KENDRIYA VIDYALAYA SANGATHAN

तत् त्वं पूषन् अपावृणु
केन्द्रीय विद्यालय संगठन

STUDY cum SUPPORT MATERIAL

2016-17

CLASS: XII

PHYSICS

Prepared by: KVS Patna Region

PREFACE

Kendriya Vidyalaya Sangathan is a pioneer organization which caters to the all-round development of the students. Time to time various strategies has been adopted to adorn the students with academic excellence.

This support material is one such effort by Kendriya Vidyalaya Sangathan, an empirical endeavor to help students learn more effectively and efficiently. It is designed to give proper platform to students for better practice and understanding of the chapters. This can suitably be used during revision. Ample opportunity has been provided to students through master cards and question banks to expose them to the CBSE pattern. It is also suggested to students to keep in consideration the time- management aspect as well.

I extend my heartiest gratitude to the Kendriya Vidyalaya Sangathan authorities for providing the supports material to the students prepared by various Regions. The same has been reviewed by the Regional Subject Committee of Patna Region who have worked arduously to bring out the best for the students. I also convey my regards to the staff of Regional Office, Patna for their genuine cooperation.

In the end, I earnestly hope this material will not only improve the academic result of the students but also include learning habit in them.

M.S.Chauhan
Deputy Commissioner

KENDRIYA VIDYALAYA SANGATHAN

PATNA REGION

SPLIT UP SYLLABUS OF PHYSICS FOR CLASS XII

CLASS XII (2016-17)
(THEORY)

One Paper **Time: 3 hrs.**
Max Marks: 70

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

Unit I: Electrostatics 22 Periods

Electric Charges; Conservation of charge, Coulomb's law-force between two point charges, forces between multiple charges; superposition principle and continuous charge distribution.

Electric field, electric field due to a point charge, electric field lines, electric dipole, electric field due to a dipole, torque on a dipole in uniform electric field.

Electric flux, statement of Gauss's theorem and its applications to find field due to infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell (field inside and outside).

Electric potential, potential difference, electric potential due to a point charge, a dipole and system of charges; equipotential surfaces, electrical potential energy of a system of two point charges and of electric dipole in an electrostatic field.

Conductors and insulators, free charges and bound charges inside a conductor. Dielectrics and electric polarisation, capacitors and capacitance, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, energy stored in a capacitor.

Unit II: Current Electricity 20 Periods

Electric current, flow of electric charges in a metallic conductor, drift velocity, mobility and their relation with electric current; Ohm's law, electrical resistance, V-I characteristics (linear and non-linear), electrical energy and power, electrical resistivity and conductivity. Carbon resistors, colour code for carbon resistors; series and parallel combinations of resistors; temperature dependence of resistance.
Internal resistance of a cell, potential difference and emf of a cell, combination of cells in series and in parallel. Kirchhoff's laws and simple applications. Wheatstone bridge, meter bridge.

Potentiometer - principle and its applications to measure potential difference and for comparing EMF of two cells; measurement of internal resistance of a cell.

Unit III: Magnetic Effects of Current and Magnetism — 22 Periods

Concept of magnetic field, Oersted's experiment.

Biot – Savart's law and its application to current carrying circular loop.

Ampere's law and its applications to infinitely long straight wire. Straight and toroidal solenoids, force on a moving charge in uniform magnetic and electric fields. Cyclotron.

Force on a current-carrying conductor in a uniform magnetic field. Force between two parallel current-carrying conductors-definition of ampere. Torque experienced by a current loop in uniform magnetic field; moving coil galvanometer-its current sensitivity and conversion to ammeter and voltmeter.

Current loop as a magnetic dipole and its magnetic dipole moment. Magnetic dipole moment of a revolving electron. Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis. Torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid, magnetic field lines; Earth's magnetic field and magnetic elements.

Para-, dia- and ferro - magnetic substances, with examples. Electromagnets and factors affecting their strengths. Permanent magnets.

Unit IV: Electromagnetic Induction and Alternating Currents — 20 Periods

Electromagnetic induction; Faraday's laws, induced EMF and current; Lenz's Law, Eddy currents. Self and mutual induction.

Alternating currents, peak and RMS value of alternating current/voltage; reactance and impedance; LC oscillations (qualitative treatment only), LCR series circuit, resonance; power in AC circuits, wattless current.

AC generator and transformer.

Unit V: Electromagnetic waves — 04 Periods

Need for displacement current, Electromagnetic waves and their characteristics (qualitative ideas only). Transverse nature of electromagnetic waves.

Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays) including elementary facts about their uses.

Unit VI: Optics — 25 Periods

Reflection of light, spherical mirrors, mirror formula. Refraction of light, total internal reflection and its applications, optical fibers, refraction at spherical surfaces, lenses, thin lens formula, lens maker's formula. Magnification, power of a lens, combination of thin lenses in contact, combination of a lens and a mirror. Refraction and dispersion of light through a prism.

Scattering of light - blue colour of sky and reddish appearance of the sun at sunrise and sunset.

Optical instruments : Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers.

Wave optics: Wave front and Huygen's principle, reflection and refraction of plane wave at a plane surface using wave fronts. Proof of laws of reflection and refraction using Huygen's principle.

Interference, Young's double slit experiment and expression for fringe width, coherent sources and sustained interference of light. Diffraction due to a single slit, width of central maximum. Resolving power of microscopes and astronomical telescope. Polarisation, plane polarised light, Brewster's law, uses of plane polarised light and Polaroids.

Unit VII: Dual Nature of Matter and Radiation **08 Periods**

Dual nature of radiation. Photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation-particle nature of light.

Matter waves-wave nature of particles, de Broglie relation. Davisson-Germer experiment (experimental details should be omitted; only conclusion should be explained).

Unit VIII: Atoms and Nuclei **14 Periods**

Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum.

Composition and size of nucleus, Radioactivity, alpha, beta and gamma particles/rays and their properties; radioactive decay law.

Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number; nuclear fission, nuclear fusion.

Unit IX: Electronic Devices **15 Periods**

Energy bands in solids (Qualitative ideas only) conductor, insulator and semiconductor; semiconductor diode - I-V characteristics in forward and reverse bias, diode as a rectifier; I-V characteristics of LED, photodiode, solar cell, and Zener diode; Zener diode as a voltage regulator.

Junction transistor, transistor action, characteristics of a transistor, transistor as an amplifier (common emitter configuration). Logic gates (OR, AND, NOT, NAND and NOR).

Unit X: Communication Systems **10 Periods**

Elements of a communication system (block diagram only); bandwidth of signals (speech, TV and digital data); bandwidth of transmission medium. Propagation of electromagnetic waves in the atmosphere, sky and space wave propagation. Need for modulation. Production and detection of an amplitude-modulated wave. Basic ideas about internet, mobile telephony and global positioning system (GPS)

PRACTICALS **(Total Periods 60)**

The record, to be submitted by the students, at the time of their annual examination, has to include:

Record of at least 15 Experiments [with a minimum of 7 from section A and 8 from section B], to be performed by the students.

Record of at least 5 Activities [with a minimum of 2 each from section A and section B], to be demonstrated by the teachers.

The Report of the project, to be carried out by the students.

Evaluation Scheme

Two experiments one from each section	8+8 Marks
Practical record [experiments and activities]	6 Marks
Investigatory Project	3 Marks
Viva on experiments, activities and project	5 Marks
	Total 30 marks

SECTION–A

Experiments

(Any 7 experiments out of the following to be performed by the students)

April	1. To determine resistance per cm of a given wire by plotting a graph of potential difference versus current.
April	2. To find resistance of a given wire using meter bridge and hence determine the resistivity (specific resistance) of its material
April	3. To verify the laws of combination (series/parallel) of resistances using a meter bridge.
May	4. To compare the EMF of two given primary cells using potentiometer.
May	5. To determine the internal resistance of given primary cell using potentiometer.
July	6. To determine resistance of a galvanometer by half-deflection method and to find its figure of merit.
July	7. To convert the given galvanometer (of known resistance and figure of merit) into an ammeter and Voltmeter of desired range and to verify the same.
July	8. To find the frequency of AC mains with a sonometer.

Activities *(For the purpose of demonstration only)*

July	1. To measure the resistance and impedance of an inductor with or without iron core.
July	2. To measure resistance, voltage (AC/DC), current (AC) and check continuity of a given circuit using multimeter.
May	3. To assemble a household circuit comprising three bulbs, three (on/off) switches, a fuse and a power source.
May	4. To assemble the components of a given electrical circuit.
June	5. To study the variation in potential drop with length of a wire for a steady current.
May	6. To draw the diagram of a given open circuit comprising at least a battery, resistor/rheostat, key, ammeter and voltmeter. Mark the components that are not connected in proper order and correct the circuit and also the circuit diagram.

SECTION–B

Experiments

(Any 8 experiments out of the following to be performed by the students)

August	1. To find the value of v for different values of u in case of a concave mirror and to find the focal length.
August	2. To find the focal length of a convex mirror, using a convex lens.
August	3. To find the focal length of a convex lens by plotting graphs between u and v or between $1/u$ and $1/v$.

August	4.	To find the focal length of a concave lens, using a convex lens.
Sept.	5.	To determine angle of minimum deviation for a given prism by plotting a graph between angle of incidence and angle of deviation.
Sept.	6.	To determine refractive index of a glass slab using a travelling microscope.
Sept.	7.	To find refractive index of a liquid by using (i) concave mirror, (ii) convex lens and plane mirror.
October	8.	To draw the I-V characteristic curve of a p-n junction in forward bias and reverse bias.
October	9.	To draw the characteristic curve of a zener diode and to determine its reverse break down voltage.
October	10.	To study the characteristic of a common - emitter *npn* or *pnp* transistor and to find out the values of current and voltage gains.

Activities ***(For the purpose of demonstration only)***

October	1.	To identify a diode, an LED, a transistor, an IC, a resistor and a capacitor from a mixed collection of such items.
October	2.	Use of multimeter to (i) identify base of transistor, (ii) distinguish between npn and pnp type transistors, (iii) see the unidirectional flow of current in case of a diode and an LED, (iv) check whether a given electronic component (e.g., diode, transistor or IC) is in Working order.
October	3.	To study effect of intensity of light (by varying distance of the source) on an LDR.
August	4.	To observe refraction and lateral deviation of a beam of light incident obliquely on a glass slab.
August	5.	To observe polarization of light using two Polaroids.
August	6.	To observe diffraction of light due to a thin slit.
August	7.	To study the nature and size of the image formed by a (i) convex lens, (ii) concave mirror, on a screen by using a candle and a screen (for different distances of the candle from the lens/mirror).
August	8.	To obtain a lens combination with the specified focal length by using two lenses from the given set of lenses.

Suggested Investigatory Projects

1. To study various factors on which the internal resistance/EMF of a cell depends.
2. To study the variations, in current flowing, in a circuit containing an LDR, because of a variation

   (a) in the power of the incandescent lamp, used to 'illuminate' the LDR. (keeping all the lamps at a fixed distance). (b) in the distance of a incandescent lamp (of fixed power) used to 'illuminate' the LDR.

3. To find the refractive indices of (a) water (b) oil (transparent) using a plane mirror, an equi convex lens, (made from a glass of known refractive index) and an adjustable object needle.
4. To design an appropriate logic gate combination for a given truth table.
5. To investigate the relation between the ratio of (i) output and input voltage and (ii) number of turns in the secondary coil and primary coil of a self-designed transformer.
6. To investigate the dependence of the angle of deviation on the angle of incidence, using a hollow prism filled, one by one, with different transparent fluids.
7. To estimate the charge induced on each one of the two identical Styrofoam (or pith) balls suspended in a vertical plane by making use of Coulomb's law.
8. To set up a common base transistor circuit and to study its input and output characteristic and to calculate its current gain.

9. To study the factor on which the self-inductance of a coil depends by observing the effect of this coil, when put in series with a resistor/(bulb) in a circuit fed up by an A.C. source of adjustable frequency.
10. To construct a switch using a transistor and to draw the graph between the input and output voltage and mark the cut-off, saturation and active regions.
11. To study the earth's magnetic field using a tangent galvanometer.

Prescribed Books:

1. Physics, Class XI, Part -I and II, Published by NCERT.
2. Physics, Class XII, Part -I and II, Published by NCERT.

INDEX

01	Electric charges and fields	Origin of charges, Additive nature of charges, Charges are quantitative , charges are conserved, ,coulombs Law, Electric Fields, Electric field lines, Electric Potential, Equi- Potential Surface. potential Energy, Electric Dipole, Electric Flux, Gauss Theorem, Application of Gausses Theorem 1) Electric field due to a charged sheet. 2) Electric field due to linear distribution of charge. 3) Electric field due to a spherical shell. Diff. Between conductor and insulator and dielectric. Capacitance of a isolated conductor. Capacitance of a parallel plate conductor with and without dielectric. Energy stored in capacitors. Grouping of capacitors and implication of Conservation of energy.	** * ** *** *** *** ** ** ***	

02	Current Electricity	Free Electrons, Drift Velocity, Relaxation time, Mobility and relation between them, resistivity, current density Color code of Carbon resisters, Cells, grouping of cells, emf, terminal potential ,internal resistance Kirchhoff's laws, Wheatstone bridge ,meter bridge, Potentiometer and their applications,	** *** ** ** *** ** ***	
03	Magnetic effect of electric current & magnetism	Origin of magnetic field& concept of its direction, Biot- Savart's law& its applications, Ampere circuital law & its applications, Force on moving charge (Lorentz force), Cyclotron, Force on current carrying wire in magnetic field, Torque, Moving coil galvanometer & its conversion, Magnetic flux and intensity, susceptibility, Permeability Curie's law Magnetic elements Difference between magnetic materials,	** ** * ** *** *** ***	
		Change in magnetic flux, Faraday's laws, Lenz's law	** **	

04	Electromagnetic Induction & alternating current	Self & mutual inductance and their relation, Peak value, rms value of A.C, A.C through L,C,R & LCR in series Reactance Impedance LC Oscillations, Resonance frequency & Q-factor AC generator & transformer	*** ** ***	
05	Electromagnetic waves	Properties and Application of EM Spectrum,	***	
06	Optics	Reflection &Refraction at spherical surfaces, Mirror and Lens Formula, Derivation of $n_2/v-n_1/u=(n_2-n_1)/R$, Condition for TIR, Lens Maker's Formula, Derivation of Prism formula, Optical instruments (Microscope & Telescope), Defects of vision and its correction. Wave front and Huygens's Principle and law of Reflection &Refraction. Superposition of waves & Interference, Coherent source, Double slit experiment (Fringe width), Diffraction due to Single slit, Difference between Interference and diffraction, Fresnel distance. Polarization of light, Brewester's Law & Malus - Law.	** *** * *** *** * ** *** ** ***	

07	Dual nature of matter and radiation	Photo-electric effect &Einstein's equation, Work function, Threshold frequency, cut off voltage, effect of potential & Intensity of light on photo electric current, Effect of frequency on stopping potential de Broglie wave length, Wave nature of particle , Davison-Germer experiment (qualitative approach)	** *** **** **	
08	Atoms & Nuclei	Bohr's Model of hydrogen atom. Spectral lines, Size of nucleus. Mass defect, Nuclear binding energy and Binding energy per nucleon, curve, Radioactivity, Decay law, Half-life, decay constant, average life relation of half-life with relation, Nuclear fission and fusion,	** ***	
09	Semiconductor devices	Band theory of solids, Intrinsic &extrinsic semiconductors, Diodes, Zener diode as voltage regulator, Half & full wave rectifiers, Transistors, N-P-N Common emitter amplifier,Transistor as an oscillator & Switch, Logic gates, NAND, NOR gate as universal gates, Waveforms of input & output of Logic gates. Integrated circuit	*** *** ** ** ***	

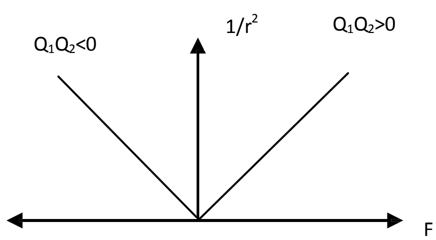
10	Communication System	Analog & digital signal, Ground wave ,sky wave & space wave propagation of electromagnetic waves, Block diagram of transmitter ,receiver & communication system Height of Antenna, Modulation & its need Modulation & Demodulation of AM, Modulation & its need Modulation & Demodulation of AM,	** *** ** ***	

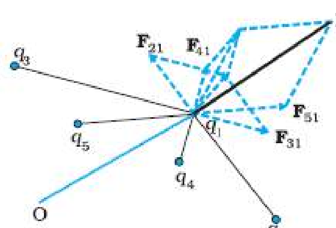
1. ELECTROSTATICS

GIST

- Electrostatics is the study of charges at rest.
- Charging a body can be done by friction, induction and conduction.
- SI unit of charge is one coulomb which is that charge which when placed at a distance of 1m from an equal charge and similar charge in vacuum would repel it by a force of 9×10^{9}newtons.
- 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



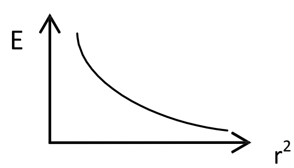


Principle of superposition: $F_{total} = F_{12} + F_{13} + ...$

$$Ftotal = \sum_{i=1}^{n} \vec{F_i}$$

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, i.e. E=F/Q or Q = F/E**

- Electric field: Force experienced by a unit positive (or test) charge. It is a vector. SI unit NC^{-1}.
- $\vec{E} = \frac{kQ}{r^2}\hat{r}$
- $\vec{E} = \lim_{q_o\to 0} \frac{\vec{F}}{q_o}$

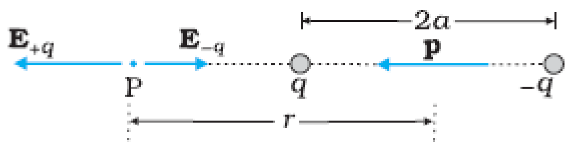


- Field due to a point charge: $\vec{E} = \frac{kQ}{r^2}\hat{r}$
- Principle of superposition: $\vec{E}_{total} = \sum_{i=1}^{n} \vec{E}_r$ [Vector sum of individual fields]

- **Electric field lines:** It is the path straight or curved in electric field, such that tangent at any point of it gives direction of electric field at that point.

  Properties of electric field lines:
    - ✓ Arbitrarily starts from +ve charge and end at –ve charge
    - ✓ Continuous, but never form closed loops
    - ✓ Tangent to elec. field line at any point gives direction of elec. field at that point.
    - ✓ Never intersect because at the point of intersection there will be two possible direction of elec. field which is not possible.
    - ✓ Relative closeness of the field lines represents the magnitude of the field strength.
    - ✓ Always normal to the surface of conductor.
    - ✓ For a set of two like charges – lateral pressure in between
    - ✓ For a set of two unlike charges – longitudinal contraction in between.

- 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 $\theta = 0^\circ \Rightarrow$ stable equilibrium; If $\theta = 180^\circ \Rightarrow$ unstable equilibrium.
- Electric field due to a dipole
- Field intensity on axial line of dipole:



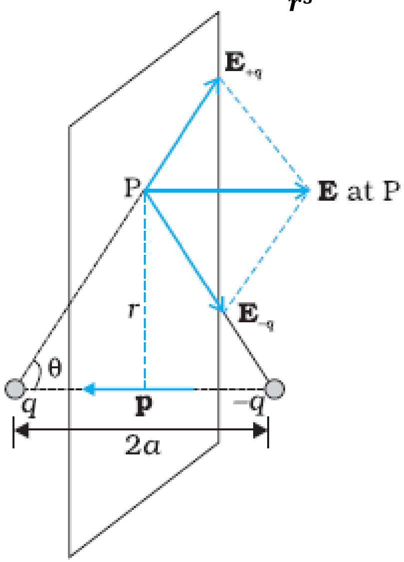
$$E = k\frac{2pr}{(r^2 - a^2)}$$

When a << r, $E = \frac{2p}{r^3}$

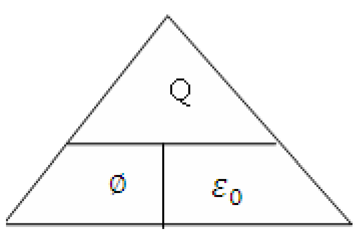
- Field intensity at a point on the equatorial line of dipole:

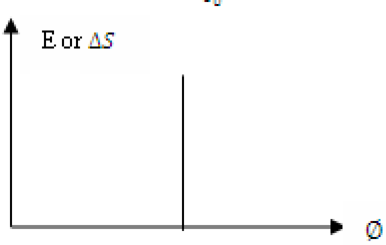
$$\boldsymbol{E = k\frac{p}{(r^2 + a^2)^{3/2}}}$$

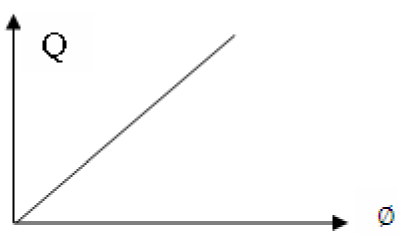
$$\boldsymbol{When\ a \ll r, E = k\frac{p}{r^3}}$$



- 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: $\emptyset_{total} = \frac{q_{total}}{\varepsilon_0}$







ϕ is independent of $\vec{E}$ & $\vec{\Delta} s$

- Uniform charge distribution:

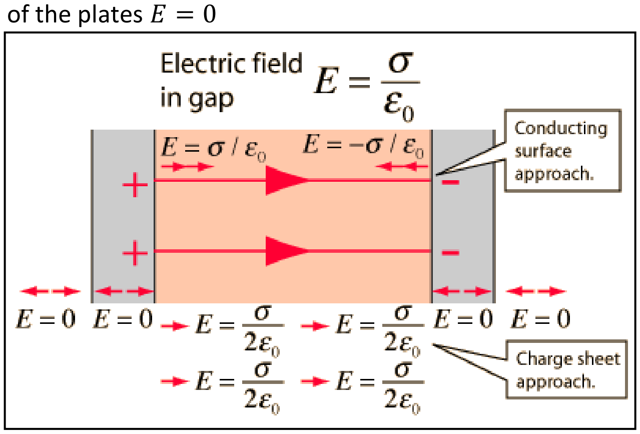
  Linear charge distribution: $\lambda = \frac{\Delta q}{\Delta l}$ [$\lambda \Rightarrow$ linear charge density Unit Cm^{-1}]

  Surface charge distribution: $\sigma = \frac{\Delta q}{\Delta s}$ [$\sigma \Rightarrow$ surface charge density Unit Cm^{-2}] Volume charge distribution $\rho = \frac{\Delta q}{\Delta V}$ [$\rho \Rightarrow$ 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 $\emptyset$	$\frac{\lambda l}{\varepsilon_0}$	$\frac{\sigma s}{\varepsilon_0}$	$\frac{\sigma 4\pi r^2}{\varepsilon_0}$
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	$\lambda = \frac{\Delta q}{\Delta l}$	$\sigma = \frac{\Delta q}{\Delta S}$	$\frac{\sigma}{4\pi r^2}$

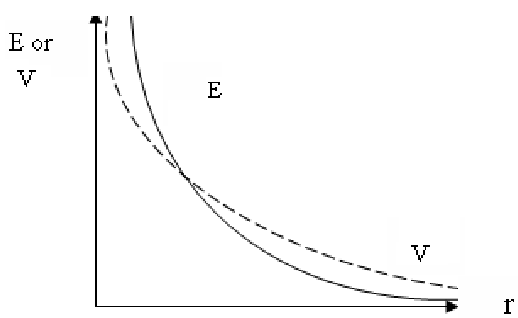
- Electric field due to two thin parallel sheet of charge: Electric field between the plates is $E = \frac{\sigma}{\epsilon_0}$ and in the region on either side of the plates $E = 0$

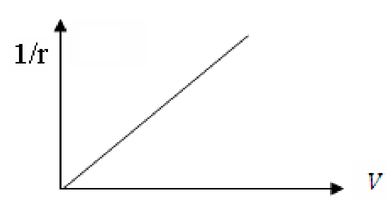


- Electrostatic Potential: Work done per unit positive Test charge to move it from infinity to that point in an electric field. It is a scalar. SI unit: J/C or V

  $V = W / q_o$

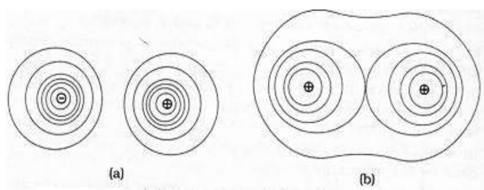
  Electric potential for a point charge: $V = \frac{kq}{r}$





- 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.

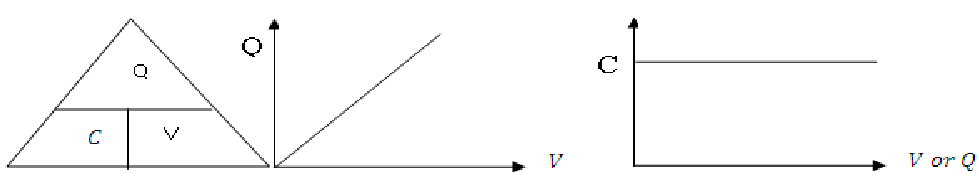
- Potential due to a system of charges: $V_{total} = \sum_{i=1}^{n} \frac{kq_i}{r_i}$
- Potential due to a dipole at a point
  - **on its axial line**: $V_{axial} = \frac{k\,|\vec{p}|}{r^2}$ [or] $\frac{k|\vec{p}|}{r^2}\cos\theta$
  - **on its equatorial line**: $V_{eq} = 0$
- Potential difference $V_A - V_B = kq\left[\frac{1}{r_A} - \frac{1}{r_B}\right]$
- Potential energy of two charges: U = $\frac{kq_1 q_2}{r}$
- Potential energy of a dipole : U = $\vec{p}.\vec{E}$ = p E $[\cos\theta_0 - \cos\theta_1]$
- 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 $\propto r$

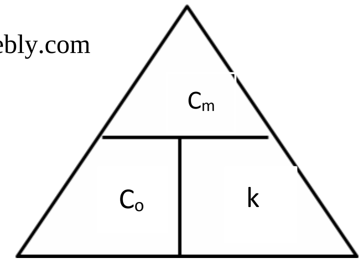
- Capacitor: A device to store charges and electrostatic potential energy.
- Capacitance: $C = \frac{Q}{V}$, Ratio of charge and potential difference. Scalar,
- SI unit: farad [F]



Capacitance of a parallel plate capacitor: $C = \frac{\epsilon_0 \times A}{d}$

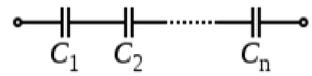
Capacitance of a parallel plate capacitor with a dielectric medium in between:

- ➢ $C_m = \frac{\epsilon_0 A}{\left(d - t + \frac{t}{k}\right)}$
- ➢ If t=0 => $C_0 = \frac{\epsilon_0 A}{(d)}$
- ➢ If t=d => $C_0 = k\frac{\epsilon_0 A}{(d)}$ => $C_m = k\, C_0$

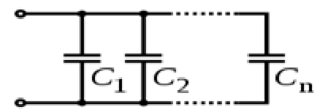


- Combination of capacitors:

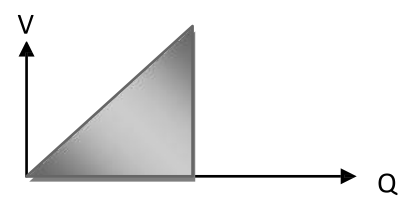
Capacitors in series: $\frac{1}{C} = \sum_{i=1}^{n} \frac{1}{C_i}$



Capacitors in parallel: $C = \sum_{i=1}^{n} C_i$



- Energy stored in capacitors: $U = ½CV = ½QV = \frac{½Q^2}{C}$



- 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]

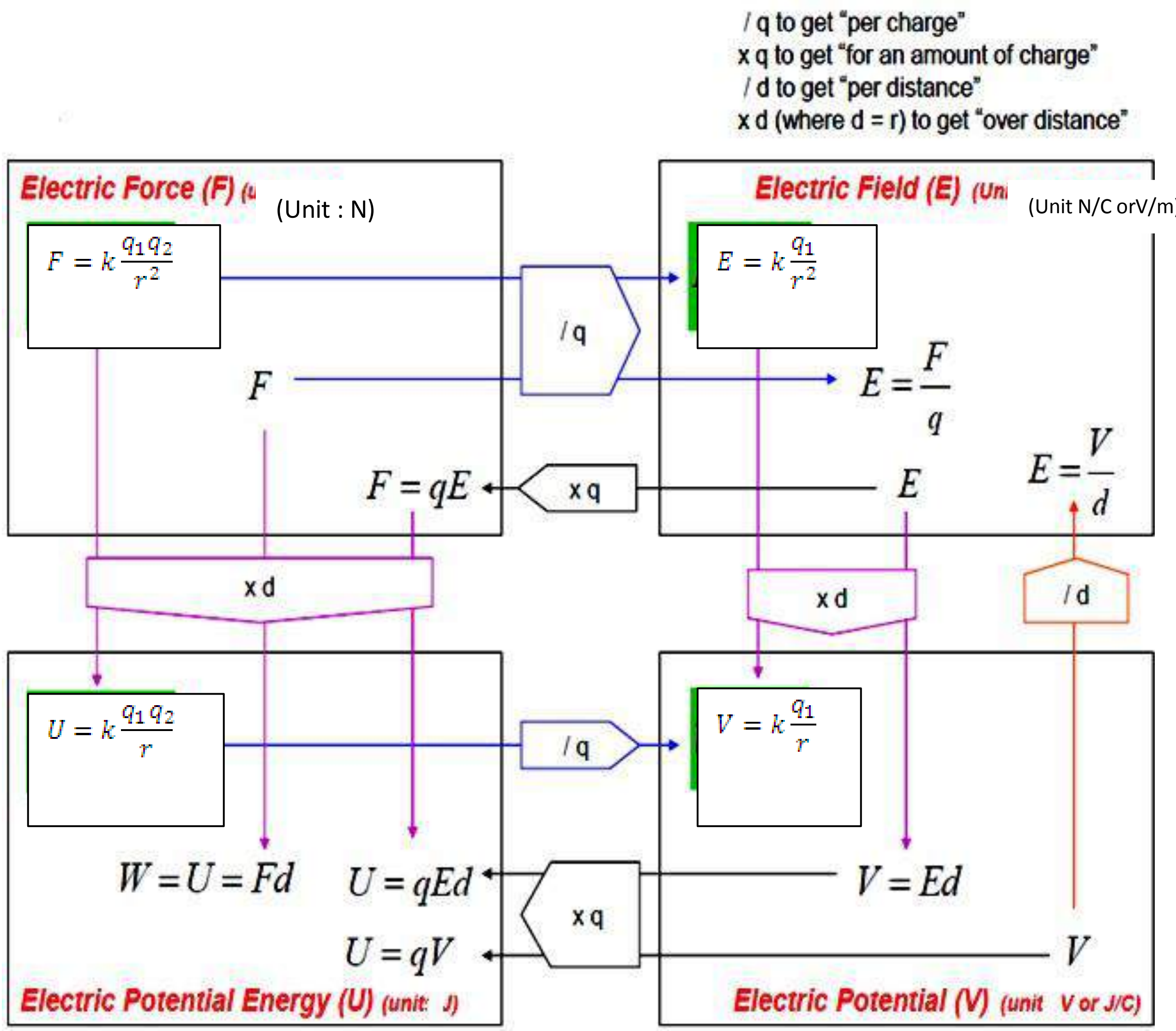
- On connecting two charged capacitors:

Common Potential: $V = \frac{C_1V_1 + C_2V_2}{V_1 + V_2}$

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

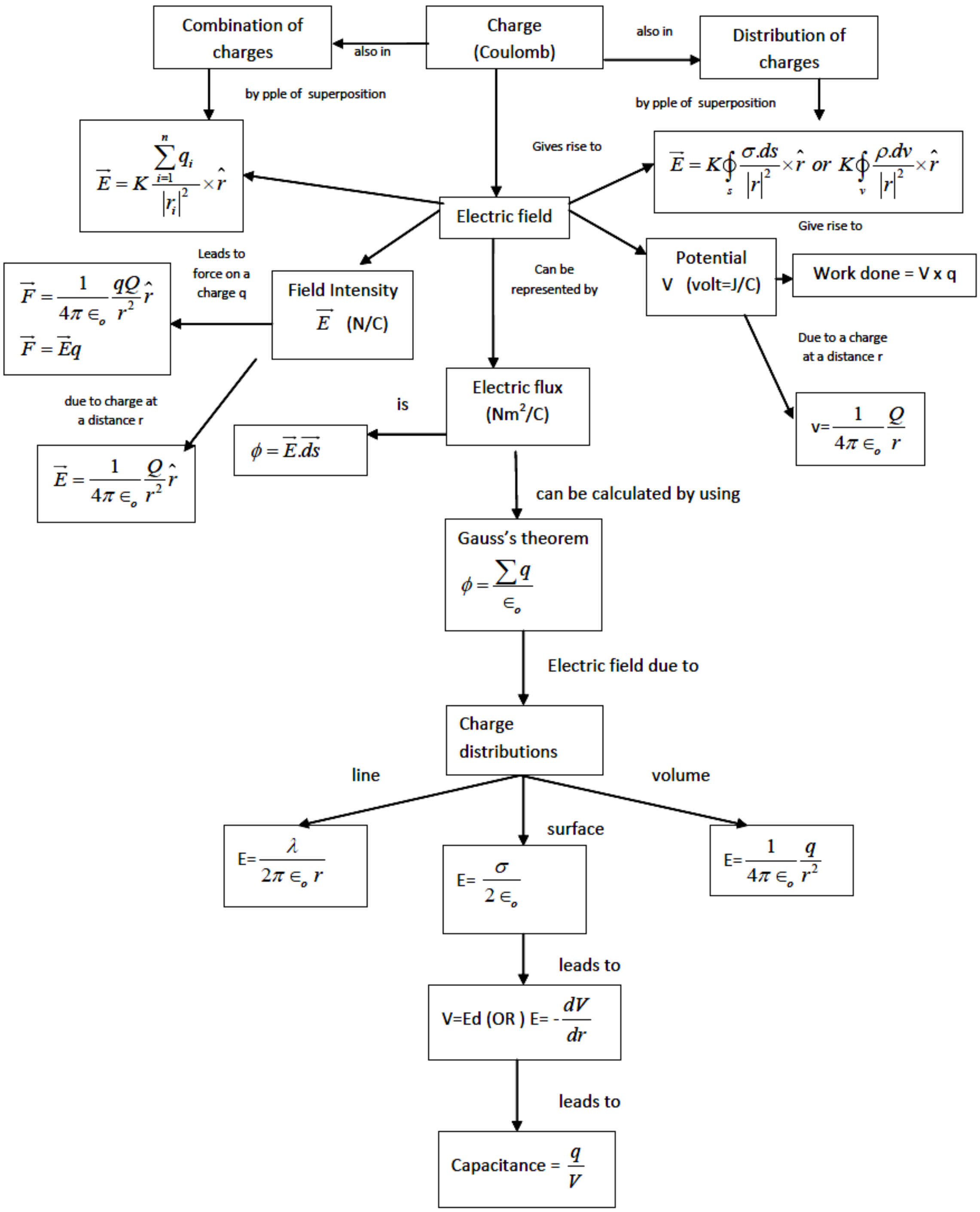
- Van de Graff generator:-
  - ✓ is an electrostatic machine to build very high voltages.
  - ✓ works on the Principle $V(r) - V(R) = kq\left(\frac{1}{r} - \frac{1}{R}\right)$;
  - ✓ Corona discharge is the electrical discharge through the defected part of the spherical conductor, where the surface is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

Electric Force/Field/Potential/P.E.



CONCEPT MAP

Charge and it's impact



CHARGES AND COULOMB'S LAW

Q. No. **QUESTIONS** Marks

1. What is the work done in moving a test charge 'q' through a distance of 1 cm along the equatorial axis 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? 1
Ans: Because charge is always quantized ie., $Q = n \times e$

3. What is meant by electrostatic shielding? 1
Ans: Electric filed inside a cavity is zero.

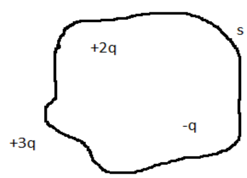
4. Why an electric dipole placed in a uniform electric field does not undergoes acceleration? 1
Ans: Because the net force on the dipole is zero. $F_{net} = 0$ as $F = \pm qE$

5. Why electric field lines 1
   (i) Can never intersect one another?
   (ii) Cannot for closed loops sometimes?
   (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

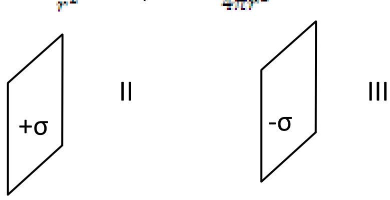
6. Show that at a point where the electric field intensity is zero, electric potential need not be zero. 2
Ans: If E = 0$\Rightarrow V = constant$ E=-dV/dr

7. What is the electric flux through the surface S in Vaccum? 2



8. Write the expression for the electric field, charge density for a uniformly charged thin spherical shell. 2
Ans: $E = \frac{kQ}{r^2}$; $\sigma = \frac{Q}{4\pi r^2}$

9. 2



Write the expression for the electric field in the regions I, II, III shown in the above figure.
Ans: $E_I = E_{III} = 0$ $E_{II} = \sigma/\varepsilon_0$

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 $K.E = \frac{e^2}{4\pi\epsilon_0 r}$] 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) $\emptyset$= constant (b) E is halved 2

12. The electric field in a certain region of space is $\vec{E} = 10^4 \hat{i}\, NC^{-1}$. 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°) =10^4 A cos30° Vm

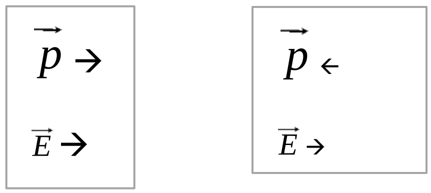
13. An electric dipole ±4μC is kept at co-ordinate points (1, 0, 4) are kept at (2,-1, 5), the electric field is given by $\vec{E}$ = 20 $\hat{i}$ NC^{-1}. Calculate the torque on the dipole. 2

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:

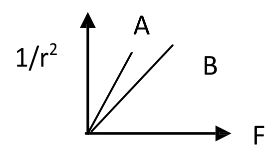


Stable Unstable

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: $|\vec{F_B}| > |\vec{F_A}|$



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

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

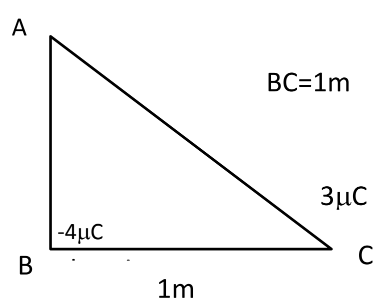
Ans: During short circuit, it provides an easy path or emergency way out for the charges flowing to the ground, preventing the accidents.

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

2

21. 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 origin. What is the angle at which it moves? 3

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.

22. 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: $k\frac{5X10^{-6}}{x^2} = k\,\frac{3X10^{-6}}{(40-x)^2}$

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

Ans: $\emptyset = E\,.S = Q/\varepsilon_0$ $E \times 4\pi r^2 = Q/\varepsilon_0$

24. 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 $\int E.ds = \frac{q}{\varepsilon_o}$ Derivation for $E = \frac{\lambda}{2\Pi\,\varepsilon_o r}$

25. 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

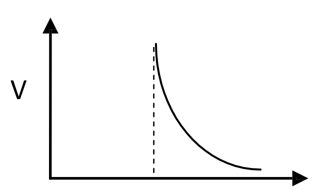
   Ans: $[M^{-1}L^{-3}T^4A^2]$

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.

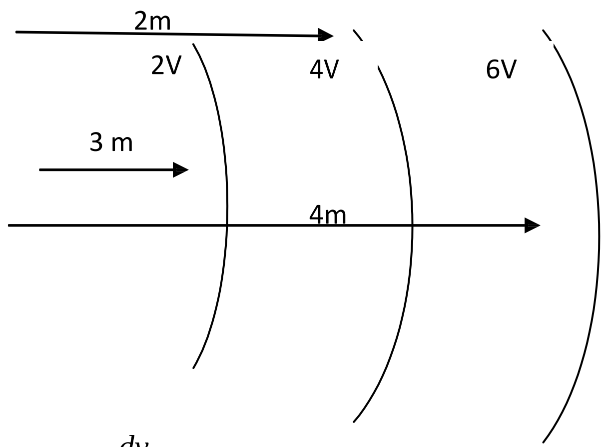
7. Draw the graph showing the variation of electric potential with distance from the centre of a uniformly charged shell. 1

Ans



Ans: 6 : 1

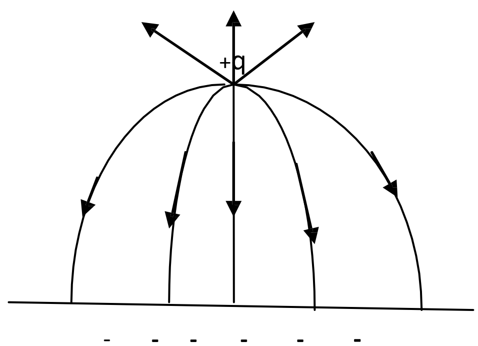
9. Calculate the electric field from the equipotential surface shown below. 1



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

(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: $(Q_1 – Q_2)/2C$

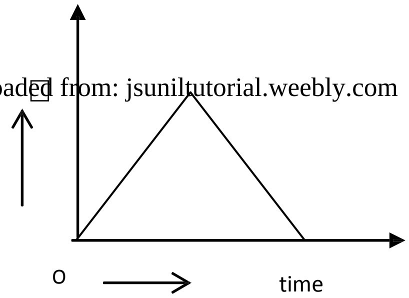
15. 27 small drops of mercury having the same radius collage to form one big drop. Find the ratio of the capacitance of the big drop to small drop. 2

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

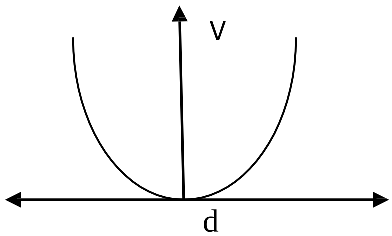
1C

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 $\vec{E} = 3\hat{i} + 4\hat{j} - 5\hat{k}$, 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

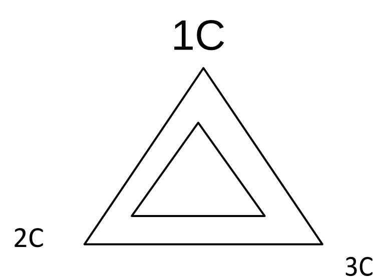
Ans: 5 in parallel and 2 in series

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

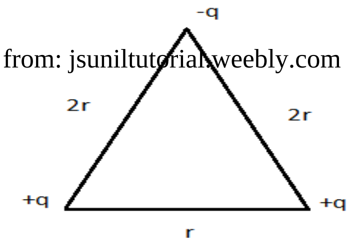
Ans: 5.56×10^{-23}m

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: 9.9×10^{10} J

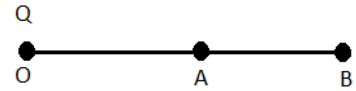


24. Suggest an arrangement of three point charges, +q,+q, -q separated by finite distance that has zero electric potential energy. 2



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: $V_a - V_b = (q/4\pi\epsilon)\,(1/r - 1/R)$

(Principle of Van de Graff generator)

CAPACITORS

S.No

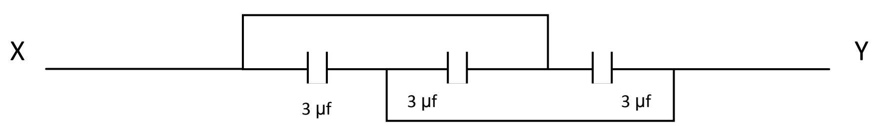
1 What happens to the capacitance of a capacitor when a copper plate of thickness one third of the separation between the plates is introduced in the capacitor? 2

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

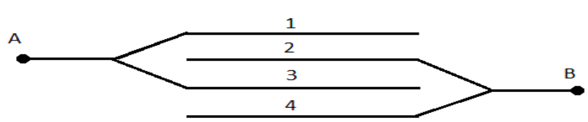


Ans: 9 µf

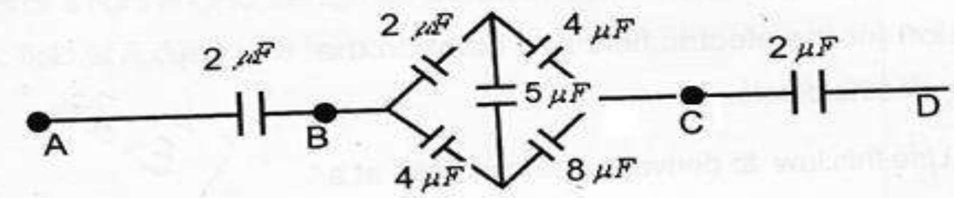
4 A pith ball of mass 0.2 g is hung by insulated thread between the plates of a capacitor of separation 8cm. Find the potential difference between the plates to cause the thread to incline at an angle 15^0 with the vertical, if the charge in the pith ball is equal to 10^{-7}C. 2

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

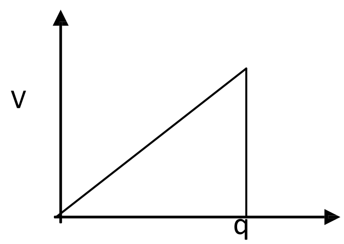
9. A potential difference of 1200 V is established between two parallel plates of a capacitor. The plates of the capacitor are at a distance of 2 cm apart. An electron is released from the negative plate, at the same instant, a proton is released from the +ve plate. 3

(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 K=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. Remains 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, SI Unit – mho or siemen and conductivity σ=1/ρ, SI Unit mho/m.
- **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=(E/V -1)R where R is external resistance.

  Grouping of cells:

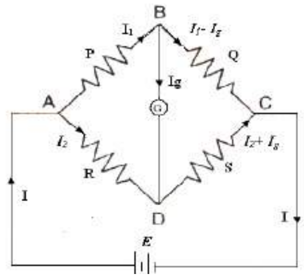
  i) In series grouping circuit current is given by $I_s = \frac{nE}{R+nr}$,

  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:**

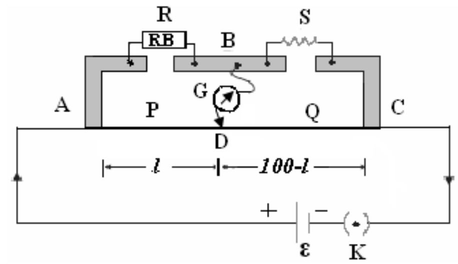
  i) Junction Rule:-The algebraic sum of currents meeting at a point is zero. $\sum I = 0$

  ii) Loop rule:-The algebraic sum of potential difference around a closed loop is zero $\sum V = o$

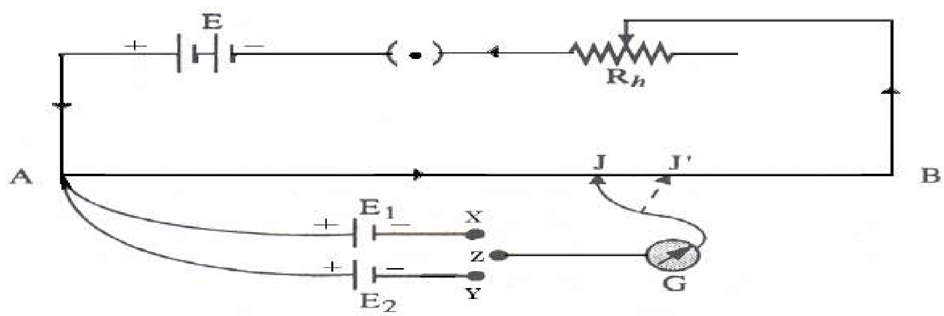
- **Wheatstone bridge** is an arrangement of four resistors arranged in four arms of the bridge and is used to determine the unknown resistance in terms of other three resistances. For balanced Wheatstone Bridge, $\frac{P}{Q} = \frac{R}{S}$



- **Slide Wire Bridge or Meter 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. $v \propto l$
- 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 r 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 $1KWh = 3.6\times10^6 J$
- **Colour code for carbon resistors –**

Colour:	Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White
Number:	0	1	2	3	4	5	6	7	8	9
Multiplier:	10^0	10^1	10^2	10^3	10^4	10^5	10^6	10^7	10^8	10^9

Tolerance: Gold : ±5% , Silver : ±10% , No colour : ±20%

(1) The first two bands indicate the first two significant figures.

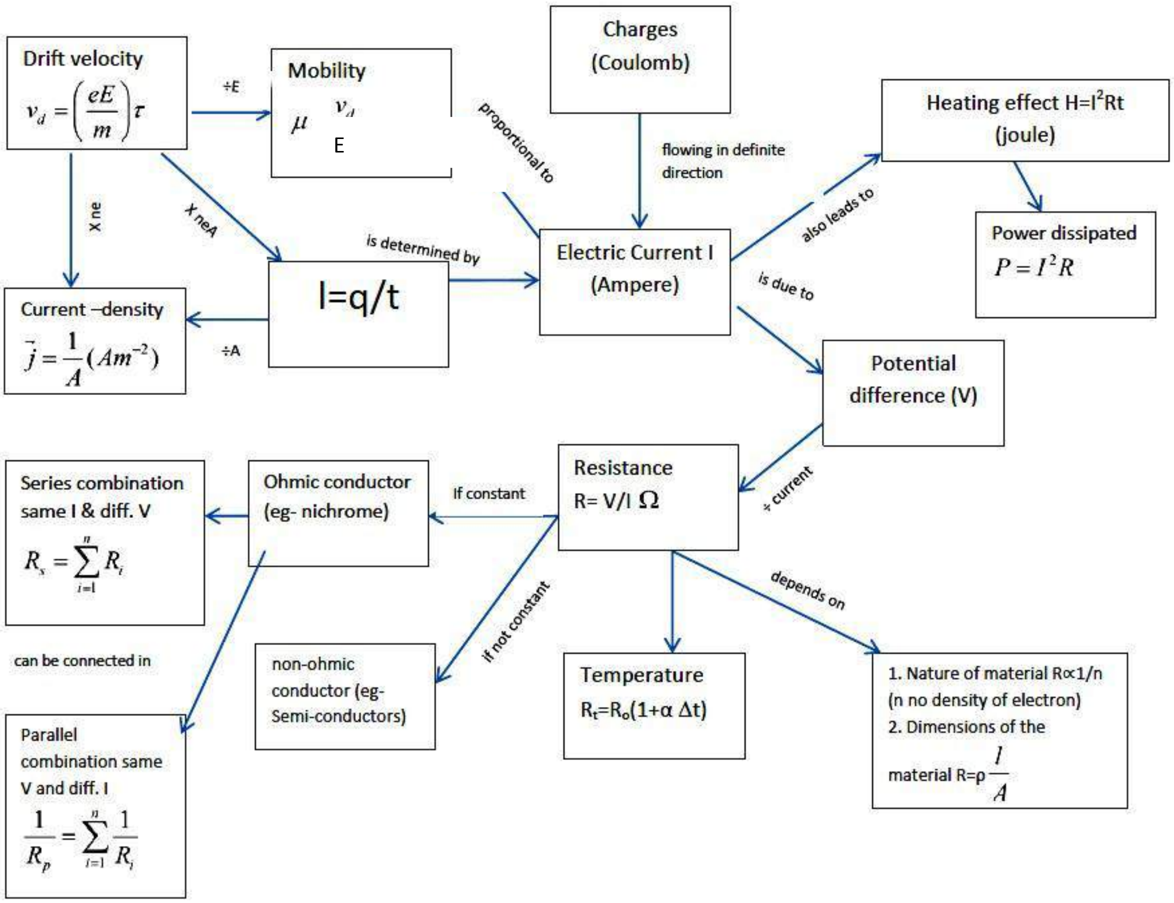
(2) The third band indicates multiplier.

(3) The last band indicates the tolerance in per cent of the indicated value.

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. remains the same

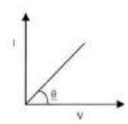
2. Two different wires X and Y of same diameter but of different materials are joined in series and connected across a battery. If the number density of electrons in X is twice that of Y, find the ratio of drift velocity of electrons in the two wires. (1)
   Ans: $V_{dx}/V_{dy} = n_y/n_x = ½$

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)

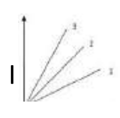


Ans: R = Cot Θ

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? (1)
   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

10. Plot a graph showing the variation of conductivity σ with the temperature T in a metallic conductor. (2)
   (Ans: see fig1)

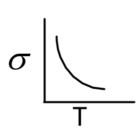


Fig 1

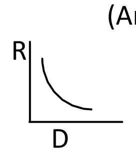


fig2

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) (2)

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

13 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? (2)

14. 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? (2) Ans: I= q/t = qω/2π

15.* 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, $R = r_1 - r_2$

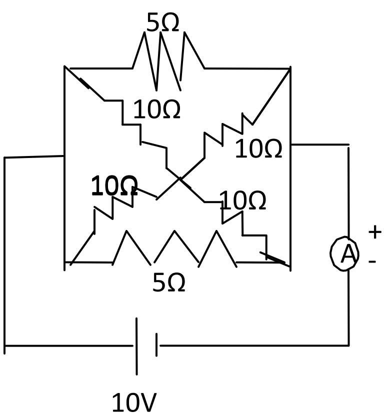
16.Why does Resistance increase in series combination and decrease in parallel combination (2)

Ans: Effective length increases in series combination (R α l).

In parallel combination area of cross section increases (R α 1/A)

17.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? (2) Ans: 40Ω

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



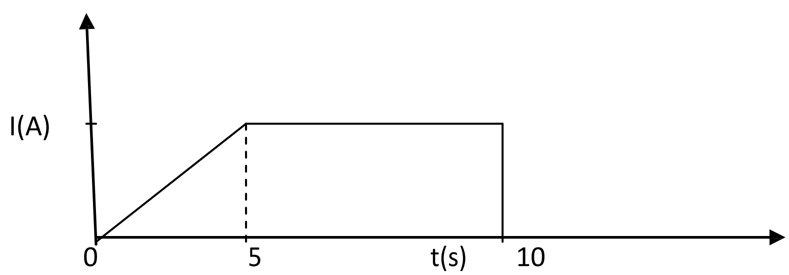


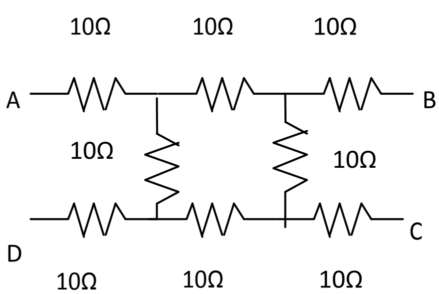
Fig 1. Fig 2.

Ans: R = 2Ω and I = 5A

19.* 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. (2) Ans: Area under the I-t graph, q = 37.5C

20.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} = 27.5Ω (ii) R_{AC} = 30Ω

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

Q27: Define velocity. Write the expression of current in a conductor of crossectional area A in terms of drift velocity. (3)

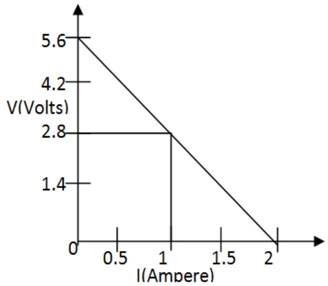
Drift

22. 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.

(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



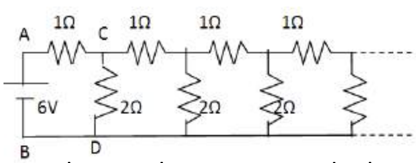
Ans: 4E = 5.6 E = 1.4 V

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

Internal resistance, $r = (E - V)/I = 0.7\Omega$

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

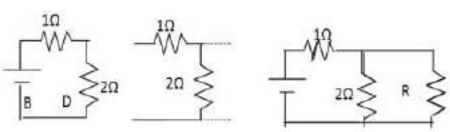
23.* An infinite ladder network of resistances is constructed with 1Ω and 2Ω resistances shown (3)



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

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

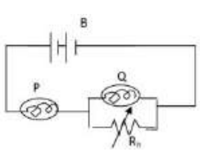


$R = \frac{2R}{R+2} + 1$ $R = 2\Omega$

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

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

25. 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)



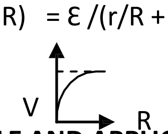
Ans: Brightness of P and Q decrease and increase respectively.

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

Ans: (a) $I = \varepsilon / (r + R)$ $I = I_{max}$ when R = 0 $I_{max} = \varepsilon / r$ (3)

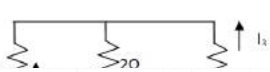
(b) $V = \varepsilon R/(r + R) = \varepsilon / (r/R + 1)$ $V = V_{max}$ when r/R + 1 = minimum, r/R = o, V = Ɛ

(c)



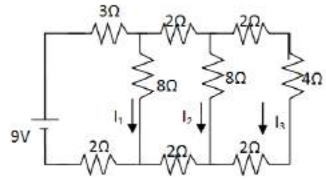
II. KIRCHHOFF'S RULE AND APPLICATIONS

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)



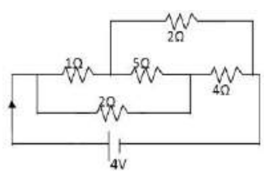
Ans: I = 1A

III. **<u>WHEATSTONE BRIDGE AND POTENTIOMETER</u>**

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)

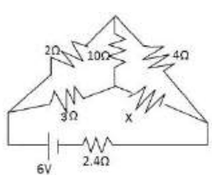
2. The resistance in the left gap of a meter bridge is 10Ω and the balance point is 45cm from the left end. Calculate the value of the unknown resistance. Ans S = 12.5Ω (1)

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.



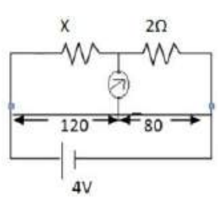
Ans: I = 2A

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



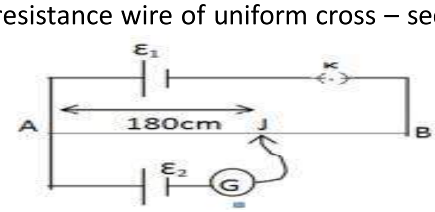
Ans: X = 6Ω and I = 1A

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 $0.01 V cm^{-1}$ exists. (3)



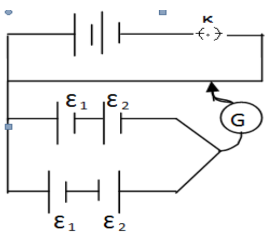
(a)If the galvanometer G shows zero deflection, what is the emf $\mathcal{E}_1$ of the cell used?

(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/l 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 $\mathcal{E}_1$ and $\mathcal{E}_2$ 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) $\mathcal{E}_1/\mathcal{E}_2$ and (ii) balancing length for the cell $\mathcal{E}_1$ only. (3)

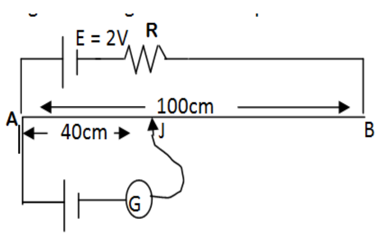
battery



Ans : $\mathcal{E}_1 + \mathcal{E}_2 \propto 400$, $\mathcal{E}_1 - \mathcal{E}_2 \propto 240$, Solving $\mathcal{E}_1/\mathcal{E}_2 = 4$, $\mathcal{E}_1 \propto l_1$,

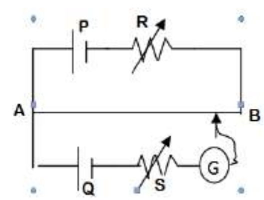
$(\mathcal{E}_1 + \mathcal{E}_2)/\mathcal{E}_1 = 400/l_1$, l_1 = 320cm

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) x 10^{-3} Resistance of 40cm wire is 4Ω. At J, (2/R +10) x 4 = 10 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.

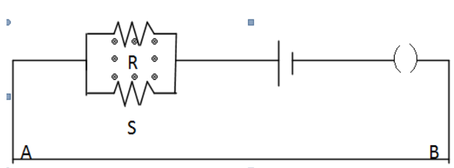
(ii)Resistance S is increased keeping R constant.

(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/l 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 $I = E/ (R_0 + (RS/R+S))$

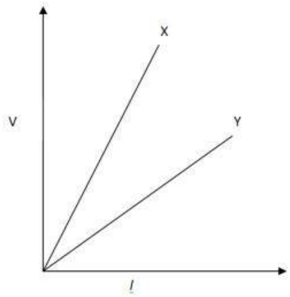
Total potential difference across AB $V = I R_0 = E R_0/ (R_0 + (RS/R+S))$

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.

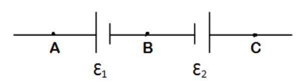
Precaution: Positive terminal of the test cell must be connected to positive terminal of the battery.

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. ELECTRIC ENERGY AND POWER

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: $R = V^2/P$, $R\ \alpha\ 1/P$, 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: $P = I^2R$ $P\ \alpha\ R$ 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$=V^2/P = 20\Omega$, $I = 5A$, for the same power dissipation, current should be 5A when the bulb is connected to a 200V supply. The safe resistance $R' = V'/I = 40\Omega$. 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 $R= V^2/P = 36/30 = 1.2\Omega$ 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, $I = V'/R + R' =5$, $R' = 22.8\Omega$

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's Law
   $dB = \mu_0 IdlSin\theta/4\pi r^2$
   $\mu_0 = 4\pi \times 10^{-7}$ 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. $B= \mu_0 NIa^2/2(a^2+x^2)^{3/2}$ (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.
   $\oint B.\, dl= \mu_0 I$
5. Applications
   i) Magnetic field due to straight infinitely long current carrying straight conductor.
      $B= \mu_0 I/2\pi r$
   ii) Magnetic field due to a straight solenoid carrying current
      $B= \mu_0 n I$
      n= no. of turns per unit length
   iii) Magnetic field due to toroidal solenoid carrying current.
      $B= \mu_0 N I / 2\pi r$
      N= Total no. of turns.
6. Force on a moving charge [Lorentz Force]
   (i) In magnetic field $F=q(V \times B)$
   (ii) In magnetic and electric field $F=q[E+(v \times B)]$ 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
   $F= (LI \times B)$
   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 2×10^{-7} N/m of their length.
11. Torque experienced by a current loop in a uniform B.

τ = NIBA Sinθ

τ=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<θ<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 θ where K= NAB / C

Current sensitivity, I_s= θ / I=NBA/K
voltage sensitivity, Vs= θ /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.

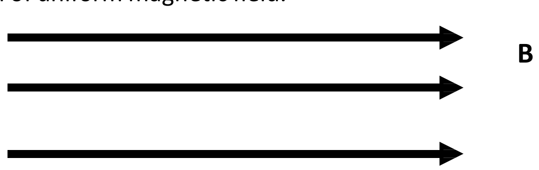
R=(V/I_g) –G ; R_v=G+R

Current loop as a magnetic dipole

Orbital Magnetic dipole moment M = $\dfrac{evr}{2}$

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

14. Representation of uniform magnetic field.



15. Magnetic dipole moment of a magnetic dipole.
    M=m (2l) SI unit of M -> ampere meter, 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)

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

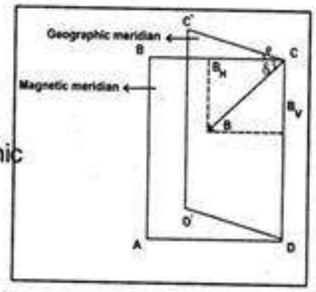
b) at any point on equatorial line

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

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.

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

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

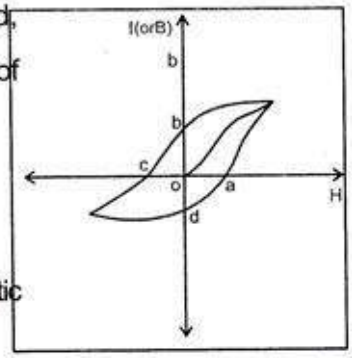
The magnetic permeability of a material may be defined as the ration of magnetic induction B to the magnetic intensity H

$\mu = B/H$

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

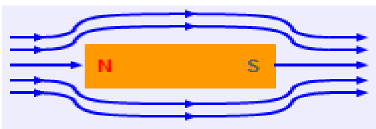
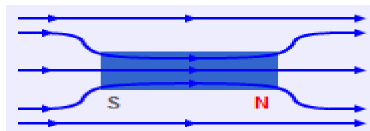
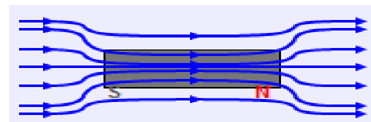
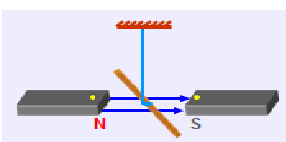
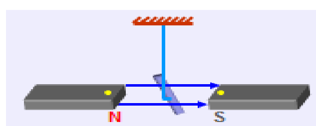
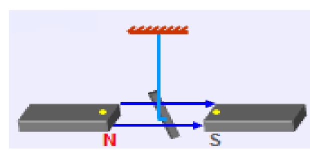
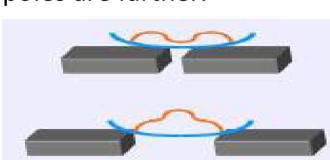
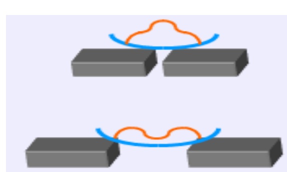
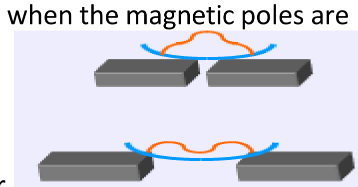
1) Electro magnet

High retentivity and low coercivity

2) Permanent magnet

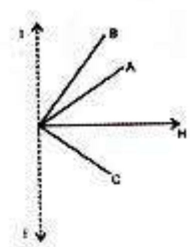
High retentivity and high coercivity

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. Aluminum, 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

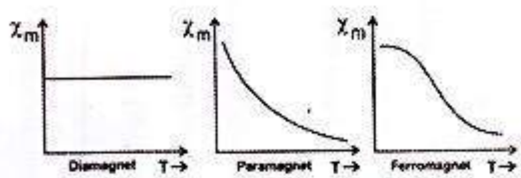


A = Paramagnet

= Ferro magnet

= Diamagnet

. Graph between χm and Temperature



CONCEPT MAP

Moving Charges

Moving charges or current

leads to

Magnetic field

which can be calculated by using

Biot Savarts law

applications

Field due to current carrying straight conductor B= $\frac{\mu_0 I}{2\pi r}$

Field due to current carrying coil at its center B= $\frac{\mu_o I}{2r}$

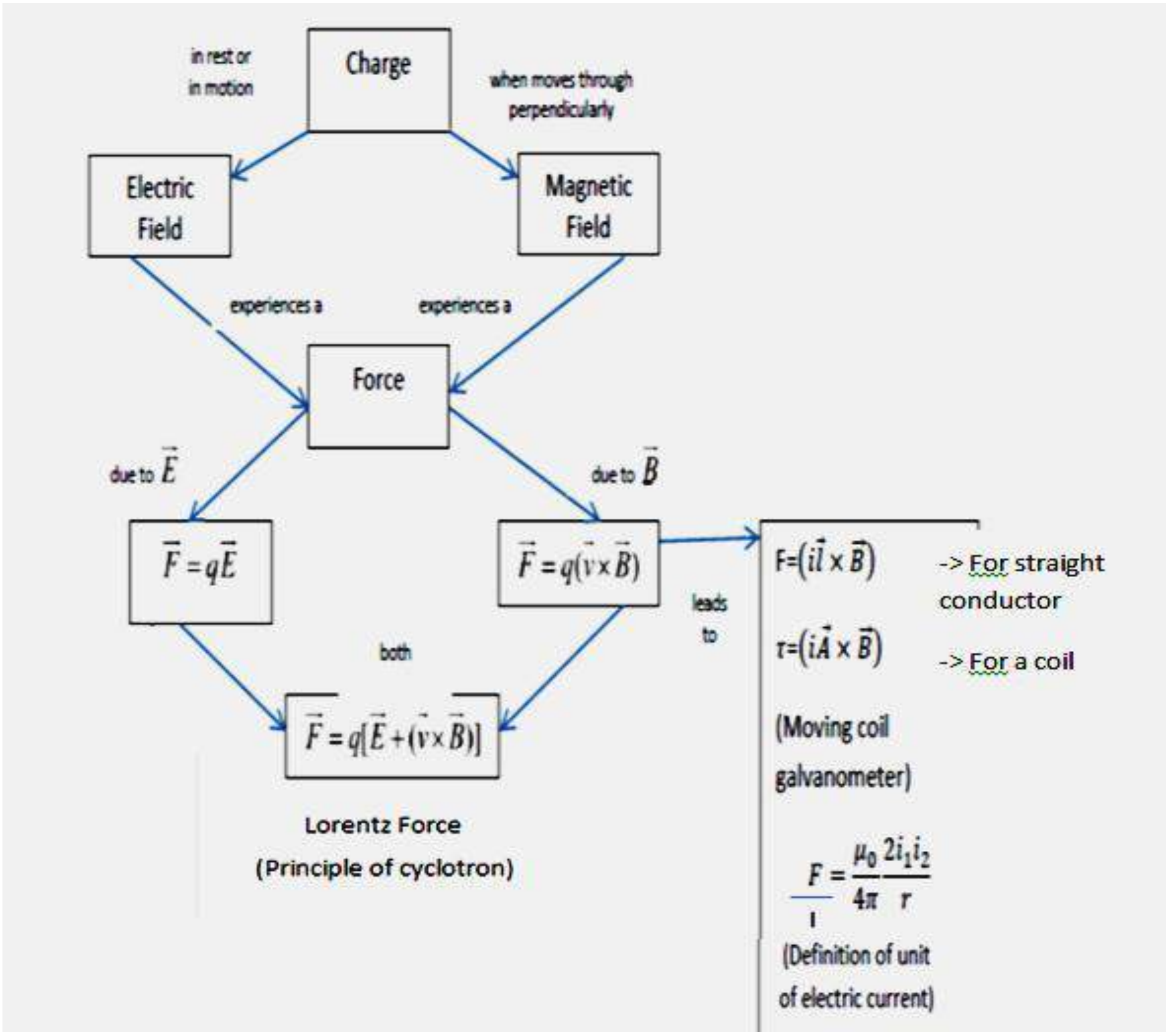
Ampere's circuit law

applications

Magnetic field due to solenoid B= $\mu_o nI$

Magnetic field due to current carrying toroid B= $\mu_o nI$

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 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. 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: $2\sqrt{2}$

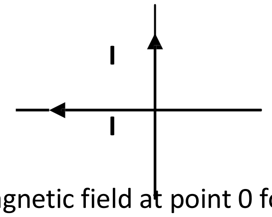
6* A current is flowing in a circular coil of radius 'r' and magnetic field at its center is B_0. At what distance from the center on the axis of the coil, the magnetic field will be $B_0/8$? 2

Ans: $x = \sqrt{3}r$

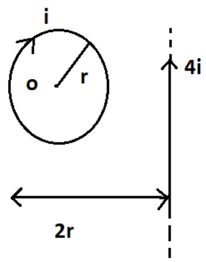
7* A straight wire of length '$\frac{\pi}{2}$'m, is bent into a circular shape. if the wire were to carry a current of 5 A, calculate the magnetic field due to it, before bending, at a point 0.01 times the radius of the circle formed from it. Also calculate the magnetic field at the center of the circular 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. $(\mu_0 I / 2r) = (\mu_0 i / \pi r)$

AMPERE'S CIRCUITAL LAW AND APPLICATIONS

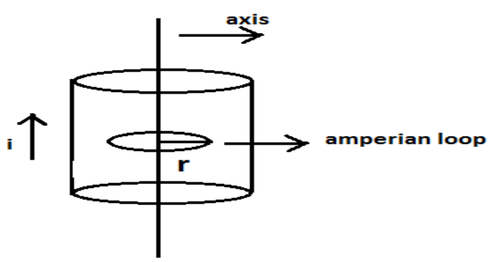
1 A long straight solid metal wire of radius 'R' carries a current 'I', uniformly distributed over its circular cross section. Find the magnetic field at a distance 'r' from the axis of the wire (a) inside and (b) outside the wire 2

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

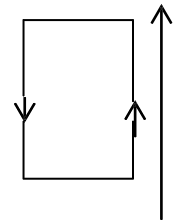


Ans B=0

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

2 The maximum value of permeability of a-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 magnesium at 300K is 1.2×10^5. At what temperature will the susceptibility be equal to 1.44×10^{-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? 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 magnetic material 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
$\Phi_B = B.A = BA\cos\theta$ 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 [Φ] = $ML^2T^{-2}A^{-1}$.

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 $\varepsilon = Blv$.

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 o f 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 ($\Phi = NBA\cos\omega t$).

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

$\varepsilon = -d\Phi/dt = NBA\omega\sin\omega t$ $\varepsilon = \varepsilon_0 \sin\omega t$

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

17 An alternating voltage $\varepsilon = \varepsilon_0\sin\omega t$, 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

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

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

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

19 In case of an a.c. circuit having pure inductance current lags behind emf by a phase angle 90°.

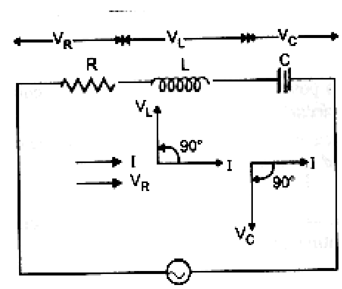
$\varepsilon = \varepsilon_m \sin \omega t$ and $i = i_m \sin(\omega t - \Pi/2)$

$I_m = \varepsilon_m / X_L$; $X_L = \omega L$ 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°.

$\varepsilon = \varepsilon_m \sin\omega t$ and $I = I_m \sin(\omega t + \pi/2)$ where

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

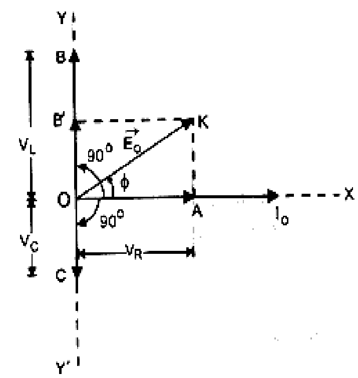


21 In case of an a.c. circuit having R, L and C, the total or effective resistance of the circuit is called impedance (Z).

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

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

$\varepsilon = \varepsilon_m \sin\omega t$, $I = I_m \sin(\omega t + \Phi)$



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

$P = \varepsilon_{rms} I_{rms} \cos\Phi$

* In a purely resistive circuit $\Phi = 0$; $P = V_{RMS} I_{RMS}$.

* In a purely inductive circuit $\Phi = \Pi/2$; $P = 0$.

* In a purely capacitive circuit $\Phi = \Pi/2$; $P = 0$.

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 $\frac{1}{\omega_r C R}$ also $Q = \frac{\omega_r}{2\Delta\omega}$ where $2\Delta\omega$ is bandwidth.

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

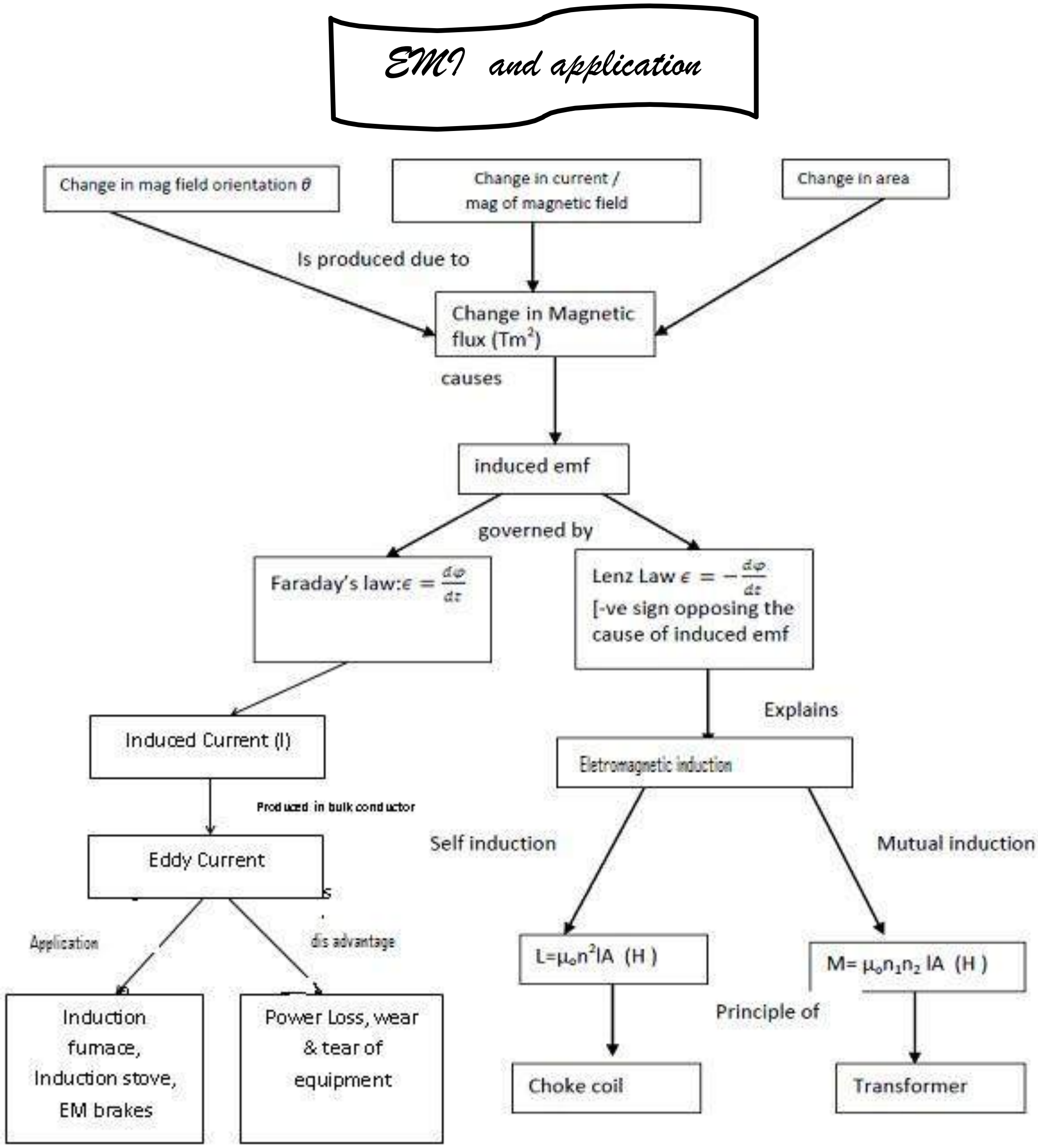
In an ideal transformer, $\varepsilon_P I_P = \varepsilon_S I_S$. i.e

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

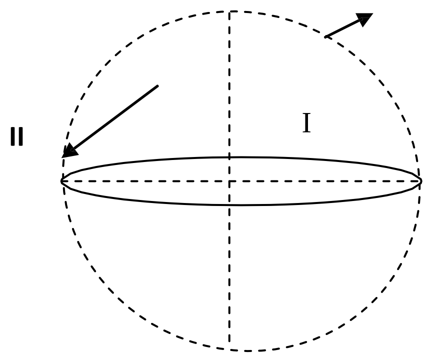


(I) Parameters of various combinations of components in ac circuits

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	$E=E_0 \sin \omega t$	$I = I_0 \sin(\omega t - 90^\circ)$	$Z = X_L = \omega L$	I lags behind E by 90°	Zero	$\cos\phi = 0$
3.	Pure capacitor	$E=E_0 \sin \omega t$	$I = I_0 \sin(\omega t + 90^\circ)$	$Z = X_C = \frac{1}{\omega C}$	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	$E=E_0 \sin \omega t$	$I = I_0 \sin(\omega t \pm \theta)$	$Z = \sqrt{R^2 + (X_L - X_C)^2}$	$\tan\phi = \frac{X_C - X_L}{R}$	$E_v I_v \cos\phi$	$\cos\phi = \frac{R}{\sqrt{R^2+(X_L-X_C)^2}}$

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

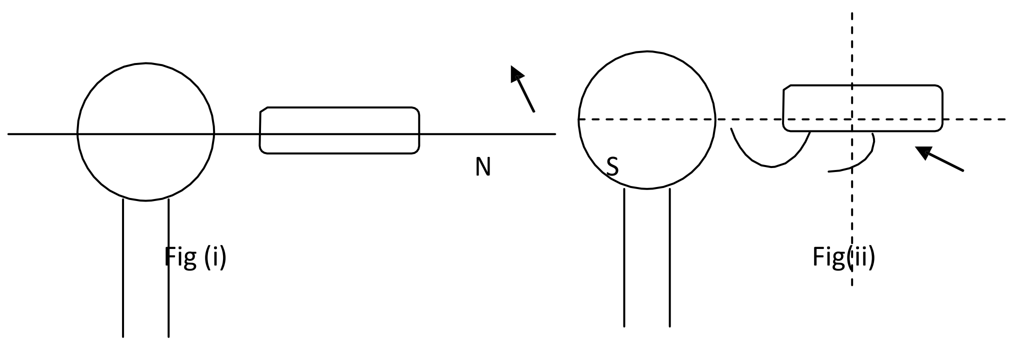


Fig (i) Fig(ii)

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? 1

(Hint: Number of spokes does not affect the net emf)

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 = dΦ/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 p e r 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]

Φ = BA

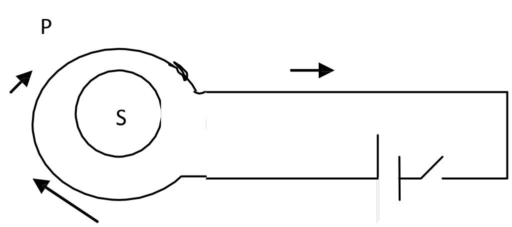
e = d(BA)/dt= B dA/dt, dA/dt= Πr^2x n

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. (Φ= $\Pi r^2 B$ d Φ/dt = 2ΠrB 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)

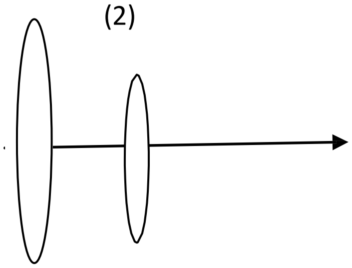
15 A coil of mean area 500 cm^2 having 1000 turns is held perpendicular to a uniform magnetic field of 0.4 G. The coil is turned through 180° in 1/10 seconds. Calculate the average induced e.m.f. 2

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

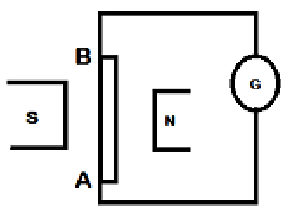
17 Two identical co-axial coils carry equal currents. What will happen to the current in each loop if the loops approach each other? 2

(2)



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

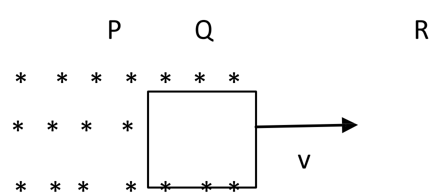
18 Obtain the direction of induced current and e.m.f when the conductor AB is moved at right angles to a stationary magnetic field (i) in the upward direction (ii) in the downward direction. 2
(i) B to A (ii) A to B)



19 A fan blade of length 0.5 m rotates perpendicular to a magnetic field of 5×10^{-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)

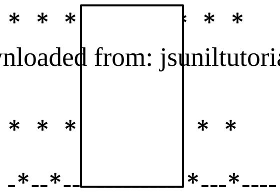
20 The figure shows a square loop having 100 turns an area of 2.5×10^{-3} m^2 and a resistance of 100Ω . The magnetic field has a magnitude of B= 0.4 T. Find the work done in pulling the loop out of the field slowly and uniformly in 1 second. 3



Also draw graph showing the variation of power delivered when the loop is moved from P to Q to R. (1×10^{-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 Sinωt 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

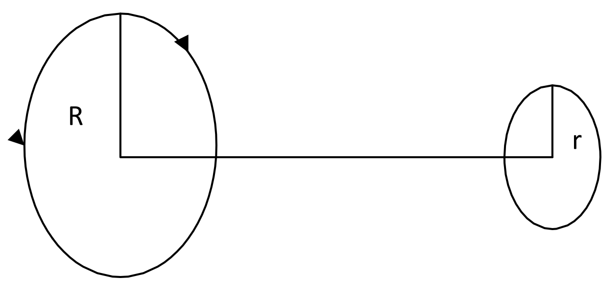
1 Two conducting circular loops of radii R_1 and R_2 are placed in the same plane with their centers coinciding. Find the mutual inductance between them assuming $R_2 << R_1$. 2
($M = \mu_0 \pi R_2^2 / 2R_1$)

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

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

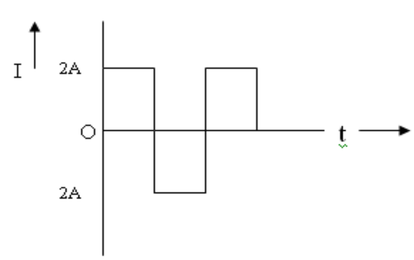
4 A coil of wire of certain radius has 600 turns and inductance of 108mH. What will be the inductance of another similar coil with 500 turns? (75mH) 2

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:- $\sqrt{2}$A

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 different 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 $I_1=I_0\sin\omega t$ and $I_2= I_0\sin(\omega t+\pi/3)$. Will the rms value of I_1 & I_2 be equal or different? 1

Ans: The rms value will be equal.

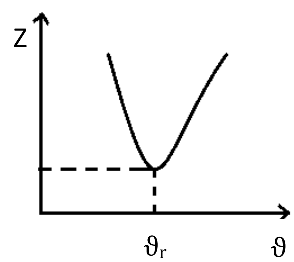
8 An alternating current is given by $i=i_1\cos\omega t+i_2\sin\omega t$. Find the rms current in the circuit. (2) 2

Ans: $\sqrt{\frac{(i_1^2+i_2^2)}{2}}$

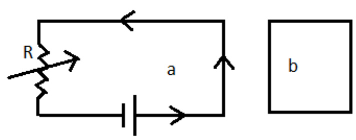
9 An alternating current having a peak value of 14A is used to heat a metal wire. What is the value of steady current which can produce the same heating effect as produced by AC? Why? Ans: i_{rms}=10A 2

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



1 What is meant by wattles 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: CosΦ=0.5, ie, Φ =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 Cosωt & I= I_0 Sinωt. What is the power dissipated in the circuit? 2

Ans:- I=I_0Sinωt & V=V_0Sin(ωt+π/2), since V leads current by a phase angle π/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

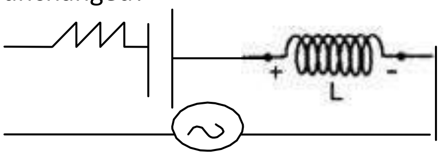
16 Define and derive the root mean square value of a.c voltage 3

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. Which of the two modes of transmission should be preferred and why? 2

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

Ans: V_0=100V I_0=100A $\Phi = \pi/3$ $P=V_{rms} I_{rms} \cos \Phi$=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: $Q=45, \omega_0=111$rad/s

11 An A.C source of voltage $V= V_m \sin\omega t$ 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.

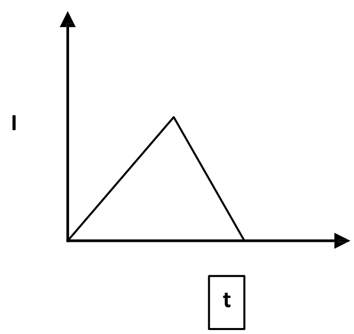
Identify the three circuit elements.

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.
Ans: (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

Ans: (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

Ans: ($e=NBA\omega$; $f=\omega/2\Pi$)

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. Ans: (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?

Ans: (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. $I_D = \varepsilon_0 \int \frac{d\phi_E}{dt}$
5. Maxwell's equations

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

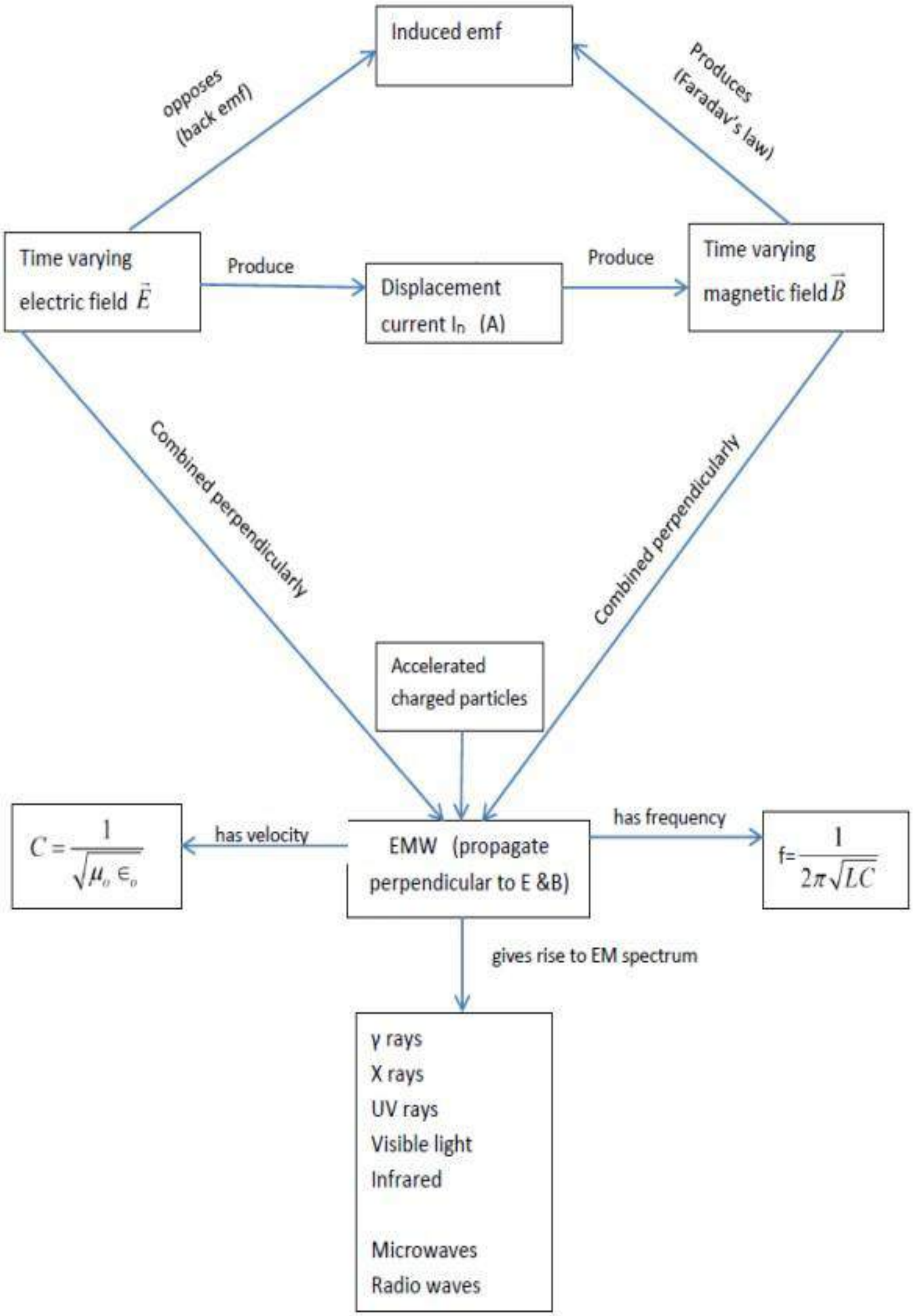
6. **Electromagnetic Wave :-** The wave in which there are sinusoidal variation of electric and magnetic field at right angles to each others as well as right angles to the direction of wave propagation.
7. Velocity of EM waves in free space: $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$ $3\text{x}10^8$ 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 E_o/B_o =C
12. Oscillating or accelerating charged particle produces EM waves.
13. Orderly arrangement of electromagnetic radiation according to its frequency or wavelength is electromagnetic spectrum.
14. **Hint to memories 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


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

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 3

(b) Find the frequency

(c)Find intensity of light

Ans Y axis

$f = (4.5 \times 10^{11})/2\pi$ Hz

$I \propto A^2$

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 $\nu = 50 \times 10^6$Hz. 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 $2\text{x}10^8$ 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 ac 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 / Radio waves.
$\lambda_3 \longrightarrow$ X – rays

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 acceleration.

(ii) It is accelerated motion - can produce EM. waves.

(iii)Can't produce EM waves because no acceleration.

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

$n=\frac{Real\ depth}{apparent\ depth}$ 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,

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

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.

$$Sin\ C=\frac{n_R}{n_D}$$

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 fiber.

4 When light falls on a convex refracting surface from n_1 to n_2 , 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

$$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$$

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

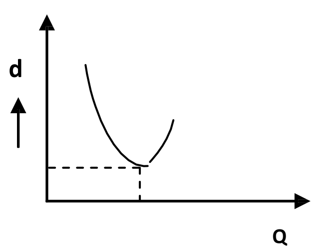
7 The lens formula is given by $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

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

The expression for refractive index is $n = \frac{\sin(A+D_m)/2}{\sin(A/2)}$

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

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?

Ans: Brightness decreases

2 Why a concave mirror is preferred for shaving?

Ans: Enlarged VIRTUAL

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

Ans: Produces 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.

$1/f=1/v+1/u$ If $u<f$, $1/f<1/u$, $1/v$ is negative i.e.image is virtual.

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 An object is placed at O in a medium of R.I n_2 (n_2>n_1). Draw a ray diagram for the image formation and hence deduce a relation between u, v and R

$n_1/v - n_2/v = (n_1-n_2)/R$

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 is 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 (n=1.5).
Ans. 4f, -f

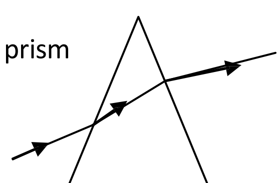
16 Calculate the critical angle for glass air surface, if a ray falling on the surface from air, suffers a deviation of 15^0 when the angle of incidence is 40^0.
Find n by Snell's law and then find $c=41.14^0$

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)

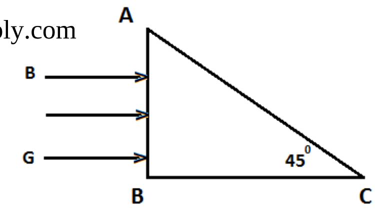
18 A glass prism has an angle of minimum deviation D in air. What happens to the value of D if the prism is immersed in water?
Ans. Decreases

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



20 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

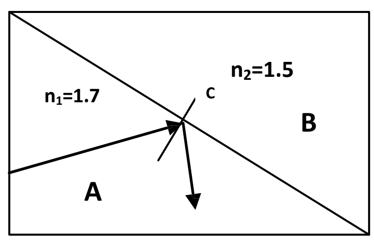
of the faces of an equilateral prism?



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

21 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)
Ans. (D= (n-1) A, 1.5^0)

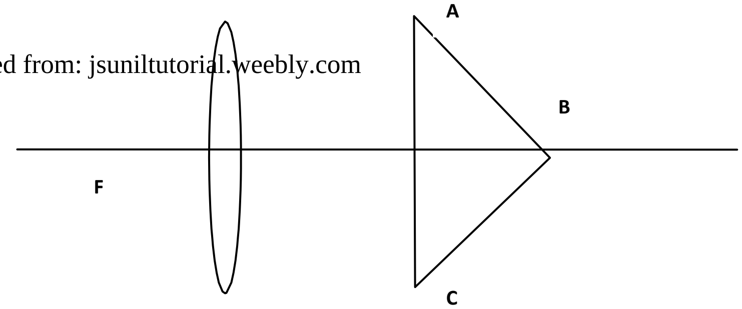
22 In the given diagram, a ray of light undergoes total internal reflection at the point C which is on the interface of two different media A and B with refractive indices1.7 and 1.5 respectively. What is the minimum value of angle of incidence? Can you expect the ray of light to undergo total internal 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)

23 The velocity of light in flint glass for wavelengths 400nm and 700nm are 1.80×10^8m/s and 1.86×10^8 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)

24 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?



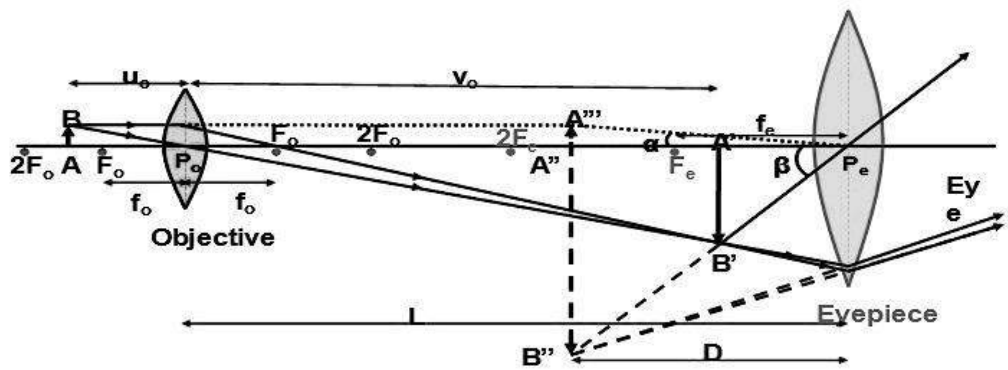
C=41.8^0 Ans - at F itself, no change

OPTICAL INSTRUMENTS

GIST

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

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.

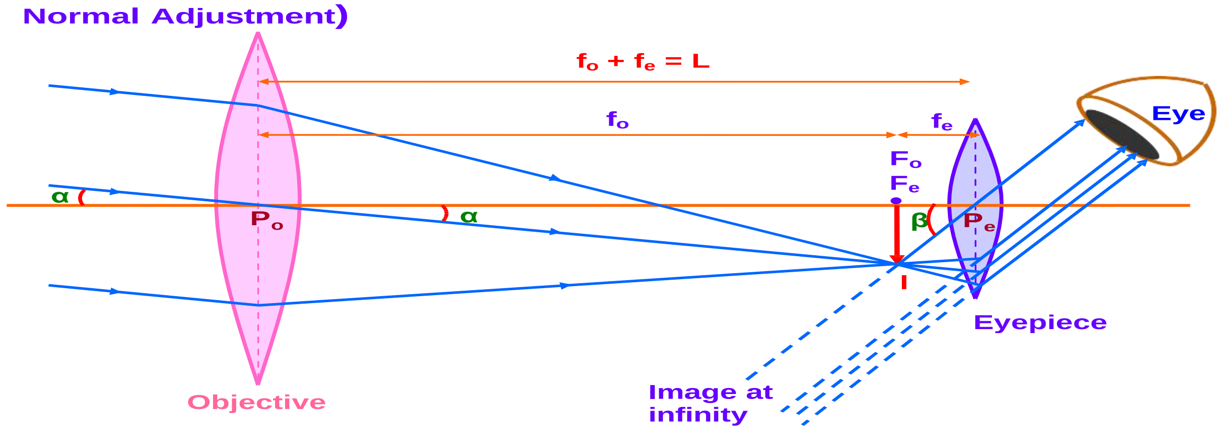
2 **Angular Magnification or Magnifying Power (M):**

$$M = M_e \times M_o$$

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

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

3. **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.

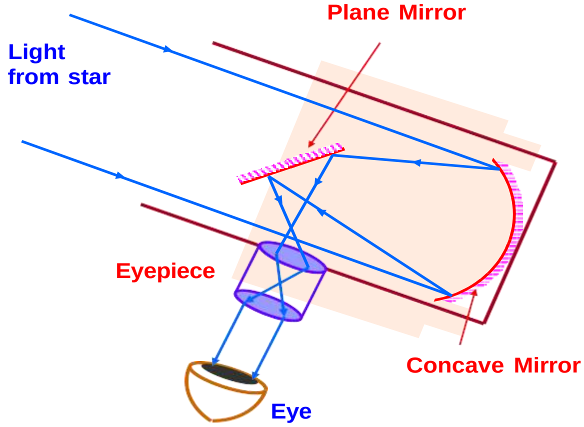
4. **Angular magnification or Magnifying power of a telescope in normal adjustment**

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

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

5.

Newtonian Telescope: (Reflecting Type)



Magnifying Power:

$$\boxed{\ldots - \frac{f_o}{f_e}}$$

6. Cassegrain telescope refer from NCERT / refer Page no 83

Resolving Power = $\dfrac{1}{\Delta d}$ = $\boxed{\dfrac{2\,\mu \sin\theta}{\lambda}}$

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:

Resolving Power = $\dfrac{1}{d\theta}$ = $\boxed{\dfrac{a}{1.22\,\lambda}}$

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

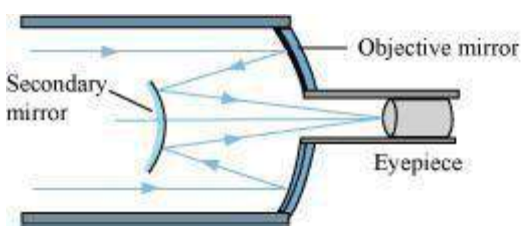
5. The magnifying power of an astronomical telescope in the normal adjustment position is 100. The distance between the objective and the eyepiece is 101 cm. Calculate the focal lengths of the objective and of the eye-piece. 2

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? 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. 5

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. Cassegra in 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 Cassegra in 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, $f_1 = \frac{R_1}{2} = 110 \text{ mm}$

Radius of 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

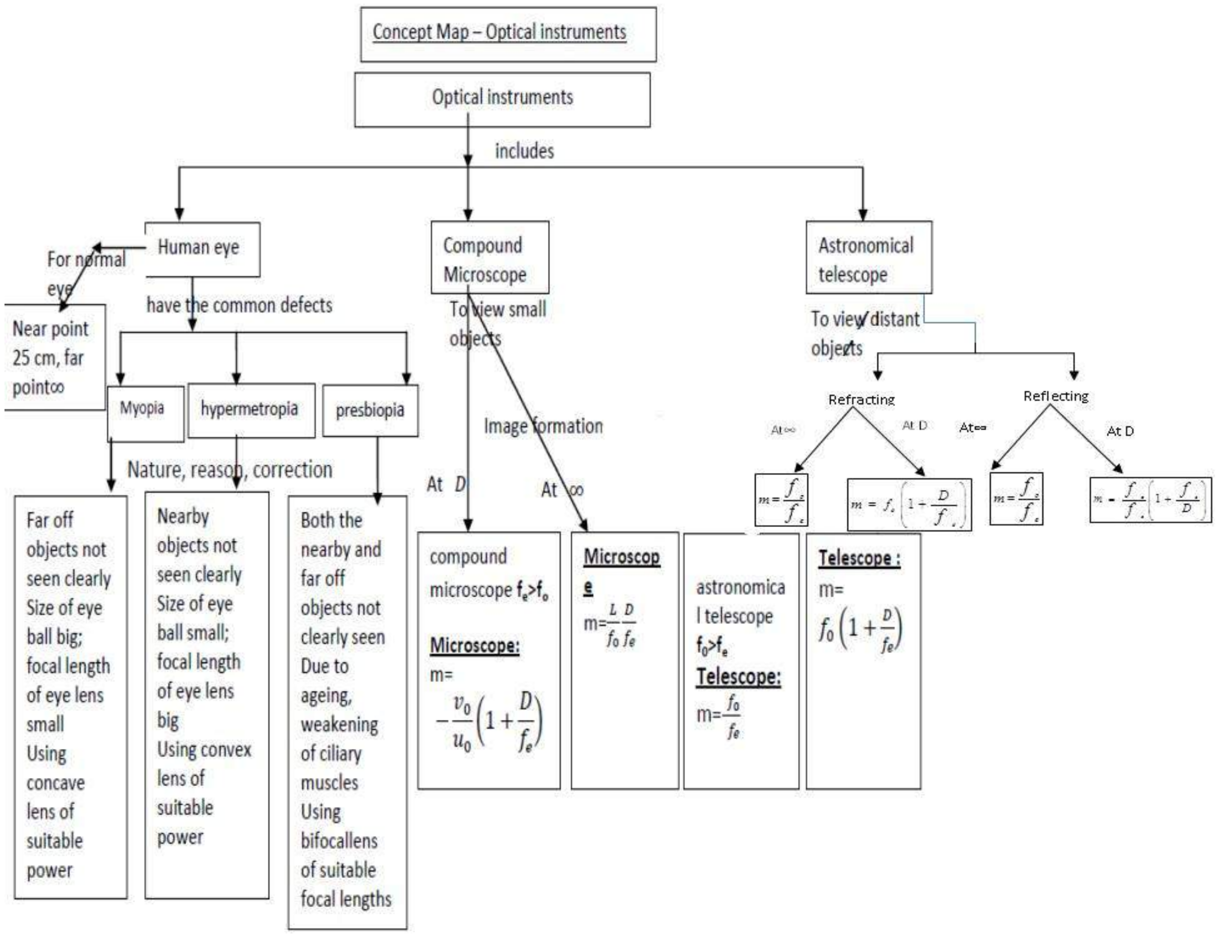
Ans - Separation between the objective lens and the eyepiece

$= 4.17 + 7.5$

$= 11.67 \text{ cm}$

 CONCEPT MAP

Optical Instruments



Wave Optics

GIST

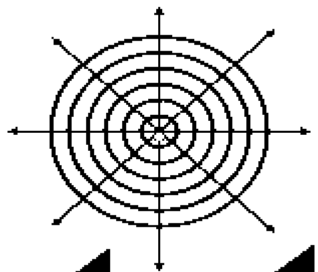
Wavefront:

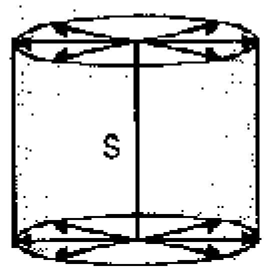
A wavelet is the point of disturbance due to propagation of light.

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

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

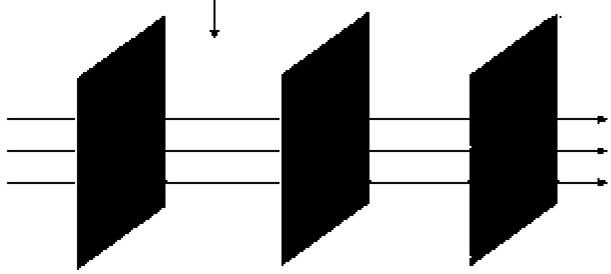
Spherical Wavefront from a



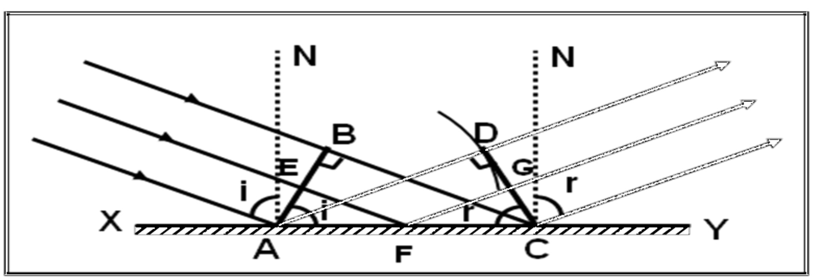


Cylindrical Wavefront from a linear source

Plane Wave front



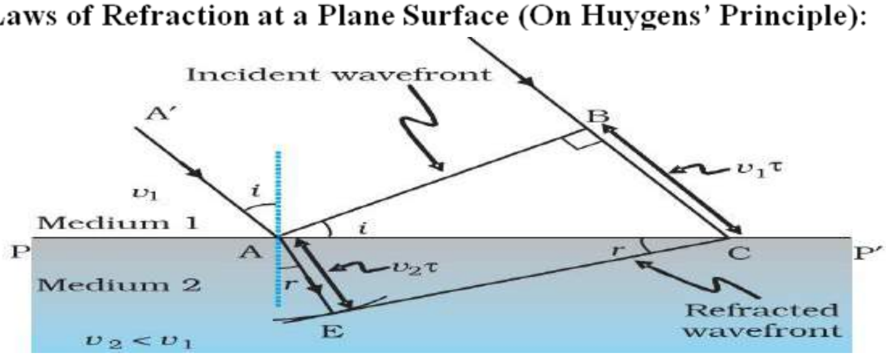
Laws of Reflection at a Plane Surface (On Huygens' Principle):



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

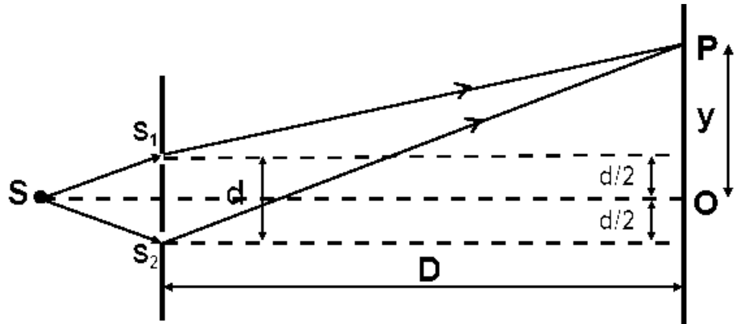
$\sin i - \sin r = 0$. i.e. $\sin i = \sin r$ or $i = r$

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



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

INTERFERENCE OF 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:

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

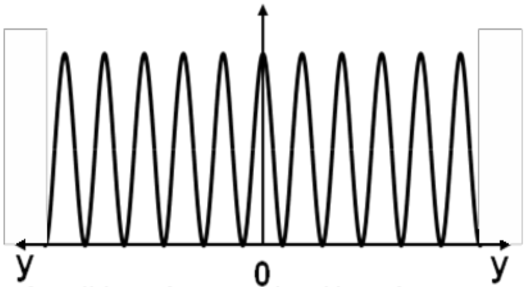
Relation between Intensity (I), Amplitude (a) of the wave and Width (w) of the slit:

$I \ \alpha\ a^2$

$a\ \alpha\ \sqrt{w}$

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

Distribution of Intensity:

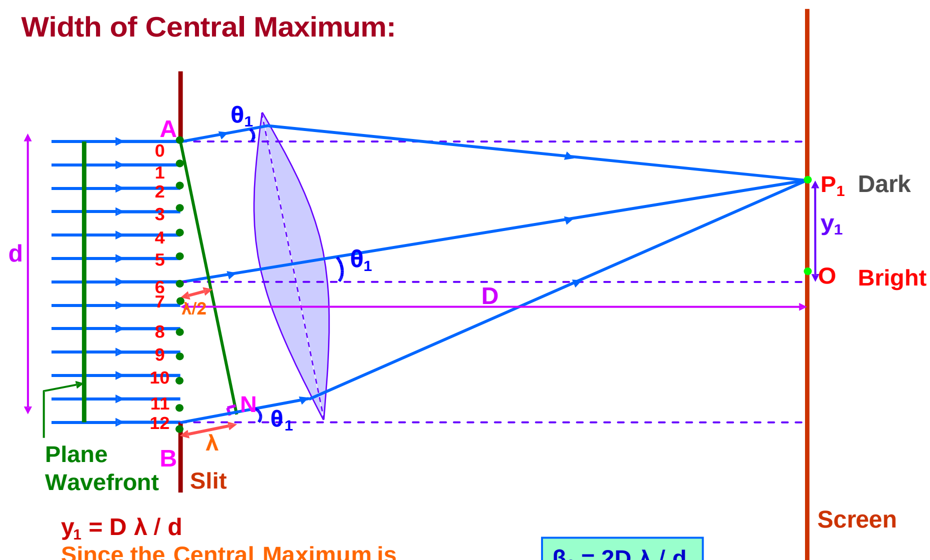


Conditions for sustained interference:

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

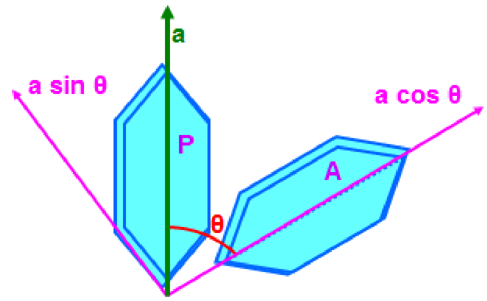
$\boxed{I \propto \cos^2\theta}$

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

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

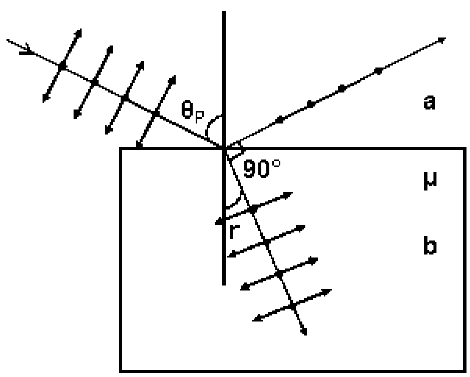
$\boxed{I = I_0\cos^2\theta}$

(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 $r = 90° - \theta_P$

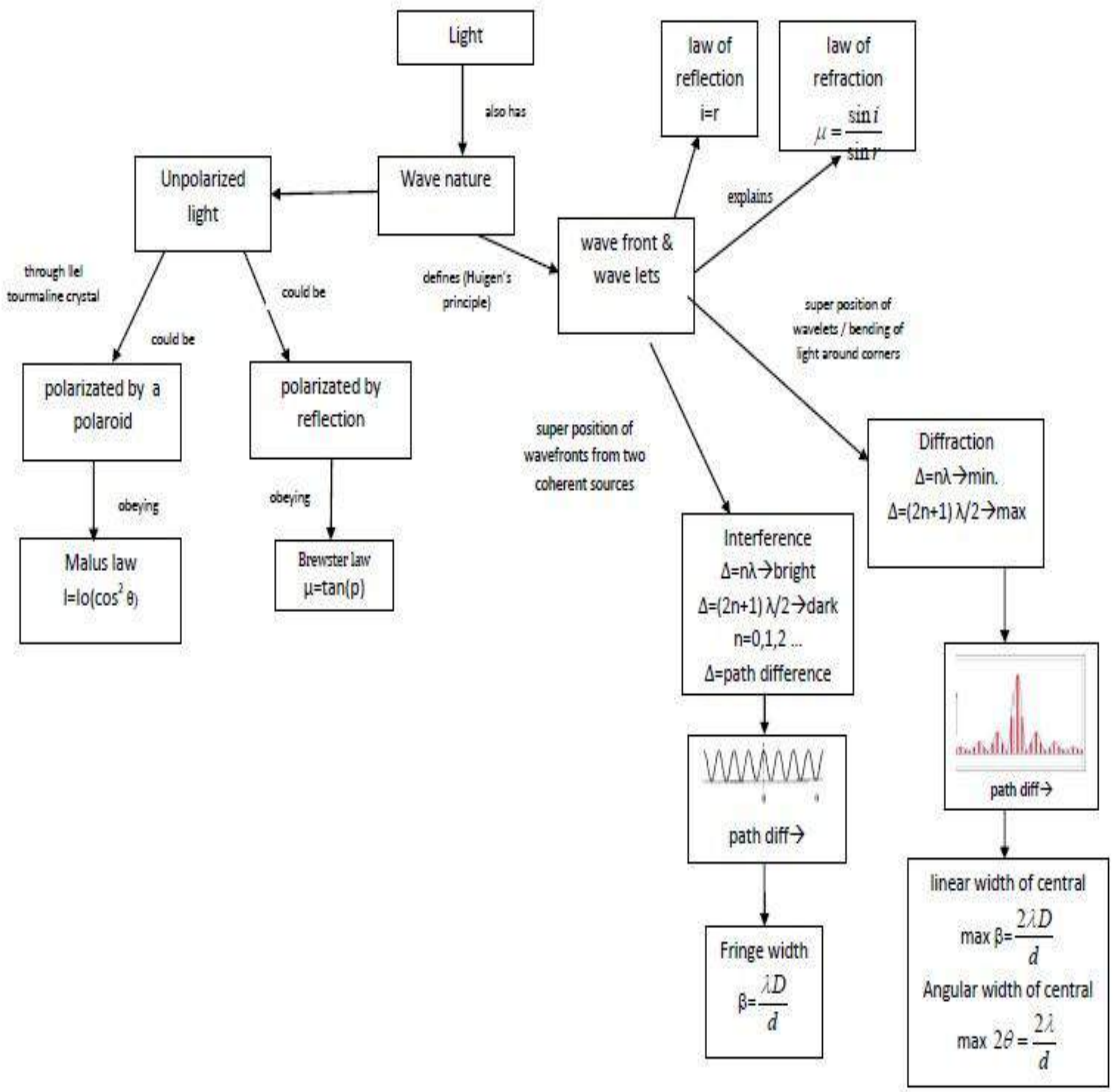
$${}_a\mu_b = \frac{\sin\theta_P}{\sin r}$$

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

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

CONCEPT MAP

WAVE NATURE OF LIGHT



CONCLUSIVE CONCEPT MAP

OPTICS → **RAY OPTICS**, **WAVE OPTICS**

RAY OPTICS

Refraction

1. $n = \frac{c}{v} = \frac{\lambda_{air}}{\lambda_{medium}}$
2. Snell's law: $\frac{\sin i}{\sin r} = {}^1n_2 = \frac{n_2}{n_1}$
3. ${}^2n_1 = 1/{}^1n_2$
4. $n = \frac{\text{real depth}}{\text{apparent depth}} = \frac{t}{t_{app}}$
5. $\sin C = 1/{}^1n_2 = \frac{1}{n}$
6. Refraction at spherical surface

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

Lenses

* Lens maker's formula: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$
* Lens formula: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
* Magnification produced by a lens: $m = \frac{I}{O} = \frac{v}{u}$
* Power of a lens $P = \frac{1}{f}$
* Lenses in contact:

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

$P = P_1 + P_2$

Refraction through a Prism

$r_1 + r_2 = A$ & $i + e = A + \delta$

$$n = \frac{\sin i}{\sin r} = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

For a thin prism: $\delta = (n-1)A$

Angular dispersion $= \delta_V - \delta_R$

Dispersive power, $\omega = \frac{\delta_V - \delta_R}{\delta_Y} = \frac{n_V - n_R}{n_Y - 1}$

Rayleigh's scattering criteria:

Intensity of scattered light, $I_s \propto \frac{1}{\lambda^4}$

Reflection

1. Mirror eqn.: $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$
2. Magnification: $m = -\frac{v}{u}$
3. $f = R/2$
4. Rules for formation of images
5. New Cartesian sign convention

Optical Instruments

1. Simple microscope $M = 1 + \frac{D}{f}$
2. Compound microscope $M = -\frac{v_o}{u_o}\left\{1 + \frac{D}{f_e}\right\}$
3. Astronomical Telescope

$M = -\frac{f_o}{f_e}$ for final image at infinity

$M = -\frac{f_o}{f_e}\left\{1 + \frac{f_e}{D}\right\}$ for final image at D

For Microscope: ResolvingPower$= \frac{1}{d} = \frac{2\, n \sin\theta}{\lambda}$

For telescope: $R.P. = \frac{1}{d\theta} = \frac{a}{1.22\,\lambda}$

WAVE OPTICS

Wavefronts

*Wavefronts: Spherical, plane & Cylindrical.

*Coherent & incoherent sources

*Relation between phase & path difference: $\Delta\phi = \left(\frac{2\pi}{\lambda}\right)\Delta x$

*Reflection/refraction of a plane wavefront by mirror/lens/prism

Huygen's wave theory:

1. Every point on a primary wave-front acts as a source of secondary wavelets which send out light in all directions just as the primary source.
2. The new position of the secondary wavefronts is the envelope of the primary wavefront.

*Verification of laws of reflection and refraction.

Interference of light

* Resultant intensity

$$I = 4 I_o \cos^2\frac{\phi}{2}$$

$$I = a_1^2 + a_2^2 + 2a_1a_2\cos\phi$$

* **Condition for maxima:**

Phase difference $\phi = 2n\pi$ &

Path difference $\Delta = n\lambda$ where $n = 0,1,2,3,..$

* **Condition for minima:**

Phase difference $\phi = (2n-1)\pi$ & Path difference $\Delta = (2n-1)\frac{\lambda}{2}$ where $n = 0,1,2,3\ldots$

Fringe width $\beta = \frac{D\lambda}{d}$

Angular fringe width, $\beta_\theta = \frac{\beta}{D} = \frac{\lambda}{d}$

Position of n^{th} maxima: $y_n = \frac{nD\lambda}{d}$

Position of n^{th} minima:

$y_n = (n - ½)\frac{D\lambda}{d}$

Polarisation of light

Brewster's Law: $n = \tan i_p$

Malus law : $I = I_o \cos^2\theta$

Diffraction of light

* Condition for the central maximum: path difference=0
* Condition for the position of n^{th} minima: $d\sin\theta = n\lambda$
* Condition for the secondary maxima: path difference=$3\lambda/2$

*Width of central maximum: $\beta' = 2y = \frac{2D\lambda}{d}$

*Fresnel distance $Z_F = \frac{d^2}{\lambda}$

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 'wave front'. Draw the wave front and corresponding rays in the case of a (i) diverging spherical wave (ii) plane wave. Using Huygen's construction of a wave front, explain the refraction of a plane wave front 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'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 a distant screen is 0.1º.Whatis 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 in a room 10 m high. 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

SHORT ANSWER 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

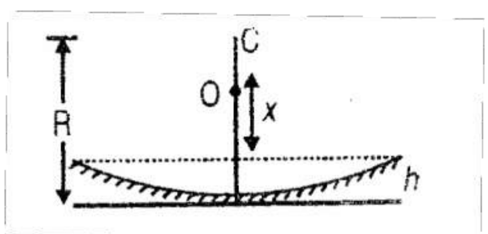


Fig 1

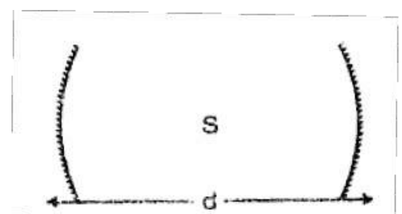
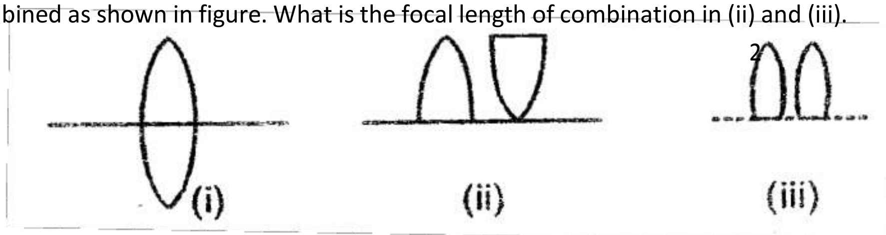


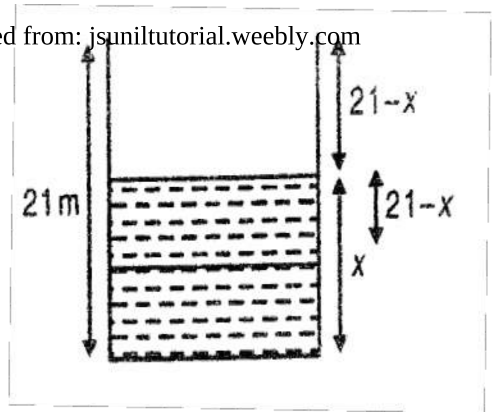
Fig 2

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



4. How much water should be filled in a container 21cm in height, so that it appears half filled when viewed



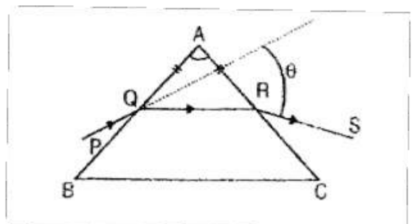
$$\frac{\text{Real depth}}{\text{Apparent depth}} = \mu$$

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

from the top of the container $\left({}^{a}\mu_{\omega} = 4/3\right)$? 2

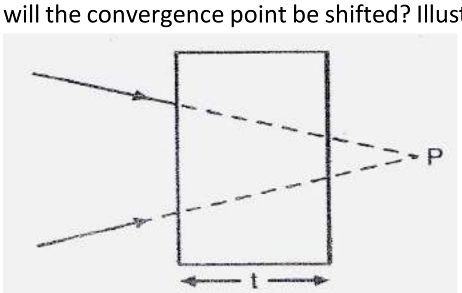
5. A ray PQ incident on the refracting face BA is refracted in the prism BAC as shown in figure and emerges from the other refracting face AC as RS such that AQ= AR. If the angle, of prism A= 60° and μ of material of prism is $\sqrt{3}$ then find angle θ. 2

Hint : This a case of min .deviation $\theta = 60^{\circ}$



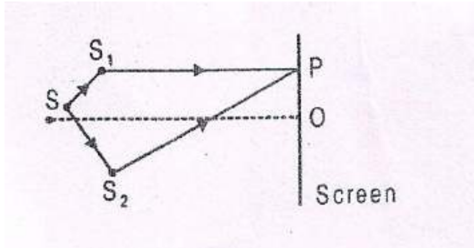
SHORT ANSWER QUESTIONS (3 MARKS)

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



$$X = (1 - 1/\mu)\tau$$

2. In double slit experiment SS_2 is greater than SS_1 by $0.25\,\lambda$. 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.

LAWS OF PHOTOELECTRIC EMISSION:

1. For a given metal and frequency of incident radiation, the number of photoelectrons ejected per second is directly proportional to the intensity of the incident radiation.
2. For a given metal, there exists a certain minimum frequency of the incident radiation below which no emission of photoelectrons takes place. This frequency is called threshold frequency.
3. Above threshold frequency, the maximum kinetic energy of the emitted photoelectrons is independent of the intensity of the incident light but depends only upon the frequency of the incident light.
4. The photoelectric emission is an instantaneous process.

PHOTOELECTRIC EFFECT

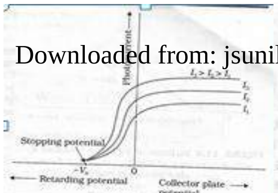
1. The minimum energy required by an electron to come out from metal surface is called the work function of a metal.
2. Photo electric effect is the phenomenon of electrons by metals when illuminated by light of suitable frequency
3. Photo electric current depends on:

   i) The intensity of incident light

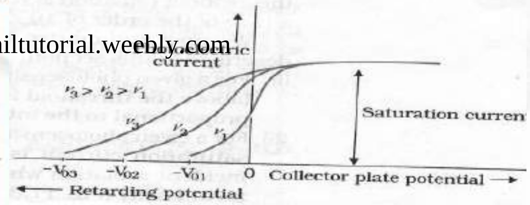
   ii) The potential difference applied between two electrodes

   iii)) The nature of the emitter material

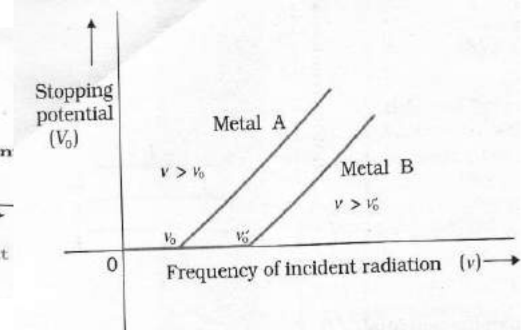
EXPERIMENTAL STUDY OF PHOTOELECTRIC EFFECT



Variation of photocurrent with collector plate potential for different intensity of incident radiation.



Variation of photoelectric current with collector plate potential for different frequencies of incident radiation.



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.

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

3. 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.

EINSTEIN'S 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 momentum p as: λ=h/p = h/mv. This is also called De Broglie Hypothesis.

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

   K = eV

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

   2mK

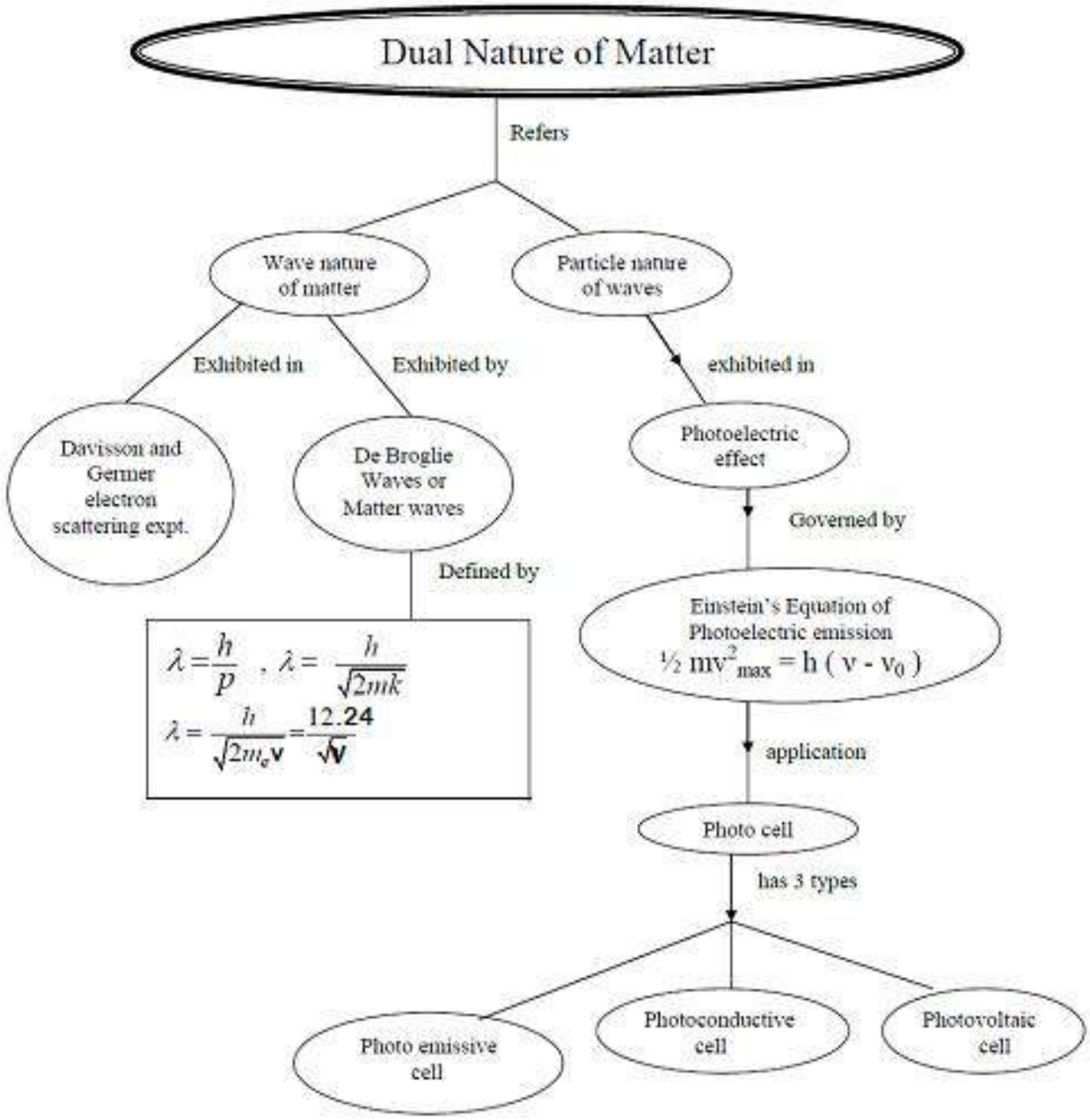
   P = √2mK = √2meV λ =

   h/ √2meV

   Substituting numerical values of h, m and e λ =

   (1.227/√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
Defined by
Governed 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 – Cesium (2.14eV) 2

9* Calculate the work function of a metal in eV if its threshold wavelength is 6800Å.
Ans: Work function = hc / λ_0 = 1.825eV. 2

10 Work function of aluminum 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 cannot. 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 ($1/E_1+1/E_2+1/E_3$)

= 1.12×10^{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 = 1.98×10^{-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 = 9.1×10^{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: λ = 1.227 A °

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: 7.3×10^{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 orbit 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/ 2π

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

$$\lambda \alpha\ 1/\sqrt{v}\ ,\ \lambda_1/\lambda_2 = \sqrt{V2/V1} = \lambda/\lambda_2 = \sqrt{4/1} \Rightarrow \lambda_2 = \lambda/2$$

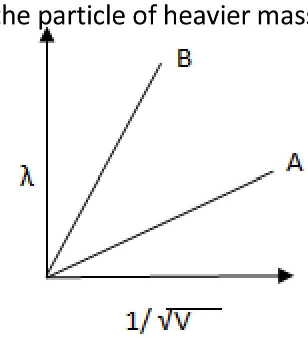
11 Determine the accelerating potential required for an electron to have a de-Broglie wavelength of 1 Å 2

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: $h/\sqrt{2mE_k}\ \alpha\ 1/\sqrt{m}$

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

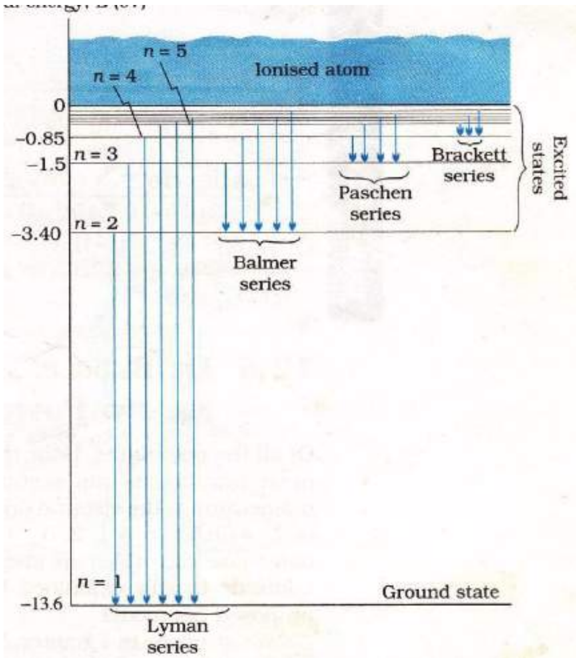


Ans: Slope of the graph is h/√2me.
Slope of A is smaller, so A represents heavier particle.

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 $\lambda_{H2}\ /\lambda_{He} = \sqrt{(m_{He}\ T_{He}/m_H T_H} = \sqrt{(8/3)}$

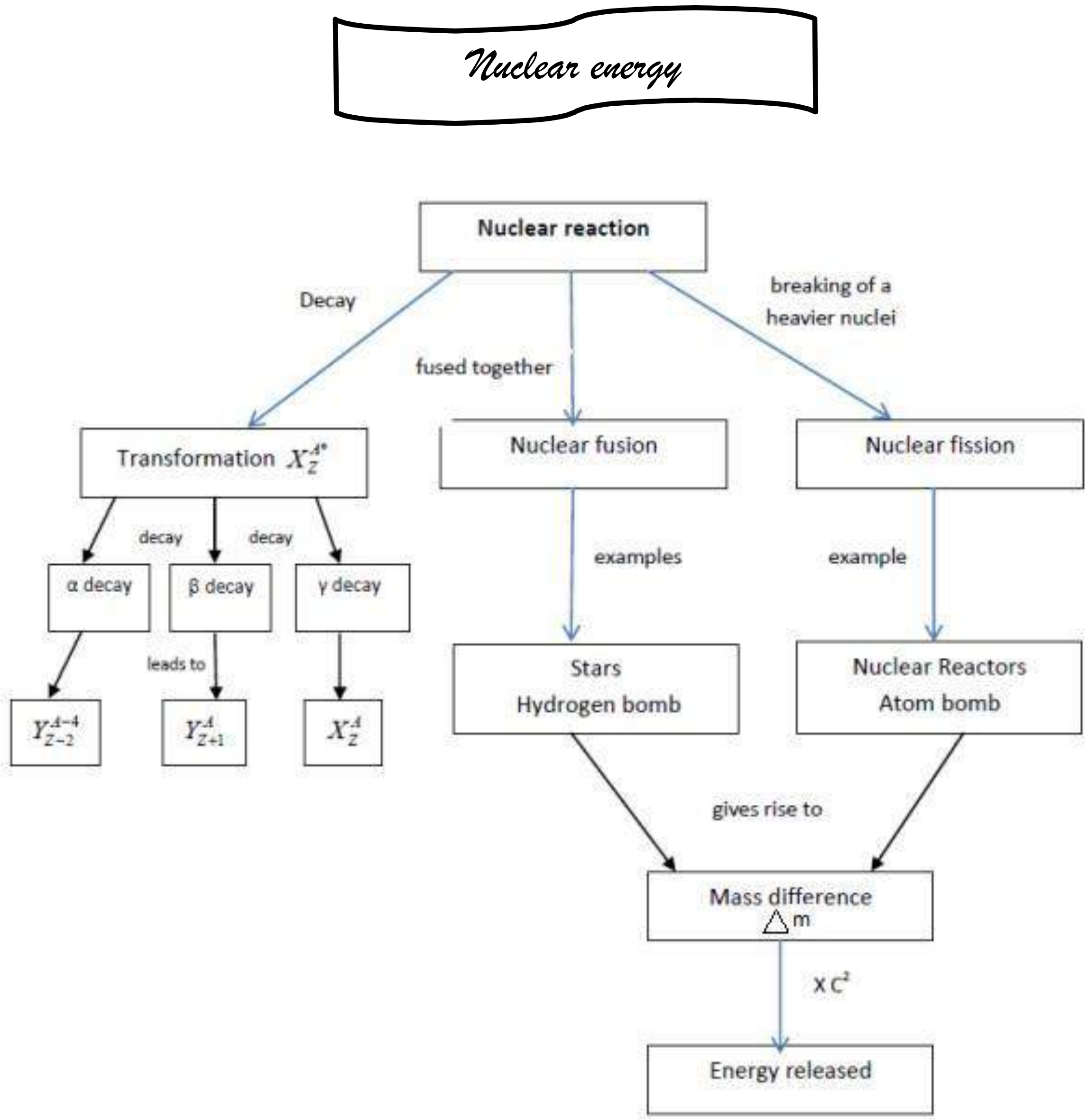
8. ATOMS & NUCLEI

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 p o s i t i v e 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 integral multiple of $h/2\pi$	$L = mvr = nh/2\pi$, n=1,2,3,...

• Wave number ν  	$1/\lambda = R(1/n_1^2 - 1/n_2^2)$ $R=1.097 * 10^{+7} m^{-1}$
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	$P= (3m/4)\pi R_o^3$
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 Mass defect$\triangle$m Binding energy E_b	Same no. of neutrons Mass of neutrons – ${}_1H^3$, ${}_2He^4$ $E= \triangle m \times c^2$ (m= mass of reactants – mass of products) 1 a.m.u.= 931.5 Mev
Radioactive decay law	$dN/dt=-\lambda N$ $-dW/dt= R=$ Activity unit Bq.
No: of nuclei remaining un-decayed at any instant of time	$N = N_0 e^{-\lambda t}$ OR $N=N_0(½)^n$, $n = t/t_{1/2}$
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) moderator 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
Nuclear reaction
Decay
fused together
breaking of a heavier nuclei
Transformation X_Z^{A*}
Nuclear fusion
Nuclear fission
decay
decay
α decay
β decay
γ decay
leads to
Y_{Z-2}^{A-4}
Y_{Z+1}^{A}
X_Z^A
examples
example
Stars
Hydrogen bomb
Nuclear Reactors
Atom bomb
gives rise to
Mass difference
△m
x c²
Energy released

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**: $r \alpha n^2$*
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)

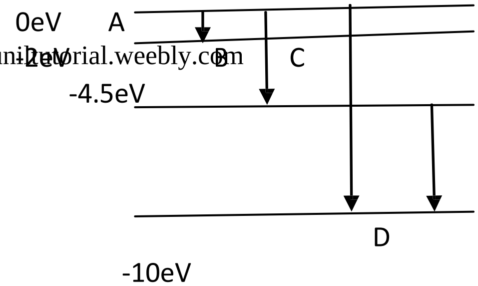
E_{2-1} = Rhc[$1/n_1^2 - 1/n^2$] = ¾ Rhc

$E_\infty - E_1$ = 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)



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*

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: *Radius 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) 1 1 & 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)

$\sqrt[3]{2}\ or\ 2^{\frac{1}{3}}\ timeA$

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)

5. Binding 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**:* $T = 1.44t_{1/2}$

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)

NUCLEAR REACTIONS

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)

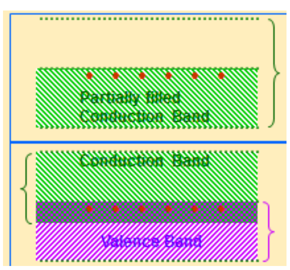
8. If 200MeV energy is released in the fission of single nucleus of $^{235}_{92}U$, how much fission must occur to produce a power of 1 kW. (3)

9.ELECTRONIC DEVICES

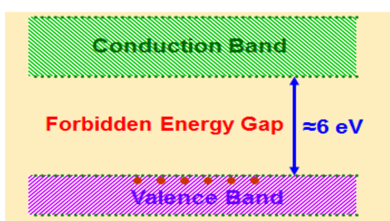
GIST

ENERGY BAND DIAGRAMS

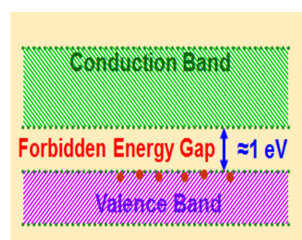
- In metals, the conduction band and valence band partly overlap each other and there is no forbidden energy gap.
- In insulators, the conduction band is empty and valence band is completely filled and forbidden gap is quite large = 6 eV. No electron from valence band can cross over to conduction band 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	3	The number of free electrons and holes is never equal. There is excess of electrons in n-type

	holes in valence band is exactly equal and very small indeed.		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

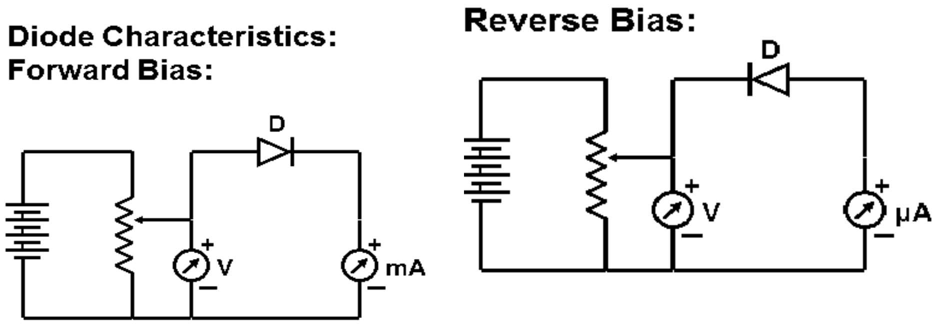
P-n Junction is FB when p-type connected to the +ve of battery and n-type connected to –ve battery

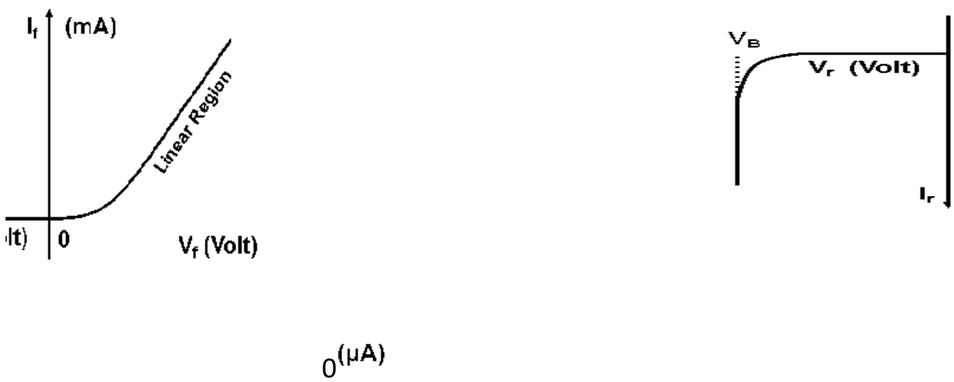
Potential barrier height is reduced and width of depletion layer decreases.

Reverse Bias

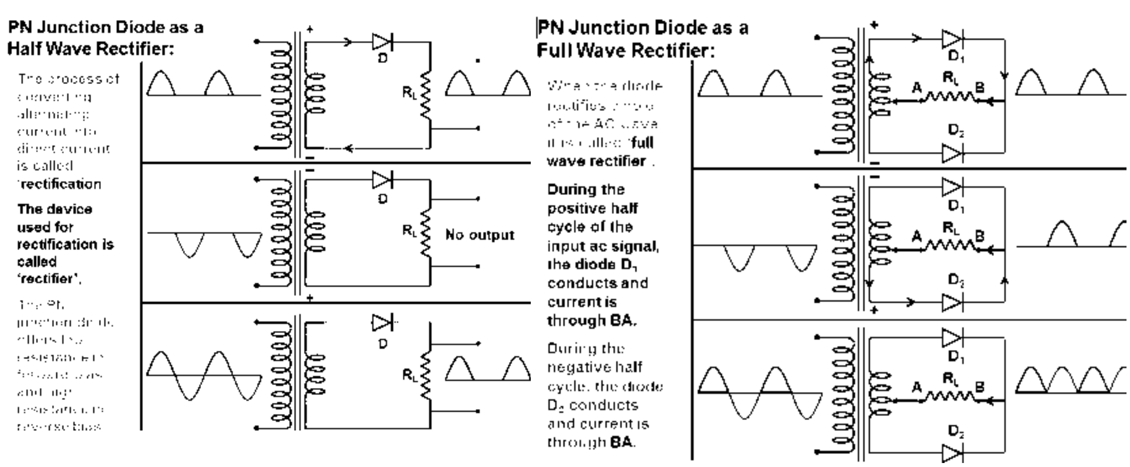
P-n junction in RB p-type connected to the –ve battery and n-type connected to +ve

Resistance of p-n junction is high to the flow of current.



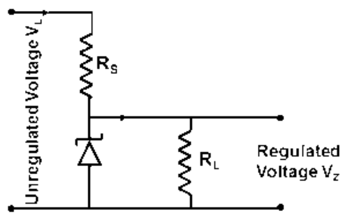


Rectification

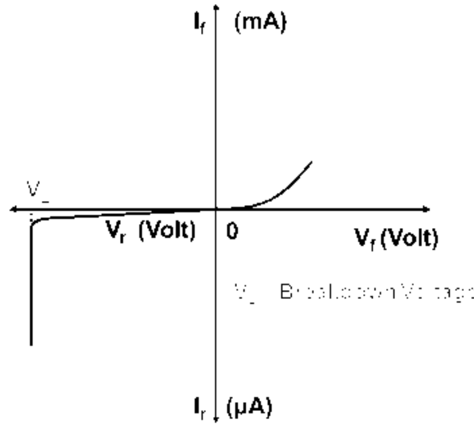


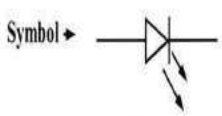
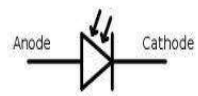
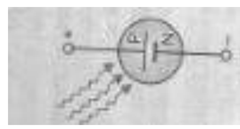
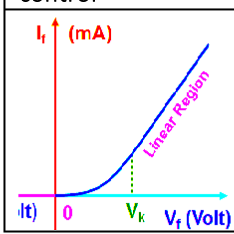
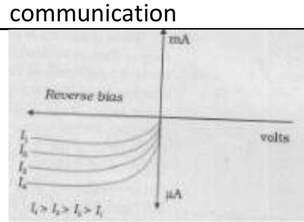
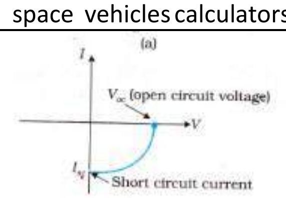
Zener Diode 

- 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

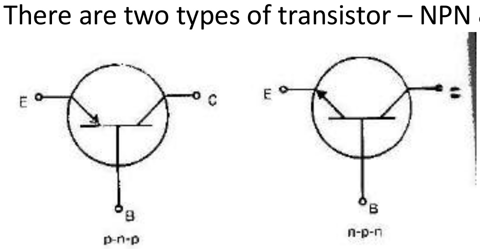


Zener Diode as a Voltage Regulator



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 vehicles calculators.
		

- There are two types of transistor – NPN & PNP



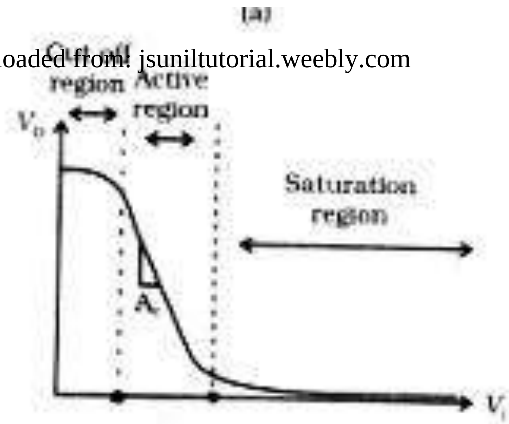
- Applications of transistor

(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 $\beta_{a.c} = \dfrac{\Delta I_C}{\Delta I_B}$

$\beta_{d.c} = \dfrac{I_C}{I_B}$

Voltage gain $A_v = \dfrac{V_o}{V_i} = -\beta_{ac} \times \dfrac{R_o}{R_i}$

Power gain $A_p = \dfrac{P_o}{P_i} = \beta_{ac} \times A_v$

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

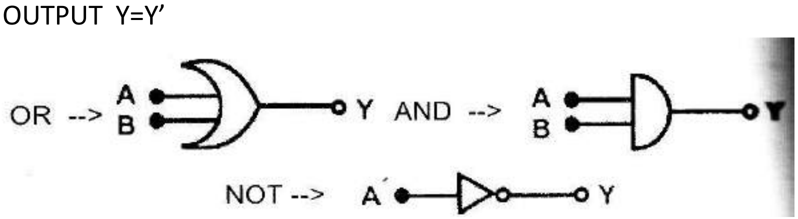
OUTPUT Y= A + B

(2) AND Gate

OUTPUT Y=A.B

(3) NOT GATE

OUTPUT Y=Y'

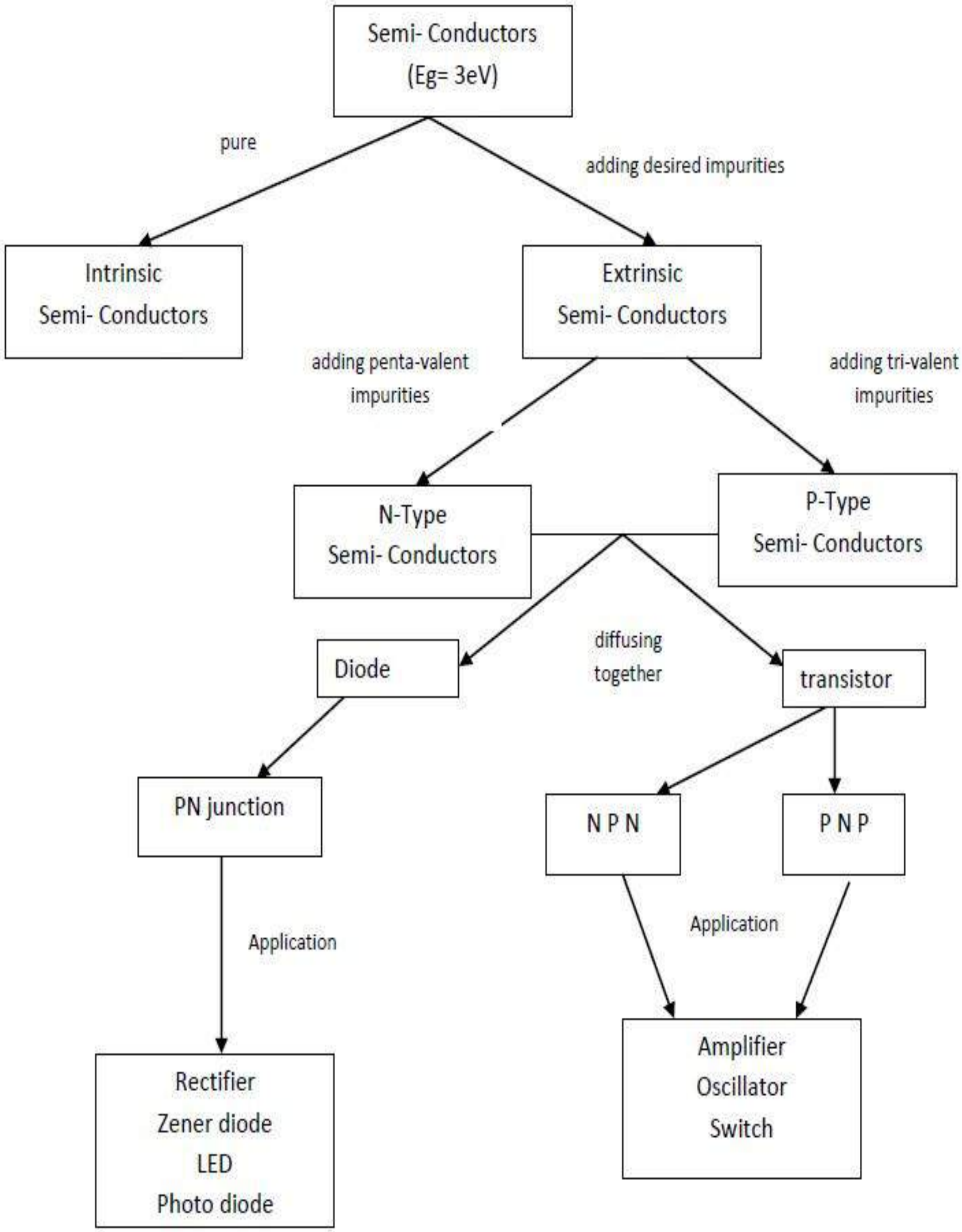


<u>**COMBINATION OF GATES**</u>

(1) **NOR GATE**--OUTPUT Y = $\overline{A+B}$

(2) **NAND GATE**--OUTPUT Y= $\overline{A.B}$

Semiconductor and electronic devices



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)

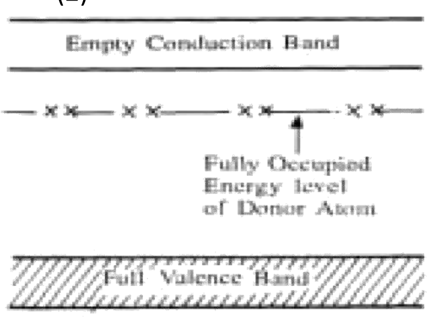
8. Energy gap of a conductor, semiconductor, insulator are E_1, E_2, E_3 respectively. Arrange them in increasing order. (1)

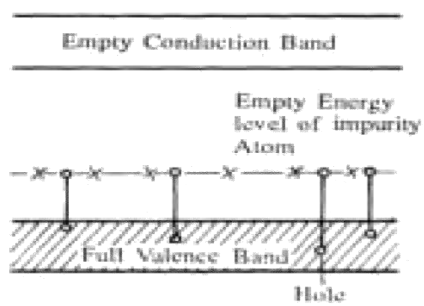
9. Name the factor that determines the element as a conductor or semiconductor? (1)

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)

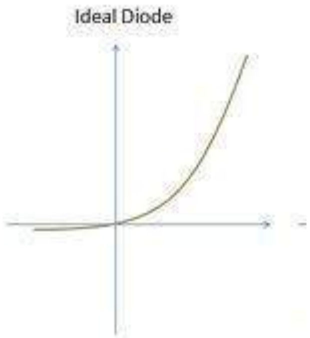
Ans: Monochromatic, Consume less power.

8. Draw a circuit diagram to show, how is a photo diode biased? (2)

9. Pure SI at 300K has equal electron and holes concentration 1.5 x 10^{16} per m^3. Doping by I n d i u m 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)

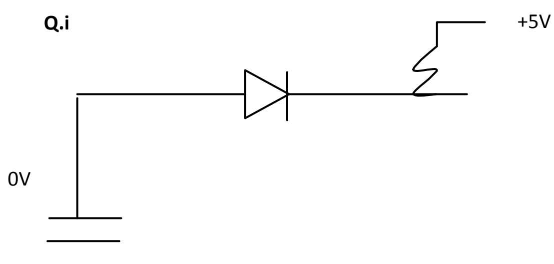
10. V-I characteristics of SI diode is given. Calculate diode resistance for bias voltage 2V. (2)

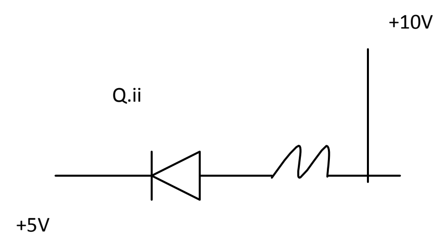


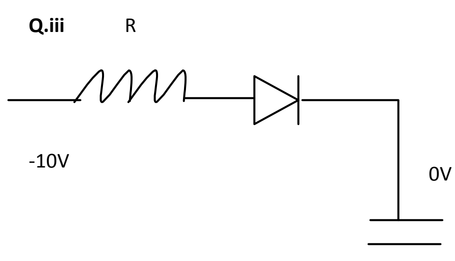
Ans: R = V / I = 2/70 x 10^3 Ohms

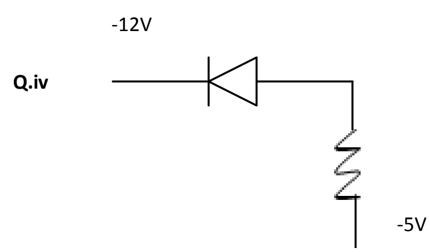
11. What is an ideal diode? Draw its output wave form.

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.

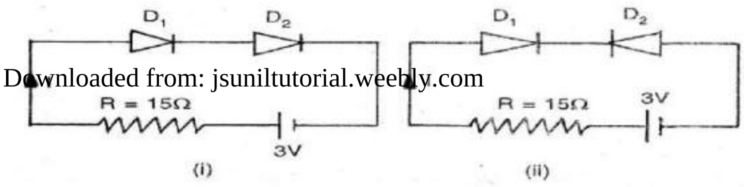
(ii) Calculate the new hole concentrations.

Ans:

(i) n-type semiconductor.

(ii) $n_e n_h = n_i^2 \Rightarrow n_h = \; = 4x10^4$ perm^2

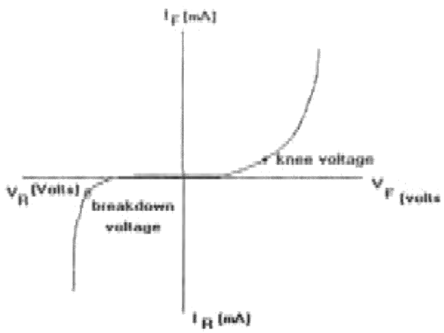
*15. Determine the current through resistance "R" in each circuit. Diodes D_1 and D_2 are identical and ideal. 2



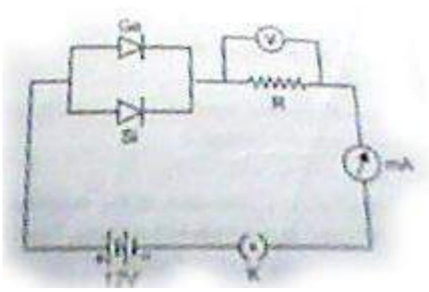
Ans: In circuit (i) Both D_1 and D_2 are forward biased hence both will conduct current and resistance of each diode is 0.Therefore, I = 3/15 = 0.2 A

(ii) Diode D_1 is forward bias and D_2 is reverse bias, therefore resistance of diode D_1 is 0 and resistance of D_2 is infinite. Hence D_1 will conduct and D_2 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 electric field 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 detect a wavelength of 600nm? Justify? (2)
Ans: Energy corresponding to wavelength 600 nm is

$$E = hc/\lambda = \frac{6.6 \times 10^{-34} \times 3\times10^{8}}{600\times10^{-9}} \text{ joule} = 0.2\text{eV}.$$

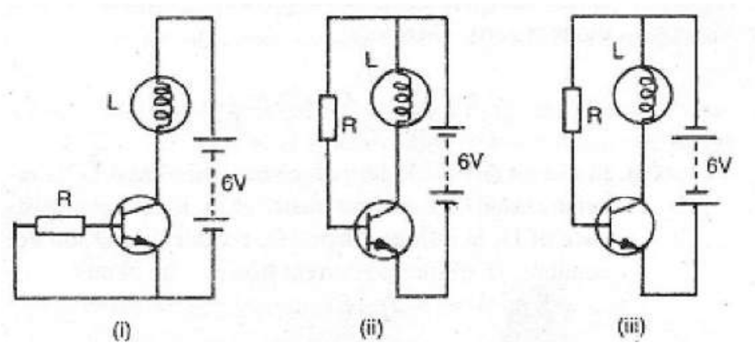
It cannot detect because $E < E_g$

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 reversed 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 = $(95 / 100)\ I_e$

$I_e = (100 / 95) \times 5\ mA = 5.26mA$,

$I_e = I_c + I_b$

$I_b = 0.25\ mA$

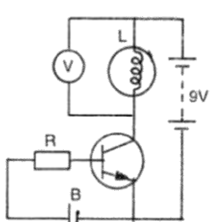
6. A student has to study the input and output characteristics of a n-p-n silicon transistor in the common emitter configuration. What kind of a circuit arrangement should she use for this purpose? Draw the typical shape of input characteristics likely to be obtained by that student.

(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 i.e. $r_o = 10^4 r_i$;

*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.

$I_b = 105 \times 10^{-6}$ A $\quad I_c = 2.05 \times 10^{-3}$ A

$\beta = I_c / I_b = 19.5$

Also,

$I_e = I_b + I_c = 2.155 \times 10^{-3}$ A

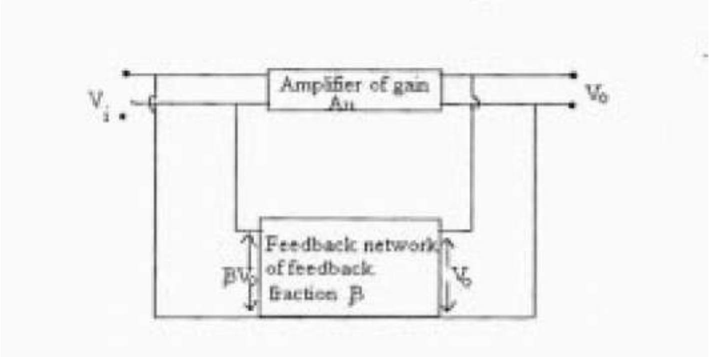
$\alpha = I_c / I_e = 0.95$

$\Delta I_b = 27\mu A = 27 \times 10^{-6}$ A

$\beta^{ac} = \Delta I_c / \Delta I_b = 24.1$

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)

Ans: $g_m = \beta / Rl$, $Av = \beta\, RL/Rl$

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)

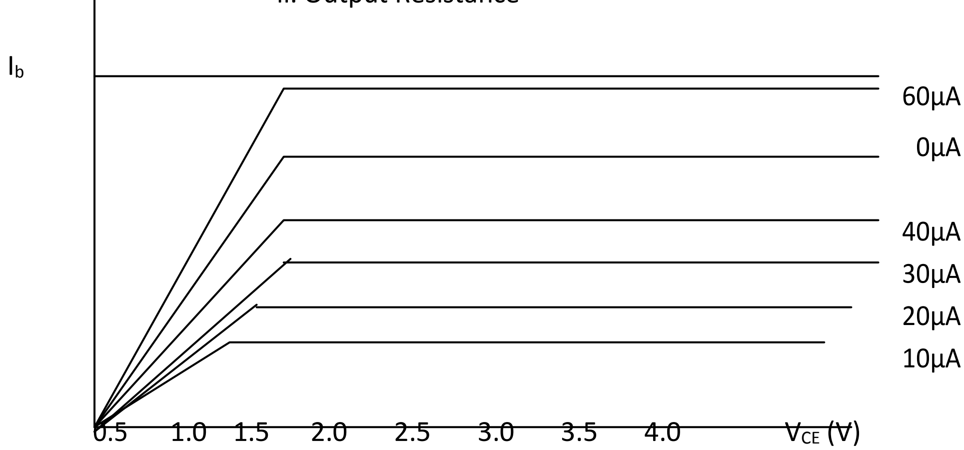
23. Explain with the help of a circuit diagram the working of N-P-N transistor as a common emitter amplifier. Draw input and output wave form. (3)

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

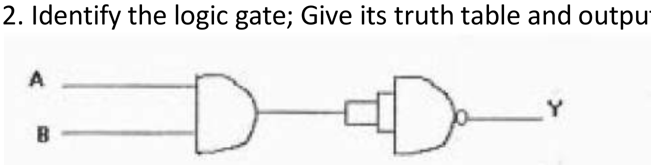


LOGIC GATES

*1. Modern technology use poly silicon instead of metal to form the gate. Why? (1)

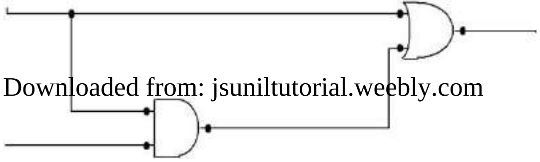
Ans: Poly silicon has high conductivity compared to metal.

2. Identify the logic gate; Give its truth table and output wave form? (1)



Ans: NAND GATE.

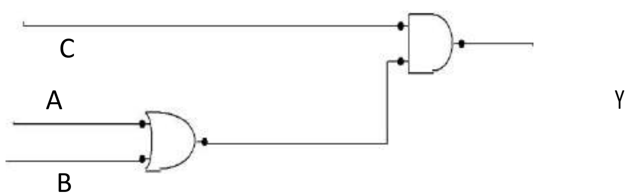
*3. Draw the logic circuit and the output wave form for given output Y=0, 0, 1, 1 (2)



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

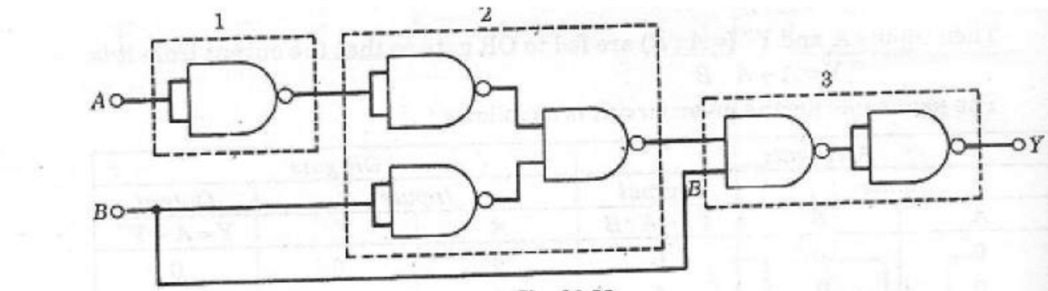
A	B	C	Y'=A+B	Y=(A+B).C=Y'.C
0	0	0	0	0
0	0	1	0	0
0	1	0	1	0
0	1	1	1	1
1	0	0	1	0
1	0	1	1	1
1	1	0	1	0
1	1	1	1	1

*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)

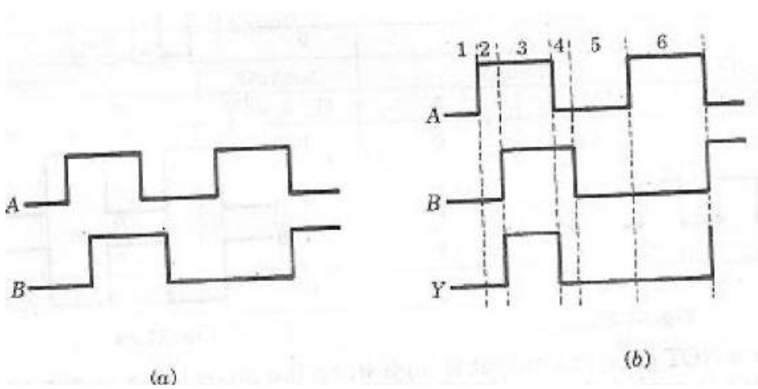


Ans: The dotted line box 1 represents a NOT gate. The dotted line box 2 represents an OR gate. Here we use de Morgan's theorem. The dotted line 3 represents AND gate.

7. Two input waveforms A and B shown in figure (a) and (b) are applied to an AND gate. Write the output (3)

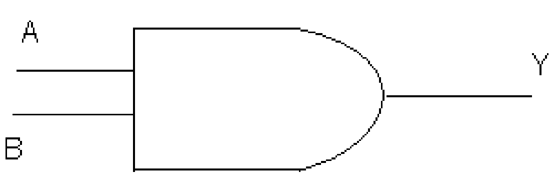
Time interval	1	2	3	4	5	6
Input A	0	1	1	0	0	1
Input B	0	0	1	1	0	0
Output Y = A.B	0	0	1	0	0	0

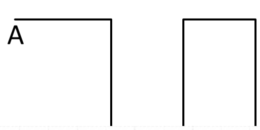
Input waveform.

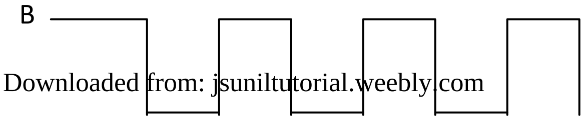


(a) (b)

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



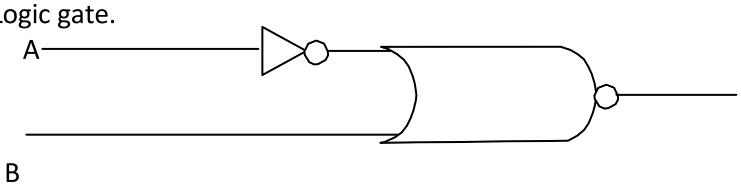




a. Name the logic gate
b. Give the output wave form (3)

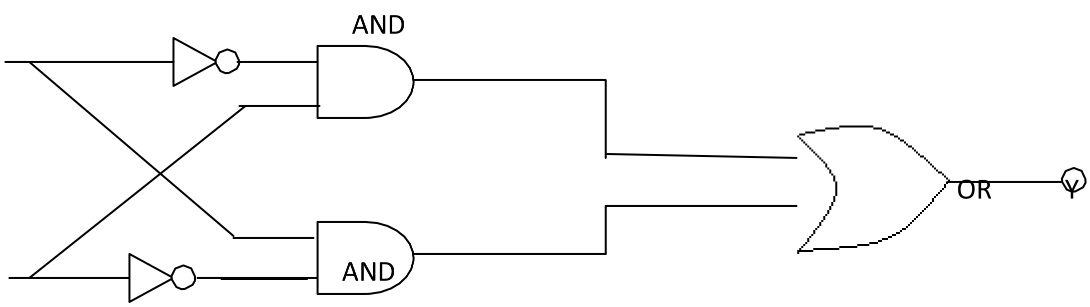
Ans: Current amplifier = **$\Delta Ic / \Delta Ib = 9.5 - 2.5 / 50 \times 10^{-6}$**

1. Identify the Logic gate.



Y = $\overline{\bar{A} + \mathbf{B}}$

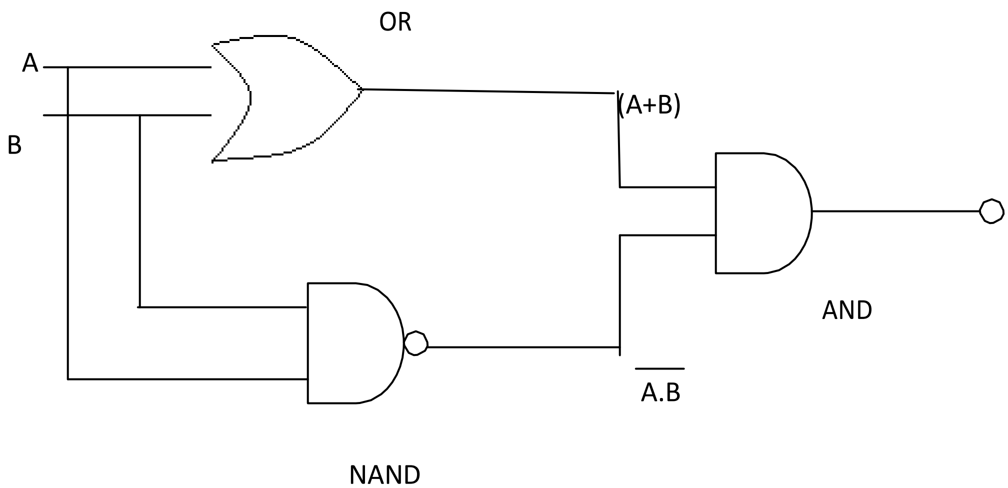
2. Draw the circuit of XOR gate.



A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

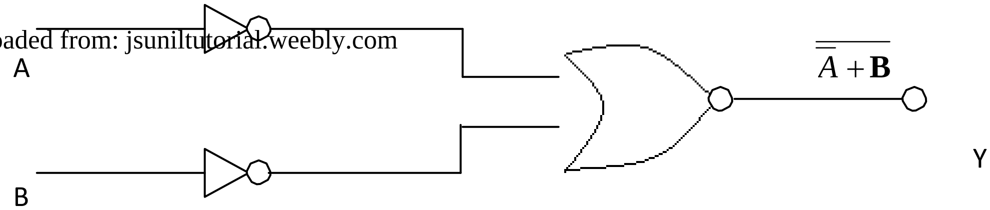
(3)

3. Identify the Logic gate



Ans: Y = (A+B) $\overline{AB}$

4. Identify the gate:



Ans: AND Gate

5. A and b wave form input given for NAND gate. Draw Output

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.

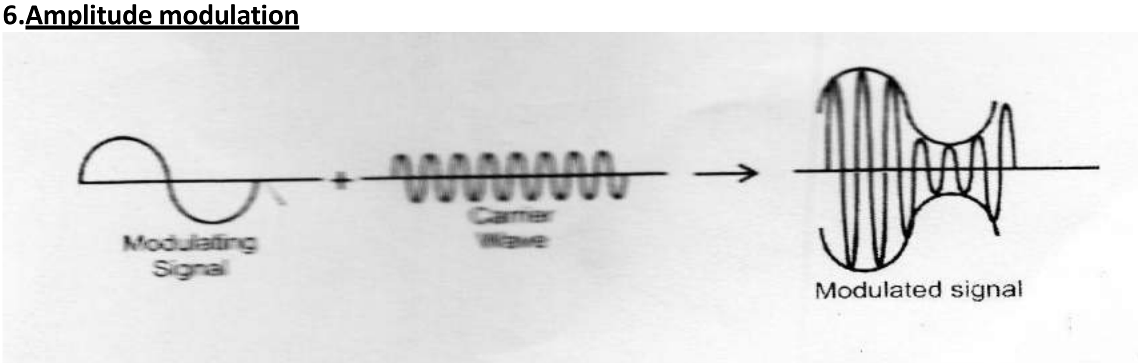
4. NEED FOR MODULATION:

* 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

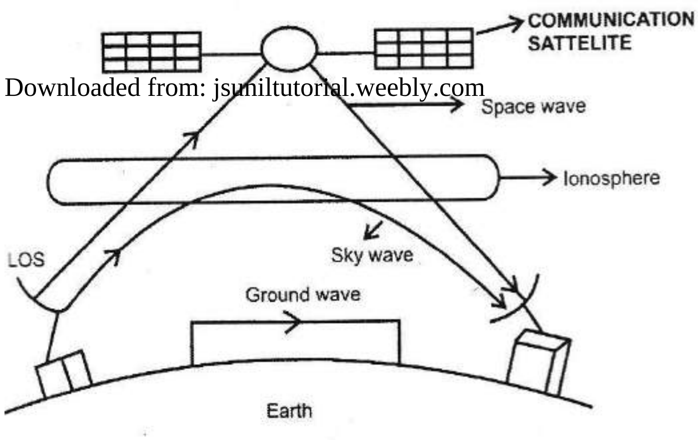
There are two broad types of modulation: (i) Continuous wave modulation
(ii) Pulse modulation.
1. Continuous wave modulation is of three types:
(i) Amplitude modulation (AM): In amplitude modulation, the amplitude of carrier wave varies in accordance with instantaneous voltage of information (or message) 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. <u>GROUND OR SURFACE WAVE PROPAGATION</u> 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. <u>SKY WAVE PROPAGATION</u> is a mode of wave propagation in which the radio wave 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. <u>SPACE WAVE PROPAGATION</u> higher than 30MHz is that mode of wave propagation in which the radio waves emitted from the transmitter antenna reach the receiving antenna through space. These radio waves 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. <u>COVERING RANGE OF T.V. TRANSMITTING TOWER</u> is $d=\sqrt{2R_e h}$, where 'h' is height of tower and R_e radius of earth. 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. <u>MAXIMUM USABLE FREQUENCY</u>

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. <u>SATELLITE COMMUNICATION</u>

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.

<u>II.**IMPORTANT FORMULAE**</u>

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 $\upsilon_{SB} = \upsilon_c \pm \upsilon_m$ where υ_m is frequency of modulating (audio) signal.

4. **Modulation index,** $m_a = E_m / E_c$

Modulation index, $m_a = E_{max} - E_{min} / E_{max} + E_{min}$

6. Coverage range (d) for a given height (h) of antenna d = √2hR where R = radius of earth.

d = √2Rh$_r$ + √2Rh$_R$, where h_T, h_R are the heights of transmitter and receiver antennas.

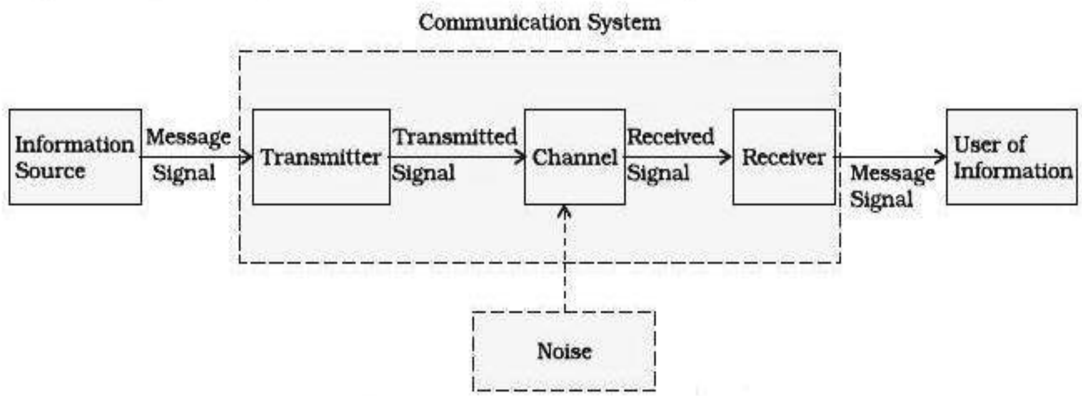
7. **Population covered = population density x area covered**.

8. **Number of channels,**

N = Total band width of channels / Band width per channel

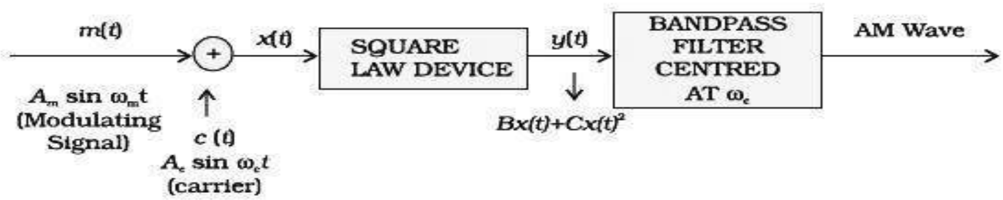
III. Communication System – Block Diagrams

1)

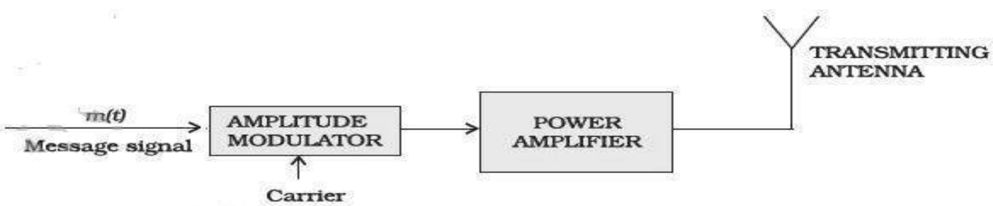


Block diagram of a generalised communication system.

2)



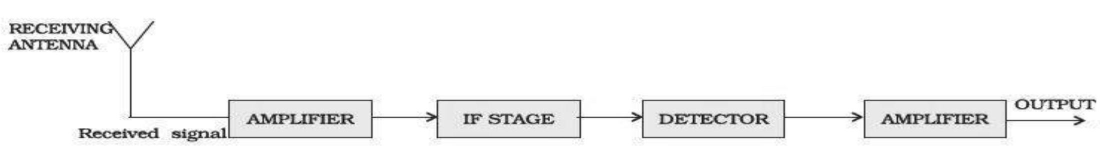
Block diagram of a simple modulator for obtaining an AM signal.



Block diagram of a transmitter.

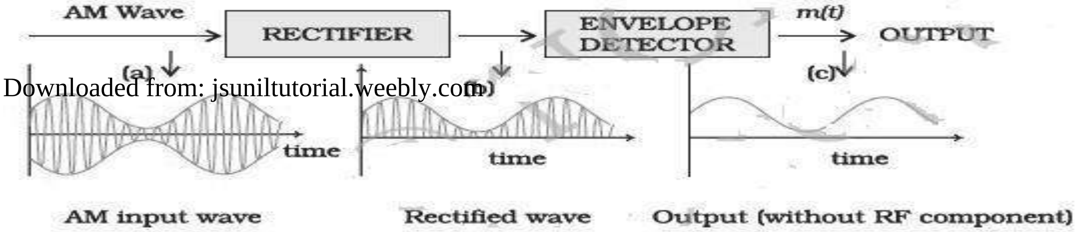
3)

4)



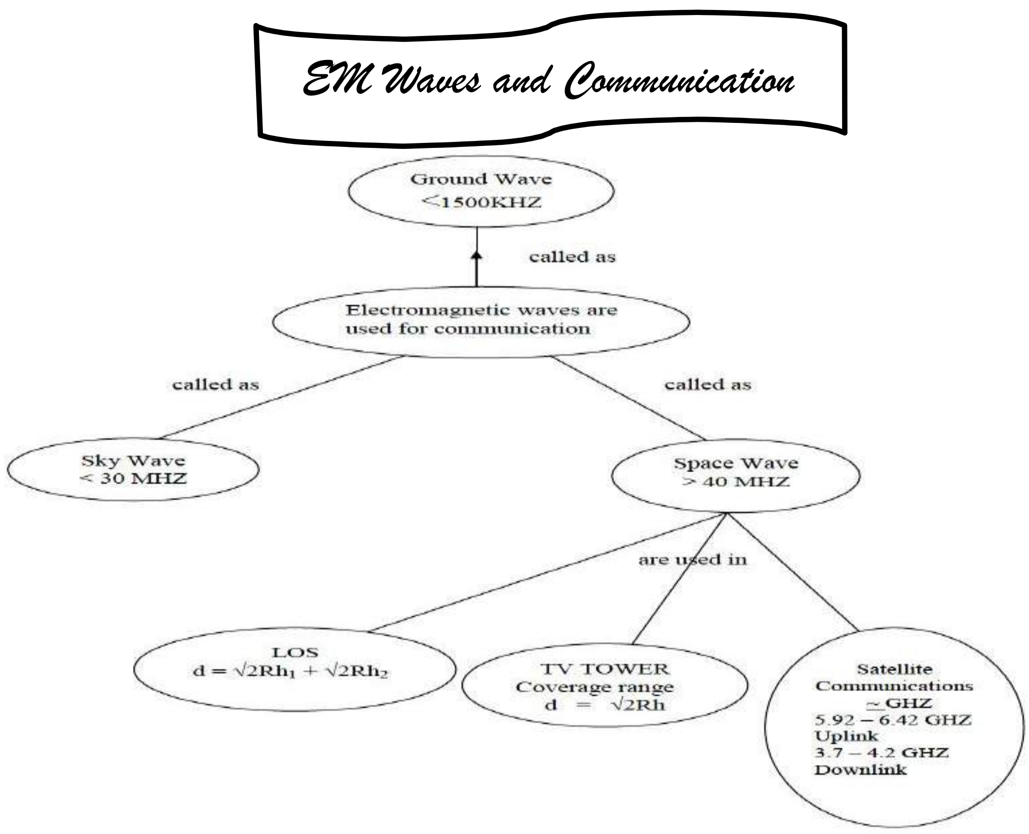
Block diagram of a receiver.

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 x 10^8 Hz? (1)

Ans: L = λ\2 = c\v x 2 = 3 x 10^8 / 5 x 10^8 x 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:

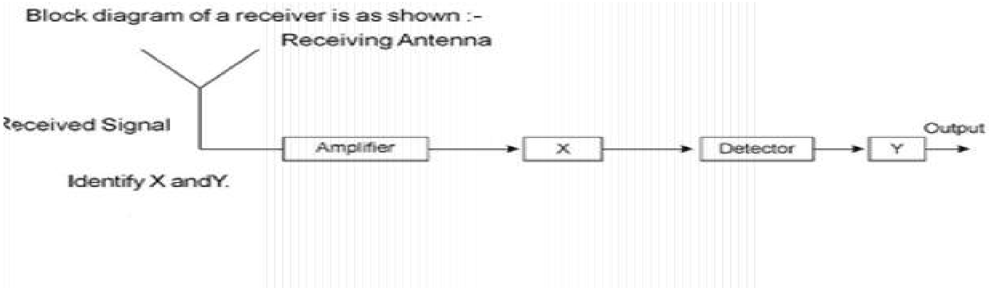
Two basic modes of transmission are (i) Point-to-point and (ii) broad cast mode.

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 whenever 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 $1200 km^{-2}$? (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 $1/2\pi f_c C << R \Rightarrow C >> 1/1.59 \times 10^{-9}$ fared or $C >> 1.59\ \mu F$.

Thus for proper detection the capacitance of output circuit must be much greater than 1.59 μF. 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 labeled diagram, describe its construction and working. How is the leakage of charge minimized 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

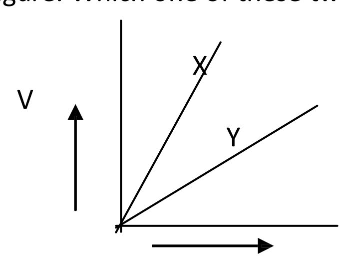
(I) potential difference between the plates
(II) electric field between the plates
(III) energy stored in the capacitor.

UNIT II

<u>CURRENT ELECTRICITY</u>

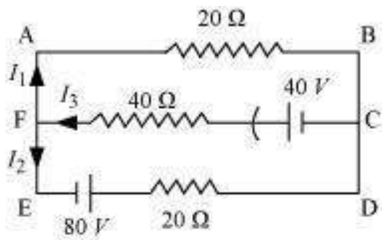
2 MARKS

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 (iii) 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 ionized 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?

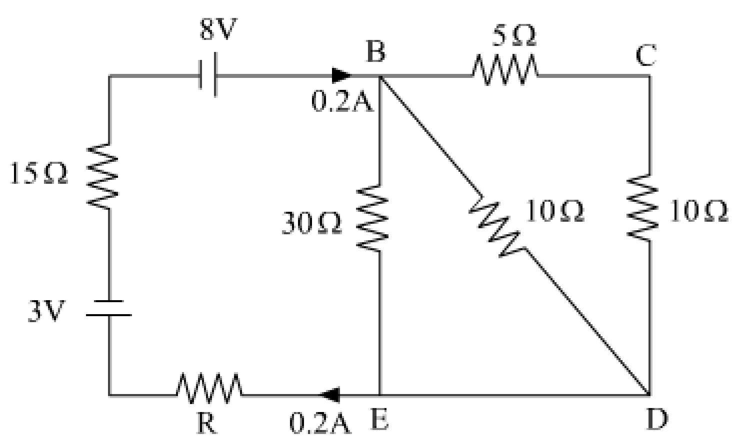


3 MARKS

14. Draw a circuit diagram using a meter 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 is charged by a dc 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 Kirchhoff's law.
19. State Kirchhoff's rules of current distribution in an electrical network.
    Using these rules determine the value of the current I_1 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 bending in the form of two loops. One of the loops is square shaped whereas 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) $-1 \geq Χ < 0$, and (b) $0 < Χ < έ$ [έ 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.

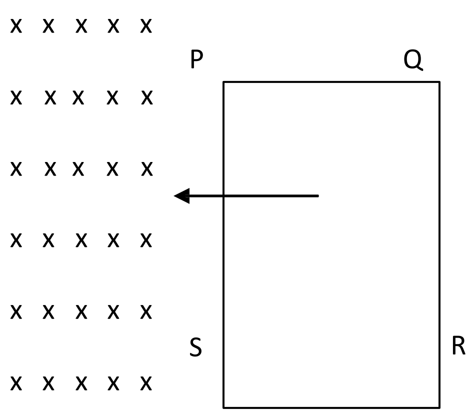
24. State Biot Savart's Law. Use this law to obtain a formula for magnetic field at the centre of a circular loop of radius R, number of turns N carrying current I. Sketch the magnetic field lines for a current loop clearly indicating the direction of the field.

25. Distinguish the magnetic properties of dia, para- and ferro-magnetic substances in terms of (i) susceptibility, (ii) magnetic permeability and (iii) coactivity. 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 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 $I = 10 \sin \omega t$?
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 ac 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 the applied 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 labeled 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 ac 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 radio wave 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? Draw diagram 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

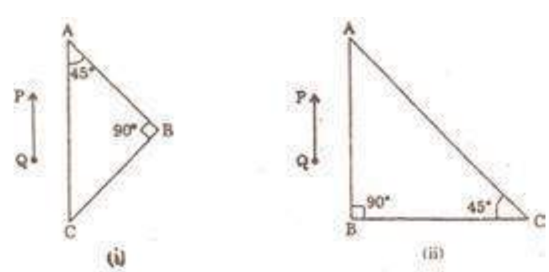
2 MARKS

1. What is the geometrical shape of the wave front 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 focused 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 labeled ray diagram showing the formation of image of a distant object using an astronomical telescope in the 'normal adjustment position'
10. Draw a labeled 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 labeled 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 interfaceof the two media. Show that the angle of incidence is equal to the angle of reflection.

20. Define the term 'wave front'. Draw the wave front and corresponding rays in the case of a (i) diverging spherical wave (ii) plane wave. Using Huygen's construction of a wave front, explain the refraction of a plane wave front 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 wave front? What is the geometrical shape of a wave front emerging from a convex lens when point source is placed at the focus?

28. What is wave front? Distinguish between a plane wave front and a spherical wave front. Explain with the help of a diagram, the refraction of a plane wave front 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.

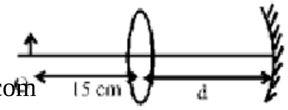
30. Distinguish between unpolarised and plane polarised light. An unpolarised light is incident on the boundary between two transparent media. State the condition when the reflected wave is totally plane polarised. Find out the expression for the angle of incidence in this case.

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.

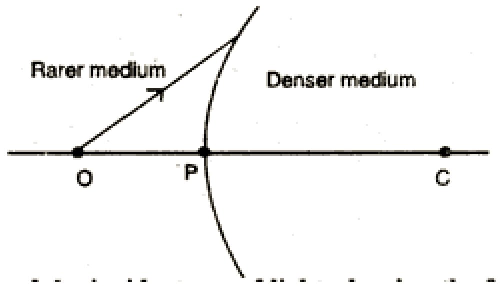
S. No.	1	2	3	4	5	6
Object distance (cm)	25	30	35	45	50	55
Image distance (cm)	97	6	37	35	32	30

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 index '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 wave front 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 wave front 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° to 90°. Show graphically the variation of intensity of light, transmitted by P_1 & P_2 as a function of the angle

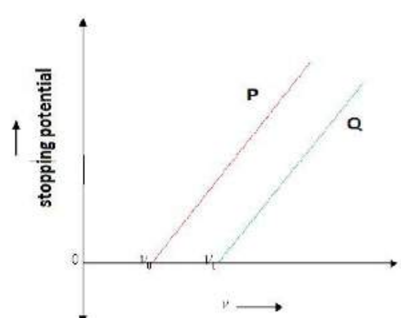
θ. Take the incident beam intensity a I_0. Why does the light from a clear blue portion of the sky, show a rise and fall of intensity when viewed through a Polaroid which is rotated?

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?

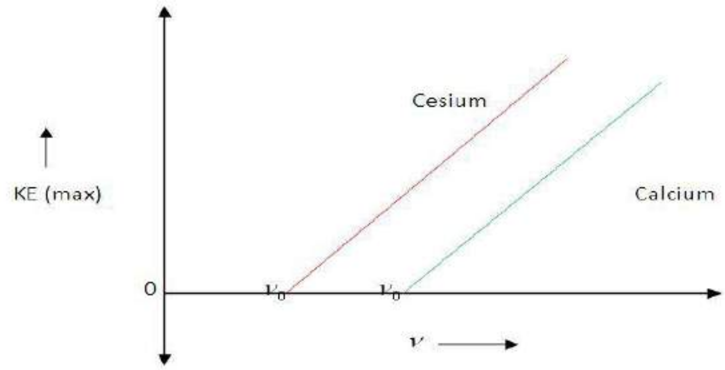


3 MARKS

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 particle 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.

CLASS XII PHYSICS VALUE BASED QUESTIONS

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COMMUNICATION SYSTEMS

1 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. Contextual: By how much should the height of the tower be increased? What values would you appreciate in Niharika?

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. Identify the solution for the problem? What values can we learn from those students?

3 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. What was the information given by group B and group C? What values do you observe in this class discussion?

COMMUNICATION SYSTEMS

1 One evening, Rahul was returning from the school on his bicycle. He saw an old man carrying groceries, walking very slowly. The old man appeared to be tired. Rahul thought for a moment and then dropped the old man home on his bicycle. The old man thanked Rahul.
(a)) What values are displayed by Rahul?
(b) How can the situation be compared with the process of modulation?

2 Ramya’s parents bought her a mobile phone as a reward for scoring good marks in the Board examination. Ramya, excited and unaware of the ill consequences of continuous usage of the mobile phone, was always engaged in talking with friends over the cell phone. When her mother observed the reckless usage of the cell phone by Ramya, She explained the ill effects of excessive usage of the mobile phone and convinced Ramya to limit the usage.
(a)) What values are displayed by Ramya’s mother?
(b) Name the electromagnetic waves used in mobile communication.
(c)) Are these waves transmitted as space waves or sky waves?

3 Aathira’s grandmother slipped in the wash room and developed inflammation in one foot. She was reluctant to go to hospital. Aathira,a nursing student convinced her grandmother and took her to hospital . The doctor took the MRI scan and diagnosed a fracture in the foot. The foot was plastered and the doctor advised the grandmother to take ample rest and the prescribed medicines regularly.
(1) What values are displayed by Aathira?
(2) Identify the electromagnetic waves used in MRI and mention its use in communication technology.
(3) Are these waves transmitted as sky waves or space waves, in the field of communication?

SEMICONDUCTORS AND DEVICES & DIGITAL CIRCUITS

1 Prakash and Rakesh, class 12 students, were fast friends. One day Prakash went to the house of Rakesh and found that he was going to connect his new T V set directly to the switch board. Prakash advised him not to do so because it could harm the T V set due to voltage fluctuations. What should I do? Rakesh asked. Prakash told him that he should connect the T V set through a voltage stabilizer. Rakesh accelerated the advice of his friend and thus saved his T V set from

possible damage.

I. What value did prakash exhibit in this situation?
II. Identify the diode used in voltage stabilizer and give its symbol.

2 The output of a rectifier is pulsating DC. The electronic devices will not function properly on such pulsating DC. These devices require steady or pure DC we use special circuits to convert pulsating DC into steady DC.

I. What type of circuit is used to convert pulsating DC into steady DC?
II. How does the working principle of this circuit allow you to overcome hurdles in your life?

3 Raman was doing social work during vacation. He visited a village and found that people did not know anything about telephone communication. He decided to educate the people about it. So he conducted awareness classes about the advantages and the applications of telephone communication.

I. State the values shown by Raman.
II. Mention the principle and working of telephone communication.

SEMICONDUCTORS AND DEVICES

Digital Circuits

1 Zener diode is a specially designed p-n junction diode, in which both p-side and n-side of p-n junction are heavily doped. The zener diode is designed especially to operate in the reverse break down voltage region continuously without being damaged? Zener diode is used to remove the fluctuation from the given voltage and thereby provides a voltage of constant magnitude (ie. Zener diode is used as voltage regulator).Read the above e paragraph and answer the following questions:

i) What is the most important use of zener diode?
ii) What are the essential conditions for proper working of zener diode?
iii) What do you learn from the above study?

2 Raghu was studying in a Science college and was staying with his grandfather. One day the old torch which was being used by Raghu's grandfather stopped working. He asked Rohan to purchase a new torch for him. Rohan himself made a torch using LED with a small recharge battery and gave it to his grandfather as a gift. Rohan explained the advantages of LED over a bulb. Raghu's grandfather was very happy.
Read the above passage and answer the following questions?

i) What is LED? Name the two materials used in making LED whose light falls in the visible region.
ii) Why LED is a better choice than a bulb in torch?
iii) What do you think about the attitude of Raghu towards his grandfather?

3 Shankari wanted to do social work during vacations. She visited a remote village where there was no electricity. She made up his mind to help the villagers for getting the solar panels. For this she educated the villagers about the technology and villagers to apply for the same to the villagers on subsidized rates. Villagers agreed and applied for the solar panels. They got the same from Government at reduced price. When the solar panels started working, the villagers were very happy. Read the above passage and answer the following questions.

i)What is a solar panel?
ii) What is the basic principle of working of a solar cell?
iii) What are the basic values you arise in Shankari?

DUAL NATURE OF MATTER AND RADIATION

1 Amit was very happy when he opened a new showroom of ladies suits in a posh colony. He tries to set a few trends e.g. latest verity, low margin of profit, good quality and fixed rates etc. He never knew that his shop is attracting thieves also. Within one month of opening the shop, his shop was wiped out by them and suffered a big loss. Your teacher has told you about photoelectric cells. What advice will you give to Amit and other to safeguard from such incidents to save the society.

2 Hitesh has a camera inherited from his father. This camera has manual settings. He has a Habit of clicking pictures of beautiful girls without seeking their permission. He requested his fast Friend Hemant to lend him his camera filled with photoelectric cell for automatic adjustment of camera so that he could click his picture quickly without being noticed by the girls or her relatives Hemant fully well knows about this habit of Hitesh. What do you think he should do?

3 Little Simi was very happy to see flood of white light coming from mercury lamp installed in her street. The yellow light from old ordinary filament lamp used to irritate her whenever she looked out of window. Mercury light was so soothing that she kept on looking at it for very long duration. Next day morning when she woke up, her eyes were paining. Her eyes were red and constantly watering. What happened to her eyes? You live in the same locality. What do you think you should do in this case?

WAVE OPTICS

Diffraction Resolving Power, Polarisation

1 On a trip to the cold tundra region, a group of friends find themselves stranded in the scorching bright sun. The match sticks they had brought with them had been spoiled by the ice. They were hungry but they could not cook as they could not light a fire although they had paper and dry wood. Just then Sita and her friends were passing by. Seeing the stranded group she thought of helping them. She cut a piece of ice and give it a convex shape .Staking the piece of paper and dry wood she allowed the ray of the sun to pass through the convex shaped ice. By adjusting the distance of the convex ice piece from the piece of paper she was able to light a fire. The group thanked her and relished the cooked food which they then made.

(a) How could sita light up a fire with the help of ice?

(b) What values do you attribute to Sita?

2 Suman and Arti are friends, both studying in class 12^{th} .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?

3 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.

What qualities do these girls possess?

What do you mean by Polarization?

Mention the other applications of polarization.

WAVE OPTICS

Wave theory and interference

1 1. A child is observing a thin film such as a layer of oil on water show beautiful colours when illuminated by while light. He feels happy and surprised to see this. His teacher explains him the reason behind it .The child then gives an example of spreading of kerosene oil on water to prevent malaria and dengue.

• What value was displayed by his teacher?

• Name the phenomenon involved?

2 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.

3 Two students were doing the polarisation of light activity using two Polaroids and found that when the axes of both Polaroids were parallel the intensity of emergent light was maximum .when they were about to find out the the intensity of emergent light when the axes of both were perpendicular one of the Polaroids fell down and broke .One student immediately went to inform it to the Physics teacher ,the other stopped him.
• Which value is displayed by the first student?
• What would be the expected result when the axes of both were perpendicular?

4 Rohan observed that thin films such as soap bubble a thin layer of oil on water show beautiful colours when illuminated by white light. He felt happy and surprised to see that. He went to his physics teacher to understand the reason behind it. The teacher explained him that a thin film of oil spread over water shows interference of light due to the interference between the light waves reflected by the lower and upper surfaces of the film on understanding this phenomena well, Rohan then gave an example of thin film of kerosene oil which is spread over water to prevent malaria and dengue.
(a) Why are the values being displayed by Rohan's teacher?

(b) Why does a soap bubble show beautiful colours?

5 Jivin observed that when a sheet of transparent plastic is placed between two crossed polarizers, no light is transmitted. When the sheet is stretched in one direction, some light passes through the crossed polar risers. He was surprised to see that and out of shear enthusiasm, he went to his physics teacher for knowing the reason behind it. The teacher explained him that the stretched plastic sheet turns into a Polaroid and allows fraction of light pass through it.
(a)) What are the values being displayed by Jivin here?
(b) When the plastic sheet is stretched in one direction, some light passes through the crossed polarizers. What is happening?

6 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

RAY OPTICS

Prism, Scattering, Optical instruments

1 Q1) Rama was watching a programme on Moon on the discovery Channel. He came to know from the observation recorded on the surface of the moon that sunrise and sunset are abrupt there and sky appears dark from there he was surprised and determined to know the reason behind it. He discussed it with his physics teacher next day who explained him the reason behind it.

a) What are the values being displayed by Rama
b) Why are sunrise and sunset abrupt on the surface of the moon

Why does the sky appear dark from the moon

2 Amit's uncle was finding great difficulty in reading a book placed at a normal place. He was not going to the doctor because he could not afford the cost. When Amit came to know of it he took his uncle to the doctor .After thoroughly checking his eyes the doctor prescribed the proper lenses for him. Amit bought the spectacles for this uncle from his pocket money By using spectacles he could now read with great ease. For this he expressed his gratitude to his nephew.

Based on the above paragraph answer the following

1) Why does the least distance of distinct vision increases with age

2) What type of lens is required to correct this defect

What are the values displaced by Amit towards his uncle

3 Satish was seeing a person wearing a shirt with a pattern comprising of vertical lines and horizontal lines. He was able to see the vertical lines more clearly than the horizontal lines he shared his problem with his friend Ramesh. Ramesh suggested him to get his eyes checked up by a doctor immediately

What value is being displaced by Ramesh here

What is this defect due to

How is such a defect of vision corrected

RAY OPTICS

Mirrors, Refraction, Lenses & Combination Lenses and Mirrors

1 A child is observing a thin film such as a layer of oil on water show beautiful colours when illuminated by while light. He feels happy and surprised to see this. His teacher explains him the reason behind it .The child then gives an example of spreading of kerosene oil on water to prevent malaria and dengue.

- What value was displayed by his teacher?
- Name the phenomenon involved ?

2 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.

3 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.

ALTERNATING CURRENT

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1 Mr. Sanjeev, a physics teacher, was doing an experiment in lab using dry cell battery. The dry cell was weak, giving less voltage, which was not sufficient to give proper reading. One of the student asked, "Sir, can't we step-up the voltage using a transformer?" Teacher replied, No, we cannot step up DC voltage using step-up transformer and explained the reason and working of a transformer .the student then constructed a transformer for his Physics project and studied the factors responsible for losses in a transformer.

- What values are displayed by the student
- Why transformer cannot be used to step-up DC voltage

2 Rahul after having lived in US for 12years returned back to India. He had a discussion with his cousin Sumit on domestic power supply in US and in India. In US domestic power supply is at

110v, 50Hz, whereas in India it is 220V, 50Hz. Rahul was stressing that US supply is better than Indian supply. Both went to Sumit's father an electrical Engineer and asked his opinion on the issue. He explained that both the supplies have advantages as well as disadvantages.

• What values are used by Rahul and Sumit?

• Write one advantage and one disadvantage of 220V supply over 110V supply

3 One Sunday Rahul and Rama were enjoying with their friends at home. Suddenly their ceiling fan stopped working. Out of shear enthusiasm Rahul first switched off the power supply of the fan and opened the cap of the fan to check the problem. Vipin tried to stop him but he did not listen. The moment he touched the interior part of the fan, he fell down because of electric shock. All friends were scared as to what has happened as the power supply was already switched off.

i)What negative trait do you think has been displayed by Rahul?

ii) What could be the possible cause of electric shock?

iii) Write expression of current and emf of the component used in fan with phase difference.

ELECTRO MAGNETIC INDUCTION.

Faradays Laws, Motional emf, Eddy Current, Self & Mutual Induction.

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1 Sanju a class IX student was doing an experiment at home using dry cells. The dry cells were weak, giving less voltage, which was not sufficient to run a toy car. He tried to step up the voltage using a transformer but failed. He went and asked his brother Shaji of class XII the reasons. He explained the reason to his brother.

a) What are the values displayed by Shaji?

b) Why a transformer cannot be used to step up the output of a battery?

2 Muthu's father purchased a new bicycle for him. He enjoyed by seeing the light from the dynamo in the bicycle. He stopped the bicycle and searched for a switch. He asked his father why he could not switch on the light when the bicycle is at rest. His father explained the working of the dynamo.

a).What are the values displayed by Muthu's father?

b). Kamla peddles a stationary bicycle the pedals of the bicycle are attached to a 100 turn coil of area 0.10 m2. The coil rotates at half a revolution per second and it is placed in a uniform magnetic field of 0.01T perpendicular to the axis of rotation of the coil. What is the maximum voltage generated in the coil?

3 Kumar while travelling in a bike with his uncle observed a meter which shows the speed. He asked his uncle how it works. His uncle being a physics graduate explained the working of it.

a) What are the values shown by Kumar and his uncle?

b) What are eddy currents?

ELECTRO MAGNETIC INDUCTION.

Faradays Laws, Motional emf, Eddy Current, Self & Mutual Induction.

1 The number of electrical generators used in areas where small workshops existed created lot of pollution. Rishab and his five friends did a survey and realized that like in multi-storeyed apartments, a common generator could be set up for all these small workshops so that the noise and air pollution could be reduced considerably. They had a tough time convincing the local bodies and now they are going to the NGOs and some financiers to help them organize funds to do the needful. It is admirable to see their perseverance.

a. What values did Rishab and his friends have?

b. Kamla pedals a stationary bicycle, the pedals of which are attached to a 100 turn coil of area 0.10 sq meters. The coil rotates at half a revolution per second and is placed in a uniform magnetic field of 0.01 Tesla perpendiculars to the axis of rotation of the coil. What is the maximum voltage generated in the coil?

2 Pooja went to the market with her mother and decided to come back home by metro. At Metro station they were made to pass through a gate way for security check. Pooja passed through it and was waiting for her mother to come. She heard a long beep when her mother passed through metal detector. Pooja was confused why metal detector beeped in case of her mother. She asked the duty staff, who explained her in detail. Both were satisfied with the security system.

a. What values are displayed by Pooja ?
b. What is cause of sound through metal detector Write the Principle on which a Metal detector works?

3 Mr. Sanjeev, a physics teacher, was doing an experiment in lab using dry cell battery. The dry cell was weak, giving less voltage, which was not sufficient to give proper reading. One of the student asked, "Sir, can't we step-up the voltage using a transformer?" Teacher replied, No, we cannot step up DC voltage using step-up transformer and explained the reason and working of a transformer .the student then constructed a transformer for his Physics project and studied the factors responsible for losses in a transformer.

a. What values are displayed by the student
b. Why transformer cannot be used to step-up DC voltage

MAGNETIC EFFECT OF CURRENT & MAGNETISM

Current Loop as a Dipole & Magnetism.

1 Mr. Narasimhan 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 who felt better.

1. What two values did Avinash exhibit towards his grandfather? Mention any two
2. What is the SI unit of magnetic induction and define it?

2 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. Mr. Santosh, their physics teacher, corrected the mistakes. He also suggested few books which could be of use to them.

1. What values did Mr. Santosh exhibit towards his students?

3 Ms. Lavanya 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 attach the cancerous tissues and destroy them.

MAGNETIC EFFECT OF CURRENT

Biot Savart's Law, Amperes Circuital Law and Applications , Force on a moving Charge & Cyclotron

1 Isabella used an induction stove and explains to her neighbor that due to shortage of LPG one must utilize other sources that are available to produce heat energy; being a Physics teacher Isabella, explains that the Oil companies are trying their best to meet the demands for LPG and that as a good citizen one must use other sources wherever feasible. Isabella uses an induction stove having a value of 7H inductor and the flow of current is from 10A to 7A in 9×10^{-2} seconds.

a) In the above, what is the quality you find in the Physics teacher?
b) Calculate the emf generated in the above?

2 Imran on entering the airport was asked to remove the contents from his pant and shirt pockets;

his hand bags and luggage were also checked by airport authorities by using a metal detector. Imran got annoyed and argued with the airport authority as to the reasons for such procedure. The authority tells him that all the passengers and their belongings will be checked for security check to ensure safe travel.

a) What is the value that imparts us in the above scenario?

b) Briefly explain the working principle of a metal detector.

3 Suhasini's uncle was advised by his doctor to have an MRI scan of his chest. Her uncle did not know much about the details and significance of this test. He also felt that it was too expensive and thought of postponing it. When Suhasini learnt about her uncle's problems, she immediately decided to do something about it. She took the help of her family, friends and neighbors and arranged for the cost of the test. She also told her uncle that an MRI (Magnetic Resonance Imaging) scan of his chest would enable the doctors to know of the condition of his heart and lungs without causing any (test related) harm to him. This test was expensive because of its set up that needed strong magnetic fields (0.5 T to 3T) and pulses of radio wave energy. Her uncle was convinced and had the required MRI scan of his chest done. The resulting information greatly helped his doctors to treat him well.

(a) What according to you, are the values displayed by Suhasini and her family, friends and neighbors to help her uncle?

(b) Assuming that the MRI scan of her uncle's chest was done by using a magnetic field of 1.0 T, find the maximum and minimum values of force that this magnetic field could exert on a proton (charge = 1.6×10^{-19}) that was moving with a speed of 10^4 m/s. State the condition under which the force has its minimum value.

MAGNETIC EFFECT OF CURRENT

Force on current elements, Torque on loops, MCG and Conversion of MCG in to Ammeter & Voltmeter -

1 While watching Discovery Channel. Sheela was impressed that certain organisms have the ability to sense the field lines of earth's magnetic field. They use this ability to travel from one location to another. Sheela wanted to find the angle of dip at her place. She got a magnetic compass, using which she found the magnetic meridian. She then mounted the compass on a cardboard and placed it vertically along the magnetic meridian. She was able to measure the angle of dip.

• What values did Sheela have?

• Define the magnetic elements of the earth.

2 Shama, a science student, while studying, was impressed that the nervous system in animals depends on the electrical signals to work. Neurons pass on signals from sense organs to the brain. The passage of an electrical signal constitutes an electric current. Shama was curious to know the range of currents in different situations. She found that current in domestic appliances is a few amperes. During lightning, the electric current is in tens of thousands of amperes, while in the nervous system, it is only a few microamperes. She further discussed with her teacher about the magnitude of the magnetic field created by these currents.

• What values did Shama have?

• A galvanometer coil has a resistance of 15 ohms and the meter shows full scale deflection for a current of 4 milliampere. How will you convert the meter into an ammeter of range 0 to 6 amperes?

3 Alka and her sister were watching a movie in which the phenomena of aurora boriolis wa shown. Alka could not believe her eyes that such a colorful display like the one durin commonwealth games could be created by nature. She went to the library, but could not find th right book. So she consulted her teacher who guided her. Hence, Alka understood that during

solar flare, a large number of electrons and protons are ejected from the sun. Some of these ge trapped in the earth's magnetic field and move in a helical path along the field lines. As th density of the field lines increases near the poles, these particles collide with atoms an molecules of the atmosphere emitting green and pink light. Alka shared this knowledge with he class when they studied the chapter of moving charges in magnetic field.

- What values did Alka have?
- What is the radius of the path of an electron moving at a speed of 3×10^7 m / sec in a magnetic field of 6 Gauss perpendicular to it? What is its frequency? Calculate its energy in kilo electron volt.

CURRENT ELECTRICITY

Kirchhoff's Laws, Meter Bridge & Potentiometer

1 Sarala 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 Sarala. Manasa increased the voltage of the eliminator (by turning the knob) supplying current to the potentiometer. Sarala tried the experiment again and got the readings. She thanked Manasa for her help.

(a) What are the values displayed by both Sarala and Manasa?

(b) State one reason why the galvanometer showed same side deflection.

(c) Distinguish between emf and terminal PD.

2 Based on the previous knowledge learnt in the class, two students of class XII(A and B) were asked to conduct an experiment in the laboratory using a meter bridge-one is made of Nichrome and the other one is made of Copper, of same length and same diameter of constant potential difference. The student A could not give explanation for not achieving the result whereas student B, could get the result and was also able to explain.

a) What made student B to perform successfully?

b) Give the formula to calculate the rate of heat production.

3 While performing an experiment on determination of unknown resistance using a meter bridge, Rahul obtained deflection in the galvanometer in the same direction even after repeated adjustments in the circuit and thus could not get any results. In order to avoid getting noticed and scolded by the teacher, he pretended having performed the experiment and copied the readings obtained by another student.

Answer the following questions based on above information:

a. Write the possible reasons for getting the deflection in the galvanometer in the same direction.

b. Which two values is Rahul violating in copying the readings from another student?

CURRENT ELECTRICITY

Up to Kirchhoff's Laws

1 Sarita, a house wife had been using in her house an inverter and a lead acid battery set for the last two years. Suddenly she felt the problem of low voltage and less back up from inverter. Instead of calling electrician she tried to set it right her in checking. She noted that the level of

electro style was less than required in the battery. She was having acid for cleaning, fleshing her house. She poured that acid in the battery to raise the electrolyte to required level. After doing so she noted that the battery was permanently damaged.

Read the above passage and answer the following questions

1. What wrong was done by Sarita?
2. What was the right way for Sarita to get of the problem?
3. What do you learn from the above study?

2 The resistivity of a conductor is given by = R.A / l where R is resistance of the conductor of 'l' (length) and area of cross section A the resistivity of conductor is independent of the dimension of the conductor. It depends on the nature of material and temperature of the conductor.

Read the above paragraph and answer the following questions

i. For which material is resistivity a. zero ,b. infinity
ii. Find the resistance of a hollow cylindrical pipe of length l = 1m and radii are 10 cm and 20 cm of inner and outer of cylinder respectively. The resistivity of material of pipe is $2x10^{-8}$
iii. How is the knowledge of resistivity useful in our daily life?

3 As is known, rubber, wood are insulating there are no free electrons or charge carriers in them. Therefore current cannot flow through them. On the other hand human body can be fatal. A current of 10ma or more will flow only through the body if the circuit is completed. Read the above passage and answer the following questions carefully.

1. How can one repair on live line wires.
2. Why is current of 10 mA or more are passing through human body fatal?
3. What is practical utility of this study?

CURRENT ELECTRICITY
Kirchhoff's Laws, Meter Bridge & Potentiometer

1 Based on the previous knowledge learnt in the class, two students of class XII (A and B) were asked to conduct an experiment in the laboratory using a meter bridge-one is made of Nichrome and the other one is made of Copper, of same length and same diameter of constant potential difference. The student A could not give explanation for not achieving the result whereas student B could get the result and was also able to explain. **(a)**What made student B to perform successfully? **(b)**Give the formula to calculate the rate of heat production.

2 Two students of Kendriya Vidyalaya were doing an experiment using potentiometer to compare the emfs of two cells. They found that when the jockey is moved from the end A to end B of the potentiometer wire show deflection in the galvanometer remains in the same direction. Seeing that another student Deepu came to their help and told them about their mistakes by recalling what the teacher told them during the demonstration class. (i)What is the value shown by Deepu according to your view? (ii)What may be the two mistakes made by these students? (iii)Write the formula used for determining the emf of a cell.

3 Neha's teacher in the class made the comment that potentiometer was a better device than a voltmeter to find potential difference. She could not understand the concept, so she went to her school library to consult some reference books. She found that infinite resistance in series is the ideal condition for p.d determination. She was now satisfied with the concept. (a) What values are exhibited by Neha? (b) How could she understand that potentiometer is a better device than a voltmeter? Explain.

4 Kishore was referring to some old book in his library on current electricity. He found out that an apparatus called Post Office Box was used earlier to find the exact location of the faulted telegraphic line in those days. On-going into further details, he found that such an experiment is

done in class XII in his lab also.(a)What are the values shown by Kishore? (b) Name the similar experiment done in class XII and give its principle.

ELECTROSTATICS
Potential, Potential energy & Capacitors

1 In Akash 's class room the fan above the teacher was running very slowly .Due to which his teacher was sweating and was restless and tired. All his class mates wanted to rectify this they called for an electrician who came and changed the capacitor only after which the fan started running fast.

2 Munish did not have any practical training of electricity repair but he always tries to carry out electricity repair with great enthusiasm. One day the seiling fan was not working. Munish immediately declared the condenser used in the fan has a problem. So he decided to check the condenser but his elder brother Neeraj stopped him from touching the condenser. Neeraj told him to wait for at least one hour after the fan is switched off. Munish argued that the fan is not working and therefore switching off has no meaning. Neeraj insisted that he would not touch the condenser immediately after switching of the fan. Munish reluctantly agreed.
a) What according to you are the values displaced by Neeraj
b) Why Neeraj stopped Munish from touching the condenser?

3 Ragav is 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 Ragav and the Authorities
b) What is the danger that could happen to the innocent birds in Ragav's view?

ELECTROSTATICS
Charge, Field, Dipole & Gauss Theorem

1 Two persons are standing under a tree and another person near them is inside a car. They were arguing about going out for a movie or to the beach, when, a lightning struck the tree with some force. The person inside the car notices his friends standing under the tree are affected by lightning; he comes out and takes them to the nearby hospital.
a) Why the person in the car was not affected by lightning? What quality do you find in the person inside the car?
b) Explain the process that takes place during lightning.

2 During an endoscopic surgery, a surgeon sees the interior of the patient's body on the viewing screen of a video monitor. The surgeon continues to do the surgery with the help of other medical staff and one of the medical staff on noticing the surgeon's gloved fingers coming within a few centimeters of a screen, pointing to a particular part of the image, say, in explaining a surgical concern to other medical staff, the gloves is contaminated. When one of the medical staff asks the surgeon that whether his gloves would have been contaminated, the surgeon, answers him later, after the completion of the operation.
a) What is learnt from the above?
b) Can you find the bacterial source? If yes, name it. AND Name the force which plays a role in bacterial contamination.

3 ‘A’ & ‘B’ are two students in a class who have been assigned to organize a Republic Day function. They have also been instructed to invite personally more than 60 members from all the nearby cultural organizations and VIPs in their area. While student ‘A’ arranged invitations using a photocopier/fax, student ‘B’ arranges invitations by writing to them individually.

a) Which student’s method would you adopt and why? AND

b) State the principle behind the source used by student ‘A’.

Kendriya Vidyalaya Sangathan, Patna Region

Sample paper-1

Class XII- Physics

General Instructions

a. *All questions are compulsory*
b. *Internal choices have been provided in some questions. You have to attend only one of the choices in such question.*
c. *Question numbers 1 to 8 are very short answer questions carrying one mark each.*
d. *Question numbers 9 to 18 are short answer questions carrying two marks each.*
e. *Question numbers 19 to 27 are also very short answers questions carrying three mark each.*
f. *Question numbers 28 to 30 are long answer type question carrying 5 marks each*
g. *Use log tables if necessary.*

1. In which orientation, a dipole placed in uniform field is in (i) Stable (ii) Unstable equilibrium? 1
2. Two different wires X and Y of same diameter but different materials are joined in series across a battery. If the number density of electrons in X is twice that in 'Y' . Find the ratio of drift velocity of electrons in two wires. 1
3. What is the magnetic moment of an electron orbiting in a circular orbit of radius 'r' with a speed 'V'? 1
4. Name the part of electromagnetic spectrum whose wavelength lies in the range of 10^{-10}m . Give one of its use. 1
5. Red light is incident on a converging lens of focal length 'f' . State with reason how 'f' will change if red light is replaced by blue light. 1
6. How does the resolving power of telescope change when the aperture of the objective is increased? 1
7. The stopping potential in an experiment on photo electric effect is 1.5V . What is the maximum kinetic energy of the photoelectrons emitted? 1
8. Two nuclei have mass numbers in the ratio 1:8 , what is the ratio of their nuclei radii? 1
9. Define electric flux. Write its SI unit. A charge q is enclosed by a spherical surface of radius R. If the radius is reduced to half, how would the electric flux through the surface change? 2

10. A infinite thin plane sheet of charge density 10^{-8} cm^{-2} is held in air. How far apart are two equipotential surfaces, whose potential difference is 5volt. 2

11. Give the expression for current sensitivity and voltage sensitivity of galvanometer. Increase in current sensitivity may not necessarily increase the voltage sensitivity of galvanometer. Justify. 2

12. An electric lamp having coil of negligible inductance 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 (i) capacitance (ii) frequency? 2

13. Find the wavelength of electromagnetic wave of frequency 4×10^{9} Hz in free space . Give its two applications. 2

14. For the same angle of incidence, the angle of refraction in media P, Q and R are 35^0 , 25^0 and 15^0 respectively. In which medium will the velocity of light be maximum. Why? 2

15. Name one device for producing polarized light. Draw a graph showing the dependence of intensity of transmitted light on the angle between polarizer and analyser. 2

16. . The radioactive nucleus 'A' undergoes a series of decays according to the following scheme:

$A \xrightarrow{\alpha} A1 \xrightarrow{\beta} A2 \xrightarrow{\alpha} A3 \xrightarrow{\gamma} A4$ 2

The mass number and atomic number of A are 180 and 72 respectively. What are these numbers for A4.

[OR]

Define activity of radio nuclei, write the S.I. unit. Give the plot of activity of a radioa ctive species versus time.

17. In a common emitter transmitter amplifier the dc current gain β= 65, output resistance is 5000 Ω and internal resistance of the transistor is 500Ω . Find the ac voltage gain and power gain. 2

18. What is the range of frequencies used in satellite communication? What is common between these waves and light waves? 2

19. With a neat diagram, deduce the effect of introducing a dielectric slab in between the plates of a parallel plate's capacitor on the capacitance of a capacitor. 3

20. With the help of circuit diagram, describe a method to find the internal resistance of a primary cell using potentiometer. 3

21. Four identical cells each of emf 2V, are joined in parallel providing supply of current to external circuit consisting of two 15 Ω resistors joined in parallel. The terminal voltage of the cells as read by an ideal Voltmeter is 1.6V. Calculate the internal resistance of each cell. 3

22. Define self-inductance and hence prove that the self-inductance of a long air cored solenoid is

$L = (\mu_0 N^2 A)/\ell$ 3

23. What is the effect on the interference fringes in a Young's double slit experiment due to each of the following operations? Explain with reason

(a) the separation between two slits is increased.

(b) the monochromatic source is replaced by another source of smaller wavelength.

(c) the source slit is moved closer to the double slit plane. 3

24. A proton and an alpha particle are accelerated through the same potential which one of the two has (i) greater value of de-Broglie wavelength associated with it. (ii) less kinetic energy? Justify your answer. 3

25. . (a) Give the relation between decay constant and half-life of a radioactive element. (b) A radioactive substance has a half-life period of 30days.Calculate (i) time takes for ¾ of original number of atoms to disintegrate. (ii) time taken for $\frac{1}{8}$ of the original number of atoms to remain unchanged.

[OR]

Calculate the longest and shortest wavelength in the Balmer series of hydrogen atom.

3

26. Why is modulation required in a transmitter? An audio signal of amplitude 0.1v is used in amplitude modulation of a carrier wave of amplitude 0.2V. Calculate the modulation index. 3

27. Your mother complaints of acute shortage of LPG. You are going to school without having break-fast and without lunch box.

(a) Suggest a possible remedy to cook food in time

(b) What is the principle of such a device? 3

28. . (a). Draw a schematic sketch of a cyclotron. Explain briefly how it works and how it is used to accelerate the charged particles.

(b). Show that the time period of ions in cyclotron is independent of both speed and radius of circular path.

(c) What is resonance condition? How is it used to accelerate the charged particles?

[OR]

(a) Distinguish between the magnetic properties of dia, para and ferro - magnetic substances in terms of (i) Susceptibility (ii) Magnetic permeability (iii) effect of temperature.

(b) Draw the field lines due to external magnetic field near a (i) dia - magnetic

(ii) para - magnetic substance. 5

29. Trace the rays of light showing the formation of an image due to a point object placed on the axis of a spherical surface separating the two media of refractive indices n1 and n2. (a) Establish the relation between the distance of object image and radius of curvature from the central point of the spherical surface. (b). Hence derive the expression for the lens makers formula.

[OR]

(a) State the condition under which the phenomenon of diffraction of light takes place. Derive an expression for the width of central maxima due to diffraction of light at single slit.

(b) A slit of width 'a' is illuminated by a monochromatic light of wave length 700nm at normal incidence. Calculate the value of 'a' for

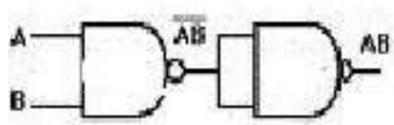
(i) first minima at an angle of diffraction of 30^0

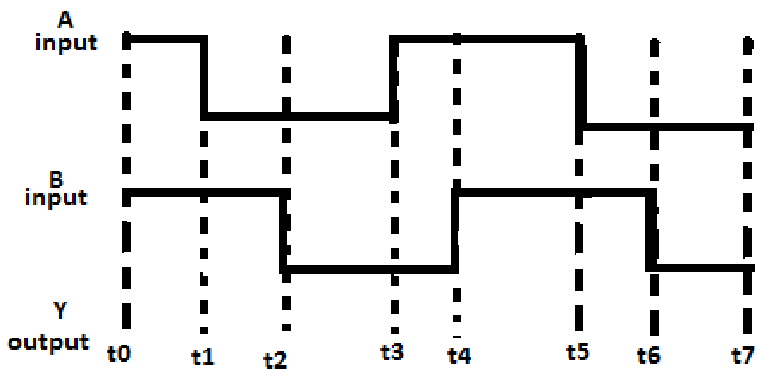
(ii) at first maxima at an angle of diffraction of 30^0 5

30. . Explain the working of a common emitter npn transistor amplifier with the help of a neat circuit diagram. Hence give the expression for the (i) current gain (ii) Voltage gain (iii) Power gain. 5

[OR]

Draw the output wave form at X, using the given inputs A and B for the logic circuit shown. Also identify the logic operations performed by this circuit. Express the output in the truth table for every combination of the given inputs.





input

Kendriya Vidyalaya Sangathan, Patna Region

Sample Paper

Class XII- Physics

General Instructions

h. *All questions are compulsory*
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m. *Question numbers 28 to 30 are long answer type question carrying 5 marks each*
n. *Use log tables if necessary*.

1 Mark Questions

1 What is the value of $A+\overline{B}$ if A=1 and B=0 is Boolean Algebra?

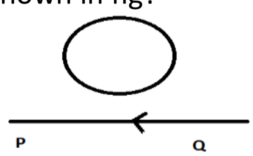
2 Pieces of Cu & Ge are cooled from room temperature to 80 K. What will be the effect on their resistance?

3 Blue light ejects electrons from photosensitive surface while orange light cannot. Will violet & red light eject electrons from same surface?

4 Why does a convex lens of glass refractive index=1.5 behaves as a diverging lens when immersed in Carbon di sulphide of refractive index=1.65?

5 Which types of em waves are used for cellular phones?

6 The electric current passing through a wire in the direction from Q to P is decreasing. What is the direction of induced current in the metallic loop kept above the wire as shown in fig?

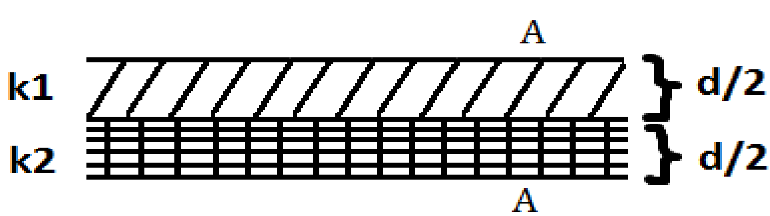


7 An ammeter and mill ammeter are converted from the same Galvanometer, out of two, which should have higher resistance?

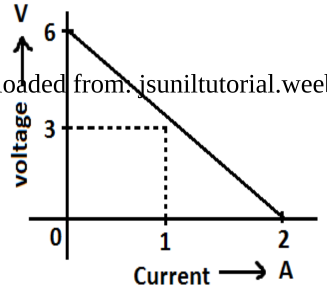
8 Draw a graph of electric field ε (r) with distance r from the centre of shell for 0≤r.

2 Mark Questions

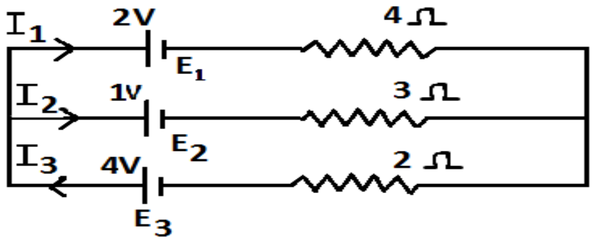
9 Two dielectric slabs of dielectric constant k_1 and k_2 have been put in between the plates of capacitor. Find the equivalent capacitor.



10 The following graph shows the variation of terminal potential V access a combination of three cells in series to a resistor, versus current I , when will the dissipation of the circuit be max?



11 State Kirchhoff rule. Use there rules to determine currents I_1 I_2& I_3

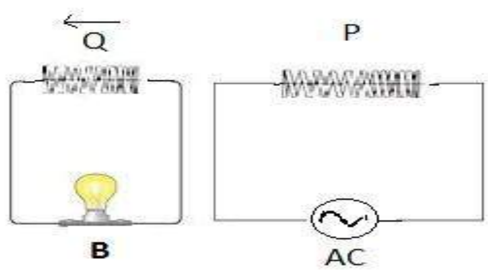


12 A particle of mass m and charge q moves at right angles to a uniform magnetic field. Plot a graph showing the variation of radius of circular path described by it with the increase in its (a) charge (b) kE where in each case other factors remain constant. Justify your answer.

13 A metallic rod of length l is rotated at a constant angular speed ω, normal to uniform magnetic field B. Derive an expression for current induced if the resistance of rod is R.

14 A coil is connected to low voltage Bulb B and placed near another coil P as shown in Fig. Give reason to explain the following observation:

a) The Bulb B lights
b) Bulbs get dimmer if the coil Q is moved towards left.

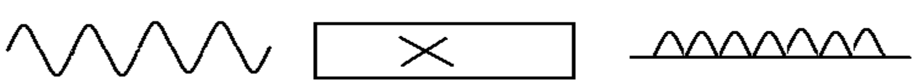


15 Two slits are made 1mm apart and the screen is placed 1m away. What is the fringe width when blue green light of $\lambda \propto 500$ nm is used?
What should be the width of each slit in order to obtain 10 maximum of the double slit pattern within the central maximum of single slit pattern?

16 A plane em wave of frequency 25 MHz travels in free space along X- direction. At a particular point in space & time. E=6.3j V/m. What is B at this point?

17 A TV tower has a height of 100m. How much population is covered by TV broadcast if the Average population density near TV tower is 1500 km^{-2}. (R_e=6.37 * 10^{6}m).

18 Explain the formulation of depletion layer & potential barrier in p-n junction.



If the Input wave form is converted by a device X. Name the device and draw circuit design.

3 Marks questions

19 How long can an electric lamp 100W be kept glowing by fusion of 2 kg of deuterium?

The fusion reaction $H^2{}_1 + H^2{}_1 \rightarrow He^3{}_2 + n^1{}_0$ + 3.27 Mev.

Or

Find the ΔQ factor and KE of α particle in α decay of Ra^{226}_{88}.

(m Ra^{226}_{88} = 22.6.0254 u

M α = 4.00260 u

Rn^{222}_{86} =222.01750 u)

20 An explosion occurred on August 6, 1945 when USA dropped an atom bomb on Hiroshima, in Japan. This resulted in the killing of 66000 persons and injury 69000 persons. About 67% of the city structures smashed. Another nuclear accident occurred in 1986 in USSR resulting in huge devastation. People living in that locality till today suffer from genetic disorders due to gene mutation.

a) Name the nuclear reaction involved in the above case.
b) What consequences do the people living in such areas face?
c) As a responsible citizen, suggest a possible peaceful method to use the nuclear energy.

21 What is momentum, speed and de-Broglie wavelength for an electron having Kinetic Energy 120 eV.

22 What is the principle of Zener diode? How is it symbolically represented? With the help of circuit diagram explain how Zener diode behaves like a Voltage stabilizer.

23 Explain with the help of block diagram explain the detection of an amplitude modulated wave.

24 Draw a labeled ray diagram to show the formation of an image by compound microscope. Write the expression for magnifying power. How does the resolving power of compound microscope change when refractive index of the medium is increased?

25 A series LCR circuit with L=0.12 H , C=480 μF , R=23 ohms is connected to 230V variable frequency supply.

a) What is the source frequency for which the current amplitude is maximum?
b) What is the source frequency for which the average power absorbed by circuit is maximum and obtain the value of this maximum power?
c) What is Q-factor?

26 State Huygene's Principle. Using this principle prove Snell's Law

27 A potential V is applied to a conductor of length L and diameter D, how are the electric field and drift velocity affected

a) When voltage is doubled
b) When length is doubled
c) Diameter is doubled

5 Marks

28 Derive an expression for the intensity at any point on the observation screen in the Young's Double Slit experiment. Hence write the conditions for constructive and destructive interference pattern

Or

Draw a graph to show the variation on (i-d) for prism. Deduce

$$\mu = \frac{\sin\left(\frac{A+dm}{2}\right)}{\sin(A/2)}$$

monochromatic beam of light incident at an angle of 40^0 on prism suffers minimum deviation if the angle of prism is 60^0, find the angle of minimum deviation.

29 Deduce an expression for Electric potential due to an electric dipole at any point on its axis. Mention one contrasting feature of electric potential of a dipole at a point as compared to that due to single change

Or

Write the principle of working of Van de Graaff generator. With the help of labeled diagram describe its construction and working. How is the leakage of charge minimized from the generator.

30 For a circular coil of radius R and N turns carrying current I , deduce the magnitude of magnetic field at a point on its axis at a distance n from its centre.

B=$\dfrac{\mu_0 IR^2 N}{2(R^2 + x^2)^{3/2}}$

a) What will be the magnetic field at the centre of the coil?
b) Consider two parallel coaxial coil of equal radius R and number of turns N, carry equal currents I in the same direction separated by a distance R. show that the field on the axis around the mid-point between the coils is given by
B=0.72 $\dfrac{\mu_0 NI}{R}$

Or

A100 turn closely wound circular coil of radius 10 cm. carries a current of 3.2 A.

a) What is the field at the centre of the coil?
b) What is the magnetic moment of this arrangement?

A coil is placed in a vertical plane and free to rotate about a horizontal axis which coincides with its diameter. A uniform magnetic field of 2 tesla in the horizontal direction exists such that initially the axis of the coil is in the same direction of the field. The coil rotates through an angle of 90^0 under the influence of magnetic field

i) What are the magnitudes of torques on the coil in the initial and final position?
ii) What angular speed is acquired by the coil when it is rotated by 90^0? The moment of inertia of the coil is $0.1 kgm^2$.

KENDRIYA VIDYALAYA SANGATHAN, PATNA REGION

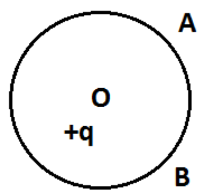
Sample Paper -3

PHYSICS – CLASS XII

General Instructions

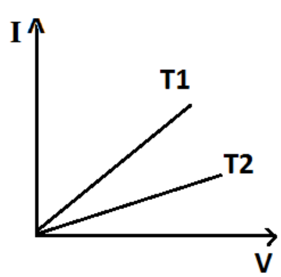
- o. *All questions are compulsory*
- p. *Internal choices have been provided in some questions. You have to attend only one of the choices in such question.*
- q. *Question numbers 1 to 8 are very short answer questions carrying one mark each.*
- r. *Question numbers 9 to 18 are short answer questions carrying two marks each.*
- s. *Question numbers 19 to 27 are also very short answers questions carrying three mark each.*
- t. *Question numbers 28 to 30 are long answer type question carrying 5 marks each*
- u. *Use log tables if necessary*.

1 What would be the work done if a point charge +q, is taken from a point A to the point B on the circumference of a circle drawn with another point charge +q, at the center. 1



2 A carbon resistor is marked in coloured bands of red, black, orange and silver. What is the resistance and tolerance value of the resistor. 1

3 V-I graph for a metallic wire t two different temperatures T_1 and T_2 are shown in figure. Which of the temperatures is higher and why? 1



4 If the magnetic field is parallel to the +ve Y-axis and the charged particle is moving along the +ve X-axis, which way would the Lorentz force be for (a) an electron (b) a proton. 1

5 The power factor of an A.C circuit is 0.5. What will be the phase difference between voltage and current in this circuit? 1

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

Lenses	Power(p)	Aperture(A)

L_1	3D	8 cm
L_2	6D	1 cm
L_3	10D	1 cm

7 Name the phenomena confirming the transverse wave nature of light. 1

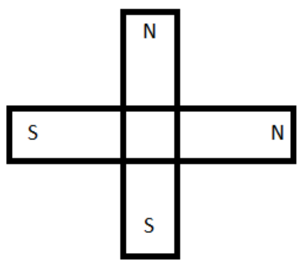
8 Write any two characteristics of nuclear forces. 1

9 Using Gauss Theorem deduce an expression for the electric field intensity at any point due to a thin, infinitely long wire of charge density λ C/m 2

10 If a charge +Q is fixed at a distance ‘d’ in front of an infinite metal plate, draw the electric lines of force indicating the direction clearly. 2

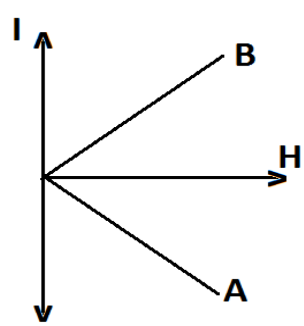
11 Two electric bulbs of 40 W, 220 V & 60W, 220 V are connected in series with a 220 V source. Which of them will glow brighter and why? What will be your answer if they are connected in parallel? 2

12 A hypothetical bar magnet is cut into two equal pieces and placed as shown in the figure. What is the magnetic moment of this arrangement? 2

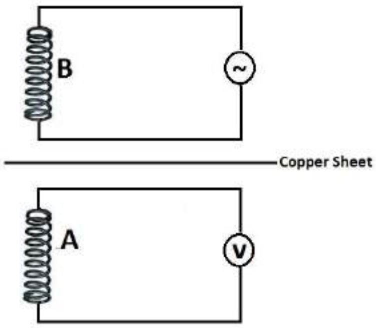


[OR]

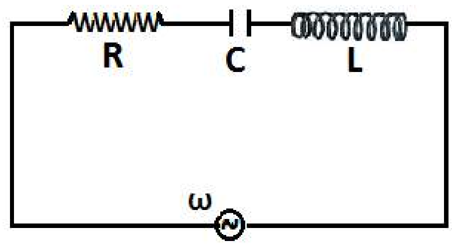
From the graphs identify the types of magnetic materials A, B and hence give an example for each one of them.



13 A coil A is connected to voltmeter V and the other coil B to an alternating current source D. If a large copper sheet C is placed between the two coils, how does the induced e.m.f in the coil A change due to current in coil B? 2



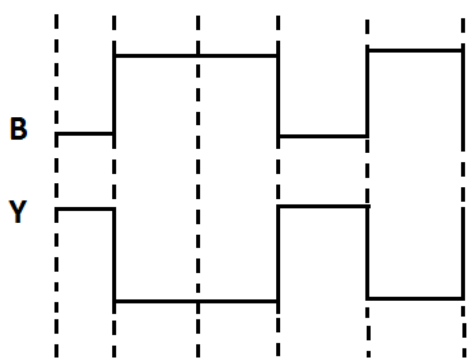
14 In the given circuit, R=10Ω, L=100mH and C=10μF. Find the value of impedance at resonance and the resonant frequency of the alternating emf. 2



15 Two slits in Young's double experiment have width in the ration 81:1. What is the ratio of the amplitudes of the light waves from them ? 2

16 Plutonium decays with a half-life of 24000 years. If plutonium is stored for 72000 years. What fraction of it remains? 2

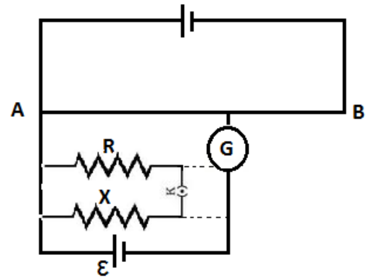
17 An unknown input (A) and the input (B) shown here are used as the two inputs in a NAND gate. The output Y, has the form shown below. Draw the input waveform of 'A' and also write the Truth Table for the given inputs.



18 What are the three frequencies contained in the AM wave. What are LSB and USB. 2

19 Explain the principle of working of a parallel plate capacitor. If two similar plates of each of area A having surface charge densities +σ, - σ are separated by a distance 'd' in air, write the expression for (i) The electric field between the plates (ii) the potential difference between the plates and (iii) capacitance of the capacitor so formed. 3

20 The figure shows a potentiometer circuit for comparison of two resistances. The balancing point with a standard resistance of 10Ω is found to be 58.3 cm, while with the unknown resistance X is 68.5 cm. Determine the value of X. What might you do if you failed to find a balance point with the given cell of emf ε. 3

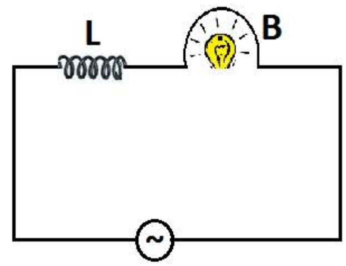


21 An inductor L of reactant X_L is connected in series with a bulb B to an ac. source as shown. Explain how the brightness of the bulb change when 3

(i) The number of turns of the inductor is reduced.

(ii) A capacitor of reactants X_C=X_L is introduced in series in the same circuit.

(iii) Draw a graph showing the variation of inductive reactance with applied frequency.



22 Name Electromagnetic radiations with wavelength 3

(i) λ_1 used to kill germs in water purifiers

(ii) λ_2 used in TV communication systems

(iii) λ_3 play an important role in maintaining the earth's warmth

Also arrange these wavelengths in their ascending order.

23 A concave lens made of material of refractive index n_2 is held in a medium of refractive index n_1. Trace the path of parallel beam of light passing through the lens when 3

(i) n_1=n_2 (ii) n_1<n_2 (iii) n_1> n_2

Or

Differentiate between interference and diffraction patterns. Mention the conditions for sustained interference pattern.

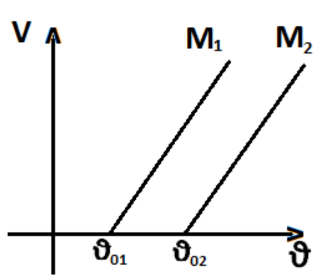
24 Your neighbor is 75 years old person living all alone. Neither he could read the newspaper nor could he goes out. He complains of blurred vision. 3

a. In what way would you help him?

b. Name the type of defect the man suffers from.

c. Suggest a suitable treatment and correction.

25 The given graphs show the variation of the stopping potential V_s with the frequency (ϑ) of the incident radiations for two different photosensitive materials M_1 and M_2 3



26 State Bohr's postulate for the 'permitted orbits' for the electron in a hydrogen atom. Use this postulate to prove that the circumference of the nth permitted orbit for the 3

electron can 'contain' exactly n wave lengths of the de-Broglie wavelength associated with the electron in that orbit.

27 Draw a block diagram for the production of AM wave? Derive the equation for the Amplitude Modulated wave. 3

28
a. State Ampere circuit law 5
b. Derive an expression for the magnetic field at a point on the axis of long solenoid with closely wound turns.
c. Draw magnetic field lines for a current carrying finite solenoid.

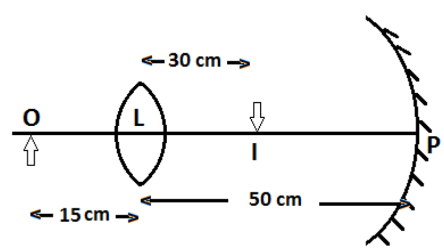
Or

With the help of a labeled diagram, explain the principle, working of a moving coil galvanometer. How can you increase the current sensitivity of the instrument, without making it bulky?

29
a. What is Total internal Reflection? 5
b. What are the conditions for it to occur?
c. Derive the relation between critical angle and refractive index.
d. A ray of light is incident on a glass slab at an angle of 45^0. The refractive index of the glass is 1.6, calculate the angle of refraction and critical angle.

Or

a. If you were driving a car, what type of mirror would you prefer for observing traffic at your back. Give reasons.
b. Why are parabolic mirrors used in search lights?
c. The figure shows the direct image formed by the lens (f=10 cm) of an object placed at O and that formed after reflection from the spherical mirror are formed at the same point O. what is the radius of curvature of the mirror?



30 Draw the circuit diagram used to study the characteristics of an npn transistor in common emitter configuration. Give the shape of these characteristics and use them to define the 5

(i) input resistance & (ii) the current amplification factor of the given transistor.

Or

a. With the help of circuit diagram explain the working of transistor as an oscillator.
b. Explain the action of transistor as a switch.

List of reference books and websites- Physics Study Material

Reference Books

1. Conceptual Physics: Paul G Hewitt
2. Principles of Modern Physics : Arthur Beiser
3. University Physics: Young, Freedman: Addison-WeslyLongman,Inc
4. The Feynman Lectures on Physics: Feynman, Leighton& Sands: Narora Publishing House, New Delhi.
5. Physics Vol I & II: Robert Resnick, David Halliday & Kenreth S Krane : Wiley India
6. Problems in General Physics: I E Irodov : Global Publications
7. Principles of Physics : Brij Lal & Subbramanyam : Eurasia Publication company (Pvt.) Ltd, New Delhi
8. Schaum's Solved Problems Series : Alvin Hulpern : McGraw hill Book Company, New Delhi
9. Conceptual Physics : Paul G Hewitt : Addison – Wesley Publishing Company, California
10. IIT Physics – Tata McGraw Hill

Websites

1. www.plustwophysics.com
2. http://www.sciencedaily.com/
3. www.askphysics.com
4. www.physicsclassroom.com
5. http://www.physicstoday.org/
6. http://real-world-physics-problems.com
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