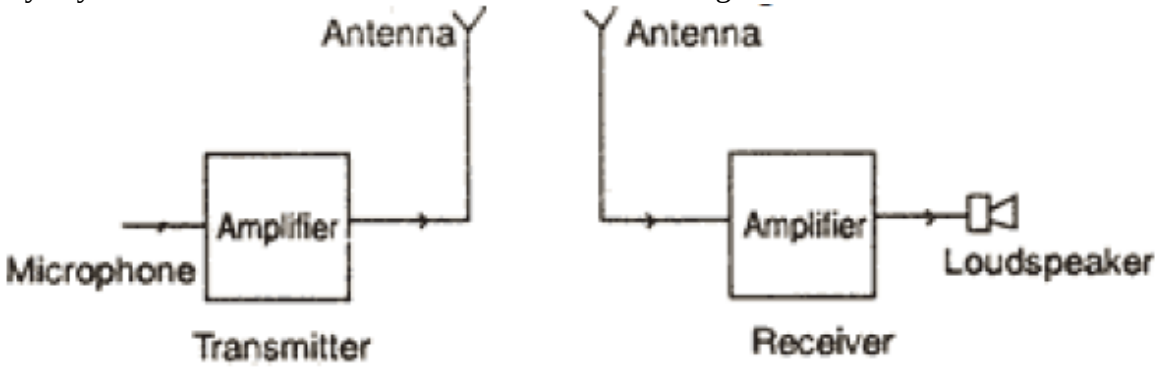
ii. Video TV signals requiring an approximate band-width of 4.5 MHz? Support your answer with suitable calculations.

9. The height of a T.V. tower at a place is 400 m. Calculate

a. the maximum range up to which signals can be received from time tower and

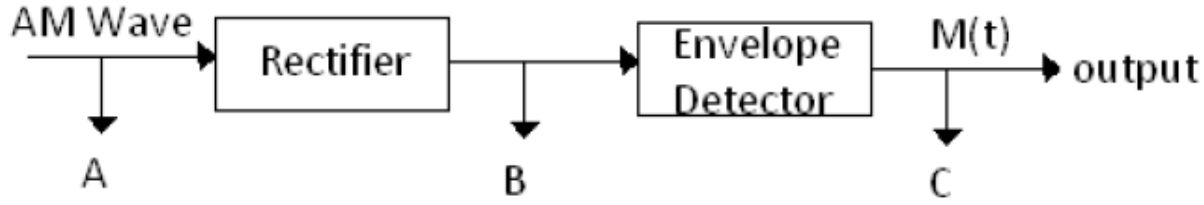
b. Area covered by the transmission. (Radius of the Earth 6400 km) .

10. Why moon cannot be as communication satellite? Give any two reasons.
11. Why sky waves are not used in the transmission of T V signal?



A schematic arrangement for transmitting a message signal (20 Hz to 20 kHz) is given above: Give two Drawbacks from which this arrangement suffers.

12. Draw the waveforms for the (i) Input AM wave at A (ii)output, B, of the rectifier and (iii)output signal, C, of the envelope detector.



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